Arrowhead Reservoir

2023 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-5

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

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Survey and Management Summary

Fish populations in Arrowhead Reservoir were surveyed in 2023 using gill netting, electrofishing, low-frequency electrofishing, and trap netting. Anglers were surveyed from March 2023 through May 2023 with a roving creel survey. Historical data are presented with the 2020-2024 data for comparison. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

Reservoir Description: Arrowhead Reservoir is a 14,969-acre impoundment located on the Little Wichita River in Archer and Clay Counties approximately 20 miles southeast of Wichita Falls. At time of sampling the elevation was around eight feet below conservation level. Habitat was limited to rock and natural banks with the low water. The dam is located in Clay County and the reservoir is owned and operated by the City of Wichita Falls as a municipal and industrial water supply. Arrowhead has a shoreline length of 106 miles at conservation level and a drainage basin of 832 square miles. Boat access is normally good with five improved public ramp sites around the reservoir. Public access includes 524-acre Lake Arrowhead State Park located on the northwest side near the dam. Bank access is adequate, but the only improved handicapped access is at the state park. Some standing timber remains in the upper reservoir and backs of coves.

Management History: Important sport fish include Blue and Channel Catfish, Largemouth Bass, White Bass and White Crappie. Arrowhead is managed under statewide regulations. Artificial fish attractors and brush were placed around the state park piers along with installing green lights under the fishing pier. Stockings included Bluegill in 2020, fingerling Florida Largemouth Bass in 2020, northern strain Largemouth Bass fry in 2021 and 2022 and fingerlings in 2021 and 2024 and White Bass adults in 2021.

Fish Community

- **Prey species:** Threadfin Shad were present in the reservoir. Electrofishing catch rate of Gizzard Shad improved and majority were available as prey to most sport fish. Electrofishing catch rate of Bluegill was low with no Bluegill over 6 inches in length.
- **Catfishes:** Blue Catfish catch rate was good with a balanced size structure. Channel Catfish and Flathead Catfish were present in the reservoir. Catfish were the second most sought-after sport fish.
- **White Bass:** White Bass were abundant in the reservoir. Angling effort for White Bass was similar to past creel surveys.
- **Largemouth Bass:** Largemouth Bass were present in low abundance. During the creel survey, Largemouth Bass angling effort increased slightly from the previous survey.
- **White Crappie:** White Crappie were the most popular sport fish. The trap net survey catch was low. Body condition was good to great. Most crappie reached legal size within two years.

Management Strategies: Work with the City of Wichita Falls to perform a stake bed habitat project. Continue working with the City of Wichita Falls to monitor for potential zebra mussel infestation, while informing the public about the negative impacts of aquatic invasive species. Conduct low-frequency electrofishing, daytime electrofishing, and trap netting surveys in 2027 for general monitoring. Access and vegetation surveys will be conducted in 2027.

Introduction

This document is a summary of fisheries data collected from Arrowhead Reservoir from 2020-2024. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2020-2024 data for comparison.

Reservoir Description

Arrowhead Reservoir is a 14,969-acre impoundment constructed in 1966 on the Little Wichita River. It is located in Archer and Clay Counties approximately 20 miles southeast of Wichita Falls and is operated and controlled by the City of Wichita Falls. Primary uses include municipal and industrial water supply. Mean depth is 16 feet and maximum depth is 42 feet. Arrowhead Reservoir is considered eutrophic with a Carlson's Trophic State Index Chl α of 54.6 which is similar to the previous sample (Texas Commission on Environmental Quality 2022). Habitat at time of sampling consisted of natural and rocky shoreline. Some standing timber remains in the upper reservoir and backs of coves. Water level was seven feet below conservation level at time of the habitat survey and dropped to eight feet below conservation level at time of fishery surveys (Figure 1). Other descriptive characteristics for Arrowhead are in Table 1.

Angler Access

Arrowhead Reservoir has five public boat ramps. Additional boat ramp characteristics are in Table 2. Shoreline access can be found at the public boat ramp areas, bridges crossing three bays on the south side of the reservoir, one bridge on the east side of the reservoir, and in Lake Arrowhead State Park. Lake Arrowhead State Park also provides a boat dock as well as an ADA accessible fishing pier for anglers.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Mauk 2020) included:

1. Poor recruitment was found in the Largemouth Bass population.

   Action: Stocking of fingerling Florida Largemouth Bass occurred in 2020. Northern strain Largemouth Bass were stocked as fry in 2021 and 2022 and fingerlings in 2021 and 2024. Only eight Largemouth Bass were sampled during the 2020 electrofishing survey and eleven were sampled in 2023.

2. Gizzard Shad and Bluegill relative abundance was down.

   Action: Relative abundance of Gizzard Shad increased dramatically in both the 2020 and 2023 electrofishing surveys. Stocked Bluegill in 2020 and saw a decline in abundance from the 2020 to the 2023 surveys.

3. Zebra mussel eDNA was found in Arrowhead Reservoir in one sample.

   Action: Worked with the City of Wichita Falls to sample for eDNA and presence/absence of veligers twice yearly since 2019. No eDNA hits were found during this sampling.

4. White Bass population was underutilized.

   Action: Promoted the fishery during presentations, talked with individuals and through social media.

5. The potential spread of zebra mussels and invasive species exists.

   Action: Signage was maintained at the boat ramps, and it was made a talking point while communicating with the public and discussed/published in various media outlets.

Harvest regulation history: Sport fish species in Arrowhead Reservoir were managed using statewide regulations. Blue and Channel Catfish statewide regulation changed to no minimum length-limit but only 10 fish can be over 20 inches in length as part of the combined 25 fish bag limit on September 1, 2021 (Table 3).

Stocking history: Arrowhead Reservoir was stocked with fingerling Florida strain Largemouth Bass in 2020. Northern strain Largemouth Bass were stocked as fry in 2021 and 2022 and fingerlings in 2021 and 2024. Bluegill adults and fingerlings were stocked in 2020. White Bass adults were stocked in 2021. The complete stocking history is in Table 4.

Vegetation/habitat management history: Problematic aquatic vegetation has not been observed in the reservoir. Fish attractors have been placed around the state park fishing pier, floating dock, and shoreline. Placement of brush piles away from the Lake Arrowhead State Park piers and docks has occasionally occurred and the sites are listed on the TPWD website.

Water transfer: There are no interbasin transfer of water from Arrowhead Reservoir.

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Arrowhead Reservoir (Mauk 2020). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected. Trap netting, gill netting and low-frequency electrofishing was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2022). Electrofishing was split between daytime and nighttime sampling.

Common names of fishes and their hybrids in this report are used following Page et al. (2023) with an exception for Largemouth Bass. While we recognize recent changes to black bass names, Texas reservoirs contain a mix of Florida Bass, Largemouth Bass, and their intergrade offspring. Therefore, Largemouth Bass is used in this report for simplicity as well as consistency with previous reports.

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (2 hour at 24, 5-min stations). Due to high turbidity and low catch rates of Largemouth Bass, catch rates between day and night electrofishing were compared. Twelve sites were sampled during the day and twelve sites were sampled at night. Catch per unit effort (CPUE) for all electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Electrofishing in 2023 was conducted using a Smith Root Apex electrofishing system, while the previous surveys used a GPP 7.5 electrofisher.

Trap netting – Crappie were collected using trap nets (15 net nights at 15 stations). CPUE for trap netting was recorded as the number of fish caught per net night (fish/nn). Ages for crappie were determined using otoliths from 26 randomly selected fish (range 9.0 to 10.9 inches).

Gill netting –- White Bass were collected from gill nets (24 net nights at 24 stations). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn). Gill net survey was part of a statewide Blue Catfish study for age and growth. No catch rate data was recorded for Blue Catfish. Otoliths were taken from 276 fish broken down to 10 fish per inch group under fifteen inches and 20 fish per inch group over fifteen inches.

Low-frequency electrofishing – Blue Catfish were collected by low-frequency electrofishing at 20 stations. The duration of electrofishing at each station was 3 minutes. CPUE for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

Statistics – Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), terminology modified by Guy et al. 2007], and condition indices [relative weight (W_r)] were calculated for target fishes according to Neumann et al. (2012). Index of Vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE and creel statistics.

Creel survey – A roving creel survey was conducted during the spring quarter in 2023. The creel period was March 2023 through May 2023. The reservoir was six feet below conservation level during the survey taking the reservoir surface acreage to 11,720 acres. Angler interviews were conducted on 5 weekend days and 4 weekdays per quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2022).

Habitat – A structural habitat survey was conducted in 2023. Vegetation surveys were conducted every four years to monitor aquatic vegetation. Habitat and vegetation surveys were assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2022).

Water level – Source for water level data was the United States Geological Survey (USGS 2024).

Results and Discussion

Habitat: Littoral zone structural habitat consisted primarily of natural shoreline and rocks (Table 6). No aquatic vegetation was documented during the 2023 survey due to the reservoir being greater than seven feet below conservation level at the time of sampling (Table 7).

Creel: A three-month spring creel (March through May) was conducted in 2023 to capture harvest of Blue Catfish for a statewide study at Arrowhead Reservoir. The 2023 survey was compared to the same quarter of a yearlong creel in 2019. Directed fishing effort by anglers was highest for crappie (51.6%), followed by anglers fishing for catfish (24.3%) and anything (20.3%, Table 8). Total fishing effort for all species and direct expenditures at Arrowhead Reservoir were similar across years (Table 9). Lake Arrowhead is heavily utilized by anglers traveling 25 miles or less (Appendix D).

