PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-2

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2011 Survey Report

Arrowhead Reservoir

Prepared by:

Robert Mauk, Assistant District Management Supervisor

Inland Fisheries Division
District 2-E, Wichita Falls, Texas

Carter Smith
Executive Director

Gary Saul
Director, Inland Fisheries

July 31, 2012

TABLE OF CONTENTS

SURVEY AND MANAGEMENT SUMMARY

Fish populations in Arrowhead Reservoir were surveyed in 2011 using trap nets and electrofishing and in 2012 using gill nets. 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 15 miles southeast of Wichita Falls. At time of sampling, the water elevation was 6.5 feet below 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 six 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 catfish, white bass, largemouth bass, and white crappie. Arrowhead is managed under statewide regulations.

  - **Fish Community**
    - **Prey species:** Gizzard shad electrofishing catch rate was the highest ever recorded for the reservoir and were in the size range consumed by predators. The catch per unit effort (CPUE) for bluegill was average.

    - **Catfishes:** During the 2012 gill net survey, blue catfish had a higher gill net CPUE than channel catfish. In fact, the 2012 blue catfish CPUE was higher than it had ever been at Arrowhead. The gill net survey for channel catfish showed an increase in relative abundance from the previous two surveys, especially for sub-legal fish. Flathead catfish persist in the reservoir.

    - **White bass:** White bass gill net survey CPUE was low compared to previous surveys but was probably more a function of the timing of the sampling as opposed to an actual decline in abundance.

    - **Largemouth bass:** The 2011 electrofishing survey for largemouth bass had a below average catch rate due to low reservoir elevations that affected the recruitment of the 2011 year class and decreased shoreline habitat quality. Bass were sampled in good numbers anytime rocky habitat was encountered. The number of legal length bass remained high for the reservoir and their body condition was good.

    - **White crappie:** The 2011 trap net survey CPUE was lower than the two previous trap net surveys. Low water elevations and the associated lack of shoreline habitat at time of survey probably influenced the results by indicating that the crappie abundance is lower than it actually is, especially when comparing the results to angler reports. Legal length crappie were all above average in body condition.

  - **Management Strategies:** Populations of catfish are in good shape and should be widely promoted for anglers to enjoy. Largemouth bass relative abundance is down, especially younger, smaller bass so request a largemouth bass stocking contingent upon a significant increase in the reservoir elevation which will result in improved habitat conditions.

INTRODUCTION

This document is a summary of fisheries data collected from Arrowhead Reservoir in 2011 and 2012. The purpose is to provide fisheries information and make management recommendations to enhance the sport fishery. While information on other species of fishes was collected, this report deals primarily with important sport fish and prey species. Historical data are presented 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 711 μmhos/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 6.5 feet below spillway elevation at time of habitat survey (Fig. 1). 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 that includes a fishing pier. Boat access consisted of six public boat ramps. Other descriptive characteristics for Arrowhead are in Table 1.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Howell and Mauk 2008) included:

1. Lake Arrowhead State Park anglers do not need a fishing license and many seem unaware of species length regulations. This is leading to an unacceptable rate of sublegal harvest.
   Action: Lake Arrowhead State Park has placed signs up by one of the piers showing the different species in the reservoir and the regulations. Measuring devices are also available. Other educational opportunities including talking to state park anglers and news releases were utilized.
   Action: Contacted the game wardens and park rangers and asked them to perform occasional angler checks.

2. 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 and expanded to other areas when trees were available.

3. Arrowhead fishing has greatly improved over the last five years and is expected to get even better. There may still be some anglers out there that are not aware of this significant improvement.
   Action: Continued to provide multiple news releases and distributed them more widely than the Wichita Falls area using Larry Hodge and VOCUS. Updated Arrowhead web page annually to reflect known reservoir conditions and fishing information. District personal worked on completion of a district waterbody brochure that will feature Arrowhead along with all public waters in the district.

Harvest regulation history: Sport fish species in Arrowhead Reservoir were managed using statewide regulations (Table 2).

Stocking history: Florida largemouth bass were stocked in 2010. The complete stocking history is in Table 3.

Vegetation/habitat history: Noxious aquatic vegetation has not been observed in the reservoir (Table 4). Christmas tree fish attractors have been placed annually around the state park fishing piers. During the past four years, placement of brush piles outside the Lake Arrowhead State Park boundaries has occurred and sites are listed on the TPWD website (Table 5).

Water Transfer: Arrowhead Reservoir is one of the primary water sources for the City of Wichita Falls which pumps water to its treatment plant. The City of Windthorst also pumps water from the reservoir for municipal purposes.

METHODS

Fishes were collected by electrofishing (2.0 hours at 24 five-minute stations), gill netting (15 net nights at 15 stations), and trap netting (15 net nights at 15 stations). Catch per unit effort for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing and for gill and trap nets, as the number of fish caught per net night (fish/nn). All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2011).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), as defined by Guy et al. (2007)], and condition indices [relative weights (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). Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE statistics and SE was calculated for structural indices and IOV. Ages were determined using otoliths for largemouth bass. Source for water level data was the United States Geological Survey.

RESULTS AND DISCUSSION

Habitat: A physical habitat survey conducted July 2011 indicated the littoral zone habitat consisted primarily of natural and rocky shoreline (Table 4). The reservoir was 6.5 feet below conservation pool at time of survey. Very few manmade changes to the physical habitat had occurred during the four year period since the last survey (Howell and Mauk 2008).

Prey species: Electrofishing catch rates of gizzard shad and bluegill were 940.0/h (Fig. 2) and 97.0/h (Fig. 3), respectively. Index of vulnerability for gizzard shad was excellent, indicating that 99% of gizzard shad were available to predators; this IOV is the highest documented for the reservoir. The catch rate was also the highest for the reservoir. Bluegill catch per unit effort (CPUE) was right at the reservoir historical average (96.3/hr). There were no threadfin shad sampled compared to 22.5/hr and 125.0/hr in 2009 and 2007; respectively. Overall, prey seems extremely abundant in sizes that predators can consume.

Blue catfish: Blue catfish 2012 gill net CPUE (16.8/nn) was up significantly from previous surveys indicating that the population has become well established since the 1995 stocking. The CPUE in 2008 was 12.5/nn and 8.9/nn in 2004 (Fig. 4). The 2012 CPUE was the highest ever for the reservoir and double the historical average (8.4/nn). Fish up to 42 inches were sampled and body condition as measured by Wr was mostly between 80-90.

