

PERFORMANCE REPORT

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STATEWIDE FRESHWATER FISHERIES MONITORING AND MANAGEMENT PROGRAM

2007 Survey Report

Arrowhead Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Arrowhead Reservoir were surveyed in 2007 using trap nets and electrofishing, in 2008 using gill nets and from June 2007 – May 2008 with a creel survey. 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 near full capacity with the shoreline habitat consisting mainly of flooded terrestrial vegetation. Aquatic vegetation was present in beneficial amounts. The reservoir elevation exceeded the spillway for the first time in 11 years during July 2007 and has been fluctuating between 2 to 12 feet below spillway elevation during the last four years. 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 at the six improved public ramp sites. 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 catch rate was the highest ever recorded for the reservoir. Threadfin shad were also collected indicating plentiful forage for game fish. The catch per unit effort (CPUE) for bluegill was also high.
 - **Catfishes:** During the 2008 gill net survey, blue catfish had a higher gill net CPUE than channel catfish. In fact, the 2008 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 2004 survey, especially for sub-legal fish. Flathead catfish persist in the reservoir with the CPUE increasing from previous surveys.
 - **White bass:** White bass 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. Evidence of relatively high white bass abundance was observed during the 12-month creel survey. Growth rates remained above ecological region averages.
 - **Largemouth bass:** The 2007 electrofishing survey for largemouth bass had the highest catch rate ever recorded at Arrowhead. High water elevations helped increase littoral habitat which led to good natural reproduction. Florida bass stockings during 2005 and 2006 when the reservoir elevation was on the rise also accounted for a good number of sampled fish. Growth rates were above reservoir historical averages.
 - **White crappie:** The 2007 CPUE was higher than the two previous trap net surveys. Recruitment continues to be good with adequate abundance of legal-size fish. Legal size crappie were all above average in body condition. Growth was improved and well above average with crappie taking less than three years to reach legal size.
 - **Management Strategies:** Populations of catfish, white bass, largemouth bass, and white crappie are in good shape and should be widely promoted for anglers to enjoy.

INTRODUCTION

This document is a summary of fisheries data collected from Arrowhead Reservoir in 2007 and 2008. 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 south 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 539 $\mu\text{mhos/cm}$. Habitat at time of sampling consisted of flooded terrestrial and aquatic vegetation. Some standing timber remains, in the upper reservoir and backs of coves. Water level was near full during sampling. The elevation has been rising since 2004 when the reservoir water level was about 12 feet below conservation pool (Figure 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 (Mauk and Howell 2004) included:

1. Anglers might benefit from increased information about fishing opportunities, locations, and strategies at Arrowhead Reservoir.
 - Action:** Published several news releases concerning fishing opportunities at Arrowhead during the last four years.
 - Action:** Every first Saturday in June, helped conduct a youth fishing event and an event for non-sport fish at Lake Arrowhead State Park.
 - Action:** Worked on completing an informational brochure on fishing at Arrowhead and the district water bodies.
2. Areas that enhance fishing success for youth and for physically challenged anglers are limited at Arrowhead.
 - Action:** Enhanced angling success by annually constructing and maintaining fish attracting structure at Lake Arrowhead State Park. A combination of donated Christmas trees and cinder blocks was used. Fishing docks and piers at the state park are physically challenged accessible.
3. Largemouth bass spawning success was poor in 2002 and 2003 and was likely to be poor again in 2004 because of low reservoir levels and the associated loss of nursery habitat.
 - Action:** Florida largemouth bass fingerlings were stocked in 2005 and 2006 when reservoir elevations started to rise and littoral habitat significantly improved.

Harvest regulation history: Sport fish species in Arrowhead Reservoir historically were managed using statewide regulations.

Stocking history: Florida largemouth bass were stocked in 2005 and 2006 since poor recruitment had occurred in previous years because of low reservoir elevations. The complete stocking history is in Table 3.

Vegetation/habitat history: Noxious aquatic vegetation has not been observed at the reservoir. Christmas tree fish attractors have been placed annually around the state park fishing piers. During 2007, the reservoir elevation was high and new aquatic vegetation became established, resulting in an estimated 0.6% coverage (121.7 acres).

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). A 12-month creel survey was conducted from June 2007 – May 2008. Creel estimates were based on daylight hours on a per month basis for this reservoir in 2007-08. Prior creel surveys daylight hour estimates were on a quarterly basis for the center of the state. All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2005).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Stock Density (PSD), Relative Stock Density (RSD)], 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). Relative standard error ($RSE = 100 \times SE$ 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 white bass, largemouth bass and crappie. Source for water level data was the United States Geological Survey.

RESULTS AND DISCUSSION

Habitat: A physical habitat survey conducted July-August, 2007 indicated the littoral zone habitat consisted primarily of flooded live terrestrial vegetation (Table 4). The reservoir was 0.3 feet below conservation pool at time of survey. The previous physical habitat survey was conducted in 2003 (Howell and Mauk 2004). Very few manmade changes to the physical habitat had occurred during the four year period.

Creel Survey: A 12-month creel survey was conducted from June 2007 – May 2008. Results from that survey are compared to a 12-month creel conducted from Dec. 1, 2003 – Nov. 30, 2004 (Tables 5 and 6). Total fishing effort increased 58.7% over the previous creel to 159,542 angler hours. The increase likely attributed to the reservoir filling, favorable publicity, and improved largemouth bass and crappie fishing. The percentage of directed effort for largemouth bass compared to the total effort for all species increased from 5.0% to 20.2%. White crappie is still the most targeted species but the percentage of total directed effort dropped from 47.9% to 42.2%. Directed white bass effort increased from 2.2% to 5.4%. Catfish spp. directed effort decreased from 23.3% to 10.4%. This decrease is not associated with any problems with the catfish populations, but reflects the increased popularity of other species. Hours of directed effort for channel catfish actually increased while blue catfish decreased. Overall hourly effort remained nearly the same for catfish compared to four years ago.

Economic Impact: An estimated total of \$681,022 in direct expenditures related to fishing trips was made by anglers during the 12-month creel period that ended in May 2008. This compares with \$240,408 for the 12-month creel period that ended in November 2004 (Table 6).

Prey species: Electrofishing catch rates of bluegill, threadfin shad, and gizzard shad were 219.5/h, 125.0/h, and 576.0/h, respectively. Index of vulnerability for gizzard shad was adequate, indicating that 88% of gizzard shad were available to predators; this IOV is lower than the previous 3 surveys which ranged from 92-99. However, total CPUE of gizzard shad was the highest ever recorded for the reservoir (Figure 2).

Blue catfish: Blue catfish 2008 gill net CPUE (12.5/nn) was up significantly from previous surveys indicating that the population has become well established since the 1995 stocking. The CPUE in 2004 was 8.9/nn and 4.4/nn in 1999 (Figure 4). Recruitment appeared excellent which is good for the future of the fishery. Many legal fish were also collected with body condition better for fish >20 inches. The creel found a decrease in the number of targeted hours for blue catfish, but total estimated harvest increased slightly (Table 7).

Channel catfish: Channel catfish 2008 gill net CPUE (0.5/nn) increased from the 2004 survey, but was down from previous surveys before 2004 (Figure 6). Channel catfish gill net catch rate has shown signs of being in a decline since 1998, around the same time that the blue catfish became well established. This is a trend we are seeing at other lakes where blue catfish have become well established. However, while we don't see as many channel catfish in our nets, they are still being caught by anglers in good numbers as evidenced by the creel survey. Why there is this discrepancy is unknown, but it could be that the blue catfish have become better established in deeper water and channel catfish predominate in water too shallow for our nets to adequately sample. Most of the sampled channel catfish were below stock length. However, recent creel results show that larger channel catfish are being caught and harvested compared to four years ago (Figure 7). Targeted hours for channel catfish increased from the previous survey (Table 8).

Flathead catfish: The gill net CPUE was 0.3/nn for 2008, up from the previous two surveys of 0.1/nn. While few fish were caught, this is still considered to be a good flathead catfish reservoir. All legal fish had Wr's over 100. Three flathead catfish were harvested during the creel, with two of them being under legal size. Many anglers apparently are not familiar with this species or the regulations. Some were caught at Lake Arrowhead State Park where anglers do not need a license. Many of these anglers seem ignorant of

ignorant of many fishing regulations, even though the park has erected a large sign explaining them.

White bass: The gill net catch rate for white bass was 6.9/nn in 2008, which was down from 17.9/nn in 2004 and the 10.1/nn sampled in 1999 (Figure 8). The historical average for the reservoir is 13.3/nn so the decrease is significant, but could be a product of the random net sites and timing of the survey. The RSE was high (66) for the 2008 CPUE data compared to 19 (2004) and 35 (1999). In past years the gill net survey has been completed in early March and all gill nets caught white bass. This year because of weather, the survey was completed early May. Less than half of the nets caught white bass and two nets set near rocky points caught the majority of the fish. Therefore the perceived decline might not be actual but a result of sampling variability. Growth was above the regional average (Prentice 1987) and is similar to growth rates in 2004 (Table 9). These last two surveys show an increase in growth compared to the previous two surveys. Angler catch from the creel survey resulted in more than double the observed harvest compared to four years ago (Figure 9).