Prey species: Electrofishing catch rates of Gizzard Shad and Bluegill were 515.5/h and 3.5/h, respectively. Index of Vulnerability (IOV) for Gizzard Shad was great, indicating that 99% of Gizzard Shad were available to existing predators. Total CPUE of Gizzard Shad improved in 2020 (415/h) and 2023 (515.5/h) surveys from the low catch rate of 37/h in 2019 (Figure 2). Total CPUE of Bluegill in 2023 decreased from surveys in 2019 and 2020, and size structure continued to be dominated by small individuals (Figure 3). Arrowhead reservoir lacks adequate habitat during low water for Bluegill due to the slow tapering clay banks.

Catfish: All survey objectives were met for Blue Catfish using low-frequency electrofishing during the late summer of 2023. Catch rates decreased in 2023 (118/h) compared to 201.3/h in 2019 (Figure 4). However, a single chase boat was used in 2023 compared to two chase boats in 2019. Body condition based on W_r was good with most length groups over 81 (Figure 4). Size structure of quality length fish (20 inches) improved from 2019 (PSD 39) to 2023 (PSD 45, Figure 4). Directed fishing effort, catch per hour, and total harvest for Blue Catfish was 8,983.7 h, 1.1 fish/h, and 12,611.6 fish, respectively, from March 2023 through May 2023. Blue Catfish were a harvest-oriented fish as 16.7% were released (Table 10). Directed effort was lower in 2023 compared to 2019, but harvest increased approximately 3.5 times. Blue Catfish took 13.8 years (N=35, 19.0 to 20.9 inches) to reach 20 inches in length on average (Figure 6). Flathead catfish were sampled (7 fish) during the low-frequency electrofishing survey. A singular Channel Catfish was sampled during the trap net survey (Appendix A).

White Bass: The gill net catch rate of White Bass was 13.4/nn in 2023. Catch rates of White Bass increased from past gill net surveys in 2012 (2.7/nn) and 2016 (6.6/nn) (Figure 7). Gill netting was conducted during a statewide Blue Catfish study with no objectives for White Bass to achieve. Leading up to the 2023 survey, anglers voiced a concern about the decimated White Bass abundance. Body condition based on W_r was great to excellent as fish lengths increased. Size structure (PSD = 50) was balanced with fish ranging from 6 to 17 inches in length (Figure 7). Directed fishing effort, catch per hour, and total harvest for White Bass was 486.9 h, 4.9 fish/h, and 837 fish, respectively, from March 2023 through May 2023 (Table 11). Over half of legal-length White Bass were harvested with a rate of 53% in 2023 (Table 11). Observed harvest from 2019 to 2023 showed good angler compliance, and harvested fish ranged in length from 10 to 16 inches (Figure 8).

Largemouth Bass: The electrofishing catch rate of Largemouth Bass was 5.5/h in 2023, higher than the 4.0/h in 2020 (Figure 9). No objectives were met during the electrofishing survey in 2023. Only eleven fish were sampled, and no age and growth was taken due low number of fish in the survey. Body condition of the fish sampled was good (W_r >90) for legal length fish. The electrofishing survey was divided into 12 random stations each for nighttime and daytime sampling to compare catch rates due to high turbidity in Arrowhead. The daytime sample captured seven of the eleven fish (Figure 11). With the small sample size, no comparisons could be made with validity. Directed fishing effort, catch per hour, and total harvest for Largemouth Bass was 2,092.3 h, 0.4 fish/h, and 0 fish, respectively, from March 2023 through May 2023 (Table 12). No harvest of Largemouth Bass occurred in 2023. Total harvest of Largemouth Bass during March 2019 through May 2019 was 944.1 fish with legal released of only 9%

(Table 12). During the creel only five Largemouth Bass were documented to be harvested by anglers fishing for crappie.

White Crappie: The trap net catch rate of White Crappie was 3.0/nn in 2023, significantly lower than in 2019 (14.6/nn) and 2015 (22.5/nn). The objective of catching 50 stock length fish was not achieved with only 43 sampled. A reason for the low catch rate could be explained by the trap nets being set on shallow, slow tapering banks with no habitat due to the reservoir being eight feet below conservation level. Recruitment has been limited since late 2021 due to low water level and lack of shallow water habitat. Size structure in 2023 was poor with a PSD of 100, similar to 2019 (PSD 90) and more unbalanced than 2015 (PSD 70, Figure 12). Mean relative weight was over 110 for most size classes and rose to 122 as the fish increased in length in 2023 similar to 2015. This differed from 2019 as mean relative weight for most size classes was around 100 and dropped to 85 at the largest size class (Figure 12). White Crappie reached 10 inches in total length (legal length) at 2.1 years on average (N=26, 9.0 to 10.9 inches). Directed fishing effort for White Crappie dropped in 2023 to 34,772 hours compared to the same time period in 2019 (51,440 hours) however, total harvest increased to 91,481 fish in 2023 from 81,595 fish in 2019 (Table 13). Length limit compliance was great in 2023 with the size of harvested White Crappie ranging from 10 to 15 inches in total length (Figure 13).

Fisheries Management Plan for Arrowhead Reservoir, Texas

Prepared – July 2024

ISSUE 1: Arrowhead Reservoir lacks abundant shoreline habitat, especially when the water recedes due to prolonged drought periods. The Largemouth Bass fishing is boom or bust and generally follows the water levels and shallow habitat availability. White Crappie require shoreline habitat to successfully maintain the high abundance in the reservoir.

MANAGEMENT STRATEGIES

1. Develop a stake bed project to establish habitat on or near the shoreline and in areas the water levels generally inundate.
2. Apply for grants with the approval of the City of Wichita Falls to complete the stake bed project at Arrowhead Reservoir.
3. Reach out to local bass fishing clubs and interested individuals to provide in kind services or materials for the stake bed project.
4. Request a stocking of Lone Star Bass fingerlings, which are 2nd generation offspring of pure Florida strain ShareLunker Largemouth Bass that have proven to be able to grow to ≥ 13 pounds, after completion of stake bed project.

ISSUE 2: White Bass are very abundant and grow to preferred lengths for anglers. White Bass estimated catch and harvest rates determined by the creel survey indicates the White Bass population is underutilized regarding anglers targeting the species.

MANAGEMENT STRATEGIES

1. Promote the fishery to the public when making presentations, talking to individuals, and through social media.

ISSUE 3: Arrowhead Reservoir has had a positive eDNA hit for zebra mussels in the past (though they have never been documented and all other water sampling has resulted in negative eDNA hits) so we must use caution in our management practices such as cleaning and drying gear, no transport of invasive species, and increasing our monitoring for their presence.

MANAGEMENT STRATEGIES

1. Plan gear usage so as not to possibly spread zebra mussels and clean, drain and dry our gear after usage.
2. Continue a partnership since 2019 with the City of Wichita Falls to monitor Arrowhead Reservoir for zebra mussels. Collect water samples biannually for the City of Wichita Falls to run tests for eDNA and presence/absence of veligers. In case of a positive test, have Texas Parks and Wildlife rerun sample for quality assurance.

ISSUE 4: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (Dreissena polymorpha) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches, and plugging engine cooling systems. Giant salvinia (Salvinia molesta) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing, and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.
2. Educate the public about invasive species through the use of media and the internet.
3. Make a speaking point about invasive species when presenting to constituent and user groups.
4. Keep track of (i.e., map) existing and future interbasin water transfers to facilitate potential invasive species responses.

Objective-Based Sampling Plan and Schedule (2024-2028)

Sport fish, forage fish, and other important fishes

Sport fishes in Arrowhead Reservoir have historically included Blue, Channel and Flathead Catfish, White Bass, Largemouth Bass, and White Crappie. The primary forage species has been Bluegill and Gizzard and Threadfin Shad.

Low-density fisheries

Gill net surveys indicate Channel Catfish are low in abundance. Additionally, the yearlong creel survey completed in 2018/2019 found low percentages of anglers targeting Channel Catfish and White Bass so survey work on these two species is not deemed needed.

Survey objectives, fisheries metrics, and sampling objectives

Largemouth Bass: The average catch rate of Largemouth Bass over the last six surveys spanning the past eleven years has an average catch rate of 14.1/h. If you take out the high-water event creating a new lake effect in 2017 (CPUE 41.0/h) the highest catch rate is 13.5/h. The catch rate in 2023 and 2020 were 5.5/h and 4.0/h respectively. Largemouth Bass will be surveyed using daytime electrofishing at 18 random sites to track general population trends in the fall of 2027. The 2023 survey showed that daytime electrofishing was sufficient in the turbid water to sample large scale population changes. The objective of the survey will be presence/absence.

Prey: Gizzard Shad will be collected while electrofishing for Largemouth Bass and the objective is general monitoring. Gizzard Shad CPUE with RSE ≤ 25 is the objective and has been met in previous electrofishing surveys presented in this report. It is anticipated that the number of Gizzard Shad collected will be sufficient for IOV calculations. Bluegill and Threadfin Shad will be sampled while electrofishing for Largemouth Bass and the objective will be presence/absence. Bluegill samples outside of new lake effect by high water events have shown it near impossible to meet any data collection objectives. Threadfin Shad will be enumerated during the survey. No extra sampling will take place if Gizzard Shad objectives are not met.

White Crappie: White Crappie will be surveyed using 15 random trap net sites in 2027. This effort historically has been adequate to meet the objectives of general monitoring with a meaningful CPUE with CPUE-S RSE ≤ 25 and a collection of 50 stock-length crappie for size structure examination. All stock-length White Crappie will be measured and weighed for relative weight analysis. No extra sampling will occur if objectives are not met.

Blue Catfish: Low-frequency electrofishing will be utilized to sample the important Blue Catfish fishery in 2027. Twenty 3-minute random stations will be completed during the late summer to monitor large scale population changes with general monitoring. Objectives to achieve are a CPUE-S RSE ≤ 25 for meaningful CPUE, 50 stock-length fish for size structure evaluation, and 10 fish per inch group for meaningful relative weight. No additional sampling will be completed if objectives are not met.

