PERFORMANCE REPORT

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FEDERAL AID IN SPORT FISH RESTORATION ACT

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STATEWIDE FRESHWATER FISHERIES MONITORING AND MANAGEMENT PROGRAM

2010 Survey Report

Belton Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Belton Reservoir were surveyed in 2010 using an electrofisher and in 2011 using gill nets. Anglers were surveyed from June 2010 through May 2011 with a creel. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Belton Reservoir is a 12,385-acre impoundment located in Bell County, Texas. Mean and maximum water depths are 37 and 124 feet respectively, and the reservoir is classified as mesotrophic with water clarity averaging around 6 feet. Habitat features consisted mainly of bluffs, rocky shoreline, sandy beaches, and some standing timber.

- **Management history:** Important sport fish include largemouth and smallmouth bass, white and palmetto bass, white crappie, and catfish. The management plan from the 2007 survey report included an evaluation of fry and fingerling palmetto bass stockings, conducting a thorough habitat survey, and conducting a comprehensive age and growth sample on largemouth bass.

- **Fish Community**
  - **Prey species:** The abundance of forage species such as threadfin shad, gizzard shad, bluegill, green sunfish, and longear sunfish was excellent for the reservoir. Many sunfish over 6 inches were collected.

  - **Catfishes:** The blue and channel catfish populations are in good shape, with relatively high catch rates and good body condition. Over 20% of all anglers at Belton Reservoir fished for some species of catfish.

  - **Temperate bass:** White and palmetto bass (hybrid striped bass) were abundant in gill net samples. Together, they accounted for 12.2% of the fishing effort in the reservoir.

  - **Black bass:** Largemouth and smallmouth bass were both collected in good numbers. These populations had good size structures, and individuals generally had good body conditions. Largemouth and smallmouth bass accounted for 40.5% of the fishing effort in the reservoir.

  - **White crappie:** Trap netting became optional in 2009 and was not performed during this report period; however, white crappie were relatively abundant in the 2011 gill net survey. White crappie comprised 5.1% of the total angling effort in the reservoir.

- **Management Strategies:** Continue managing Belton Reservoir with existing regulations. Conduct general monitoring with electrofisher in 2014 and gill nets in 2013 and 2015.

INTRODUCTION

This document is a summary of fisheries data collected from Belton Reservoir in 2010-2011. 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 are presented with the 2010-2011 data for comparison.

Reservoir Description

Belton Reservoir is located on the Leon River in Bell County, Texas. The reservoir was constructed in 1954 by the United States Army Corps of Engineers to serve as a source of municipal water and for flood control and is managed by the same agency (Table 1). The conservation pool is 594 feet above mean sea level, and the reservoir has a maximum and average depth of 124 and 37 feet respectively (Figure 1). The 12,385-acre impoundment has a drainage area of 3,531 square miles, a storage capacity of 457,600 acre-feet, and a shoreline length of 136 miles. Water levels were two to three feet low during 2010 and 2011 surveys (Figure 1; Table 4). Fish habitat at time of sampling consisted primarily of natural and rocky shorelines, with limited standing timber and little to no aquatic vegetation. Bank fishing and boat access is excellent with numerous parks and seventeen public boat ramps. There are no handicap-specific facilities (Table 1). Further information about Belton Reservoir and its facilities can be obtained by visiting the Texas Parks and Wildlife Department web page at www.tpwd.state.tx.us and navigating within the fishing link.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Tibbs and Baird 2007) included:

1. Requesting palmetto bass fry stockings at 100/acre in 2009 and 2011 and fingerling stockings at 15/acre in 2008 and 2010.
   Action: Requests were initially made according to the plan, however, due to the variable availability of fry and fingerlings, fingerlings were received and stocked at 10/acre in both 2008 and 2009, and fry were stocked at 91/acre in 2010. The 2011 request was for fingerlings at 10/acre.
2. Sample the reservoir in 2011 with gill nets to compare the recruitment of each palmetto bass stocking method and determine most efficient stocking regime. Continue this stocking regime pending results.
   Action: Gill nets were used to collect a tier IV age and growth sample of palmetto bass in spring 2011. Results were very promising but inconclusive. A refined management strategy is included in this report.
3. Conduct a thorough habitat survey in 2009/2010.
   Action: A physical habitat survey was conducted in winter 2010; those data are included in this report.
4. Request smallmouth bass stockings at 25/acre on an annual basis.
   Action: Smallmouth bass have been requested annually; fingerlings were stocked at 7/acre in 2008 and 23/acre in 2010.
5. Continue springtime collection efforts for smallmouth bass brood stock when requested.
   Action: Smallmouth brooders were collected for hatcheries in spring 2007, 2010, and 2011.
6. Perform a tier IV age and growth sample on largemouth bass using electrofishing.
   Action: A tier IV age and growth sample was collected on largemouth bass in fall 2010.