Largemouth bass: The electrofishing CPUE of largemouth bass was 86.0/h in 2007, the highest ever recorded for the reservoir. This is a much higher CPUE than the previous two surveys of 25.0 in 1999 and 16.5 in 2003 (Figure 10). This was caused by a large 2007 year class from good spawning conditions and two years of Florida stockings when the reservoir elevation was on the rise (Figure 1). Body condition for these fish was good with relative weights near 100 (Figure 10). The percent of Florida alleles was 38.9% with 0.0% pure Florida being documented for the 2007 year class (Table 11). Category 3 (TPWD, Inland Fisheries Division, unpublished manual revised 2005) age and growth determined that growth was better than the regional average (Prentice 1987) and has remained relatively constant over time (Table 12). The 2007-08 creel survey showed that largemouth bass effort has increased over 600% compared to four years ago. Bass tournaments are increasing in popularity with an evening tournament taking place every Wednesday and numerous club and circuit tournaments. Various data was collected on these tournaments and the average number of anglers participating was 31 (range 7-80) for the 13 tournaments monitored. The big bass averaged 6.66 lbs. (range 4.07-9.58 lbs.) and the average winning stringer was 16.53 lbs. (range 9.51-27.79 lbs.).

White crappie: The trap net catch rate of white crappie was 38.6/nn in 2007, higher than the previous surveys of 2005 (18.1/nn) and 2003 (15.1/nn) (Figure 12). Recruitment remains good. Abundance of legal size crappie was also improved over the last two surveys. Body condition as measured by Wr was over 100 for all legal size inch groups. Category 4 age and growth performed during 2006 found improved growth rates compared to previous surveys (Table 14). Crappie are averaging almost 12 inches in length at age 2+. Growth rates are well above regional averages (Prentice 1987) and well above historical data for the reservoir (Table 14). White crappie remain the most popular species in terms of angler effort and harvest at the reservoir.

Fisheries management plan for Arrowhead Reservoir, Texas

Prepared – July 2008

ISSUE 1: Lake Arrowhead State Park anglers do not need a fishing license (so they do not receive the TPWD Annual) and many seem unaware of species length regulations. This is leading to an unacceptable rate of sublegal harvest.

MANAGEMENT STRATEGIES

1. 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. Another station by the other fishing pier would help. Other educational opportunities should be pursued.
2. Contact the game wardens and park rangers and ask them to perform occasional angler checks.

ISSUE 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.

MANAGEMENT STRATEGY

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

ISSUE 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.

MANAGEMENT STRATEGY

1. Continue to provide multiple news releases and distribute them more widely than the Wichita Falls area. Also work on completion of district lake pamphlet that will feature Arrowhead.

SAMPLING SCHEDULE JUSTIFICATION:

Conduct standard electrofishing survey every other year beginning in fall of 2009 to more closely monitor the dynamic largemouth bass population. Also, complete another 12-month creel survey from June 2009 through May 2010 to monitor for changes in angler effort and catch. Conduct gill netting and trap netting surveys according to standard four-year rotational schedule.

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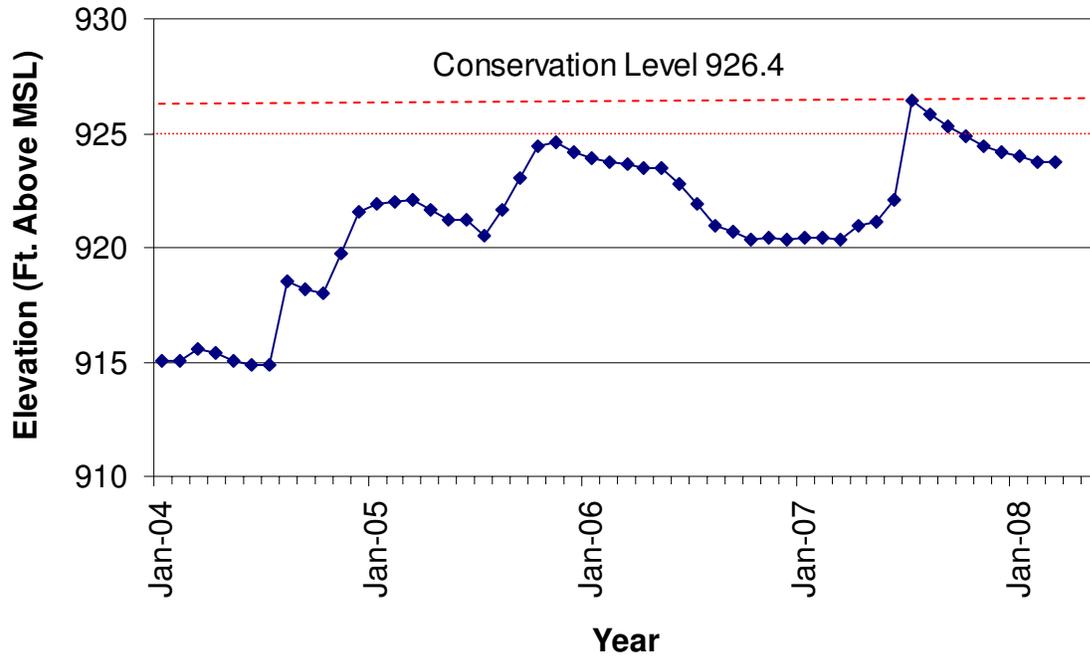


Figure 1. Monthly water level elevations in feet above mean sea level (MSL) recorded for Arrowhead Reservoir, Texas.

Table 1. Characteristics of Arrowhead Reservoir, Texas.

Characteristic	Description
Year constructed	1966
Controlling authority	City of Wichita Falls
Counties	Archer and Clay
Reservoir type	Mainstem
Shoreline Development Index (SDI)	6.36
Conductivity	539 μ mhos/cm

Table 2. Harvest regulations for Arrowhead Reservoir.

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, 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
	Total	1,709,356		
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 2007. 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 926.1 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
Flooded terrestrial vegetation	120.5	94.4		
Bulkhead	<0.1	<0.1		
Concrete	0.1	0.1		
Featureless/nondescript	0.5	0.4		
Rocky bluff	0.7	0.5		
Rocky shore	1.6	1.3		
Riprap	3.9	3.1		
Overhanging brush	0.3	0.2		
Total shoreline length	127.7			
<hr/>				
<u>Habitat adjacent to shoreline</u>				
Standing timber			712.8	4.8
Boat docks			9.7	<0.1
Native floating vegetation			47.2	0.3
Native submerged vegetation			29.3	<0.1
Native emerged vegetation			45.2	0.3

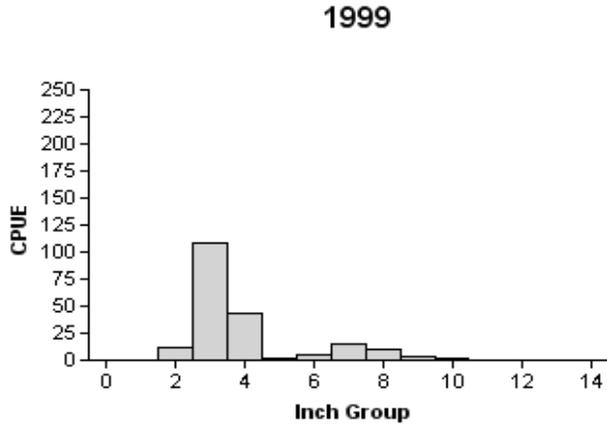
Table 5. Percent directed angler effort by species; percent harvest and catch all anglers for Arrowhead Reservoir, Texas, Dec. 1, 2003 – Nov. 30, 2004 and June 1, 2007 – May 31, 2008.