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Tables and Figures

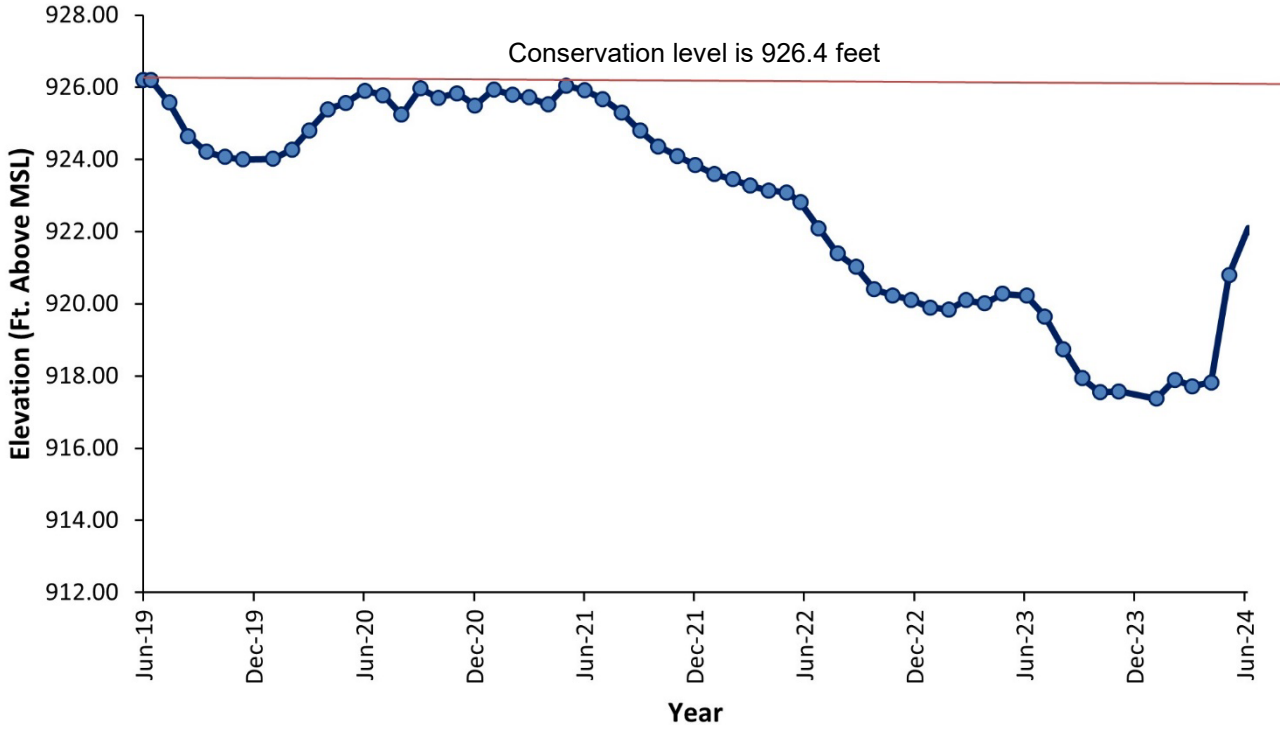


Figure 1. Monthly water level elevations in feet above mean sea level (MSL) recorded for Arrowhead Reservoir, Texas.

Table 1. Characteristics of Arrowhead Reservoir, Texas.

Characteristic	Description
Year constructed	1966
Controlling authority	City of Wichita Falls
County	Archer and Clay
Reservoir type	Mainstem
Shoreline Development Index	6.4
Conductivity	837 µS/cm

Table 2. Boat ramp characteristics for Arrowhead Reservoir, Texas, May 2024. Reservoir elevation at time of survey was 921.72 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
State Park	33.75475 -98.38766	Y	115	916	Good
Westside Ramp	33.74502 -98.36544	Y	25	906	Good
Pawnee Point	33.74158 -98.33917	Y	10	917	Good
Henrietta Bridge	33.72989 -98.31939	Y	50	917	Good
Deer Creek	33.66894 -98.37933	Y	7	920	Good

Table 3. Harvest regulations for Arrowhead Reservoir, Texas.

Species	Bag limit	Length limit
Catfish: Channel and Blue Catfish, their hybrids and subspecies	25 (only 10 ≥ 20 inches)	None
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Largemouth	5	14-inch minimum
Crappie: White and Black crappie, their hybrids and subspecies	25 (in any combination)	10-inch minimum

Table 4. Stocking history of Arrowhead Reservoir, Texas. FRY = fry, FGL = fingerling; AFGL = advanced fingerling; ADL = adults.

Species	Year	Number	Size
Blue catfish	1987	24,100	FGL
	1988	16	ADL
	1995	333,436	FGL
	Total	357,552	
Bluegill	2020	12,040	AFGL
	2020	39,248	FGL
	Total	51,288	
Channel catfish	1967	60,000	AFGL
	1969	10,000	AFGL
	1970	121,600	AFGL
	1972	155,000	AFGL
	Total	346,600	
Florida largemouth bass	1990	405,682	FRY
	1995	408,934	FGL
	2001	397,726	FGL
	2005	136,905	FGL
	2006	360,109	FGL
	2010	376,777	FGL
	2015	116,638	FGL
	2016	180,811	FGL
	2016	604,125	FRY
	2020	102,246	FGL
	Total	3,089,953	
Largemouth bass	1967	468,000	FRY
	1970	50,000	UNK
	1971	105,000	UNK
	2021	142,743	FGL
	2021	331,850	FRY
	2022	523,679	FRY
	2024	154,773	FGL
	Total	1,776,045	
Striped bass	1982	25,351	UNK
	1983	126,805	UNK
	Total	152,156	
White bass	2021	101	ADL
	Total	101	

Table 4. Objective-based sampling plan components for Arrowhead Reservoir, Texas 2020-2024.

Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	Abundance	CPUE–Stock	RSE-Stock ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Age-and-growth	Age at 14 inches	N = 13, 13.0 – 14.9 inches
	Condition	W_r	10 fish/inch group (max)
Bluegill [a]	Exploratory	Presence/absence	Practical effort
Gizzard Shad [a]	Abundance	CPUE–Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
	Prey availability	IOV	N ≥ 50
Low-frequency electrofishing			
Blue Catfish	Abundance	CPUE–stock	RSE-Stock ≤ 25
	Size structure	Length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)
Trap netting			
Crappie	Abundance	CPUE–stock	RSE-Stock ≤ 25
	Size structure	Length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)

[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of Bluegill and Gizzard Shad if not reached from designated Largemouth Bass sampling effort. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density.

Table 5. Survey of structural habitat types, Arrowhead Reservoir, Texas, 2023. Shoreline habitat type units are in miles and standing timber is acres.

Habitat type	Estimate	% of total
Bulkhead	<0.1 miles	<0.1
Natural	121.0 miles	94.3
Rocky	7.3 miles	5.6
Boat docks	9.7 acres	<0.1
Standing timber	1,384.6 acres	11.9

Table 6. Survey of aquatic vegetation, Arrowhead Reservoir, Texas, 2003-2023. Surface area (acres) is listed with percent of total reservoir surface area in parentheses.

Vegetation	2003	2007	2011	2015	2023
Native submersed	0.3 (<0.1)	29.3 (<0.1)	0	0	0
Native floating-leaved	0	47.2 (0.3)	3.5 (<0.1)	2.4 (<0.1)	0
Native emergent	0	45.2 (0.3)	0	0	0

Table 7. Percent directed angler effort by species for Arrowhead Reservoir, Texas, 2019 - 2023. Survey periods were from 1 March through 31 May.

Species	2019	2023
Channel Catfish	0.3	0.0
Blue Catfish	6.6	1.6
White Bass	1.0	0.7
Largemouth Bass	6.7	3.1
Crappie	61.4	51.6
Catfish	13.4	22.7
Anything	10.6	20.3

Table 8. Total fishing effort (h) for all species and total directed expenditures at Arrowhead Reservoir, Texas, 2019 - 2023. Survey period was from 1 March through 31 May. Relative standard error is in parentheses.

Creel statistic	2019	2023
Total fishing effort	68,772 (32)	67,397 (24)
Total directed expenditures	$347,545 (36)	$391,387 (30)