Harvest regulation history: Sportfishes in Belton Reservoir are currently managed with statewide regulations (Table 2).

Stocking history: Smallmouth bass and palmetto bass are currently requested each year. Historical stockings of palmettos have been very consistent, including 1,039,169 fry in 2007, 124,433 fingerlings in 2008, 116,731 fingerlings in 2009, and 1,130,132 fry in 2010. Smallmouth bass were stocked in 2007 (16,873), 2008 (87,250), and 2010 (289,719). Blue catfish fingerlings were stocked in 2008 at a rate of 25/acre. The complete stocking history is in Table 3.

Vegetation/habitat history: Belton Reservoir supports little aquatic vegetation. Buttonbush has been observed along rocky shorelines during historical habitat surveys, and a couple of isolated patches of southern naiad were observed in fall, 2006. There have been several reports of hydrilla in recent years, but none were confirmed by TPWD surveys. Currently, no noxious vegetation is known to exist in the reservoir.

A grass roots initiative began in 2006 by an angling group called Centex Bass Hunters, in conjunction with Bass Anglers Sportsman's Society (BASS), Texas Parks and Wildlife Department (TPWD), and the U.S. Army Corps of Engineers (USACOE) aquatic research laboratory in Lewisville, to establish native aquatic vegetation in Belton Reservoir. Although funding contributions from that effort fell short of expectations, there is still interest in planting native vegetation and improving fish habitat in Belton.

Water Transfer: Belton Reservoir is primarily used for flood control, municipal water supply, and recreation. There are currently three raw water intake stations on the reservoir which transfer water offsite. The first is operated by the Water Control Improvement District #1(WCID#1), the second is Bluebonnet Water Supply and the third is for the City of Gatesville. All three pump treated water to their destinations for use as municipal water. There is one additional proposal to install a pumping station on Belton Reservoir and pump untreated water directly to Stillhouse Hollow, thereby increasing the water transfer capabilities of Stillhouse Hollow; this proposal has not yet been approved.

Reservoir capacity: Belton was impounded in 1954. Original plans calculated the reservoir's capacity at conservation pool (594 feet above mean sea level) to be 457,600 acre-feet with a surface area of 12,300 acres. Two volumetric surveys have been conducted by the Texas Water Development Board (TWDB) on Belton since impoundment; one in 1994 and one in 2003. The 1994 survey found a volume of 434,500 acre-feet and a surface area of 12,385 acres at top of conservation pool (TOL), whereas the 2003 survey found a volume of 435,225 acre-feet and surface area of 12,135 acres, indicating a loss of approximately 2% in surface acreage and a gain of approximately 2% in volume between surveys. According to the TWDB, the two surveys are within the margin of error and are essentially identical. Additional information can be found at the following web link:
http://www.twdb.state.tx.us/hydro_survey/Belton2003/Belton_Report_2003.pdf

METHODS

Fishes were collected by electrofisher (2.0 hours at 24 5-minute stations) and gill nets (15 net nights at 15 stations) Only 10 net nights of gill netting were used to collect white and black crappie. 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 nets, as the number of fish per net night (fish/nn). All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (unpublished, revised manual, 2009). Additional sampling for palmetto bass and largemouth bass was completed as described in Appendix D. A vegetative habitat survey was conducted by boat during summer 2010 and a structural habitat survey was conducted in winter 2010 using satellite imagery according to the Habitat Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2009).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD)], and condition indices [relative weight (Wr)] 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 for creel statistics and SE was calculated for structural indices and IOV. Ages were determined using otoliths from up to 10 fish per centimeter group for palmetto bass. Source for water level data was the United States Geological Survey (USGS) website.

