PERFORMANCE REPORT

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2015 Fisheries Management Survey Report

Arrowhead Reservoir

Prepared by:

Robert Mauk, Assistant District Management Supervisor
and
Tom Lang, District Management Supervisor

Inland Fisheries Division
Wichita Falls District
Wichita Falls, Texas

Carter Smith
Executive Director

Craig Bonds
Director, Inland Fisheries

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Arrowhead Reservoir were surveyed in 2015 using electrofishing and trap netting and in 2016 using gill netting. Historical data are presented with the 2015-2016 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 water elevation was near full capacity with the shoreline habitat consisting mainly of natural and rocky shoreline. 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 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 Catfish, Largemouth Bass, White Bass and White Crappie. Arrowhead is managed under statewide regulations.

- **Fish Community**

  - **Prey species:** Gizzard Shad electrofishing catch rate was slightly below average for the reservoir and were in the size range consumed by predators. The catch per unit effort (CPUE) for Bluegill was well below average. The drought negatively impacted the prey populations because of a lack of spawning habitat. Threadfin Shad have been sampled in previous surveys but were not documented in the recent survey. It is expected that the prey numbers will rebound quickly.

  - **Catfishes:** During the 2016 gill net survey, Blue Catfish CPUE decreased by over half from the previous survey. Most of this decrease can be attributed to a lack of smaller fish, probably related to the four-year drought that ended in early 2015 and the resulting lack of habitat that affected recruitment. No Channel Catfish were sampled during the gill net survey but they are present in the reservoir as they were caught during the trap net survey. Flathead Catfish are also present in the reservoir.

  - **White Bass:** White Bass gill net survey CPUE was up compared to the previous survey but was below the historical average. Over half the bass sampled were 10-inches in length.

  - **Largemouth Bass:** The 2015 electrofishing survey for Largemouth Bass had the lowest catch rate ever. This was the result of a prolonged drought that led to low reservoir elevations that negatively affected the recruitment of young bass. No legal-length bass were sampled. Sampled bass were likely from the 2015 stocking.

  - **Crappie:** The 2015 trap net survey CPUE increased over the previous survey and was near the historical average. Legal-length crappie were all above average in body condition. A Black Crappie was sampled during the survey, the first ever documented.

- **Management Strategies:** Request supplemental stocking of Largemouth Bass since their relative abundance was down. Conduct a catfish creel survey in 2016-2017, a traditional creel in 2018-2019, and standard electrofishing, low-frequency electrofishing, and trap netting in 2019-2020.

INTRODUCTION

This document is a summary of fisheries data collected from Arrowhead Reservoir in 2015-2016. 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 2015-2016 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 was 16 feet, shoreline development index was 6.4, and conductivity was 312 *µ*S/cm. 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 near spillway elevation at time of habitat survey (Figure 1). Other descriptive characteristics for Arrowhead are in Table 1.

Angler Access

Arrowhead Reservoir has five public boat ramps and no private boat ramps. All five public ramps were available to anglers once the reservoir filled in 2015. Before that, only the Westside ramp was usable and had undergone an extension of the ramp. 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 a fishing pier for anglers.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Mauk 2012) included:

1. Lake Arrowhead State Park fishing piers are a popular fishing destination for anglers. We have placed discarded Christmas trees there annually to increase catch rates and this has proven to be successful and popular.
   Action: Continued annual fish attractor enhancement program except for 2014-2015 when the reservoir was so low that the piers were out of the water and 2015-2016 when the trees were not available.

2. Arrowhead, in terms of number of anglers, is the District's most popular destination. Angler interest in the fish and reservoir is quite high.
   Action: Continued to provide multiple news releases and distributed them more widely than the Wichita Falls area.
   Action: Updated Arrowhead web page annually to reflect known reservoir conditions and fishing information.

3. Educating the public about Invasive species which threaten aquatic habitats and organisms in Texas is a priority as well as documenting their presence.
   Action: Multiple presentations about invasives have been given since the last report.
   Action: The reservoir is checked for invasives and signage has been put up at the boat ramps promoting Clean, Drain, and Dry.

4. A 2011 study identified zebra mussel DNA to be present in the reservoir, though no veligers or adults had ever been found. The possibility that they were present in the reservoir altered some of the District's management activities.

   Action: Standard operating procedures of cleaning and drying all sampling gear were put in place after use in Arrowhead. Later, because of water restrictions put in place by the City of Wichita Falls in response to the drought, we could not wash the equipment. All sampling gear had to be left to dry to insure that zebra mussels would not be spread.

   Action: In response to the report, it became district policy not to move any water or fish from Arrowhead. Efforts were made to educate the public about invasive species through the use of media and the internet.

   Action: Zebra mussel samplers, rocky substrates, docks and any hard surface objects near boat ramps were monitored until the reservoir elevation dropped so far that they were out of the water.

   Action: Results from Dr. McMahon's follow up 2012 investigation into the presence/absence of zebra mussel DNA, veligers or adults in the reservoir came back negative.

5. Largemouth Bass are a popular species targeted by tournament anglers in Arrowhead Reservoir. The population is highly dynamic with abundance dependent on reservoir elevations. Recruitment is highly variable. The 2011 electrofishing survey indicated a lack of recruitment most likely caused by lack of suitable habitat.

   Action: Conducted a standardized electrofishing survey in 2013 to monitor changes in the Largemouth Bass population.

   Action: Requested a Florida Largemouth Bass stocking contingent on the reservoir elevation increasing enough to submerge vital nursery habitat. The reservoir elevation did not improve until 2015 when nursery habitat was submerged. Stockings occurred in 2015 and 2016

6. The Blue Catfish fishery was becoming quite popular with anglers but little was known about the population.

   Action: Collected category 3 age and growth data for the Blue Catfish population at Arrowhead in 2013 using low-pulse electrofishing. Planned on conducting a creel survey in 2013-2014 and acquiring data from catfish tournaments but the reservoir elevation prevented boat access.

Harvest regulation history: Sport fish species in Arrowhead Reservoir were managed using statewide regulations (Table 3).

Stocking history: Florida Largemouth Bass were stocked in 2015 and 2016. The complete stocking history is in Table 4.

Vegetation/habitat management history: Noxious aquatic vegetation has not been observed in the reservoir (Table 7). Christmas tree fish attractors have been placed annually around the state park fishing pier when possible. Placement of brush piles outside the Lake Arrowhead State Park boundaries has occasionally occurred and the sites are listed on the TPWD website.

Water Transfer: Arrowhead Reservoir is one of the primary water sources for the City of Wichita Falls. The City of Windthorst also pumps water from the reservoir for municipal purposes. There is no interbasin transfer of water from Arrowhead.

METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Arrowhead Reservoir (TPWD unpublished). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Electrofishing – Largemouth Bass, Sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (2 hour at 24, 5-min stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

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).

Gill netting – Blue Catfish and White Bass were collected by gill netting (15 net nights at 15 stations). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn).

Low-frequency electrofishing – Blue Catfish were collected by low-frequency electrofishing in 2013 at 20 stations for age and growth evaluation. The minimum duration of electrofishing at each station was 5 minutes. Additional sampling occurred to fill out length groups that were missing for age and growth. Ages for Blue Catfish were determined using otoliths from over 200 Blue Catfish (5.2-37.0 inches in length; N=212).

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2015 and by electrophoresis for previous years.

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 Anderson and Neumann (1996). 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.