Species	Percent directed effort		Percent harvest all anglers		Percent catch all anglers	
	2003-04	2007-08	2003-04	2007-08	2003-04	2007-08
Longnose gar						<0.1
Gizzard shad					0.1	<0.1
Carp	0.8				0.7	<0.1
Smallmouth buffalo			0.1		0.4	<0.1
Blue catfish	4.9	1.8	10.0	4.0	5.5	2.1
Channel catfish	2.0	1.5	5.2	3.2	4.6	2.7
Flathead catfish			0.1	0.2	0.1	0.2
Catfish spp.	16.4	7.1			0.1	
White bass	2.2	5.5	14.8	16.2	20.0	16.7
Green sunfish				0.3		0.1
Warmouth						<0.1
Bluegill			0.1	2.2	0.4	2.1
Longear sunfish				0.5		0.2
Panfish spp.		0.5			0.8	1.4
Largemouth bass	5.0	20.2	0.8	4.8	1.7	10.1
White crappie	47.9	42.2	67.8	67.8	64.5	63.4
Freshwater drum			1.1	0.8	1.0	0.9
Anything	20.8	21.3				

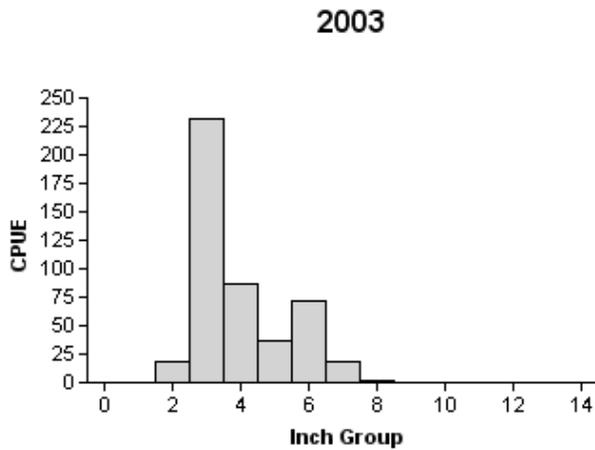
Table 6. Total fishing effort (h) for all species and total directed expenditures at Arrowhead Reservoir, Texas, Dec. 1, 2003 – Nov. 30, 2004 and June 1, 2007 – May 31, 2008.

Creel Statistic	Year	
	Dec. 1, 2003-Nov. 30, 2004	June 1, 2007-May 31, 2008
Total fishing effort (h)	93,757.3	159,542.2
Total directed expenditures	\$240,408	\$681,022

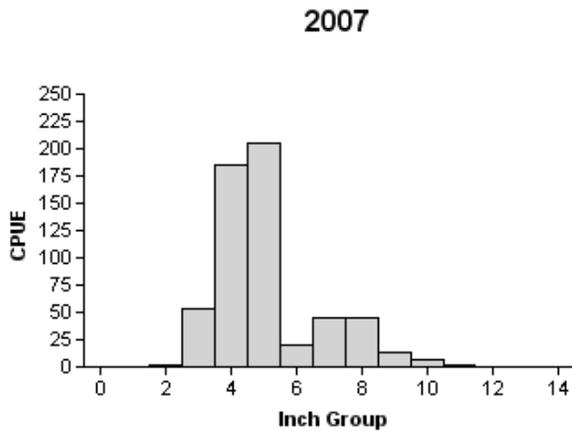
Gizzard Shad



Effort = 2.0
 Total CPUE = 200.0 (21; 400)
 Stock CPUE = 30.0 (39; 60)
 PSD = 0 (196.6)
 IOV = 92.25 (3.2)



Effort = 2.0
 Total CPUE = 468.0 (19; 936)
 Stock CPUE = 21.0 (40; 42)
 PSD = 2 (2.6)
 IOV = 99.47 (0.4)



Effort = 2.0
 Total CPUE = 576.0 (16; 1152)
 Stock CPUE = 112.0 (30; 224)
 PSD = 1 (0.5)
 IOV = 88.45 (3.4)

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, 1999, 2003, and 2007.

Bluegill

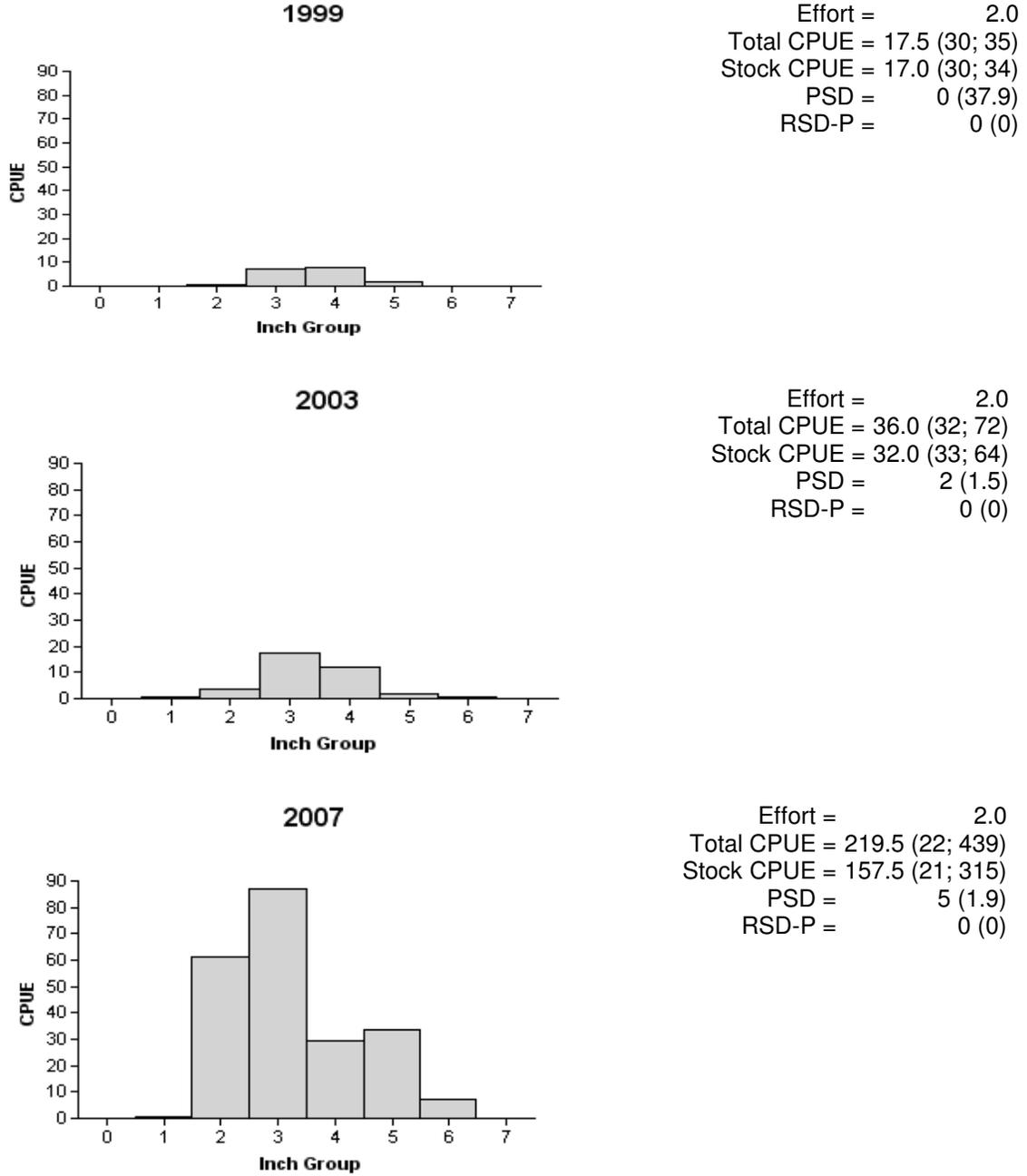
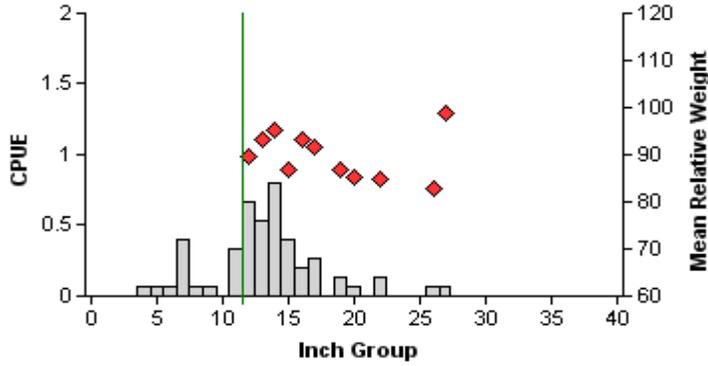


Figure 3. Number of bluegill caught per hour (CPUE) and population indices for fall electrofishing surveys, Arrowhead Reservoir, Texas, 1999, 2003, and 2007. (RSE and N for CPUE and SE for size structure are in parentheses)