Channel catfish: Channel catfish 2012 gill net CPUE (0.9/nn) increased from the 2008 and 2004 surveys (Fig. 5) and is at the reservoirs historical average (0.9/nn). Most of the sampled channel catfish were below stock length.

Flathead catfish: The gill net CPUE was 0.1/nn for 2012, down from the previous survey of 0.3/nn (Fig. 6). While only two fish were caught, this is still considered to be a good flathead catfish reservoir. Both fish had Wr's near or above 100.

White bass: The gill net catch rate for white bass was 2.7/nn in 2012, which was down from 6.9/nn in 2008 and 17.9/nn sampled in 2004 (Fig. 7). The historical average for the reservoir is 11.5/nn so the decrease is significant. The RSE was high (72) for 2012 indicating great variability in catch among the sampling sites. It was noted during the survey that white bass were being caught by anglers along rocky shoreline in relatively shallow water (<5 feet). Our net sites were in deeper water (>8 feet) and usually in nondescript habitat. This would explain the lower CPUE and high RSE. Body condition as measured by Wr was near or above 100.

Largemouth bass: The electrofishing CPUE of largemouth bass was 37.0/h in 2011, well below the two previous surveys of 2009 and 2007 with CPUE's of 59.0/hr and 86.0/hr; respectively (Fig. 8). Extremely low water elevation at the time of sampling left much of the habitat out of the water and many sites were bare banks. Electrofishing conditions were much like they were in 1999 and 2003 when CPUE was 16.5/hr and 25.0/hr, respectively. The historical CPUE is 49.6/hr. Catch rate for legal sized bass ($\geq$14 inches) was 17.0/hr, the same as it was the last survey and higher than 2007 when it was 10.5/hr. Few small bass were sampled indicating poor recruitment in 2011, probably caused by a lack of suitable spawning habitat and nursery areas due to low reservoir elevations. Body condition of sub-legal bass was above 100 while legal sized bass average relative weight was 95. Category 2 age and growth determined that legal size is attained on average by 2.5 years (range 2-4 years; Table 6). The percent of Florida alleles was 53.0% with 7.0% pure Florida bass being documented in the 2011 genetic sample (Table 7). Bass tournament angling has been popular on Arrowhead and since 2007 data from tournaments has been collected when available. In 2011, the average number of anglers participating in tournaments was 21 (range 10-44) for the 27 tournaments monitored. The big bass averaged 5.26 lbs. (range 3.21-9.61 lbs.) and the average winning stringer was 13.5 lbs. (range 5.76-22.19 lbs.; Table 8).

White crappie: The trap net catch rate of white crappie was 14.1/nn in 2011, lower than the previous surveys of 2007 (38.6/nn) and 2005 (18.1/nn; Fig. 9) and well below the historical average (26.0/nn). This decrease in CPUE is probably caused by low reservoir elevations at the time of the survey resulting in mainly bare banks being sampled. Body condition as measured by Wr was over 100 for all legal length inch groups. 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).

Fisheries management plan for Arrowhead Reservoir, Texas

Prepared – July 2012

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 catch rates and this has proven to be successful and popular.

MANAGEMENT STRATEGY

1. Continue fish attractor enhancement program and try to expand to other areas.

Issue 2: Arrowhead in terms of number of anglers is the districts most popular destination. Angler interest is quite high in the fish and reservoir.

MANAGEMENT STRATEGIES

1. Continue to provide multiple news releases and distribute them more widely than the Wichita Falls area.
2. Work on completion of district lake brochure that will feature Arrowhead Reservoir along with other district water bodies.
3. 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 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 recent study identified zebra mussel DNA to be present in the reservoir though no veligers or adults have ever been found. The possibility that they are in the reservoir will alter some of the districts management activities.

MANAGEMENT STRATEGIES

1. Clean and dry all sampling gear thoughly after use in Arrowhead.
2. Do not move any fish from Arrowhead to other water bodies. Educate the public about invasive species through the use of media and the internet.

3. Closely monitor zebra mussel samplers, rocky substrate, docks and any other hard substrate that zebra mussel will colonize.
4. Get results from Dr. McMahon's follow up investigation into the presence/absence of zebra mussel DNA, veligers or adults to be completed in 2012.

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

MANAGEMENT STRATEGIES

1. Conduct a standardized electrofishing survey every other year starting in 2013 to monitor the largemouth bass population.
2. Request a stocking contingent on the reservoir elevation increasing enough to submerge vital nursery habitat.

Issue 6: The blue catfish population continues to improve. Arrowhead Reservoir is now considered one of the best catfish reservoirs in the area with catfish tournaments being held annually. Much is not known about the population such as age and growth and angler rod and reel statistics were last collected during 2007-2008. No passive gear information exists for the reservoir and hand fishing has become legal. The local game wardens report hand fishing is popular at the reservoir.

MANAGEMENT STRATEGIES

1. Collect category 3 age and growth data for the catfish population at Arrowhead in 2013.
2. Conduct a creel survey during 2013-2014 and include passive gear anglers in the survey to better monitor the catfish usage by the anglers.
3. Collect results from catfish tournaments when possible.

SAMPLING SCHEDULE JUSTIFICATION:

Conduct standard electrofishing survey every other year beginning in fall of 2013 to monitor the dynamic largemouth bass population. Conduct low-pulse electrofishing, jug lining, and possibly gill netting to collect blue catfish for age and growth determination in 2013. Conduct creel survey during 2013-2014 to monitor fishery. Gill and trap netting surveys according to standard four-year rotation schedule.

LITERATURE CITED

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

DiCenzo, V. J., M. J. Maceina, and M. R. Stimert. 1996. Relations between reservoir trophic state and gizzard shad population characteristics in Alabama reservoirs. North American Journal of Fisheries Management 16:888-895.

Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution (PSD): a further refinement of population size structure index terminology. Fisheries 32:348.

Howell, M., and R. Mauk. 2008. Statewide freshwater fisheries monitoring and management program survey report for Arrowhead Reservoir, 2007. Texas Parks and Wildlife Department, Federal Aid Report F-30-R-33, Austin.

Prentice, J. A. 1987. Length-weight relationships and average growth rates of fishes in Texas. Inland Fisheries Data Series No. 6. Texas Parks and Wildlife Department, Inland Fisheries Division. Austin.