Habitat – A structural habitat survey was conducted in 2015. Vegetation surveys were conducted once every four years, the latest occurring in in 2015. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Water level – Source for water level data was the United States Geological Survey (USGS 2016).

RESULTS AND DISCUSSION

Habitat: A physical habitat survey conducted July 2015 indicated the littoral zone habitat consisted primarily of natural and rocky shoreline (Table 6). The reservoir was 0.4 feet below conservation pool (conservation pool = 926.4 MSL) at time of survey. Few manmade changes to the physical habitat had occurred during the four year period since the last survey (Mauk 2012).

Prey species: Electrofishing catch rates of Gizzard Shad and Bluegill were 375.5/h (Figure 2) and 19.0/h

(Figure 3), respectively. Index of vulnerability for Gizzard Shad was excellent, indicating that 100% of Gizzard Shad were available to predators. The catch rate was slightly down from the 2013 survey and below the historical average (468.1/h). Bluegill CPUE was below the reservoir historical average (77.0/hr). The drought of record that ended in 2015 negatively impacted the Bluegill population abundance because of a lack of spawning habitat. There were no Threadfin Shad sampled compared to 22.5/hr and 125.0/hr in 2009 and 2007; respectively. Overall, prey seems abundant in sizes that predators can consume; especially considering the predators were also greatly impacted by the drought.

Blue Catfish: Blue Catfish 2016 gill net CPUE (6.7/nn) was significantly down from previous surveys (12.5 in 2008 and 16.8 in 2012; Figure 4) indicating that the population was likely negatively impacted by the drought. Examining the CPUE of sub-stock fish finds that in 2008 and 2012 the CPUE was 5.0 and 5.7 respectively while in 2016 it was 0.4. This is the lowest CPUE since Blue Catfish became established in 1999. Fish from 9- to 32 inches were sampled. Body condition as measured by W_r was relatively constant over inch groups ranging from 88-99. Age and growth performed in 2013 indicated that it took about five years for a Blue Catfish to attain legal length (12 inches; Table 8).

Channel Catfish: No Channel Catfish were caught during the 2016 gill net survey (Figure 5). This is the first time that no Channel Catfish were caught during gill net surveys. Over the years, CPUE has always been low ranging from 0.3/nn to 1.9/nn. While no Channel Catfish were sampled with gill nets, the 2015 trap netting survey had 34 individuals caught, so they are still present in the reservoir.

Flathead Catfish: The gill net CPUE was 0.1/nn for 2016, the same as in 2012 but down from the 2008 survey of 0.3/nn (Figure 6). When discussing a species like Flathead Catfish that are represented in our surveys in low abundance, it is hard to determine whether it is a change in the abundance or just catch variability that we are observing. While only two fish were caught, this is still considered to be a good Flathead Catfish reservoir by anglers. Both fish had W_r's above 100.

White Bass: The gill net catch rate for White Bass was 6.6/nn in 2016, which was up from 2.7/nn in 2012 but less than the historical average of 10.8/nn (Figure 7). Sizes ranged from 7 to 16 inches in length but half of the sampled population was 10 inches in length, which bodes well for the future. Body condition as measured by W_r ranged from 103-124.

Largemouth Bass: The electrofishing CPUE of Largemouth Bass was 9.5/h in 2015, well below the historical average of 40.9/h and the last survey before the drought (37.0/h) in 2011 (Figure 8). No bass longer than 11-inches were sampled, so all bass could be from the stocking that occurred in 2015 when compared to historical mean length at age of capture data (Table 9). Body condition as measured by W_r of bass was above 100.

Crappie: The trap net catch rate of White Crappie was 22.5/nn in 2015, an increase from the previous survey of 2011 (14.1/nn) but lower than 2007 (38.6/nn; Figure 9). The CPUE was just below the historical average of 25.6/nn. Body condition as measured by W_r was over 100 for all legal-length crappie. White Crappie have historically been the most popular species in terms of angler effort and harvest at the reservoir according to past creel surveys (Howell and Mauk 2008). A Black Crappie was also surveyed, the first one ever documented in Arrowhead. It most likely escaped from a pond in the watershed during the 2015 flood events.

Fisheries management plan for Arrowhead Reservoir, Texas

Prepared – July 2016

Issue 1: Lake Arrowhead State Park fishing piers are a popular fishing destination for anglers. We have placed discarded Christmas trees there annually to increase angler catch rates and this has proven to be successful and popular with the anglers.

MANAGEMENT STRATEGIES

1. Continue fish attractor enhancement program and continue expanding to other areas of the reservoir.
2. Explore funding sources to purchase longer lasting artificial structures for Lake Arrowhead.

Issue 2: Arrowhead Reservoir is the District's most popular fishing destination, typically being responsible for more fishing trips than any other District reservoir. Angler interest in Arrowhead Reservoir and fishing is quite high and anglers expect fishery information.

MANAGEMENT STRATEGIES

1. Continue to engage multiple media outlets to keep the public informed of the fishing opportunities.
2. Maintain the Arrowhead Reservoir web page by updating it with any changes that occur at the reservoir.

Issue 3: 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 and state park to post appropriate signage at access points around the reservoir.
2. Contact and educate marina owners about invasive species, and provide them with posters and literature so that they can, in turn, educate others.
3. Educate the public about invasive species through the use of media and the internet.
4. Make a speaking point about invasive species when presenting to constituent and user groups.
5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.
6. Maintain zebra mussel samplers near highly utilized boat ramps.

Issue 4: A 2011 study identified zebra mussel DNA to be present in the reservoir though no veligers or adults have been found. Arrowhead Reservoir is very popular and not that far from reservoirs that have zebra mussels, so vigilance is needed. The possibility that they may eventually become established in the reservoir will alter some of the District's management activities.

MANAGEMENT STRATEGIES

1. Clean and dry all sampling gear thoroughly after use in Arrowhead.

2. Do not move any fish from Arrowhead to other water bodies.
3. Educate the public about invasive species through the use of media and the internet.
4. Closely monitor rocky substrate, docks and any other hard substrate that zebra mussel are likely to colonize.

Issue 5: Largemouth Bass are a popular species targeted by tournament anglers. The population is highly dynamic with abundance dependent on reservoir elevations. Recruitment is highly variable. The recent survey documented a lack of recruitment probably caused by lack of suitable habitat.

MANAGEMENT STRATEGY

1. Request supplemental stockings of Florida Largemouth Bass.

Issue 6: The Blue Catfish population in Arrowhead Reservoir is now considered one of the best in the area and it now attracts annual catfish tournaments. Much is not known about exploitation of the population. Passive gear (jug and trot lines) and hand fishing occurs, but there is no information as to the extent of their usage and population impacts. The local game wardens report hand fishing is popular at the reservoir.

MANAGEMENT STRATEGIES

1. Conduct a catfish creel survey during 2016-2017 including passive gear anglers to better monitor the catfish usage by anglers.
2. Collect results from catfish tournaments when possible.
3. Use low-frequency electrofishing to survey the population.

Objective-Based Sampling Plan and Schedule

FY 2016 – 2019

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 Shad.

Low-density fisheries

Due to extreme low water elevation prior to 2015, the Largemouth Bass fishery would be considered a low density population. Largemouth Bass are an important species that is targeted by 20.2% of anglers according to a 2007-2008 creel survey. Channel Catfish have historically been present but in low abundance in gill net surveys. Threadfin Shad have historically been present in the reservoir but were not collected during the recent surveys.