RESULTS AND DISCUSSION

Habitat: Littoral zone habitat consisted primarily of natural and rocky shoreline (Table 4). Standing timber was very limited, with just a few acres present. A habitat survey was conducted during winter 2010 using satellite imagery. No native or exotic vegetation was observed in summer, 2010.

Creel: Directed fishing effort by anglers was highest for black bass spp. (40.5%), followed by anglers fishing for anything (20.9%), catfish spp., blue catfish, channel catfish, and flathead catfish combined (20.3%), temperate bass spp. (12.2%), and lastly crappie spp., black and white crappie combined (5.1%; Table 5). Total fishing effort for all species at Belton Reservoir was 315,021 h from June 2010 to May 2011, which is much higher than the previous creel survey from March 2003, through February 2004, during which the total fishing effort was 94,065 hours. Bank anglers comprised 32% of the total fishing effort in ’10-’11. Anglers spent an estimated $2,590,627 on direct expenditures in ’10-‘11, compared to $302,391 in ’03-’04. Bank anglers contributed $660,284 of the total expenditures in ’10-‘11.

Prey species: The electrofishing catch rates of threadfin and gizzard shad were 61.0/h and 191.5/h, and exceeded those from the previous two surveys (Figure 2; Appendices A and B). Index of vulnerability (IOV) for gizzard shad was good, and 86% of gizzard shad were available to existing predators as forage. Bluegill catch rates remained good at 236.5/h, comparable to the 2008 (347.5/h) and 2006 (196.5/h) surveys (Figure 3; Appendices A and B). Bluegill populations had individuals in the 6 to 8-inch classes, thus providing good panfishing for anglers. Other forage species collected were green sunfish (110.0/h), longear sunfish (67.5/h), redear sunfish (12.0/h), and warmouth (2.5/h).

Catfishes: Blue catfish catch rates were 3.1/nn in 2011. The proportional size distribution (PSD) has remained good over the past three surveys; 50 in 2007, 28 in 2007, and 31 in 2011 – indicating many quality-sized fish and larger in the population. Body condition, expressed as relative weight (Wr), generally increased from smaller to larger fish and ranged from 60 to 120. One fish was collected in the preferred size category of 30 inches or more (Figure 4; Appendices A and B).

Channel catfish were relatively abundant with a catch rate of 3.9/nn in 2011. Recruitment and population size structure was excellent (PSD = 51) and body condition averaged around 95, again with an upward trend from smaller to larger fish (Figure 6; Appendices A and B).

The flathead catfish population is a low density one and only a single individual was collected. No age and growth work was performed on catfishes during this survey period.

Directed fishing effort, catch per hour, and total catch for all catfish showed a thriving catfish fishery (Tables 5, 7, 8).

Temperate bass: The gill net catch rate of white bass was 4.3/nn in 2011, much higher than the 2009 catch rate of 0.7/nn. Twenty-seven percent of the population was of quality length (12-inches) or larger. Body condition (Wr) averaged around 90, and was also much higher than in previous surveys (Figure 8; Appendices A and B). No age and growth work was performed on white bass during this survey period.

Palmetto bass catch rates were 5.5/nn, similar to the previous two surveys. Proportional size distribution was the highest on record (96) indicating high numbers of quality-sized fish and larger for anglers. Body condition (Wr) was higher than in previous surveys. Growth was excellent, with mean total length reaching 18" in the spring of the third year (Figure 10, 12, Table 11; Appendices A and B).

Percent directed effort and catch per hour for temperate bass spp. increased in the '10-'11 creel as compared to the '03-'04 creel (Table 5). Additionally, total harvest of white bass and palmetto bass substantially increased over the same time period.