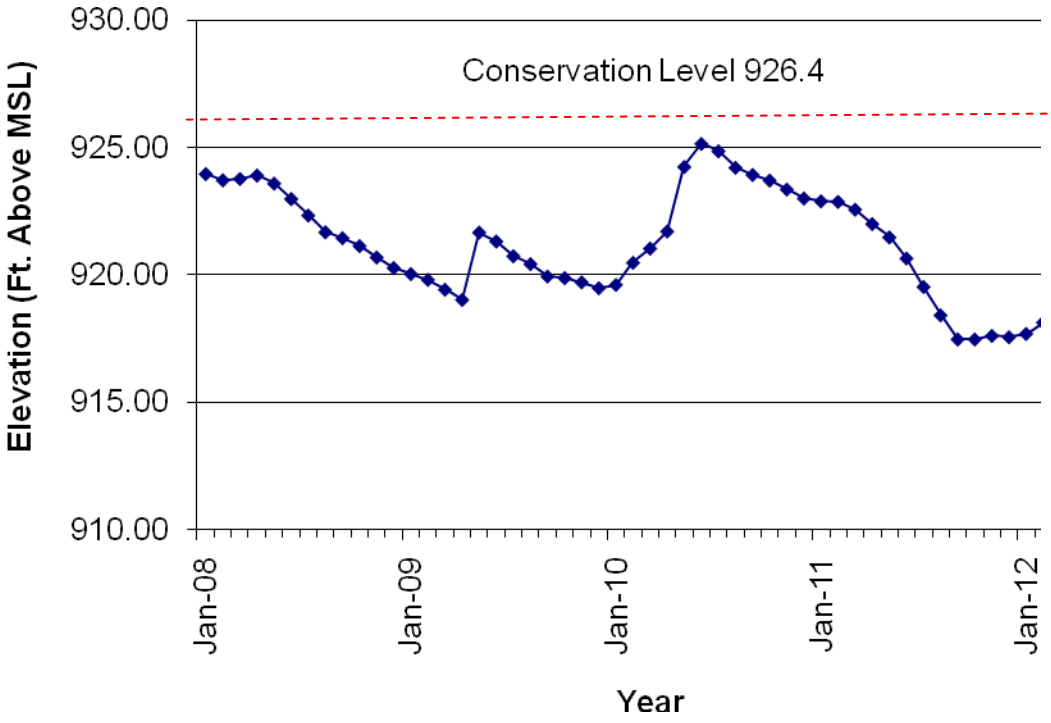


Figure 1. Monthly water level elevations in feet above mean sea level (MSL) recorded for Arrowhead Reservoir, Texas. Water elevation data obtained from the USGS website.

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	711 μmhos/cm

Table 2. Harvest regulations for Arrowhead Reservoir, Texas.

Species	Bag Limit	Length Limit (inches)
Catfish: Channel and blue catfish, their hybrids and subspecies	25 (in any combination)	12 minimum
Catfish, Flathead	5	18 minimum
Bass, White	25	10 minimum
Bass, Largemouth	5	14 minimum
Crappie, White	25	10 minimum

Table 3. Stocking history of Arrowhead Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), adults (ADL) and unknown (UNK). Life stages for each species are defined as having a mean length that falls within the given length range. For each year and life stage the species mean total length (Mean TL; in) is given. For years where there were multiple stocking events for a particular species and life stage the mean TL is an average for all stocking events combined.

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
	Total	2,086,133		
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		

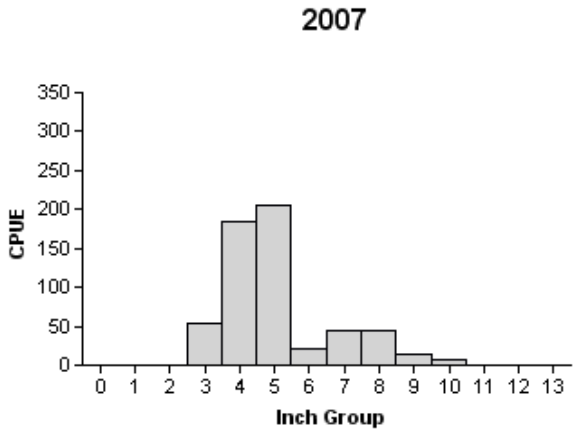
Table 4. Survey of littoral zone and physical habitat types at Arrowhead Reservoir, Texas in July 2011. A linear shoreline distance (miles) was recorded for each habitat type found. Surface area (acres) and percent of reservoir surface area was determined for each type of aquatic vegetation found. Reservoir elevation was 919.9 msl at time of survey (926.4 MSL is full).

Shoreline habitat type	Shoreline Distance		Surface Area	
	Miles	Percent of total	Acres	Percent of reservoir surface area
Concrete	0.1	0.1		
Natural shoreline	54.9	74.9		
Rocky bluff	0.5	0.7		
Rocky shore	17.8	24.3		
Total shoreline length	73.3			
Habitat adjacent to shoreline				
Standing timber			1,384.6	11.9
Boat docks			9.7	<0.1
Native floating vegetation			3.5	<0.1

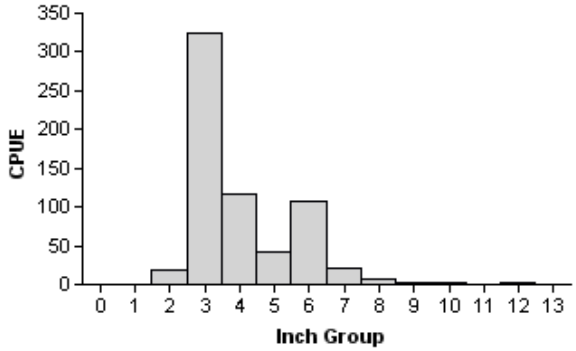
Table 5. Locations of Arrowhead Reservoir, Texas brush piles.