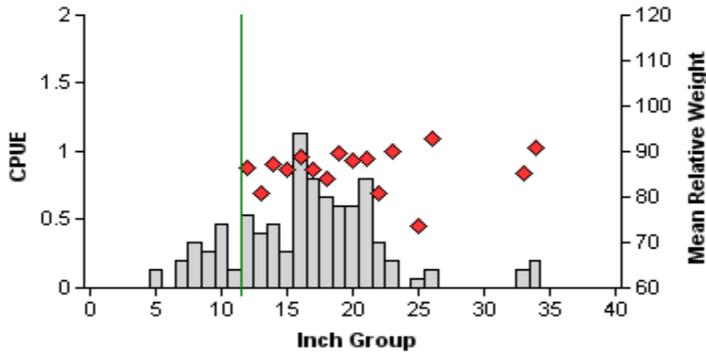
Blue Catfish

1999



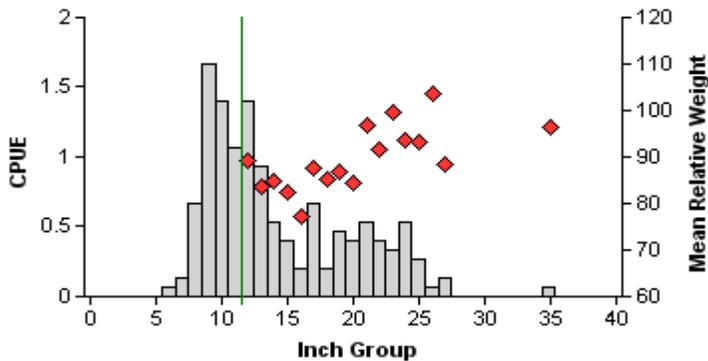
Effort = 15.0
 Total CPUE = 4.4 (13; 66)
 Stock CPUE = 3.3 (14; 50)
 PSD = 10 (4.5)
 RSD-P = 0 (0)

2004



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

2008



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

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 winter gill netting surveys, Arrowhead Reservoir, Texas, 1999, 2004, and 2008. Line indicates minimum size limit at time of sampling.

Blue Catfish

Table 7. Creel survey statistics for blue catfish at Arrowhead Reservoir from Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008 where total catch per hour is for anglers targeting blue catfish and total harvest is the estimated number of blue catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year	
	Dec. 1, 2003 – Nov. 30, 2004	June 1, 2007 – May 31, 2008
Directed effort (h)	4,604.0 (23.5)	2,940.9 (33.3)
Directed effort/acre	0.3 (23.5)	0.2 (33.3)
Total catch per hour	0.9 (81.3)	0.5 (108.4)
Total harvest	5,275.4 (51.6)	5,697.5 (59.1)
Harvest/acre	0.4 (51.6)	0.4 (59.1)
Percent legal released	34.8	21.3

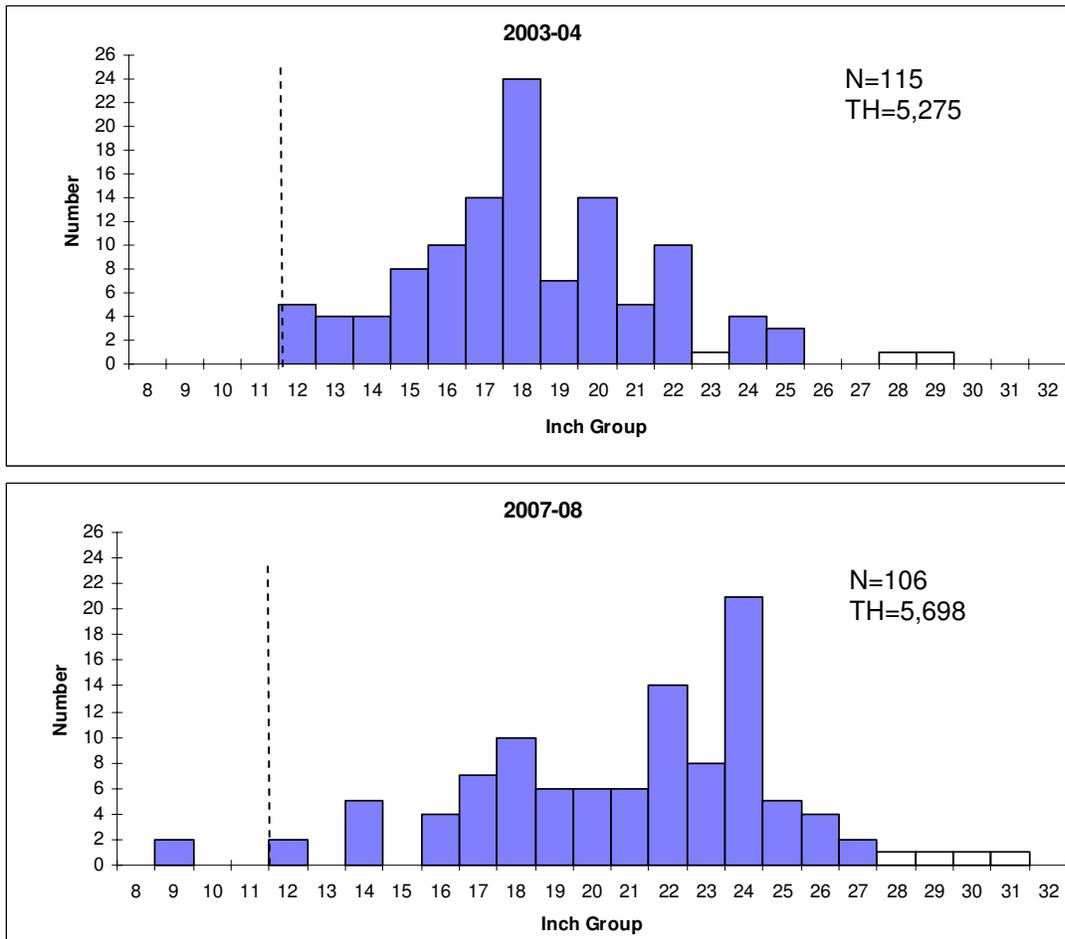
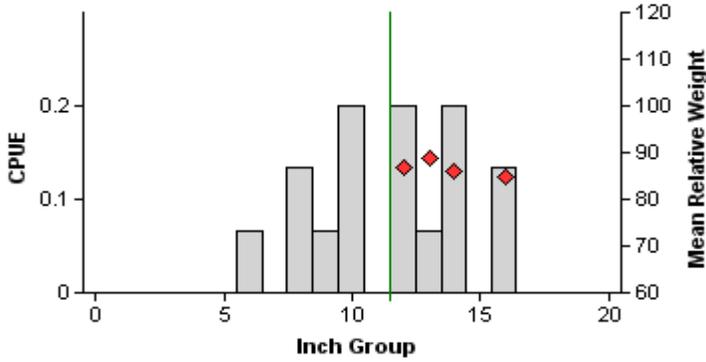


Figure 5. Length frequency of harvested blue catfish observed during creel surveys at Arrowhead Reservoir, Texas, Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

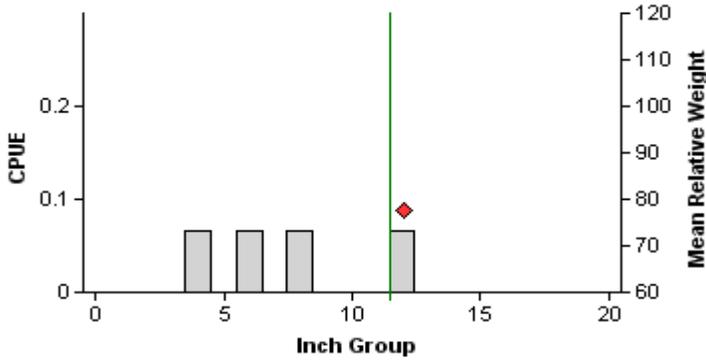
Channel Catfish

1999



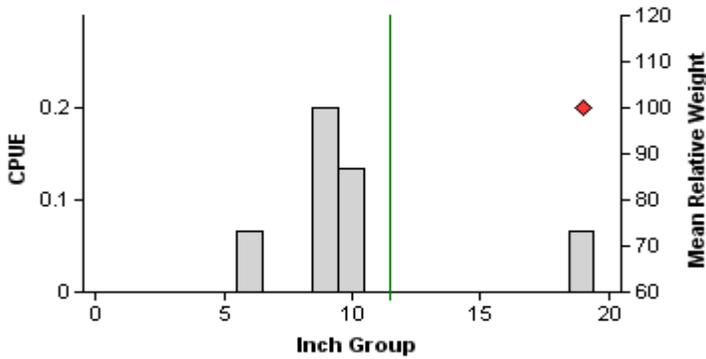
Effort = 15.0
 Total CPUE = 1.1 (28; 16)
 Stock CPUE = 0.6 (39; 9)
 PSD = 22 (11.9)
 RSD-P = 0 (0)

2004



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

2008



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

Figure 6. 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 winter gill netting surveys, Arrowhead Reservoir, Texas, 1999, 2004, and 2008. Line indicates minimum size limit at time of sampling.

