ANNUAL REPORT

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

OKLAHOMA PADDLEFISH

RESEARCH AND MANAGEMENT

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EXECUTIVE SUMMARY

Statewide management of Oklahoma Paddlefish prioritizes sustainable fisheries in naturally recruiting stocks. Therefore, our regulatory framework provides recreational snagging opportunities with moderated harvest. Management activities in 2024 primarily consisted of standardized winter gillnetting, which encountered 1,845 Paddlefish on three reservoirs- Eufaula, Grand, and Webber's Falls with the assistance of regional management staff and US Fish and Wildlife Service staff. The status of Paddlefish in Oklahoma is overall stable. Multiple observations of recruitment in recent years (i.e., 2017, 2019) have provided stocks with young fish poised to recruit to Oklahoma snag fisheries.

Net catches on Eufaula, Grand, and Webber's Falls provided a diversity of information relevant to management. Recent trends in low and variable Grand Lake catch rates in addition to observations of Paddlefish inhabiting waters deeper than our nets indicated that prior catch rates were an inaccurate surrogate for relative stock abundance. Therefore, statewide standard sampling protocols were substantially modified in 2024 to provide more robust data for informed management of genetic management units. Revised methodologies were designed with a focus on estimation of population abundance. A key management focus in 2025 and beyond will likely be concerned with the potential for snag and release mortality in warmer months. Increased popularity of live imaging sonar has expanded Oklahoma's Paddlefish snagging opportunities and it is now a year-round pursuit. Further, the growth of the licensed guide industry (and assisted by active sonar) may be responsible for a large share of the statewide annual harvest. A deeper examination of existing databases (net catches, harvest / e-check, and angler survey results) provides further perspectives to evaluate the effectiveness of our current harvest regulatory framework in meeting the objectives of our Oklahoma Paddlefish Management Plan.

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INTRODUCTION

The American Paddlefish (*Polyodon spathula*) is the lone survivor of its family Polyodontidae since the declared extinction of the Chinese Paddlefish (*Psephurus gladius*) in 2020 (Zhang et al. 2020). Paddlefish is within the order Acipenseriformes- often regarded as one of the most imperiled groups of freshwater fishes (Paddlefish and sturgeon). Their unique morphology, conservation value, and value to recreational snag anglers make the Paddlefish an important species native to the major river watersheds in Oklahoma (Arkansas, Neosho, Verdigris, Canadian, and Red rivers). Paddlefish are common to abundant in larger rivers and reservoirs in Oklahoma, though primarily restricted to waters East of Interstate 35. Paddlefish are large-bodied, long-lived, pelagic, zooplanktivorous, and migratory, traveling upstream in springtime to spawn. The species primarily inhabits deeper waters within and adjacent to the inundated river channels in the upstream segments of reservoirs and will aggregate in pools or downstream of navigational barriers (both high and natural or artificial low-head dams). Historically, recreational angling for Paddlefish in Oklahoma was restricted to these seasonal aggregations in springtime (Gordon 2009), however, aided by consumer sonar technology, Paddlefish angling in Oklahoma is now a year-round pursuit (Scarnecchia and Schooley 2022).

Paddlefish investigations in Oklahoma by Oklahoma Department of Wildlife Conservation (ODWC) began in the 1960's-70's and continued to 2005, with various studies limited in scope and duration, but primarily focused in the Grand/Neosho River watershed (Houser and Bross 1959; Houser 1965; Combs 1982). Management activities were primarily limited to periodic capture and marking of fish paired with creel surveys at the Miami Park low-head dam fishery on the Neosho River in Ottawa County (for review of earlier studies, see Gordon 2009). With the advent of the Paddlefish Research Center (PRC; formerly the Paddlefish Research and Processing Center until 2012) in 2008, the research and management of Oklahoma Paddlefish intensified as ODWC invested substantial resources and personnel to focus on management of the species. Modeled after smaller programs on the upper Missouri River in Montana and North Dakota, the PRC utilized angler-harvested Paddlefish as study specimens for stock assessment while salvaging roe from female fish for production and sale of caviar to help fund conservation programs (Gordon et al. 2007).

In 2013, ODWC formalized a Comprehensive Plan for the Management of Paddlefish in Oklahoma (Scarnecchia et al. 2013) with ten fundamental hypotheses and eight management goals (see summary in Appendix A). The primary theme for the management of Paddlefish in Oklahoma is the importance of sustainable fisheries for naturally recruiting Paddlefish stocks within a regulatory framework informed by research. Since 2008, ODWC has developed large, long-term databases on Paddlefish stocks across the state, with enhanced focus 2008-2023 on the Neosho River / Grand Lake stock due to its linkage to the spring fishery and caviar production at the PRC.

Paddlefish angling regulations in Oklahoma prioritize opportunity while moderating harvest. Therefore, catch and release fishing is legal year-round during daytime (6am-10pm). The daily harvest limit is one fish (no size limit), and the annual harvest limit is two fish. A Paddlefish permit is required in addition to a fishing license and online harvest reporting is mandatory. Gear restrictions include barbless hooks, one rod per angler, no culling, and no gaffing. Bowfishing for Paddlefish is legal, though release is prohibited. Additional rules exist on harvest tagging, roe restrictions, and transport/export. https://www.wildlifedepartment.com/fishing/regs

RESEARCH AND MANAGEMENT ACTIVITIES / METHODS

Paddlefish Angler Survey: An online survey of 20,052 Paddlefish permit holders was performed in summer 2023 with enhanced focus on harvest assisted by licensed fishing guides. We received responses in part from 2,609 recipients These results will be reported separately in a document reviewing Paddlefish angler surveys 2008-2023. Due to enhanced effort on bowfishing management being prioritized in 2024, the expected completion of this Paddlefish angler survey report is delayed to 2025.

Standardized Paddlefish Winter Gillnetting: Standardized Paddlefish gillnetting was performed on Eufaula (January 2024) and Grand and Webber's Falls lakes (November-December 2024). See lake maps in Appendix B.

Standardized netting methodologies were revised in summer 2024, therefore netting on Eufaula used the old standardized methods whereas Grand and Webber's Falls used the revised protocols. See Appendix C for standardized methods used 2012-2023 and Appendix D for standardized netting protocols revised for 2024.

Once captured and removed from the net, all Paddlefish were measured for body length eye to fork in mm (EFL; Ruelle and Hudson 1977), weighed (kg), assigned sex (male, female, or juvenile), and scanned for a coded wire tag (CWT), which would indicate hatchery origin. For these fish, the tip of the rostrum was removed and retained for later tag extraction, reading, and decoding to determine stocking cohort. All fish ≥3kg were affixed with an individually coded jaw band on the left dentary, anterior to the mesial bend. Jaw band codes were distinct to major watershed (e.g., coded with the prefix "A" for reservoirs on the Arkansas River) and individually numbered (i.e., A12345). Bands were newly affixed for "marked" fish and fish banded in previous years were noted as "recaptures". Jaw bands allowed for the monitoring of individual growth or movements in addition to allowing for estimates of abundance or exploitation when paired with angler harvest recoveries. All fish were examined externally for injuries or deformities and observations were noted (e.g., hook scars).

Bycatch were recorded by species, but not consistently measured or weighed. Bycatch were often sacrificed to supplement ongoing age and growth studies by regional fisheries management crews (e.g., large catfishes) or for studies on nongame life history (e.g., buffalofishes).

All Paddlefish data were entered into a netting database and analyzed for summary statistics including catch rates, average length, weight, and relative weight (W_r) by sex, sex ratios, and frequencies of notations on condition. Histograms of length were examined as an approximator for age in identifying the presence or absence of recruitment. Relative abundance was approximated as catch per unit effort (number of Paddlefish per net per day [24 hrs]) and compared across years within reservoir and among reservoirs. The coefficient of variation of the mean (CV) catch rate was calculated for each standardized sample.

Although Paddlefish are sexually size dimorphic and growth is nonlinear, capture histories of recaptured Paddlefish were examined to estimate average daily growth (within reservoir) between initial capture and subsequent recapture. For hatchery-origin Paddlefish, known-age was back-estimated from coded wire tags (CWT, Figure 1) and a query of the stocking database. von Bertalanffy growth curves were generated for stocks with aged fish and catch curves were used to estimate mortality, where appropriate.

Figure 1. Paddlefish reared at Tishomingo Fish Hatchery are implanted with a coded wire tag (CWT) in the tip of the rostrum prior to stocking. These stainless, magnetized segments of wire are etched with a code unique to the stocking batch and are detectable with a proprietary device (yellow T-wand). CWT examples below represent the variety of observations- legible (left), scratched and faintly legible (middle), and binary coded with notches (right), a deprecated style used in the 1990’s.

<u>Estimation of Population Abundance:</u>

When possible, abundance was estimated for each waterbody using standardized sampling. Fin punches were used as a marking methodology (in addition to the typical jaw bands) to provide a short-term and easily-recognizable mark for Schnabel series population estimation. New standardized protocols (Appendix D) focused on repeated samples over a broad spatial area in each reservoir with the intent to sample a large portion of the standing stock. All fish were marked using a fin punch on the first capture during the sample period (4 days, 5 days, or 8 days). All first captures were considered a “Mark” and subsequent captures of fin-punched Paddlefish were considered “Recaptures” for this abundance estimation. For each gillnet deployed (*G*) on each day, the number of marks (*M*) and recaps (*R*) were totaled and summed across each day (*i...j*). These daily totals were entered into an Excel worksheet at the end of each netting day and the worksheet auto-calculated the Schnabel population estimate (*N*) with 95% confidence intervals. Any mortalities were excluded from estimation.

Schnabel Estimate $$N = \frac{\sum(C_t * M_t)}{\sum R_t}$$

Confidence intervals (95%) were calculated using two methods. When $\sum R_t \leq 50$, upper and lower table values from a Poisson distribution were used in place of $\sum R_t$. When $\sum R_t > 50$, confidence intervals were calculated from a normal approximation using Student's T table, using number of sample days (s-1) as df for Schnabel estimation.

Daily estimates and trends in estimate refinement (i.e., narrowing confidence intervals) on successive sampling days were examined in concert with a parallel examination of variability in catch rate (target CV ≤ 0.20) to determine when catches and estimates are adequate to describe the population abundance and stock composition.

<u>Paddlefish Broodstock Collections and Restoration Stocking:</u>
ODWC and US Fish and Wildlife Service Tishomingo National Fish Hatchery collaborated on broodstock collections from Grand Lake and Keystone Lake for restoration efforts in the Verdigris and Neosho rivers of Kansas. No fish were otherwise directly stocked in Oklahoma waters.

<u>Other Paddlefish Research and Collaborations:</u>
A University of Illinois PhD student, Shasta Kamara, accompanied our netting crews on Keystone Lake in March 2024 to continue research on stress response and movements post-release from commercial netting operations. Blood samples were drawn to assess for levels of stress hormones (e.g., plasma lactate, glucose, cortisol, ions, etc.). Prior to release, a total of 12 fish (5 males and 7 females) were affixed with an accelerometer to the caudal peduncle to track post-release movements. This follows similar efforts on Grand Lake, which examined 18 males and 5 females. The accelerometer was equipped with a quick-release mechanism and a long trailing line affixed to a small float. After 1 hour, the accelerometers were retrieved and re-used on additional fish. These techniques may be useful for assessing immediate post-release movements and stresses of snagged and released Paddlefish in a range of water temperatures.

RESULTS / DISCUSSION

Lake Eufaula

We used the old standardized Paddlefish gill-net sampling protocols (see Appendix C) for Lake Eufaula and encountered a total of 337 Paddlefish. Body length ranged 537-1,153 mm and weight ranged 2.5-31.4 kg. Average catch rates were 47.8 fish/net/day (SE = 9.7, CV = 0.20) for the two sampled arms, combined. Catch rates in the individual arms were 25.0 fish/net/day (SE = 2.4, CV = 0.09) in the Deep Fork and 70.7 fish/net/day (SE = 11.5, CV = 0.16) in Gaines Creek. Male:Female sex ratio was 1.24:1 (179 males, 144 females, and 14 juveniles). Despite our 3.0 kg minimum weight protocol for banding Paddlefish, all juveniles were banded.

Paddlefish catch rates typically increase at upstream sites, which was pronounced in the Gaines Creek arm, but less observed in the Deep Fork arm (Figure 1).

Figure 2. Catch rates for Lake Eufaula generally follow historical patterns of higher relative abundance at upstream sites

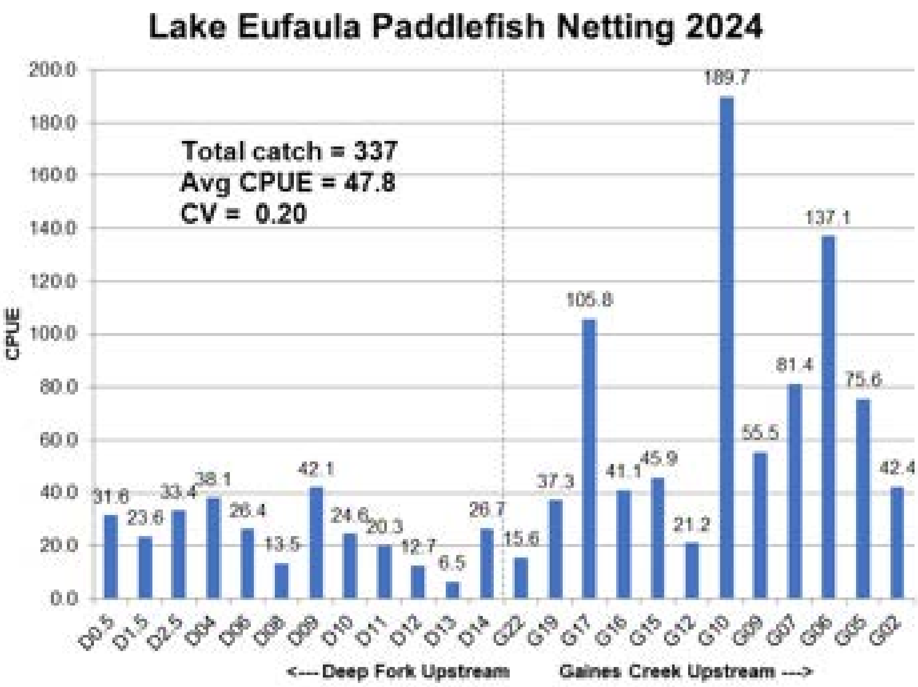


Table 1. Winter Paddlefish netting effort summary for Lake Eufaula

Sample Period	Area Sampled	Total Nets	Total Catch	Catch Rate
January 2013	Entire lake	32	104	10.6 (SE=2.9, CV=0.27)
December 2016	Entire lake	16	72[1]	20.1 (SE=5.6, CV=0.28)
November 2018	Entire lake	10	35	16.9 (SE=2.4, CV=0.14)
January 2021	Entire lake	20	53	8.9 (SE=2.7, CV=0.30)
January 2022	Deep Fork & Gaines Creek	24	377	61.4 (SE=10.3, CV=0.17)
January 2023	Deep Fork & Gaines Creek	23	303	40.0 (SE=7.1, CV=0.18)
January 2024	Deep Fork & Gaines Creek	24	337	47.8 (SE=9.7, CV=0.20)
Totals		149	1,281	

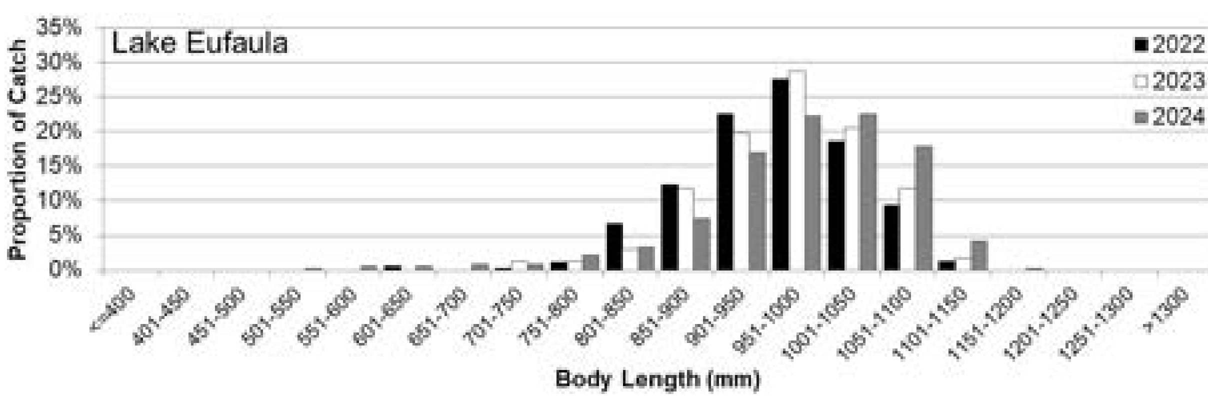
Table 2. Lake Eufaula Paddlefish catch summary 2024

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	179	175	4	964	16.8	106.7
Female	144	134	10	1,019	20.5	101.7
Juvenile	14	14	0	676	4.9	-
Totals	337	323	14			

Table 3. Lake Eufaula Paddlefish combined catch summary from previous years (2013-23)[2]

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	507	501	6	936	15.5	107.3
Female	353	350	3	996	19.5	102.5
Juvenile	16	16	0	700	5.8	-
Unknown	55	55	0	861	11.1	
Totals	931	922	9			

Figure 3. Size structure of Lake Eufaula Paddlefish comparing 2022, 2023, and 2024 catches



Size structure observed 2022-2024 (Figure 2) reflects a population typical of restoration stocks, which consists of mature, growing individuals with very few Paddlefish captured below the size at maturity (approximately 750 mm). Given that this reservoir was stocked for restoration 2007-2017 (n = 217,280; see Appendix E for a summary table of Oklahoma Paddlefish restoration stocking), we would expect few small fish to exist in the stock unless the population were recruiting naturally. However, the catch includes a growing segment of smaller fish, which were unlikely (in previous collections) or impossibly (2023-2024) stocked fish based on expectations of growth rate.

[1] A subset (n=12) of Paddlefish captured in 2016 were not weighed or measured due to darkness.
[2] Data exclude 12 unsexed fish from 2016 (one M, 1 R, and 10 not processed) and one unsexed fish from 2021.

Figure 4. Percent of Lake Eufaula Paddlefish catch for "immature fish" (≤750 mm) for 2022-2024

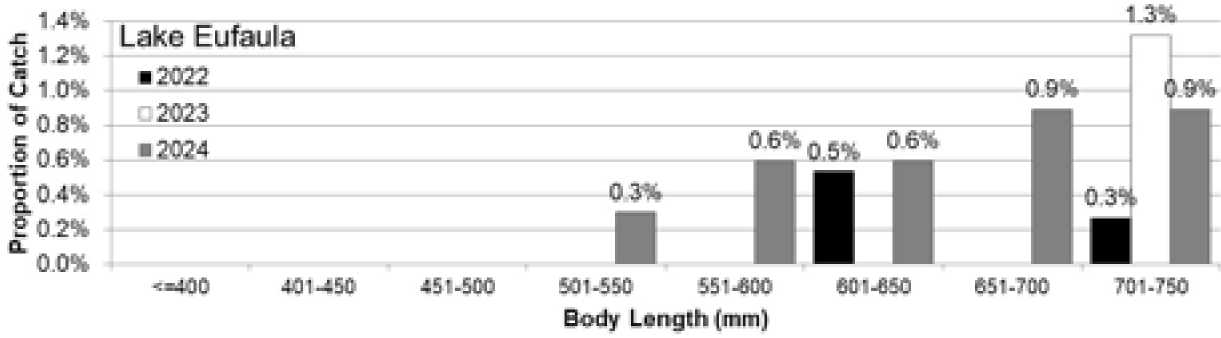
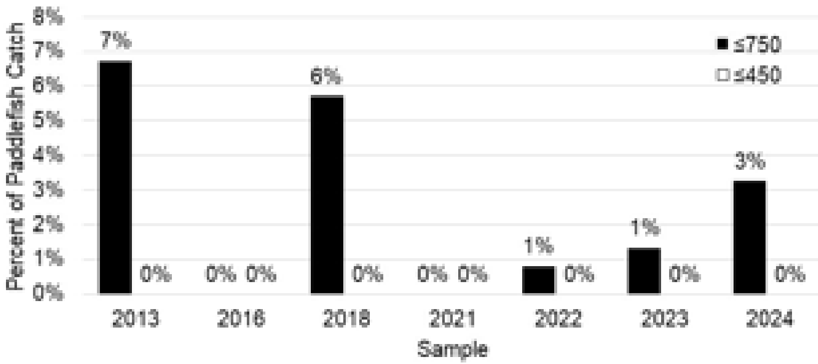


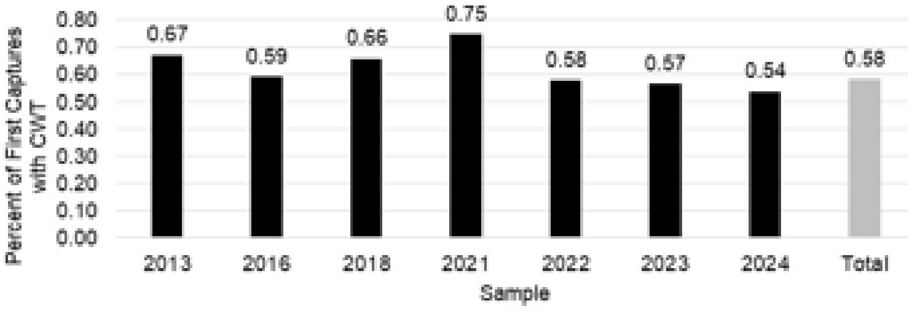
Figure 5. Percent of Lake Eufaula Paddlefish catch for "immature fish" (≤750 mm) and presumptive age-1 fish (≤450 mm). Bars represent fish grouped by size only, and data are irrespective of sex ID (M, F, J). Although no fish ≤450 mm have been encountered even during active stocking 2006-2017, a progressive increase in the population segment ≤750 mm during 2022-2024 reflects putative, though low, natural recruitment in this restoration stock.



A total of 173 (54%) Paddlefish first-captured[3] in Lake Eufaula in 2024 were detected with a coded wire tag (CWT) indicating hatchery origin and the rostrum tips were retained for later extraction, decoding, and database query. However, it cannot be assumed that the 46% of fish without a CWT are of wild origin, as loss is known to be high for CWT used in certain circumstances and species. Loss of CWT in hatchery-reared Paddlefish has been documented to range from 71% in concrete raceways (Pitman and Isaac 1995) to 10% in circular fiberglass tanks (Fries 2001) to <3% in pond culture (Guy et al. 1996), where presumably Paddlefish less frequently bump their rostrum tip on their enclosure. The rate of tag loss at Tishomingo National Fish Hatchery, which uses a combination of raceways and circular tanks, is not known, however the mechanism of tag loss is presumed to be confined within the period of hatchery residence and is assumed to be zero post-stocking. Prevalence of CWT in the Lake Eufaula catch has varied (Figure 5), with the 2024 catch representing the lowest observation to date.