One management strategy from the previous survey report (Tibbs and Baird 2007) included alternating palmetto bass stockings between fry and fingerlings in order to determine which stocking methodology contributed most efficiently to the fishery. The 2007 report strategy called for fry stockings at 100 fish/acre in 2009 and 2011 and fingerling stockings at 15 fish/acre in 2008 and 2010. Requests were initially made according to the plan, however due to the variable availability of fry and fingerlings, fingerlings were received and stocked at 10/acre in both 2008 and 2009, and fry were stocked at 91/acre in 2010. A total of 232 Palmetto bass were collected and aged or assigned ages from a length-age key during spring 2011. Dominant year classes identified from this sample were 2004 and 2007 (See Appendix D for results and additional discussion). Because of the confounding factors of water levels and intraspecific competition possibly affecting recruitment we recommend that additional evaluation comparing fingerling and fry stockings be completed.

Black bass: The electrofishing catch rate of smallmouth bass was 57.5/h, one of the highest catch rates on Belton to date. Population size structure was excellent with good recruitment and good numbers of legal-sized fish (PSD = 25). Body condition generally decreased from smaller to larger individuals and that trend was evident in the two previous surveys as well (Figure 13; Appendices A and B).

Creel data from 2010-2011 showed smallmouth bass are an important component of the black bass fishery. A total of 11,064 smallmouth bass were caught, of which 6,372 were longer than 14". Of these, 1,666 were released immediately. A total of 3,703 were taken to a tournament weigh-in where they were then released. The rest (1,003) were harvested.

Smallmouth bass brood stock continues to be periodically collected from the lake (N = 200 in 2011; total length 6"-16") and provided to hatcheries in an effort to rebuild the smallmouth bass hatchery program.

The electrofishing catch rate of largemouth bass was 127.5/h in 2010, similar to the 2008 catch rate. Population size structure was good as the PSD was 48, similar to the 2006 PSD; the 2008 PSD was skewed due to the abnormally large year class produced from the 2007 high water year. Body condition in 2010 was good (relative weight greater than 90) for all size classes of fish and was similar to body condition in previous surveys (Figure 15; Appendices A and B). Growth of largemouth bass was good with mean total length reaching 14 inches in the fall of the third year (Table 14). Genetic results from the 2006 survey report are included (Table 15).

Creel data from 2010-2011 showed largemouth bass are heavily utilized. A total of 100,164 largemouth bass were caught, of which 50,971 were longer than 14". Of these, only 7,831 were released immediately. A total of 38,570 were taken to a tournament weigh-in where they were later released. The rest (4,570) were harvested.

Tournament angling comprised slightly more than half of the total angling effort for black bass, expending 60,557 hours. In contrast, non-tournament anglers spent 57,998 hours pursuing black bass.

One management strategy from the 2007 report was to perform a category IV age and growth sample in 2010 using electrofishing. A total of 425 largemouth bass were collected and aged or assigned ages from a length-age key during fall 2010 (See Appendix D for results and additional discussion). The largemouth

bass population in Belton exhibited the lowest total mortality of any measured to date in the district. However, a strong year class in 2007 created this artificially low total mortality. One of the assumptions of the FAST program is consistent recruitment, something that rarely occurs. If only Age-0 through Age-2 are included in the model, and the Age-3 (2007) year class is removed, the mortality rate is 43.6% which is much more comparable to other reservoirs in the district. However, none of the Age-0 through Age-2 bass were vulnerable to harvest, so this estimate does not take into account angling-induced mortality. Recruitment during those three years was very similar, as evidenced by the low residuals generated from the regression equation.

The relatively high maximum length and age calculated by the FAST program illustrates the potential of this population. However the lack of larger bass in electrofishing surveys is troubling. This, coupled with the fact that 76% of all the legal-sized bass caught by anglers are retained for a tournament weigh-in hints at a possible issue with delayed mortality.

White crappie: Trap netting became an optional gear in 2009, and since recent crappie surveys have failed to collect useful sample sizes, trap netting was not conducted during this survey period. However, an abundance of white crappie were observed during spring gill netting in 2011. The gill net catch rate of white crappie was 4.4/nn in 2011. The PSD-10 was 64. Relative weights were not measured. (Figure 18).

Creel data showed that crappie were pursued by 5.1% of the anglers, and catch per hour was low relative to other reservoirs. Some large crappie were harvested however and the fishery, while variable in nature, does provide good fishing during some years (Table 16, Figure 16).