Channel Catfish

Table 8. Creel survey statistics for channel catfish at Arrowhead Reservoir from Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008 where total catch per hour is for anglers targeting channel catfish and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year	
	Dec. 1, 2003 – Nov. 30, 2004	June 1, 2007 – May 31, 2008
Directed effort (h)	1,846.4 (37.4)	2,326.8 (30.9)
Directed effort/acre	0.1 (37.4)	0.2 (30.9)
Total catch per hour	0.3(84.2)	0.4 (75.3)
Total harvest	2,771.4 (55.7)	4,539.1 (73.0)
Harvest/acre	0.2 (55.7)	0.3 (73.0)
Percent legal released	8.1	15.6

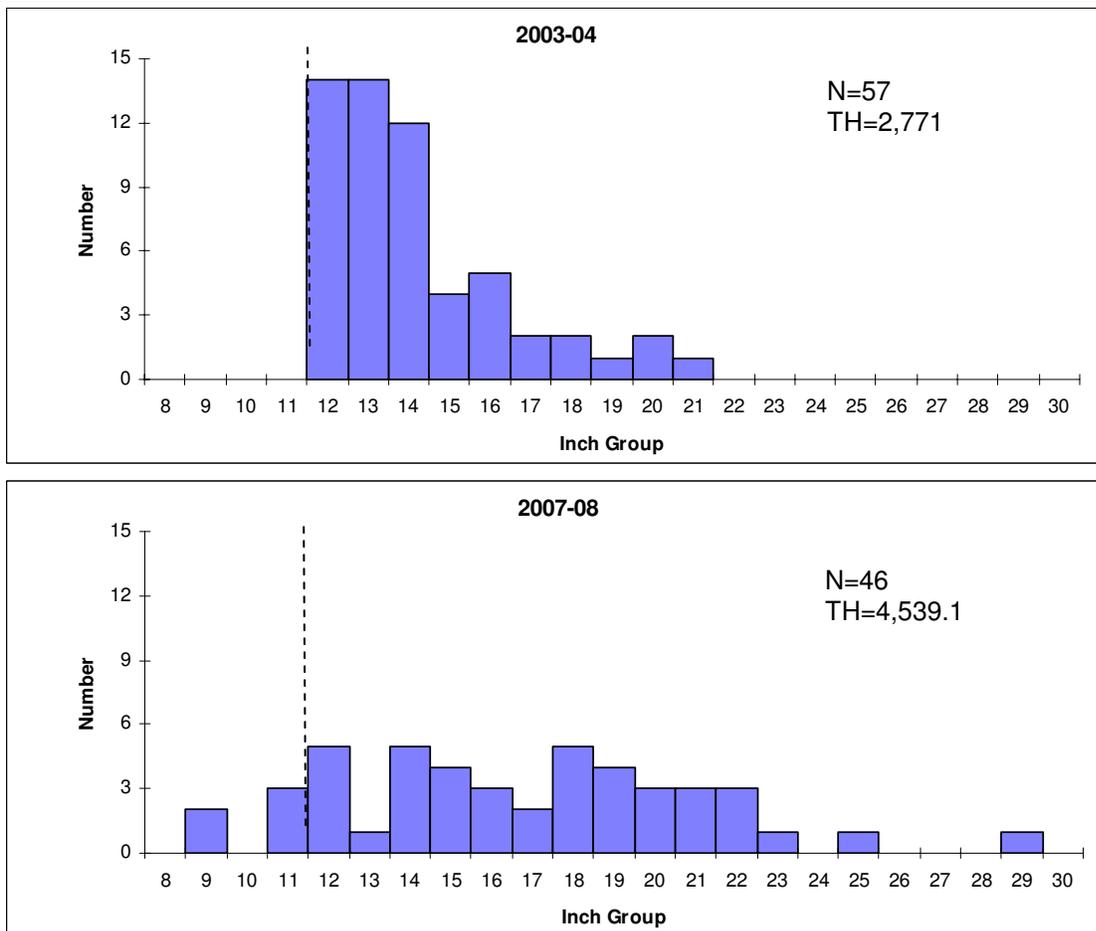


Figure 7. Length frequency of harvested blue catfish observed during creel surveys at Arrowhead Reservoir, Texas, Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

White Bass

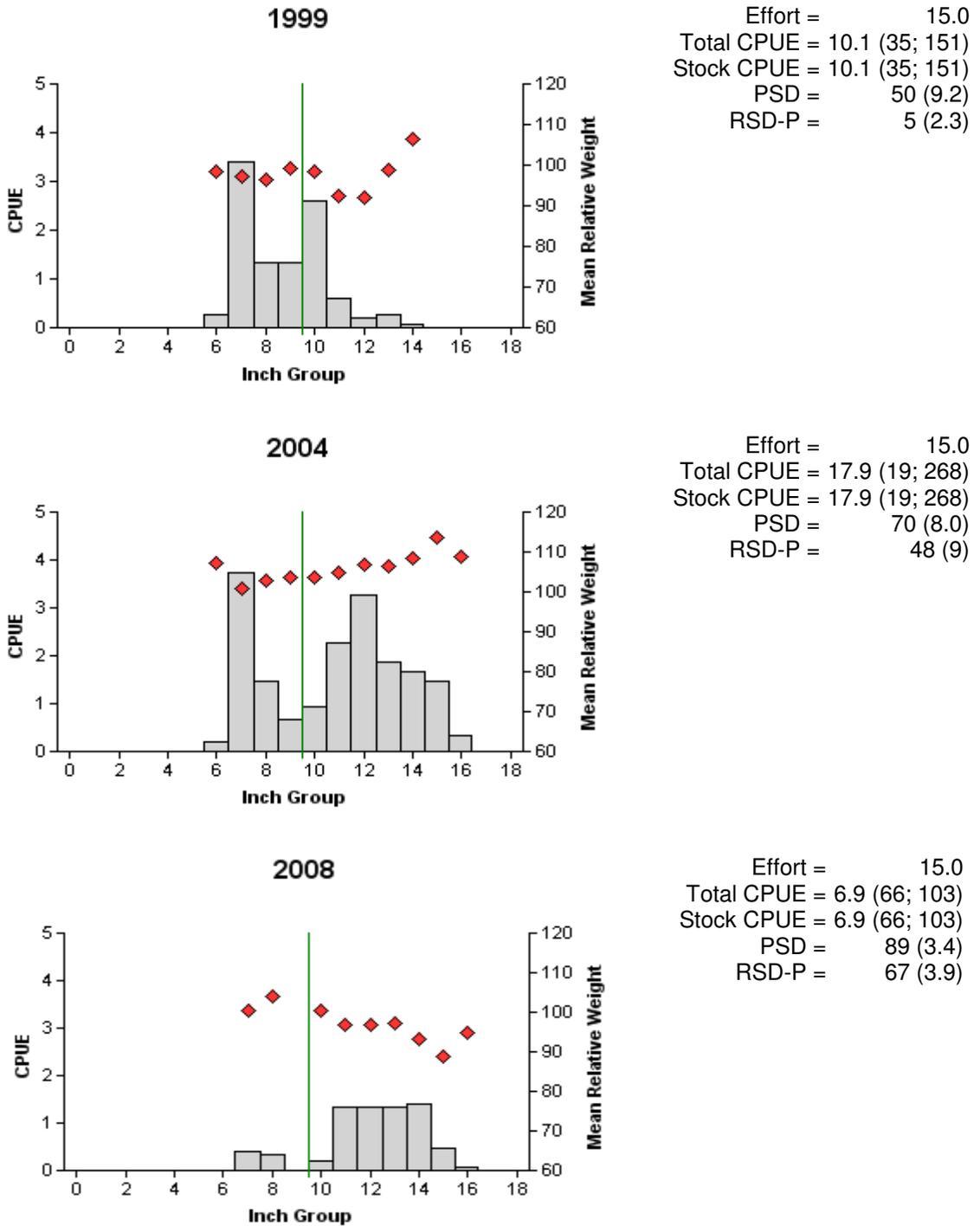


Figure 8. Number of white bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for winter gill netting surveys, Arrowhead Reservoir, Texas, 1999, 2004 and 2008. Line indicates minimum size limit at time of sampling.

White Bass

Table 9. Mean length at age of capture for white bass (sexes combined) collected during March gill netting surveys except for 2008 when fish were collected during May gill net survey, Arrowhead Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	Length (inches) at age of capture						
	1	2	3	4	5	6	7
1996	7.2(11)	11.0(11)	13.1(11)	14.7(9)	16.1(2)		
1997	7.3(4)	10.2(19)	12.6(7)	14.2(8)	15.5(8)	15.7(2)	17.8(1)
1998	7.7(17)	10.9(8)	12.8(14)	14.5(1)	15.3(8)	15.9(1)	16.5(1)
1999	7.1 (7)	9.4 (19)	11.9 (5)	13.5 (6)			
2004	8.0(17)	11.7(18)	14.0(5)	14.6(2)	15.7(7)		15.6(3)
2008	8.5(11)	12.0(10)	14.0(5)	14.3(5)			
Averages ^a	8.6	11.0	12.8	14.2	15.3	16.1	16.7

^aEcological averages from Prentice (1987); lengths derived for March 15.

