ANNUAL REPORT

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

OKLAHOMA PADDLEFISH

RESEARCH AND MANAGEMENT

[AREA 045]

2023

ANNUAL REPORT

State: Oklahoma

Project Title: Oklahoma Paddlefish Research and Management

Period Covered: July 1[1] – December 31, 2023

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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 2023 (July-December) primarily consisted of the completion of a survey of >20,000 Paddlefish permit holders and our standardized winter gillnetting, which encountered 901 Paddlefish on three reservoirs- Grand, Kaw, and R. S. Kerr with the assistance of regional management 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 the snag fishery.

Net catches on Grand, Kaw, and R.S. Kerr provided a diversity of information relevant to management. While quite low in December 2023, Grand Lake catch rate has historically been highly variable. Observations of Paddlefish inhabiting waters deeper than our nets may indicate that our Grand Lake catch rate isn't an accurate surrogate for relative stock abundance. Modifications to standard protocols in 2024 may remedy this concern with enhanced techniques to provide more robust data for informed management of genetic management units. A key management focus in 2024 and beyond will likely be concerned with the potential for snag and release mortality in warmer months. Increased popularity of live imaging sonar had 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) will provide further perspectives to evaluate the effectiveness of our current harvest regulatory framework in meeting the objectives of our Oklahoma Paddlefish Management Plan.

[1] Area 045 entered SFR funding on July 1, 2023. Prior to that, all activities were state funded. Therefore, the collections and activities described here occurred after July 1. However, where appropriate for context, prior data are included.

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 the 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. Expected completion of this Paddlefish angler survey report is in 2024.

Standardized Paddlefish Winter Gillnetting: During November and December 2023, standardized Paddlefish gillnetting was performed on Grand, Kaw, and R.S. Kerr lakes. See lake maps in Appendix B.

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).

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 growth (within reservoir) per year between initial capture and subsequent recapture.

Other Paddlefish Research and Collaborations:

A University of Illinois PhD student, Shasta Kamara, accompanied our netting crews on Grand Lake in December 2023 to perform some preliminary 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 23 fish (18 males and 5 females) were affixed with an accelerometer to the caudal peduncle to track post-release movements. 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. Data analyses are ongoing; however, this was an opportunity to explore this technique as one that might be useful for assessing immediate post-release movements and stresses of snagged and released Paddlefish in a range of water temperatures.

RESULTS / DISCUSSION

Grand Lake

We used standardized Paddlefish gill-net sampling for Grand Lake and encountered a total of 63 Paddlefish. Body length ranged 670-1,065 mm and weight ranged 3.5-22.6 kg. Average catch rates were 13.7 fish/net/day (SE = 3.5, CV = 0.25). Male:Female sex ratio was 2.6:1.

Paddlefish catch rates in Grand Lake typically increase at upstream sites. However, this collection saw low and variable catches. Sites that historically and reliably catch fish did not produce catches as expected. One hypothesis, which has been increasingly informed using sonar, is that Paddlefish are inhabiting deeper water (i.e., below our nets). While this may explain lower catches at sites downstream of 20 (between the Elk River mouth and Wolf Creek), at upstream sites our nets are sufficiently spanning the entire depth of the inundated channel (<12 m). Further, sites 1-12 are <10 m in maximum depth, yet the catch rates at those sites were far lower than in previous years. Therefore, a hypothetical explanation for the low catch rates could be that most fish were aggregated in deeper waters (below our nets). Further examination of this phenomenon on deeper reservoirs may warrant a revision of standardized protocols.

Figure 1. Catch rates for Grand Lake were irregular and did not follow historical patterns of relative abundance.

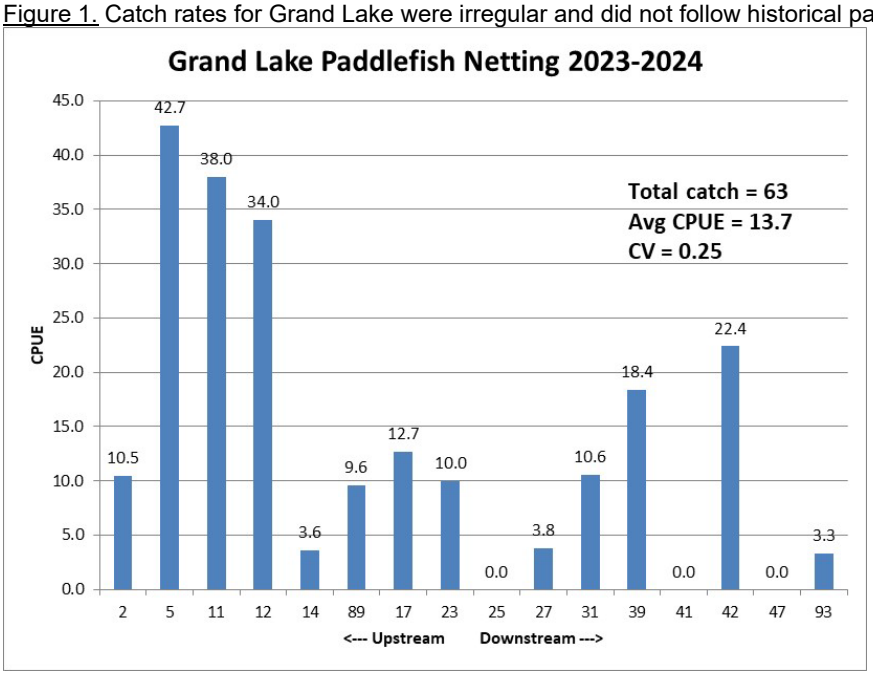


Figure 2. Historically, spatial patterns of relative abundance would predict higher catches in upstream sites in addition to an overall greater catch rate.

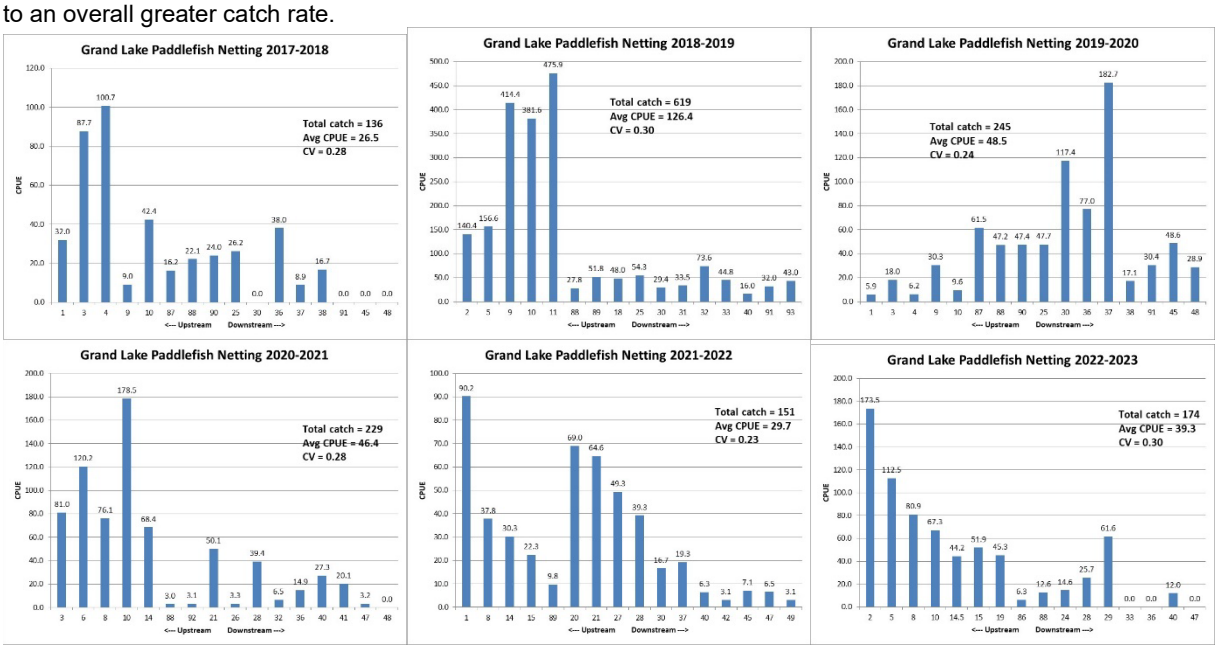


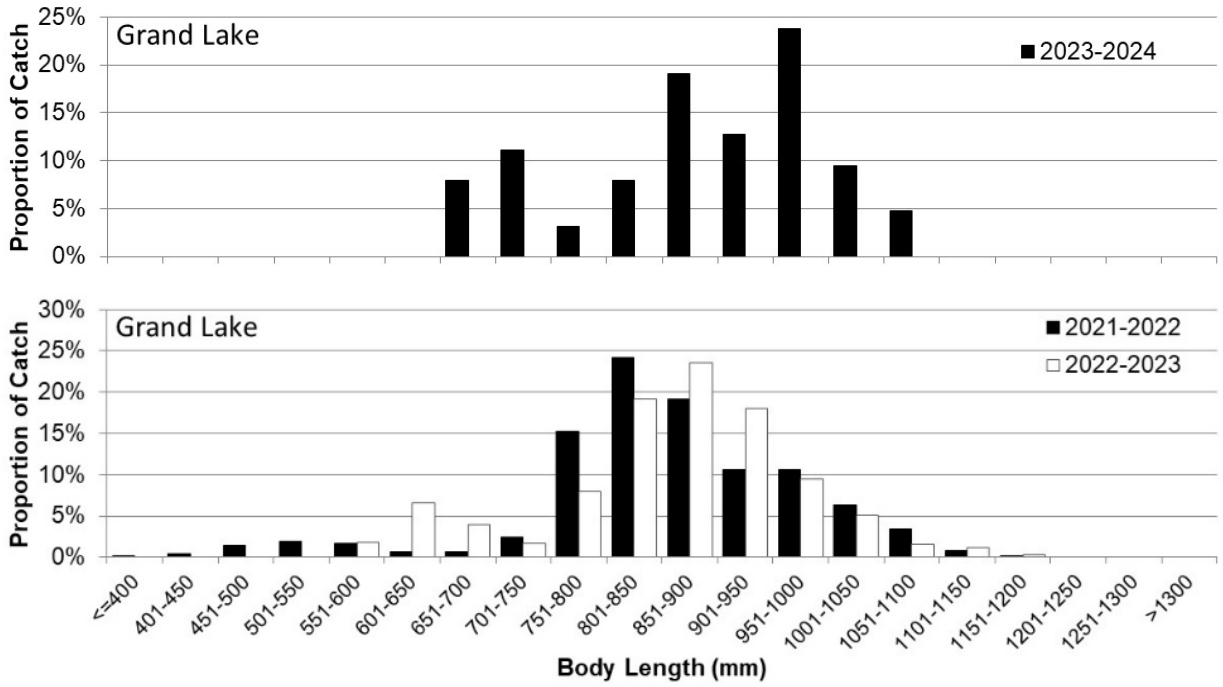
Table 1. Grand Lake Paddlefish catch summary 2023-24

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	37	30	7	927	12.5	89.8
Female	12	12	0	988	17.1	91.7
Juvenile	14	13	1	720	4.9	-
Totals	63	55	8			

Table 2. Grand Lake Paddlefish combined catch summary from previous years (2011-23).