Fisheries management plan for Belton Reservoir, Texas

Prepared – July 2011.

ISSUE 1: The spring 2011 palmetto bass survey continued the high catch rates for this species first experienced in 2007 and again documented in 2009. Age and growth data showed large cohorts from 2004 and 2007, both years where fry were stocked. However confounding factors include combined fingerling/fry stockings in 2004, water levels, and possible intraspecific competition among cohorts. Although these results are very promising, additional evaluation is needed. Consecutive annual stocking of the same life stage is recommended to help determine if intraspecific competition exists. Based on these initial positive results, it is also suggested that at least two other reservoirs be recommended for evaluation to confirm the viability of this approach. The benefit of fry stocking is that they are inexpensive, do not require outdoor hatchery space to raise, labor costs are minimal, hauling can be done in a regular pickup, and they are often more readily available.

MANAGEMENT STRATEGIES

1. Request fry stockings at 100 fish/acre in 2012 and 2013 and fingerling stockings at 10 fish/acre in 2014 and 2015.
2. Sample the reservoir in spring, 2013 and 2015 using gill netting to compare the recruitment of each method and determine most efficient stocking regime at that time. Continue this stocking and sampling regime pending results.
3. Work with two other districts that have palmetto fisheries to evaluate the viability of fry stockings in other reservoirs.

ISSUE 2: Smallmouth bass electrofishing rates were the highest recorded, and creel information showed good utilization by anglers. In fact, Belton is likely the best smallmouth bass fishery in the state. TPWD hatcheries continue to rebuild their smallmouth bass program after losing brood stock to golden alga. In spring 2011, 200 smallmouth from 6 to 16 inches in length were collected for hatchery use.

MANAGEMENT STRATEGIES

1. Continue to request smallmouth bass stockings at 25 fish/acre on an annual basis.
2. Continue spring time collection efforts for smallmouth bass to be used by hatcheries as brood stock when requested.
3. Collect a category III age-and-growth sample in Fall, 2014 to document year class strength and relate to stocking densities.
4. Publicize the excellent smallmouth bass fishing through news releases.
5. Conduct an additional electrofishing sample in Fall, 2012.

ISSUE 3: Black bass tournament anglers are handling a significant number of bass on Belton. A total of 42,273 largemouth and smallmouth bass were taken to tournament weigh-ins in ’10-’11 compared to a total combined harvest and tournament-caught fish of only 7,813 in ’03-’04. This represents a large jump in utilization of the resource and it is imperative that steps be taken to limit the effects of this extra pressure on the population.

MANAGEMENT STRATEGIES

1. Request historical, current, and future data on tournament permits issued by the U.S. Army Corps of Engineers (USACOE). Determine if the data is suitable to be used for examining trends.
2. Conduct an angler creel in 2014-2015 to determine if tournament angling pressure changes. Use this information, along with population sampling data, to determine if additional strategies are necessary to protect the black bass fishery.
3. Discuss best practices for tournament weigh-ins with USACOE personnel and suggest requiring it

of tournaments held on the reservoir. Include the results of this report in those discussions. Suggest the USACOE house one or more weigh-in kits if they would be used.

4. Identify bass clubs fishing Belton and give presentations to interested clubs regarding best weigh-in and fish care practices. Investigate the possibility of cost sharing weigh-in kits either through sponsorship or grant money from Bass Anglers Sportsman's Society (BASS) or other similar organizations.

ISSUE 4: Belton Reservoir has never supported much aquatic vegetation. A grass roots initiative began in 2006 by an angling group called Centex Bass Hunters, in conjunction with Bass Anglers Sportsman's Society (BASS), Texas Parks and Wildlife Department (TPWD), and the U.S. Army Corps of Engineers (USACOE) aquatic research laboratory in Lewisville, to establish native aquatic vegetation in Belton Reservoir. Funding did not materialize, and no work was ever done. However Belton is still a good candidate for native aquatic vegetation introduction, and there is still interest in improving fish habitat in Belton.