White Bass

Table 10. Creel survey statistics for white bass at Arrowhead Reservoir from Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008 where total catch per hour is for anglers targeting white bass and total harvest is the estimated number of white bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year	
	Dec. 1, 2003 – Nov. 30, 2004	June 1, 2007 – May 31, 2008
Directed effort (h)	2,093.7 (34.9)	8,675.9 (21.5)
Directed effort/acre	0.1 (34.9)	0.6 (21.5)
Total catch per hour	3.4 (134.8)	1.6 (45.4)
Total harvest	7,820.9 (35.5)	23,121.2 (26.3)
Harvest/acre	0.5 (35.5)	1.5 (26.3)
Percent legal released	44.3	9.3

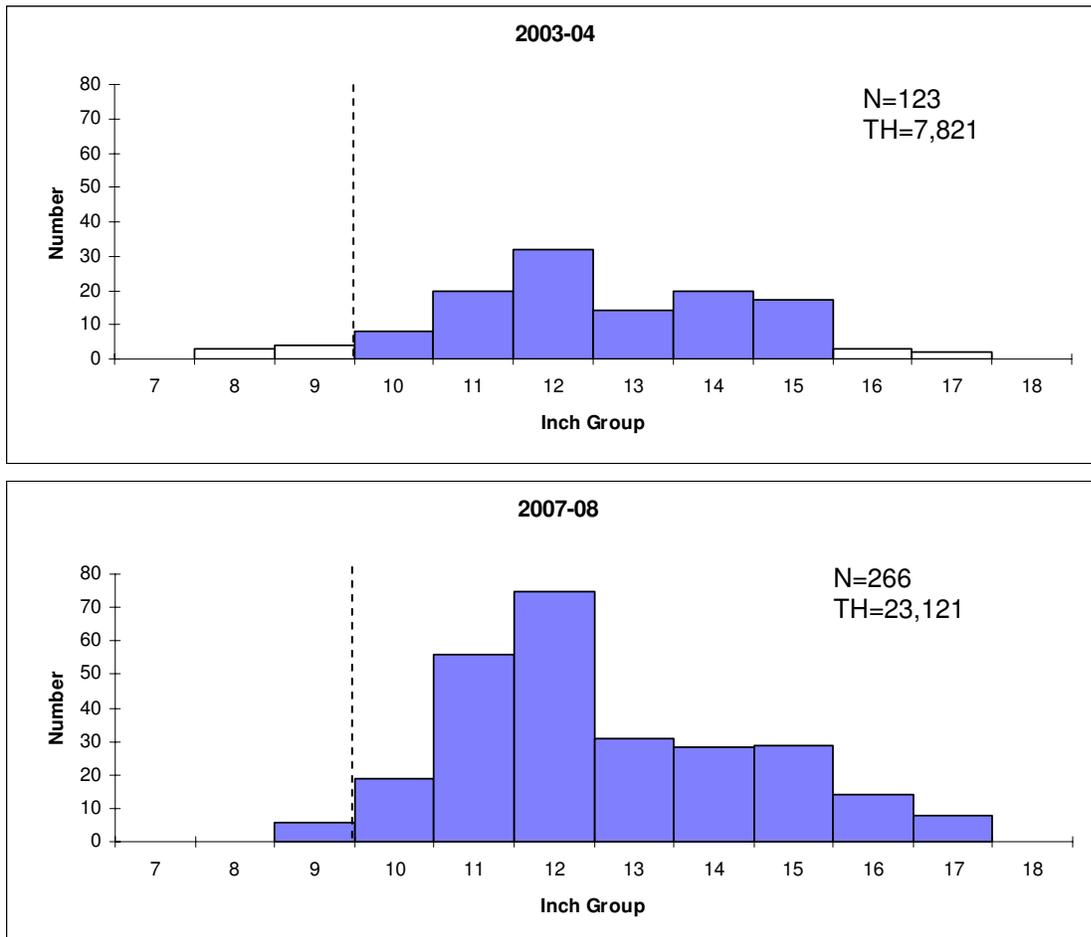


Figure 9. Length frequency of harvested white bass observed during creel surveys at Arrowhead Reservoir, Texas, Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

Largemouth Bass

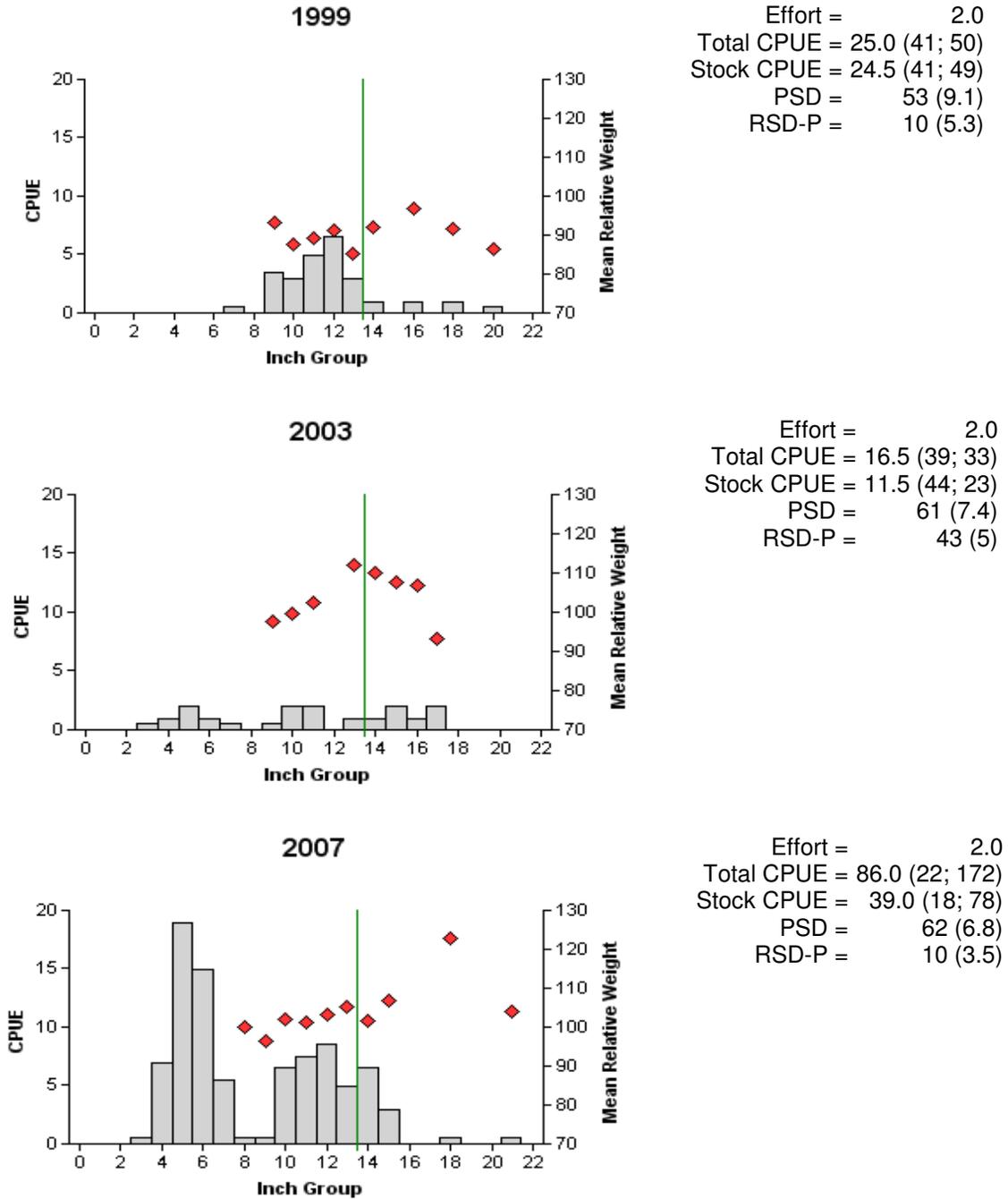


Figure 10. Number of largemouth bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Arrowhead Reservoir, Texas, 1999, 2003, and 2007. Line indicates minimum size limit at time of sampling.

Largemouth Bass

Table 11. Results of genetic analysis of largemouth bass collected by fall electrofishing, Arrowhead Reservoir, Texas, 1996, 1997, 1998, 1999, 2003 and 2007. 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.

Year	Sample size	Genotype			% FLMB alleles	% pure FLMB
		FLMB	F1 or Fx	NLMB		
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

Table 12. Mean length at age of capture for largemouth bass (sexes combined) collected during October 1996, 1997, 1998, 1999, September 2003 and 2007 electrofishing surveys, Arrowhead Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	Length (inches) at age of capture				
	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)
Averages ^a	10.1	12.9	15.1	16.9	18.3

^aEcological averages from Prentice (1987); lengths derived for October 15.