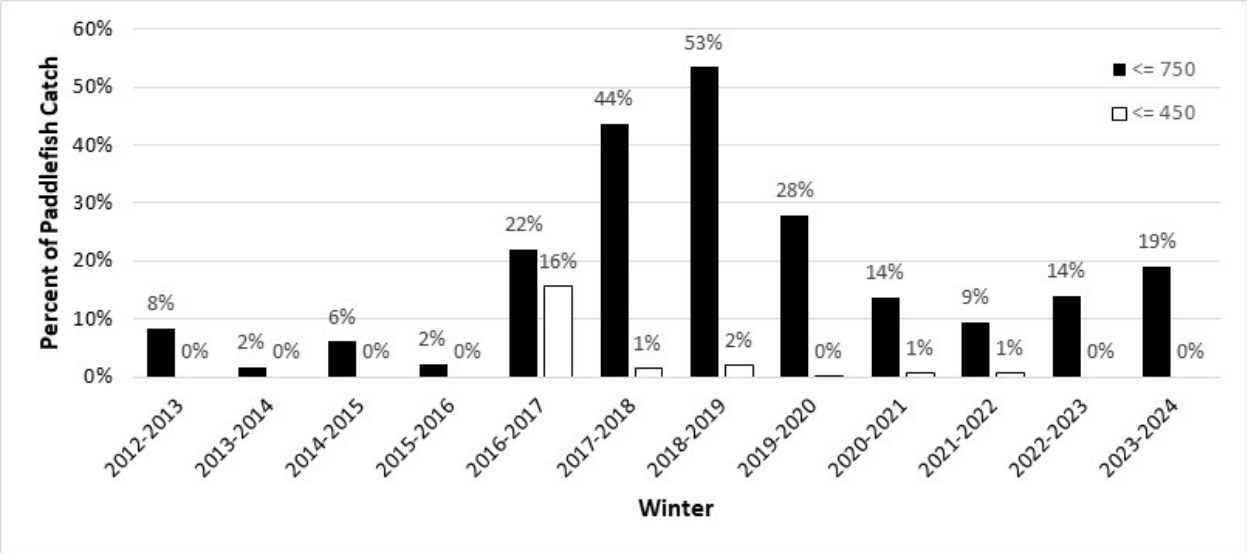
Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	6,510	5,934	576	937	14.2	97.3
Female	3,401	3,214	187	971	16.7	92.1
Juvenile	1,299	1,295	4	616	3.5	-
Totals	11,210	10,443	767			

Figure 3. Size structure of Grand Lake Paddlefish catch



Size structure observed in 2023-24 likely reflects recruitment in 2019 and the continued somatic growth of this year class from 601-650 mm in 2022-23 to 651-750 mm. 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 in 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.

Figure 4. 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).



Two 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. Both fish were recaptures, indicating that the tags were not detected when initially captured and marked with jaw bands. One additional Paddlefish was 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.

Additional notations on condition of fish encountered included hook scars (29%), prop scars (one fish), or rostrum injuries/deformations (9.5%). Two 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.

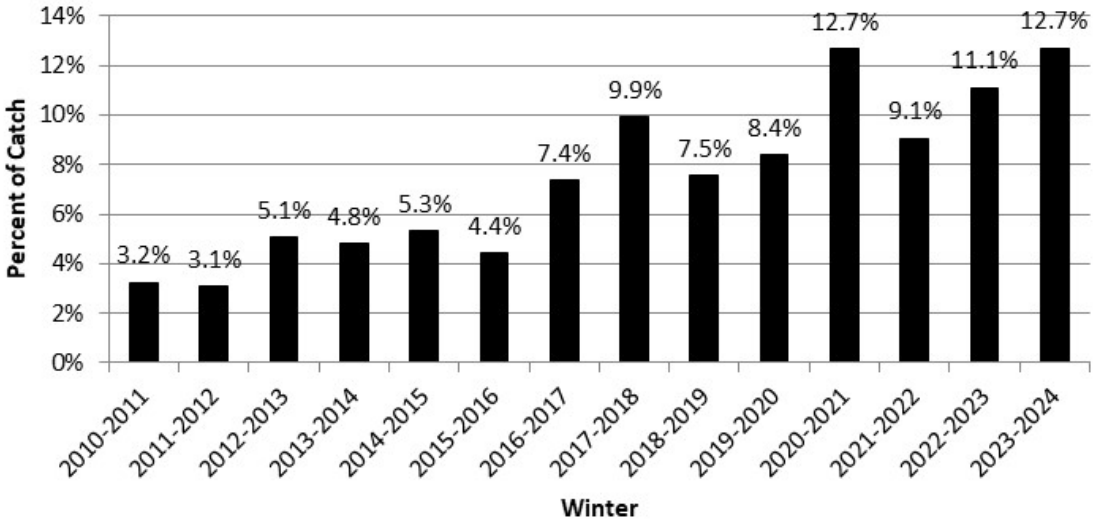
Relative weights of the Grand Lake stock are typically in the 90’s with exceptional individuals exceeding 100. *Wr* for males was unexpectedly lower than historical trends, however the lower catch may be down weighting the males due to inaccurately identifying larger, non-tuberculate males as females.

Eight Paddlefish caught in Grand Lake were recaptures from previous collections (Table 3). Two of these were banded last year (December 2022), however the remaining six fish were initially captured and banded over the years 2010-2020. One fish (G23635) was recaptured once in the interim (12/2/2016) between initial marking (12/7/2015) and subsequent recapture this year (12/11/2023). The growth rates for this young fish calculated over that initial 361-day at large period are more representative of the rapid somatic growth experienced by immature Paddlefish (0.288 mm/d, 9.695 g/d). The high variability in growth rates must be taken in context of multiple variables such as age, sex, and reservoir, therefore averages derived from small sample sizes over a broad range of days at large are not entirely informative.

Table 3. Back-calculated daily growth rates of Grand Lake recaptured Paddlefish. One fish, indicated by an asterisk [*]), was captured an additional time between initial marking and the latest recapture.

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex
G23635*	12/7/15 (01)	12/11/23 (93)	2,926	0.095	3.213	M
G22060	12/16/13 (40)	12/12/23 (39)	3,648	0.014	0.247	M
G16866	1/26/10 (13)	12/13/23 (89)	5,069	0.048	2.024	M
G29093	12/18/20 (09)	12/13/23 (17)	1,090	0.013	1.330	M
G25250	12/12/18 (09)	12/13/23 (17)	1,827	0.015	0.739	M
G29697	12/11/20 (E85)	12/13/23 (23)	1,097	0.015	0.228	M
G27748	12/12/22 (S5)	12/14/23 (11)	367	0.044	1.362	M
G27342	12/8/22 (2)	12/14/23 (11)	371	0.323	4.178	J
Average:				0.071	1.665	

Figure 5. 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 provide robust estimates of population abundance.



Bycatch encountered in standardized Paddlefish gillnets on Grand Lake included one Bighead Carp that was examined and retained by ODWC Aquatic Nuisance Species personnel. Additional bycatch included Threadfin Shad, Blue Catfish, Freshwater Drum, Bigmouth Buffalo, and a number of Flathead Catfish that were used for an age and growth study by the regional management personnel.

Kaw Lake

We used standardized Paddlefish gill-net sampling for Kaw Lake and encountered a total of 615 Paddlefish. Body length ranged 656-1,200 mm and weight ranged 6.3-32.2 kg. Average catch rates were 125.2 fish/net/day (SE = 15.9, CV = 0.13). Male:Female sex ratio was 0.78:1.

Figure 6. Catch rates for Kaw Lake generally increased at sites near the Hwy 11 bridge.

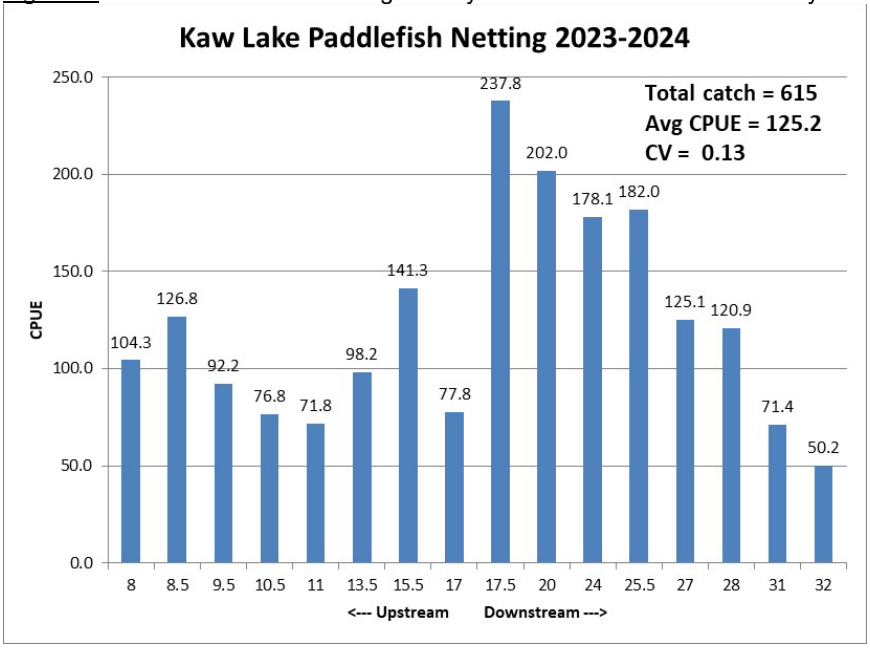


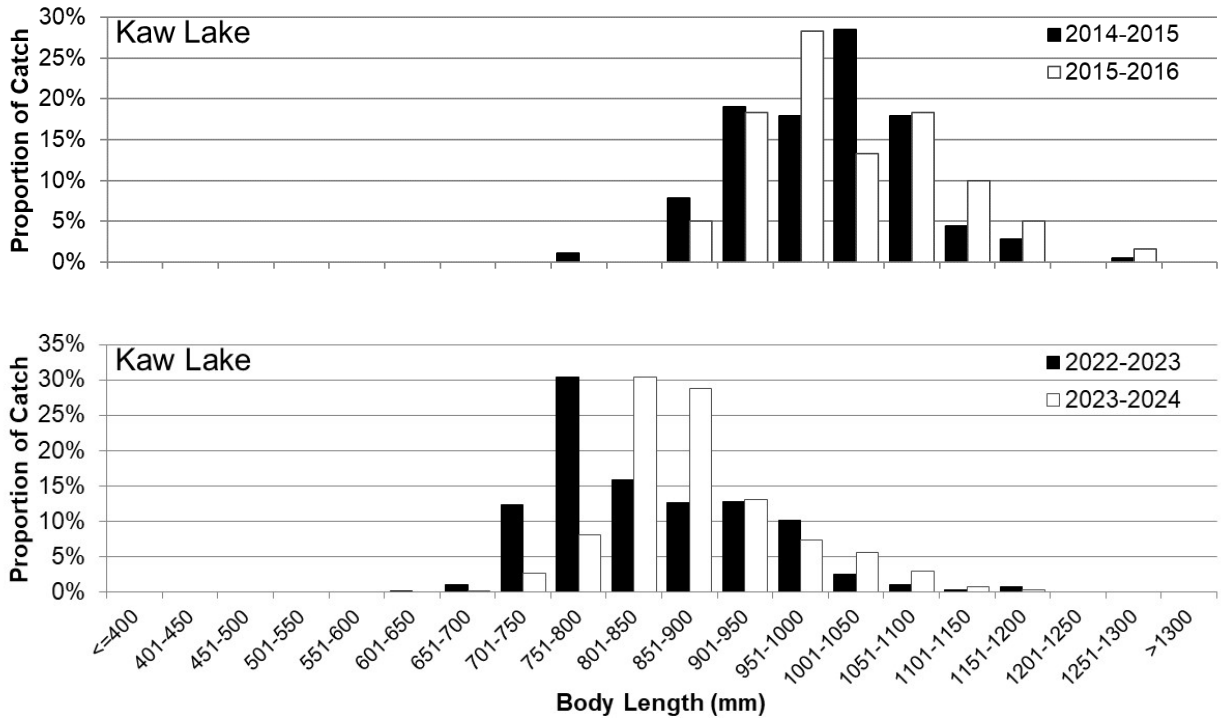
Table 4. Kaw Lake Paddlefish catch summary 2023-24

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	266	262	4	867	13.2	113.2
Female	341	338	3	893	14.8	104.6
Juvenile	8	8	0	735	7.1	-
Totals	615	608	7			

Table 5. Kaw Lake Paddlefish combined catch summary from previous years (2014-16).