[3] As recaptures are often recorded with a rostrum notation on the healing of "old CWT" removal wounds, only first captures are considered when examining the prevalence of CWT in the catch.

Figure 6. Percent of first-capture Paddlefish on Lake Eufaula with CWT detected, indicating hatchery origin

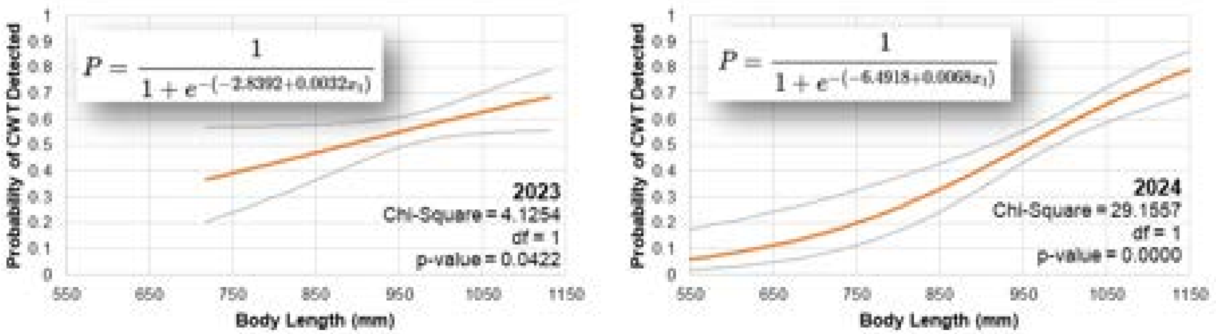


Our catches of young Paddlefish on Lake Eufaula, well-after the culmination of stocking supports a hypothesis of natural recruitment in this restoration stock. However, it is not known whether recruitment is a new phenomenon, or if it has been occurring within the period of restoration stocking (though presumably after the first repatriated Paddlefish reached sexual maturity in approximately 2012-2015). To begin examining this, we can model the detection of CWT related to body length using logistic regression, where the probability of a fish being captured with a CWT is influenced by fish size.

Using data from 2013-2016 (i.e., during the stocking period) compared to 2023-2024 (i.e., well after the stocking period), we would predict that smaller fish would have a lower probability of having a CWT in 2023-2024 than they would in 2013-2016. When probability of CWT detection was modeled against body length independently for 2013 and 2016, the models were found to be non-significant (X^2 = 2.8214, df = 1, p-value = 0.093 and X^2 = 0.0261, df = 1, p-value = 0.872, respectively). This would support a hypothesis that most, if not all catches are hatchery origin fish and any tag loss was instantaneous (i.e., prior to stocking) and not related to fish size or age.

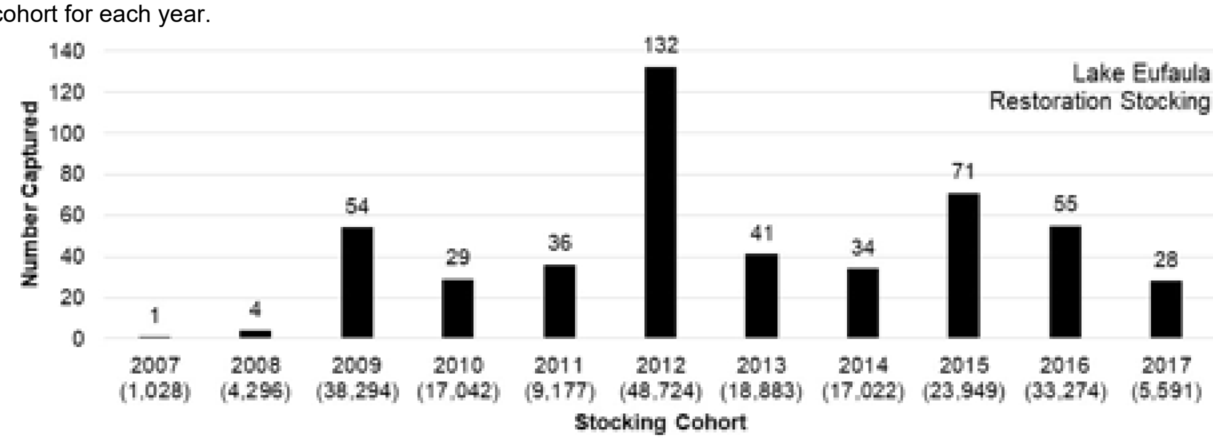
However, significant models for 2023 and 2024 were independently produced (Figure 6). In contrast to 2024, the 2023 model was not well-informed by data from small fish, as the smallest fish in that dataset was 718 mm. In 2023, 16 fish were captured <850 mm and five of these (31%) had wire tags. In 2024, 29 fish were captured <850 mm and only two of these (7%, 726 mm and 832 mm) had wire tags. Based on these limitations, direct comparison of the two models is generally restricted to fish ≥750 mm. The 2024 model predicts that a 750 mm Paddlefish has only a 20% probability of being hatchery-origin (presuming no tag loss). This estimate lies outside of the confidence interval of the 2023 model (though the two models' 95% confidence intervals overlap), which predicts double the probability at approximately 40%. Independent examination of the 2024 model supports the hypothesis that small fish captured have a very high probability of being wild recruits (e.g., ~95% probability for 550 mm fish and ~90% for 650 mm fish). As monitoring of the Lake Eufaula stock continues and logistic models are updated, we would expect the slope of the curve to increase and the asymptote to shift to the right, such that progressively larger fish would have higher probabilities of being wild recruits.

Figure 7. Logistic regression models for Lake Eufaula Paddlefish 2023 (n = 299) and 2024 (n = 323) catch data. Model curves are depicted in orange with 95% confidence intervals in grey. Capture of smaller fish in 2024 allowed for development of a model for a larger size range.



Within the 2024 catch with CWT, a subset (124[4]) were successfully dissected, readable, and linked to stocking records (see Appendix E), allowing the fish to serve as known-age individuals for examination of length at age, growth rates, and other population metrics. Five fish were captured bearing healed evidence of previous removal of rostrum tip. These data were appended to a known-age Paddlefish database for analyses. To date, we have recovered and decoded 485 CWT from fish stocked in Lake Eufaula (Figure 7), with a general pattern of higher recoveries from larger stocking cohorts and all stocking cohorts are represented by at least one recovery.

Figure 8. Count of Paddlefish captured in Lake Eufaula from each restoration stocking cohort. The total number of Paddlefish stocked for each year is noted in parentheses (grand total n = 217,280). Multiple stocking events occurred per year, and they varied in average length at stocking, however these stockings are pooled into a single production cohort for each year.



Due to the inconsistent seasonality of Lake Eufaula collections, development of the length at age models was restricted to fish captured 2021-2024. All these fish were captured in January and fish are considered to be hatched in their stocking year (e.g., a fish stocked in 2017 and captured in 2021 would be four years old). Inconsistencies in detection of CWT has resulted in some fish being captured and banded with no detected CWT, but later recaptured and detected with CWT. Therefore, only the date at first capture and length at first capture were used for consistency. In total, valid records for 479 known-age Paddlefish have been accumulated for

[4] Total excludes a batch of 16 CWT belatedly discovered in a freezer after analyses were completed and written for this report. All 16 were successfully dissected and decoded. These fish will be included in future analyses.

Lake Eufaula (278 males, 200 females, and 1 juvenile). Separate length at age models were developed for each sex and the juvenile was excluded.

Figure 9. Average length at age for hatchery origin Paddlefish captured on Lake Eufaula 2021-2024

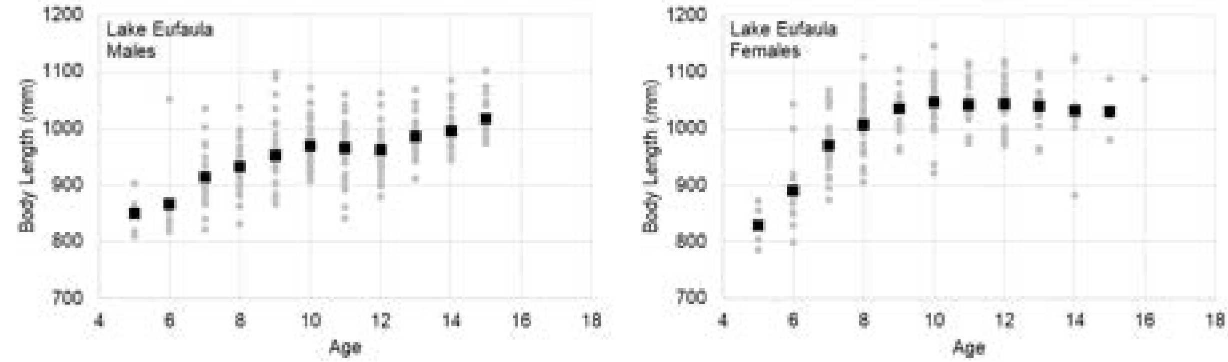


Figure 10. Von Bertalanffy growth curves modeled for Lake Eufaula Paddlefish (male- left, female- right) using the Oklahoma Fisheries Analysis Tool. Model development was informed by 2024 netting data and 2021-2024 sex-specific age data.

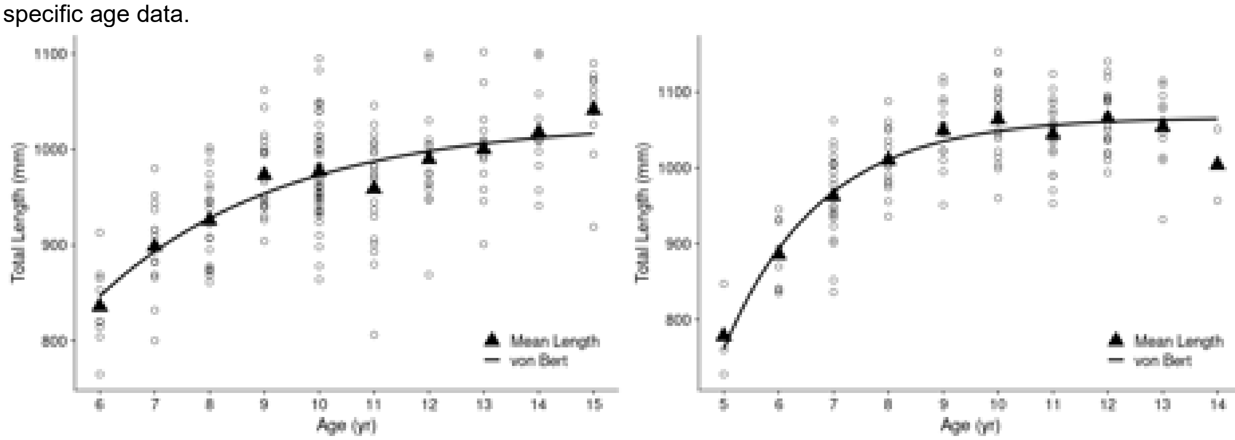


Table 4. Coefficients (with 95% CI) for von Bertalanffy growth equations for Lake Eufaula male and female Paddlefish

Coefficient	Male Paddlefish	Female Paddlefish
L_∞	1,029 (1,000-1,107)	1,067 (1,053-1,082)
K	0.29 (0.13-0.49)	0.57 (0.44-0.70)
t_0	0.14 (-5.79-2.50)	2.80 (1.96-3.35)

Due to the absence of small, known-age fish in addition to the absence of large fish (i.e., those older than the onset of stocking in the lake), the growth models depicted above should be interpreted with caution. Oklahoma Paddlefish have been aged to 30 years and are known to grow to >1,300 mm in body length. We would expect, based on the notable sexual size dimorphism of Paddlefish, that maximum size would differ to a greater magnitude than these models suggest. For example, Scarnecchia et al. (2011) reported L_∞ values for male and female Paddlefish from Grand Lake as 968 mm and 1,336 mm, respectively. However, low densities and an abundance of zooplankton resources (evident in *Wr*; see below) may result in growth patterns divergent from those observed in Grand Lake. A more thorough dataset including younger and older fish will allow for more meaningful interpretation of the population dynamics of Lake Eufaula Paddlefish.

The size and age truncation of this stocked population in Lake Eufaula renders catch curve modeling of mortality problematic, therefore this exercise was not completed.

Additional notations on condition of Paddlefish encountered in Lake Eufaula included hook scars (13 fish, 4%), prop scars (three fish, 1%), or rostrum injuries/deformations (eight fish, 2%). These low frequencies of scars and injuries likely indicate that the stock is not heavily pressured by snag angling.

Relative weights of Paddlefish vary across Oklahoma stocks, with exceptional individuals exceeding 100. *Wr* for males for both sexes in Lake Eufaula exceeded 100 (Table 2), indicating that the population is not limited by availability of zooplankton prey. An examination of gonadal fat bodies (GFB) and gonadosomatic index (GSI) with known ages (from CWT) and estimated ages (from dentary bones) would be a valuable investigation if harvested fish from this restoration stock were available in the future.

Thirteen Paddlefish caught in Lake Eufaula in 2024 were recaptures from previous collections (Table 3) in addition to another five recaptured in prior years. Time at large ranged from approximately one to seven years. All fish showed positive growth in length with the exception of one male whose mark and recap length measurements differed by one millimeter, well within the likely variance of measurement error. All but three fish showed positive growth in weight except for two females and one male who weighed less at recapture. It is plausible that the two females (differences of 3.2 kg and 1.35 kg) may have been gravid at first capture and in a period of gonadal recrudescence at recapture, therefore weighing less. The male weighed 0.5 kg less at recapture, which may be within the margin of error when weighing a live fish on a watercraft in motion. Regardless, the estimated average daily growth rates from Lake Eufaula Paddlefish are comparable to those of Grand Lake.

Table 5. Back-calculated daily growth rates of Lake Eufaula Paddlefish recaptured in 2024 (upper table) and previous years (lower table). For fish of confirmed hatchery origin, stocking cohort is noted.

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex	Cohort
C00204	12/11/16 (G03)	1/24/24 (G07)	2,599	0.053	2.432	M	
C00280	1/10/22 (D05)	1/23/24 (G16)	743	0.097	4.078	F	
C00400	1/14/21 (S12)	1/23/24 (G15)	1,104	0.032	2.880	F	
C00678	1/11/22 (D09)	1/24/24 (G07)	743	0.043	3.943	F	2009
C00870	1/13/22 (G13)	1/24/24 (G02)	741	0.047	0.175	M	2014
C00896	1/12/22 (G10.5)	1/24/24 (G10)	742	0.031	1.550	F	2012
C00902	1/13/22 (G19)	1/23/24 (G19)	740	0.084	6.081	M	2015
C00918	1/12/22 (G10.5)	1/24/24 (G06)	742	0.032	0.404	F	2014
C00936	1/12/22 (G08)	1/10/24 (D09)	728	0.155	9.615	F	
C00985	1/12/22 (G06)	1/24/24 (G05)	742	0.013	-1.819	F	
C03261	1/11/23 (G09)	1/24/24 (G05)	378	0.026	-11.111	F	
C03372	1/10/23 (G22)	1/24/24 (G02)	379	0.071	1.953	M	
C04196	1/13/23 (D14)	1/10/24 (D09)	362	0.135	3.453	F	2016
Average:			826	0.063	1.818		

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex	Cohort
C00302	1/11/21 (D03)	1/13/22 (G15)	367	0.052	-1.362	M	
C00305	1/11/21 (D03)	1/10/22 (D07)	364	-0.003	0.275	M	
C00279	1/11/22 (D10)	1/10/23 (G21)	364	0.014	1.923	F	
C00820	1/12/22 (G10.5)	1/11/23 (G09)	364	0.203	5.632	F	2017
C00986	1/12/22 (G09)	1/11/23 (G11)	364	0.146	2.390	F	2016
Average:			365	0.082	1.771		
Overall Average:			698	0.068	1.805		

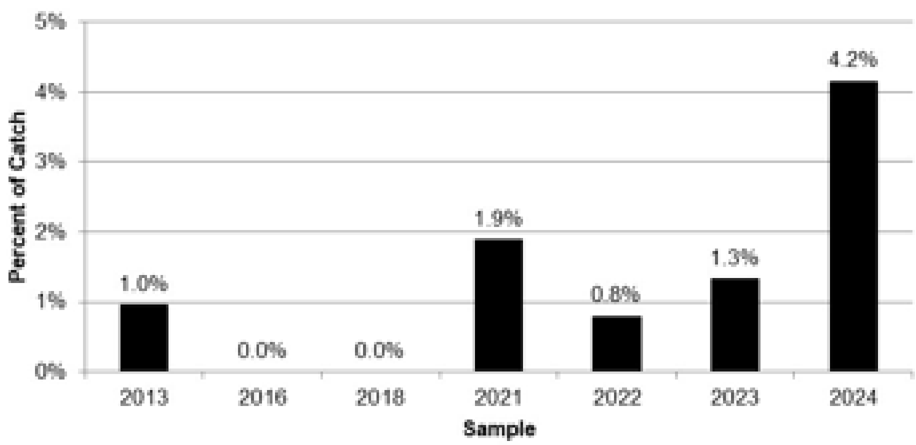
The marking and subsequent recapture of individual Paddlefish also provides the ability to examine movements and habitat selection. Although Paddlefish are known for their long distance, migratory, riverine movements, three fish were recaptured in Lake Eufaula in very close proximity to their initial capture (Table 4). For example, fish C00896 was marked at site G10.5 and recaptured 742 days later at site G10, only 0.18 miles (0.29 km) away. Fish C00902 was marked at site G19 and recaptured 740 days later at the exact same location. And fish C00985 was marked at site G06 and recaptured 742 days later at site G05, only 0.69 miles (1.1 km) away. Given the size of Lake Eufaula, these observations indicate that at least a portion of the population (3 of 18, 17%) may be demonstrating some site or habitat fidelity. In contrast to these putatively small home ranges, another fish C00678 was marked and later recaptured approximately 30 miles (48 km) between sites D09 and G07, respectively.

Though Paddlefish were stocked in Lake Eufaula at chiefly one location (Cardinal Point in upper Gaines Creek), capture of the fish at other locations in the lake indicates that the fish can and do move about freely. However, in the examination of marking locations compared to recapture locations for individual fish, some interesting trends emerge. Although most fish initially captured in Gaines Creek were secondarily recaptured in Gaines Creek, this phenomenon was reduced for fish in the Deep Fork (Table 5). These fish captured in the Deep Fork have already potentially dispersed away from Gaines Creek post-stocking. However, most fish initially caught in the Deep Fork have been recaptured after having returned to Gaines Creek. It would likely be premature speculation to hypothesize motivation for these movements, however, additional habitat and hydrology studies on the Deep Fork and Gaines Creek are currently underway. Also, as standardized collections accumulate more recaptures of individual fish (Figure 5) in these two major lake arms, more robust interpretation of findings on growth, movements, habitat use/selection in Lake Eufaula will be possible.

Table 6. Paddlefish movement in Lake Eufaula. For the 18 recaptured Paddlefish described in above Table 4, a disproportionately high fraction of fish originally captured in Gaines Creek (90.9%) were recaptured in Gaines Creek, whereas a much lower fraction of fish originally captured in the Deep Fork (33.3%) were recaptured in the Deep Fork.

		Recap. Loc.		
		Deep Fork	Gaines Creek	
Mark Loc.	Deep Fork	2	4	6
	Gaines Creek	1	10	11
	Other	0	1	1
		3	15	18

Figure 11. Percent of Lake Eufaula Paddlefish for recaptures (i.e., fish captured and marked with a jaw band in previous collections). Typically, studies on wild populations with >10% of individuals marked can provide robust estimates of population abundance. In the absence of recruitment, we would expect the percentage of recaptures to increase consistently and rapidly, unlike that observed on Grand Lake (Figure 17).



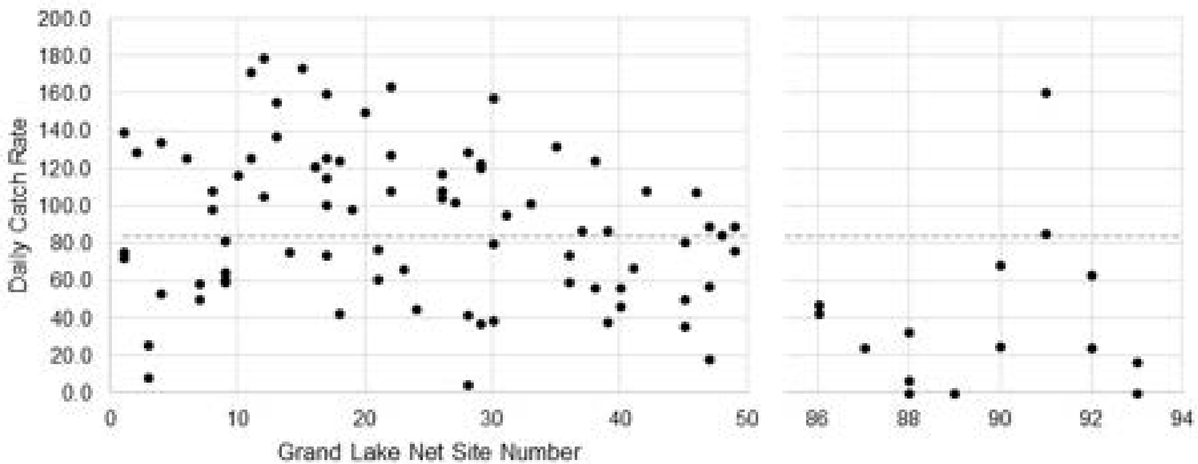
Bycatch encountered in standardized Paddlefish gillnets on Lake Eufaula included Blue Catfish, Bigmouth Buffalo, Smallmouth Buffalo, and Flathead Catfish.

Grand Lake

We used new standardized Paddlefish gill-net sampling protocols (Appendix D) for Grand Lake and encountered a total of 1,169[5] Paddlefish in 96 nets. Body length ranged 600-1,190 mm and weight ranged 2.6-30.0 kg. Average catch rates were 83.8 fish/net/day (SE = 4.6, CV = 0.05), ranging 4.7-178.9 [excluding three nets with zero catches]). Male:Female sex ratio was 1.6:1.

Paddlefish catch rates in Grand Lake typically increase at upstream sites. Despite some variable catches, this pattern was generally realized. Sites 10-20, which span the area above Gray's Ranch to approximately the mouth of Wolf Creek, had consistently high catches (16 of 19 samples with above-average catch rates). Off-channel sites (i.e., Elk River, Wolf Creek, and Honey Creek) had generally lower than average catches. Overall, the randomly selected sites (12 sites per day over 8 days) provided adequate spatial coverage resulting in remarkably consistent catch rates.