MANAGEMENT STRATEGIES

1. Form a partnership with the U.S. Army Corps of Engineers and interested constituent/user groups to introduce native vegetation into Belton.
2. Request appropriate species of native vegetation from the Texas Freshwater Fisheries Center (TFFC) aquatic plant nursery, and plant vegetation when available.
3. Monitor the spread/growth of native vegetation plantings on an annual basis. Then based on results, review the program during the next report year and make recommendations.

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, literature, etc… 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 electrofisher sampling in 2012 and 2014 and gill net sampling in 2013 and 2015 (Table 17).

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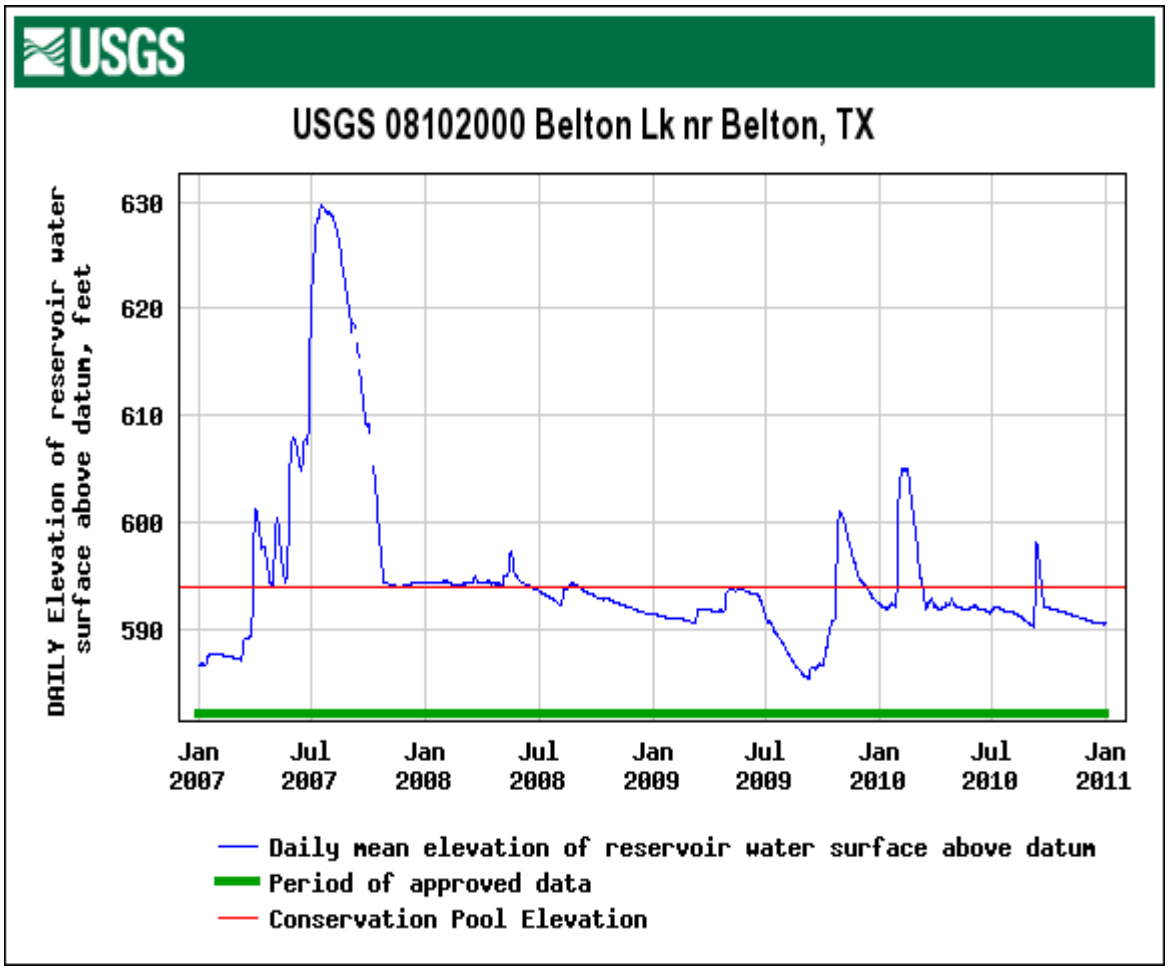


Figure 1. Daily mean water levels for Belton Reservoir from January 1, 2007 through January 1, 2011. Conservation pool level is 594 feet above mean sea level. Figure from USGS website.