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	394	393	1	864	13.8	116.7
Female	571	567	4	896	16.5	108.6
Juvenile	2	2	0	676	5.5	-
Totals	967	962	5			

Figure 7. Size structure of Kaw Lake Paddlefish catch



Size structure of the Kaw Lake Paddlefish stock in 2014-2016 indicated a small, old population of large fish with essentially no evidence of recent recruitment. However, subsequent evidence of a spawn in 2017 and potentially again in 2019 have replenished the population, revising the size structure to reflect the high abundance of these two year classes and low abundance of older, larger fish. Rapid somatic growth of immature fish is evident in the peak shift from 751-800 mm to ~850 mm in one year.

Figure 8. Juvenile Paddlefish captured in a cast net by a catfish angler in winter 2017-2018 near the Hwy 11 bridge (evidence of successful recruitment in 2017).

No Paddlefish captured were detected with a CWT indicating hatchery origin, despite the history of restoration stocking in Kaw Lake in the 1990's (Scarnecchia et al. 2013). With the oldest age Paddlefish estimated in Oklahoma at 29 years (Scarnecchia and Schooley 2022), it is likely that natural mortality of these restoration stockings nearly three decades ago has been complete. Additional notations on condition of fish encountered included hook scars (1.5%), prop scars (one fish), or rostrum injuries/deformations (0.8%).

Relative weights for Kaw Lake Paddlefish are consistently high- perhaps the highest of any Oklahoma reservoir. The reasons for this are not well understood, however, our recent research with Oklahoma State University hypothesized that plankton quality, specifically high lipid content, may play a role in enhanced growth and fat accumulation (Gary et al. 2023).

Seven Paddlefish caught in Kaw Lake were recaptures from previous collections. Six of these were banded last year (January 2023), however one fish was initially banded in 2014. The corrosive qualities of high salinity in the Arkansas River necessitates the usage of stainless-steel bands, however, their longevity remains far lower than the monel or aluminum bands used in other stocks. The band from 2014 was heavily corroded, barely legible, and coming apart, therefore it was replaced with a newer band with a new code. Long term tag loss due to corrosion may be a concern for Paddlefish in Kaw and Keystone. Having banded 1,335 Paddlefish in Kaw during 2022-2024, we will likely see further evidence of the degradation of bands in future collections.

Table 6. Back-calculated daily growth rates of Kaw Lake recaptured Paddlefish.

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex
A11866	1/6/23 (16)	12/5/23 (17.5)	333	0.288	9.610	F
A11727	1/4/23 (17.5)	12/5/23 (20)	335	0.242	4.328	M
A10849	1/6/23 (16)	12/6/23 (10.5)	334	0.180	6.437	F
A10751	1/6/23 (16)	12/6/23 (10.5)	334	0.240	10.180	F
A10623	1/4/23 (20)	12/7/23 (8)	337	0.172	5.786	M
A11590	1/4/23 (20)	12/7/23 (8.5)	337	0.092	6.588	M
Average:				0.202	7.155	

BandCode	Mark Date (Site)	Recap Date (Site)	At large (days)	Growth Rate (mm/d)	Growth Rate (g/d)	Sex
A00618	12/2/14 (24)	12/5/23 (25.5)	3,290	0.027	1.277	M

Bycatch encountered in standardized Paddlefish gillnets on Kaw Lake included Flathead and Blue catfishes in addition to forty large, gravid female Bigmouth Buffalo. These buffalo were used for our statewide life history, morphology, and genetics research with Oklahoma State University and will be reported separately.

R.S. Kerr Lake

We used standardized Paddlefish gill-net sampling for R.S. Kerr Lake and encountered a total of 223 Paddlefish. Body length ranged 576-1,159 mm and weight ranged 2.1-27.4 kg. Average catch rates were 45.5 fish/net/day (SE = 14.4, CV = 0.32). Male:Female sex ratio was 0.86:1.

While catch rates generally increase in upstream sites within Oklahoma reservoirs, R.S. Kerr catch rates are spatially distinct. Due to the presence and positioning of the navigation channel, which sometimes deviates from the historic inundated river channel, Paddlefish distribution patterns may be in direct response to shipping traffic. Higher catch rates are realized where the river channel and navigation channel do not overlap (e.g., sites 41-50 and 60-65). It is presumed that the deeper waters outside of the shipping channel is preferred habitat for Paddlefish, hence the higher catch rates. Further, it is challenging to deploy nets at sites where most of the channel width is open for barge travel (e.g., sites 1-40). Our efforts to avoid net destruction by barges may influence our ability to catch Paddlefish, were they present at that site.

Figure 9. Catch rates for R.S. Kerr Lake followed a pattern unique to this reservoir.

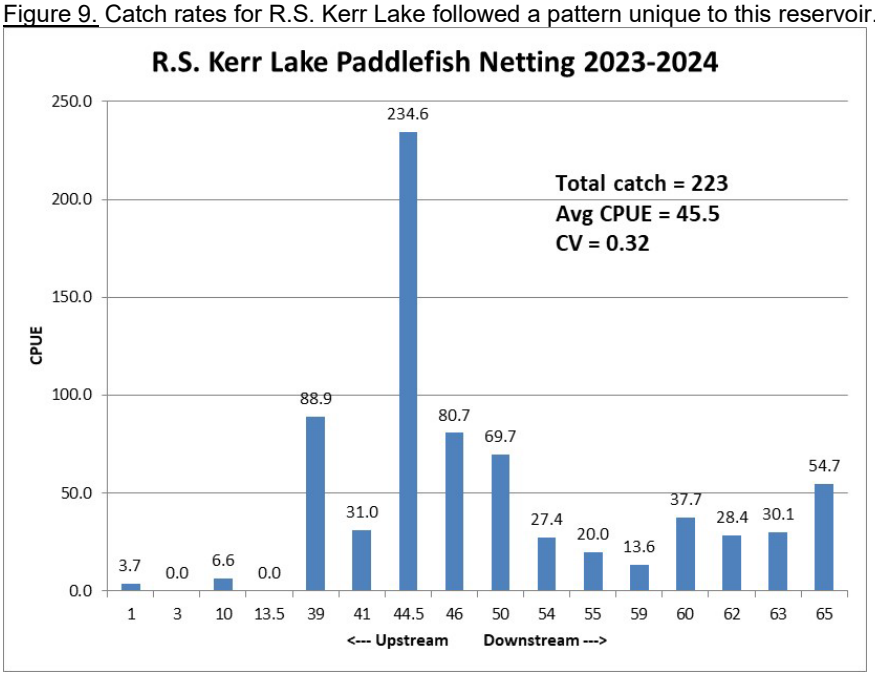


Table 7. R.S. Kerr Lake Paddlefish catch summary 2023-24

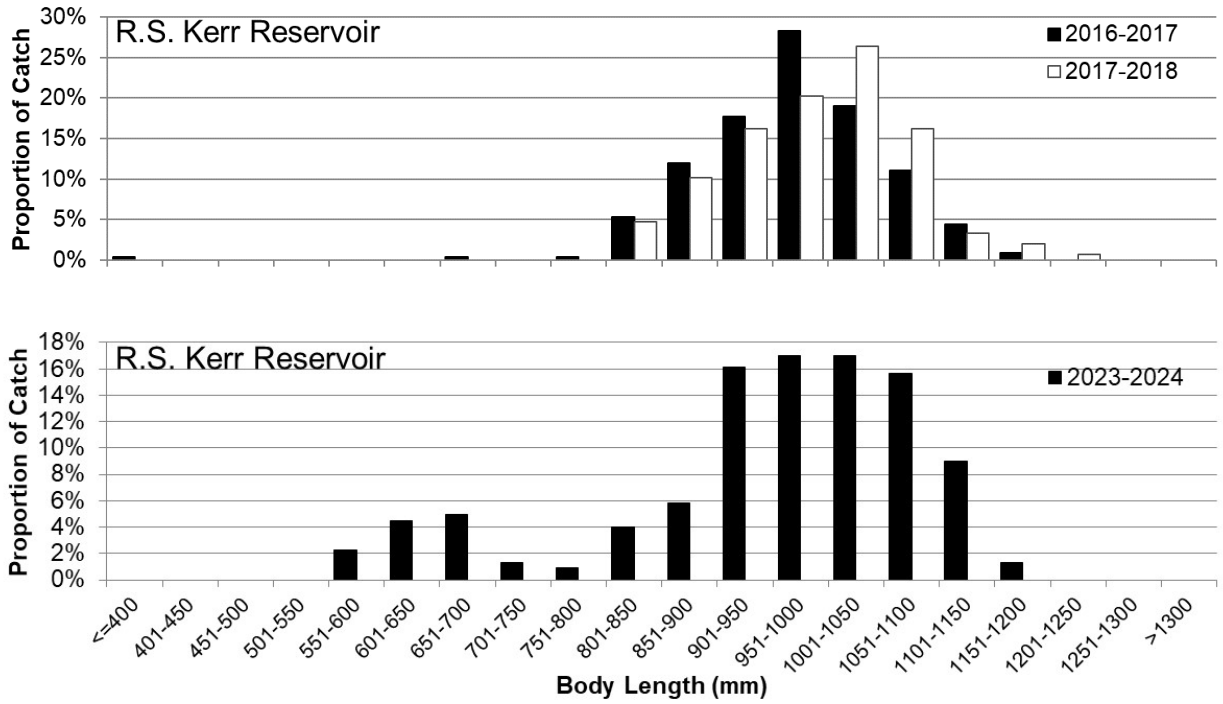
Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	90	90	0	966	13.3	84.8
Female	105	104	1	1020	16.3	80.1
Juvenile	28	24[2]	0	648	3.5	-
Totals	223	218	1			

Table 8. R.S. Kerr Lake Paddlefish combined catch summary from previous years (2016-2018).

Sex	Captured	Marks	Recaptures	Avg EFL (mm)	Avg Wt (kg)	Avg W_r
Male	210	210	0	965	13.9	88.9
Female	154	152	2	1009	16.6	84.1
Juvenile	2	2	0	540	2.9	-
Totals	366	364	2			

[2] Juveniles <3 kg are considered too small for banding; therefore, they do not count among marks.

Figure 10. Size structure of R.S. Kerr Lake Paddlefish catch



Size structure of the R.S. Kerr Paddlefish stock was typified by catch of maturing adults in 2016-2018. Catch in 2023-2024 indicated a broader distribution of adult sizes in addition to a secondary peak likely associated with recruitment in 2019. As this stock is a sink for fish migrating out of multiple other stocks (e.g. Keystone, Oologah, Eufaula, and Ft. Gibson), attributing the recruitment to any particular stock (or *in situ*) is not possible without a genetic assessment. However, this is positive evidence of natural recruitment in the larger Arkansas River watershed.