Figure 12. Catch rates for Grand Lake were variable (with average catch rate 83.8 indicated by the dashed line), but generally followed historical patterns of relative abundance with upstream sites (particularly sites 10-20) with higher catches. Main channel sites (numbered 1-49) generally had higher catch rates upstream. With only two exceptions at site 91, all side-channel sites (e.g., Elk River 86-89, Wolf Creek 90, and Honey Creek 91-93) had catch rates below the average, irrespective of their upstream or downstream position in the system.



[5] Total catch includes 13 fish captured twice.

Figure 13. Historically, spatial patterns of relative abundance would predict higher catches in upstream sites in addition to an overall greater catch rate, however this pattern was disrupted in 2019-2020 and, to a lesser extent, 2023-2024.

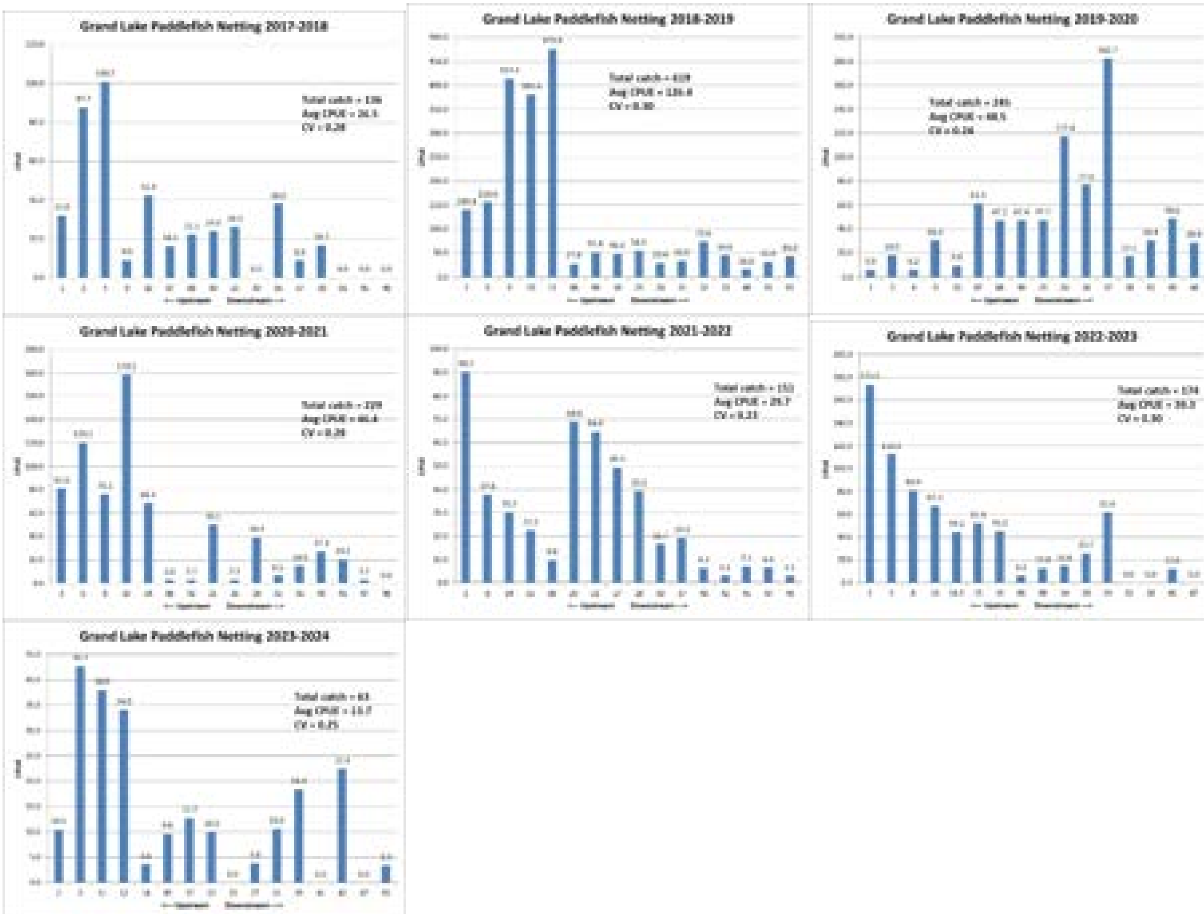


Table 7. Grand Lake Paddlefish catch summary 2024-25

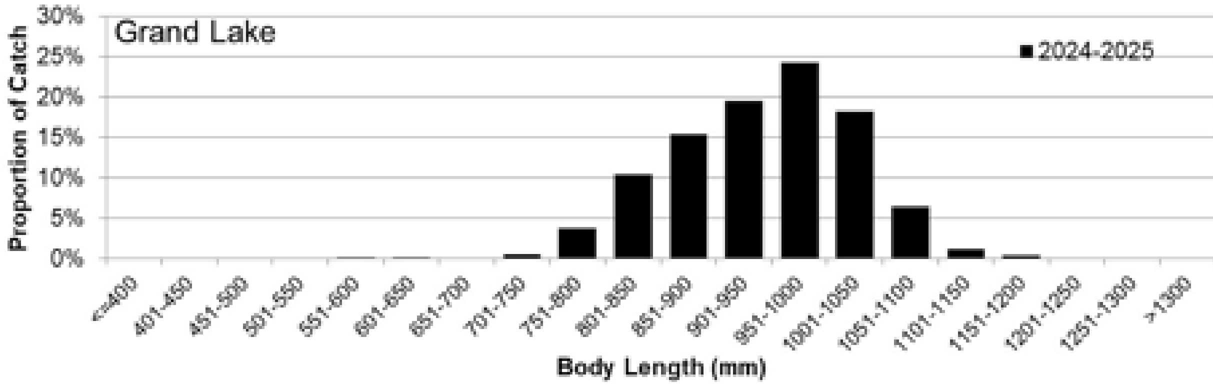
Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	704	650	54	936	13.2	91.0
Female	430	419	11	961	15.6	89.7
Juvenile	12	12	0	748	5.7	-
Totals	1,146[6]	1,081	65			

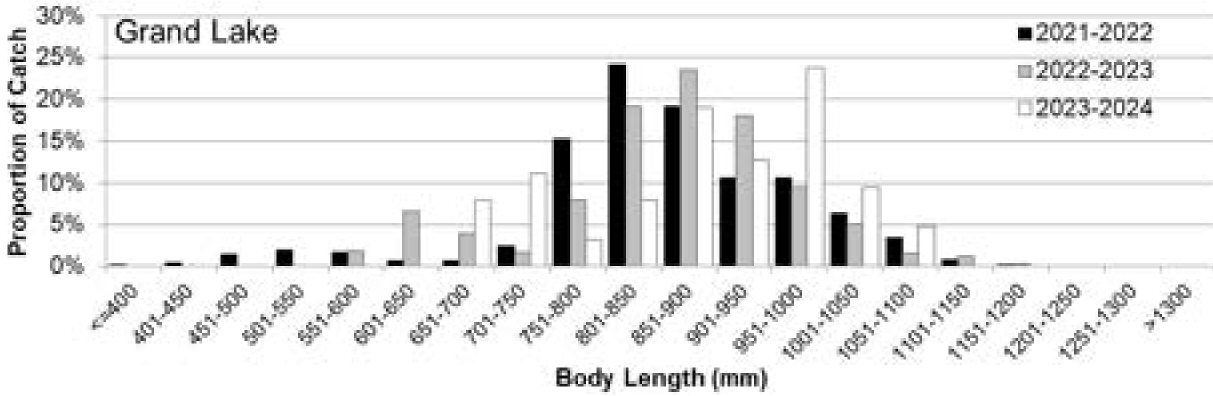
Table 8. Grand Lake Paddlefish combined catch summary from previous years (2011-24)

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	5,887	5,328	556	936	14.2	97.9
Female	3,020	2,846	173	962	16.4	92.0
Juvenile	2,183	1,102	4	616	3.5	-
Unknown	92	91	1	782	7.6	-
Totals	11,182	9,367	734			

[6] Capture total excludes 13 fish captured two times, which were used for population abundance estimation, but not weighed and measured twice.

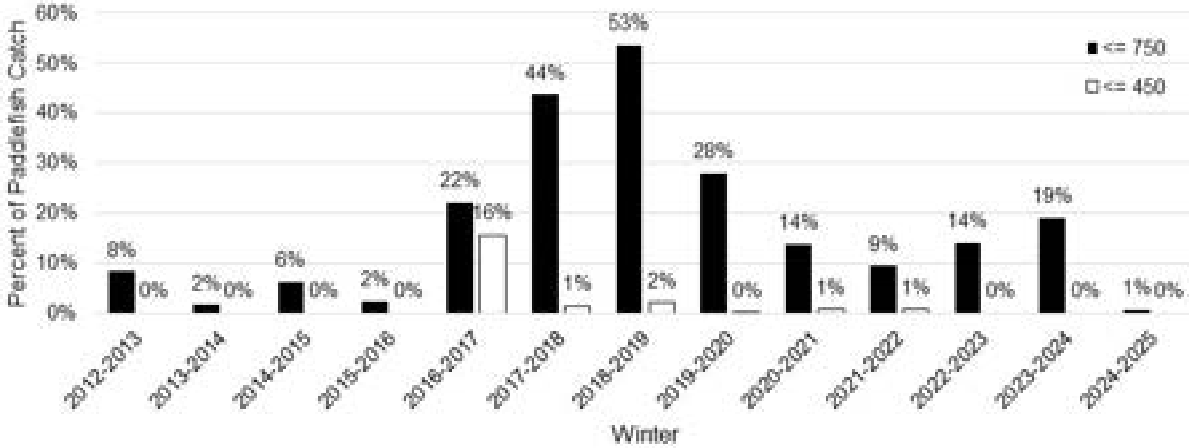
Figure 14. Size structure of Grand Lake Paddlefish catch. For comparison, size structure from the previous three winters is also included. The anomalous distribution in 2023-2024 is due to low sample size.





Population size structure observed in 2021-24 likely reflects recruitment in 2019 and the continued somatic growth of this year class from 601-650 mm (2022-23) to 651-750 mm (2023-24). Continued growth of this cohort has made them indistinguishable from the remainder of the stock. Long-term trends in Grand Lake indicate that medium-to-large recruitment events are readily detectable when the fish are age-1. Though the yearling Paddlefish are far too small for our large mesh gillnets to accurately assess their abundance, we do catch age-1 Paddlefish when they are present. Based on additional trawl collections and information from Paddlefish anglers in 2016, we know that a large recruitment event occurred in 2015. This was the first observation of a large successful recruitment on record since 1999. As reflected in our standardized netting catch, the detection of age-1 Paddlefish was evident in winter 2016-2017 (efforts in December 2016). We know that spawning and recruitment occurred in 2015, 2016, 2017, and 2019 due to hydrology characteristics, the observation of spawned out females in the spring harvest, and the eventual detection of age-1 recruits. However, the netting results indicate that the strength of those cohorts was far from equivalent, with substantially more age-1 Paddlefish captured from the 2015 spawn. Therefore, the remaining spawn years observed in recent years likely represent a typical low-level of recruitment punctuated by episodic large cohorts, as is known to be typical for the species in Oklahoma and elsewhere (Scarnecchia et al. 2011, 2014). Conservative harvest regulations as currently implemented by the Department (e.g., daily limit of one, annual limit of two) are designed to buffer against population depletion through harvest during periods of low recruitment. The absence of yearling Paddlefish in the 2024-25 catch is not remarkable considering the low observation rate in previous years.

Figure 15. Percent of Grand Lake Paddlefish catch for “immature fish” (≤750 mm) and presumptive age-1 fish (≤450 mm). Bars represent fish grouped by size only, and data are irrespective of sex ID (M, F, J).

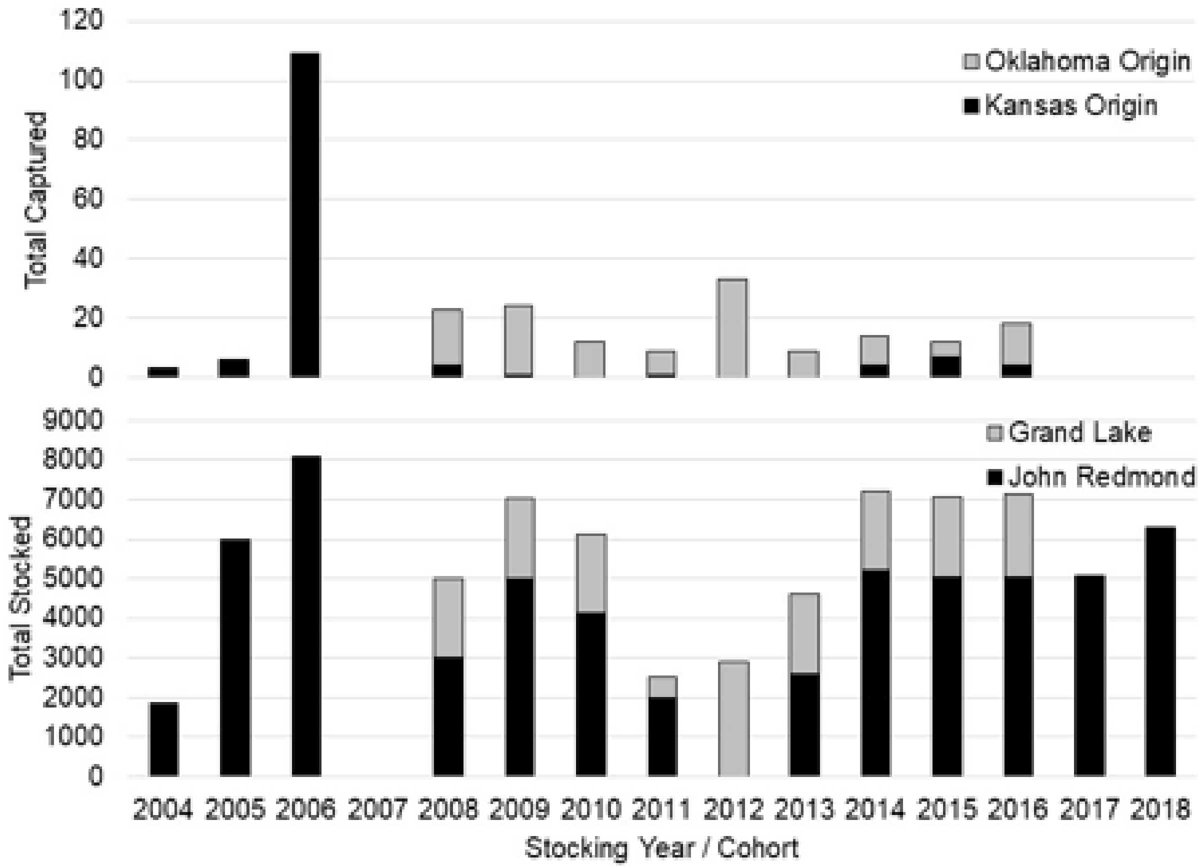


Seventeen Paddlefish captured in Grand Lake were detected with a coded wire tag (CWT) indicating hatchery origin and the rostrum tips were retained for later extraction, decoding, and database query. Three of these fish were recaptures, indicating that the tags were not detected when initially captured and marked with jaw bands. two additional Paddlefish were recaptured displaying a healed rostrum tip following previous removal of a CWT. Detection of hatchery-origin Paddlefish is not uncommon in Grand Lake, as there is a long-term restoration stocking program on the upper Neosho River in John Redmond Reservoir in central Kansas and these fish readily migrate downstream. Also, several experimental stockings have occurred in Grand Lake (i.e., not for restoration purposes; see Appendix E).

Due to malfunctions of one of the two T-Wands (CWT detector), not every fish was scanned for CWT December 17-19, 2024. The upstream crew was anticipated to have higher catches, therefore they used the working T-Wand and the downstream crew did not scan their catch. This likely resulted in the failure to detect one or more fish with CWT.

Decoding of the CWT removed from Paddlefish netted in Grand Lake December 2024 will occur in 2025. However, previous CWT captures from Grand Lake are summarized here. A total of 272 Paddlefish encountered in nets or harvested at the PRC were successfully decoded and linked to stocking records. Due to database inconsistencies after 2017, an additional ~40 Paddlefish have unconfirmed origins and are not included here. These fish have origins in approximately 77,000 Paddlefish stocked into John Redmond Reservoir (59,000) on the Neosho River in Kansas or directly into Grand Lake (17,500). The largest proportional returns (n=109) have been from the 8,000 fish stocked into Redmond in 2006, however, since 2008, most CWT recoveries in Grand Lake have been fish stocked directly into Grand Lake (Figure 16).

Figure 16. Summary of Grand Lake Paddlefish CWT captures with stocking origin 2004-2018.



Additional notations on condition of fish encountered included hook scars (277 fish, 24%), prop scars (11 fish), or rostrum injuries/deformations (32 fish). Fourteen fish were recaptured bearing scars suggesting that their jaw bands were removed, therefore their identities were unknown, and they received new bands. One fish was recaptured with an opercle tag from 2018, when approximately 200 Paddlefish were double tagged (jaw and opercle) to examine tag loss/removal.

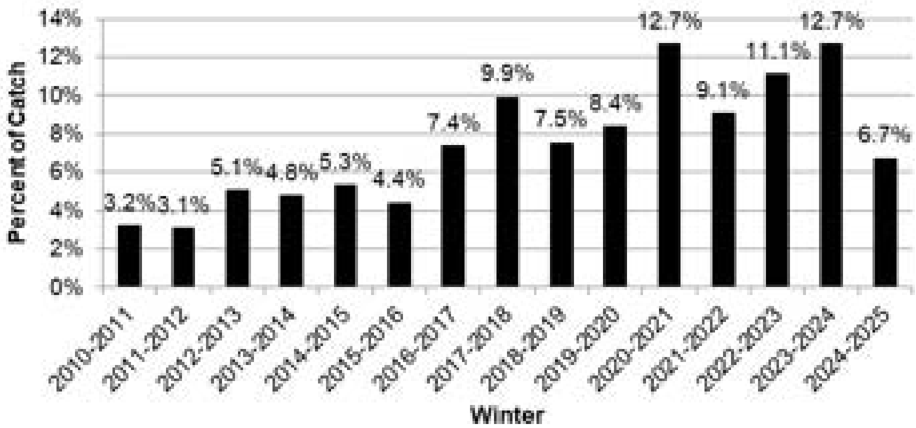
Relative weights of the Grand Lake stock are typically in the 90's with exceptional individuals exceeding 100. *Wr* for both sexes was lower than historical trends. Additional examination or statistical analyses may be warranted to examine whether condition is declining.

Sixty-one Paddlefish caught in Grand Lake were recaptures from previous collections. Due to the high number of recaptures, these fish were not examined individually, but growth rates were summarized by sex (Table 9). A record of marking for one female was not found in the database, therefore it is excluded below.

Table 9. Average back-calculated daily growth rates of Grand Lake recaptured Paddlefish, grouped by sex.

Sex	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)
Male (52)	1,829	0.034	0.431
Female (8)	1,551	0.096	3.751

Figure 17. Percent of Grand Lake Paddlefish for recaptures (i.e., fish captured and marked with a jaw band in previous collections). Typically, studies on wild populations with >10% of individuals marked can generally provide robust estimates of population abundance.



One Paddlefish captured in Grand Lake was found to have a band code of A10942, indicating that it was one of 15 adult males translocated from Keystone Lake to Grand Lake on February 24, 2021. At release, the fish was 800 mm in length and 10.0 kg. At capture 1,385 days later, the fish was 895 mm and 11.4 kg. These fish were part of our genetic restoration efforts to mimic historical connectivity between stocks and to re-introduce Arkansas River alleles back into the Grand Lake stock. Translocation totals from Keystone Lake to Grand Lake are as follows: February 24, 2021 – 15; March 16, 2022 – 20; March 15, 2023 – 13; March 19, 2024 – 13.

This is not the first time one of these fish has been encountered. Soon after the initial release in 2021, snag anglers noted on social media that they had captured and released fish with green bands (likely in response to a Facebook post notifying snag anglers to be on the lookout for green bands with a request to release the fish). Three days after the 2023 translocation, one of the fish was checked in to the PRC (A10639) and it is likely that several others have been harvested and not reported. On at least one occasion between 2021 and 2023, an angler took a translocated fish into possession and attempted to check it in to the PRC, but we asked them to release the fish upon discovering the fish's identity.

Figure 18. Male Paddlefish that was translocated from Keystone Lake to Grand Lake. Part of a long-term effort to enhance the genetic diversity of the Grand Lake stock, numerous Paddlefish have been moved from Keystone Lake to Grand Lake, beginning in 2021. This fish is one of the original 15 fish moved to Grand Lake on February 24, 2021. Faint remnants of green paint used on the bands are still visible on the band.

Bycatch encountered in standardized Paddlefish gillnets on Grand Lake included Hybrid Striped Bass, Gizzard Shad, Blue Catfish, Channel Catfish, Longnose Gar, Freshwater Drum, Bigmouth Buffalo, and several Flathead Catfish that were used for an age and growth study by the regional management personnel.

Webber's Falls Lake

We tested a modified version of new standardized Paddlefish gill-net sampling protocols (Appendix D) for Webber's Falls and encountered a total of 339 Paddlefish (seven of these were captured a second time, which are included in catch rates, but the fish were not measured or weighed twice). Body length ranged 602-1,325 mm and weight ranged 2.9-50.7 kg. Average catch rates were 76.0 fish/net/day (SE = 9.1, CV = 0.12). Male:Female sex ratio was a perfect 1:1.

Figure 19. Catch rates for net sites in Webber's Falls. Nets were densely deployed in a relatively small area of the lower lake from Brewers Bend to the dam outside of the navigation channel, therefore site numbers used decimals and E/W suffixes to denote their placement on the East or West side of the basin.

