PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-30-R-35

STATEWIDE FRESHWATER FISHERIES MONITORING AND MANAGEMENT PROGRAM

2009-10 Survey Report

Graham Reservoir

Prepared by:

Mark Howell and Robert Mauk
Inland Fisheries Division
District 2-E, Wichita Falls, Texas

Carter Smith
Executive Director

Gary Saul
Director, Inland Fisheries

July 31, 2010

TABLE OF CONTENTS

Survey and management summary ... 2

Introduction ... 3

Reservoir description ... 3

Management history ... 3

Methods ... 4

Results and discussion ... 4

Fisheries management plan ... 7

Literature cited ... 9

Figures and tables ... 10-34
- Water level (Figure 1) ... 10
- Reservoir characteristics (Table 1) ... 10
- Harvest regulations (Table 2) ... 10
- Stocking history (Table 3) ... 11
- Habitat survey (Table 4) ... 12
- Percent directed effort, harvest, and catch (Table 5) ... 13
- Total fishing effort and fishing expenditures (Table 6) ... 13
- Gizzard shad (Figure 2) ... 14
- Bluegill (Figure 3) ... 15
- Redear sunfish (Figure 4) ... 16
- Blue catfish (Figures 5-6; Table7) ... 17
- Channel catfish (Figures 7-8; Table 8) ... 19
- White bass (Figures 9-10; Table 9) ... 21
- Palmetto bass (Figures 11-12; Tables 10-12) ... 23
- Largemouth bass (Figures 13-14; Tables 13-17) ... 26
- White crappie (Figure 15; Tables 18-19) ... 30
- Black crappie (Figure 16) ... 32
- Crappie creel statistics (Figure 17; Table 20) ... 33
- Proposed sampling schedule (Table 21) ... 34

Appendix A
- Catch rates for all species from all gear types ... 35

Appendix B
- Map of 2009-2010 sampling locations ... 36

SURVEY AND MANAGEMENT SUMMARY

Fish populations in Graham Reservoir were surveyed in 2009 using electrofishing and trap nets and in 2010 using gill nets. A 12-month creel survey was conducted June 2008-May 2009. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Graham Reservoir is a 2,396-acre impoundment located on Salt Creek in the Brazos River Basin approximately two miles northwest of Graham. The water level has been within five feet of full pool since January 2006. Graham Reservoir has moderate to high productivity. Habitat features consisted of standing timber, rocks, emergent aquatic vegetation, and abundant flooded brush and trees. There are three public boat ramps and limited bank-fishing access.

- **Management history:** Important sport fish include white bass, palmetto bass, largemouth bass, white crappie and catfish. Palmetto bass have been stocked annually since 2004 (with the exception of 2009. Blue catfish were introduced into Graham Reservoir sometime in the late 1990s by unknown sources.

- **Fish Community**
  - **Prey species:** Threadfin shad continued to be present in the reservoir. Electrofishing catch rates of gizzard shad and bluegill were near historical averages. Gizzard shad size structure has continued recent trends towards larger sizes to where only 66% of the population is vulnerable to largemouth predation. Redear sunfish abundance has increased significantly compared to previous surveys.

  - **Catfishes:** Channel catfish abundance was up slightly over the previous two surveys. Blue catfish abundance has greatly expanded since 2002 and should be an excellent resource for anglers. Flathead catfish were present in the reservoir.

  - **Temperate basses:** White bass and palmetto bass were both present in the surveys. The white bass 2010 gill net catch rate was down from previous surveys, but many white bass were on their spawning run and not vulnerable to our nets. Palmetto bass abundance has been steadily increasing in recent years with good body condition.

  - **Largemouth bass:** Although catch rate was below the historical average, it is still higher than other district reservoirs. Catch rate of legal sized bass (14 inches) was half what was found in 2006, but still considered good. Body condition was fair to good.

  - **Crappie:** White crappie abundance and size distribution continued to be good; about one in four adult white crappie collected were 10 inches or longer. Black crappie, which were first sampled in 2005, were sampled in much higher abundance in 2009. They have become well established at Graham and accounted for 25% of the crappie sampled.

- **Management Strategies:** Stock palmetto bass every year at a rate of 5-10/acre, depending on prey availability in order to provide a trophy species and large pelagic predator. Gill net and electrofish every other year and trap net every four years.

INTRODUCTION

This document is a summary of fisheries data collected from Graham Reservoir in 2008-2010. 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 species of fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data is presented with the 2009-2010 data for comparison.

Reservoir Description

Graham Reservoir is a 2,396-acre impoundment consisting of two distinct parts often referred to Graham-Eddleman. The Eddleman dam was completed in 1929 impounding Flint Creek. In 1958, Graham dam was constructed on the Salt Creek. The two reservoirs were connected via a canal sometime after June of 1959 creating Graham reservoir. It is located in Young County approximately two miles north of Graham and is operated and controlled by the city of Graham. The reservoir provides municipal and industrial water supply for the city of Graham and water for a steam-electric generating plant, which is on standby status and used only during peak demands. The reservoir is also used for flood control and recreation. Land use around the reservoir includes both residential and agricultural. Graham reservoir has a watershed of 221 mi^2. Mean depth is 18.5 ft. with a maximum depth of 49.1 ft. (Sullivan et al. 2003).

Habitat at time of sampling was diverse, consisting mainly of natural and rocky structure, standing timber, and emergent native aquatic plants. Water level has been within 5 feet of full pool since the last management report in 2006 (Figure 1).

Graham Reservoir was eutrophic with a mean TSI chl-*a* of 45.92 and a trend that indicated a slight decrease in algal content (Texas Commission on Environmental Quality 2008). Boat access consisted of three public boat ramps and several private boat ramps. Bank fishing access was restricted to the area around the boat ramps. A user pay crappie house is available on the Eddleman side of the reservoir. Other descriptive characteristics for Graham Reservoir are in Table 1.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Dumont and Farooqi 2006) included:

1. Continue stocking hybrid striped bass at a stocking rate of 10-15 fish/acre annually until abundance is increased to a desirable level.

    Action: Palmetto bass were stocked for 5 consecutive years at a rate of between 5-10/acre. The stocking rates did not reach the targeted rates since the reservoir was to be used in a hybrid striped bass study comparing palmetto and sunshine bass with a 7/acre stocking rate for both. Sunshine bass were never available for the study so only palmetto bass requests were filled.

2. Graham Reservoir is located closer to Wichita Falls inland fisheries district office then the Abilene office and many anglers are from the Wichita Falls area.

    Action: Transferred Graham Reservoir and all of Young County from the Abilene district office to the Wichita Falls office effective June 1, 2006.

Harvest regulation history: Sport fish in Graham Reservoir are currently managed, and have always been managed, with statewide regulations (Table 2).

Stocking history: Graham Reservoir has been stocked every year with palmetto bass since 2004, with the exception of 2009. Florida largemouth bass were introduced in 1979 and were stocked again in 1992, 1994, and 1997. The complete stocking history is in Table 3. Blue catfish were never stocked into the reservoir but began showing up in the 2002 surveys and are now well established.

Vegetation/habitat history: Graham Reservoir has no significant vegetation or habitat management history.

Water Transfer: Graham Reservoir is primarily used for municipal water supply, recreation, and to a lesser extent, flood control for the city of Graham, Texas. In 2009, 1.03 billion gallons of raw water was pumped from the reservoir. A relatively small amount of this volume is sold to the cities of Newcastle and Bryson for their municipal use. This has greatly reduced the demand on the small city lakes Newcastle and Bryson previously used resulting in better fishing at those locations. Small amounts of untreated water are also used by Graham lake lot owners for irrigation purposes. One other water use is for cooling water for a local power plant operated on the lake. While much of this water is recycled back to the reservoir, a certain amount of cooling water is lost through evaporation. No water is directly transferred to other reservoirs unless the lake elevation exceeds spillway level. In that situation, the excess water flows down the Brazos River to Possum Kingdom Reservoir.

METHODS

Fishes were collected by electrofishing (1 hour at 12 five-minute stations), gill netting (10 net nights at 10 stations), and trap netting (10 net nights at 10 stations). Catch per unit effort (CPUE) 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 per net night (fish/nn). A 12-month creel survey was conducted June 2008-May 2009. All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2009).

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 from 5 to 10 fish per inch group. Source for water level data was the United States Geological Survey (USGS) website.

RESULTS AND DISCUSSION

Habitat: A habitat survey was conducted in July 2009 (Table 4). Reservoir elevation at time of survey was 1,071.3 ft. above mean sea level Aquatic native species documented included chara *Chara spp.*, duckweed *Lemna minor*, water willow *Justicia spp.*, cattails *Typha spp.*, bulrush *Scirpus spp.*, and American lotus *Nelumbo lutea*.

Creel Survey: A creel survey was conducted from June 2008-May 2009 and the fishery generated an estimated $321,209 in direct expenditures (Table 6). Anglers fished an estimated 64,198 hours at the reservoir which is the equivalent of 26.8hr/acre (Table 6). Crappie spp. were the most sought after fish being targeted by 33.6% of the anglers (Table 5). Largemouth bass were targeted by 25.1% of anglers while *Morone* species were targeted by 13.5% of the anglers (Table 5). Bass tournaments were popular as indicated by the fact that on 19.4% of the creel days there were tournaments being held. Among all the interviews from all the creel surveys, 19.1% of the anglers interviewed were actively participating in a tournament at the time of the interview. The ratio of tournament angler caught to non-tournament angler harvested bass observed during the creel was 3.4:1. Allen et al. (2004) determined that any ratio equal to or above 3.0:1 could cause possible declines in largemouth bass size structure because of tournament mortality affecting legal size and above bass. Several summer tournaments were noted with some practicing poor fish handling techniques that resulted in directly observed mortality.

Prey species: Electrofishing catch rates of bluegill, gizzard shad, and threadfin shad were 266.0/h, 242.0/h, and 39.0/h, respectively (Appendix A). Index of vulnerability (IOV) for gizzard shad was 66% which was lower than the IOV estimates in 2005 (79%) and 2006 (71%; Figure 2). Total CPUE of gizzard shad (242.0/h) was similar to 2006 (240.0/h) and near the historical average of 263.4/h. Total CPUE of bluegill (Figure 3) in 2009 (266.0/h) was also nearly the same as in 2006 (281.0/h) and near the historical average of 256.9/h. Bluegill size structure has shifted slightly from a population dominated by 2-5 inch fish in 2006 to one dominated by 3-6 inch fish. Threadfin shad abundance could decline if the power plant continues to function on a standby basis, especially during cold winters. The redear sunfish population has continued to increase in abundance going from a catch rate of 29.0/h in 2005 to 45.0/h in 2006 to 89.0/h in 2009 (Figure 4). Larger individuals (6-8 inches) are more abundant and during the 2008-09 creel survey, directed effort and harvest was observed. The redear fishery could become more important in the future.

Blue catfish: Blue catfish were first collected in Graham Reservoir in 2002 when 11 fish were collected in 15 gill nets, ranging in length from 8 to 20 inches. Blue catfish abundance continued to increase in 2006 (3.2/nn), 2008 (7.0/nn) and in 2010 when CPUE increased to 8.0 fish/nn with a sampled length range from 5 to 25 inches (Figure 5). Body condition of blue catfish was acceptable in 2010 as the average relative weight of 12.0- to 19.9-inch blue catfish was 89 (N = 25). It appears that blue catfish are thriving in Graham Reservoir.