Gizzard Shad

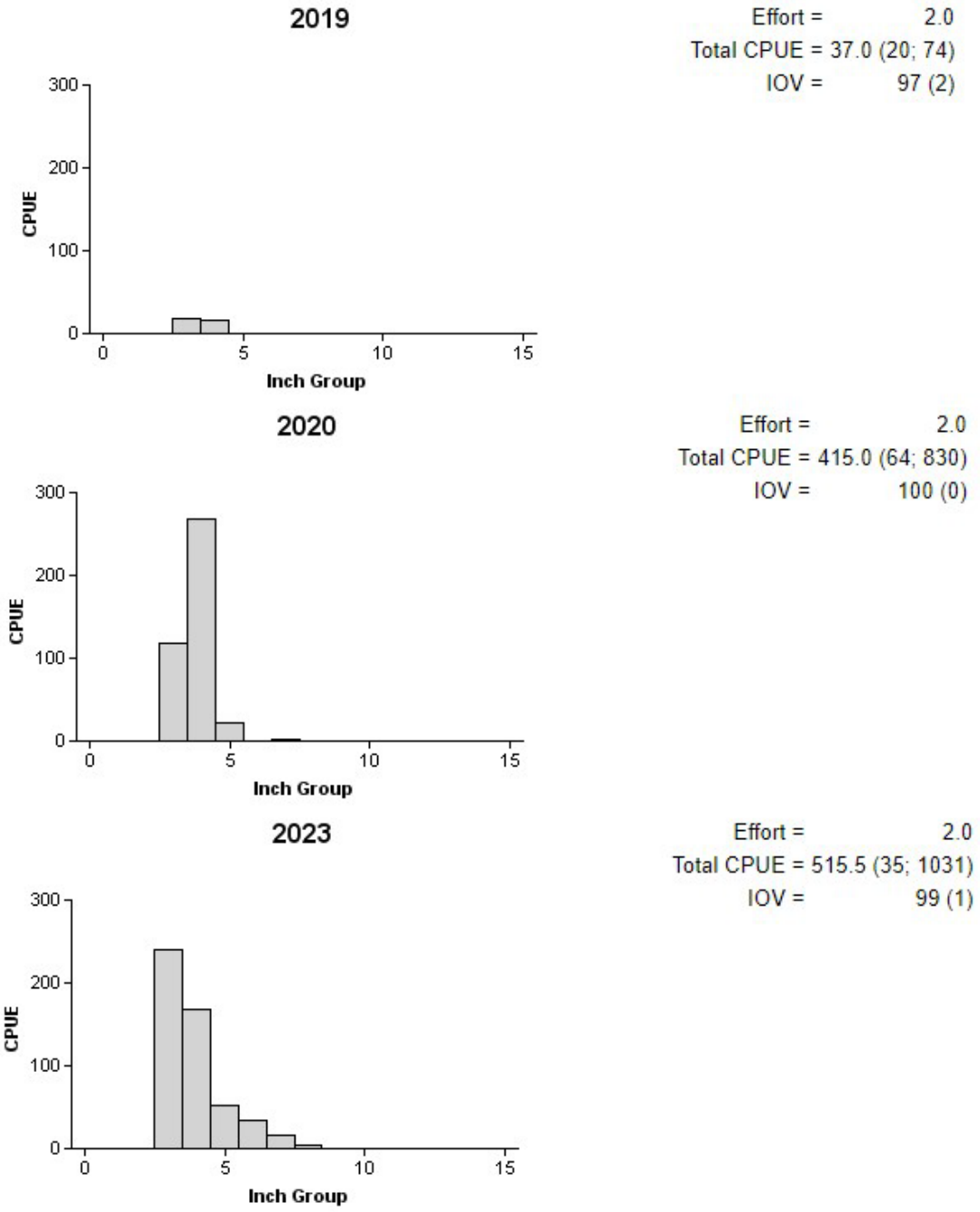


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2019, 2020, and 2023.

Bluegill

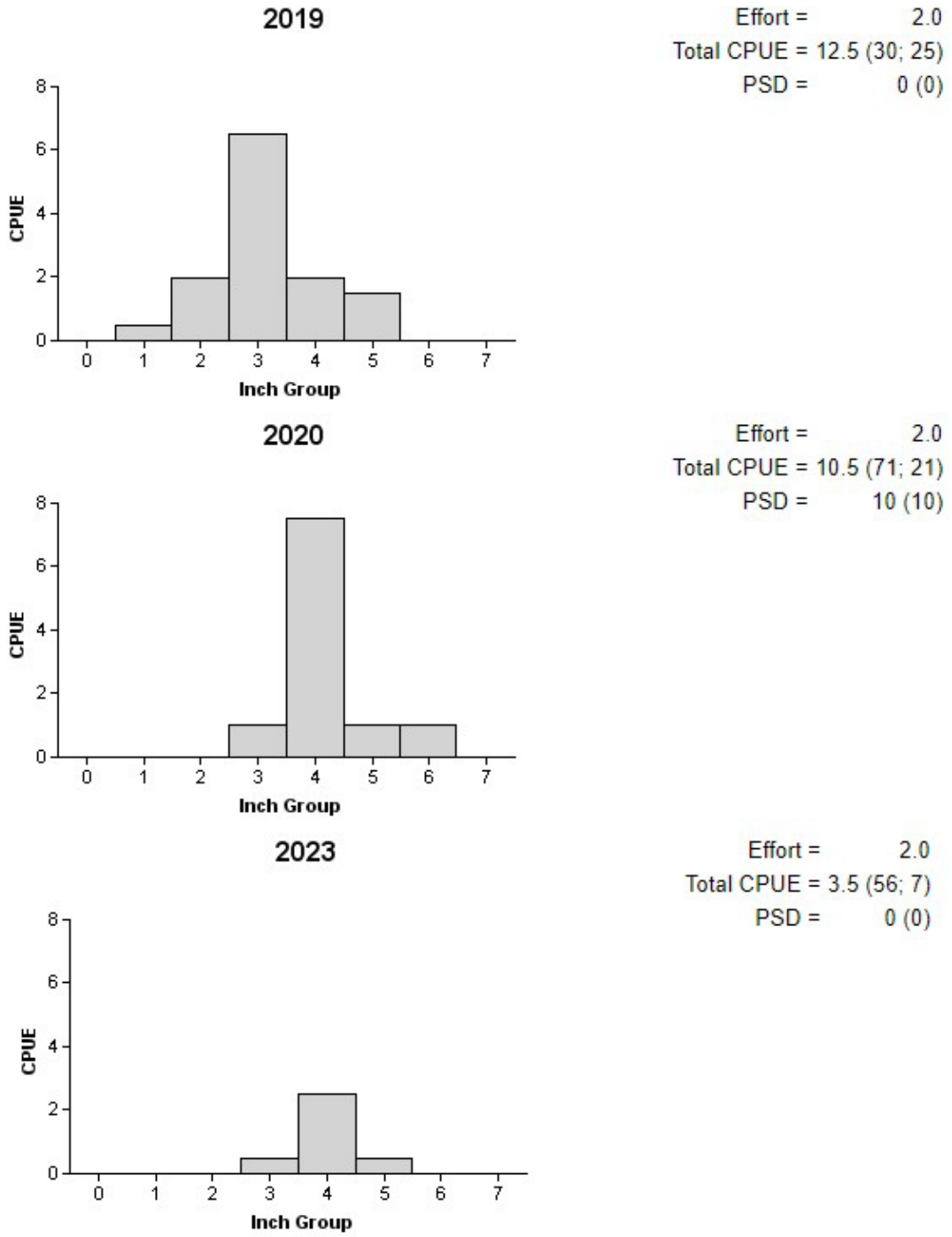


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2019, 2020, and 2023.

Blue Catfish

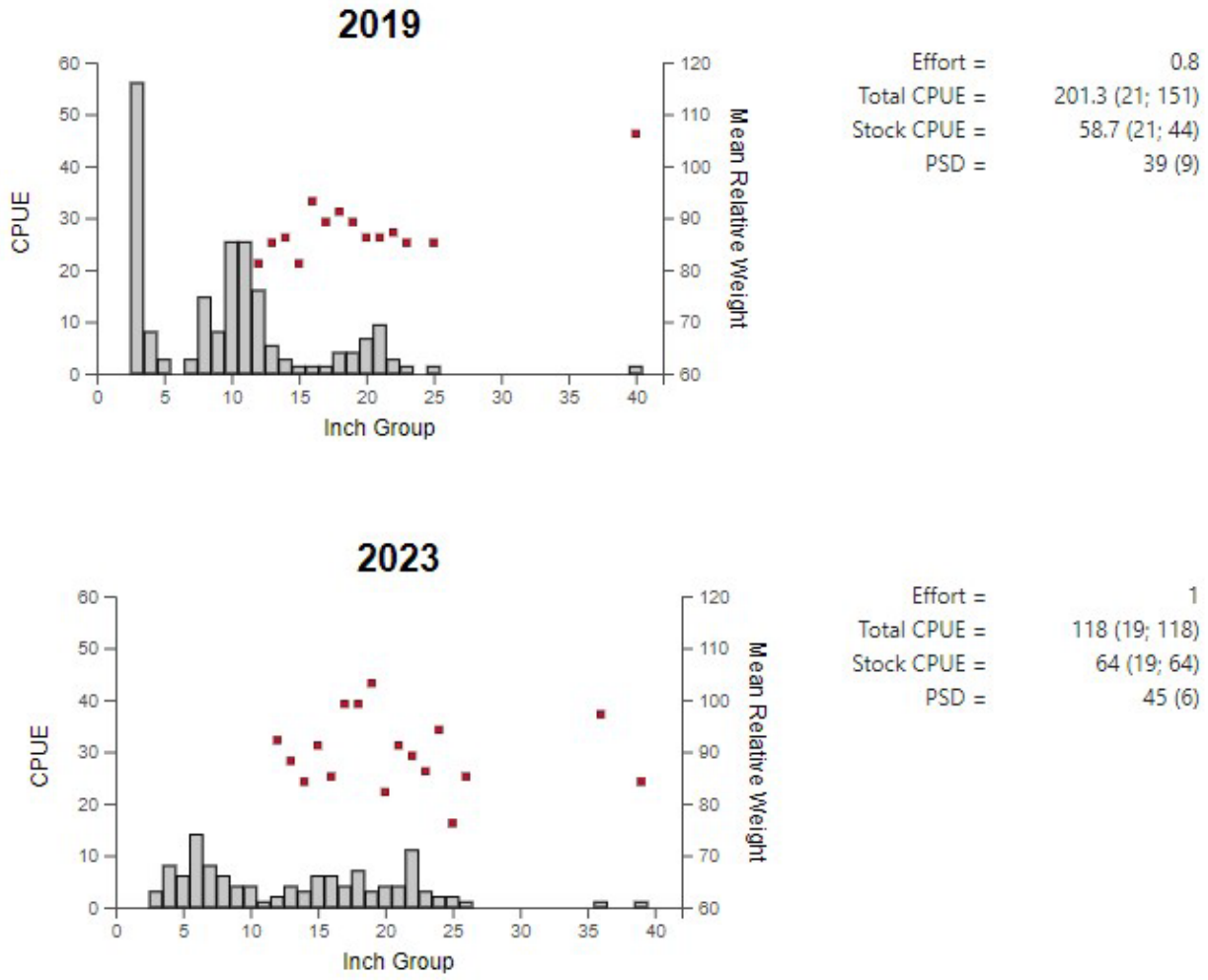


Figure 4. Number of Blue Catfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for low-frequency electrofishing surveys, Arrowhead Reservoir, Texas, 2019 and 2023.