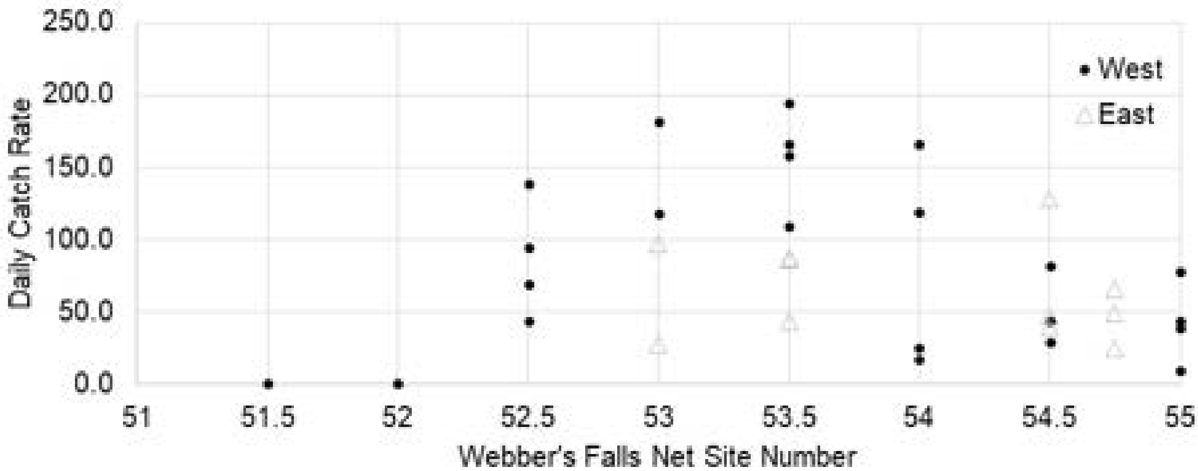


Table 10. Webber's Falls Paddlefish catch summary 2024-25

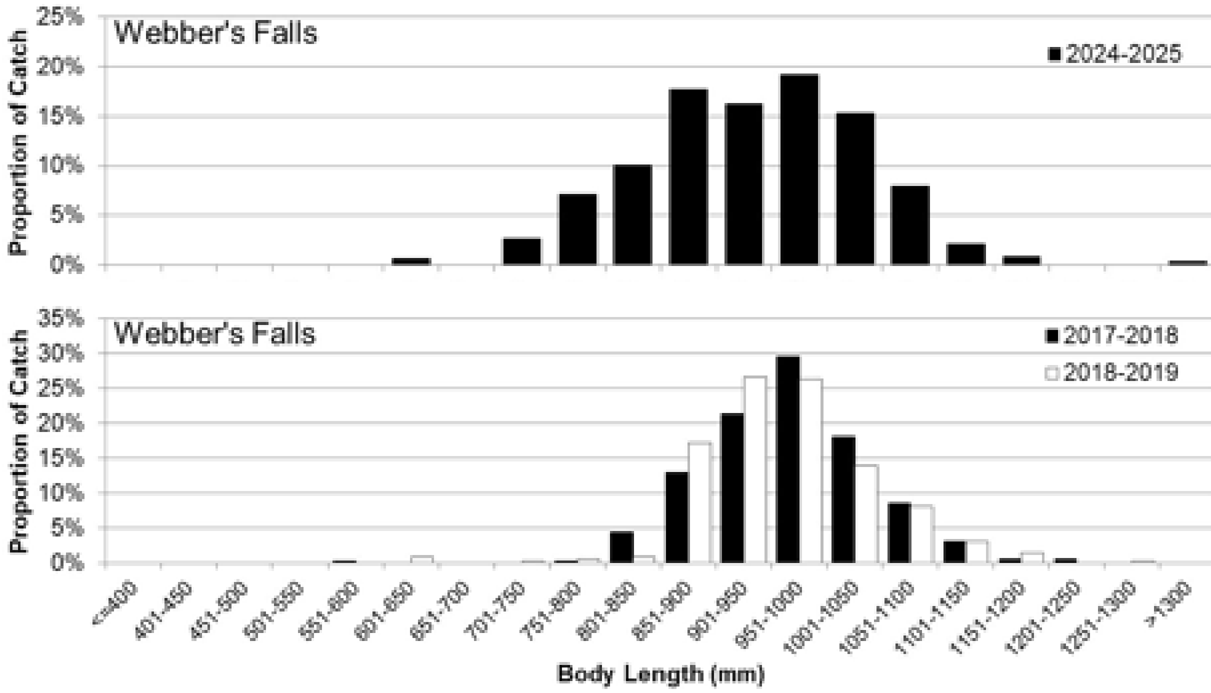
Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	167	166	1	925	13.5	96.4
Female	167	165	2	952	15.4	90.4
Juvenile	5[7]	4	0	695	4.6	-
Totals	339[8]	335	3			

Table 11. Webber's Falls Paddlefish combined catch summary from previous years (2017-18)

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	328	309	19	946	13.2	89.4
Female	320	305	15	994	16.1	85.6
Juvenile	8[9]	4	0	698	4.9	-
Unknown	2	2	0	889	8.7	-
Totals	658	620	34			

[7] Total includes one juvenile Paddlefish that was weighed and measured, but not marked with a jaw band.
[8] Capture total excludes seven fish captured two times, which were used for population abundance estimation, but not weighed and measured twice.
[9] Total includes 4 juvenile Paddlefish that were weighed and measured, but not marked with a jaw band.

Figure 20. Size structure of Webber's Falls Paddlefish catch



Size structure of the Webber's Falls Paddlefish stock in 2017-2019 indicated few fish below 850 mm, which would suggest little recent recruitment inputs from upstream reservoir stocks in the Grand River, Verdigris River, or Arkansas River watersheds. However, the latest catch data have revised the size structure to reflect the higher abundance of younger and smaller fish. The capture of a 50.7 kg female was remarkable, representing the heaviest fish captured since 2019, the largest ever captured in Webber's Falls, and the 7th heaviest captured in our netting database (n=29,700).

No Paddlefish captured were detected with a CWT indicating hatchery origin. Additional notations on condition of fish encountered included hook scars (26%), prop scars (five fish), or rostrum injuries/deformations (17%). Three fish had complete rostrum amputations and the nature of rostrum injuries varied from partial amputations, disfigurement, or fractures to the rostrum and/or skull, among others. Paired with the prop scars, wounding of Paddlefish due to putative boat strikes is common in the Webber's Falls stock. It is likely that this is a key source of cryptic mortality.

Relative weights appear to have improved for both sexes in the Webber's Falls stock, though individual fish (generally with injuries) remain in the stock with *Wr* values in the 50's.

Only three Paddlefish caught in Webber's Falls were recaptures from previous collections (Table 12). Remarkable among them is the recapture of G14329, which was located in an archived file of fish banded in Hudson Lake in 2006. At the time, protocols did not include assigning sex or weighing fish. The fish was a presumably mature male in December 2006, measuring 965 mm. The fish only grew 39 mm in 18 years at large, remaining relatively thin, but healthy at 1,004 mm and 16.5 kg (*Wr* = 94.7). Though the fish was noted as bearing a hook scar, the capture of the fish in Webber's Falls required the fish to have passed as an adult downstream through two high dams- Kerr Dam impounding Lake Hudson and Ft. Gibson Dam impounding Ft. Gibson Lake – which it appears to have done unscathed.

Table 12. Back-calculated daily growth rates of Webber's Falls recaptured Paddlefish

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex
A10572	11/29/18 (53.5)	12/3/24 (53.5)	2,196	0.007	-0.797	M, F
A00265	11/27/17 (54)	12/4/24 (52.5)	2,564	0.034	2.145	F
G14329	12/14/06 (Hudson)	12/5/24 (53.5)	6,566	0.006	NA	M
Average:			3,775	0.016	0.674	

Bycatch encountered in standardized Paddlefish gillnets on Webber's Falls included Flathead Catfish, Blue Catfish, and Smallmouth Buffalo.

ESTIMATION OF POPULATION ABUNDANCE

For the 2024-2025 winter Paddlefish netting season, new collection protocols (Appendix D) allowed for estimation of population abundance using a series Schnabel estimator.

Table 13. Schnabel estimation summary for Oklahoma Paddlefish stocks, winter 2024-25

Stock	Sample Days	Total Nets	Captured	Recaptured	*N* (95%CI)
Grand	8	96	1,167	17	34,538 (22,320-61,174)
Webber's Falls	4	32	345	7	6,242 (3,174-13,300)

Estimates above cannot accurately capture the entire stock, as fish are free to disperse throughout the reservoirs and outside of our sample area limitations (e.g., adequate depth for large gill nets). We know that Paddlefish inhabit the uppermost stretches of Grand Lake (below Twin Bridges), however, to include this area creates logistical issues due to shallow water between Oogeeche Bend and Campbell Point. Similarly, on Webber's Falls, Paddlefish have access to more areas of the reservoir than we can safely deploy nets due to barge traffic in the navigation channel. However, we have observed in previous collections that greater densities of Paddlefish are found in the inundated river channel when it does not overlap with the navigation channel. Therefore, collections on Webber's Falls target those areas. Given the intensity of our netting efforts in a relatively small stretch of Webber's Falls (sites 51-55), it was unexpected to encounter so few recaptures over four days and zero on the fourth day. However, in the absence of barge traffic, we may have dispersed the fish out of their otherwise preferred habitat. Declining daily average catch rates may have been an indicator that Paddlefish were leaving the area (Figure 20).

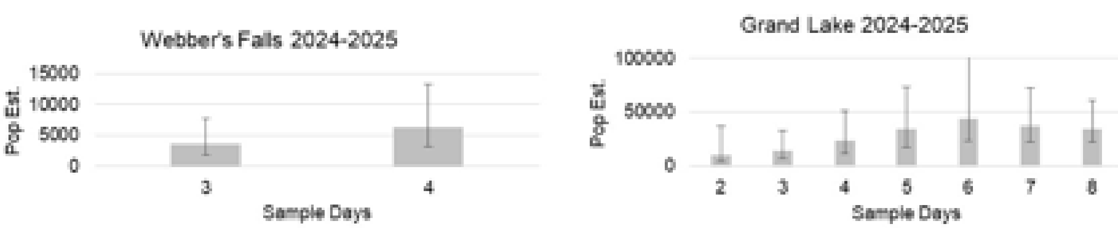
Figure 21. Gillnetting daily catch rates declined notably in Webber's Falls over the duration of four days and less so in Grand Lake over eight days. This may be an indicator that our intense efforts pushed fish from the sample area, though neither of these decreasing trends is statistically significant.

In Grand Lake, a general trend of higher likelihood of recapture occurred in upstream sites, perhaps because the inundated channel sampled accounts for a greater portion of the total surface area. However, catch rates were also higher at upstream sites (Figure 11).

In both examples, netting collections for abundance estimation are as thorough as practicable. Estimates therefore might be more responsibly interpreted qualitatively (i.e., comparing year to year within reservoir) or coarsely (i.e., large differences exist when comparing stocks) rather than quantitatively (i.e., direct comparison of X to Y).

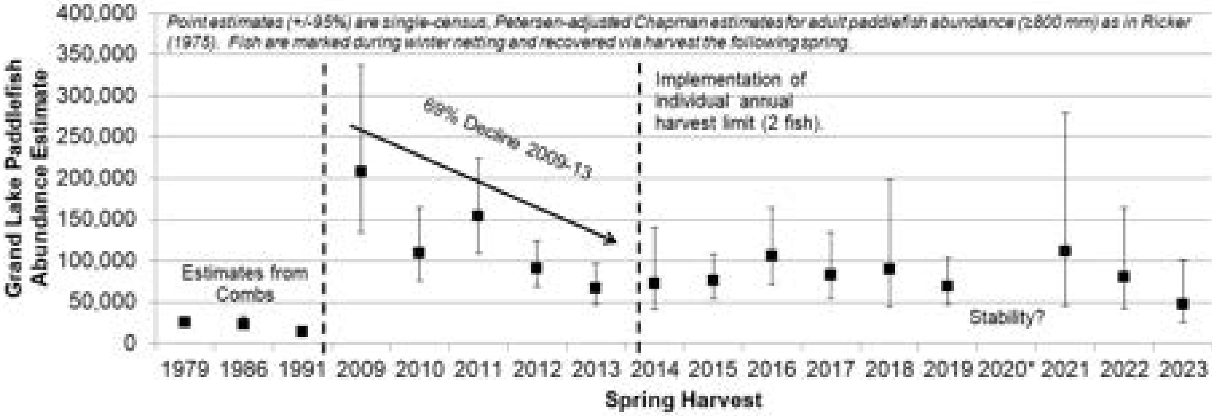
To evaluate daily efforts and to inform refinement of protocols, abundance estimate calculations were completed daily after three days for Webber's Falls and two days for Grand Lake. Given the caveats described above for Webber's Falls, precision in the estimates did not improve with additional sampling. However, it appears that eight days of sampling resulted in refinement of the estimate and narrowing of the 95% confidence intervals. Early successes in encountering recaptures resulted in some low, but relatively precise estimates on day three. However, the population size is likely >2x as large. These results will be examined again in 2025 for a similar number of sample days to determine adequacy. Perhaps a good rule of thumb for evaluation is whether or not the upper bound of the 95% confidence interval exceeds 2x the estimate. This was not achieved on Webber's Falls, but was reached on Grand only after the 8th sample (96 nets).

Figure 22. Comparison of abundance estimates derived from sequential days' catches



Earlier efforts to estimate abundance of Paddlefish in Oklahoma have been restricted to the Neosho River / Grand Lake stock. Recent population abundance estimates from Grand Lake used marked fish from winter netting that were later recovered from harvest at the Paddlefish Research Center (Figure 13). The trend in estimated abundance following the 2014 harvest regulation changes indicated stability of the "catchable" population (≥800 mm). The estimate for 2023 was the lowest in the modern era of Paddlefish management, however this estimate is known to exclude a segment of the stock upstream (and perhaps downstream, though to a lesser extent) of our netting boundary. As our focus has expanded from the Grand Lake stock to other statewide Paddlefish snag fisheries, revised sampling protocols allow for abundance estimation on all distinct Paddlefish reservoir stocks. New sampling protocols do not rely on the recovery of recaptures from angler harvest, therefore the consideration of what is “catchable” is less relevant and the exclusion of fish <800 mm from mark/recapture would likely hinder the viability of estimates. For this and a list of various other reasons, direct comparison of estimates across the two methodologies should be done with high caution.

Figure 23. Modified single-census estimates of catchable Paddlefish abundance on Grand Lake, with estimates from Combs 1979-1991 for comparison. The harvest season in 2020 was abbreviated due to COVID closure of the Paddlefish Research Center, therefore no estimate is available for that year.



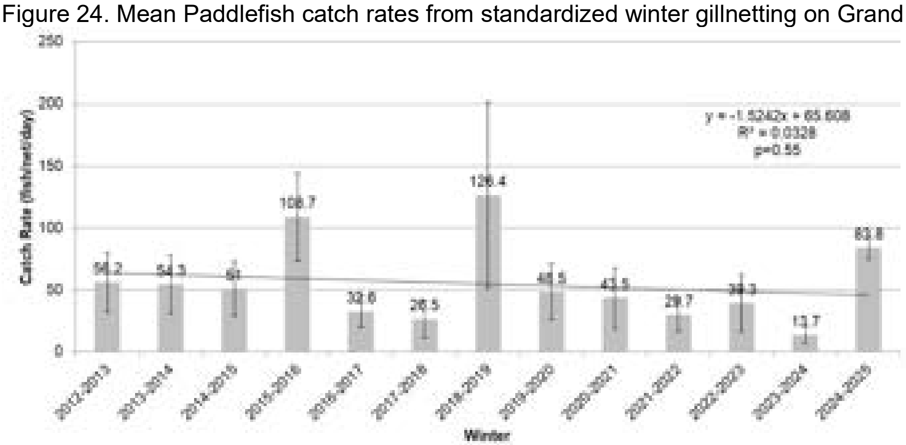
LONG-TERM, STATEWIDE TREND DATA[10]

Table 14. Summary matrix of average Paddlefish catch rates (with coefficients of variation of the mean [CV] in parentheses) from all Oklahoma lakes sampled 2010-2024. Lakes indicated by an asterisk (*) are recipients of restoration stocking. Lakes with planned collections in 2025-26 are shaded in grey.

Year	Grand	Eufaula*[11]	Webber's Falls	R.S. Kerr	Texoma*[12]	Kaw*	Oologah*	Hudson	Ft. Gibson	Keystone
2010-11[13]	*NS*									
2011-12	24.9 (0.29)								94.6 (0.10)	32.5 (0.13)
2012-13	56.2 (0.22)	10.0 (0.28)						69.6 (0.12)	166.7 (0.11)	
2013-14	54.3 (0.22)						143.7 (0.22)	93.0 (0.28)		
2014-15	51.0 (0.22)					32.4 (0.23)	80.4 (0.16)			
2015-16	108.7 (0.16)				0 (0)	12.7 (0.18)				
2016-17	32.6 (0.20)			43.6 (0.53)	*NS*					
2017-18	26.5 (0.28)		15.4 (0.56)	28.2 (0.44)						
2018-19	126.4 (0.30)		*NS*[14]							31.5 (0.14)
2019-20	48.5 (0.24)								50.1 (0.31)	41.2 (0.21)
2020-21	43.5 (0.29)	8.9 (0.30)						100.2 (0.21)	33.2 (0.29)	
2021-22	29.7 (0.23)	61.6 (0.17)					43.2 (0.17)	88.0 (0.27)		
2022-23	39.3 (0.30)	39.6 (0.17)				132.7 (0.27)	121.4 (0.28)			
2023-24	13.7 (0.25)	47.8 (0.20)		45.5 (0.32)		125.2 (0.13)				
2024-25[15]	83.8 (0.05)	*Jan 2025*	76.0 (0.12)	*Jan 2025*						
2025-26	*Dec 2025*	*Jan 2026*	*Dec 2025*							*Jan 2026*

Standardized catch rates on Grand Lake using old methods are variable (with large peaks in 2016 and 2019; Figure 21). New netting methodologies as of 2024-25 may not be directly comparable to those of prior years, but may indicate that enhanced effort (more nets over a consistent spatial coverage) yielded higher average catch rates compared to the previous year. Although historical sampling (2012-24) appears to be in a long-term decline, this linear trend was not statistically significant (linear regression, R^2= 0.0328, p=0.55).

Figure 24. Mean Paddlefish catch rates from standardized winter gillnetting on Grand Lake



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[10] Relevant long-term trend data are included here, although all collections prior to July 1, 2023, were state funded.
[11] Paddlefish collections on Eufaula Lake were restricted to the Deep Fork and Gaines Creek arms in 2021-22 after poor lake wide catch rates in previous years.
[12] Standardized sampling encountered only one Paddlefish in 2015-16, therefore enhanced effort was used in 2016-17 and no additional Paddlefish were encountered. This stock was concluded as a restoration failure and no additional collections have occurred.
[13] Standardized winter Paddlefish gillnetting was refined in 2012-13 and effort was reduced from 24 nets to 16 nets.
[14] Due to shallow water, highly variable catch rates in 2017-18, and a companion project at Ft. Gibson Dam, collections in 2018-19 did not follow standardized protocols to enhance catch.
[15] New standardized netting protocols were developed and implemented for winter 2024-25. Average catch rates are calculated the same way; however, net soak times were shorter across more nets deployed per day.

FISH KILLS OR MASS MORTALITY EVENTS IMPACTING PADDLEFISH

On July 8, 2024, we responded to a report of dead Paddlefish below Keystone Dam on the Arkansas River near Sand Springs. In our search of the affected area, we recovered carcasses from 36 Paddlefish, collecting measurements of body length, dentary bone samples for later aging, and assigning sex based on visual examination of viscera. We produced and submitted a 10-page report titled "Memo: Arkansas River Paddlefish Kill July 7-8, 2024" to the ODWC Fish Kill Coordinator and Fisheries Division administration (see Appendix F). Although the cause of the kill was not definitively known, we presumed that dam/hydropower operation resulted in the dewatering of the Keystone Dam tailrace, creating a lethal combination of low dissolved oxygen and high summer temperatures, resulting in the demise of a number of Paddlefish inhabiting or stranded in the tailwater. Dam releases had been resumed prior to our arrival to the fish kill, therefore many of the carcasses were dispersing downstream as we attempted to examine them and a rock weir prevented the expansion of our search efforts downstream. It is likely that our count of 36 dead Paddlefish substantially underestimated the true count.

At the 2024 annual meeting of the North American Sturgeon and Paddlefish Society (NASPS), a workshop was held to initiate development of standard protocols for response and assessment of mass mortality events of sturgeons and Paddlefish. These efforts, upon completion, are intended to result in a guidance document or publication advising best management practices for states, Tribes, agencies, and corporations. Our program will continue to play a role in the development of these guidelines.

FUTURE EFFORTS AND MANAGEMENT RECOMMENDATIONS

<u>Standardized Collections in 2024 and beyond:</u> In winter 2024-25, new standardized winter collections were implemented on Grand, Webber's Falls, R.S. Kerr, and Eufaula lakes. Evaluation of these changes is ongoing. One key modification was the ended use of bullet floats at 75' intervals on the float line. This simplified net deployment and retrieval, particularly in wind and wave lake conditions. On one occasion, a Paddlefish snagging guide on Grand Lake complained on Facebook that they had encountered our net, stating that it was inadequately marked. Also among the complaints was that our nets were abundant, and widely distributed. They were indeed.

Deployment and retrieval of six 300' nets resulted in challenges for spatial logistics on the boats. Using no bullet buoys allowed for the stowing of two nets in one barrel, reducing the number of containers on the boat. However, the additional inflatable buoys and anchors filled the space quickly, making the boat crowded for the 5th and 6th net retrieval.

One a priori concern was that deployment of 12 nets would result in excessive catches and longer days. After running 8 or 9 nets on Webber's Falls and 12 nets on Grand Lake, this concern was assuaged. Given that we are not "checking" the nets and retrieving them later, the catches from shorter net soaks were manageable with a maximum of 28 fish in a net on Webber's Falls (avg. 10) and 29 on Grand Lake (avg. 12). On reservoirs where the Paddlefish abundance is known to be high (e.g., Oologah Lake), deployment of 12 nets may result in extreme catches and the amount of netting effort required to adequately estimate the population size would be equally unreasonable. Perhaps a simplified or cautious approach would be warranted.

Previous protocols resulted in more crew loitering time compared to a more consistent activity level with the new protocols. Paired with the likelihood of longer boat rides to distant net sites, potentially in inclement weather (wind and waves), the new protocols may be viewed as substantially more "difficult", challenging our abilities to fill the crews with willing participants. It should therefore be a goal to consider any and all efficiencies that could enhance crew safety and comfort. Consistent among complaints is the inadequacy of the Blue Wave boat for this type of work. Though the v-hull and 250hp outboard are appropriate for efficient travel on large reservoirs, additional effort is required to hoist a net weighed down by large fish over the side or the bow. Further, the slanted gunwales at the fore end of the deck are a slip/trip hazard, resulting in consistent issues with crew losing their footing and/or falling into the lake. It should become a priority to replace this watercraft with one that is more appropriately suited to performing this work in a safe manner.

<u>Assessment of Oklahoma Paddlefish Snag Fisheries:</u> A creel survey of the upper Keystone Lake – Kaw Dam snag fishery is scheduled for spring 2025. Identification and inspection of access points will initially inform the structure and frequency of efforts. Where possible, harvested Paddlefish will be salvaged for dentaries, otoliths, and gonadal data to supplement population metrics from standardized netting efforts.