Channel catfish: The gill net catch rate of channel catfish was 2.3/nn in 2010, a slight increase over 2008 (2.2/nn) and 2006 (2.0/nn; Figure 7). Fish length ranged from 5 to 21 inches (Figure 7). Average Wr for channel catfish, 11.0 to 16.9 inches long, was 95 in 2010 and 99 in 2006 indicating good body condition and adequate forage for these fish. Channel catfish were harvested five times more often than blue catfish during the creel survey (Tables 7-8).

White bass: The gill net catch rate of white bass was 2.2/nn in 2010, compared to 4.8/nn in 2008 and 5.6/nn in 2006 (Figure 9). In the 2006, 2008, and 2010 surveys, average Wr for white bass, 10.0 to 14.9 inches long, has remained steady ranging from 100 to 104. Size structure of white bass declined in terms of legal fish in 2010. PSD was 96 in 2006, 95 in 2008 and down to 59 in 2010 (Figure 9). Other reservoirs have shown a decline in catch rate and size structure as palmetto bass have increased in number and size – a likely result of interspecific competition. Still white bass were the second most harvested species at Graham during the creel survey (Table 5).

Palmetto bass: The gill net catch rate of palmetto bass increased from 0.7/nn in 2008 to 1.0/nn in 2010 (Figure 11). The overall body condition as measured by relative weight continued to improve over the last three surveys and ranged from 94 – 111 for the inch groups sampled, which is excellent (Table 10). This continued improvement in size structure and body condition supports an increased stocking rate in the future. On the negative side over 27% of the observed palmetto bass harvested were below legal size (Figure 12).

Largemouth bass: The electrofishing catch rate of stock-length largemouth bass ($\geq$ 8 inches) was 78.0/h in 2009, considerably lower than the 2006 catch rate (122.0/h) but much higher than the 2005 rate of 27.0/h (Figure 13). Size structure continues to be excellent with a 2009 PSD of 45. Historically, PSD has ranged from 32 to 51. However, the number of legal sized bass sampled was half of what it was in 2006. Growth of largemouth bass in Graham Reservoir has historically been above the regional average for age 1 and age 2 fish; but performing a type I age and growth analysis on bass electrofished in 2009 found average growth in these age classes (Table 14). Largemouth bass attain legal size by age 3. Florida largemouth bass influence was exclusively limited to second generation, or higher, hybrids between northern and Florida strains as 97% of the bass tested were F1 or Fx with similar results in 2006 (93%) (Table 13). Florida alleles were 46% in both 2006 and 2009 (Table 13). Mean Wr among inch classes ranged from 78 to 92 and have shown a slight decline for most inch groups since the 2001 survey (Table 15). Largemouth bass had the second highest percentage (25.1%) of directed effort relative to other species during the 12-month creel survey (Table 5).

White crappie: The trap net catch rate of white crappie was 4.7/nn in 2009, lower than in 2005 (10.0/nn) but higher than 2001 (3.7/nn; Figure 15). However, the PSD was 70, which was higher and more desirable than the PSD in 2005 (63). The percentage of legal-size fish has remained high ranging from 34% in 2001; 20% in 2005 and 30% in 2009. Growth of white crappie has typically been good with an average age of 1.8 for the length range 9.0 to 10.9 inches (Table 19). Body condition for stock-quality,

quality-preferred, and preferred and greater size white crappie were all were all considered good and in the 92-94 range (Table 18). Crappie spp. had the highest directed effort at 33.6% by anglers during the creel survey (Table 5).

Black crappie: A single 10-inch black crappie was sampled in 2005, the first documented observation of this species on record. In 2006, during a crappie capture study 20 black crappie between 7-9 inches were sampled. In 2009, we had a catch rate of 1.6/nn (Figure 16). Body condition as measured by Wr for all inch groups was above 90. However, only one black crappie was above the legal length limit of 10-inches.

Fisheries management plan for Graham Reservoir, Texas

Prepared – July 2010

ISSUE 1 Palmetto bass have been increasing in size and number at Graham Reservoir. The body condition as measured by relative weight has been excellent in the last two surveys. Past stocking rates have been conservative and none were stocked in 2009 or 2010. It now appears that stocking frequency could be increased to further enhance the fishery.

MANAGEMENT STRATEGIES

1. Stock palmetto bass at a rate of 5-10 fish/acre every year depending on prey availability.
2. Monitor with gill nets every other year to insure continued good growth and body condition.

ISSUE 2 Over 27% of the observed harvest for palmetto bass was comprised of fish below the legal size limit of 18 inches. This amount of illegal harvest could compromise planned enhancements of the fishery.

MANAGEMENT STRATEGIES

1. Post enhanced signage at public boat ramps, bait shops and fishing docks that details the difference between palmetto and white bass.
2. Communicate directly with area game wardens about this problem in order to enhance enforcement and public education.

ISSUE 3 Largemouth bass relative abundance has declined and the IOV for gizzard shad has also decreased. One possible reason for the largemouth bass decline is from tournament induced mortality.

MANAGEMENT STRATEGY

Continue to monitor largemouth bass and shad populations more frequently by conducting electrofishing surveys every other year. This enhanced monitoring is expected to provide further evidence that may lead to more intensive management actions in the future. Additionally, work directly with tournament angler groups on methods for enhancing fish survival from tournaments. The city of Graham has a tournament permit requirement already established that has not been administered in recent years. Some future thought may be given to reinstituting this if necessary after consultation with city management.

ISSUE 4 Increased boat ramp demands from bass tournaments and enhanced recreational activities have created congestion at launch facilities and frustrated anglers.

MANAGEMENT STRATEGY

Consult with City of Graham leaders and make them more fully aware of the 75% cost-share grants for boat ramp improvement and construction administered by TPWD. Specific improvements could include converting the old single lane ramp on the Eddleman side to a new double lane ramp. Further improvements could also include a T-shaped courtesy dock and parking lot improvements for boat trailers.

ISSUE 5: 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 their customers.
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.

SAMPLING SCHEDULE JUSTIFICATION:

The proposed sampling schedule includes standard monitoring in 2013/2014. Additional gill netting will occur in 2012 to monitor palmetto bass populations and additional electrofishing will occur in 2011 to examine largemouth bass and shad populations (Table 21).

LITERATURE CITED

Allen, M. S., M. W. Rogers, R. A. Myers, and W. M. Bivin. 2004. Simulated impacts of tournament-associated mortality on largemouth bass populations. North American Journal of Fisheries Management 24:1252-1261.

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.

Dumont, S., and M. Farooqi. 2006. Statewide freshwater fisheries monitoring and management program survey report for Graham Reservoir, 2005. Texas Parks and Wildlife Department, Federal Aid Report F-30-R, Austin.

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.

Sullivan, S., D. Thomas, W. Elliott, P. Hayes, and M. Sansom. 2003. Volumetric survey of Lake Graham. Texas Water Development Board. Austin.

Texas Commission on Environmental Quality. 2008. Trophic classification of Texas reservoirs; 2008 water quality inventory and 303(d) list (March 19, 2008). 15 pp.

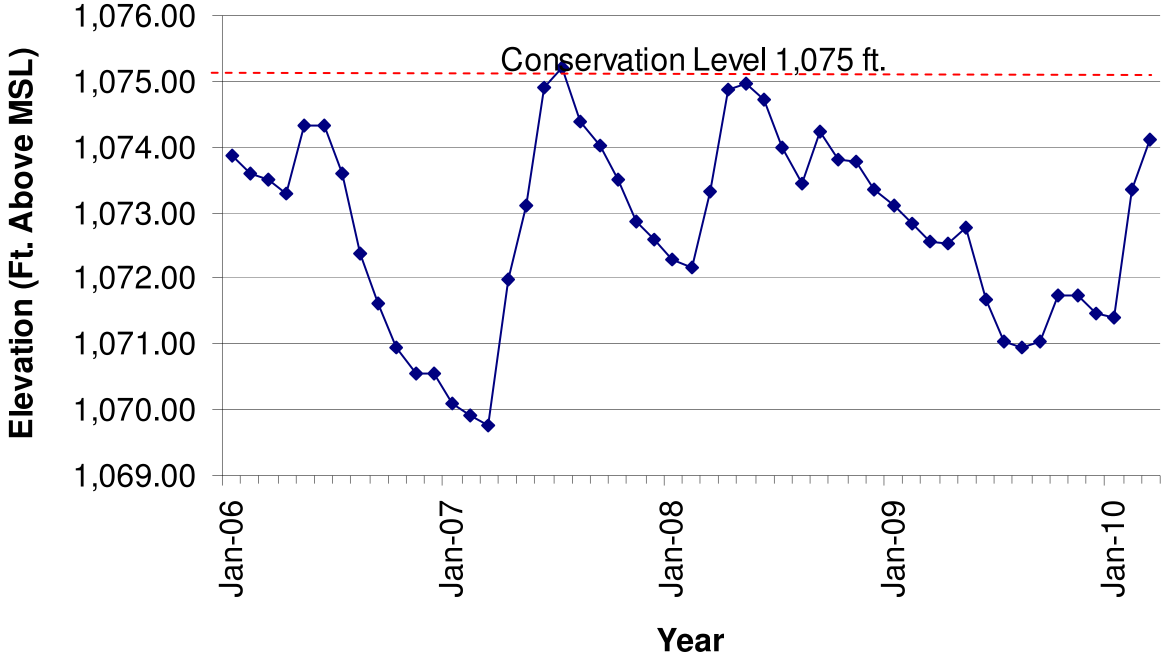


Figure 1. Monthly water level elevations in feet above mean sea level (MSL) recorded for Graham Reservoir, Texas.

Table 1. Characteristics of Graham Reservoir, Texas.

Characteristic	Description
Year Constructed	1929
Controlling authority	City of Graham
Counties	Young
Reservoir type	Main stream
Shoreline Development Index (SDI)	3.25
Conductivity	512 µmhos/cm

Table 2. Harvest regulations for Graham Reservoir.

Species	Bag Limit	Minimum-Maximum Length (inches)
Catfish: channel and blue catfish, their hybrids and subspecies	25 (in any combination)	12 - No Limit
Catfish, Flathead	5	18 - No Limit
Bass, White	25	10 - No Limit
Bass, Palmetto	5	18 - No Limit
Bass: largemouth	5	14 – No Limit
Crappie: white and black crappie, their hybrids and subspecies	25 (in any combination)	10 - No Limit

Table 3. Stocking history of Graham, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL) 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)**
Channel catfish	1970	50,000	AFGL	7.9
	Total	50,000		
Florida Largemouth bass	1979	50,022	FRY	1.0
	1992	151,869	FRY	1.0
	1994	150,217	FGL	1.3
	1997	151,247	FGL	1.5
	Total	503,355		
Largemouth bass	1966	303,000	FRY	0.7
	1967	60,000	UNK	UNK
	1969	10,000	UNK	UNK
	1970	50,000	UNK	UNK
	1971	4,000	UNK	UNK
	Total	427,000		
Palmetto Bass (striped X white bass hybrid)	1979	100,000	UNK	UNK
	1981	100,000	UNK	UNK
	1983	148,500	UNK	UNK
	1985	60,600	FGL	2.0
	1986	59,900	FRY	1.0
	1987	59,900	FRY	1.0
	1988	60,868	FRY	1.0
	1989	69,426	FGL	1.2
	1991	56,235	FGL	1.3
	1992	25,415	FGL	1.3
	1994	46,350	FGL	1.5
	1995	52,277	FGL	1.5
	1996	45,334	FGL	1.7
	1997	30,974	FGL	1.7
	1998	30,536	FGL	1.4
	1999	22,655	FGL	1.4
	2002	15,050	FGL	1.8
	2004	16,816	FGL	1.5
	2005	12,867	FGL	1.6
	2006	12,000	FGL	1.7
	2007	24,001	FGL	1.4
	2008	17,272	FGL	1.4
	Total	1,066,976		

Table 4. Survey of littoral zone and physical habitat types for Graham Reservoir, Texas in July 2009. 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 offshore habitat type identified.