Sites	Latitude	Longitude
Site 1	33.75305	-98.38187
Site 2	33.75182	-98.37386
Site 3	33.75244	-98.38258

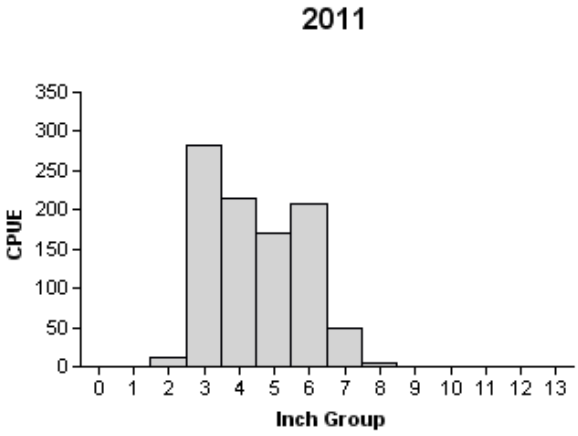
Gizzard Shad



Effort = 2.0
Total CPUE = 576.0 (16; 1152)
Stock CPUE = 112.0 (30; 224)
IOV = 88 (3.4)



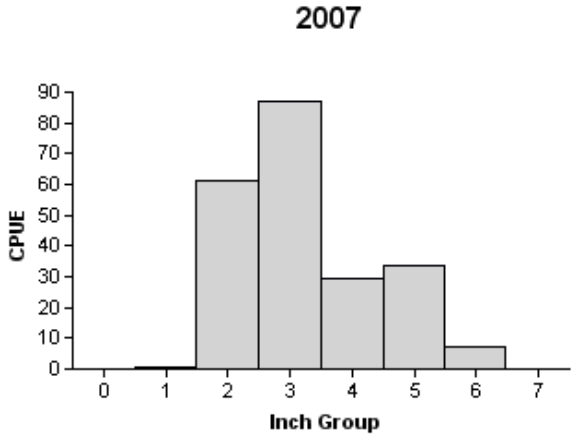
Effort = 2.0
Total CPUE = 642.0 (31; 1284)
Stock CPUE = 32.5 (23; 65)
IOV = 98 (0.8)



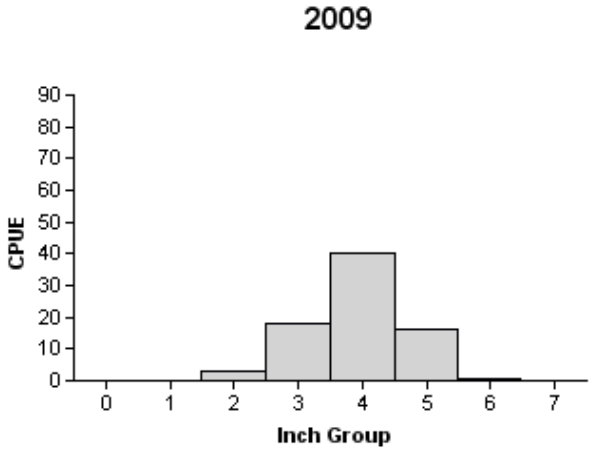
Effort = 2.0
Total CPUE = 940.5 (12; 1881)
Stock CPUE = 53.5 (19; 107)
IOV = 99 (0.3)

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, 2007, 2009, and 2011.

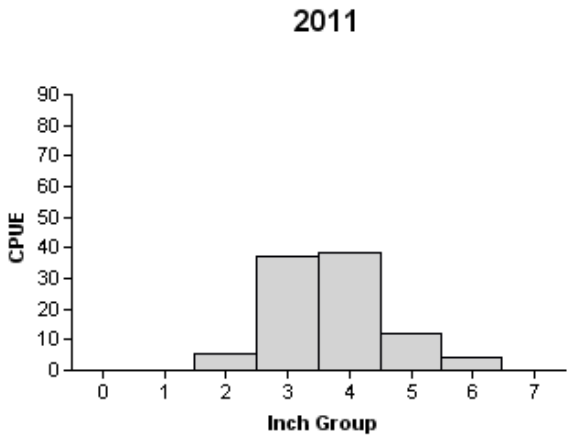
Bluegill



Effort =	2.0
Total CPUE =	219.5 (22; 439)
Stock CPUE =	157.5 (21; 315)
PSD =	5 (1.9)
PSD-P =	0 (0)



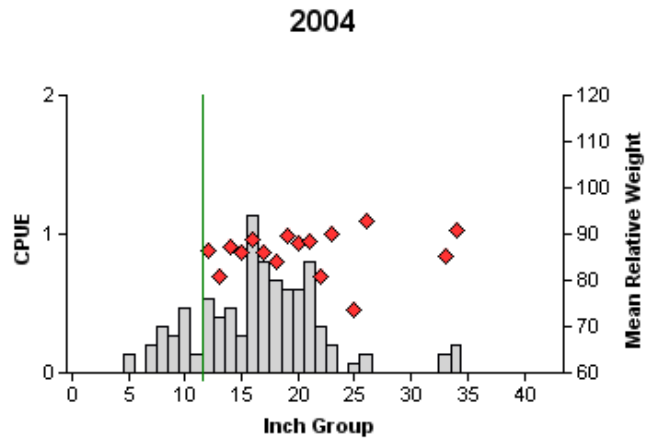
Effort =	2.0
Total CPUE =	77.5 (32; 155)
Stock CPUE =	74.5 (33; 149)
PSD =	1 (0.6)
PSD-P =	0 (0)



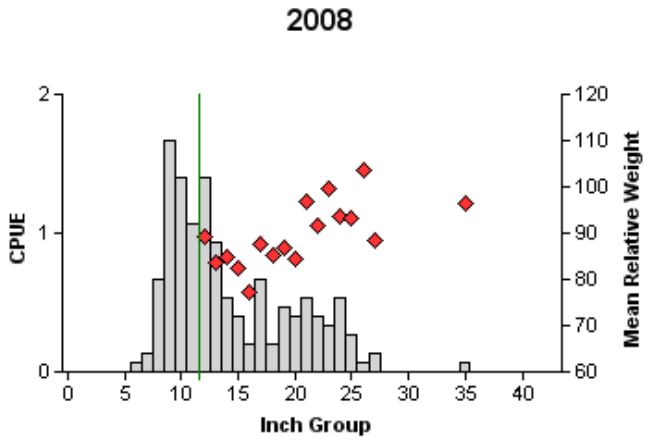
Effort =	2.0
Total CPUE =	97.0 (32; 194)
Stock CPUE =	91.5 (32; 183)
PSD =	4 (1.7)
PSD-P =	0 (0)

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, 2007, 2009, and 2011.