<u>Assessment of Natural Recruitment of Oklahoma Paddlefish:</u> The generalized outlook of Oklahoma Paddlefish recruitment as depicted by catches in the three reservoirs described here is good. All three reservoirs have a size structure indicating that a visible component of the stock represents one or more recent recruitment events. Given that a primary objective of Paddlefish management in Oklahoma (see Appendix A.) is to maintain sustainable fisheries in naturally recruiting stocks, these collection results would indicate that the future of these fisheries and the status of Paddlefish in Oklahoma is positive. Natural recruitment should continue to be a priority focus for future management efforts. Although methodologies for early detection of age-0 Paddlefish are not well defined for Oklahoma waters, detection of age-1 Paddlefish in standard gillnetting collections is adequate to evaluate the presence of rare, large recruitment events among smaller, low-level recruitment on a more regular frequency. Continued evaluation of the 2015 cohort in the Grand Lake stock will determine if the abundance of this cohort will adequately buffer current and future harvest levels within the current regulatory framework or if adjustments are needed.

<u>Sex Ratios and Harvest Bias for Female Paddlefish:</u> A known size-bias for larger Paddlefish exists in the harvest fishery. Multiple lines of evidence have demonstrated this phenomenon- e.g., a disproportionate prevalence of hook scars on smaller males compared to fewer scars on larger females, trophy-seeking guides harvest more females than males. When sex ratio of netting catch is compared across reservoirs, the long-term effects of this harvest bias can be observed. For example, the Male:Female sex ratio of Grand Lake is slightly skewed at 1.6:1, whereas this ratio was observed as 1.24:1 and 1:1 in Eufaula and Webber's Falls, respectively. The latter two stocks likely represent a closer approximation of the presumed natural 1:1 sex ratio of a wild stock without a severe harvest (trophy-seeking) bias. While the harvest pressure is disproportionately felt by female Paddlefish in Oklahoma's more heavily fished stocks, it is unknown at what level this ratio may cause concern. Given that Paddlefish are promiscuous with individual spawning females attended by multiple males and the same males likely spawning with multiple females over the spawning season (whereas females only spawn once), a severe imbalance in sex ratio (skewed to an abundance of males) may still result in adequate maintenance of genetic diversity and recruitment in a heavily fished stock. A genetic assessment which estimates the effective breeding population size may better illustrate this phenomenon. Previous genetic efforts on Grand Lake found no cause for concern regarding the

effective breeding stock size (Schwemm et al. 2015, 2019). In other stocks such as Kaw Lake, where the sex-linked size dimorphism is less pronounced (i.e., males are heavier by length than in Grand Lake), this may buffer against the long-term effects of harvest bias for females and the sex ratio may remain un-skewed.

Angler Surveys and Human Dimensions: An in-depth examination of the influences of the licensed fishing guide industry on Paddlefish snagging and harvest in Oklahoma is warranted due to an apparent growth of the industry fueled by the advent of live imaging sonar technology. The snag fishery has expanded far beyond the historical spatial and temporal limitations of a springtime, primarily bank fishery at aggregating sites such as low head dams in a few locations. As of 2023, Paddlefish snagging in Oklahoma occurs throughout the distribution of the species and in rivers and reservoirs year-round, as anglers (many assisted by licensed fishing guides) pursue this large and distinctly shaped fish using live imaging sonar. A preliminary *ad hoc* creel survey of harvest anglers at the PRC in 2023 determined the following:

1. a majority of Paddlefish harvested by anglers March 1 – April 30, 2023, were assisted by licensed fishing guides (58%) and early season cumulative harvest was heavily dominated by guided anglers (86% of harvest up to March 27, 2023)
2. guided Paddlefish harvest anglers caught and subsequently released more fish per day (1.18) than unguided anglers (0.50)
3. guided Paddlefish anglers harvested larger fish (combined sexes) than unguided anglers (35mm longer and 1.5kg heavier)
4. guided Paddlefish anglers harvested proportionally more females (43%) than unguided anglers (29%)

These observations indicate that in off-peak conditions (i.e., outside of historical springtime “snagging season”), angler harvest is likely driven by or enhanced by guides. Further, this harvest likely targets larger, older female Paddlefish of greater conservation value. The expertise and technology offered by a guide likely has a significant impact on the statewide snagging pressure and harvest of Paddlefish. Pairing these results with the Oklahoma Licensed Fishing Guide Survey performed by ODWC in summer/fall 2023 (York and Schooley 2024) will likely provide important insights on whether fisheries in reservoirs across Oklahoma continue to support sustainable Paddlefish snagging opportunities.

Research to Inform Management: The substantial amounts of data generated by the Paddlefish Research Center 2008-2023 will likely continue to yield analyses and products relevant to management of Oklahoma Paddlefish in the years to come. A study is in progress on validated age estimation using dentaries, otoliths, and pectoral fin rays as age structures in comparison to known age from coded wire tags for hatchery origin fish. A study is nearing completion on validated field sex identification using two methods. And a long-term monitoring study for the introgression of Arkansas River genetics into the Neosho and Verdigris river Paddlefish stocks has been funded and begins in 2025.

Although catch and release mortality for Paddlefish is presumed to be low due to lack of evidence for such mortality (Bettoli et al. 2019) and a common observation of healed hook scars on harvested and netted fish (ODWC, unpublished data), the expansion of the Oklahoma snag fishery into warmer summer months may call for further investigation. A key research need for Oklahoma Paddlefish is to enhance our understanding of the cryptic mortality from warmer season snagging catch and release. This may be best achieved via short-term, active telemetry tracking of adult fish snagged and released via live-imaging sonar in summer on Keystone Lake with a comparison to fish snagged and released in cooler months.

Validated Age Estimation for Oklahoma Paddlefish from Dentaries: Recovery of coded wire tags (CWT) indicating hatchery origin are valuable for our long-term assessment of validated age estimation for Paddlefish. During the era of the Paddlefish Research Center, thousands of Grand Lake Paddlefish were aged using annular rings on dentary bones. Recovery of CWTs on Grand Lake from fish stocked in John Redmond Reservoir, Kansas, and on Lake Eufaula have provided the opportunity to validate dentaries on known-age fish with the additional comparison of age estimates from other structures (otoliths and pectoral fin rays). This research is ongoing.

Restoration Stocking and Genetic Management: There are no ongoing or planned restoration stocking efforts for Paddlefish within the state of Oklahoma. However, restoration stocking is ongoing in the Neosho and Verdigris rivers of Kansas, which flow into Oklahoma reservoirs Grand and Oologah, respectively. In an attempt to maximize genetic diversity and to mimic patterns of historic connectivity (Schwemm et al. 2019), ODWC has partnered with U.S. Fish and Wildlife Service Tishomingo National Fish Hatchery (TNFH) and Kansas Department of Wildlife and Parks (KDWP) to capture adult Paddlefish from Keystone Lake for production of fish to be stocked in Elk City Reservoir (Verdigris River) and John Redmond Reservoir (Neosho River). This genetic introgression project began in 2021 and includes the translocation of adult Paddlefish from Keystone Lake to Grand Lake each spring during broodstock collection in addition to the release of Keystone Lake broodstock into Grand Lake after propagation. A long-term genetic monitoring program with periodic screening from Grand Lake Paddlefish is in development and will likely be funded for 2025.

Harvest Management through Regulation: Although the harvest regulation and reporting framework implemented in 2014 (including the annual limit and mandatory reporting; Schooley et al. 2014) has been successful in moderating statewide harvest while maintaining ample opportunities for snagging, changes in the fishery may warrant a reappraisal and consideration of a different regulatory strategy. This framework was developed at a time when springtime harvest from the Grand Lake / Neosho River stock comprised a majority of the annual, statewide take for Paddlefish. However, the fishery has expanded to other stocks and is no longer concentrated in springtime. These changes are due, in part, to the development of live imaging sonar and the proliferation of Paddlefish fishing guides. No longer does the information gathered from Grand Lake springtime harvest anglers suffice to inform the statewide management of the species and different approaches may be needed. The harvest regulatory framework developed in 2014 was a proactive one, in that it prescribed for future regulation changes to be made within “management units” (i.e., Genetic Management Units; GMUs) rather than blanket statewide regulations. Further, rule changes could be recommended and implemented via the Wildlife Commission rather than through the full state regulatory review process.

> 800:10-1-4. Size and bag limits on fish
> (11) The statewide daily bag limit for paddlefish is one (1) per day, statewide. The catch and release of paddlefish is permitted by use of rod and reel, trotline and throwlines.
>
> > (A) Individual annual harvest limit- An individual harvest limit for paddlefish may be set or amended annually by the Wildlife Conservation Commission and will be listed in the Oklahoma Fishing and Hunting Regulations. Special area (or management unit) paddlefish harvest caps, a general statewide paddlefish harvest cap, and the total number of paddlefish permits issued may be set or amended annually by the Wildlife Conservation Commission for use in determining the individual annual harvest limit. Once an individual angler has reached their annual harvest limit, continued catch and release is permitted.

A thorough review of recent harvest trends (since the development of online reporting for Paddlefish) and all other sources of data is forthcoming to determine if the current harvest regulations continue to serve as intended. Pressure on Keystone Lake after the world record frenzy of 2020-2021 has greatly increased. Pursuit of larger (predominantly female) Paddlefish using live-imaging sonar in all waters and in all times of the year has resulted in the development of a trophy-hunting fishery, the impacts of which are not fully known. In light of the fishery's expansion into warmer months, where catch and release mortality is likely elevated in warmer water temperatures, key consideration must be given to a summer fishery closure, which would align Oklahoma with most other states where Paddlefish are recreationally fished.

A town-hall meeting with Keystone Lake fishing guides is scheduled for January 2025. This meeting comes at the request of several Paddlefish guides with an interest in discussing the status of the Keystone population and potential regulations. The results and outcomes of this meeting will be described in a later report.

LITERATURE CITED

Bettoli, P. W., and G. D. Scholten. 2006. Bycatch rates and initial mortality of paddlefish in a commercial gillnet fishery. Fisheries Research 77(3):343–347.

Bettoli, P. W., G. D. Scholten, and E. Ganus. 2019. Cryptic Mortality of Paddlefish. Pages 151–162 *in* J. D. Schooley and D. L. Scarnecchia, editors. Paddlefish: Ecological, Aquacultural, and Regulatory Challenges of Managing a Global Resource. American Fisheries Society, Bethesda, Maryland.

Combs, D. L. 1982. Angler Exploitation of Paddlefish in the Neosho River, Oklahoma. North American Journal of Fisheries Management 2(4):334–342.

Fries, J. N. 2001. Retention of Coded Wire Tags in Four Locations in Juvenile Paddlefish. North American Journal of Fisheries Management 21(4):962–966.

Gordon, B. 2009. Paddlefish Harvest in Oklahoma. Pages 223–233 *in* C. P. Paukert and G. D. Scholten, editors. Paddlefish management, propagation, and conservation in the 21st century: building on 20 years of research and management. American Fisheries Society.

Gordon, B. D., K. Green, G. Frankwick, T. Bowser, J. Young, A. Crews, N. Rodefeld, and M. Sturgess-Streich. 2007, August 10. Oklahoma Department of Wildlife Conservation Paddlefish Management and Caviar Program Proposal and Business Plan. Oklahoma State University Spears School of Business and FCAP.

Guy, C. S., R. D. Schultz, and C. P. Clouse. 1996. Coded Wire Tag Loss from Paddlefish: A Function of Study Location. North American Journal of Fisheries Management 16(4):931–934.

Houser, A. 1965. Growth of Paddlefish in Fort Gibson Reservoir, Oklahoma. Transactions of the American Fisheries Society 94(1):91–93.

Houser, A., and M. G. Bross. 1959. Observations on Growth and Reproduction of the Paddlefish. Transactions of the American Fisheries Society 88(1):50–52.

Pitman, V. M., and J. Isaac. 1995. Coded Wire Tag Retention by Paddlefish at Three Implant Sites. North American Journal of Fisheries Management 15(4):878–880.

Ruelle, R., and P. L. Hudson. 1977. Paddlefish (Polyodon spathula): Growth and Food of Young of the Year and a Suggested Technique for Measuring Length. Transactions of the American Fisheries Society 106(6):609–613.

Scarnecchia, D. L., B. D. Gordon, J. D. Schooley, and A. A. Nealis. 2013. A Comprehensive Plan for the Management of Paddlefish in Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

Scarnecchia, D. L., B. D. Gordon, J. D. Schooley, L. F. Ryckman, B. J. Schmitz, S. E. Miller, and Y. Lim. 2011. Southern and Northern Great Plains (United States) Paddlefish Stocks Within Frameworks of Acipenseriform Life History and the Metabolic Theory of Ecology. Reviews in Fisheries Science 19(3):279–298.

Scarnecchia, D. L., Y. Lim, L. F. Ryckman, K. M. Backes, S. E. Miller, R. S. Gangl, and B. J. Schmitz. 2014. Virtual Population Analysis, Episodic Recruitment, and Harvest Management of Paddlefish with Applications to Other Acipenseriform Fishes. Reviews in Fisheries Science & Aquaculture 22(1):16–35.

Scarnecchia, D. L., and J. D. Schooley. 2022. Trophies, Technology, and Timescape in Fisheries Management, as Exemplified through Oklahoma's World Record Paddlefish *Polyodon spathula*. Fisheries 47(9):381–394.

Schooley, J. D., D. L. Scarnecchia, and A. Crews. 2014. Harvest Management Regulation Options for Oklahoma's Grand Lake Stock of Paddlefish.

Schwemm, M. R., A. M. Asher, E. J. Heist, and T. F. Turner. 2019. Genetic Management of North American Paddlefish: Case Studies and Recommendations. Pages 29–48 *in* J. D. Schooley and D. L. Scarnecchia, editors. Paddlefish: Ecological, Aquacultural, and Regulatory Challenges of Managing a Global Resource. American Fisheries Society, Symposium 88, Bethesda, Maryland.

Schwemm, M. R., A. A. Echelle, and J. D. Schooley. 2015. Fine-scale genetic structuring of American Paddlefish populations in Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

York, B., and J. D. Schooley. 2024. Review of the Fishing Guide Industry in Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

Zhang, H., I. Jarić, D. L. Roberts, Y. He, H. Du, J. Wu, C. Wang, and Q. Wei. 2020. Extinction of one of the world's largest freshwater fishes: Lessons for conserving the endangered Yangtze fauna. Science of The Total Environment 710:136242.

APPENDIX A. COMPREHENSIVE PLAN FOR THE MANAGEMENT OF PADDLEFISH IN OKLAHOMA

Oklahoma Department of Wildlife Conservation (summarized from Scarnecchia, et al. 2013)

Philosophy and fundamental hypotheses

1. The paddlefish is an irreplaceable species of historical, recreational, commercial, and aesthetic significance in Oklahoma and throughout the Mississippi and Missouri river drainages.
2. Maintaining natural habitat conditions and numbers of wild fish adequate to sustain natural reproduction, growth and survival are critical to the long-term survival of the species.
3. Benefits from the paddlefish resource should accrue to the entire public, rather than to just a few individuals or groups.
4. Sustainable recreational harvest and non-harvest fishing opportunities are desirable at the level appropriate within the productive capacity of the stocks.
5. The management plan for harvest and habitat should lead to sustainability of the resource and be matched to the life history of the species.
6. High-quality data is critical to stock assessment and sustainable management; fish harvest should be a key source of necessary data.
7. Goals, objectives, and actions, including management regulations and monitoring, should be as uniform as practicable among the stocks but remain sensitive to stock-specific and location-specific fisheries constraints and conditions.
8. A thorough knowledge of the stock-recruitment relationship and factors affecting year class strength should be high priorities for stock assessment.
9. The plan for Oklahoma paddlefish stocks and harvest management units need not be consistent with, but should not be detrimental to, broader (regional or national) paddlefish conservation and management goals and activities. The plan should strive for consistency with other in-state and tri-state regional fisheries management plans, including those for paddlefish.
10. Evaluation, regulation, enforcement, information, and education are keys to the success of the plan and should be assessed annually for effectiveness.

Goals for paddlefish management in Oklahoma

1. Provide a basis for cooperative, coordinated management of Oklahoma paddlefish in consultation with the appropriate federal agencies and Native American Tribes.
2. Provide for an orderly, equitable, and sustainable recreational fishery for paddlefish and a harvest consistent with the productive capacity of the stocks. This goal should include similar regulations between in-state harvest areas and between states, to the extent possible.
3. Develop and maintain a standardized database for stock assessment and yield forecasting.
4. Maintain and enhance existing paddlefish habitat and obtain additional information to better define and provide for paddlefish habitat requirements.
5. Conduct research necessary for successful long-term management.
6. Integrate and define the role of artificial propagation and stocking in the successful long-term management.
7. Increase public awareness of the paddlefish and its habitat requirements.
8. Incorporate public acceptance and compliance with the regulatory framework established for long-term management.

APPENDIX B. MAPS OF OKLAHOMA RESERVOIRS MANAGED FOR PADDLEFISH

Management authority is noted with an asterisk (*) for Grand River Dam Authority. All others are under the authority of U.S. Army Corps of Engineers.

Basin	Tributary Rivers	Reservoir	Completion	Surface Acres	Paddlefish Status
Arkansas	Arkansas, Salt Fork	Kaw	1976		Restoration, naturally recruiting
	Arkansas, Cimarron	Keystone	1964	23,610	Wild, naturally recruiting
	Arkansas, Grand, Verdigris	Webbers Falls	1970	11,600	Wild, unknown[16]
	Arkansas, Illinois, Canadian	Robert S. Kerr	1970	43,800	Wild, unknown
Arkansas	Verdigris	Oologah	1974	29,460	Restoration, naturally recruiting
Arkansas	Neosho, Spring, Elk	Grand Lake O' the Cherokees	1940*	41,749	Wild, naturally recruiting
	Neosho	Hudson	1964*	11,029	Wild, unknown
	Neosho	Fort Gibson	1953	19,896	Wild, unknown
Arkansas	Canadian, S. Canadian	Eufaula	1964	105,500	Restoration, TBD
Red	Red, Washita	Texoma	1944	88,000	Restoration, failure

[16] Reservoir stocks with unknown recruitment are recipients of upstream reproduction which cannot be differentiated from potential *in situ* reproduction.