Table 1. Characteristics of Belton Reservoir, Texas.

Characteristic	Description
Year Constructed	1954
Controlling authority	United States Army Corps of Engineers
Counties	Bell
Reservoir type	Mainstem
Shoreline Development Index (SDI)	8.8
Conductivity	370 umhos/cm

Table 2. Harvest regulations for Belton 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 and smallmouth	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 Belton (Bell County), 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	1998	308,987	FGL	2.2
	2008	312,748	FGL	2.1
	Total	621,735		
Channel catfish	1971	44,000	AFGL	7.9
	Total	44,000		
Florida largemouth bass	1989	307,142	FRY	0.8
	1991	357,741	FGL	1.2
	1995	308,552	FGL	1.2
	Total	973,435		
Largemouth bass	1967	4,600	UNK	UNK
	1969	350,000	FRY	0.7
	1970	100,000	UNK	UNK
	1972	225,000	UNK	UNK
	Total	679,600		
Palmetto bass (striped X white bass hybrid)	1977	60,455	UNK	UNK
	1979	65,518	UNK	UNK
	1981	120,625	UNK	UNK
	1983	125,550	UNK	UNK
	1984	242,239	FGL	2.0
	1987	250,850	FRY	1.0
	1988	259,977	FRY	1.0
	1989	88,000	FGL	1.2
	1991	133,832	FGL	1.3
	1992	218,884	FGL	1.3
	1993	92,386	FGL	1.2
	1994	185,744	FGL	1.3
	1995	185,151	FGL	1.3
	1996	187,907	FGL	1.6
	1997	101,100	FGL	1.5
	1998	189,434	FGL	1.2
	1999	94,098	FGL	1.4
	2000	93,674	FGL	1.6
	2002	94,200	FGL	1.8
	2004	99,180	FGL	1.6
	2004	1,337,574	FRY	0.4

Species	Year	Number	Life Stage	Mean TL (in)
	2005	124,081	FGL	1.7
	2006	123,337	FGL	1.8
	2007	1,039,169	FRY	0.2
	2008	124,433	FGL	1.5
	2009	116,731	FGL	1.4
	2010	1,130,132	FRY	0.3
	Total	6,884,261		
Sauger	1985	54,113		1.5
	Total	54,113		
Smallmouth bass	1978	99,850	UNK	UNK
	1979	100,000	UNK	UNK
	1980	101,320	UNK	UNK
	1995	28,450	FGL	1.5
	1997	302,150	FGL	1.1
	1998	184,500	FGL	1.2
	1999	189,258	FGL	1.4
	2000	130,000	FGL	1.5
	2007	4,373	ADL	8.4
	2007	12,500	FGL	3.0
	2008	87,250	FGL	1.4
	2010	289,719	FGL	1.3
	Total	1,529,370		
Walleye	1973	493,000	FRY	0.2
	1974	327,000	FRY	0.2
	Total	820,000		

Table 4. Survey of littoral zone and physical habitat types, Belton Reservoir, Texas, 2010. Linear shoreline distance (miles) and percent of linear shoreline distance was recorded for each habitat type greater than one percent; otherwise noted as trace. Percent of total shoreline distance is blank for boat docks/piers

because they were dually coded with adjacent habitat; counts are given instead. Survey was conducted using 2010 NAIP, 1-meter resolution satellite imagery.

	Shoreline Distance	
Shoreline habitat type	Miles	Percent of total
Natural shoreline	148.2	93.7
Rock shoreline (rocks > 4")		trace
Rock Bluff	9.6	6.0
Boat docks/piers		N=32