Survey objectives, fisheries metrics, and sampling objectives

Most fish populations are in the process of rebuilding. Until populations have recovered, sampling objectives are to conduct general monitoring for comparison with long term trend data. The sampling objective for Largemouth Bass, Blue Catfish, and White Crappie data needed is CPUE with an RSE of $\leq$25. White Bass are present in good numbers but historically make up a small proportion of the angler effort ($\leq$ 5.5%). Because Channel Catfish are found in low abundance in the gill net surveys and there are few management options for White Bass (which is mostly a non-targeted species in the reservoir), gill netting will not be conducted. Low-frequency electrofishing will be utilized to sample the important Blue Catfish fishery. At minimum, 15 3-minute stations will be completed, with more being conducted to achieve an RSE of $\leq$25. While Largemouth Bass were restocked in 2015, they were stocked at a reduced rate calculated on the reservoir being half full. Largemouth Bass sampled in 2015 were sub-legal in length and most were probably stocked fish. Because the population is rebuilding, standard effort will initially be used to determine CPUE with RSE $\leq$25 and will begin with 24 random electrofishing stations. Sunfish and shad will be collected with the Largemouth Bass but no RSE target will be set for them. White Crappie will be examined using, at minimum, 15 trap net sites until RSE is 25 or less. Once fish populations are detected in the above sampling techniques and determined to have re-established to pre-drought CPUE and length frequency; survey objectives, fisheries metrics, and sampling effort will be reevaluated. Because of the importance of the Blue Catfish population in Arrowhead and our lack of knowledge regarding exploitation, we will also conduct a catfish specific creel survey in 2016-2017 that includes passive gear and handfishing anglers (Table 11). A traditional creel will be conducted in 2018-2019 (Table 11).

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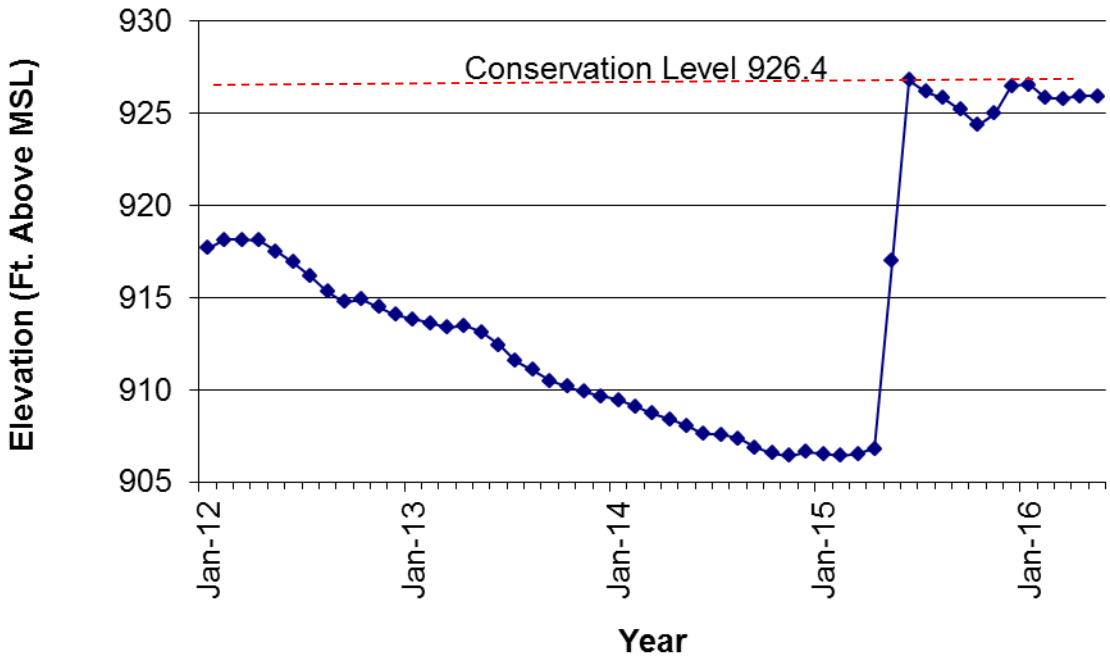


Figure 1. Monthly water level elevations in feet above mean sea level (MSL) recorded for Arrowhead Reservoir, Texas. Water elevation data obtained from the USGS website.

Table 1. Characteristics of Arrowhead Reservoir, Texas.

Characteristic	Description
Year constructed	1966
Controlling authority	City of Wichita Falls
Counties	Archer and Clay
Reservoir type	Mainstem
Shoreline Development Index (SDI)	6.36
Conductivity	312 *µS*/cm

Table 2. Boat ramp characteristics for Arrowhead Reservoir, Texas, August, 2015. Reservoir elevation at time of survey was 926.0 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	Y	115	916	Good
	-98.38766				
Westside Ramp	33.74502	Y	25	906	Good
	-98.36544				
Pawnee Point	33.74158	Y	10	917	Good
	-98.33917				
Henrietta Bridge	33.72989	Y	50	917	Good
	-98.31939				
Deer Creek	33.66894	Y	7	920	Good
	-98.37933				

Table 3. Harvest regulations for Arrowhead Reservoir, Texas.

Species	Bag limit	Length limit
Catfish: Channel and Blue, their hybrids and subspecies	25 (in any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Largemouth	5	14-inch minimum
Crappie, White	25	10-inch minimum

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

Species	Year	Number	Life Stage	Mean TL (in)
Blue Catfish	1987	24,100	FGL	2.0
	1988	16	ADL	15.8
	1995	333,436	FGL	2.0
	Total	357,552		
Channel Catfish	1967	60,000	AFGL	7.9
	1969	10,000	AFGL	7.9
	1970	121,600	AFGL	7.9
	1972	155,000	AFGL	7.9
	Total	346,600		
Florida Largemouth Bass	1990	405,682	FRY	0.6
	1995	408,934	FGL	1.3
	2001	397,726	FGL	1.5
	2005	136,905	FGL	1.9
	2006	360,109	FGL	1.6
	2010	376,777	FGL	1.6
	2015	116,638	FGL	1.8
	2016	180,811	FGL	1.8
	2016	604,125	FRY	0.3
	Total	2,987,707		
Largemouth Bass	1967	468,000	FRY	0.7
	1970	50,000	UNK	UNK
	1971	105,000	UNK	UNK
	Total	623,000		
Striped Bass	1982	25,351	UNK	UNK
	1983	126,805	UNK	UNK
	Total	152,156		

Table 5. Objective-based sampling plan components for Arrowhead Reservoir, Texas 2015-2016.

Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	Exploratory	Presence/absence	Practical effort
Bluegill	Exploratory	Presence/absence	Practical effort
Gizzard Shad	Exploratory	Presence/absence	Practical effort
Trap netting			
White Crappie	Exploratory	Presence/absence	Practical effort
Gill netting			
Channel Catfish	Exploratory	Presence/absence	Practical effort
Blue Catfish	Exploratory	Presence/absence	Practical effort

Table 6. Survey of structural habitat types, Arrowhead Reservoir, Texas, 2015. 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	6.6 miles	5.1
Rocky bluff	0.7 miles	0.5
Standing timber	1,384.6 acres	11.9
Boat docks	9.7 acres	<0.1
Flooded terrestrial vegetation	150.3 acres	1.0

Table 7. Survey of aquatic vegetation, Arrowhead Reservoir, Texas, 2003-2015. Surface area (acres) is listed with percent of total reservoir surface area in parentheses.