Shoreline habitat type	Shoreline Distance		Surface Area	
	Miles	Percent of total	Acres	Percent of reservoir surface area
Bulkhead	0.4	1.1		
Natural	20.8	58.3		
Rocky shore	14.5	40.6		
Total shoreline length	35.7			
Habitat adjacent to shoreline				
Standing timber			354.0	14.8
Boat docks			13.2	0.6
Flooded terrestrial			2.5	0.1
Native emergent vegetation			59.3	2.5
Native floating vegetation			58.6	2.4

Table 5. Percent directed angler effort by species, percent harvest and catch for all anglers for Graham Reservoir, Texas, from June 2008 through May 2009
.

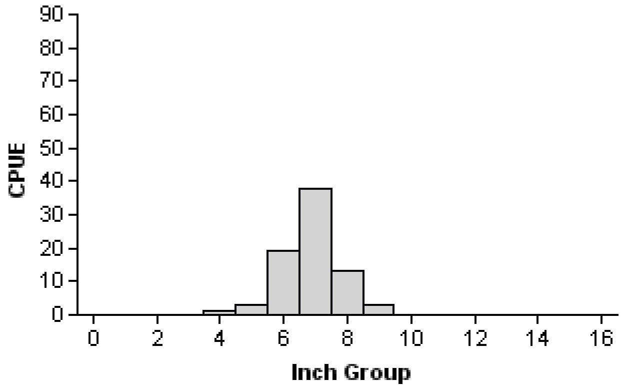
Species	Percent directed effort	Percent harvest all anglers	Percent catch all anglers
Blue catfish	0.2	0.3	0.7
Channel catfish	1.8	2.4	2.4
Flathead catfish	0.3	0.3	0.1
Catfish spp.	6.7		0.9
White bass	7.6	26.8	27.2
Palmetto bass	2.1	5.2	3.6
Temperate bass spp.	3.8		
Bluegill		2.8	0.7
Longear sunfish		0.2	0.0
Redear sunfish	0.9	0.7	0.1
Sunfish spp.	0.0	0.1	1.9
Largemouth bass	25.1	7.8	13.2
White crappie		48.6	36.3
Black crappie		3.9	0.9
Crappie spp.	33.6		11.0
Freshwater drum			1.0
Anything	18.0		

Table 6. Total fishing effort (h) for all species and total directed expenditures at Graham Reservoir from June 2008 through May 2009.

Creel Survey Statistic	
Total fishing effort (h)	64,197.9
Total directed expenditures	$321,209

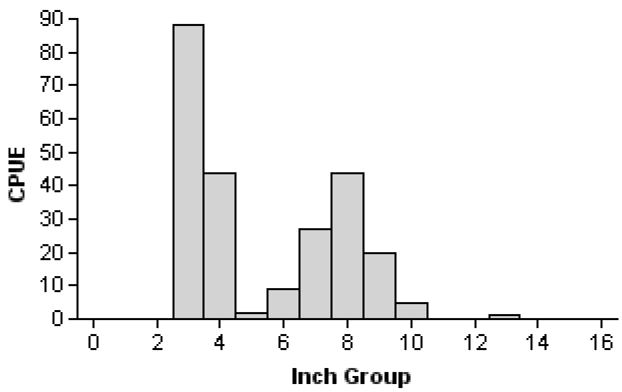
Gizzard Shad

2005



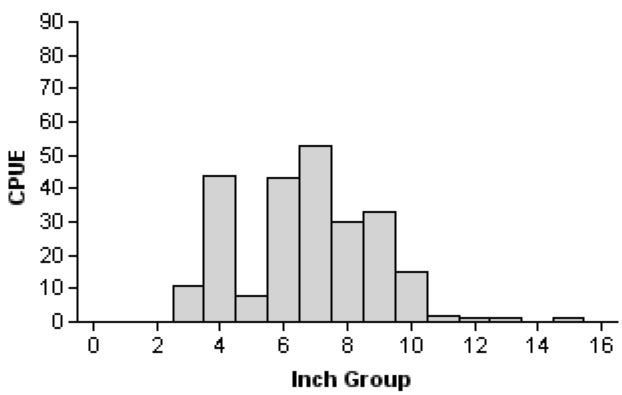
Effort = 1.0
Total CPUE = 77.0 (23; 77)
Stock CPUE = 54.0 (26; 54)
PSD = 0 (54)
IOV = 79.22 (3.6)

2006



Effort = 1.0
Total CPUE = 240.0 (37; 240)
Stock CPUE = 97.0 (45; 97)
PSD = 1 (1.1)
IOV = 70.83 (10.9)

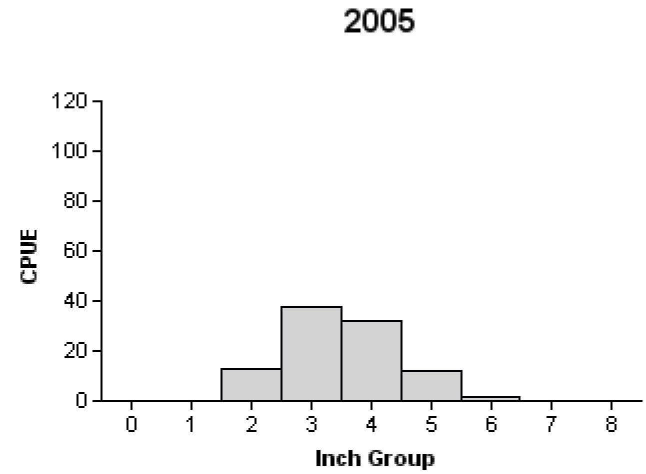
2009



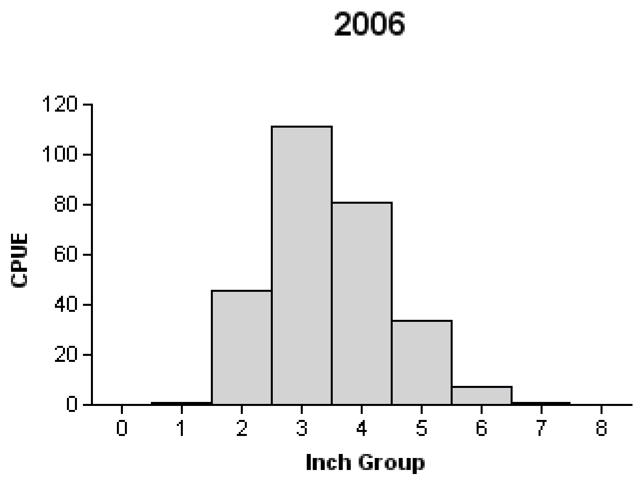
Effort = 1.0
Total CPUE = 242.0 (19; 242)
Stock CPUE = 136.0 (25; 136)
PSD = 4 (1.9)
IOV = 65.7 (4.2)

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, Graham Reservoir, Texas, 2005, 2006, and 2009.

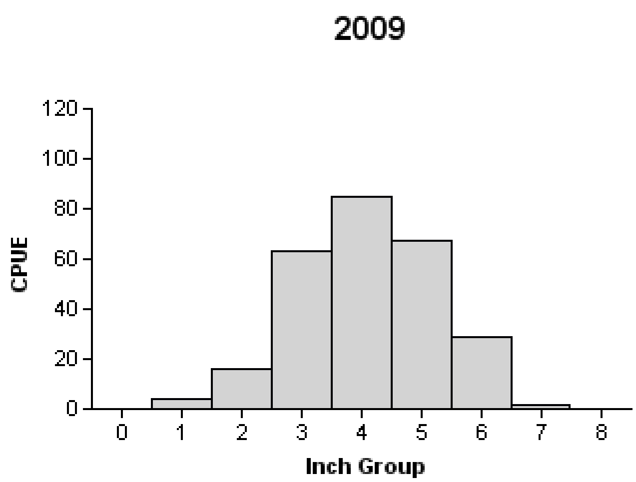
Bluegill



Effort = 1.0
Total CPUE = 97.0 (17; 97)
Stock CPUE = 84.0 (14; 84)
PSD = 2 (1.5)
PSD-P = 0 (0)



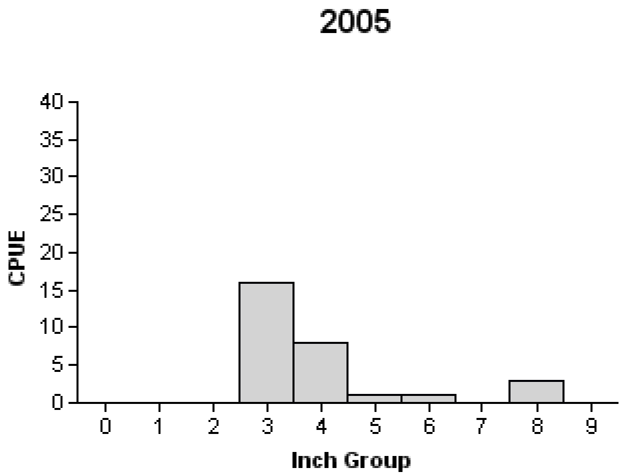
Effort = 1.0
Total CPUE = 281.0 (23; 281)
Stock CPUE = 234.0 (27; 234)
PSD = 3 (1.1)
PSD-P = 0 (0)



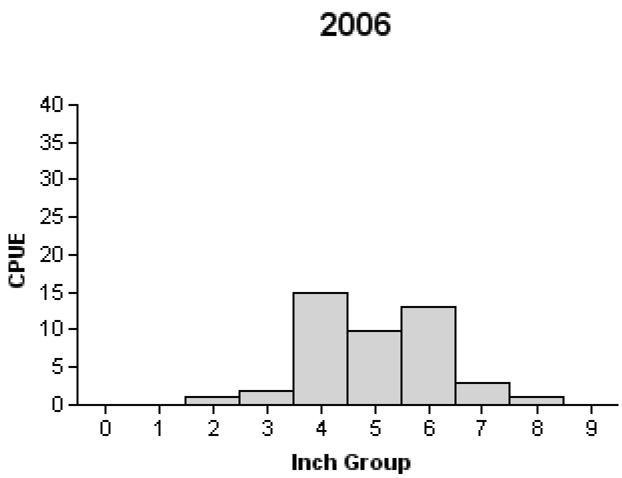
Effort = 1.0
Total CPUE = 266.0 (23; 266)
Stock CPUE = 246.0 (23; 246)
PSD = 13 (7.4)
PSD-P = 0 (0)

Figure 3. Number of bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Graham Reservoir, Texas, 2005, 2006, and 2009.