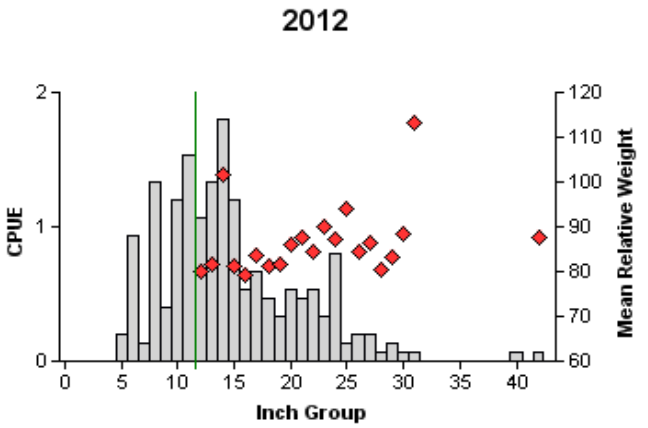
Blue Catfish



Effort =	15.0
Total CPUE =	8.9 (14; 133)
Stock CPUE =	7.3 (17; 110)
PSD =	34 (4.5)
PSD-P =	5 (2.5)



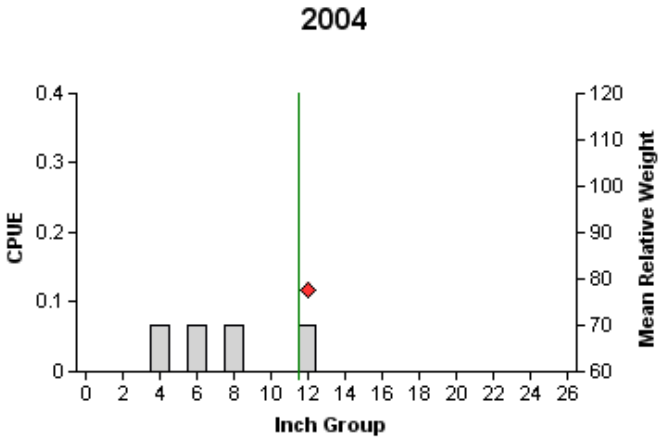
Effort =	15.0
Total CPUE =	12.5 (14; 188)
Stock CPUE =	7.5 (16; 113)
PSD =	36 (3.4)
PSD-P =	1 (0.9)



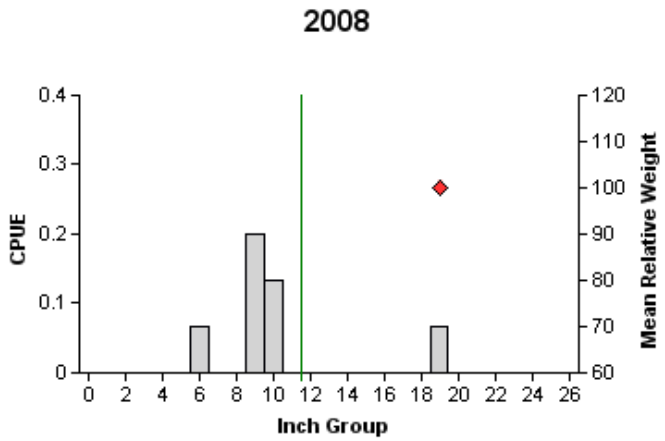
Effort =	15.0
Total CPUE =	16.8 (12; 252)
Stock CPUE =	11.1 (11; 166)
PSD =	33 (3.6)
PSD-P =	2 (1.4)

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 netting surveys, Arrowhead Reservoir, Texas, 2004, 2008, and 2012. Line indicates minimum length limit at time of sampling.

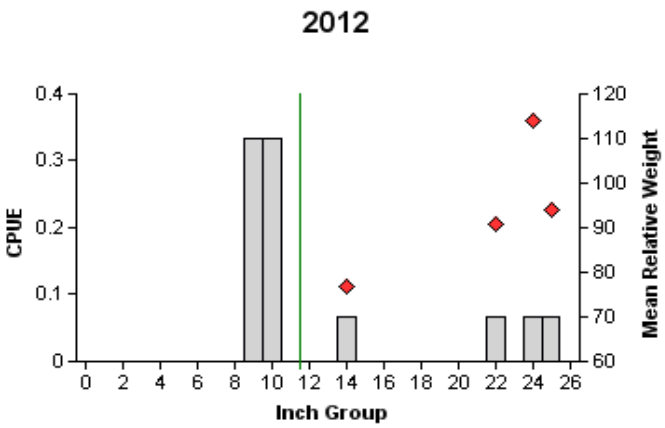
Channel Catfish



Effort =	15.0
Total CPUE =	0.3 (68; 4)
Stock CPUE =	0.1 (100; 1)
PSD =	0 (292.8)
PSD-P =	0 (0)



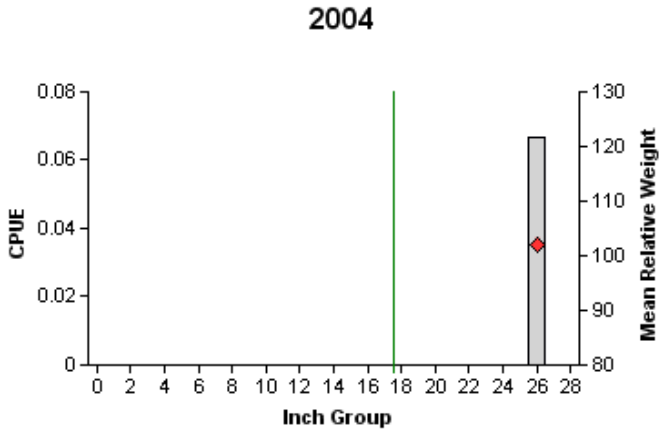
Effort =	15.0
Total CPUE =	0.5 (59; 7)
Stock CPUE =	0.1 (100; 1)
PSD =	100 (0)
PSD-P =	0 (0)



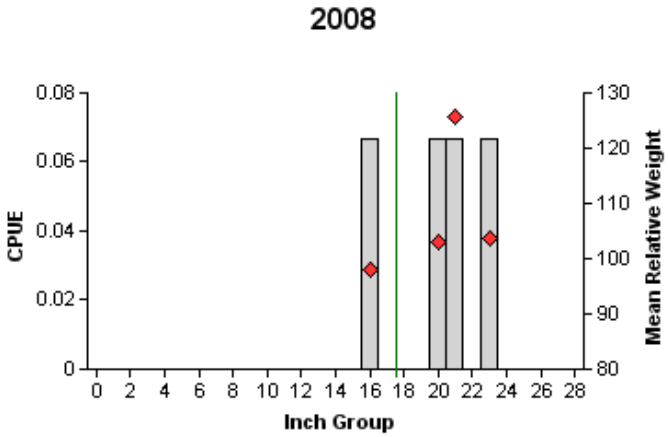
Effort =	15.0
Total CPUE =	0.9 (54; 14)
Stock CPUE =	0.3 (100; 4)
PSD =	75 (0)
PSD-P =	50 (0)

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 netting surveys, Arrowhead Reservoir, Texas, 2004, 2008, and 2012. Line indicates minimum length limit at time of sampling.