No Paddlefish captured were detected with a CWT indicating hatchery origin. Additional notations on condition of fish encountered included hook scars (18%), prop scars (2%), and wounds likely attributable to bowfishing (2 fish; Figure 11). The R.S. Kerr stock typically has a high frequency of rostrum injuries/deformations, and this collection aligned with that trend (23%). Among those with rostrum issues, five fish had full amputations, ten fish had partial amputations, and the remaining 37 had various deformities or injuries. One fish was recaptured bearing scars suggesting that the jaw band was removed and four fish were captured with jaw injuries, potentially from catch and release handling or jaw band removal. Therefore, the identity was unknown for these fish, and they received new bands.

Figure 11. Putative evidence of a bow-shot and released Paddlefish. The entry wound (right) matched up with a larger exit wound (left) and both bowfishing scars were healed. Release of Paddlefish taken by bowfishing is specifically prohibited.

Relative weights of Paddlefish in R.S. Kerr have historically been low compared to other Oklahoma stocks. This can be explained by several factors. First, rostrum amputation or injury may impart an acute (through the loss of the body part) or a chronic reduction in weight (due to long-term degraded effects on electrosense foraging ability resulting in depletion of fat reserves). Additionally, the high frequency of rostrum and other injuries on Paddlefish in R.S. Kerr indicates that the stock may experience greater overall stress than other stocks. Further, though R.S. Kerr is a reservoir, it functions ecologically (and perhaps productively) as a river during higher flow conditions. Paddlefish in river environments are leaner and with lower *Wr* than what is observed in reservoir stocks. And lastly, given that R.S. Kerr is a sink population for out-migrants from several upstream stocks or perhaps migrants from downstream stocks in the lock and dam navigation system, numerous other variables may be responsible for lower *Wr* for Paddlefish in R.S. Kerr.

Only one Paddlefish encountered on R.S. Kerr was a recapture (band code G15085). Unfortunately, this band code was not found in the tagging database, therefore, growth cannot be calculated. It is likely that the fish was initially captured and marked in Grand Lake in 2008, as band codes sequential to that one were used at that time. The fish was a female with a low *Wr* (72.4) and it had an injured rostrum. The fish had survived downstream passage at Pensacola, Markham Ferry (Hudson), and Ft. Gibson dams, after which it had to pass over or through Webber's Falls lock and dam to be captured in R.S. Kerr. Such extensive dam passage movements would be exceptional in Oklahoma; however, we have captured fish in Webber's Falls after passing through two high dams (Markham Ferry and Ft. Gibson).

Bycatch encountered in standardized Paddlefish gillnets on R.S. Kerr Lake included Freshwater Drum, Flathead and Blue catfishes, Longnose Gar, Skipjack Herring, and Smallmouth Buffalo. The Skipjack Herring and catfishes were used by regional management crews for ongoing age and growth research.

LONG-TERM, STATEWIDE TREND DATA[3]

Table 9. Summary matrix of average Paddlefish catch rates (with coefficients of variation of the mean [CV] in parentheses) from all Oklahoma lakes sampled 2010-2023. Lakes indicated by an asterisk (*) are recipients of restoration stocking. Lakes with planned collections in 2024-25 are shaded in grey.

Year	Grand	Eufaula*[4]	Webber's Falls	R.S. Kerr	Texoma*[5]	Kaw*	Oologah*	Hudson	Ft. Gibson	Keystone
2010-11[6]	*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*[7]							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)	*Jan 2024*		45.5 (0.32)		125.2 (0.13)				
2024-25	*Dec 2024*	*Jan 2025*	*Dec 2024*	*Dec 2024*						

Although the standardized catch rates on Grand Lake are variable (with large peaks in 2016 and 2019; Figure 12) and somewhat in a long-term decline, this linear trend is not statistically significant. We are considering a modification to standardized sampling procedures for more robust assessment of distinct Paddlefish reservoir stocks (see Management Recommendations below).

[3] Relevant long-term trend data are included here, although all collections prior to July 1, 2023, were state funded.

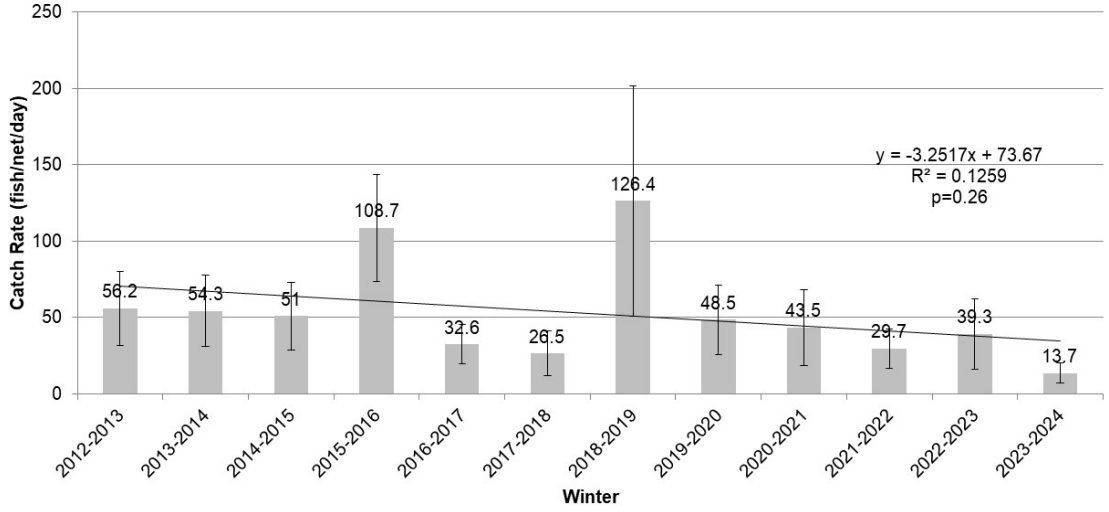
[4] Paddlefish collections on Eufaula Lake were restricted to the Deep Fork and Gaines Creek arms in 2021-22 after poor lake wide catch rates in previous years.

[5] 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.

[6] Standardized winter Paddlefish gillnetting was refined in 2012-13 and effort was reduced from 24 nets to 16 nets.

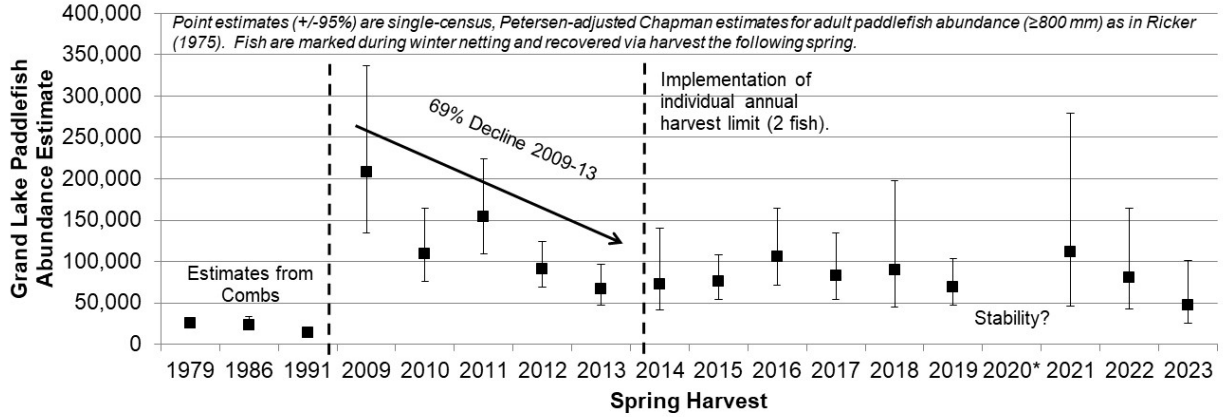
[7] Due to shallow water, highly variable catch rates in 2017-18, and a companion project at Ft. Gibson Dam, collections in 2018-19 did not follow standardized protocols to enhance catch.

Figure 12. Mean Paddlefish catch rates from standardized winter gillnetting on Grand Lake.



Population abundance estimates from Grand Lake utilizing marked fish from winter netting that were later recovered from harvest at the Paddlefish Research Center (Figure 13) indicate stability of the catchable population (≥800 mm). Although the estimate for 2023 is the lowest in the modern era of Paddlefish management, the size structure from our catch in 2023-24 indicates that a substantive proportion of the population (19% of the net catch, Figure 4) will soon be recruiting to the "catchable" population (≥800 mm). As we expand our focus from the Grand Lake stock to other statewide Paddlefish snag fisheries, we are evaluating a revision to standardized winter sampling protocols that would allow for abundance estimation on all distinct Paddlefish reservoir stocks (see Management Recommendations below).

Figure 13. 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.



FUTURE EFFORTS AND MANAGEMENT RECOMMENDATIONS

Standardized Collections in 2024 and beyond: In winter 2024-25, standardized winter collections are planned for Grand, Webber's Falls, R.S. Kerr, and Eufaula lakes. Modification of standardized netting protocols is currently being evaluated. First among considerations is a practical modification to the standard deployment. Protocols require that the negatively buoyant

nets are buoyed at intervals approximately 2 m deep to allow for safe boat traffic. However, at many sites in Grand Lake, water depth and intel gathered via sonar on Paddlefish depth positioning suggests that many fish utilizing deeper waters (12-18 m deep) in the inundated channel may be escaping capture because the net is suspended above them. A suggested modification is as follows: bullet floats should be used on the float line when the water is <12 m in total depth. However, if the water is >12 m deep, no bullets should be used, as the net will sink beyond a depth where it is at risk of being struck by watercraft. When both conditions exist at different sections of the 91 m net, the application of bullet floats should be responsive.

A more substantive change to the standard netting protocols would comprise of a shift in focus to abundance estimation. Transitioning to a more intense netting effort focused on mark/recapture techniques may provide additional dimensions of information to better manage distinct Paddlefish reservoir stocks/fisheries. These methodological revisions are still in development, but would potentially require more nets to be set in a day, but at shorter durations. Net sites would be selected to provide broad coverage over a larger area in a single day, with repeated collections on successive days up to 5 days per reservoir.

Assessment of Oklahoma Paddlefish Snag Fisheries: A creel survey of the upper Keystone Lake – Kaw Dam snag fishery is currently in development. 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.

Assessment of Natural Recruitment of Oklahoma Paddlefish: 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.

Sex Ratios and Harvest Bias for Female Paddlefish: 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 2.6:1, whereas this ratio was observed as 0.78:1 and 0.86:1 in Kaw and R.S. Kerr, 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 (report forthcoming) 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 submitted in a request for proposals for pass-through SFR funding 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 Eufaula Lake 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.