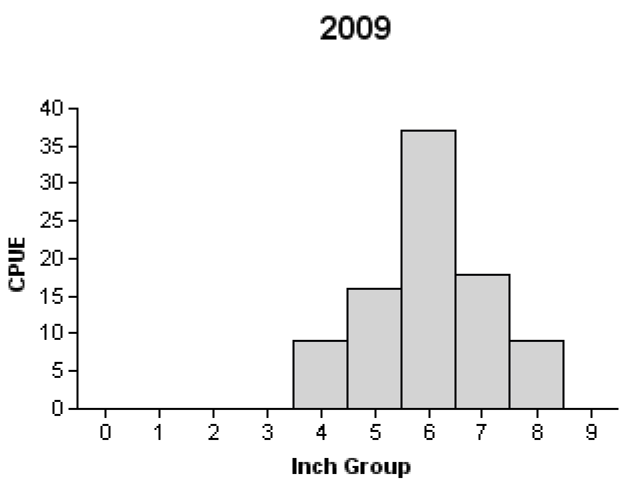
Redear Sunfish



Effort = 1.0
Total CPUE = 29.0 (27; 29)
Stock CPUE = 13.0 (27; 13)
PSD = 23 (15.2)
PSD-P = 0 (0)



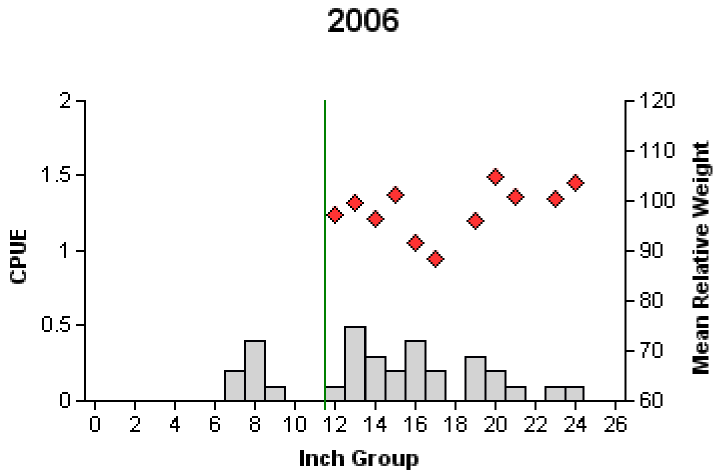
Effort = 1.0
Total CPUE = 45.0 (22; 45)
Stock CPUE = 42.0 (22; 42)
PSD = 10 (4.5)
PSD-P = 0 (0)



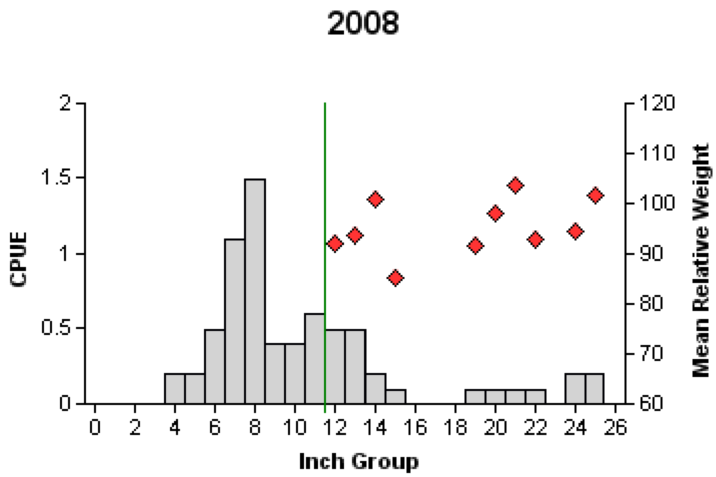
Effort = 1.0
Total CPUE = 89.0 (17; 89)
Stock CPUE = 89.0 (17; 89)
PSD = 30 (9.7)
PSD-P = 0 (0)

Figure 4. Number of redear sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Graham Reservoir, Texas, 2005, 2006, and 2009.

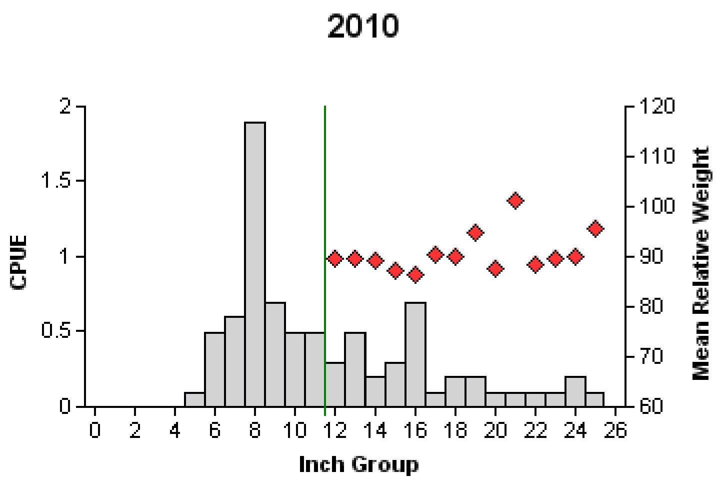
Blue Catfish



Effort = 10.0
Total CPUE = 3.2 (47; 32)
Stock CPUE = 2.5 (45; 25)
PSD = 20 (12.2)
PSD-P = 0 (0)



Effort = 10.0
Total CPUE = 7.0 (20; 70)
Stock CPUE = 2.1 (21; 21)
PSD = 33 (9.7)
PSD-P = 0 (0)



Effort = 10.0
Total CPUE = 8.0 (19; 80)
Stock CPUE = 3.2 (21; 32)
PSD = 22 (2.9)
PSD-P = 0 (0)

Figure 5. Number of blue catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Graham Reservoir, Texas, 2006, 2008, and 2010.

Blue Catfish

Table 7. Creel survey statistics for blue catfish at Graham Reservoir from June 2008 through May 2009, 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	
Directed effort (h)	151.8 (145.5)
Directed effort/acre	0.1 (145.5)
Total catch per hour	0.0
Total harvest	137.9 (347.4)
Harvest/acre	0.1 (347.4)

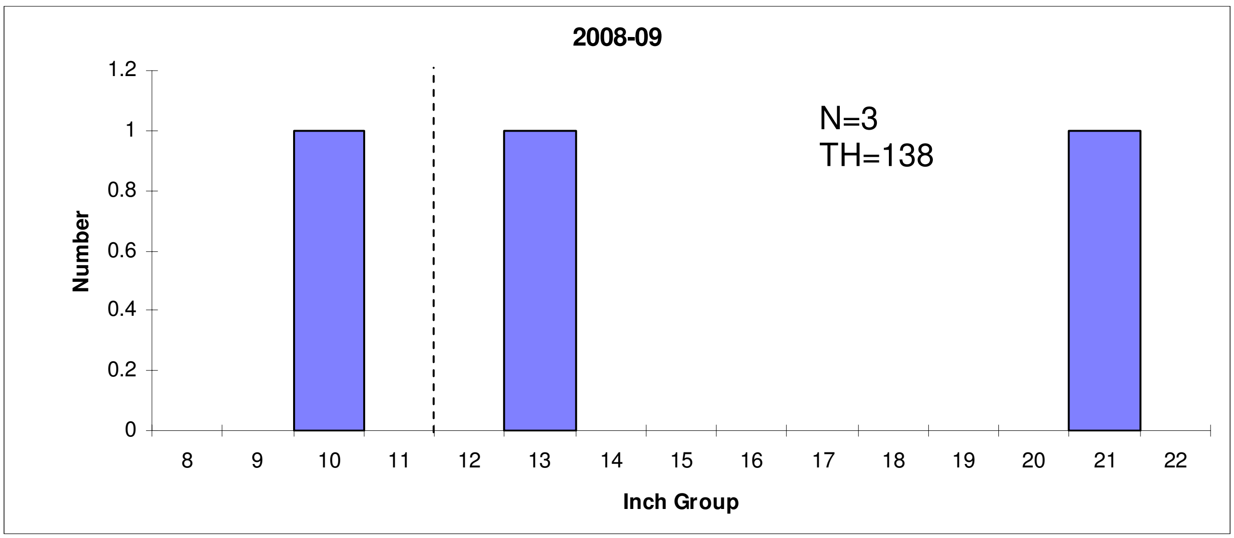
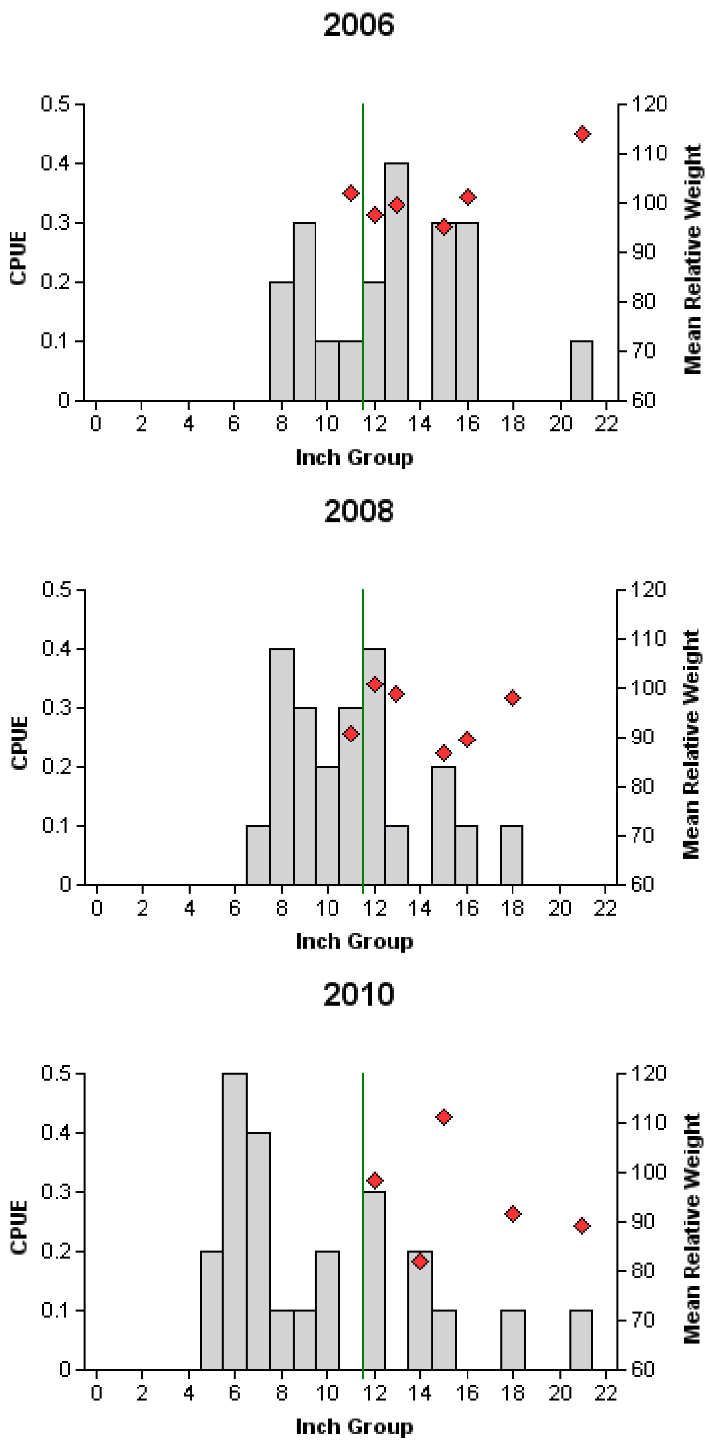


Figure 6. Length frequency of harvested blue catfish observed during creel surveys at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

Channel Catfish



2006

Effort = 10.0
Total CPUE = 2.0 (36; 20)
Stock CPUE = 1.4 (28; 14)
PSD = 29 (10.6)
PSD-P = 0 (0)

2008

Effort = 10.0
Total CPUE = 2.2 (25; 22)
Stock CPUE = 1.2 (35; 12)
PSD = 17 (9.3)
PSD-P = 0 (0)

2010

Effort = 10.0
Total CPUE = 2.3 (58; 23)
Stock CPUE = 0.8 (74; 8)
PSD = 25 (12.3)
PSD-P = 0 (0)

Figure 7. Number of channel catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Graham Reservoir, Texas, 2006, 2008, and 2010.