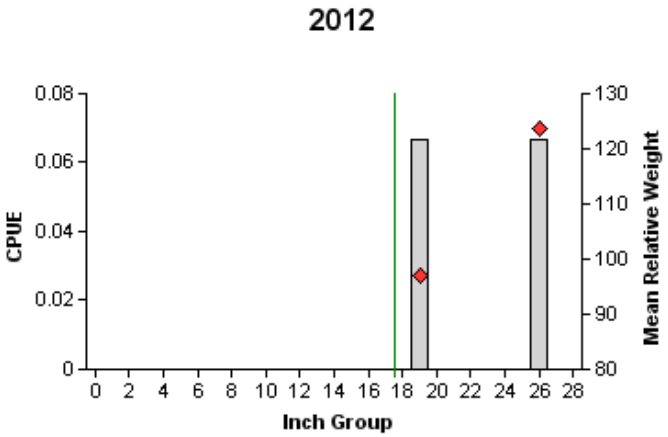
Flathead Catfish



Effort = 15.0
Total CPUE = 0.1 (100; 1)
Stock CPUE = 0.1 (100; 1)
PSD = 100 (0)
PSD-P = 0 (0)



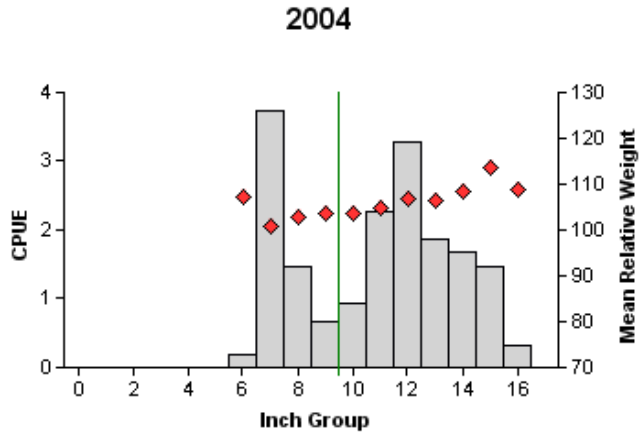
Effort = 15.0
Total CPUE = 0.3 (44; 4)
Stock CPUE = 0.3 (44; 4)
PSD = 75 (22.4)
PSD-P = 0 (0)



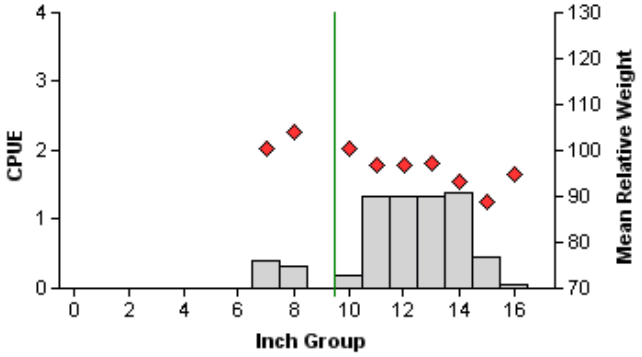
Effort = 15.0
Total CPUE = 0.1 (68; 2)
Stock CPUE = 0.1 (68; 2)
PSD = 50 (36.6)
PSD-P = 0 (0)

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 netting surveys, Arrowhead Reservoir, Texas, 2004, 2008, and 2012. Line indicates minimum length limit at time of sampling.

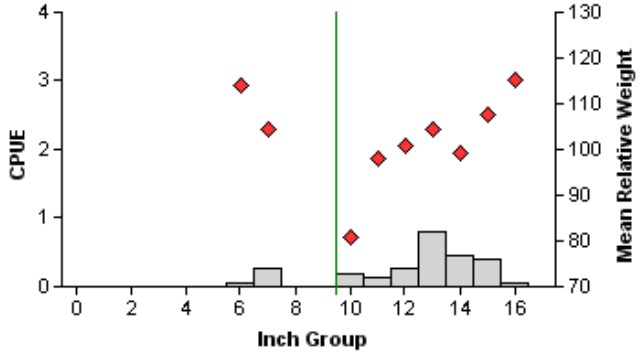
White Bass



Effort =	15.0
Total CPUE =	17.9 (19; 268)
Stock CPUE =	17.9 (19; 268)
PSD =	70 (8)
PSD-P =	48 (9)



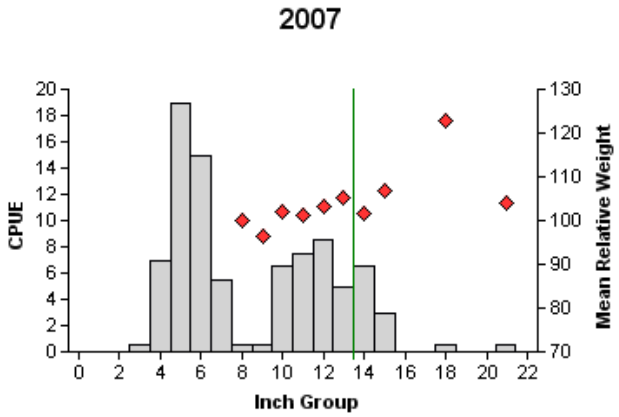
Effort =	15.0
Total CPUE =	6.9 (66; 103)
Stock CPUE =	6.9 (66; 103)
PSD =	89 (3.4)
PSD-P =	67 (3.9)