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Appendix A.
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[8]
	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

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

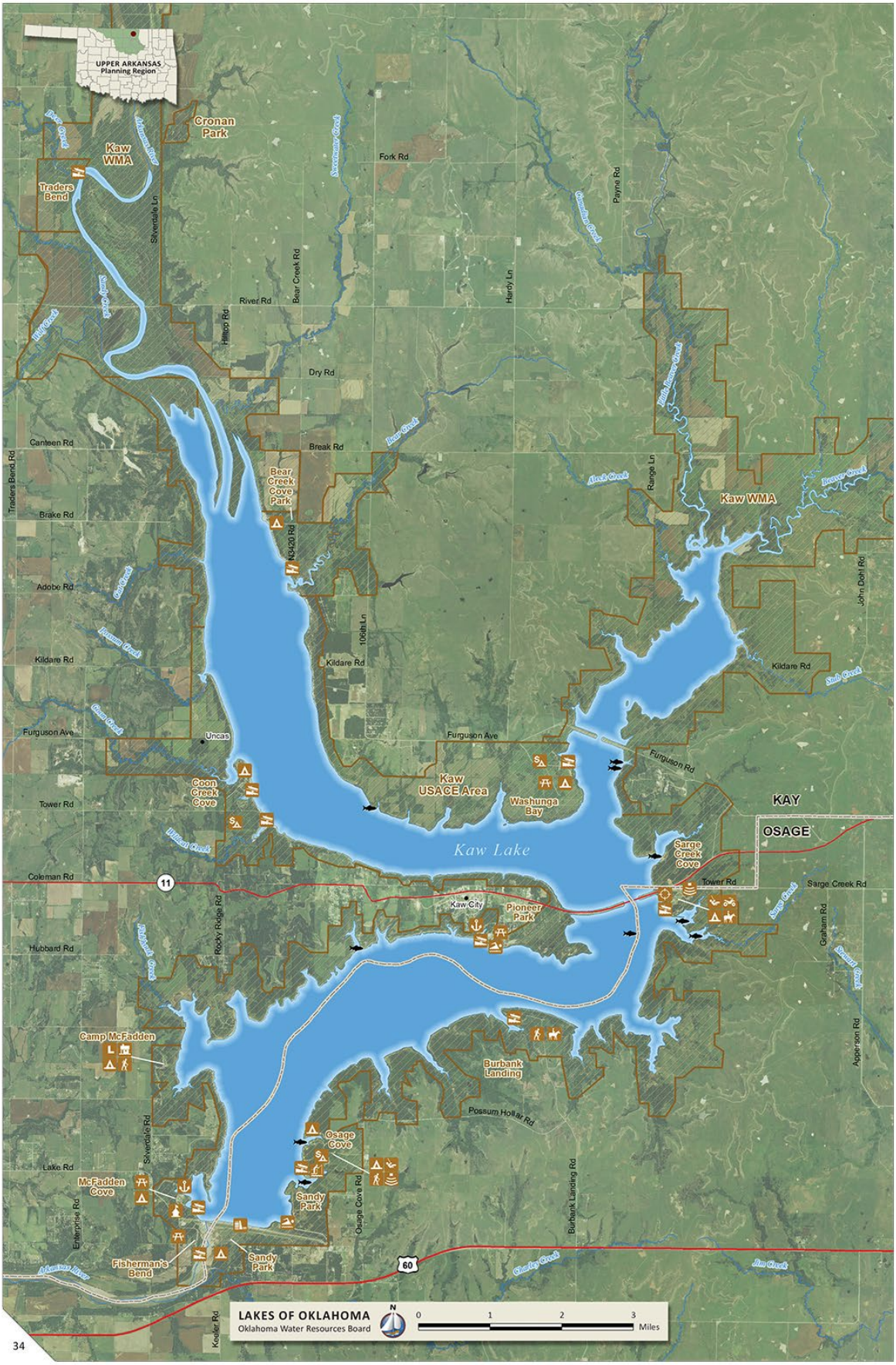
Kaw

US ARMY CORPS OF ENGINEERS

36.76435°N 96.81071°W
Normal Elevation: 1,010 ft

Area: 23,610 ac
Shoreline: 149 mi

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



36.14020°N 96.25991°W
Normal Elevation: 723 ft

Area: 23,610 ac
Shoreline: 296.5 mi

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

Keystone

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

Webbers Falls

US ARMY CORPS OF ENGINEERS

63

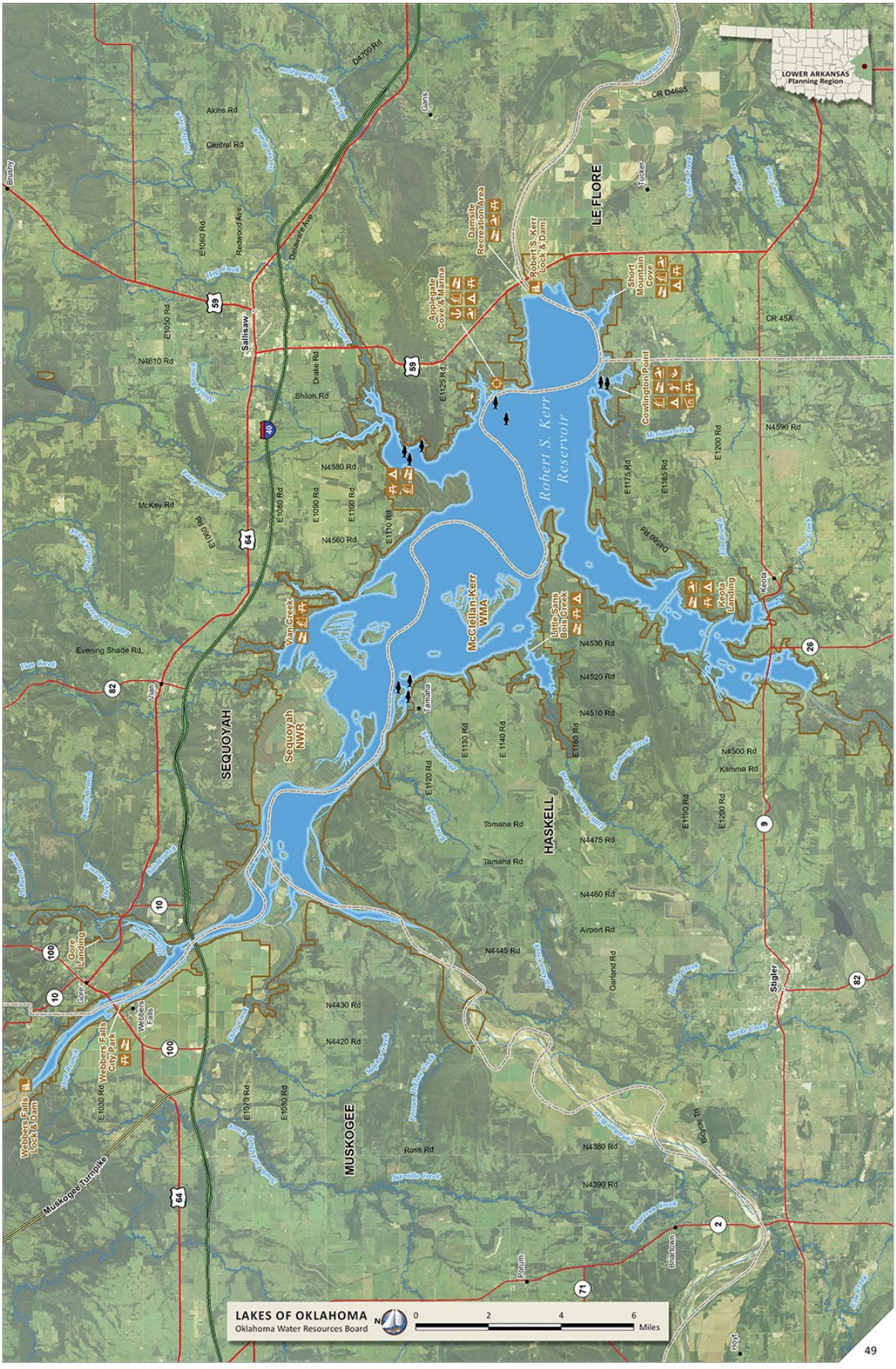
35.36450°N 94.82454°W
Normal Elevation: 460 ft

Area: 43,800 ac
Shoreline: 278 mi

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

Robert S. Kerr

US ARMY CORPS OF ENGINEERS



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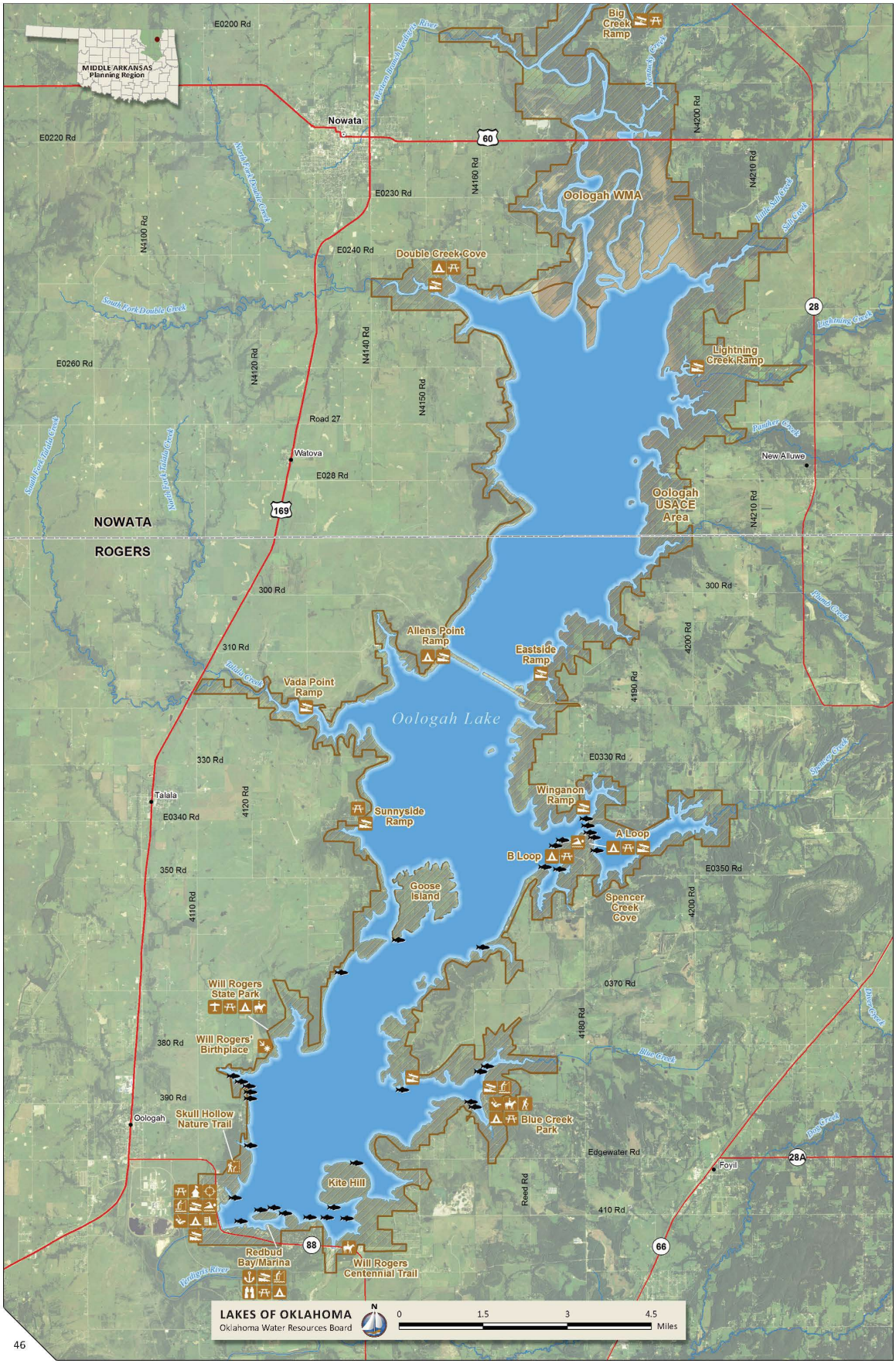
Oologah