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

Gizzard Shad

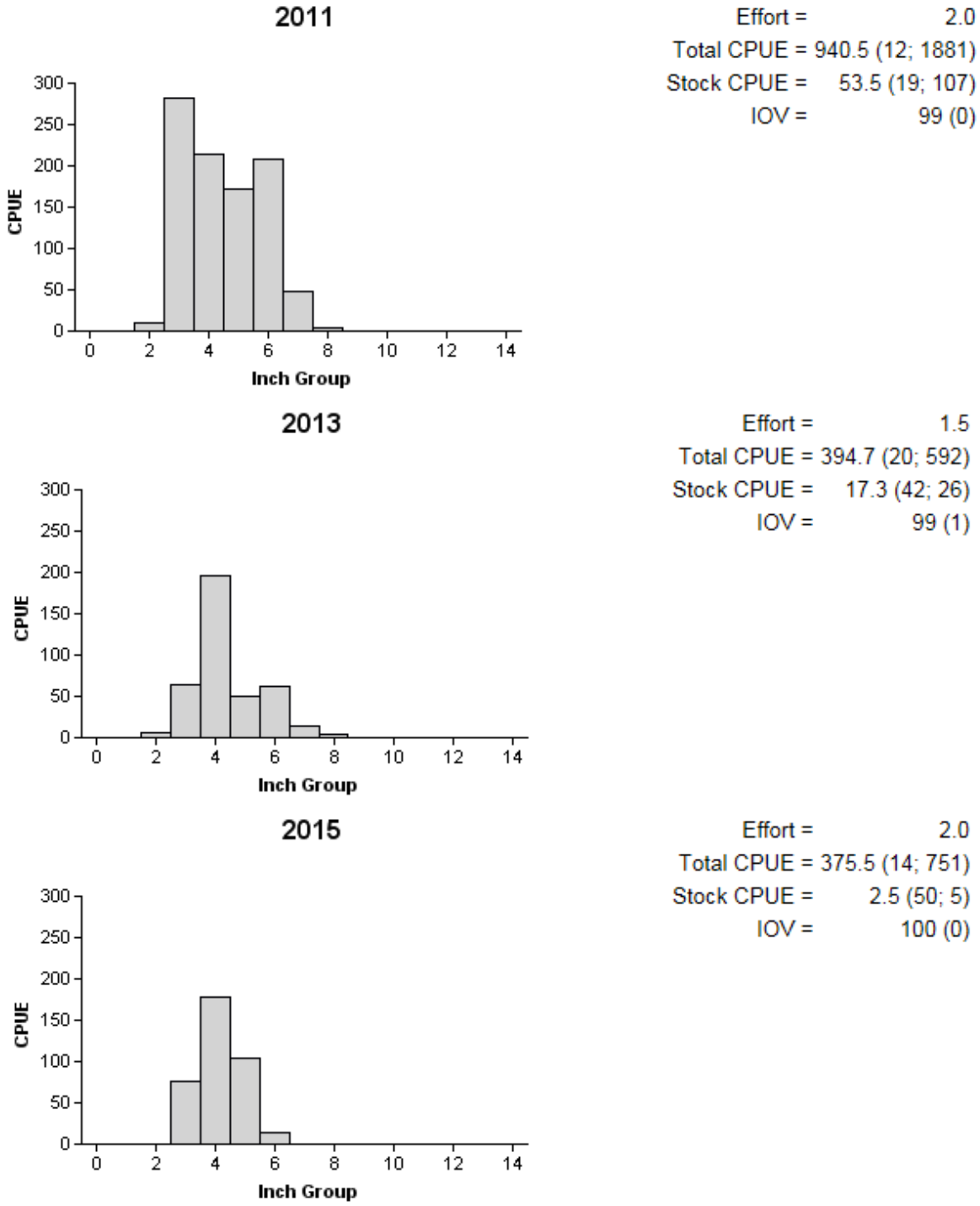
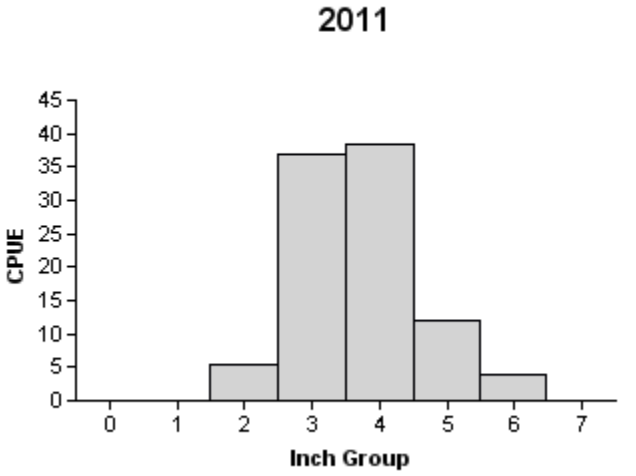
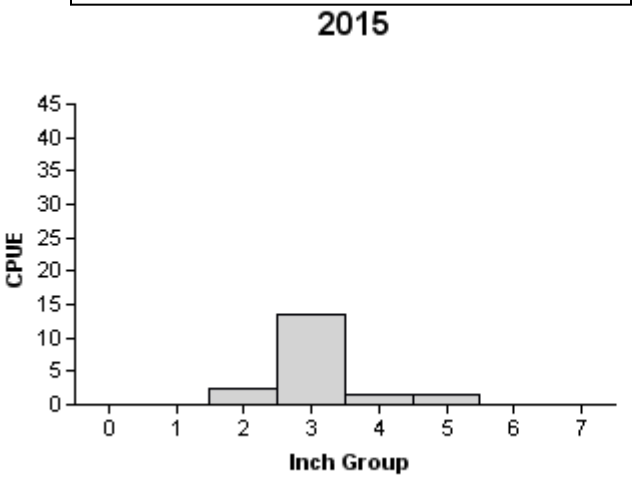


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2011, 2013, and 2015.

Bluegill



Effort = 2.0
Total CPUE = 97.0 (32; 194)
Stock CPUE = 91.5 (32; 183)
PSD = 4 (2)



Effort = 2.0
Total CPUE = 19.0 (39; 38)
Stock CPUE = 16.5 (44; 33)
PSD = 0 (0)

Figure 3. Number of Bluegill caught per hour (CPUE) and population indices population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2011, 2013, and 2015.