Table 9. Creel survey statistics for Blue Catfish Arrowhead Reservoir, Texas, from March 2019 through May 2019 and March 2023 through May 2023. Total catch per hour is for anglers targeting Blue Catfish and total harvest is the estimated number of Blue Catfish by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Statistic	Year	
	2019	2023
Surface area (acres)	13,939	11,720
Directed effort (h)	13,769.24 (35)	8,983.72 (41)
Directed effort/acre	0.98 (35)	0.77 (41)
Total catch per hour	0.34 (86)	1.10 (50)
Total harvest	3,570.5 (98)	12,611.56 (58)
Harvest/acre	0.26 (98)	1.08 (58)
Percent legal released	0.0	16.7

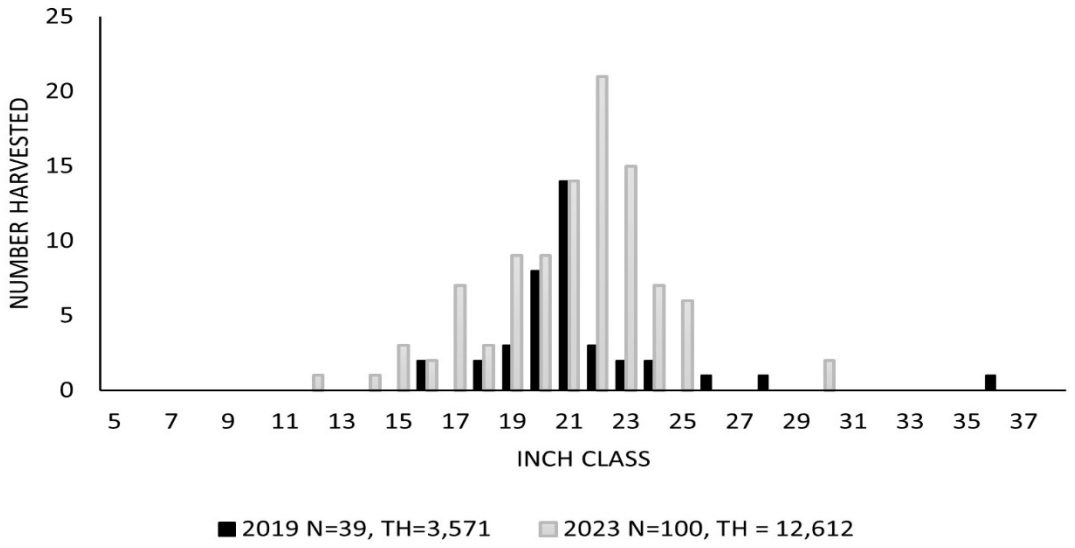


Figure 5. Length frequency of harvested Blue Catfish observed during creel surveys at Arrowhead Reservoir, Texas, March 2019 through May 2019 and March 2023 through May 2023, all anglers combined. N is the number of harvested Blue Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

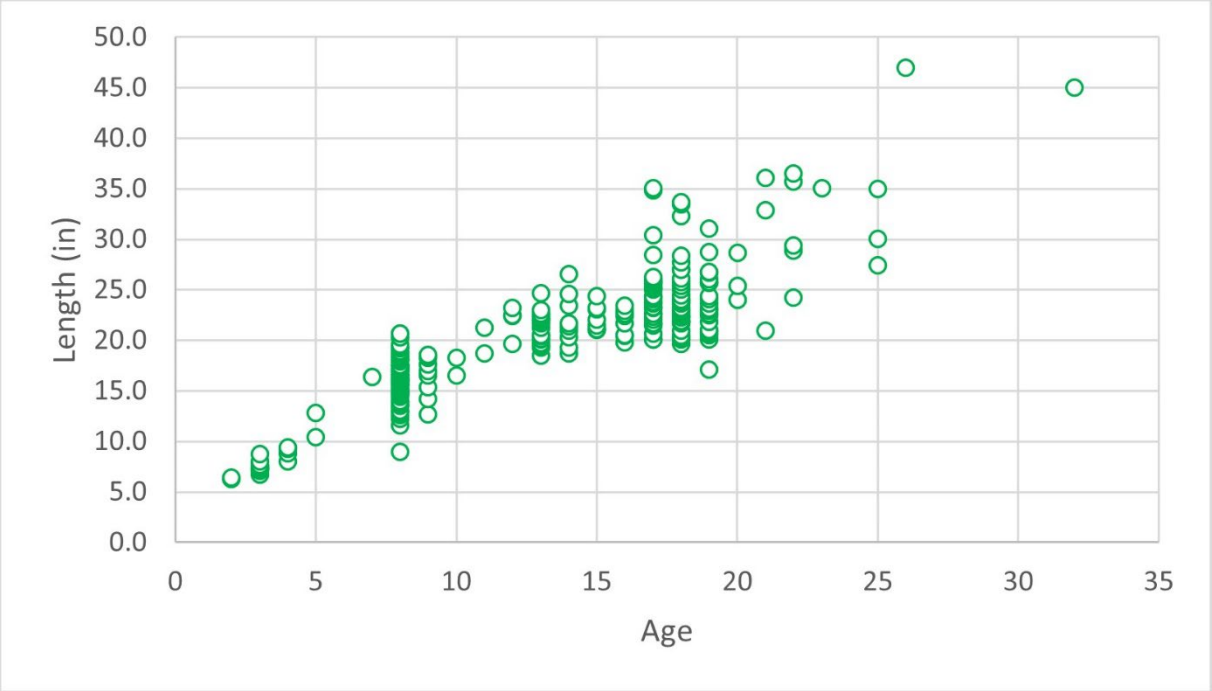


Figure 6. Length at age for Blue Catfish collected by gill net at Arrowhead Reservoir, Texas, April 2023.

White Bass

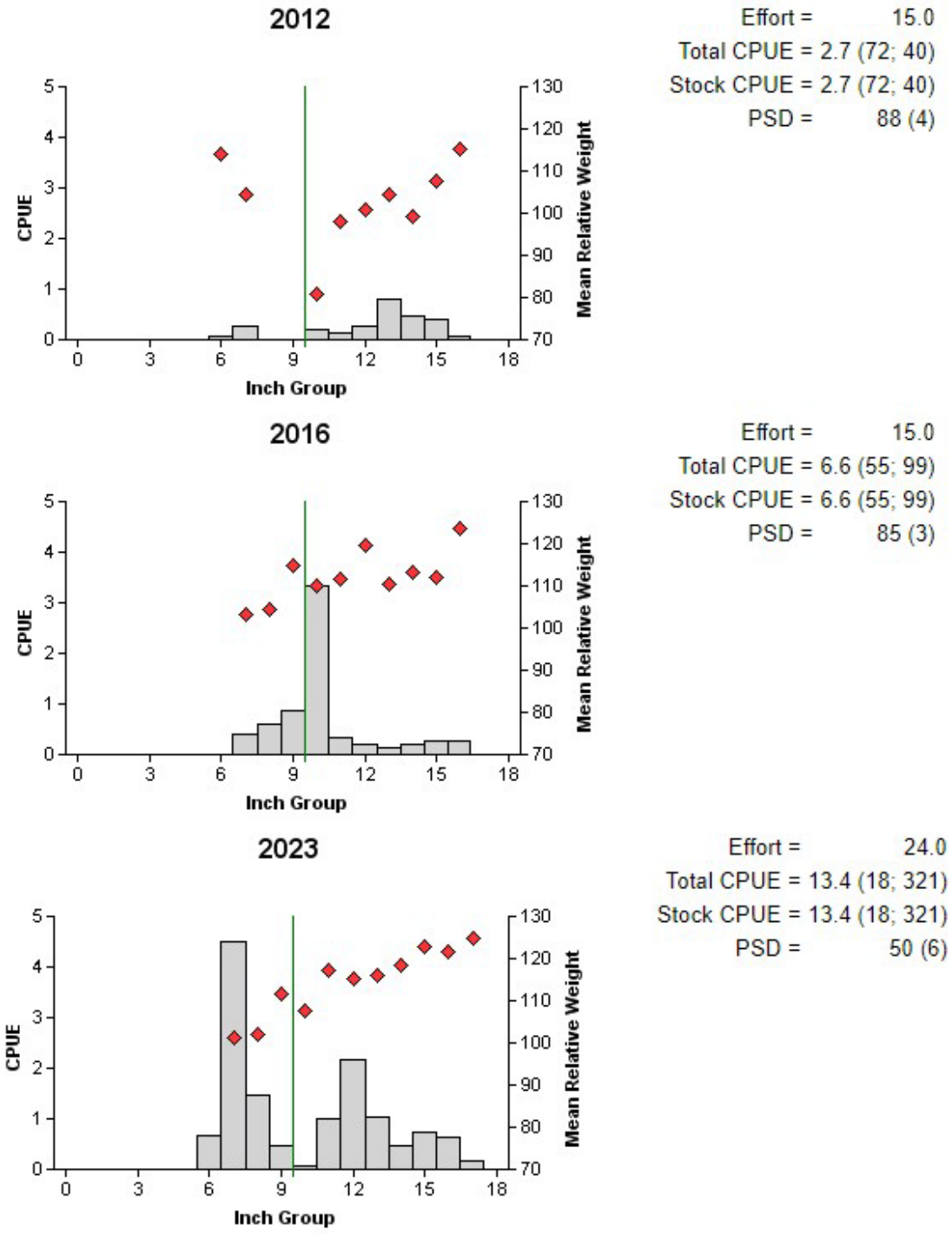


Figure 7. Number of White Bass caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Arrowhead Reservoir, Texas, 2012, 2016 and 2023. Vertical line indicates minimum length limit.