Channel Catfish

Table 8. Creel survey statistics for channel catfish at Graham Reservoir from June 2008 through May 2009, where total catch per hour is for anglers targeting channel 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	
Directed effort (h)	1,157.5 (49.2)
Directed effort/acre	0.5 (49.2)
Total catch per hour	1.1 (113.1)
Total harvest	948.7 (86.8)
Harvest/acre	0.4 (86.8)

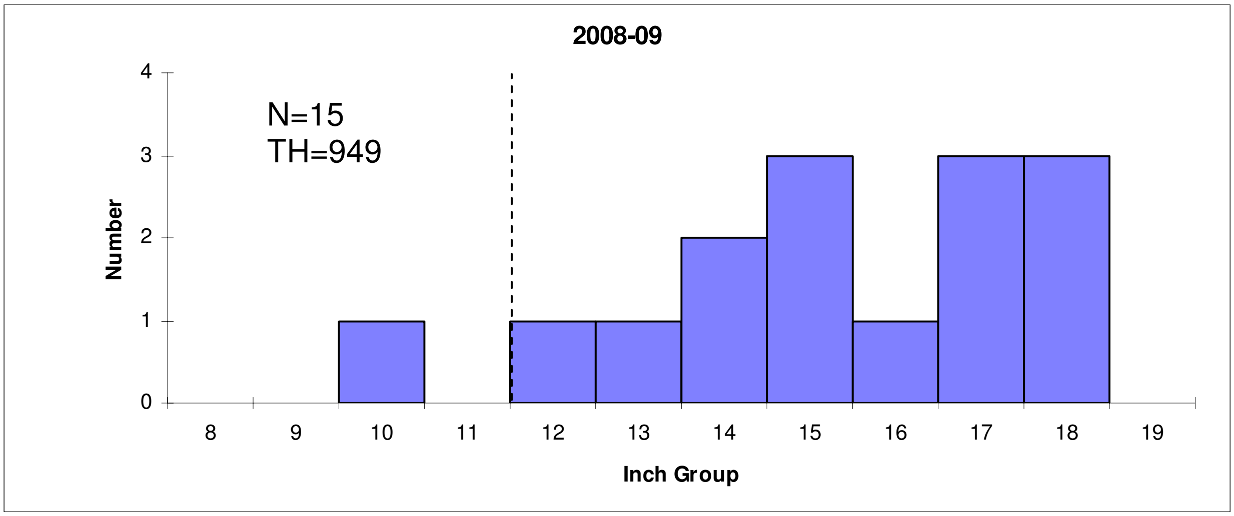
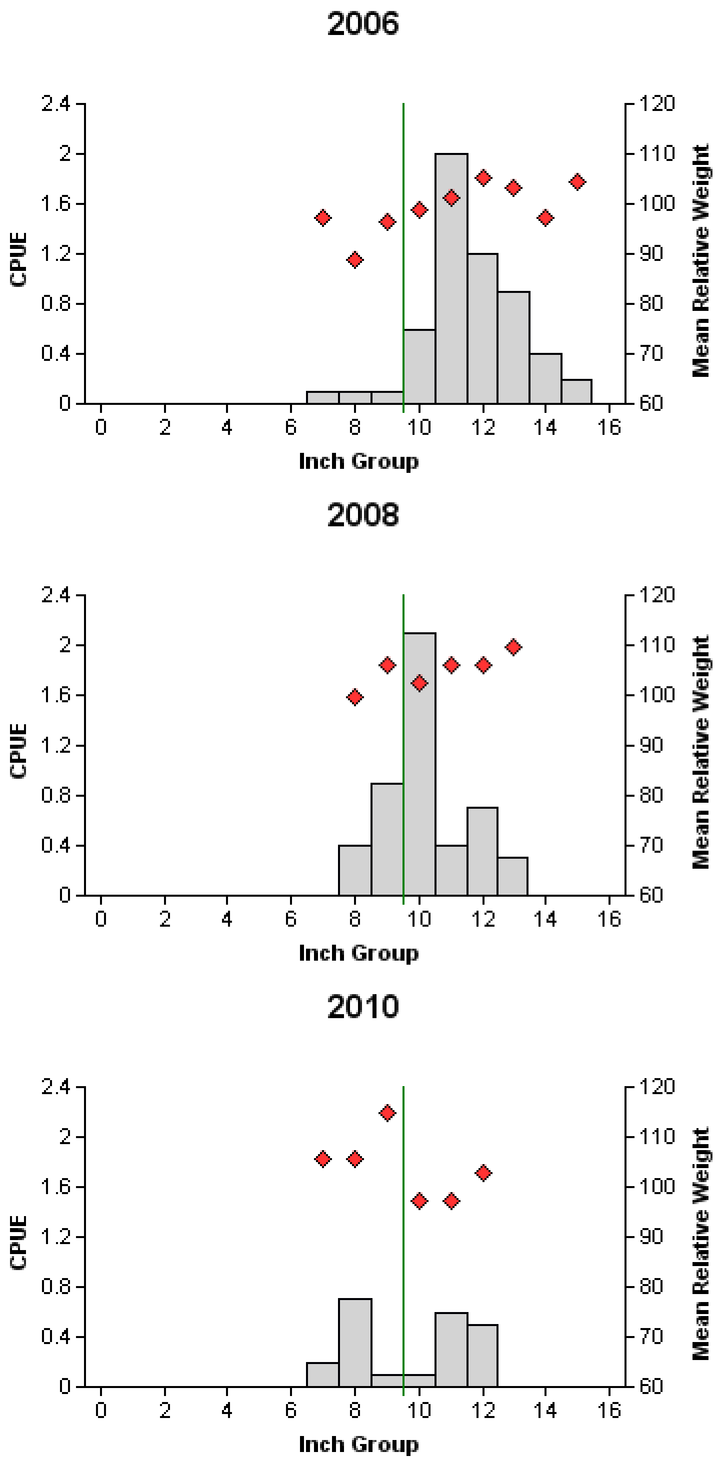


Figure 8. Length frequency of harvested channel catfish observed during creel surveys at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested channel catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

White Bass



2006

Effort = 10.0
Total CPUE = 5.6 (35; 56)
Stock CPUE = 5.6 (38; 56)
PSD = 96 (2.2)
PSD-P = 0 (0)

2008

Effort = 10.0
Total CPUE = 4.8 (56; 48)
Stock CPUE = 4.8 (45; 48)
PSD = 92 (5.3)
PSD-P = 0 (0)

2010

Effort = 10.0
Total CPUE = 2.2 (52; 22)
Stock CPUE = 2.2 (45; 22)
PSD = 59 (7)
PSD-P = 0 (0)

Figure 9. Number of white bass caught per net night (CPUE) and population indices (RSE and N are in parentheses) for spring gill net surveys, Graham Reservoir, Texas, 2006, 2008, and 2010.

White Bass

Table 9. Creel survey statistics for white bass at Graham Reservoir from June 2008 through May 2009, 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	
Directed effort (h)	4,853.0 (25.1)
Directed effort/acre	2.0 (25.1)
Total catch per hour	2.6 (26.1)
Total harvest	10,688.5 (30.4)
Harvest/acre	4.5 (30.4)

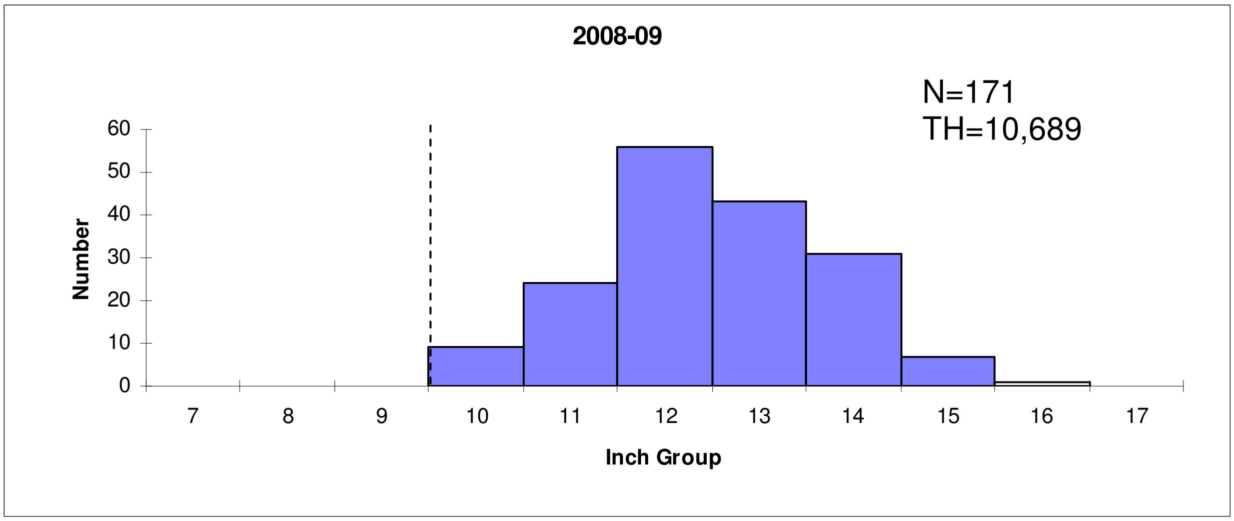
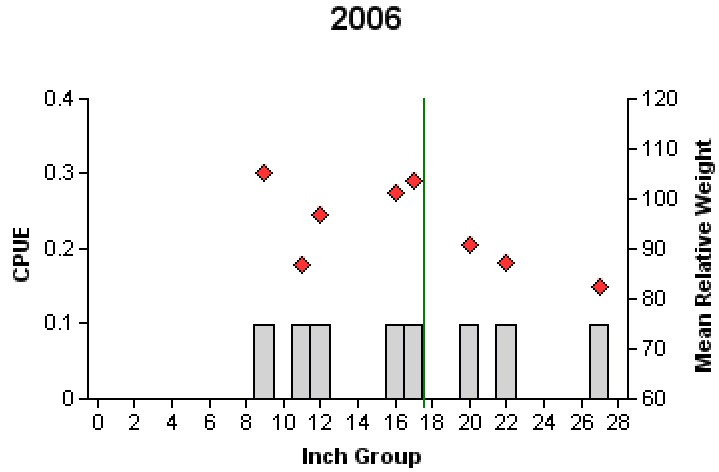
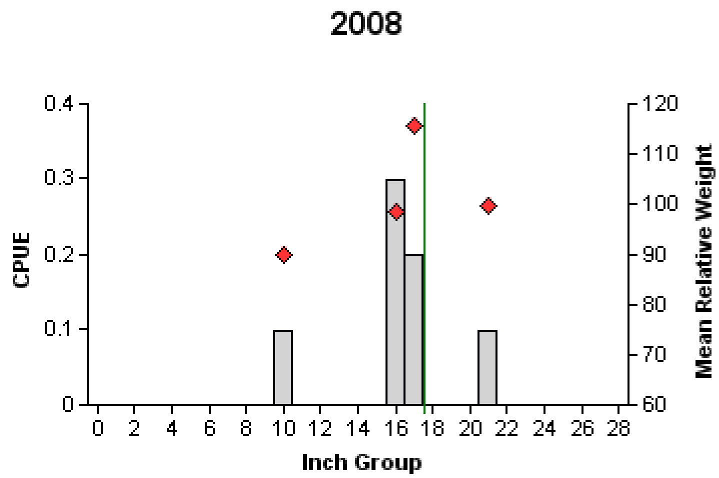