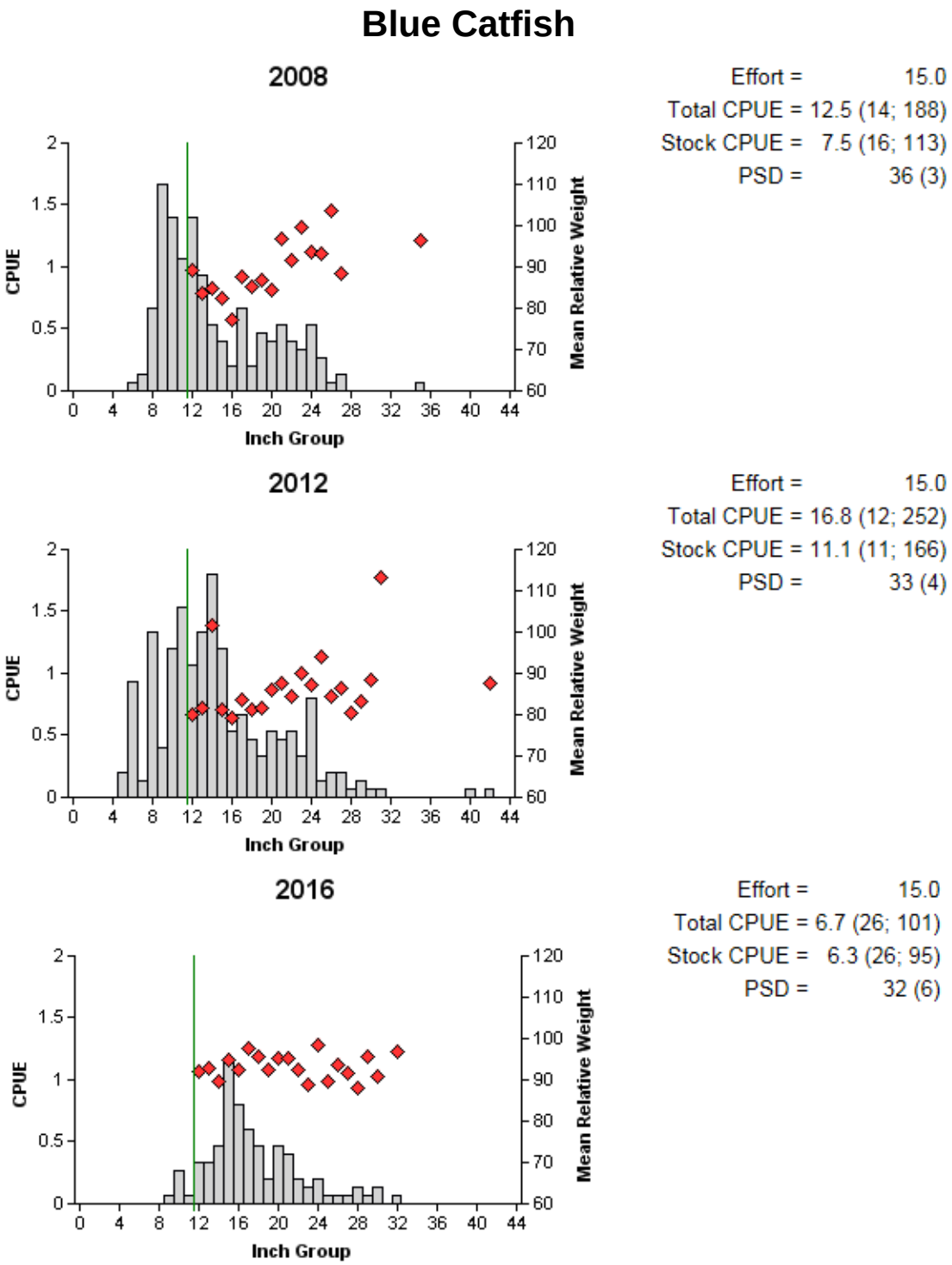


Figure 4. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Arrowhead Reservoir, Texas, 2008, 2012, and 2016. Line indicates minimum length limit at time of sampling.

Table 8. Average length at capture for Blue Catfish (sexes combined) ages 1 – 18 collected in low pulse electrofishing surveys, Arrowhead Reservoir, Texas, 2013. Lengths are followed by the sample size in parenthesis (N).

Sampling	Length (inches) at capture for age					
date	1	2	3	4	5	6
9/24/2013	6.1 (5)	7.3 (9)	8.7 (34)	10.3 (8)	12.7 (6)	13.6 (16)

Sampling	Length (inches) at capture for age					
date	7	8	9	10	11	12
9/24/2013	14.7 (15)	16.1 (33)	19.4 (12)	26.5 (5)	24.4 (10)	22.9 (17)

Sampling	Length (inches) at capture for age					
date	13	14	15	16	17	18
9/24/2013	26.0 (3)	25.3 (8)	26.3 (6)	25.7 (11)	28.8 (1)	29.0 (1)

Channel Catfish

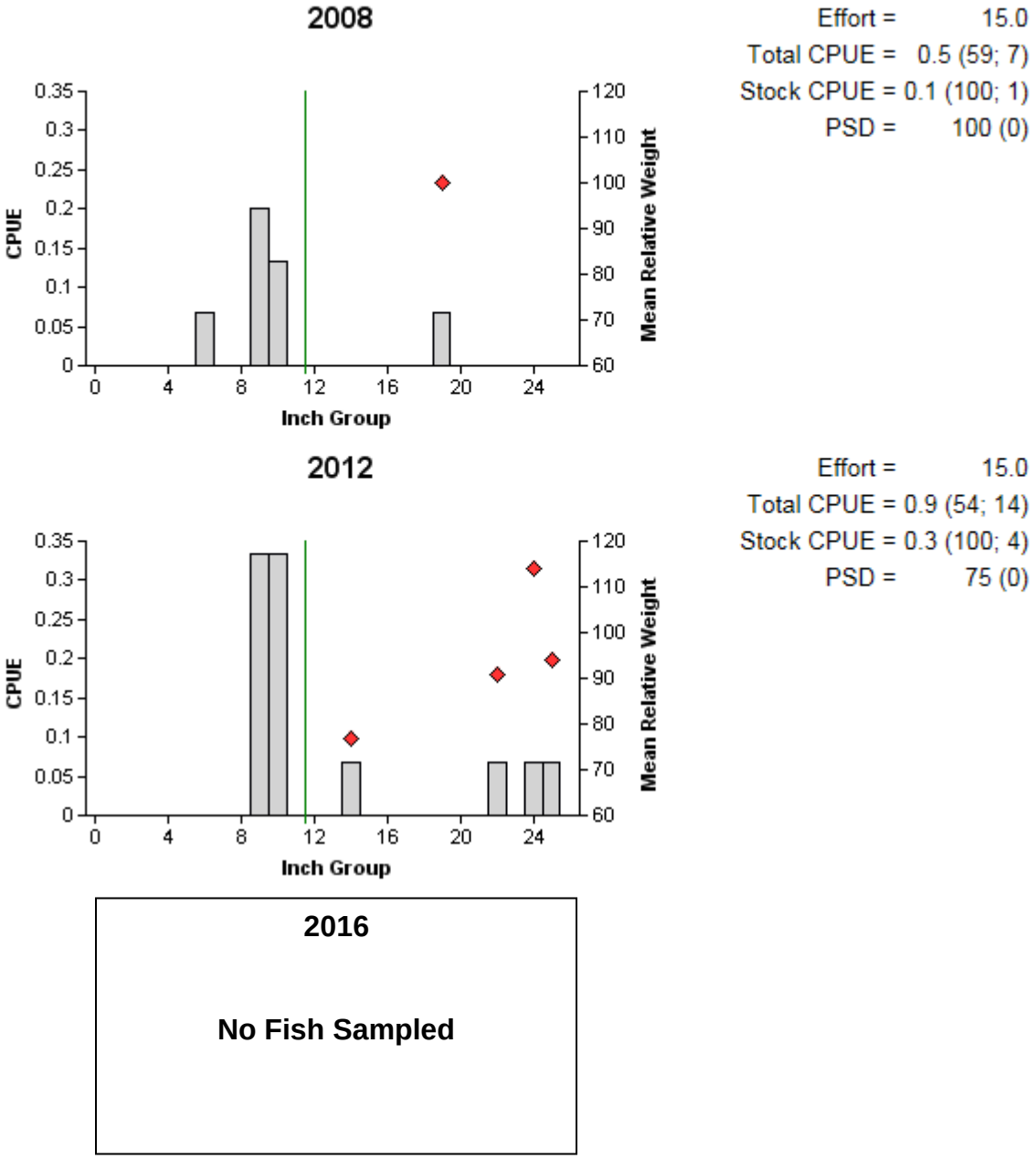


Figure 5. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Arrowhead Reservoir, Texas, 2008, 2012, and 2016. Line indicates minimum length limit at time of sampling.