Table 10. Creel survey statistics for White Bass Arrowhead Reservoir, Texas, from March 2019 through May 2019 and March 2023 through May 2023. Total catch per hour is for anglers targeting White Bass and total harvest is the estimated number of White Bass by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Statistic	Year	
	2019	2023
Surface area (acres)	13,939	11,720
Directed effort (h)	704.48 (70)	486.92 (81)
Directed effort/acre	0.05 (70)	0.04 (81)
Total catch per hour	19.30 (45)	4.94 (122)
Total harvest	9,705.04 (56)	837.00 (260)
Harvest/acre	0.70 (56)	0.07 (260)
Percent legal released	10.4	47.2

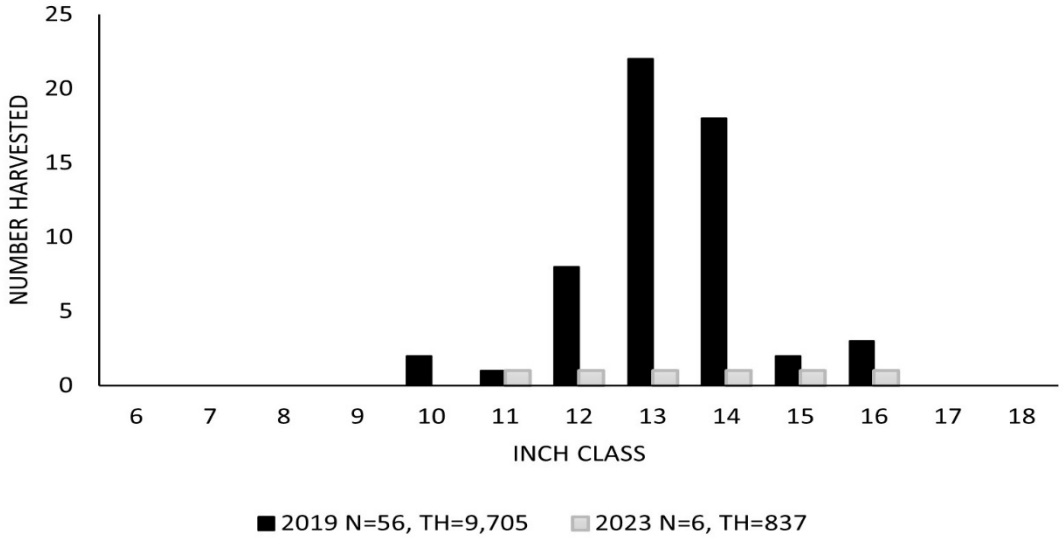


Figure 8. Length frequency of harvested White Bass observed during creel surveys at Arrowhead Reservoir, Texas, March 2019 through May 2019 and March 2023 through May 2023, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

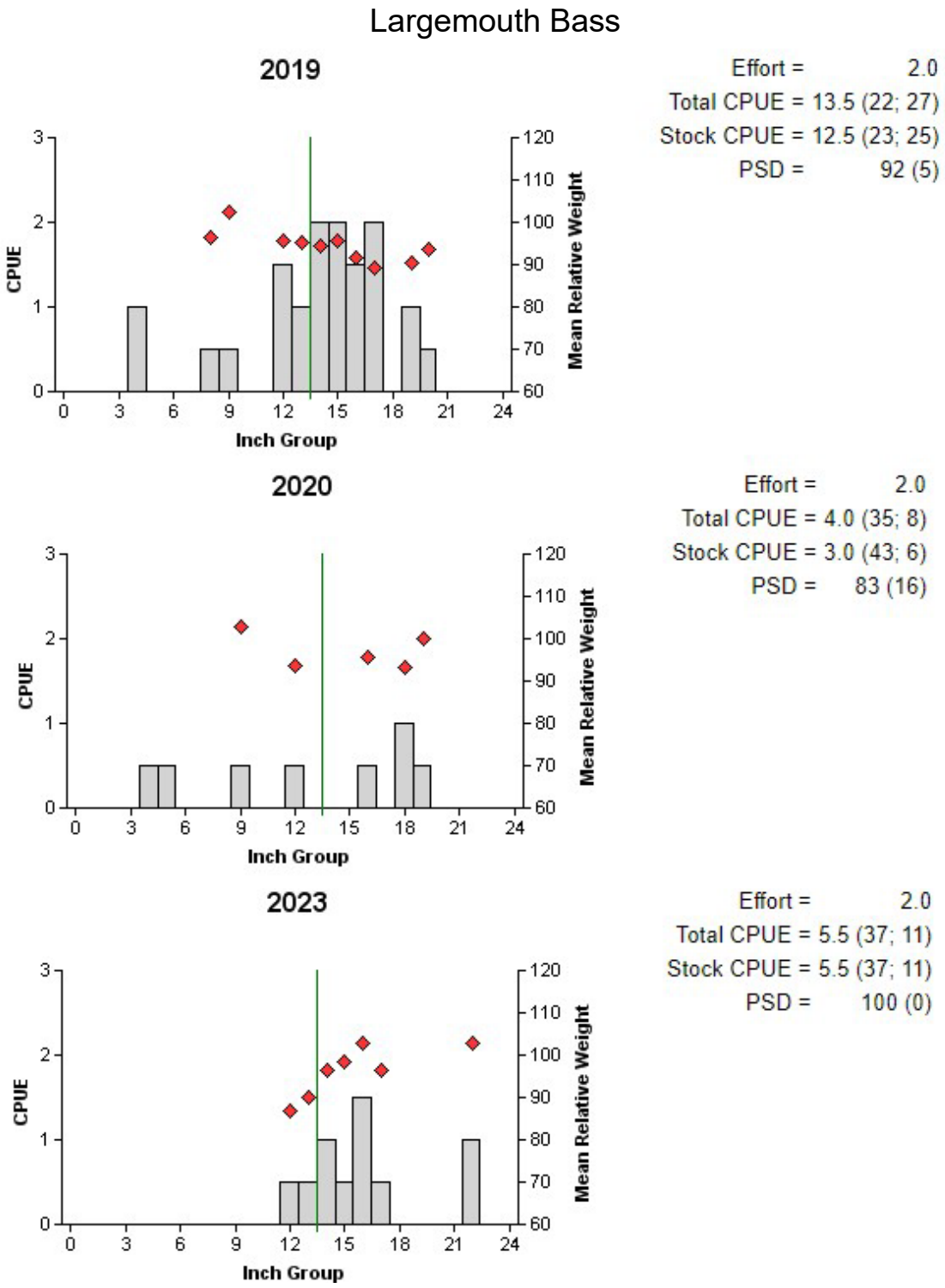


Figure 9. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2019, 2020, and 2023. Vertical line indicates minimum length limit.

Table 11. Creel survey statistics for Largemouth Bass at Arrowhead Reservoir, Texas, from March 2019 through May 2019 and March 2023 through May 2023. Catch rate is for all anglers targeting Largemouth Bass. Harvest is partitioned by the estimated number of fish harvested by non-tournament anglers and the number of fish retained by tournament anglers for weigh-in and release. The estimated number of fish released by weight category is for anglers targeting Largemouth Bass. Relative standard errors (RSE) are in parentheses.

Statistic	2019	2023
Surface area (acres)	13,939	11,720
Directed angling effort (h)		
Tournament	3,424 (49)	0 (0)
Non-tournament	1,132 (60)	2,092 (43)
All black bass anglers combined	4,556 (49)	2,092 (43)
Angling effort/acre	0.3 (49)	0.2 (43)
Catch rate (number/h)	0.3 (49)	0.4 (26)
Harvest		
Non-tournament harvest	944 (344)	0.0 (0)
Harvest/acre	0.1 (344)	0.0 (0)
Tournament weigh-in and release	160 (75)	0 (0)
Percent legal released (non-tournament)	10	100

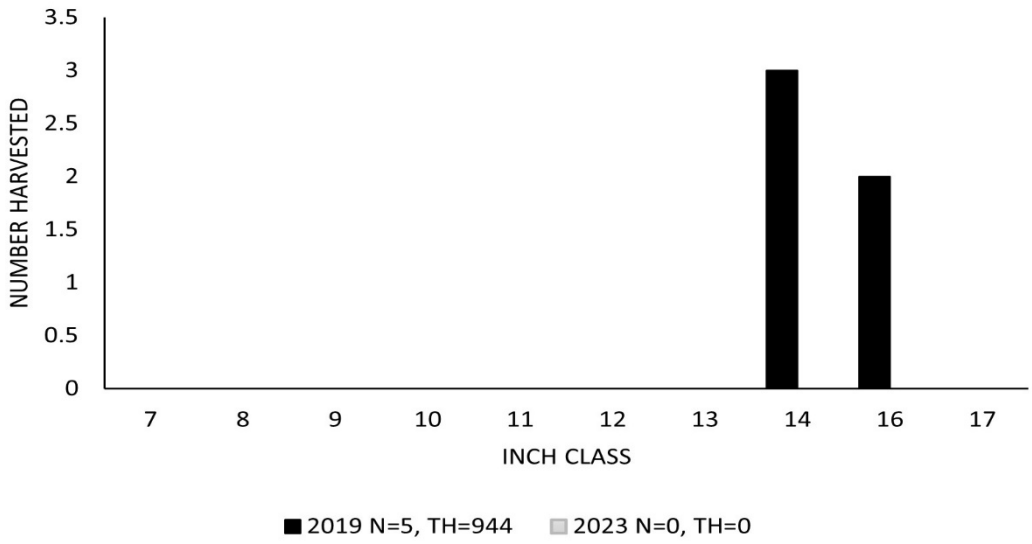


Figure 10. Length frequency of harvested Largemouth Bass observed during creel surveys at Arrowhead Reservoir, Texas, March 2019 through May 2019 and March 2023 through May 2023, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