US ARMY CORPS OF ENGINEERS

36.42815°N 95.68108°W
Normal Elevation: 638 ft

Area: 29,460 ac
Shoreline: 216.9 mi

Capacity: 544,100 ac-ft
Maximum Depth: 72.2 ft



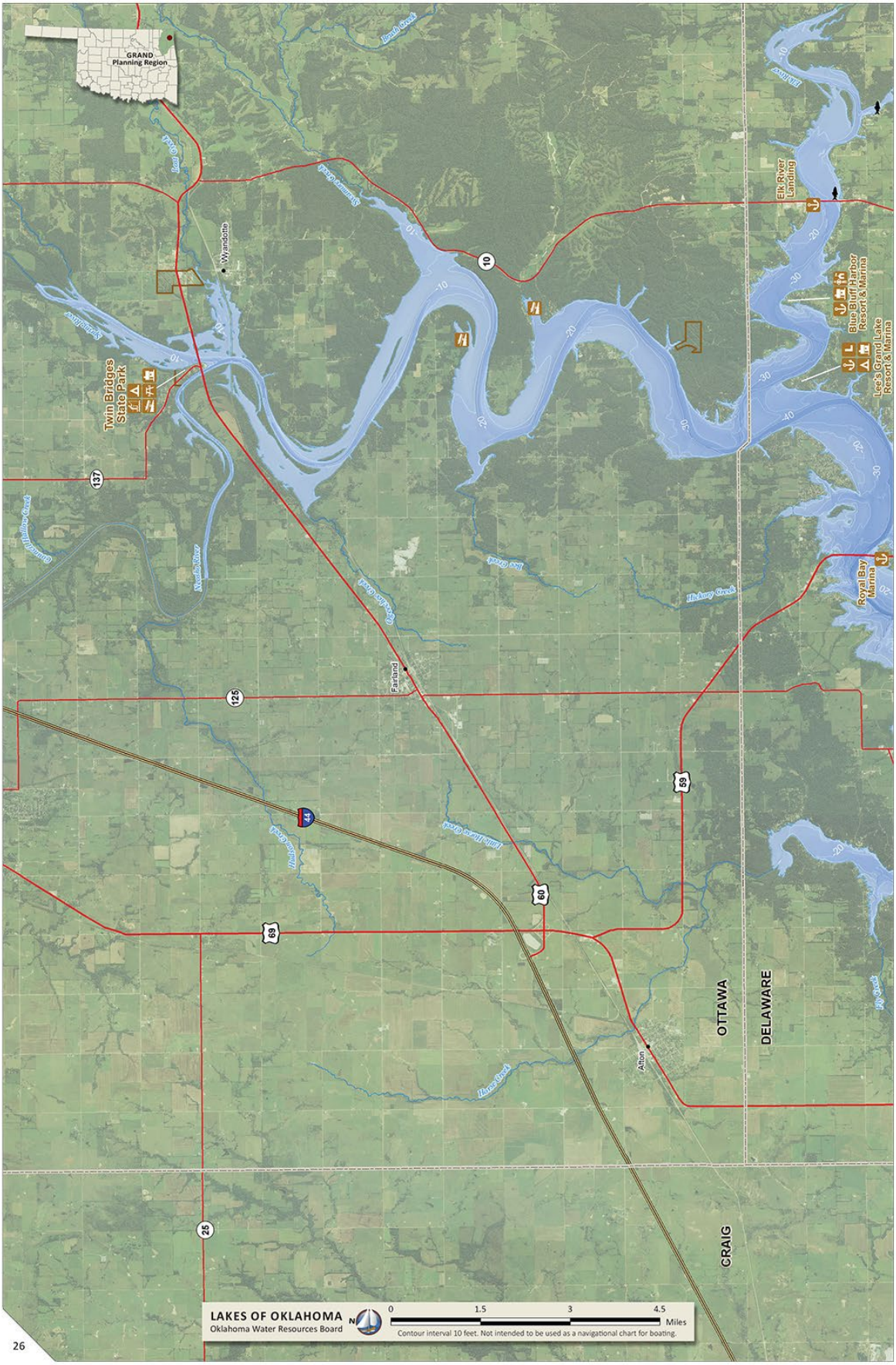
Grand

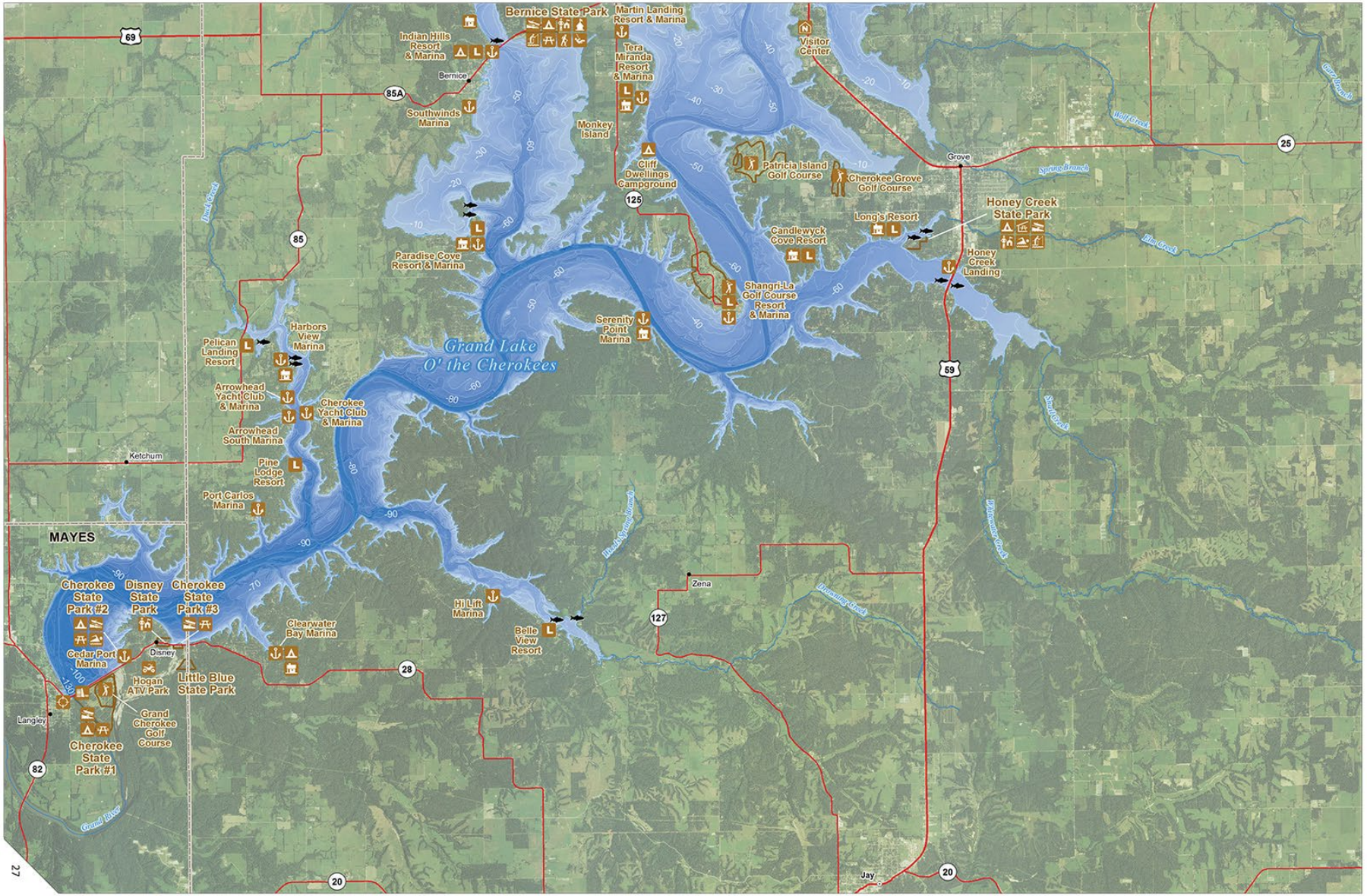
GRAND RIVER DAM AUTHORITY

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




Bernice State Park
Martin Landing Resort & Marina
Indian Hills Resort & Marina
Visitor Center
Bernice
Tera Miranda Resort & Marina
Southwinds Marina
Monkey Island
Cliff Dwellings Campground
Patricia Island Golf Course
Cherokee Grove Golf Course
Grove
Honey Creek State Park
Long's Resort
Candlewyck Cove Resort
Paradise Cove Resort & Marina
Honey Creek Landing
Shangri-La Golf Course Resort & Marina
Serenity Point Marina
Harbors View Marina
Pelican Landing Resort
Grand Lake O' the Cherokees
Arrowhead Yacht Club & Marina
Cherokee Yacht Club & Marina
Arrowhead South Marina
Ketchum
Pine Lodge Resort
Port Carlos Marina
MAYES
Cherokee State Park #2
Disney State Park
Cherokee State Park #3
Hi Lift Marina
Zena
Clearwater Bay Marina
Belle View Resort
Cedar Port Marina
Disney
Hogan ATV Park
Little Blue State Park
Grand Cherokee Golf Course
Langley
Cherokee State Park #1
Jay
69
85A
85
125
25
59
127
28
82
20
Wolf Creek
Spring Branch
Elm Creek
Sand Creek
Drowning Creek
Illinois Springs Branch
Grand River