Kaw

US ARMY CORPS OF ENGINEERS

36.76435°N 96.83071°W
Normal Elevation: 1,010 ft

Area: 23,610 ac
Shoreline: 149 mi

Capacity: 428,600 ac-ft
Maximum Depth: 74.5 ft

Keystone

US ARMY CORPS OF ENGINEERS

36.14020°N 96.25993°W
Normal Elevation: 723 ft

Area: 23,610 ac
Shoreline: 296.5 mi

Capacity: 557,600 ac-ft
Maximum Depth: 73 ft

Webbers Falls

US ARMY CORPS OF ENGINEERS

35.57434°N 95.17980°W
Normal Elevation: 490 ft

Area: 11,600 ac
Shoreline: 232.2 mi

Capacity: 165,200 ac-ft
Maximum Depth: 54.1 ft

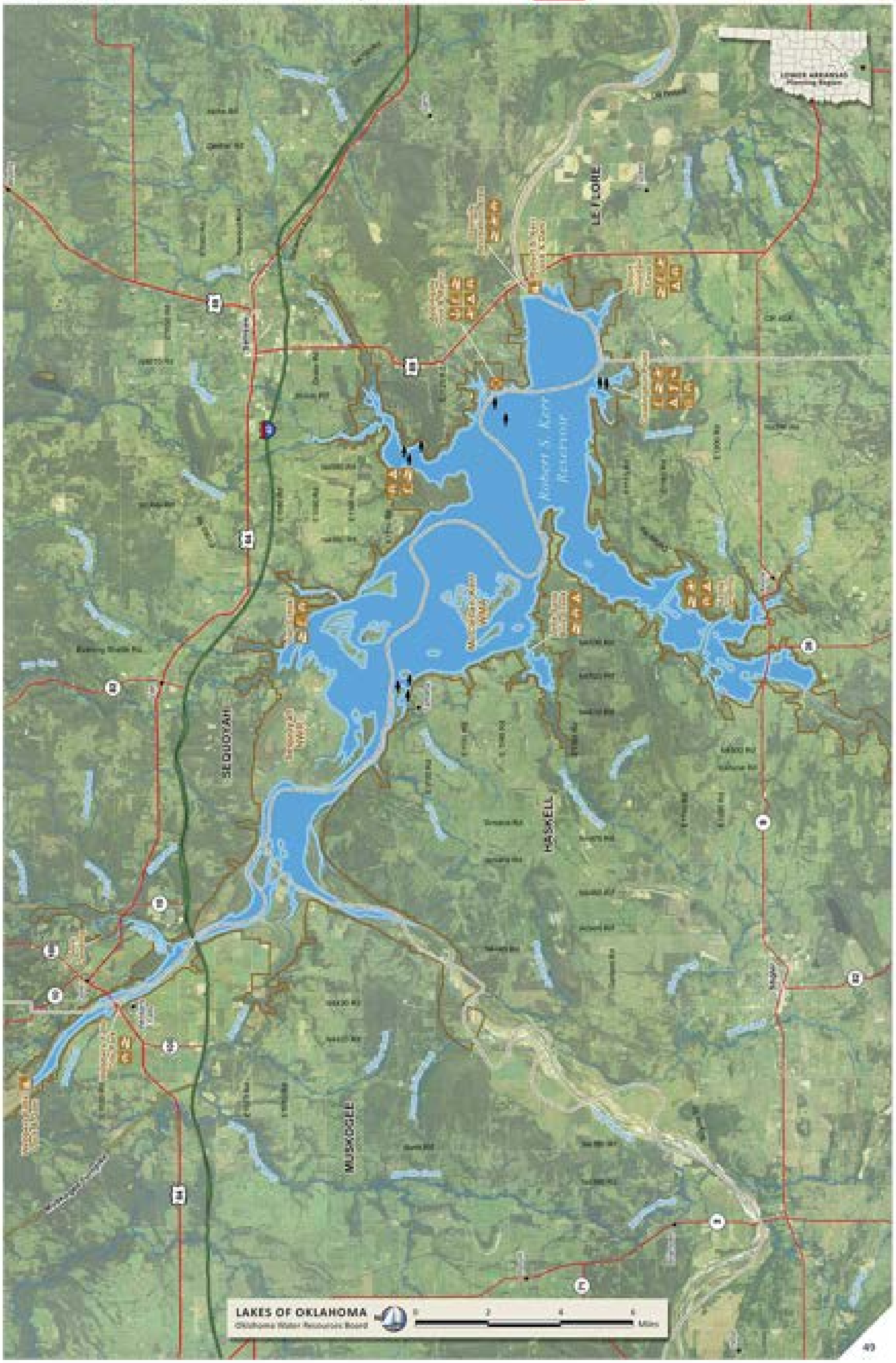
Robert S. Kerr

US ARMY CORPS OF ENGINEERS

35.36450°N 94.82454°W
Normal Elevation: 460 ft

Area: 43,800 ac
Shoreline: 278 mi

Capacity: 493,600 ac-ft
Maximum Depth: 52.5 ft



Oologah

US ARMY CORPS OF ENGINEERS

36.42855°N 95.68308°W
Normal Elevation: 638 ft

Area: 29,460 ac
Shoreline: 216.9 mi

Capacity: 544,300 ac-ft
Maximum Depth: 72.2 ft

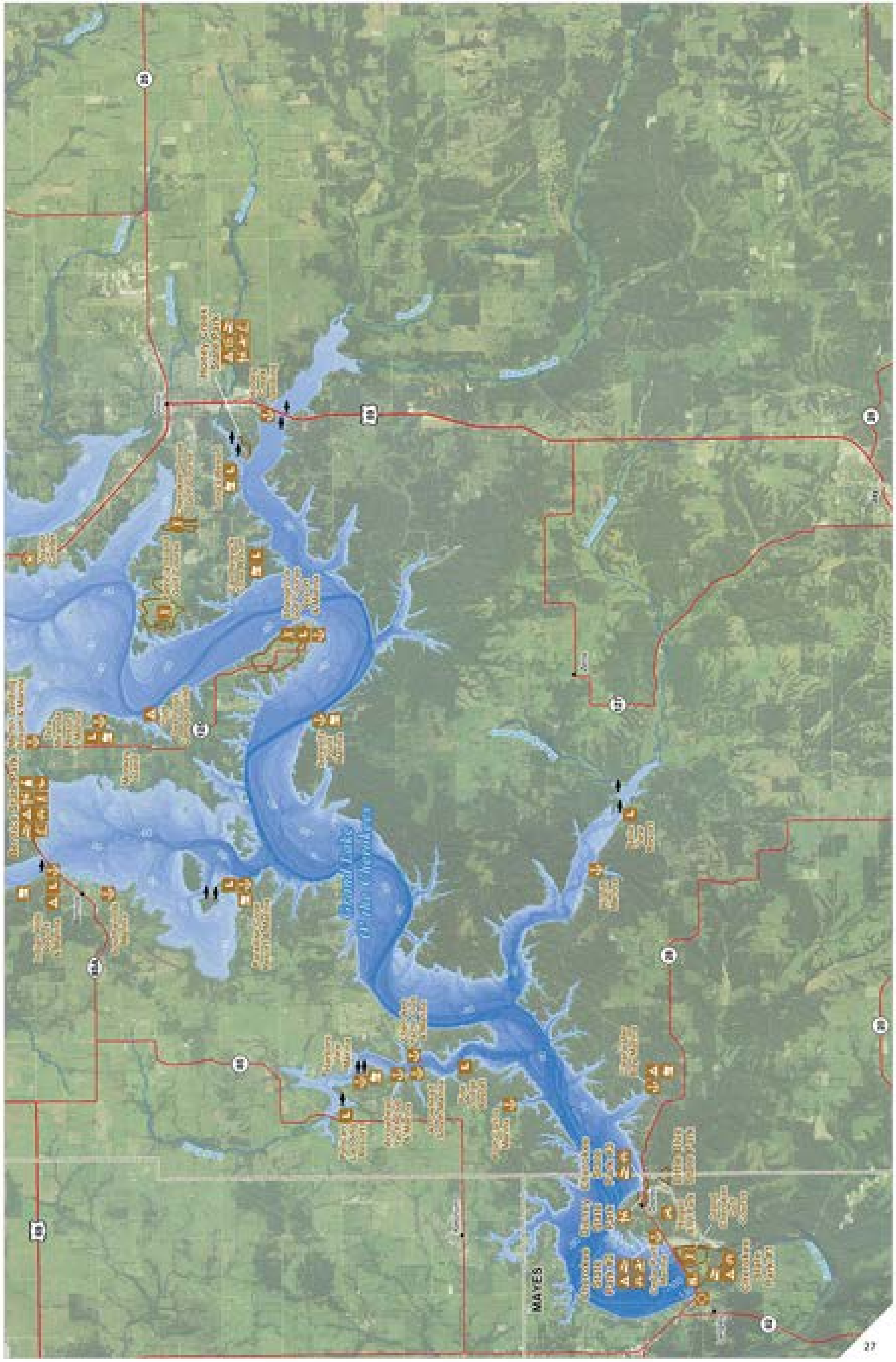
Grand

GRAND RIVER DAM AUTHORITY

36.46813°N 95.04262°W
Normal Elevation: 745 ft

Area: 41,749 ac
Shoreline: 460 mi

Capacity: 1,515,414 ac-ft
Maximum Depth: 133 ft


MAYES
27

Hudson/Markham Ferry

GRAND RIVER DAM AUTHORITY

36.28512°N 95.15537°W
Normal Elevation: 619 ft

Area: 11,029 ac
Shoreline: 143.3 mi

Capacity: 200,185 ac-ft
Maximum Depth: 65 ft

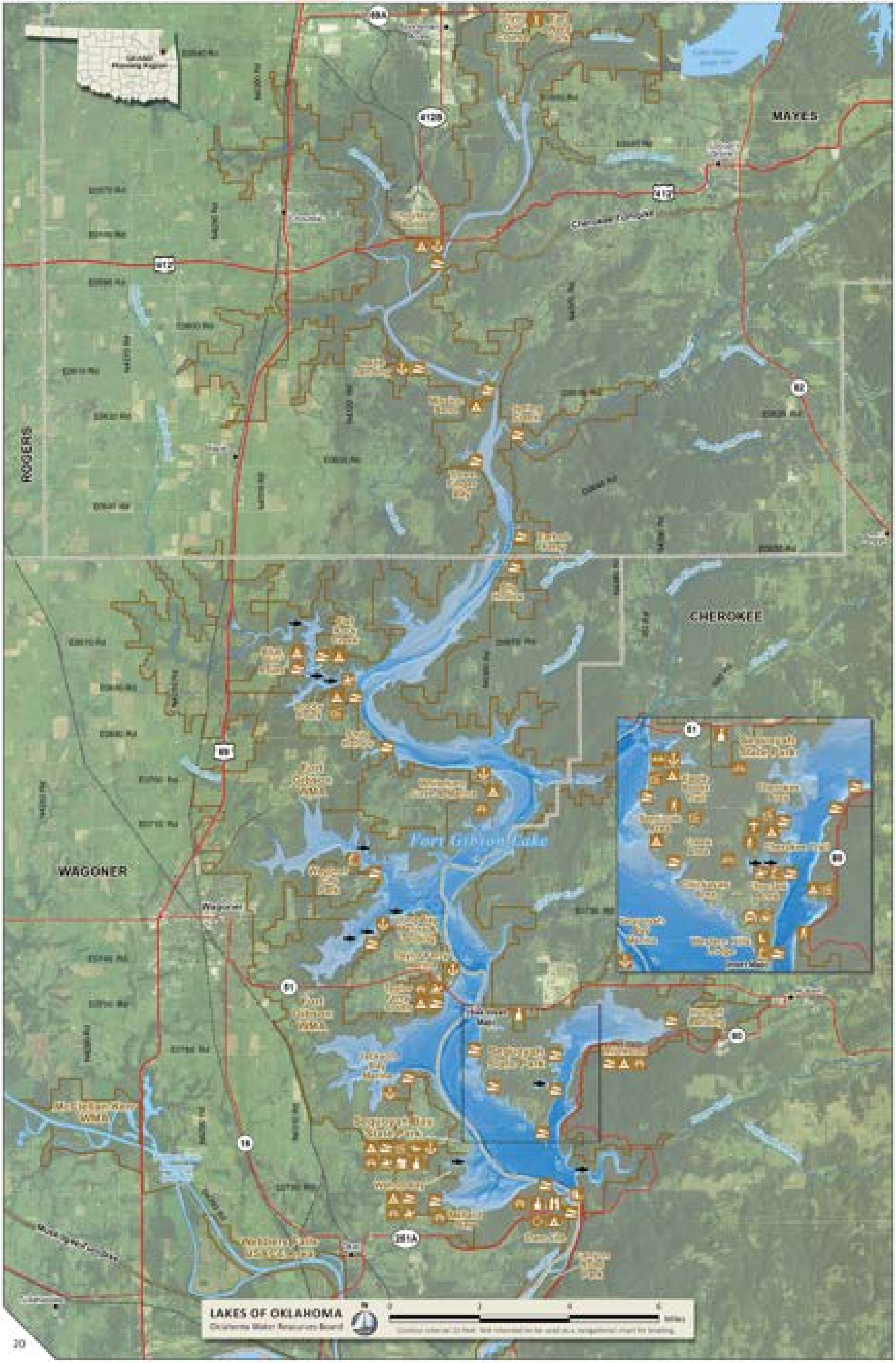
Fort Gibson

US ARMY CORPS OF ENGINEERS

35.86521°N 95.24108°W
Normal Elevation: 554 ft

Area: 19,896 ac
Shoreline: 211 mi

Capacity: 306,133 ac-ft
Maximum Depth: 60.2 ft



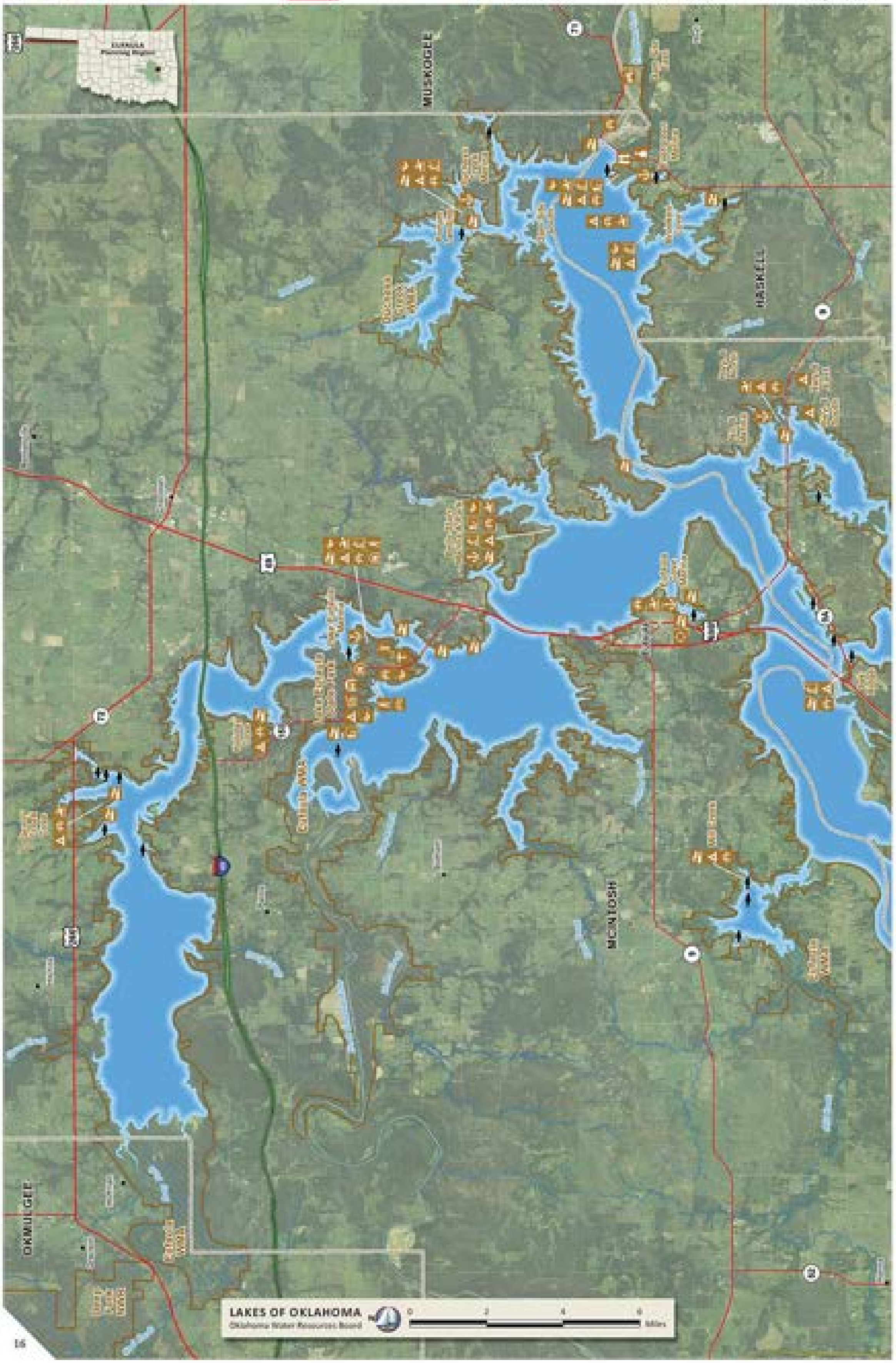
Eufaula

US ARMY CORPS OF ENGINEERS

35.27963°N 95.57849°W
Normal Elevation: 585 ft

Area: 105,500 ac
Shoreline: 833.9 mi

Capacity: 2,330,000 ac-ft
Maximum Depth: 90.2 ft



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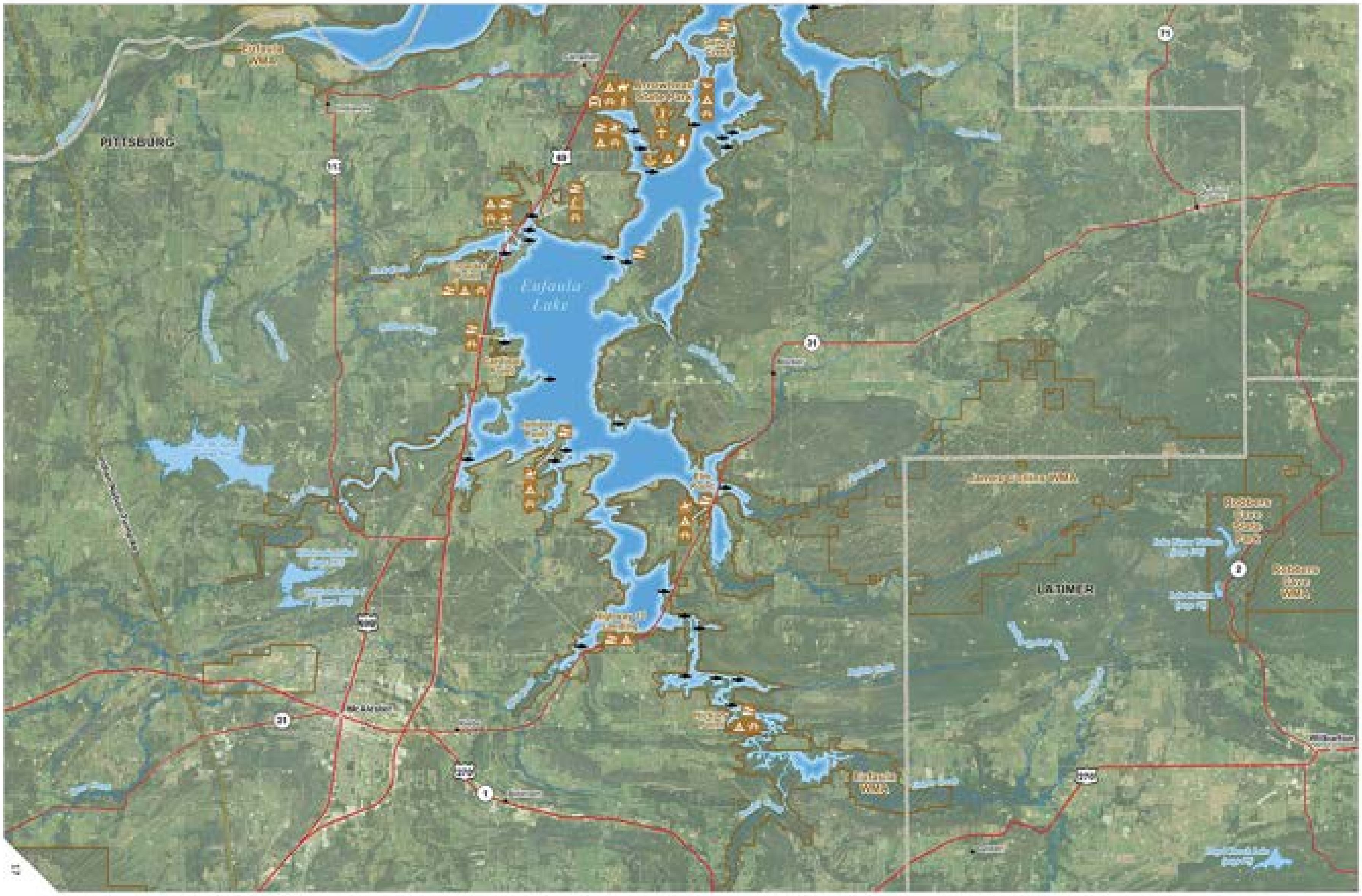

PITTSBURG
Eufaula WMA
Arrowhead State Park
Eufaula Lake
LATIMER
Robbers Cave State Park
Robbers Cave WMA
McAlester
Wilburton

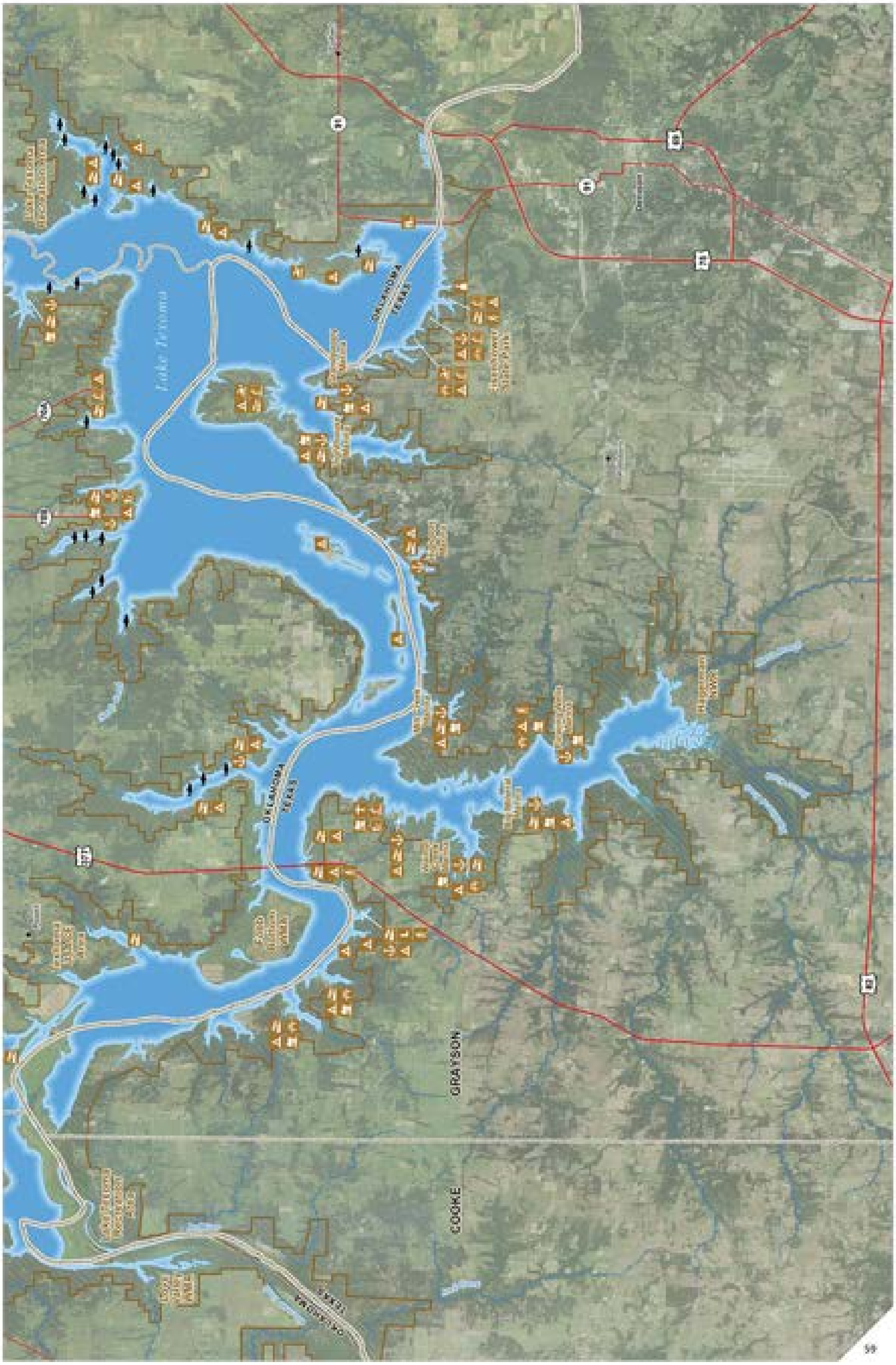
Texoma

US ARMY CORPS OF ENGINEERS

33.99933°N 96.57257°W
Normal Elevation: 616 ft

Area: 88,000 ac
Shoreline: 592.7 mi

Capacity: 2,722,000 ac-ft
Maximum Depth: 142 ft


Lake Texoma
OKLAHOMA
TEXAS
GRAYSON
COOKE
59

APPENDIX C. STANDARDIZED WINTER GILLNET SAMPLING FOR PADDLEFISH 2012-2023

A standardized Paddlefish gillnet consisted of two 91 m x 9.14 m (tied down or "hobbled" to 7.32 m) x 15.2 cm (bar mesh) negatively buoyant monofilament nets. Two nets were clipped together and deployed in tandem as a single 182m unit. Nets were suspended approximately 2m below the surface (to allow for safe watercraft travel over the net) via a combination of inflatable buoys at the start, middle, and end of each tandem set and a total of six expanded foam bullet floats clipped at approximate 1/5 intervals between buoys. Steel anchors were tied to the terminal ends of the tandem net.

Tandem nets were deployed in reservoirs perpendicular to and spanning the inundated river channel. Deployment occurred at approximately 0700hrs and nets soaked for approximately 8hrs until 1500hrs. Nets were checked *in situ* at least once during the day and cleared of all fish to minimize entanglement time and reduce mortality of Paddlefish. Nets were deployed in wintertime in cool water temperatures as an additional precaution against mortality (Bettoli and Scholten 2006).

A standardized sample consisted of ≥16 nets in one reservoir. Site selection consisted of a stratified random process. Candidate sites were identified at fixed intervals along the inundated channel and in all major tributaries or creek arms deeper than 9.14 m. Site numbers were randomly selected, sorted in order of downstream to upstream, and strategically paired and assigned to one of two crews (2 nets per crew x 2 crews x 4 days = 16 nets).