White Crappie

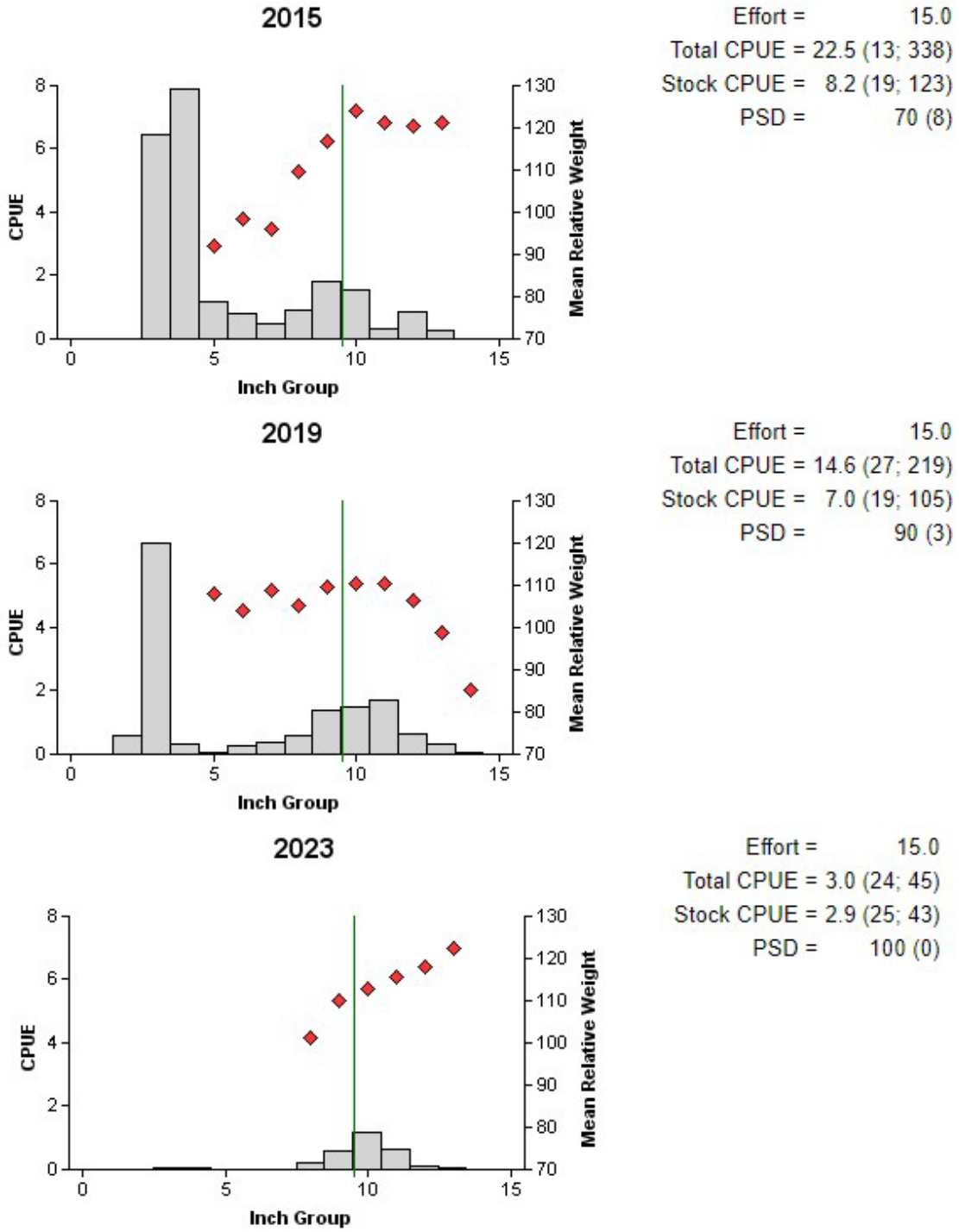


Figure 6. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Arrowhead Reservoir, Texas, 2015, 2019, and 2023. Vertical line indicates minimum length limit.

Table 12. Creel survey statistics for White Crappie at Arrowhead Reservoir, Texas, from March 2019 through May 2019 and March 2023 through May 2023. Total catch per hour is for anglers targeting White Crappie and total harvest is the estimated number of White Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel statistic	Year	
	2019	2023
Surface area (acres)	13,939	11,720
Directed effort (h)	51,440 (24)	34,772 (25)
Directed effort/acre	3.69 (24)	2.97 (25)
Total catch per hour	3.13 (21)	4.19 (31)
Total harvest	81,595 (33)	91,481 (29)
Harvest/acre	5.9 (33)	7.8 (29)
Percent legal released	7.1	2.4

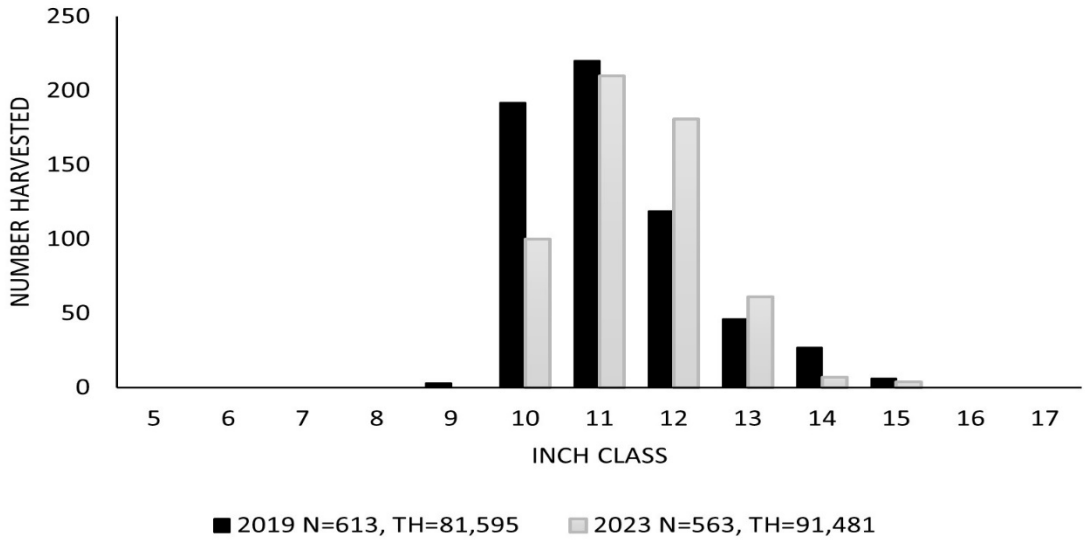


Figure 7. Length frequency of harvested White Crappie observed during creel surveys at Arrowhead Reservoir, Texas, March 2019 through May 2019 and March 2023 through May 2023, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Proposed Sampling Schedule

Table 13. Proposed sampling schedule for Arrowhead Reservoir, Texas. Survey period is June through May. Low-frequency electrofishing, electrofishing and trap netting surveys are conducted in the fall.

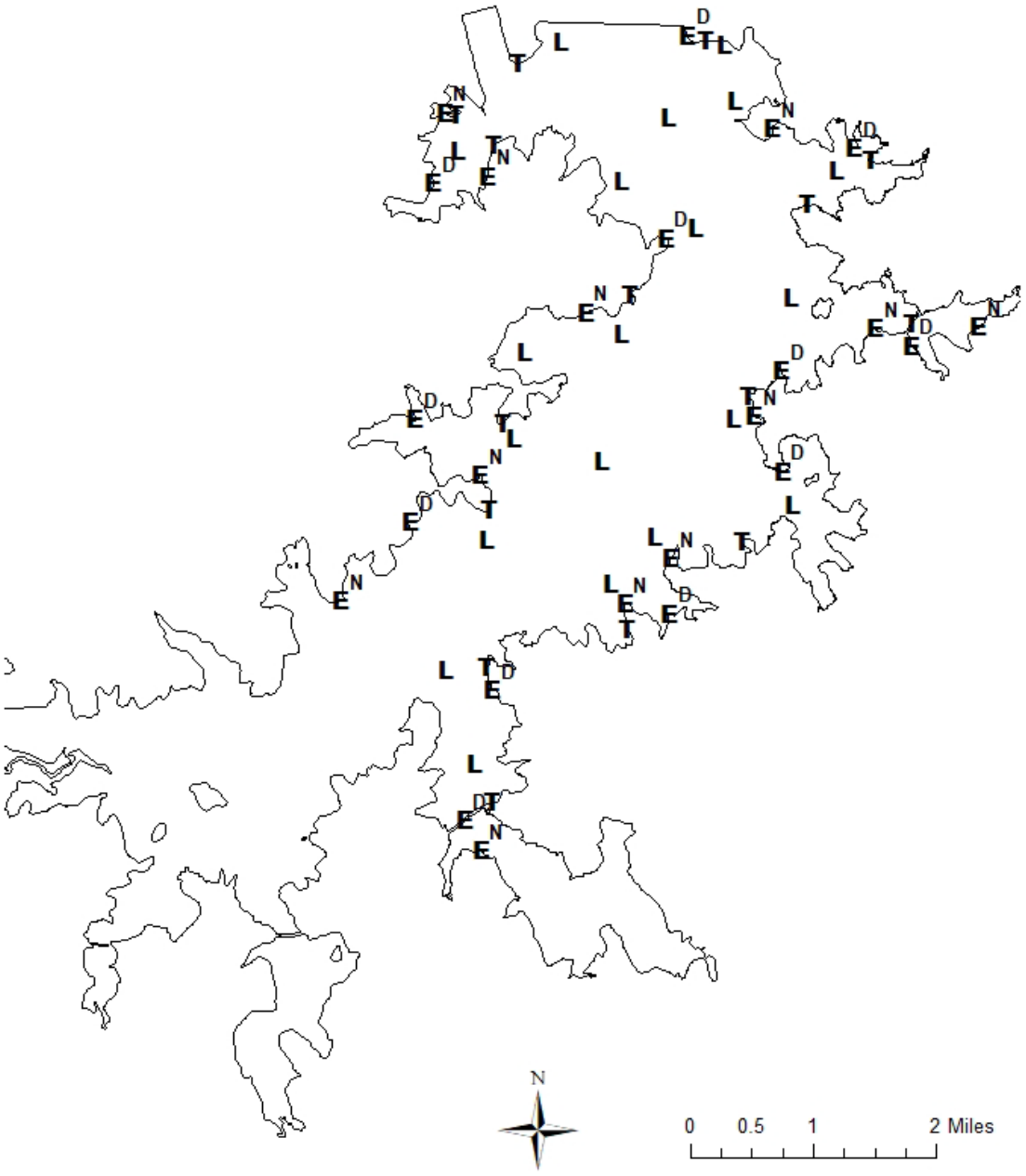
	Survey year			
	2024-2025	2025-2026	2026-2027	2027-2028
Angler Access				X
Structural Habitat				X
Vegetation				X
Electrofishing – Fall				X
Electrofishing – Low frequency				X
Trap netting				X
Report				X