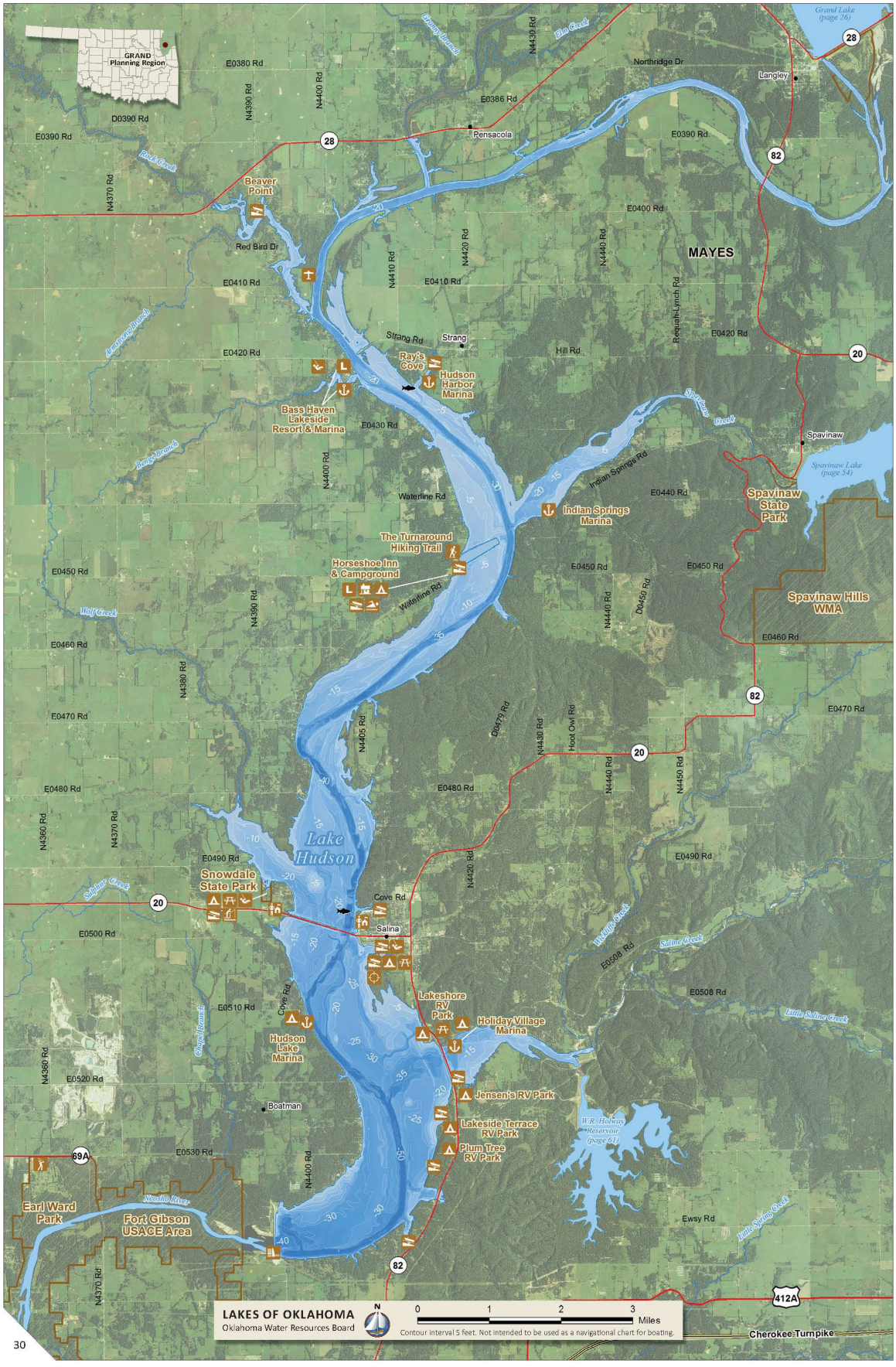
Hudson/Markham Ferry

GRAND RIVER DAM AUTHORITY

36.28912°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



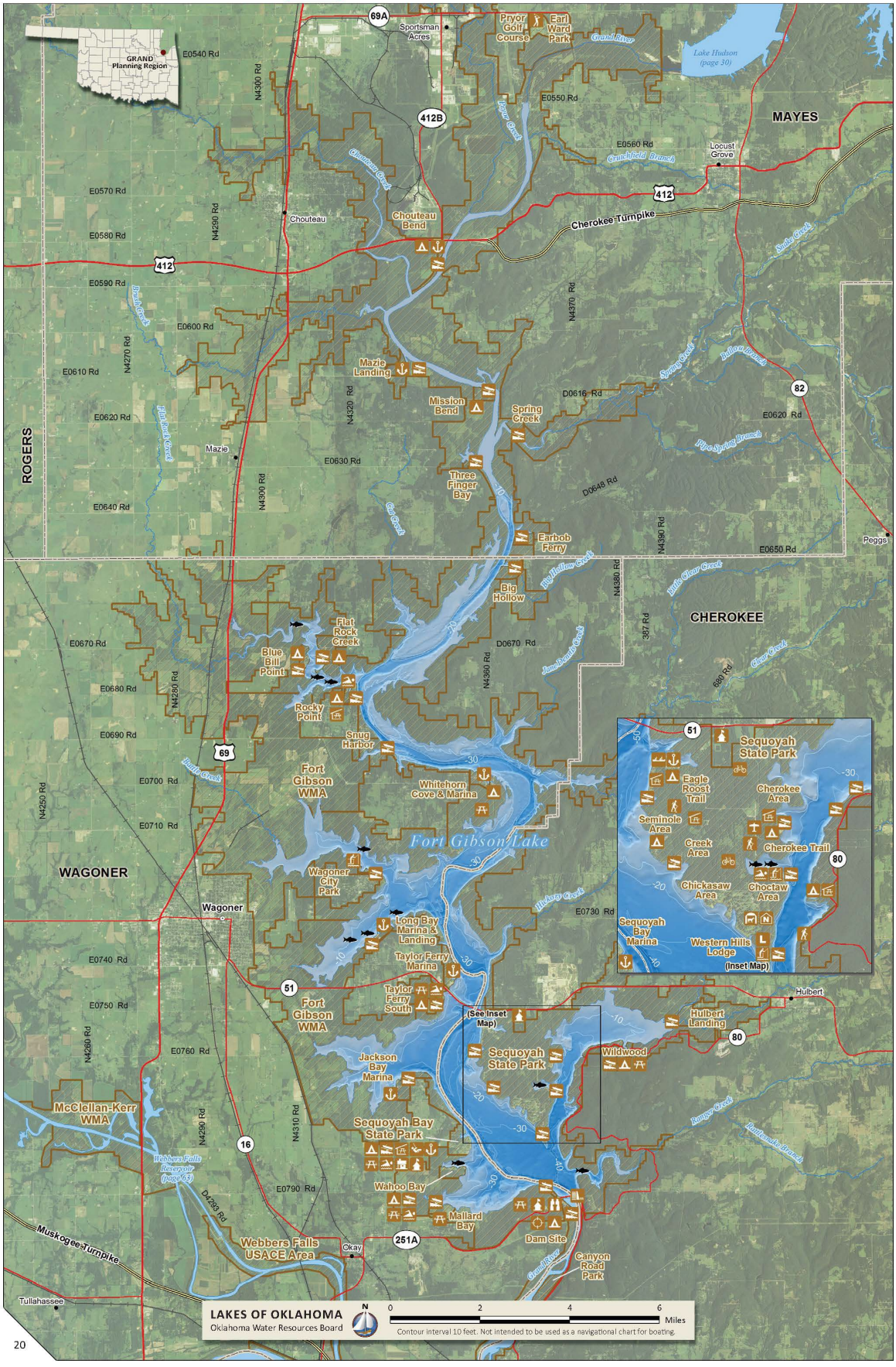
Fort Gibson

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



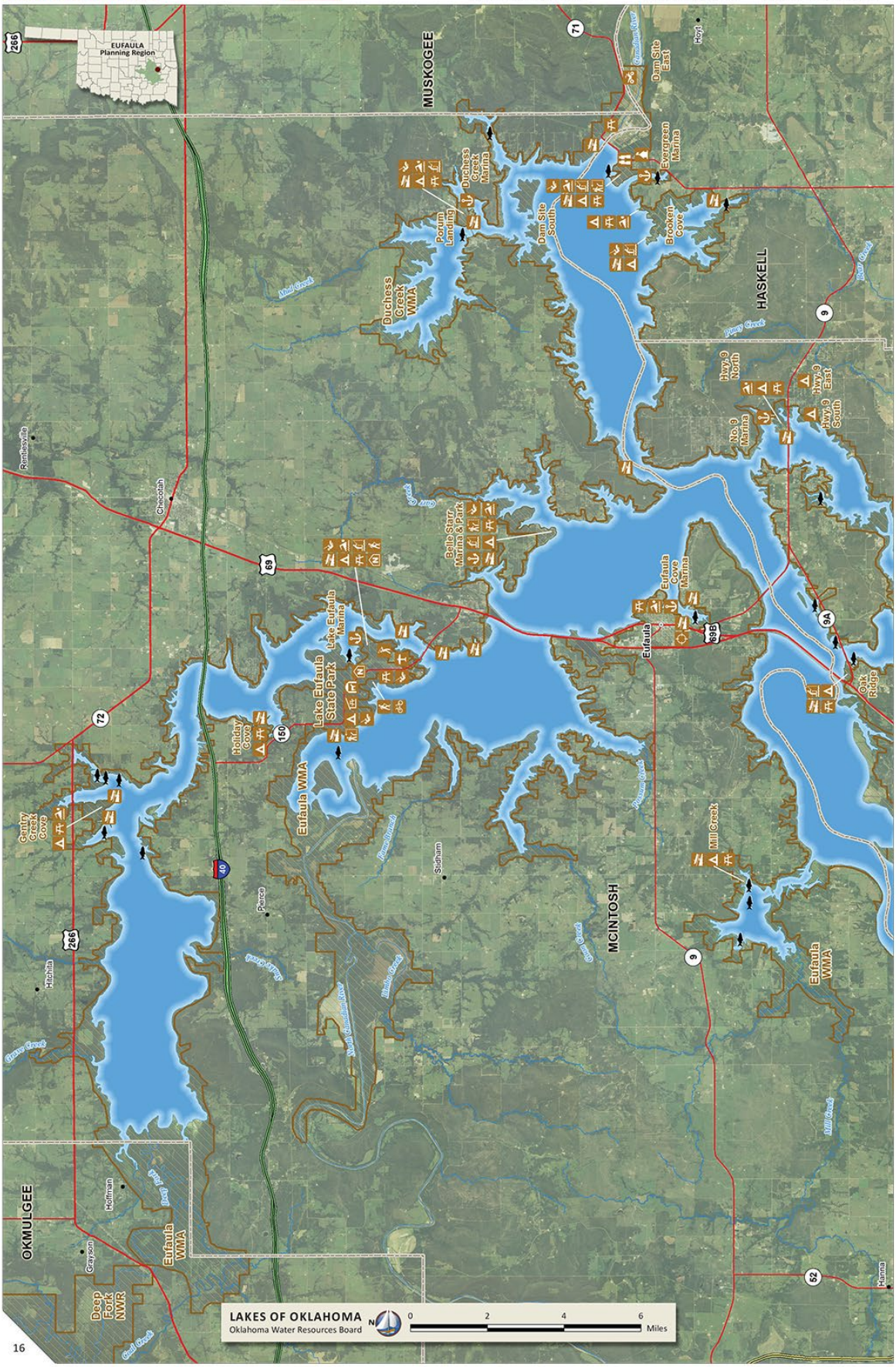
Eufaula

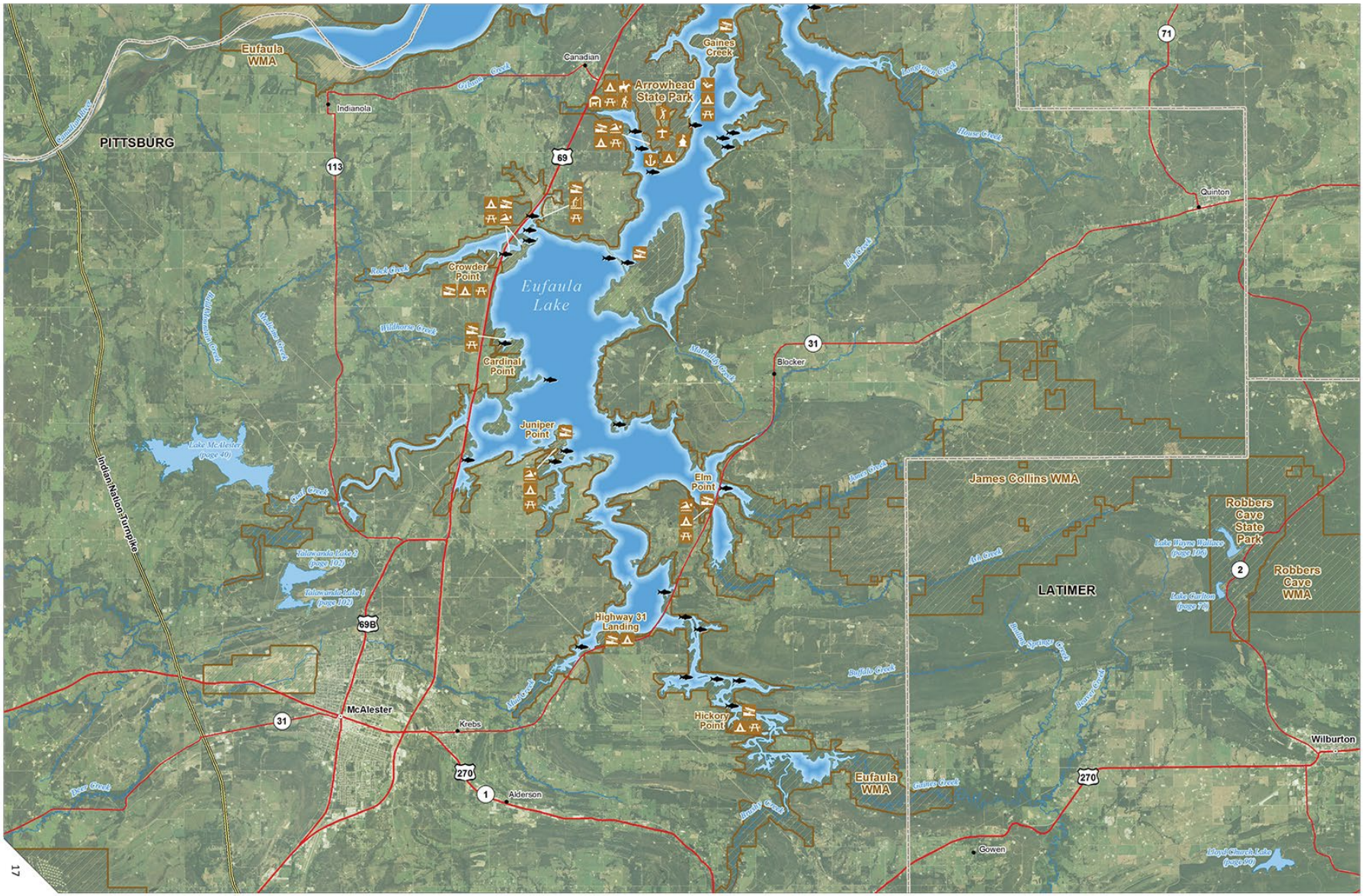
US ARMY CORPS OF ENGINEERS

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




Eufaula WMA
Canadian
Gaines Creek
Arrowhead State Park
Indianola
PITTSBURG
113
69
71
Quinton
House Creek
Rock Creek
Crowder Point
Eufaula Lake
Wildhorse Creek
Cardinal Point
31
Blocker
Juniper Point
Lake McAlester (page 40)
Elm Point
James Collins WMA
Robbers Cave State Park
Robbers Cave WMA
Lake Wayne Wallace (page 106)
Lake Carlton (page 78)
LATIMER
2
Talawanda Lake 2 (page 102)