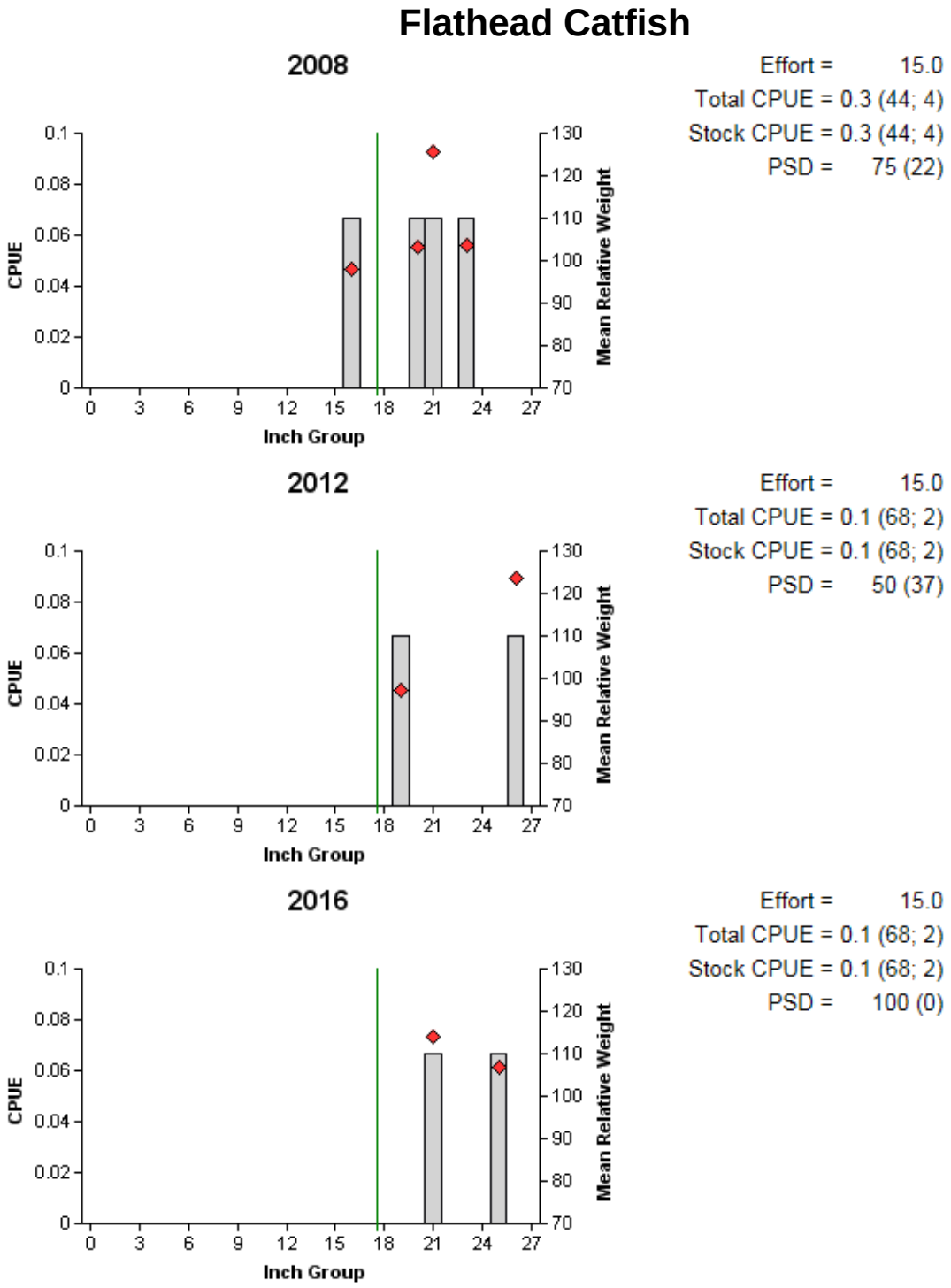


Figure 6. Number of Flathead Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Arrowhead Reservoir, Texas, 2008, 2012, and 2016. Line indicates minimum length limit at time of sampling.