APPENDIX A – Catch rates for all species from all gear types

Number (N) and catch rate (CPUE) (RSE in parentheses) of all target species collected from all gear types from Arrowhead Reservoir, Texas, 2023. Sampling effort was 24 net nights for gill netting, 1 hour for low-frequency electrofishing, 15 net nights for trap netting and 2 hours for electrofishing.

Species	Gill Netting		Low-frequency Electrofishing		Electrofishing		Trap netting	
	N	CPUE	N	CPUE	N	CPUE	N	CPUE
Longnose Gar							2	0.1 (68)
Shortnose Gar							1	0.1 (100)
Gizzard Shad					1031	515.5 (35)	17	1.1 (57)
Threadfin Shad					458	229.0 (62)	40	2.7 (67)
River Carpsucker							1	0.1 (100)
Blue Catfish			118	118.0 (19)			3	0.2 (72)
Channel Catfish							1	0.1 (100)
Flathead Catfish			7	7.0 (43)				
White Bass	321	13.4 (18)					1	0.1 (100)
Bluegill					7	3.5 (56)	21	1.4 (33)
Longear Sunfish					7	3.5 (86)	17	1.1 (49)
Largemouth Bass					11	5.5 (37)		
White Crappie							45	3.0 (24)
Freshwater Drum							1	0.1 (100)

APPENDIX B – Map of sampling locations



Location of sampling sites, Arrowhead Reservoir, Texas, 2023. Trap net, low-frequency electrofishing, and electrofishing daytime and electrofishing nighttime stations are indicated by T, L, E^D and E^N, respectively. Water level was around eight feet below conservation level at time of sampling.

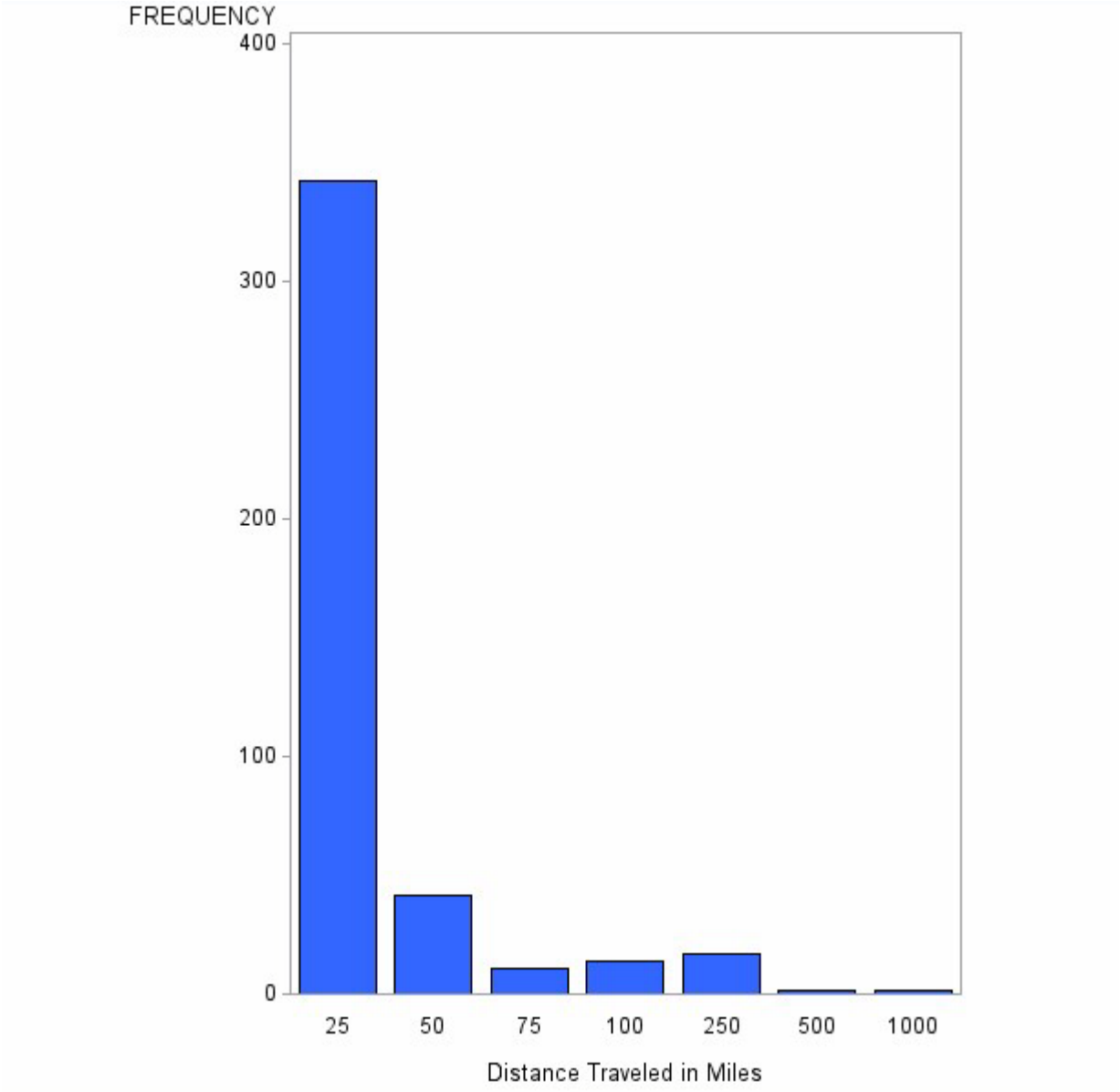
APPENDIX C – Historical catch rates of targeted species by gear type

		Year									
Gear	Species	1999	2000	2003	2004	2005	2007	2008	2009	2011	2012
Gill Netting (fish/net night)	Blue Catfish	4.4			8.9			12.5			16.8
	Channel Catfish	1.1			0.3			0.5			0.9
	Flathead Catfish	0.1			0.1			0.3			0.1
	White Bass	10.1			17.9			6.9			2.7
Electrofishing (fish/hour)	Gizzard Shad	200.0		468.0			576.0		642.0	940.5	
	Threadfin Shad	36.5		0.0			125.0		22.5	0.0	
	Green Sunfish	0.5		0.0			40.5		0.0	0.0	
	Warmouth	1.0		0.5			13.0		0.0	4.0	
	Bluegill	17.5		36.0			219.5		77.5	97.0	
	Longear Sunfish	8.0		19.5			58.0		7.0	16.5	
	Largemouth Bass	25.0		16.5			86.0		59.0	37.0	
Trap Netting (fish/net night)	White Crappie	10.7	11.0	15.1		18.1	23.0			14.1	

Appendix C – Continued

		Year							
Gear	Species	2013	2015	2016	2017	2019	2020	2023	Mean
Gill Netting	Blue Catfish			6.7					9.9
(fish/net night)	Channel Catfish			0.0					0.6
	Flathead Catfish			0.1					0.1
	White Bass			6.6				13.4	9.6
Electrofishing	Gizzard Shad	397.7	375.5		255.0	37.0	415.0	515.5	438.4
(fish/hour)	Threadfin Shad	4.7	0.0		32.0	1895.5	86.0	229.0	221.0
	Green Sunfish	0.0	1.5		0.5	0.5	0.0		4.4
	Warmouth	0.0	0.0		0.0	0.0	0.0		1.9
	Bluegill	0.0	19.0		44.0	12.5	10.5	3.5	48.8
	Longear Sunfish	6.7	4.0		6.5	2.0	6.0	3.5	12.5
	Largemouth Bass	11.3	9.5		41.0	13.5	4.0	5.5	28.0
Trap Netting	White Crappie		22.5			14.6		3.0	14.7
(fish/net night)									
Low frequency	Blue Catfish					201.3		118.0	159.7
Electrofishing	Channel Catfish					1.3			1.3
(fish/hour)	Flathead Catfish					1.3		7.0	4.2

APPENDIX D – Reporting of creel Zip code data



Frequency of anglers that traveled various distances (miles) to Arrowhead Reservoir, Texas, as determined from the March 2023 through May 2023 creel survey.

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