Largemouth bass

Table 13. Creel survey statistics for largemouth bass at Arrowhead Reservoir from Dec. 1, 2003 through Nov. 30, 2004 and June 1, 2007 through May 31, 2008 where total catch per hour is for anglers targeting largemouth bass and total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year	
	Dec. 1, 2003 – Nov. 30, 2004	June 1, 2007 – May 31, 2008
Directed effort (h)	4,711.9 (26.3)	32,152.8 (17.5)
Directed effort/acre	0.3 (26.3)	2.1 (17.5)
Total catch per hour	0.3 (35.8)	0.9 (25.1)
Total harvest	414.8 (198.5)	6,864.7 (43.6)
Harvest/acre	0.0 (198.5)	0.5 (43.6)
Percent legal released	61.6	59.1

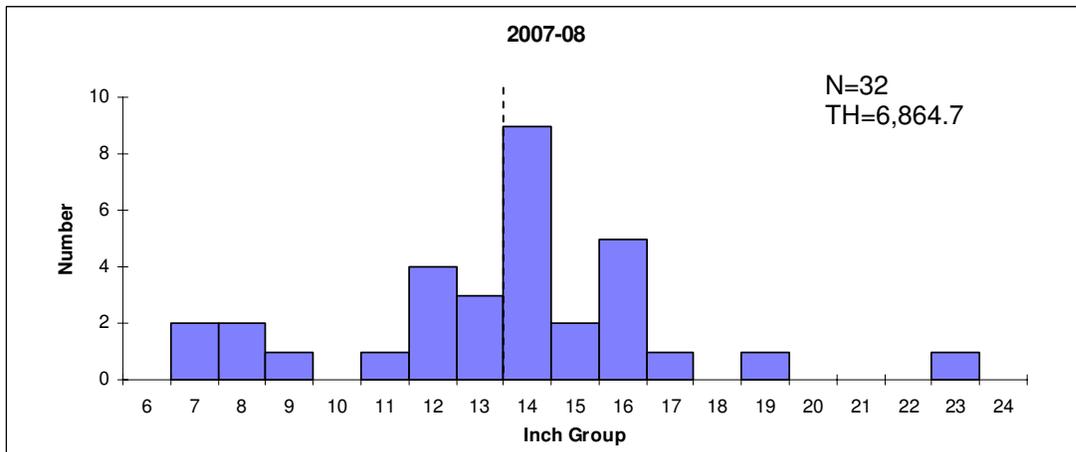
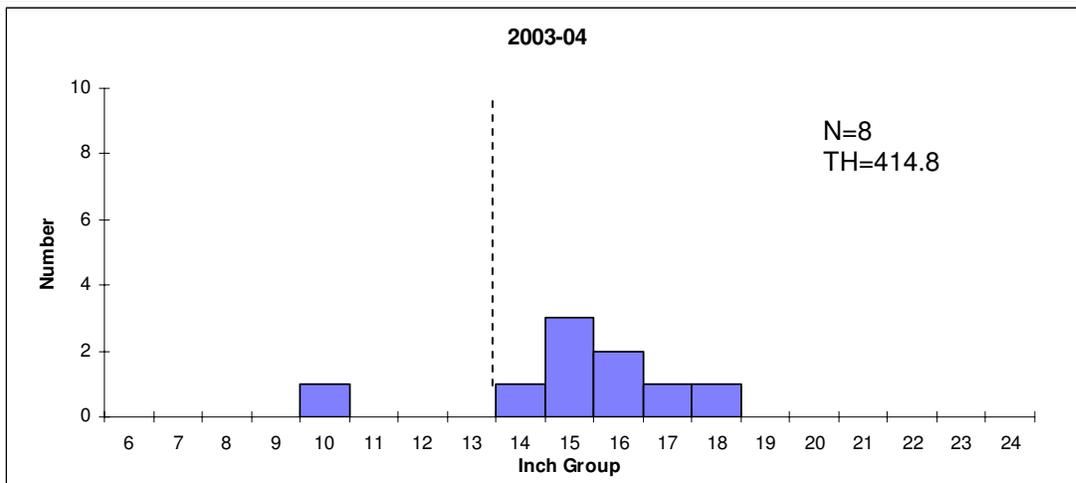
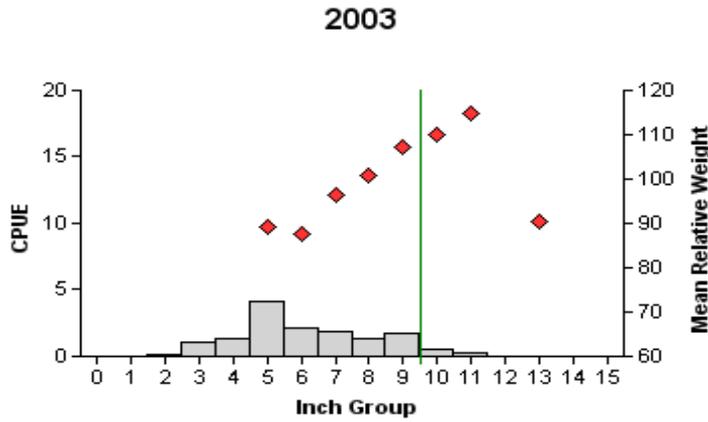
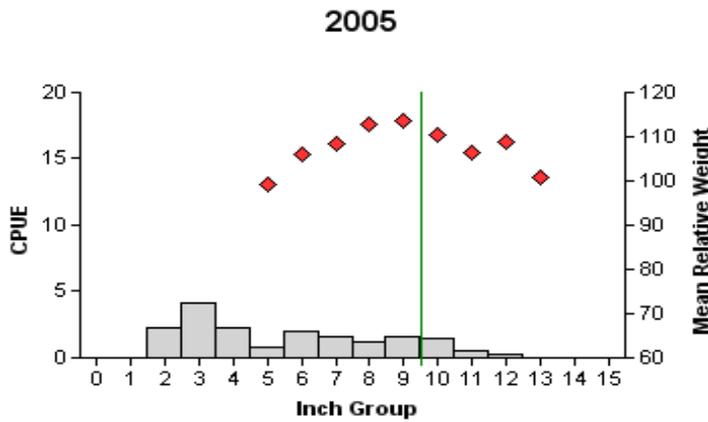


Figure 11. Length frequency of harvested largemouth bass (tournament fish not included) observed during creel surveys at Arrowhead Reservoir, Texas, Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

White Crappie



Effort = 15.0
 Total CPUE = 15.1 (25; 227)
 Stock CPUE = 12.4 (26; 186)
 PSD = 33 (12.5)
 RSD-P = 8 (4.5)



Effort = 24.0
 Total CPUE = 18.1 (17; 435)
 Stock CPUE = 9.5 (22; 229)
 PSD = 53 (6.3)
 RSD-P = 23 (3.4)



Effort = 15.0
 Total CPUE = 38.6 (23; 579)
 Stock CPUE = 17.7 (24; 265)
 PSD = 80 (5)
 RSD-P = 46 (7.1)

Figure 12. 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, 2003, 2005, and 2007. Line indicates minimum size limit at time of sampling.

Table 14. Mean length at age of capture for white crappie (sexes combined) collected during November trap netting surveys, Arrowhead Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	1	2	3	4	5	6	9
1997	7.1(16)	8.8(9)	10.9(8)	11.6(5)	13.1(4)	14.1(4)	
1998	6.0(21)	9.6(11)	10.8(8)	11.7(2)	13.3(2)		
1999	7.1(15)	9.8(12)	11.1(3)				
2000	6.7(18)	9.7(9)	10.7(8)	12.5(5)	9.8(2)		
2003	5.7(14)	9.1(25)		10.7(1)	13.4(1)		
2006	7.9(173)	11.9(27)	12.9(8)	13.2(4)	13.3(2)		14.1(1)
Averages ^a	6.9	8.9	10.3	11.3	11.9	12.4	

^aEcological averages from Prentice (1987); lengths derived for November 15.