Talawanda Lake 1 (page 102)
69B
Highway 31 Landing
Buffalo Creek
McAlester
Krebs
Hickory Point
Wilburton
270
Eufaula WMA
Alderson
1
Gowen
Boyd Church Lake (page 90)
Indian Nation Turnpike

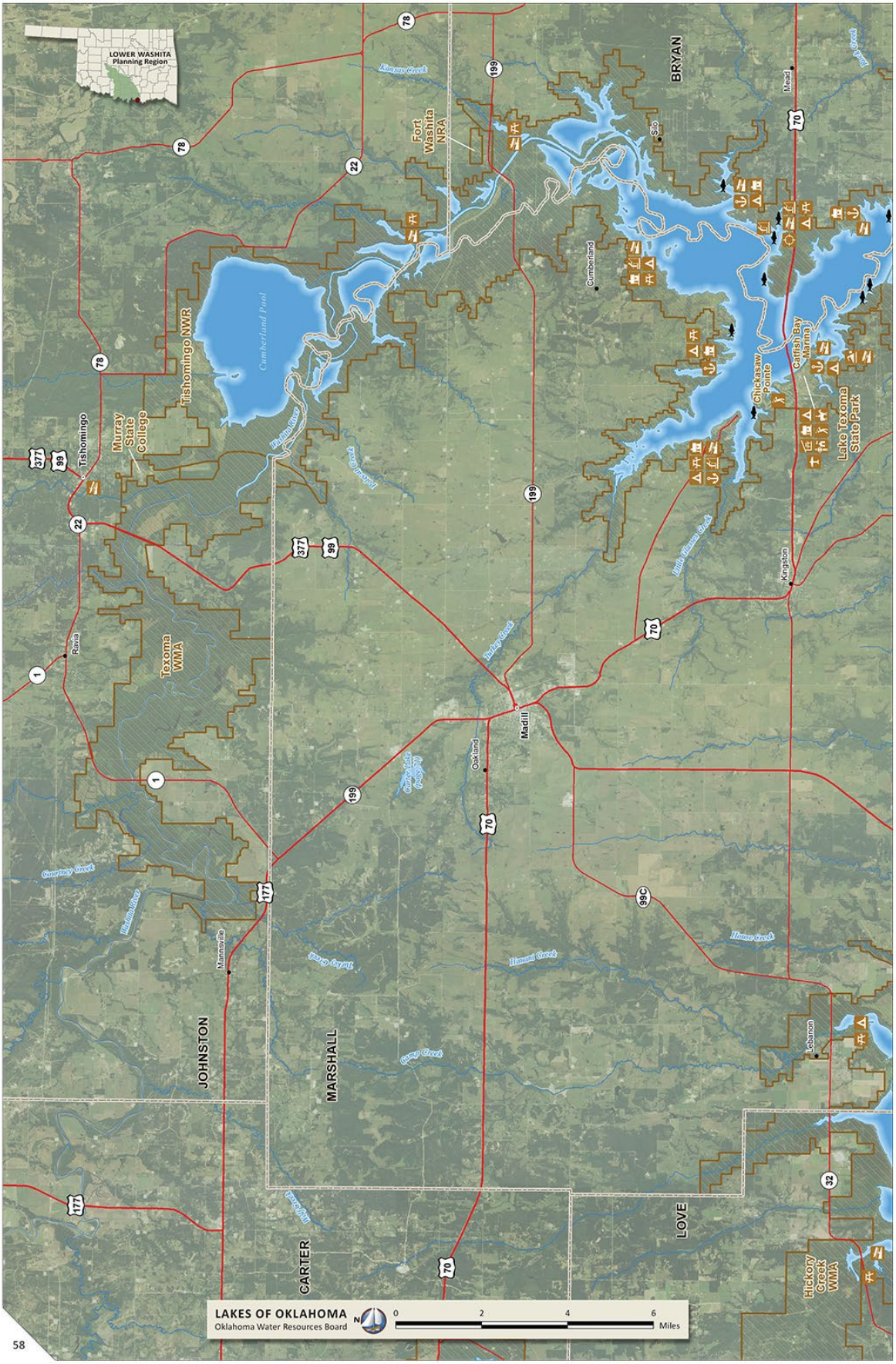
Texoma

US ARMY CORPS OF ENGINEERS

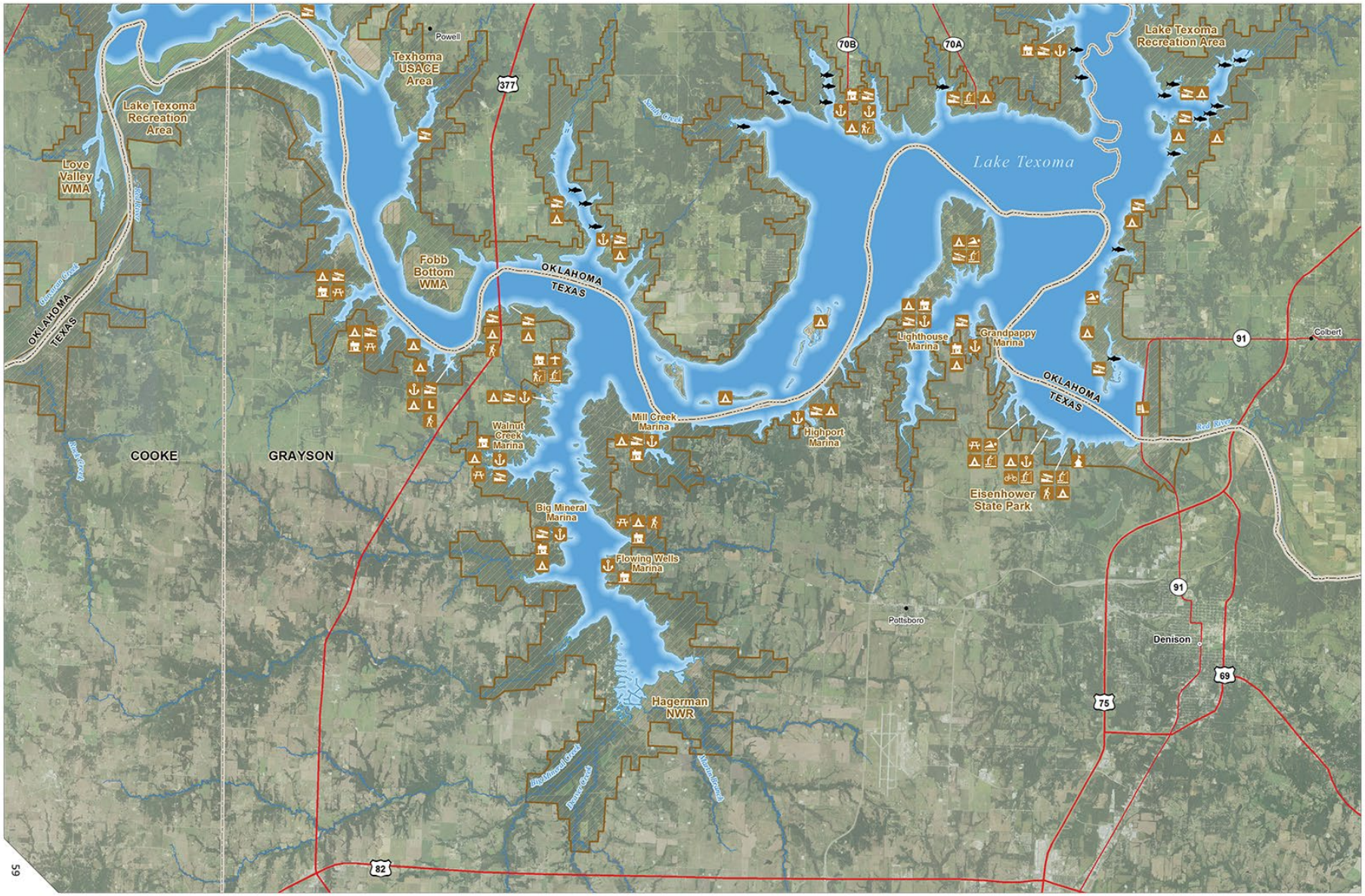
33.99933°N 96.57257°W
Normal Elevation: 616 ft

Area: 88,000 ac
Shoreline: 592.7 mi

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



58


Lake Texoma
Lake Texoma Recreation Area
Texhoma USACE Area
Powell
Love Valley WMA
Fobb Bottom WMA
OKLAHOMA
TEXAS
377
70B
70A
91
Colbert
Lighthouse Marina
Grandpappy Marina
Mill Creek Marina
Walnut Creek Marina
Highport Marina
Eisenhower State Park
Big Mineral Marina
Flowing Wells Marina
COOKE
GRAYSON
Pottsboro
Denison
69
75
82
Hagerman NWR
Red River