APPENDIX D. REVISED PADDLEFISH GILLNETTING POPULATION ASSESSMENT STANDARDIZED PROTOCOLS – SUMMER 2024

Objectives – standardized sampling methods for population assessment of Oklahoma Paddlefish reservoir stocks will focus on abundance estimation techniques in addition to standardized examination of population size structure, fish health/condition, sex ratios, relative weights, and catch rates. These revised methodologies will allow for assessment of angler exploitation when paired with self-reported harvest from e-check.

1. Equipment Specifications:
    a. Monofilament gillnets – Constructed of monofilament #208, 6" bar mesh (12" stretch with 3/8" poly foam float lines and 30# lead core, net segments have the dimensions of 300' x 30' (tied down/hobbled to 300' x 24' with nylon hobbles laced through the mesh). Two net segments are linked to create a standard 600' net that is negatively buoyant.
    b. Expanded foam bullet buoys – Bullet buoys are 14" long x 6" diameter tethered to the net using a 6' polypropylene rope and stainless net clips. Each segment of net is marked at 75' intervals on the float line for spacing of bullet floats (max of three per segment).
    c. Inflatable buoys – Each net is marked with a large (24") inflatable buoy at each end and a smaller (12" buoy) where the segments are joined. The buoys are tethered to the net's float line leads with 6' of polypropylene rope and stainless net clips.
    d. Anchors – Anchors are 24" and constructed from 5/8" steel oilfield sucker rod. At least 60' of polypropylene rope is affixed to each anchor and additional 60' segments are added when needed to maintain a safe ratio (i.e., anchor rope > 7 x distance from bottom of net to substrate) and prevent net drift in wind or channel current. Anchor ropes are tied to steel rings attached to the lead line of each net (one on each end of the net). When the inundated channel is near shore, anchoring the net on shore is preferred such that the net is fishing the nearest channel margin, if not the entire channel width.
2. Site Selection:
    a. Candidate sites for selection will be initially established at approximately 0.5 mi intervals along the inundated river channel (including side channels and tributaries) where water depth exceeds 30'. Netting boundaries may be individually defined within a reservoir based on depth, siltation, stands of timber, navigation channels, hazards, or other justification. Sample sites will be selected from a suite of all viable sample sites between the reservoir dam and the upper netting boundary. If the total number of candidate sites totals fewer than 60, then "half" site numbers may be used to increase the total number of sites available for random selection. For example, Kaw Lake only contains 39 sites, and the upper 6 sites are not utilized due to siltation, so sites 7.0, 7.5, 8.0 ... 38.0, 38.5, and 39.0 are used for random assignment for a total of 65 possible.

b. Randomized vs. Stratified vs. Fixed site selection – As the target species is a large, roaming, pelagic species with only vague association to the inundated river channel (compared to strong association to particular microhabitats observed with other sport fishes) catch rates will often vary among similar sites within reservoir. Therefore, at the biologists' discretion, randomly selected or fixed sites may be used within a reservoir. Smaller reservoirs may be adequately covered by a total of 12 sites in a single day, therefore fixed sites that avoid hazards may be prudent. However, for larger reservoirs with an abundance of possible sites and minimal hazards, daily randomization may allow for more adequate coverage of the entire reservoir during the sample period. For this latter site selection methodology, repetition of sites need not be avoided. Regardless of selection technique, selected sites are daily ordered numerically upstream to downstream and equally divided between the two crews. Twelve sites are sampled per day over the duration of 5-8 days, therefore a total of 60-96 sites are needed.

c. Exceptions –

   i. Grand Lake – historical samples in lower Grand Lake between Shangri La and Pensacola Dam resulted in very few Paddlefish captured, indicating a generalized preference for the remainder of the lake above Shangri La. Therefore, only those sites are considered candidates for selection. Depth limitations and the inability to navigate safely through Oogeechee flats necessitated that the upper netting boundary being established at Wilson Point. Although Paddlefish can be captured above Oogeechee flats, this upstream segment is not typically sampled due to the need for portage.

   ii. Lake Eufaula – Lake-wide samples of Lake Eufaula have revealed concentrations of Paddlefish in the Deep Fork and Gaines Creek arms of the reservoir, whereas catches were otherwise low. Therefore, efforts are currently targeted in those two areas.

3. <u>Standardized Units of Netting Effort:</u>

   a. Standard sample duration for Paddlefish stock assessment in reservoirs is 5 days. Exceptions include Grand Lake (8 days) and Lake Eufaula (8 days, split between Deep Fork and Gaines Creek arms). Sample is repeated each day, such that a day's sample achieves broad spatial coverage of the lake. This may be achieved by sequential randomization, or repetition of fixed sites (due to other limitations on site selection).

   b. Within a sample, two crews will deploy and retrieve 6 nets per crew, per day. Crews will launch from a central location when possible and disperse upstream and downstream. Nets will be deployed "outside-in" such that each crew's 6th net is proximal to that of the other crew. Once all nets are deployed, after a minimum soak time of 2 hours for any single net, the crews may begin retrieving nets in the order they were deployed. Catches will be variable, but perhaps predictably higher in known areas. Therefore, crews should alternate upstream or downstream on subsequent sample days and the crew with the lighter catch will assist the crew with the heavier catch in retrieval of their remaining net(s).

4. <u>Net Deployment and Retrieval Protocols:</u>

   a. Starting at 8am, nets are deployed generally perpendicular to the inundated river channel, the angle of which may be discretionarily selected based on wind forecasts, current, or other local variables. When the inundated river channel is wider than the length of the net, the net should be deployed to fish one of the channel margins.

b. Prior to deploying the net, a transect covering the intended deployment location should be floated while examining the substrate, depth profile, presence of sonar returns indicating fish, and to determine if there are any underwater hazards such as trees. Due to the cost of replacing nets, extra diligence to avoid hazards is necessary. When appropriate, the deployment location may be shifted upstream or downstream to avoid hazards. The shift distance may require use of an alternative site number, if appropriate (e.g., site G08 shifted to site G07.5).
c. Nets should be deployed in a linear fashion unless local conditions prevent it. Net should be free of twists and any significant snarls should be removed prior to deployment.
d. Use of bullet floats – Net segments are pre-marked at 75’ intervals on the float line for attachment of bullet floats. The purpose of bullet floats is to clearly mark the net as a warning to boaters. Bullet floats will be used when water depth is ≤30’. When deploying a net across the inundated channel, only part of the net may meet this depth criterion, therefore, only the shallow section should be affixed with bullet floats.
e. After a minimum soak time of 2 hours, nets should be fully retrieved and fish processed in real time. Fish should not be left waiting on the deck to be processed, therefore, pacing the net retrieval to match the rate of fish processing is essential to reduce fish stress and mortality.
f. Due to the cost of replacing nets, all fish should be extracted without intentionally damaging the net (except in very rare circumstances where fish removal requires cutting the net).

5. <u>Fish Processing:</u>
    a. Length - Body length measured flat on a table from anterior edge of eye to fork of tail. Measured in mm.
    b. Weight - Body weight measured in a sling/cradle from a hanging scale to nearest 0.1 kg.
    c. Sex - Sex is assigned for all fish based on external examination. For mature-sized fish (generally ≥750 mm), tuberculation on caudal fin determines assignment as male. Lack of tuberculation determines assignment as female. Immature fish may be labeled as juvenile and fish ≥750 mm for which sex cannot be confidently assigned may be labeled as unknown.
    d. Notations on fish condition - External morphology is examined for common observations (e.g., hook scars [HS], prop scars [PS], injuries [IN] or deformities [DF] with location noted, rostrum [RO] damages, etc.). Standardized terminology for locations and common notations will be used.
    e. Coded Wire Tags - Fish rostrums are scanned with T-Wand coded wire tag (CWT) detector to determine hatchery origin. Positive detections are noted and the anterior tip of the rostrum containing the CWT are removed with a knife, scanned to confirm presence of CWT in the sample, and the rostrum tip placed in an envelope with the band code from the fish for later dissection and decoding.
    f. Marking / Tagging Paddlefish – All fish will be uniquely marked with a jaw band containing an alpha-numeric code. The prefix of the band code will be a single letter corresponding to the river system of capture (e.g., G – Grand/Neosho

River, A – Arkansas River, C – Canadian River, V – Verdigris River, and R – Red River). Following the prefix, the band code will contain five numerical digits ranging 00001 to 99999. Some band codes produced in the early 2000's contained only four numerical digits, however for database purposes, the format of five numerical digits is required for validation (i.e., G0123 is recorded as G00123).

g. Secondary marking within sample period – Within a sample period, fish are marked secondarily for rapid identification using a 4mm punch on the 2nd to 3rd soft rays of the left pectoral fin at approximately ≥50% of the length of the fin. As the utility of this secondary mark is intended to be brief (only within the sample period), placing the punch closer to the tip of the fin than the fin's origin will likely render the mark undetectable by the following year. For the purposes of population estimation (see below), application of the fin punch will serve as the estimation "Mark" and subsequent captures of fin-punched fish within the sample period will serve as the "Recaptures". This will allow rapid daily summarization of Mark/Recapture statistics prior to full data entry and analysis of individual capture histories using band codes.
    i. Within the sample period, fish captured bearing a fin punch will not be weighed, measured, or examined subsequent times, as no growth or physical changes are expected and additional measurements would only introduce variability. However, any observations of physical issues potentially related to capture stress or injury sustained during the sample period should be noted.

h. All fish should be released in the immediate vicinity of the capture location and not displaced.

6. <u>Stock Assessment and Analyses:</u>
    a. Population estimation will utilize a Schnabel Census with repeated sampling. Model assumptions are met within the sampling period because angler harvest is known via e-check and fish are unlikely to enter or leave the system via other means during the sample duration. Fin punches will serve as a secondary mark that is immediately identifiable as a recapture within the sample, though band codes will serve as the primary mark. The presence of a fin punch with no band will be evidence of tag loss (i.e., band removal by angler).
        i. Full population estimation within a reservoir stock will be performed based on all fish captured.
        ii. "Harvestable" size population estimation will be restricted to fish ≥800 mm in body length, based on earlier precedent. If catch rates and size structure allows it, estimation of abundance for other population sub-segments may be performed.
        iii. Any observed mortalities, which are rare, will be removed from estimation calculation. Any fish captured during the sample period, banded, and then harvested (verified via e-check) will also be removed from analyses.
    b. Size structure of individual fish will be examined through the construction of length histograms with 25 mm size bins (for all fish, males only, and females only). Specific attention will be given to multi-modal length distributions, as they likely represent episodic recruitment events.

i. Comparison of population length groups to known length-at-age data for the reservoir stock will be performed when possible.
ii. Presence of Paddlefish ≤450mm in body length (putative age-1 fish) will be evidence of probable recruitment in the previous year.

c. Relative weights will be calculated for all fish for which sex was determined at capture. Average relative weight by sex will be calculated for comparison to other reservoir stocks.
d. Frequency of external deformities and injuries will be summarized by type and frequency for comparison to other stocks.

7. <u>Sampling for Age Structure within a Stock:</u>
   a. Periodically, stocks should be examined for age/size structure. Harvested fish should be preferentially utilized for collection of dentary bones. These efforts should be aligned with access point creel surveys and/or coordinated with fishing guides. Additional samples can be taken from voucher specimens captured via nets. Voucher specimens should be taken after the completion of population estimate.
   b. When paddlefish are taken from angler harvest or sacrificed, sex should be verified internally, and weights of gonad and gonadal fat should be collected for calculation of gonadosomatic index (GSI) and gonadal fat bodies (GFB).

APPENDIX E. SUMMARY OF PADDLEFISH STOCKING IN OKLAHOMA WATERS 2006-2017

Stocking Year	Tag Date	Agency	Data 1	Data 2	Sequence Range	Sequence Range	Release Location	Number of Fish Tagged	Year Class	Release Date	Age @ Release (Months)	Mean Total Length (mm)
2006	6/27/06	25	56	08	16803	18493	Lake Texoma	852	2006	6/27/06	2.9	
2006	6/28/06	25	56	08	18496	20357	Lake Texoma	869	2006	8/30/06	5.0	
2006	6/29/06	25	56	08	20358	21911	Lake Texoma	405	2006	6/29/06	3.0	
2006	7/5/06	25	56	08	21942	23485	Lake Texoma	437	2006	8/29/06	5.0	
2006	7/6/06	25	56	08	23490	24673	Lake Texoma	852	2006	8/24/06	4.8	
2006	6/27/06	25	56	09	10696	13213	Lake Texoma	700	2006	6/27/06	2.9	
2006	6/28/06	25	56	09	13221	17912	Lake Texoma	750	2006	8/31/06	5.1	
2006	6/29/06	25	56	09	17913	19776	Lake Texoma	400	2006	6/29/06	3.0	
2006	7/5/06	25	56	09	19788	21304	Lake Texoma	300	2006	8/30/06	5.0	
2006	7/6/06	25	56	09	21309	24930	Lake Texoma	500	2006	8/24/06	4.8	
2006	7/6/06	25	56	10	00229	03409	Lake Texoma	500	2006	8/24/06	4.8	
2006	7/6/06	25	56	10	03430	03549	Lake Texoma	500	2006	8/25/06	4.9	
2006	7/6/06	25	56	10	03564	07275	Lake Texoma	500	2006	8/25/06	4.9	
2006	6/29/06	25	56	10	07280	08652	Lake Texoma	400	2006	6/29/06	3.0	
2006	7/5/06	25	56	10	08661	09215	Lake Texoma	300	2006	8/30/06	5.0	
2006	6/28/06	25	56	10	09222	12245	Lake Texoma	750	2006	9/21/06	5.8	
2006	7/6/06	25	56	10	25159	26838	Lake Texoma	500	2006	8/25/06	4.9	
2007	8/21/07	25	56	10	27222	29963	Lake Eufaula	1,028	2007	8/21/07	4.7	
2007	8/22/07	25	56	10	29968	35173	Lake Texoma	2,029	2007	8/22/07	4.8	
2008	7/23/08	25	56	10	35506	36775	Lake Eufaula	503	2008	7/23/08	3.8	
2008	7/24/08	25	56	10	36783	40746	Lake Eufaula	1,853	2008	7/24/08	3.8	
2008	8/19/08	25	56	10	40812	42188	Lake Eufaula	440	2008	8/19/08	4.7	
2008	7/23/08	25	56	11	00129	01630	Lake Eufaula	500	2008	7/23/08	3.8	
2008	7/24/08	25	56	11	01638	05970	Lake Eufaula	1,000	2008	7/25/08	3.8	
2008	7/23/08	25	56	14	00152	02507	Grand Lake	1,000	2008	7/30/08	4.0	
2008	7/23/08	25	56	14	04701	07340	Grand Lake	1,000	2008	7/30/08	4.0	
2009	7/7/09	25	56	10	42620	45507	Lake Eufaula	2,067	2009	7/7/09	3.2	
2009	7/8/09	25	56	10	48645	49638	Lake Eufaula	1,731	2009	7/9/09	3.3	
2009	7/7/09	25	56	11	05995	08811	Lake Eufaula	2,000	2009	7/8/09	3.3	
2009	7/8/09	25	56	11	11384	16964	Lake Eufaula	1,000	2009	7/9/09	3.3	
2009	7/13/09	25	56	11	16971	20823	Lake Eufaula	1,178	2009	7/15/09	3.5	
2009	7/14/09	25	56	11	20830	22883	Grand Lake	500	2009	7/22/09	3.7	
2009	7/14/09	25	56	11	22890	25175	Lake Eufaula	800	2009	7/15/09	3.5	
2009	7/8/09	25	56	11	25176	30088	Lake Eufaula	1,000	2009	7/9/09	3.3	
2009	7/13/09	25	56	11	30093	32715	Lake Eufaula	1,000	2009	7/15/09	3.5	
2009	7/14/09	25	56	11	32722	33794	Grand Lake	500	2009	7/22/09	3.7	
2009	7/14/09	25	56	11	33800	42234	Lake Eufaula	800	2009	7/15/09	3.5	
2009	7/15/09	25	56	11	42241	49755	Lake Eufaula	2,250	2009	7/16/09	3.5	
2009	7/15/09	25	56	12	00103	01649	Lake Eufaula	1,500	2009	7/16/09	3.5	
2009	7/16/09	25	56	12	01655	06839	Lake Eufaula	2,261	2009	7/17/09	3.6	
2009	7/20/09	25	56	12	06845	13410	Lake Eufaula	2,694	2009	7/21/09	3.7	

2009	7/21/09	25	56	12	13416	20461	Lake Eufaula	2,789	2009	7/22/09	3.7	
2009	7/22/09	25	56	12	20467	24666	Lake Eufaula	1,647	2009	7/23/09	3.8	
2009	7/15/09	25	56	13	00105	01104	Lake Eufaula	1,500	2009	7/16/09	3.5	
2009	7/16/09	25	56	13	01110	06492	Lake Eufaula	1,500	2009	7/17/09	3.6	
2009	7/20/09	25	56	13	06498	12380	Lake Eufaula	2,000	2009	7/21/09	3.7	
2009	7/21/09	25	56	13	12386	19978	Lake Eufaula	2,500	2009	7/23/09	3.8	
2009	7/22/09	25	56	13	19984	24781	Lake Eufaula	1,500	2009	7/24/09	3.8	
2009	7/14/09	25	56	14	02532	04694	Grand Lake	525	2009	7/14/09	3.5	
2009	7/14/09	25	56	14	07360	08956	Grand Lake	500	2009	7/14/09	3.5	
2009	7/24/09	25	95	01	00157	03560	Lake Eufaula	1,354	2009	7/24/09	3.8	
2009	7/29/09	25	95	01	03566	06363	Lake Eufaula	1,223	2009	7/31/09	4.0	
2009	7/24/09	25	95	01	15024	17950	Lake Eufaula	1,000	2009	7/24/09	3.8	
2009	7/29/09	25	95	01	17956	21143	Lake Eufaula	1,000	2009	7/31/09	4.0	
2010	7/19/10	25	56	15	00139	04508	Lake Eufaula	1,500	2010	7/19/10	3.6	
2010	7/19/10	25	56	15	04519	05989	Lake Eufaula	500	2010	7/20/10	3.7	
2010	7/20/10	25	56	15	06000	08252	Lake Eufaula	941	2010	7/20/10	3.7	
2010	7/20/10	25	56	15	08263	12615	Lake Eufaula	1,500	2010	7/21/10	3.7	
2010	8/9/10	25	56	15	12626	14977	Grand Lake	500	2010	8/11/10	4.4	
2010	8/9/10	25	56	15	14986	18657	Lake Eufaula	1,878	2010	8/11/10	4.4	
2010	8/10/10	25	56	15	18668	21835	Lake Eufaula	1,556	2010	8/11/10	4.4	
2010	10/12/10	25	56	15	22009	26067	Lake Eufaula	1,493	2010	10/13/10	6.5	
2010	8/9/10	25	56	15	28876	30075	Grand Lake	500	2010	8/11/10	4.4	
2010	8/9/10	25	56	15	30081	34048	Lake Eufaula	1,000	2010	8/11/10	4.4	
2010	8/10/10	25	56	15	34059	38326	Lake Eufaula	1,200	2010	8/11/10	4.4	
2010	7/19/10	25	95	01	06404	11683	Lake Eufaula	2,059	2010	07/19/10	3.6	
2010	7/19/10	25	95	01	11695	13129	Lake Eufaula	597	2010	7/20/10	3.7	
2010	7/20/10	25	95	01	13140	22655	Lake Eufaula	1,000	2010	7/20/10	3.7	
2010	7/20/10	25	95	01	22666	27363	Lake Eufaula	1,818	2010	7/21/10	3.7	
2010	8/9/10	25	95	01	27374	29461	Grand Lake	1,000	2010	8/11/10	4.4	
2011	8/3/2011	25	56	15	26116	28750	Lake Eufaula	1,000	2011	8/4/2011	4.2	306
2011	8/3/2011	25	56	15	28751	42931	Lake Eufaula	1,000	2011	8/4/2011	4.2	306
2011	8/8/2011	25	56	15	42974	45639	Lake Eufaula	1,057	2011	8/10/2011	4.4	333
2011	8/9/2011	25	56	15	45673	47771	Lake Eufaula	982	2011	8/10/2011	4.4	298
2011	8/9/2011	25	56	15	47778	49498	Lake Eufaula	600	2011	8/11/2011	4.4	311
2011	8/29/2011	25	56	15	49535	51438	Lake Eufaula	700	2011	8/30/2011	5.0	383
2011	8/29/2011	25	56	15	51444	52226	Grand Lake	250	2011	9/1/2011	5.1	383
2011	8/29/2011	25	56	15	52232	52917	Lake Eufaula	247	2011	12/6/2011	8.3	482
2011	8/3/2011	25	56	15	57501	57660	Lake Eufaula	905	2011	8/4/2011	4.2	306
2011	8/9/2011	25	56	15	58640	61707	Lake Eufaula	1,000	2011	8/10/2011	4.4	298
2011	8/9/2011	25	56	15	61726	63388	Lake Eufaula	692	2011	8/11/2011	4.4	311
2011	8/29/2011	25	56	15	63434	65216	Lake Eufaula	744	2011	8/30/2011	5.0	383
2011	8/29/2011	25	56	15	65217	65945	Grand Lake	255	2011	9/1/2011	5.1	383
2011	8/29/2011	25	56	15	65954	66691	Lake Eufaula	250	2011	12/6/2011	8.3	482
2012	7/23/2012	25	56	15	52947	57319	Lake Eufaula	1,500	2012	7/23/2012	3.8	288
2012	7/23/2012	25	56	15	66733	72219	Lake Eufaula	1,503	2012	7/23/2012	3.8	288
2012	7/23/2012	25	56	16	00206	02330	Lake Eufaula	1,500	2012	7/23/2012	3.8	288
2012	7/24/2012	25	56	16	02336	10119	Lake Eufaula	2,569	2012	7/24/2012	3.8	297
2012	7/25/2012	25	56	16	10125	17547	Lake Eufaula	2,831	2012	7/25/2012	3.8	280