White Crappie

Table 15. Creel survey statistics for white crappie at Arrowhead Reservoir from Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008 where 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 Survey Statistic	Year	
	Dec. 1, 2003 – Nov. 30, 2004	June 1, 2007 – May 31, 2008
Directed effort (h)	44,885.4 (13.8)	67,356.2 (13.9)
Directed effort/acre	3.0 (13.8)	4.5 (13.9)
Total catch per hour	1.5 (21.9)	2.6 (24.8)
Total harvest	35,834.0 (23.1)	96,818.2 (21.4)
Harvest/acre	2.4 (23.1)	6.5 (21.4)
Percent legal released	0.7	9.3

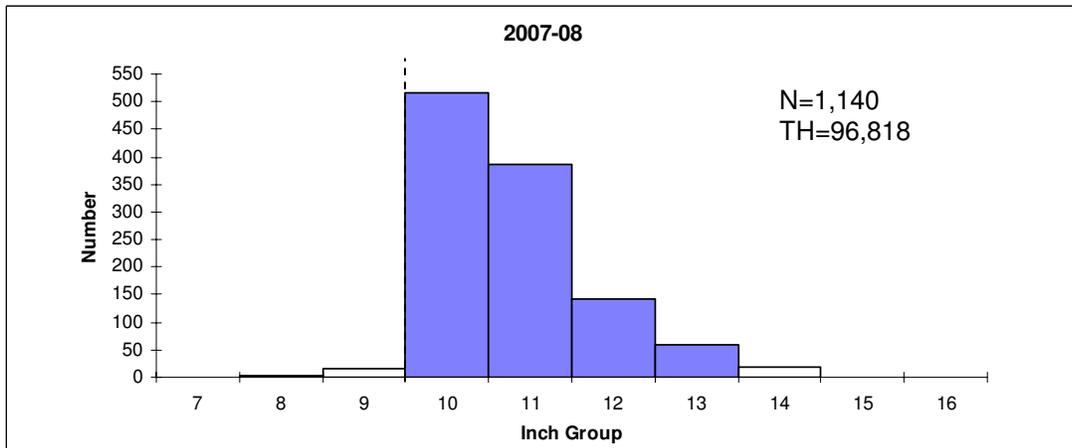
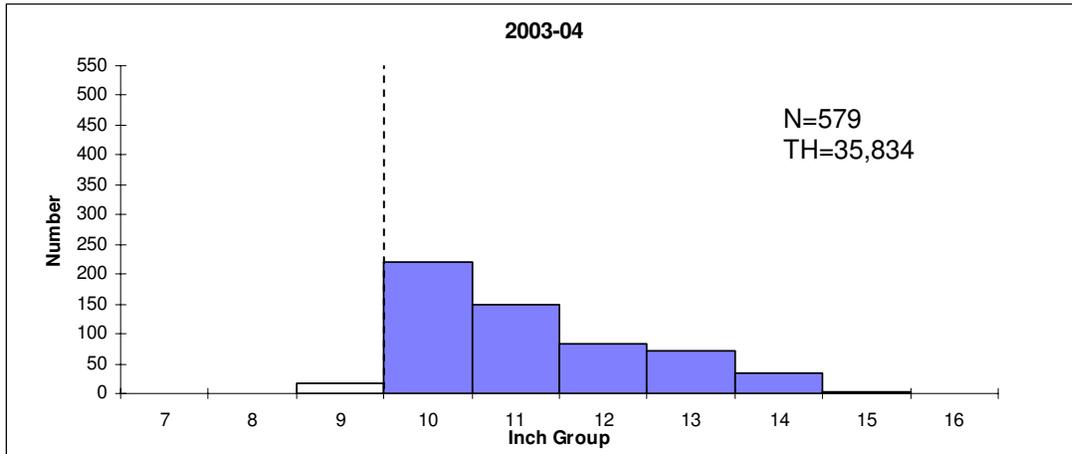


Figure 13. Length frequency of harvested white crappie observed during creel surveys at Arrowhead Reservoir, Texas, Dec. 1, 2003 through May 31, 2004 and June 1, 2007 through May 31, 2008, all anglers combined. N is the number of harvested white crappie observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

Table 16. Proposed sampling schedule for Arrowhead, 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.

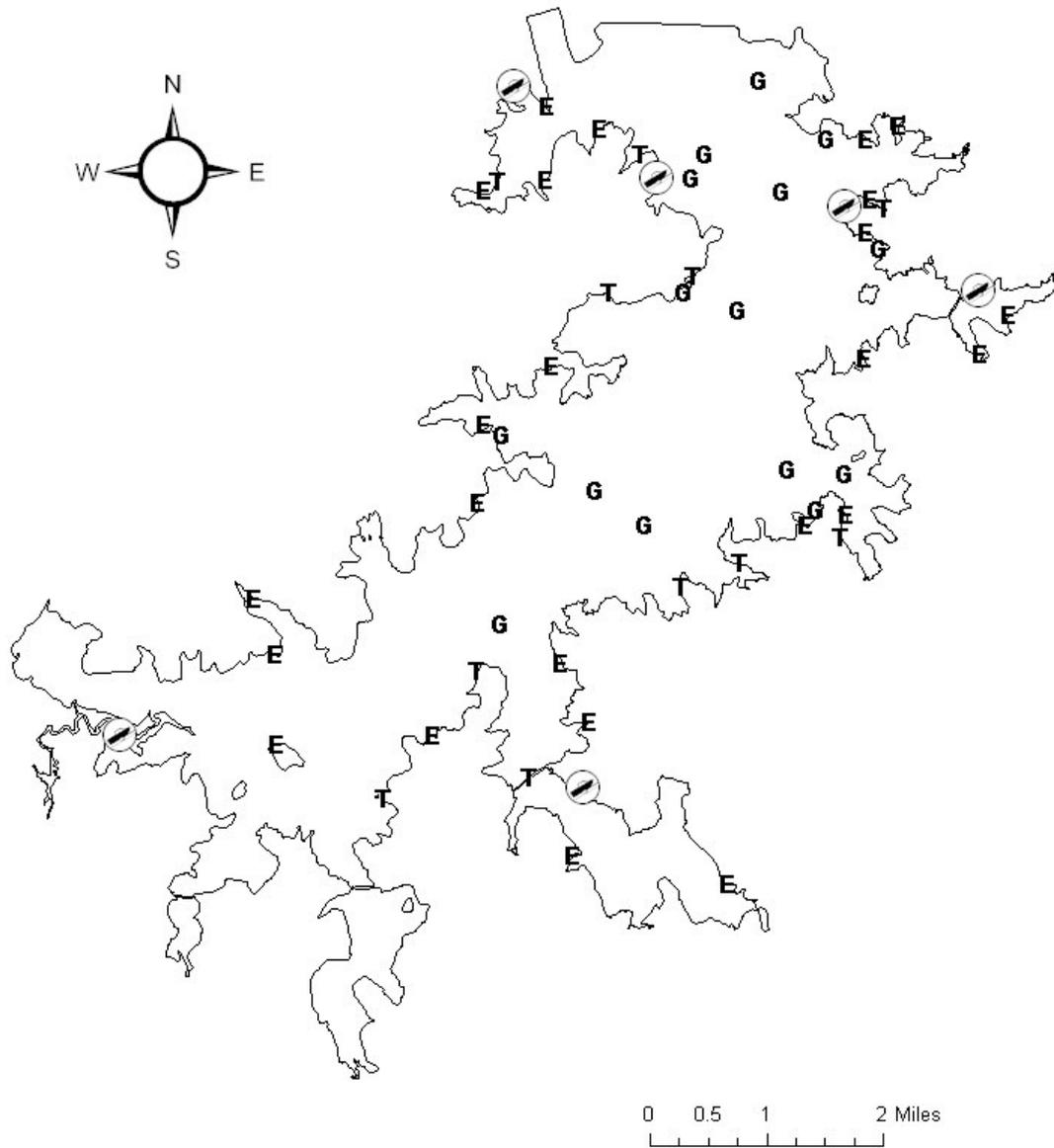
Survey Year	Electrofishing	Trap Net	Gill Net	Creel	Report
Fall 2008-Spring 2009					
Fall 2009-Spring 2010	A			A	
Fall 2010-Spring 2011					
Fall 2011-Spring 2012	S	S	S		S

APPENDIX A

Number (N) and catch rate (CPUE) of all species collected from all gear types from Arrowhead, Texas, 2007-2008

Species	Gill Nets		Trap Nets		Electrofishing	
	N	CPUE	N	CPUE	N	CPUE
Spotted gar			3	0.2		
Longnose gar	18	1.2				
Gizzard shad	460	30.7	111	7.4	1,152	576.0
Threadfin shad			44	2.9	250	125.0
River carpsucker	113	7.5	4	0.3		
Smallmouth buffalo	38	2.5	2	0.1		
Blue catfish	188	12.5	11	0.7		
Channel catfish	7	0.5	9	0.6		
Flathead catfish	4	0.3				
White bass	103	6.9	16	1.1		
Green sunfish					81	40.5
Warmouth			10	0.7	26	13.0
Bluegill	5	0.3	2,417	161.1	439	219.5
Longear sunfish	1	0.1	82	5.5	116	58.0
Largemouth bass	1	0.1	1	0.1	172	86.0
White crappie	27	1.8	579	38.6		
Freshwater drum	5	0.3	4	0.3		

APPENDIX B



Location of sampling sites, Arrowhead, Texas, 2007-2008. Trap net, gill net, and electrofishing stations are indicated by T, G, and E respectively.