White Bass

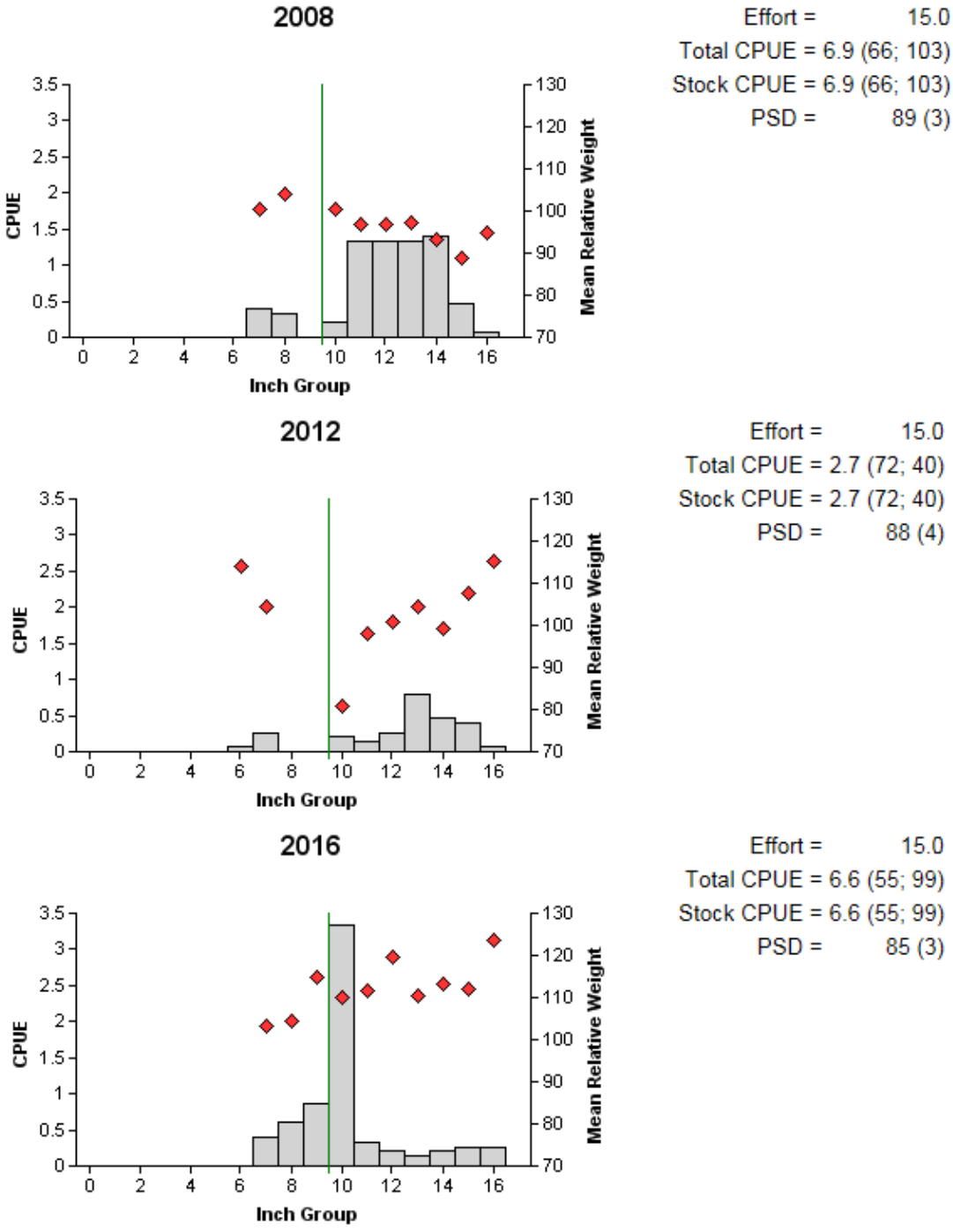


Figure 7. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Arrowhead Reservoir, Texas, 2008, 2012, and 2016. Line indicates minimum length limit at time of sampling.

Largemouth Bass

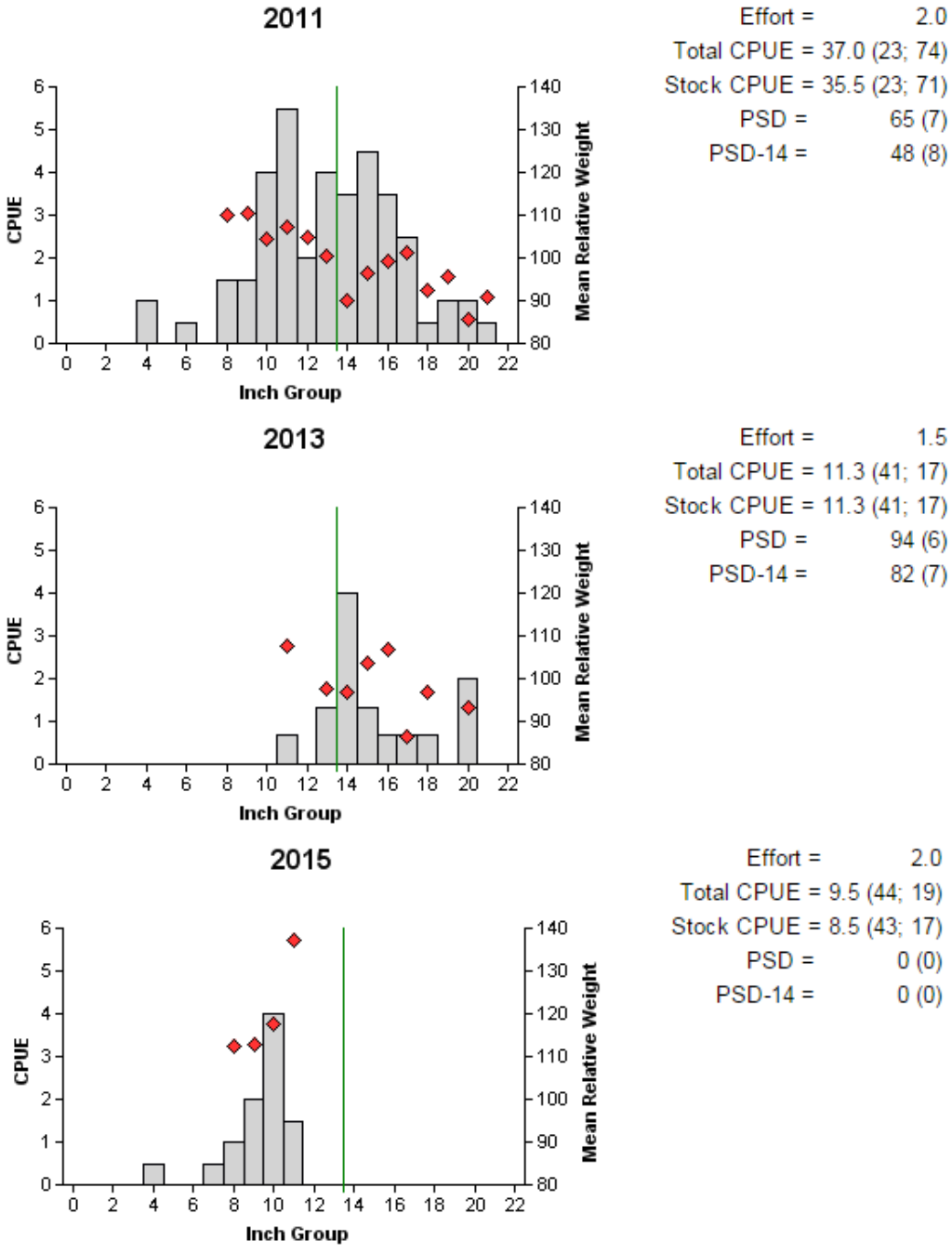


Figure 8. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 2011, 2013, and 2015. Line indicates minimum length limit at time of sampling.

Largemouth Bass

Table 9. Mean length at age of capture for Largemouth Bass (sexes combined) collected during fall 1996, 1997, 1998, 1999, 2003, 2007, and 2011 electrofishing surveys, Arrowhead Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

	Length (inches) at age of capture				
Year	1	2	3	4	5
1996	11.4(19)	14.6(2)	15.8(1)		19.1(1)
1997	11.5(3)	13.6(6)			
1998	10.6(16)	11.6(2)	15.5(1)		
1999	9.8(13)	12.8(18)	14.9(4)		
2003	10.9(9)	14.9(10)			17.8(1)
2007	11.0(30)	13.8(44)		18.3(1)	18.7(1)
2011	10.5(10)	13.8(9)	15.0(3)	15.9(4)	
Averages[a]	10.1	12.9	15.1	16.9	18.3

[a]Ecological averages from Prentice (1987); lengths derived for October 15.

Table 10. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Arrowhead Reservoir, Texas, 1996 - 2011. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined by electrophoresis prior to 2005 and with micro-satellite DNA analysis since 2005.