2012	7/30/2012	25	56	16	17553	22836	Lake Eufaula	1,500	2012	7/31/2012	4.0	306
2012	7/31/2012	25	56	16	22861	28057	Lake Eufaula	1,755	2012	8/1/2012	4.1	323
2012	8/1/2012	25	56	16	28090	28532	Lake Eufaula	1,538	2012	8/1/2012	4.1	334
2012	7/24/2012	25	56	17	00144	05710	Lake Eufaula	2,500	2012	7/24/2012	3.8	297
2012	7/25/2012	25	56	17	05716	12462	Lake Eufaula	2,500	2012	7/26/2012	3.9	280
2012	7/30/2012	25	56	17	12470	15820	Lake Eufaula	1,798	2012	7/31/2012	4.0	306
2012	7/31/2012	25	56	17	15849	19767	Lake Eufaula	1,750	2012	8/1/2012	4.1	323
2012	8/1/2012	25	56	17	19796	25466	Lake Eufaula	1,500	2012	8/2/2012	4.1	334
2012	8/2/2012	25	56	17	25662	28516	Lake Eufaula	1,000	2012	8/2/2012	4.1	310
2012	8/1/2012	25	56	18	00115	05895	Lake Eufaula	1,500	2012	8/2/2012	4.1	334
2012	8/2/2012	25	56	18	05924	09065	Lake Eufaula	481	2012	8/2/2012	4.1	310
2012	8/8/2012	25	56	18	09096	18778	Lake Eufaula	2,924	2012	8/15/2012	4.5	300
2012	8/14/2012	25	56	18	18802	28553	Lake Eufaula	2,500	2012	8/15/2012	4.5	312
2012	8/2/2012	25	56	18	28870	29846	Lake Eufaula	1,000	2012	8/2/2012	4.1	310
2012	8/8/2012	25	56	18	29882	38101	Lake Eufaula	3,000	2012	8/8/2012	4.3	300
2012	8/14/2012	25	56	18	38124	48135	Lake Eufaula	3,022	2012	8/15/2012	4.5	312
2012	10/17/2012	25	56	18	48163	54099	Lake Eufaula	2,158	2012	10/23/2012	6.8	436
2012	8/14/2012	25	56	18	57599	60234	Lake Eufaula	2,500	2012	8/15/2012	4.5	312
2012	8/23/2012	25	56	18	60259	60324	Grand Lake	20	2012	8/28/2012	5.0	448
2012	8/23/2012	25	56	18	60329	62497	Grand Lake	881	2012	8/28/2012	5.0	390
2012	10/15/2012	25	56	18	62530	70020	Grand Lake	2,003	2012	10/17/2012	6.6	423
2012	10/16/2012	25	56	18	70070	79180	Lake Eufaula	3,062	2012	10/17/2012	6.6	423
2012	10/17/2012	25	56	18	79200	80449	Lake Eufaula	466	2012	10/18/2012	6.7	395
2013	8/7/2013	25	56	18	54162	57224	Lake Eufaula	1240	2013	8/9/2013	4.3	300
2013	8/13/2013	25	56	20	00125	02080	Lake Eufaula	756	2013	8/14/2013	4.5	283
2013	8/14/2013	25	56	20	02100	08959	Lake Eufaula	2698	2013	8/15/2013	4.5	290
2013	8/19/2013	25	56	20	08992	22009	Lake Eufaula	4,977	2013	8/20/2013	4.7	290
2013	7/9/2013	25	56	20	28958	38996	Lake Eufaula	4058	2013	7/10/2013	3.3	302
2013	8/7/2013	25	56	20	39029	48585	Lake Eufaula	3781	2013	8/9/2013	4.3	300
2013	8/12/2013	25	56	20	48624	53775	Grand Lake	2052	2013	8/14/2013	4.5	283
2013	8/13/2013	25	56	20	53811	57218	Lake Eufaula	1373	2013	8/14/2013	4.5	283
2014	7/15/2014	25	56	19	28751	34620	Lake Eufaula	1517	2014	7/15/2014	3.5	292
2014	7/16/2014	25	56	19	34656	42368	Lake Eufaula	2777	2014	7/16/2014	3.5	257
2014	7/17/2014	25	56	19	42376	48520	Lake Eufaula	2110	2014	7/18/2014	3.6	257
2014	7/23/2014	25	56	19	48549	51355	Lake Eufaula	975	2014	7/23/2014	3.8	259
2014	8/14/2014	25	56	19	52782	57501	Grand Lake	1000	2014	8/15/2014	4.5	294
2014	3/24/2014	25	56	20	22024	23647	Lake Eufaula	367	2012	3/24/2014	24	745
2014	7/15/2014	25	56	20	23695	57228	Lake Eufaula	1500	2014	7/15/2014	3.5	292
2014	7/15/2014	25	56	21	00000	01216	Lake Eufaula	1500	2014	7/15/2014	3.5	292
2014	7/16/2014	25	56	21	01243	07720	Lake Eufaula	2500	2014	7/16/2014	3.5	257
2014	7/17/2014	25	56	21	07722	12737	Lake Eufaula	2000	2014	7/18/2014	3.6	257
2014	7/23/2014	25	56	21	12753	14641	Lake Eufaula	800	2014	7/23/2014	3.8	259
2014	10/6/2014	25	56	21	14671	16421	Lake Eufaula	600	2014	10/6/2014	6.3	275
2014	8/14/2014	25	56	21	28751	29613	Grand Lake	1005	2014	8/15/2014	4.5	294
2014	10/6/2014	25	56	21	34709	36594	Lake Eufaula	743	2014	10/6/2014	6.3	275
2015	8/18/2015	25	56	19	00000	02890	Lake Eufaula	2000	2015	8/20/2015	4.7	278
2015	9/2/2015	25	56	19	03466	05116	Lake Eufaula	406	2015	9/3/2015	5.2	428
2015	9/2/2015	25	56	19	05117	12138	Lake Eufaula	1825	2015	9/3/2015	5.2	297

2015	9/8/2015	25	56	19	12535	17952	Lake Eufaula	2092	2015	9/10/2015	5.4	307
2015	7/13/2015	25	56	21	16444	26708	Lake Eufaula	3820	2015	7/13/2015	3.4	276
2015	7/14/2015	25	56	21	26723	28751	Lake Eufaula	2558	2015	7/14/2015	3.5	264
2015	7/13/2015	25	56	21	36626	44266	Lake Eufaula	3000	2015	7/15/2015	3.5	276
2015	7/14/2015	25	56	21	44284	51735	Lake Eufaula	2000	2015	7/15/2015	3.5	264
2015	9/2/2015	25	56	21	51773	52569	Lake Eufaula	300	2015	9/3/2015	5.2	428
2015	9/2/2015	25	56	21	52569	56464	Lake Eufaula	1500	2015	9/3/2015	5.2	297
2015	7/14/2015	25	56	21	57609	66978	Lake Eufaula	2400	2015	7/14/2015	3.5	264
2015	8/7/2015	25	56	21	67002	72157	Grand Lake	2035	2015	8/11/2015	4.4	288
2015	8/18/2015	25	56	21	72175	80702	Lake Eufaula	2048	2015	8/20/2015	4.7	278
2016	7/11/2016	25	56	19	20198	23516	Lake Eufaula	1006	2016	7/11/2016	3.4	263
2016	7/11/2016	25	56	19	23531	28750	Lake Eufaula	1861	2016	7/12/2016	3.4	270
2016	9/6/2016	25	56	22	00000	02720	Lake Eufaula	880	2016	9/8/2016	5.3	265
2016	7/11/2016	25	56	23	00000	02461	Lake Eufaula	1000	2016	7/11/2016	3.4	263
2016	7/11/2016	25	56	23	02468	06057	Lake Eufaula	1000	2016	7/12/2016	3.4	270
2016	8/2/2016	25	56	23	06126	09995	Lake Eufaula	1000	2016	8/2/2016	4.1	315
2016	8/2/2016	25	56	23	10007	14590	Lake Eufaula	1695	2016	8/3/2016	4.1	305
2016	8/3/2016	25	56	23	14613	25010	Lake Eufaula	3079	2016	8/4/2016	4.2	275
2016	8/16/2016	25	56	23	25030	28750	Grand Lake	1112	2016	9/28/2016	6.0	377
2016	8/2/2016	25	56	23	28751	32029	Lake Eufaula	1564	2016	8/2/2016	4.1	315
2016	8/2/2016	25	56	23	32035	35365	Lake Eufaula	1000	2016	8/3/2016	4.1	305
2016	8/3/2016	25	56	23	35383	42587	Lake Eufaula	3000	2016	8/4/2016	4.2	275
2016	8/16/2016	25	56	23	42610	45200	Grand Lake	1000	2016	9/28/2016	6.0	377
2016	8/16/2016	25	56	23	45202	49227	Lake Eufaula	1000	2016	8/18/2016	4.6	304
2016	8/16/2016	25	56	23	49232	52937	Lake Eufaula	1000	2016	8/18/2016	4.6	304
2016	8/22/2016	25	56	23	52953	57501	Lake Eufaula	2000	2016	8/23/2016	4.8	304
2016	8/16/2016	25	56	23	57502	61227	Lake Eufaula	1521	2016	8/18/2016	4.6	304
2016	8/16/2016	25	56	23	61239	65145	Lake Eufaula	1572	2016	8/18/2016	4.6	304
2016	8/22/2016	25	56	23	65166	73687	Lake Eufaula	2967	2016	8/23/2016	4.8	304
2016	9/6/2016	25	56	23	74508	83649	Lake Eufaula	2829	2016	9/7/2016	5.3	265
2016	9/6/2016	25	56	23	83656	86252	Lake Eufaula	800	2016	9/8/2016	5.3	265
2016	9/6/2016	25	56	23	86253	92803	Lake Eufaula	2500	2016	9/7/2016	5.3	265
2017	8/24/2017	25	56	19	57615	59980	Lake Eufaula	1053	2017	8/25/2017	4.9	335
2017	10/24/2017	25	56	19	59995	65729	Lake Eufaula	2040	2017	10/24/2017	6.9	387
2017	11/29/2017	25	56	19	65745	66249	Lake Eufaula	198	2017	11/29/2017	8.1	387
2017	8/24/2017	25	56	22	28907	31521	Lake Eufaula	800	2017	8/25/2017	4.9	335
2017	10/24/2017	25	56	22	31549	35190	Lake Eufaula	1500	2017	10/24/2017	6.9	387

APPENDIX F. ARKANSAS RIVER PADDLEFISH KILL MEMO JULY 2024

Memo: Arkansas River Paddlefish Kill July 7-8, 2024

On July 8, 2024, at approximately noon, we (Oklahoma Department of Wildlife Conservation [ODWC], Jenks Office) received a phone call from a concerned angler regarding dead and dying paddlefish in the Arkansas River below Keystone Dam in Sand Springs, Tulsa County. We reported the event via voicemail to ODWC fish kill coordinator, Elaine Gainer. At approximately 1300hrs, we (Jason Schooley - Senior Fisheries Biologist, Matt Pallett - Fisheries Technician, and Caleb Taylor - Fisheries Technician) arrived at Swift Park (36.138711, -96.238321), the most proximal boat ramp to Keystone Dam to survey the scene (Fig. 1). Dead paddlefish were immediately evident to have washed down from the dam to the river margins both upstream and downstream of the boat ramp. The angler who had called in the report was still on the scene, so we gathered information from his observations prior to launching a boat.

We searched the river within an approximate 1.85 mile stretch of the river bounded by rocky hazards upstream (36.143923, -96.246022) and a downstream riffle (36.142189, -96.216384), which prevented expansion of the search area by boat. Within the search area, we encountered 39 dead paddlefish, 3 longnose gar, 2 smallmouth buffalo, and 2 freshwater drum. We did observe one or more live paddlefish and a number of other live fish in the search area. Condition of dead fish varied, indicating that fish died at different times, perhaps over the course of several days. Hydropower release data from Keystone Dam indicates that during July 6-8, 2024, there were extended periods of zero water discharge followed by extended periods of 6,300 cu. ft/sec (Fig. 2). The latter flow condition is what we observed while on the scene, therefore, dead fish may have been actively dispersing with the river flow and our observations likely do not capture the extent of the fish kill. Considering the pattern of release data prior to the fish kill, where hydropower releases are ramped-up or ramped-down (i.e., data recordings of 200 or 400 cu. ft/sec both before and after transitioning from 0 to 6,300 or from 6,300 to 0), it is unusual that only twice in the period examined in Fig. 2, was a "ramp-up" absent- 6/30 and 7/8.

We recovered carcasses of 36 paddlefish for examination (Figures 3-7). An additional three paddlefish were not physically examined due to advanced decay. We measured each fish for body length (eye to fork), removed dentary bones for later age analysis, and opened the body cavity to confirm sex (Table 1). Some fish were too decayed for confidence in sex assignment (Fig. 6). Fish were not weighed due to advanced decay, however several paddlefish were fully intact and appeared to have recently died within hours of our arrival.

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Internal examination indicated that 9 paddlefish were male, 18 female, and 8 undetermined. Overall, fish were found to exhibit enhanced gonadal fat reserves more typical of reservoir-dwelling paddlefish, compared to river fish (which are typically leaner). However, no weights were collected. Only one female had eggs, however mature females should be in post-spawn condition or possibly in the initial stages of developing new eggs.

Although the source of the fish kill is not known with certainty, we hypothesize that the fish succumbed to a combination of warm water (≥30 degrees Celsius) and low dissolved oxygen during a period of zero discharge from Keystone Dam. Compounding those conditions, it is possible that paddlefish were stranded or crowded in a dewatered area of the dam tailrace during the period of zero discharge. The lack of observation of smaller fish or smaller species in the fish kill may lend credence to this hypothesis, as smaller bodied fishes may have been able to escape the area.

To approximate the minimum monetary value of the loss of this fisheries resource, we can apply the $21.53 per pound replacement value from *Investigation and Monetary Values of Fish and Freshwater Mollusk Kills* by Southwick and Loftus (American Fisheries Society Special Publication 35). Using known relationships of length and weight for paddlefish in Oklahoma (Table 2), we can assign an estimated weight to each fish (Table 1). Therefore, the total monetary value loss of the 34 measured paddlefish is $22,293.63. However, the true value of the fish kill cannot be estimated or known.

At the completion of our observations at approximately 1700hrs on July 8, 2024, fish kill was reported to the fish kill reporting hotline and relevant details were conveyed to the Department of Environmental Quality.

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Table 1. Summary of data collected from 36 dead paddlefish recovered from the Arkansas River near Swift Park, Sand Springs, Tulsa County on July 8, 2024.

FishID	Body Length (in)	Sex	Dentary Taken	Comments	Estimated weight (lbs)
A01	32	M	y	intact	19.8
A02	35	U	y	partial evisceration	23.1
A03	40	F	y	leathery, partial evisceration	35.9
A04	36	M	y	fresh dead, intact	26.4
A05	41	F	y	intact	38.7
A06	42	F	y	fresh dead, intact	41.7
A07	35	M	y	fresh dead, intact	24.7
A08	32	M	y	rotten, intact	19.8
A09	N/A	N/A	N/A	number not used	N/A
A10	41	F	y	upturned rostrum, intact, rotten	38.7
A11	35	M	y	rotten, intact	24.7
A12	N/A	U	y	very rotten, unable to measure	N/A
A13	36	U	y	no viscera	25.1
A14	40	F	y	rotten, intact	35.9
A15	N/A	U	y	very rotten, unable to measure	N/A
A16	42	F	y	rotten, intact	41.7
A17	38	F	y	fillet removed, intact	30.6
A18	36	F	y	intact	25.9
A19	34	M	y	intact	23.0
A20	37	F	y	intact	28.2
A21	41	F	y	intact	38.7
A22	43	F	y	intact	44.9
A23	43	F	y	rotten, intact	44.9
A24	40	U	y	missed sex, rotten, intact	34.0
A25	37	F	y	gravid, rotten, intact	28.2
A26	41	F	y	none	38.7
A27	38	M	y	intact	30.2
A28	38	U	y	partial evisceration	29.3
A29	38	F	y	fresh dead, intact	30.6
A30	32	U	y	partial evisceration	17.9
A31	40	F	y	fresh dead, intact	35.9
A32	35	F	y	fresh dead, intact	23.8
A33	33	M	y	fresh dead, head curvature	21.4
A34	40	F	y	fresh dead, intact	35.9
A35	37	M	y	fresh dead, intact	28.3
A36	33	U	y	rotten, intact	19.5
A37	40	M	y	fresh dead, intact	34.2
				Total:	1040.3

Table 2. Table of values used by ODWC to approximate paddlefish weight using length. The right column "Other Oklahoma Waters" is likely most appropriate for use in the Arkansas River below Keystone Dam.

Estimated weight in pounds for combined sexes / females / males				
Eye to Fork Length (inches)	Grand, Hudson, and Ft. Gibson lakes	Kaw and Keystone lakes	Oologah Lake	Other Oklahoma waters
30	16.5 / 14.6 / 15.5	17.6 / 21.5 / 20	15.8 / 17.4 / 17.2	14.8 / 14.7 / 16.9
31	18.2 / 16.1 / 17	19.5 / 23.9 / 21.9	17.4 / 19.2 / 18.8	16.3 / 16.3 / 18.3
32	20.1 / 17.9 / 18.7	21.5 / 26.6 / 24	19.1 / 21.2 / 20.5	17.9 / 18 / 19.8
33	22.2 / 19.7 / 20.5	23.7 / 29.4 / 26.2	21 / 23.2 / 22.3	19.5 / 19.8 / 21.4
34	24.3 / 21.6 / 22.4	26 / 32.4 / 28.4	22.9 / 25.4 / 24.1	21.3 / 21.7 / 23
35	26.7 / 23.7 / 24.4	28.5 / 35.7 / 30.9	24.9 / 27.7 / 26.1	23.1 / 23.8 / 24.7
36	29.1 / 26 / 26.5	31.1 / 39.1 / 33.4	27.1 / 30.2 / 28.1	25.1 / 25.9 / 26.4
37	31.7 / 28.3 / 28.7	33.9 / 42.8 / 36.1	29.4 / 32.8 / 30.3	27.2 / 28.2 / 28.3
38	34.5 / 30.8 / 31	36.9 / 46.7 / 38.9	31.8 / 35.6 / 32.6	29.3 / 30.6 / 30.2
39	37.4 / 33.5 / 33.5	40.1 / 50.9 / 41.8	34.3 / 38.5 / 34.9	31.6 / 33.2 / 32.2
40	40.4 / 36.3 / 36.1	43.4 / 55.3 / 44.9	37 / 41.5 / 37.4	34 / 35.9 / 34.2
41	43.7 / 39.2 / 38.8	46.9 / 60 / 48.2	39.7 / 44.8 / 40	36.5 / 38.7 / 36.4
42	47.1 / 42.3 / 41.6	50.6 / 64.9 / 51.5	42.7 / 48.1 / 42.6	39.2 / 41.7 / 38.6
43	50.7 / 45.6 / 44.6	54.4 / 70.1 / 55.1	45.7 / 51.7 / 45.4	41.9 / 44.9 / 40.9
44	54.5 / 49.1 / 47.7	58.5 / 75.7 / 58.7	48.9 / 55.4 / 48.3	44.8 / 48.2 / 43.3
45	58.4 / 52.7 / 51	62.8 / 81.5 / 62.6	52.3 / 59.3 / 51.3	47.8 / 51.7 / 45.7
46	62.6 / 56.5 / 54.4	67.3 / 87.6 / 66.6	55.8 / 63.4 / 54.5	50.9 / 55.3 / 48.3
47	66.9 / 60.5 / 58	72 / 94 / 70.7	59.4 / 67.6 / 57.7	54.2 / 59.1 / 50.9
48	71.5 / 64.6 / 61.7	76.9 / 100.7 / 75	63.3 / 72.1 / 61.1	57.6 / 63.1 / 53.6
49	76.2 / 69 / 65.5	82.1 / 107.8 / 79.5	67.2 / 76.7 / 64.6	61.2 / 67.2 / 56.4
50	81.2 / 73.6 / 69.5	87.4 / 115.2 / 84.2	71.3 / 81.5 / 68.2	64.8 / 71.5 / 59.2
51	86.4 / 78.4 / 73.7	93.1 / 122.9 / 89	75.6 / 86.5 / 71.9	68.6 / 76.1 / 62.2
52	91.8 / 83.3 / 78	98.9 / 131 / 94	80.1 / 91.8 / 75.8	72.6 / 80.8 / 65.2
53	97.4 / 88.5 / 82.5	105 / 139.5 / 99.2	84.7 / 97.2 / 79.8	76.7 / 85.7 / 68.3
54	103.3 / 93.9 / 87.2	111.4 / 148.3 / 104.5	89.5 / 102.9 / 83.9	81 / 90.8 / 71.5
55	109.4 / 99.6 / 92	118 / 157.5 / 110.1	94.5 / 108.7 / 88.2	85.4 / 96.1 / 74.8

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Figure 1. Location of paddlefish kill on the Arkansas River below Keystone Dam July 8, 2024. The search area is indicated between the green boundary lines and Swift Park is indicated on the South shore.

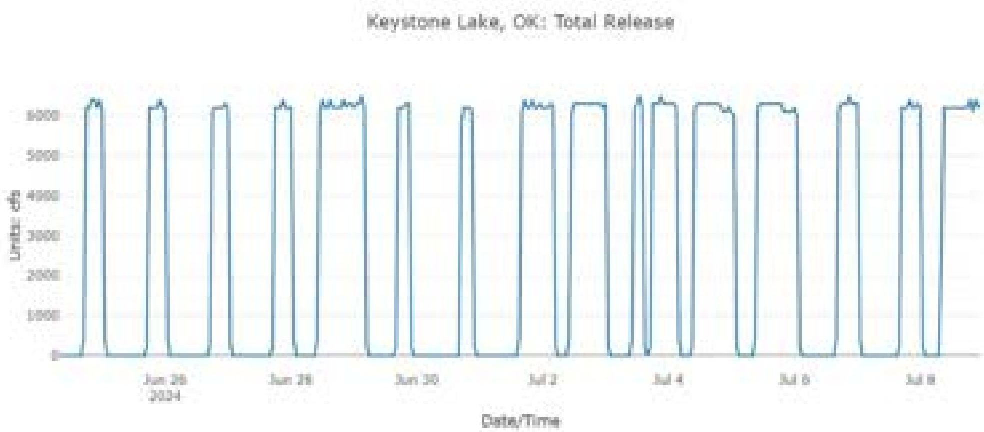

Figure 2. Total release data for Keystone Dam prior to fish kill on July 8, 2024. Source: https://www.swt-wc.usace.army.mil/hydrologicdata/

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Figure 3. One of many dead paddlefish deposited adjacent to Swift Park boat ramp, July 8, 2024.

Figure 4. ODWC fisheries personnel examining three paddlefish carcasses on the Arkansas River below Keystone Dam July 8, 2024.

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Figure 5. Three dead paddlefish (including one floating downstream) adjacent to Swift Park boat ramp on the Arkansas River July 8, 2024. The fish in the foreground was partially cleaned (one side fillet removed). This likely occurred opportunistically by a bank angler salvaging usable parts from a dead or dying fish (i.e., not the cause of death).

Figure 6. Some paddlefish were discovered in advanced decay and were not physically examined.

Figure 7. A number of dead or dying paddlefish were likely pushed into this Arkansas River tributary creek arm adjacent to Swift Park as it back-filled from hydropower releases July 8, 2024.

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