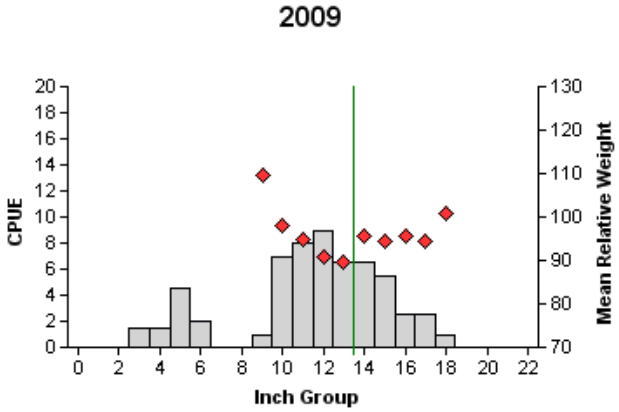
Effort =	15.0
Total CPUE =	2.7 (72; 40)
Stock CPUE =	2.7 (72; 40)
PSD =	88 (4.3)
PSD-P =	75 (5.2)

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 netting surveys, Arrowhead Reservoir, Texas, 2004, 2008, and 2012. Line indicates minimum length limit at time of sampling.

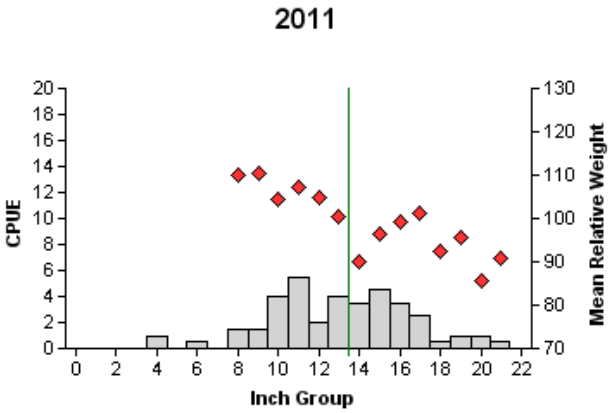
Largemouth Bass



Effort =	2.0
Total CPUE =	86.0 (22; 172)
Stock CPUE =	39.0 (18; 78)
PSD =	62 (6.8)
PSD-14 =	27 (4.8)



Effort =	2.0
Total CPUE =	59.0 (22; 118)
Stock CPUE =	49.5 (23; 99)
PSD =	68 (4.2)
PSD-14 =	36 (4.6)



Effort =	2.0
Total CPUE =	37.0 (23; 74)
Stock CPUE =	35.5 (23; 71)
PSD =	65 (7)
PSD-14 =	48 (7.7)

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, 2007, 2009, and 2011. Line indicates minimum length limit at time of sampling.

Largemouth Bass

Table 6. 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 7. Results of genetic analysis of largemouth bass collected by fall electrofishing, Arrowhead Reservoir, Texas, 1996, 1997, 1998, 1999, 2003, 2007, and 2011. FLMB = Florida largemouth bass, NLMB = Northern largemouth bass, F1 = first generation hybrid between a FLMB and a NLMB, Fx = second or higher generation hybrid between a FLMB and a NLMB.

		Genotype				
Year	Sample size	FLMB	F1 or Fx	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

Table 8. Largemouth bass statistics for known tournaments at Arrowhead Reservoir, Texas in 2007, 2008, 2009, 2010 and 2011. N is the number of tournaments used to calculate the average. Some tournaments did not report all of the results needed for calculations.

Year	Avg. # anglers/tour	Avg. Winning Wgt.	Avg. Big Bass Wgt.	Avg. Wgt. of tour. Bass	Avg. # Bass Caught/Angler
2007	28 (N = 6)	17.90 (N = 6)	7.20 (N = 6)	3.02 (N = 5)	1.14
2008	40 (N = 8)	17.23 (N = 8)	7.12 (N = 7)	2.27 (N = 7)	2.22
2009	36 (N = 8)	16.33 (N = 8)	6.24 (N = 8)	2.36 (N = 7)	1.48
2010	25 (N = 5)	12.99 (N = 5)	4.08 (N = 6)	2.14 (N = 4)	1.80
2011	21 (N = 27)	13.50 (N = 27)	5.26 (N = 27)	2.44 (N = 25)	1.28

White Crappie

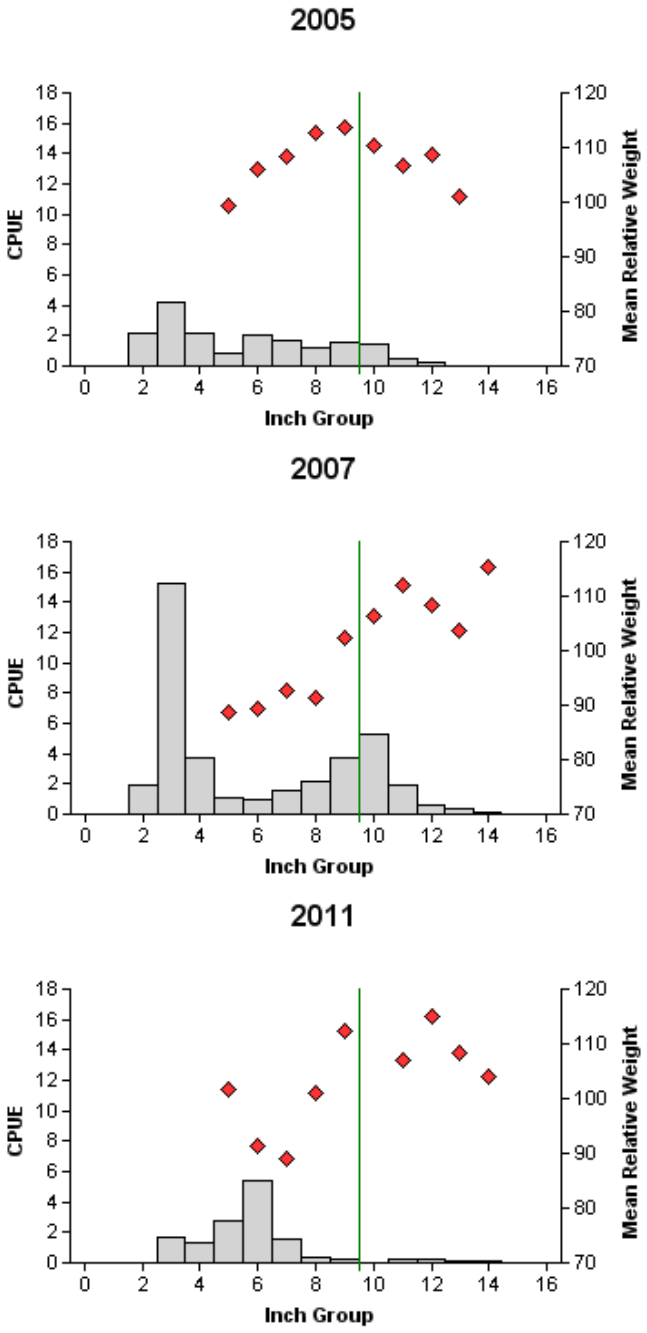


Figure 9. Number of white crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Arrowhead Reservoir, Texas, 2005, 2007, and 2011. Line indicates minimum length limit at time of sampling.