		Genotype				
Year	Sample size	FLMB	Intergrade	NLMB	% FLMB alleles	% pure FLMB
1996	21	10	4	7	56.0	47.6
1997	30	3	9	18	21.7	10.0
1998	29	3	9	17	25.0	10.3
1999	6	2	4	0	54.2	33.3
2003	11	2	7	2	52.3	18.2
2007	30	0	27	3	38.9	0.0
2011	30	2	27	1	53.0	7.0

White Crappie

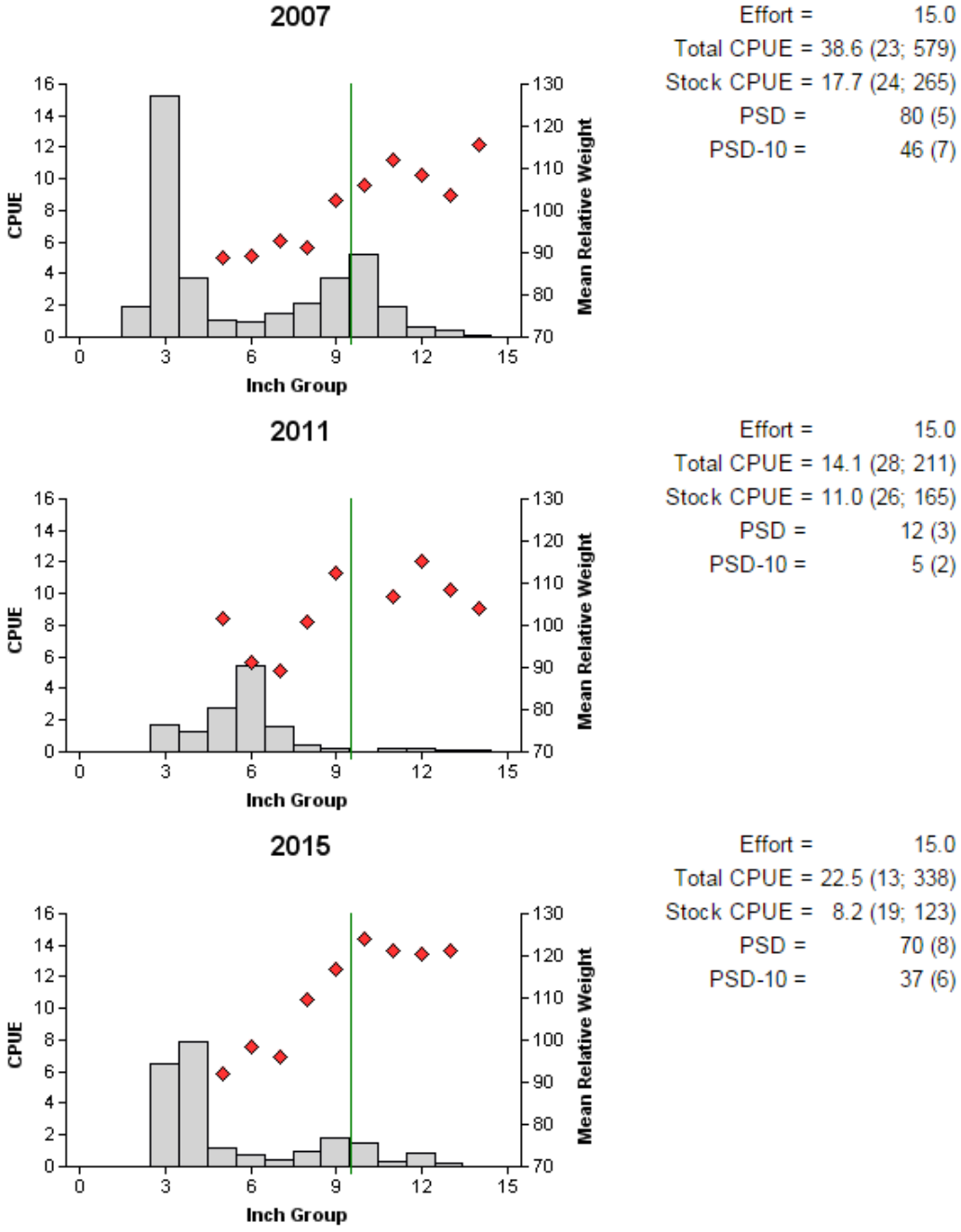


Figure 9. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap net surveys, Arrowhead Reservoir, Texas, 2007, 2011, and 2015. Line indicates minimum length limit at time of sampling.

Table 11. Proposed sampling schedule for Arrowhead Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A

			Habitat					
Survey year	Electrofish Fall(Spring)	Trap net	Structural	Vegetation	Access	Creel survey	Low-Frequency Electrofish	Report
2016-2017						A*		
2017-2018								
2018-2019						S		
2019-2020	S	S		S	S		A	S

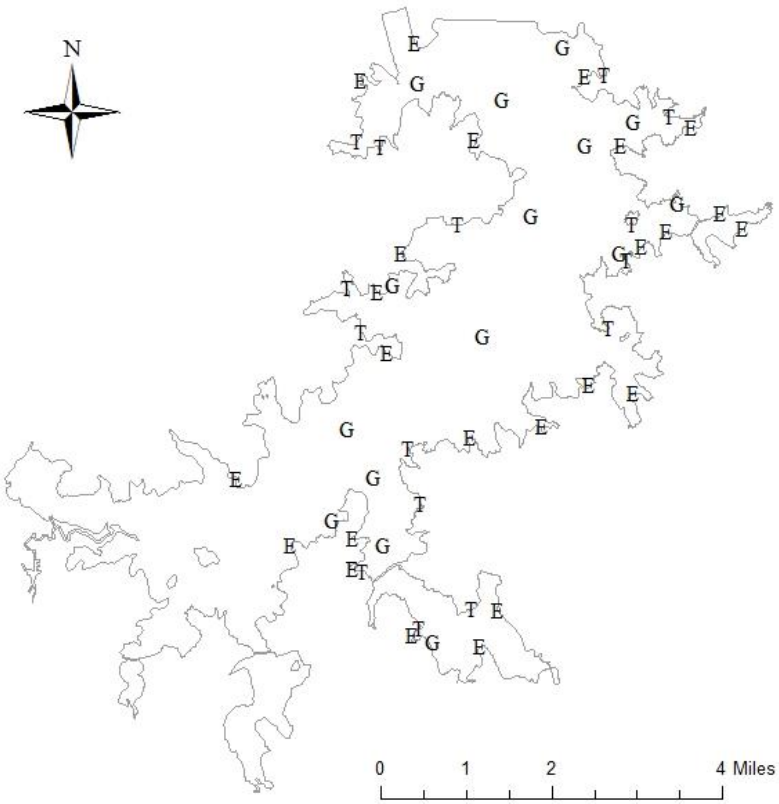
* A non-traditional creel survey targeting all catfish anglers.

APPENDIX A

Number (N) and catch rate (CPUE) of all species collected from all gear types from Arrowhead Reservoir, Texas, 2015-2016.

	Gill Nets		Trap Nets		Electrofishing	
Species	N	CPUE	N	CPUE	N	CPUE
Spotted Gar	2	0.1	3	0.2		
Longnose Gar	38	2.5				
Gizzard Shad	21	1.4	14	0.9	751	375.5
Common Carp	34	2.3	58	3.9		
River Carpsucker	8	0.5	11	0.7		
Smallmouth Buffalo	10	0.7	16	1.1		
Bigmouth Buffalo			2	0.1		
Blue Catfish	101	6.7	91	6.1		
Black Bullhead			2	0.1		
Channel Catfish			34	2.3		
Flathead Catfish	2	0.1				
White Bass	99	6.6	30	2.0		
Warmouth			4	0.3		
Green Sunfish					3	1.5
Bluegill			35	2.3	38	19.0
Longear Sunfish			7	0.5	8	4.0
Orangespotted Sunfish			1	0.1	1	0.5
Largemouth Bass			3	0.2	18	9.5
White Crappie	6	0.4	338	22.5		
Black Crappie			1	0.1		
Freshwater Drum	7	0.5	7	0.5		

APPENDIX B



Location of sampling sites, Arrowhead Reservoir, Texas, 2015-2016. Trap net, gill net, and electrofishing stations are indicated by T, G, and E respectively. Water level was near full pool at time of sampling.