Figure 10. Length frequency of harvested white bass observed during creel surveys at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

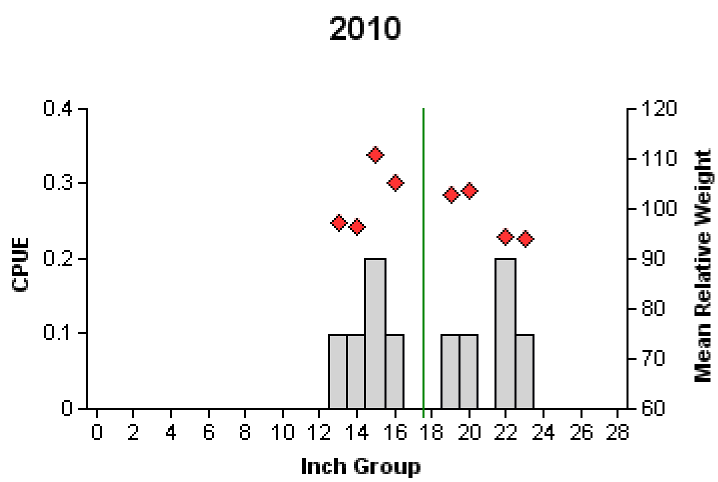
Palmetto Bass



Effort = 10.0
Total CPUE = 0.8 (45; 8)
Stock CPUE = 0.8 (51; 8)
PSD = 75 (14)
PSD-P = 0 (0)



Effort = 10.0
Total CPUE = 0.7 (48; 7)
Stock CPUE = 0.7 (57; 7)
PSD = 86 (15.2)
PSD-P = 0 (0)



Effort = 10.0
Total CPUE = 1.0 (37; 10)
Stock CPUE = 1.0 (37; 10)
PSD = 100 (0)
PSD-P = 0 (0)

Figure 11. Number of palmetto bass caught per net night (CPUE) and population indices (RSE and N are in parentheses) for spring gill net surveys, Graham Reservoir, Texas, 2006, 2008, and 2010.

Palmetto Bass

Table 10. Mean relative weight and sample size (N) of palmetto bass in size-classes (in) collected from spring gill net surveys, Graham Reservoir, Texas, 1997, 2002, 2006, 2008 and 2010.

	Mean relative weight and number (N) in size-classes (in)	
Year	15.0 – 17.9	18.0 – 25.9
1997	85 (N = 12)	81 (N = 29)
2002	82 (N = 17)	78 (N = 9)
2006	89 (N = 3)	89 (N = 2)
2008	105 (N = 5)	99 (N = 1)
2010	109 (N = 3)	98 (N = 5)

Table 11. Mean length at age of capture for palmetto bass (sexes combined) collected during spring gill netting surveys, Graham Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	1	2	3	4	5	6	7	8
1994		15.8(10)	19.0(15)		20.1(1)			
1997	10.8(15)	14.9(14)	17.6(17)	18.5(1)	21.5(1)	24.9(2)		
2002			17.6(14)	18.6(7)	20.2(6)	20.1(6)	19.2(2)	20.9(6)
2008	10.4(1)	17.1(4)	21.4(1)					
Averages[a]	13.2	17.1	20.1	22.4	24.3	25.8	26.9	27.8

[a]Ecological averages from Prentice (1987); lengths derived for April 1.

Palmetto Bass

Table 12. Creel survey statistics for palmetto bass at Graham Reservoir from June 2008 through May 2009, where total catch per hour is for anglers targeting palmetto bass and total harvest is the estimated number of palmetto bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	
Directed effort (h)	1,375.0 (42.2)
Directed effort/acre	0.6 (42.2)
Total catch per hour	0.4 (80.2)
Total harvest	2,091.3 (74.5)
Harvest/acre	0.9 (74.5)

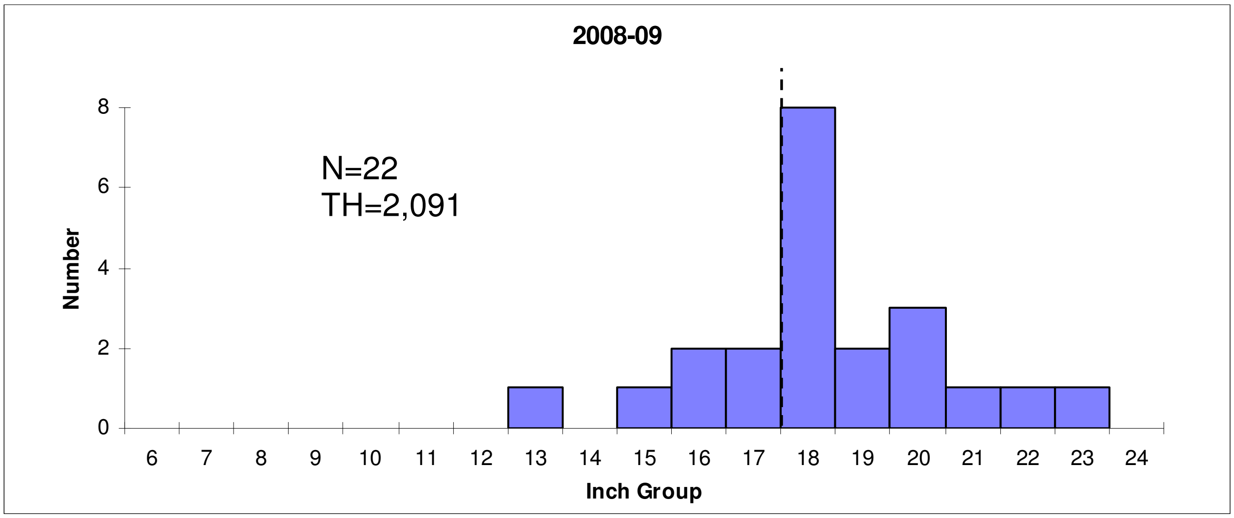
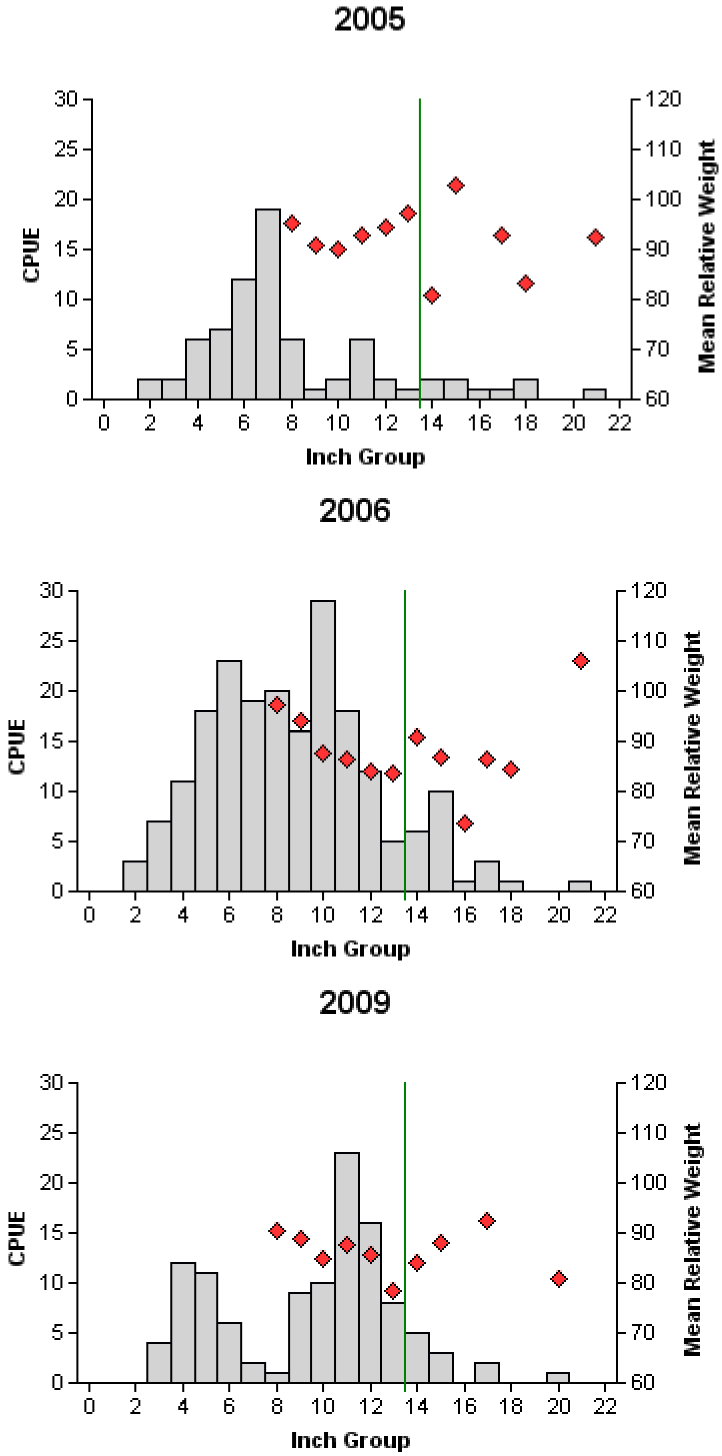


Figure 12. Length frequency of harvested palmetto bass observed during creel surveys at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested palmetto bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

Largemouth Bass



2005

Effort =	1.0
Total CPUE =	75.0 (18; 75)
Stock CPUE =	27.0 (14; 27)
PSD =	44 (8.7)
PSD-14 =	33 (6.8)

2006

Effort =	1.0
Total CPUE =	203.0 (17; 203)
Stock CPUE =	122.0 (20; 122)
PSD =	32 (3)
PSD-14 =	18 (3.9)

2009

Effort =	1.0
Total CPUE =	113.0 (17; 113)
Stock CPUE =	78.0 (19; 78)
PSD =	45 (6)
PSD-14 =	14 (3.7)

Figure 13. 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, Graham Reservoir, Texas, 2005, 2006, and 2009.