Table 9. Proposed sampling schedule for Arrowhead Reservoir, Texas. Gill net surveys are conducted in the spring, while electrofishing and trap net surveys are conducted in the fall. S denotes standard survey and A denotes additional survey.

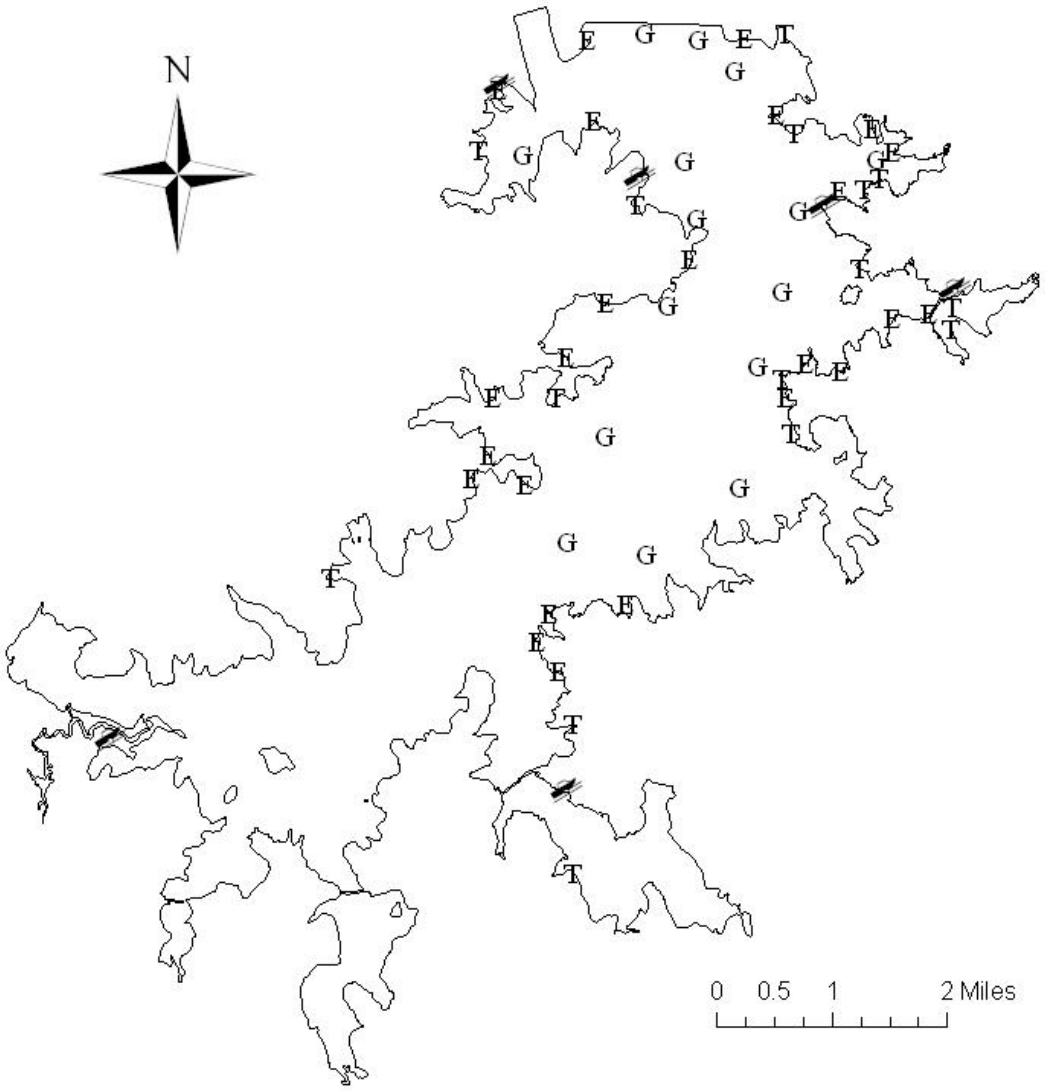
Survey Year	Electrofish	Trap Net	Gill Net	Creel Survey	Vegetation Survey	Access Survey	Report
Fall 2012-Spring 2013							
Fall 2013-Spring 2014	A			A			
Fall 2014-Spring 2015							
Fall 2015-Spring 2016	S	S	S		S	S	S

APPENDIX A

Number (N) and catch rate (CPUE) of all species collected from all gear types from Arrowhead Reservoir, Texas, 2011-2012.

	Gill Nets		Trap Nets		Electrofishing	
Species	N	CPUE	N	CPUE	N	CPUE
Spotted gar	3	0.2				
Shortnose gar	1	0.07				
Gizzard shad	93	6.2	34	2.3	1,881	940.5
Common carp	2	0.13				
River carpsucker	31	2.07	19	1.3		
Smallmouth buffalo	58	3.87	8	0.5		
Blue catfish	252	16.8	18	1.2		
Channel catfish	14	0.93	30	2.0		
Flathead catfish	2	0.13				
White bass	40	2.67	1	0.1		
Warmouth					8	4.0
Bluegill			45	3.0	194	97.0
Longear sunfish			4	0.3	33	16.5
Largemouth bass					74	37.0
White crappie	9	0.6	211	14.1		
Freshwater drum	6	0.4	20	1.3		

APPENDIX B



Location of sampling sites, Arrowhead Reservoir, Texas, 2011-2012. Trap net, gill net, and electrofishing stations are indicated by T, G, and E respectively.