Largemouth Bass

Table 13. Results of genetic analysis of largemouth bass collected by fall electrofishing, Graham Reservoir, Texas, 1994, 1997, 2001, 2005, 2006, and 2009. 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
1994	33	0	19	14	22.7	0.0
1997	30	1	12	17	18.3	3.3
2001	28	1	20	7	37.1	3.6
2005	34	0	26	8	30.7	0.0
2006	30	0	28	2	46.0	0.0
2009	30	0	29	1	46.0	0.0

Table 14. Mean length at age of capture for largemouth bass (sexes combined) collected during October electrofishing surveys, Graham Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	1	2	3	4	5
1994	10.6(24)	12.4(23)	14.0(7)		
1997	10.1(13)	12.6(11)	14.6(10)	13.5(1)	
2001	10.8(15)	13.5(12)	14.3(3)	15.9(3)	16.4(1)
2009	9.8(11)	12.2(15)	15.2(6)	14.8(3)	14.6(1)
Averages[a]	9.9	12.8	15.0	16.8	18.2

[a]Ecological averages from Prentice (1987); lengths derived for October 1.

Table 15. Mean relative weight and sample size (N) of largemouth bass in size-classes (in) collected from fall electrofishing surveys, Graham Reservoir, Texas, 1997, 2001, 2005, 2006 and 2009.

	Mean relative weight and number (N) in size-classes (in)		
Year	8.0 – 11.9	12.0 – 14.9	≥ 15.0
1997	94 (N = 71)	83 (N = 40)	93 (N = 16)
2001	95 (N = 49)	92 (N = 45)	94 (N = 8)
2005	93 (N = 15)	89 (N = 5)	93 (N = 6)
2006	91 (N = 83)	86 (N = 23)	87 (N = 16)
2009	85 (N = 43)	83 (N = 29)	88 (N = 6)

Table 16. Largemouth bass statistics for known tournaments at Graham Reservoir, Texas in 2007, 2008, 2009 and 2010. 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	37 (N = 16)	15.06 (N = 16)	6.02 (N = 16)	2.41 (N = 16)	1.43
2008	44 (N = 11)	9.17 (N = 10)	4.92 (N = 9)	2.15 (N = 10)	0.70
2009	32 (N = 8)	10.22 (N = 8)	5.03 (N = 9)	1.62 (N = 6)	0.94
2010	20 (N = 5)	4.99 (N = 5)	3.62 (N = 5)	1.75 (N = 5)	0.35

Largemouth Bass

Table 17. Creel survey statistics for largemouth bass at Graham Reservoir from June 2008 through May 2009, 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	
Directed effort (h)	16,101.1 (26.2)
Directed effort/acre	6.7 (26.2)
Total catch per hour	0.7 (24.7)
Total harvest	3,104.1 (41.7)
Harvest/acre	1.3 (41.7)

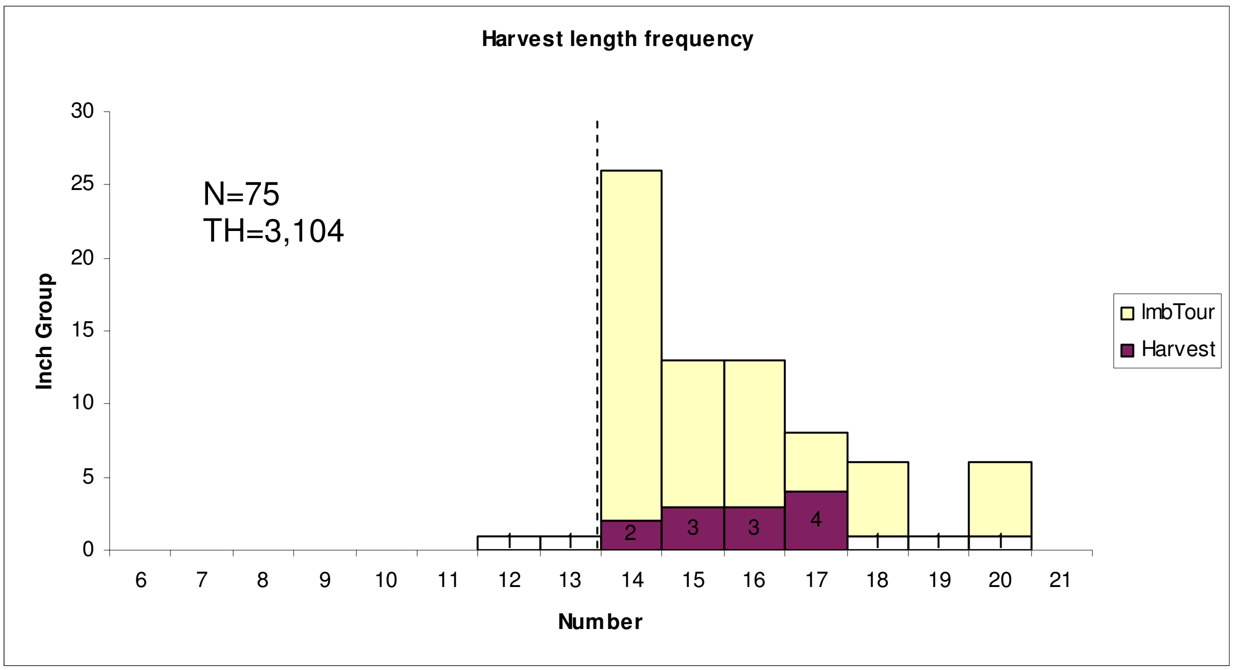
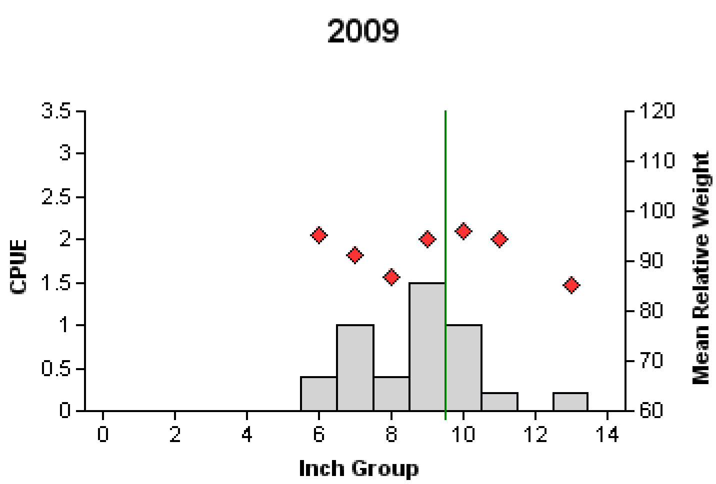


Figure 14. Length frequency of harvested largemouth bass observed during creel surveys at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Harvest is the number of largemouth bass actually harvested while lmb tour are the number of bass recorded as harvested during bass tournaments that will be released after the events. Dash line indicates minimum size limit at time of sampling.

White Crappie

Effort = 19.0
Total CPUE = 3.7 (21; 71)
Stock CPUE = 3.3 (22; 63)
PSD = 89 (5.6)
PSD-10 = 38 (8.4)

Effort = 5.0
Total CPUE = 10.0 (16; 50)
Stock CPUE = 9.2 (17; 46)
PSD = 63 (5.6)
PSD-10 = 22 (6.5)



Effort = 10.0
Total CPUE = 4.7 (45; 47)
Stock CPUE = 4.7 (45; 47)
PSD = 70 (7.3)
PSD-10 = 30 (7)

Figure 15. 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, Graham Reservoir, Texas, 2001, 2005, and 2009.

White Crappie

Table 18. Mean relative weight and sample size (N) of white crappie in size-classes (in) collected from fall trap netting surveys, Graham Reservoir, Texas, 1994, 1997, 2001, and 2009.

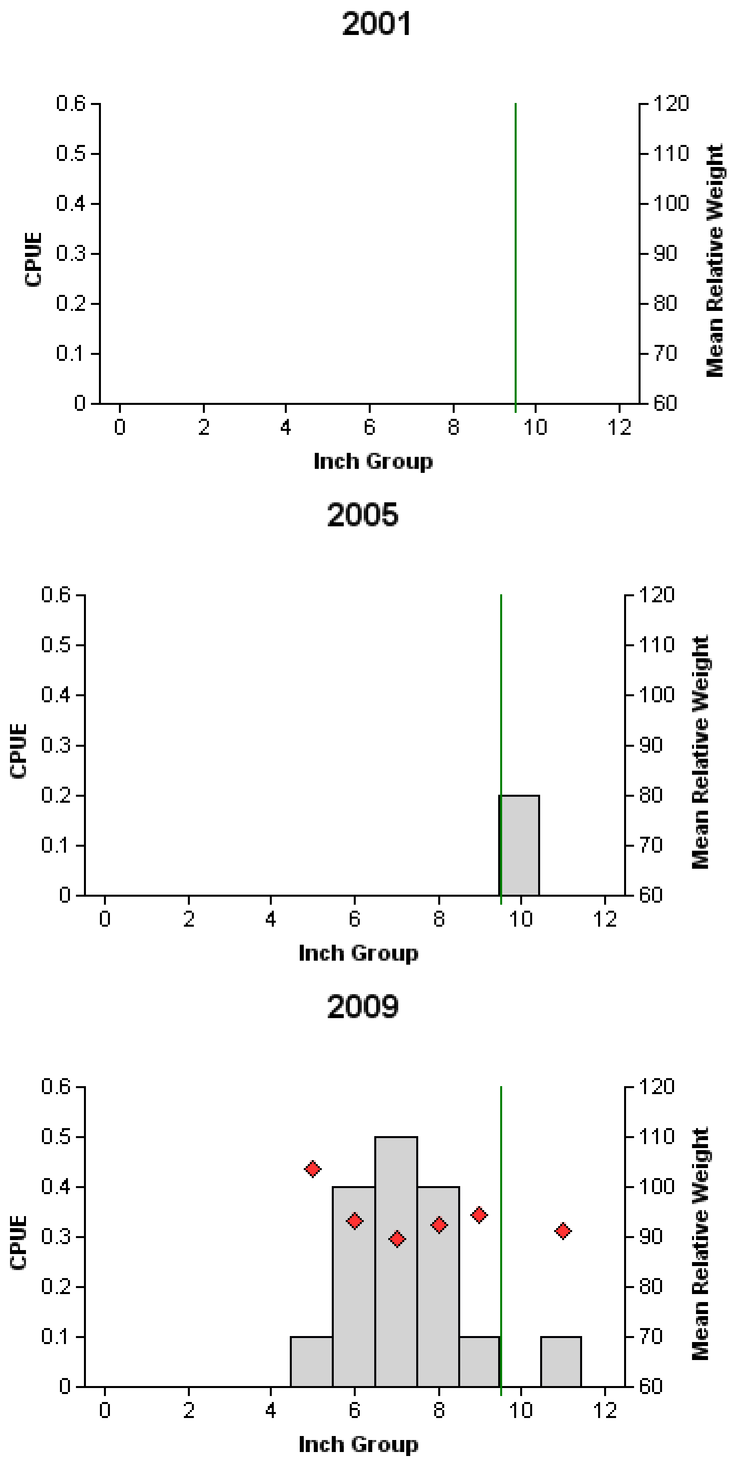
	Mean relative weight and number (N) in size-classes (in)		
Year	5.0 – 7.9	8.0 – 9.9	≥ 10.0
1994	89 (N = 28)	91 (N = 39)	92 (N = 32)
1997	93 (N = 28)	96 (N = 57)	92 (N = 23)
2001	97 (N = 7)	96 (N = 32)	99 (N = 24)
2009	92 (N = 14)	93 (N = 19)	94 (N = 14)

Table 19. Mean length at age of capture for white crappie (sexes combined) collected during November trap netting surveys, Graham Reservoir, Texas. Sample sizes are in parentheses. Ages determined using otoliths.

Year	1	2	3	4	5
1994	7.5(3)	9.3(24)	11.4(12)	10.3(4)	14.2(1)
1997	7.9(18)	10.5(9)	12.1(3)	12.0(2)	13.6(1)
2001	9.0(39)	11.1(17)	12.6(2)		
2006	8.8(37)	10.8(66)	13.0(8)	13.1(1)	13.4(1)
Averages[a]	6.8	8.9	10.3	11.2	11.9

[a]Ecological averages from Prentice (1987); lengths derived for November 1.

Black Crappie



2001

Effort = 19.0
Total CPUE = 0.0 (0; 0)
Stock CPUE = 0.0 (0; 0)
PSD = 0 (-1)
PSD-P = 0 (2.9)

2005

Effort = 5.0
Total CPUE = 0.2 (100; 1)
Stock CPUE = 0.2 (100; 1)
PSD = 100 (0.0)
PSD-P = 100 (0)

2009

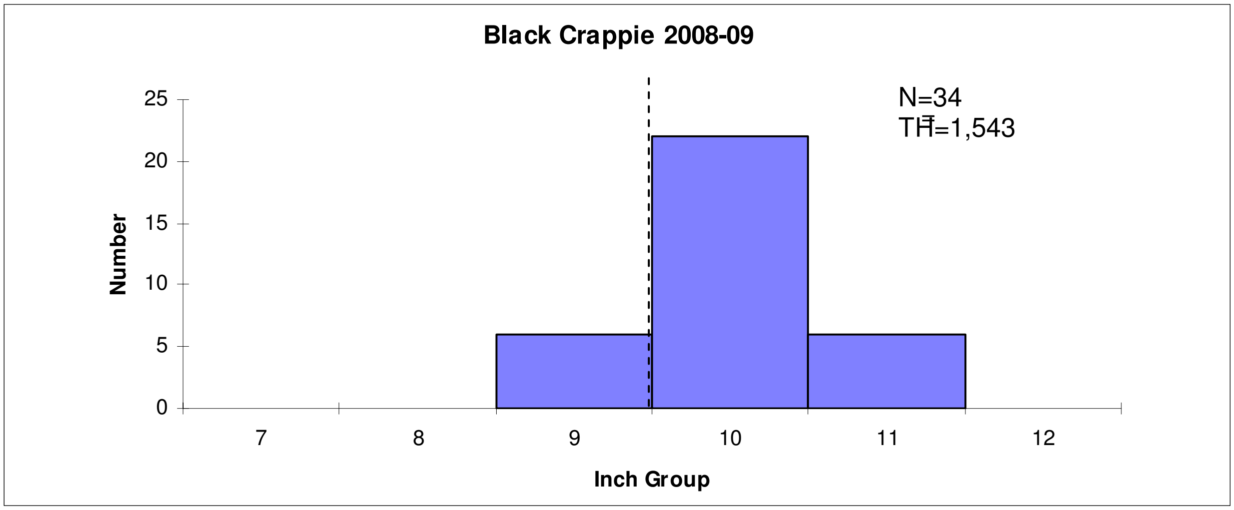
Effort = 10.0
Total CPUE = 1.6 (61; 16)
Stock CPUE = 1.6 (61; 16)
PSD = 38 (10.1)
PSD-P = 6 (2.9)

Figure 16. Number of black 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, Graham Reservoir, Texas, 2001, 2005, and 2009.

Crappie

Table 20. Creel survey statistics for black and white crappie combined at Graham Reservoir from June 2008 through May 2009, where total catch per hour is for anglers targeting crappie and total harvest is the estimated number of crappie harvested by all anglers.

Creel Survey Statistic	
Directed effort (h)	21,542.5
Directed effort/acre	9.0
Total catch per hour	6.9
Total harvest	20,906.3
Harvest/acre	8.7



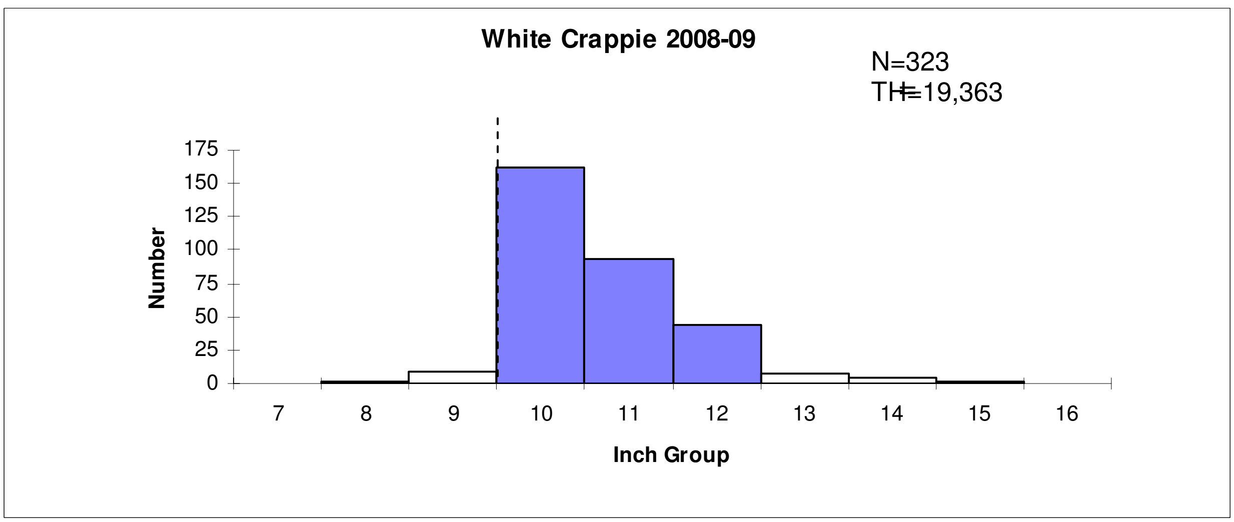


Figure 17. Length frequency of harvested black and white crappie observed during creel survey at Graham Reservoir from June 2008 through May 2009, all anglers combined. N is the number of harvested crappie observed during creel surveys, and TH is the total estimated harvest for the creel period. Dash line indicates minimum size limit at time of sampling.

Table 21. Proposed sampling schedule for Graham Reservoir, Texas. 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.

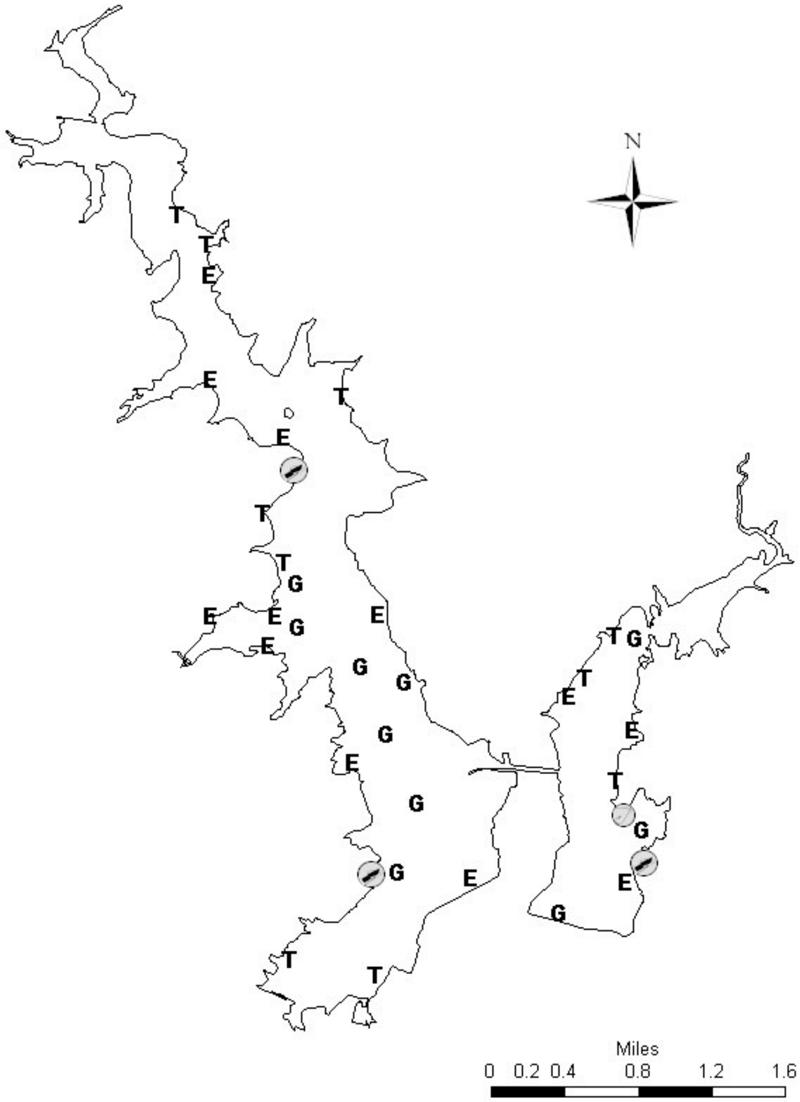
Survey Year	Electrofisher	Trap Net	Gill Net	Creel Survey	Report
Fall 2010-Spring 2011					
Fall 2011-Spring 2012	A		A		
Fall 2012-Spring 2013					
Fall 2013-Spring 2014	S	S	S		S

APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Graham Reservoir, Texas, 2009-2010.

Species	Gill Netting		Trap Netting		Electrofishing	
	N	CPUE	N	CPUE	N	CPUE
Spotted gar	1	0.1				
Longnose gar	2	0.2				
Gizzard shad	164	16.4			242	242.0
Threadfin shad					39	39.0
River carpsucker	12	1.2				
Smallmouth buffalo	11	1.1				
Blue catfish	80	8.0				
Channel catfish	23	2.3				
Flathead catfish	3	0.3				
White bass	22	2.2				
Palmetto bass	10	1.0	1	0.1		
Green sunfish					10	10.0
Warmouth			1	0.1	7	7.0
Orange spotted sunfish					4	4.0
Bluegill			63	6.3	266	266.0
Longear sunfish			5	0.5	58	58.0
Redear sunfish	1	0.1	8	0.8	89	89.0
Largemouth bass	10	1.0			113	113.0
White crappie	20	2.0	47	4.7		
Black crappie	3	0.3	16	1.6		
Freshwater drum	13	1.3				

APPENDIX B



Location of sampling sites, Graham Reservoir, Texas, 2009-2010. 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.