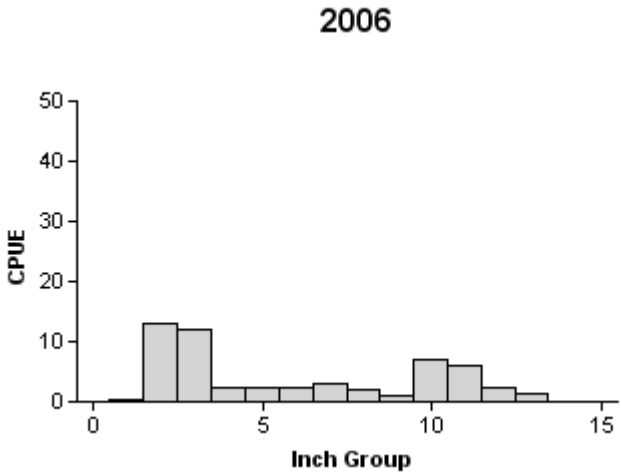
Table 5. Percent directed angler effort, directed catch per hour, and total harvest for all anglers by species for Belton Reservoir, Texas, 2003-2004 and 2010-2011.

Species	Percent directed effort		Directed catch per hour		Total harvest	
Year	2010-2011	2003-2004	2010-2011	2003-2004	2010-2011	2003-2004
Blue catfish					3,780	1,473
Channel catfish					6,257	2,191
Flathead catfish					988	83
Catfish spp.	20.3	21.8	0.3	0.2		
White bass					52,243	1,775
Palmetto bass					13,389	493
Temperate bass spp.	12.2	9.3	2.6	1.0		
Panfish spp.	0.7	0.0	1.1	NA	3,851	43
Smallmouth bass					4,706	921
Largemouth bass					43,139	6,891
Black bass spp.	40.5	48.0	0.7	0.8		
White crappie					16,895	4,384
Crappie spp.	5.1	8.9	0.9	1.4		
Anything	20.9	11.3	0.6	0.5		

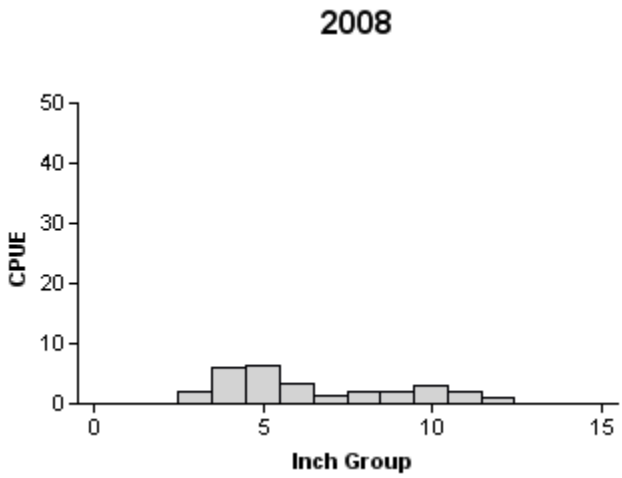
Table 6. Total fishing effort (h) for all species and total directed expenditures at Belton Reservoir, Texas, 2003-2004 and 2010-2011. Relative standard errors (RSE) are in parentheses.

Creel Statistic	Year	
	2010-2011	2003-2004
Total fishing effort (hours)	315,021 (10)	94,065 (15)
Total directed expenditures	$2,590,627 (41)	$302,391 (29)

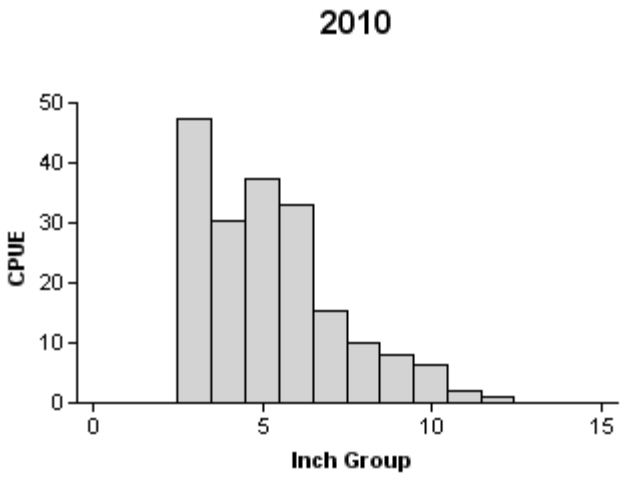
Gizzard Shad



Effort = 2.0
Total CPUE = 56.0 (30; 112)
Stock CPUE = 23.0 (30; 46)
IOV = 51 (13.5)



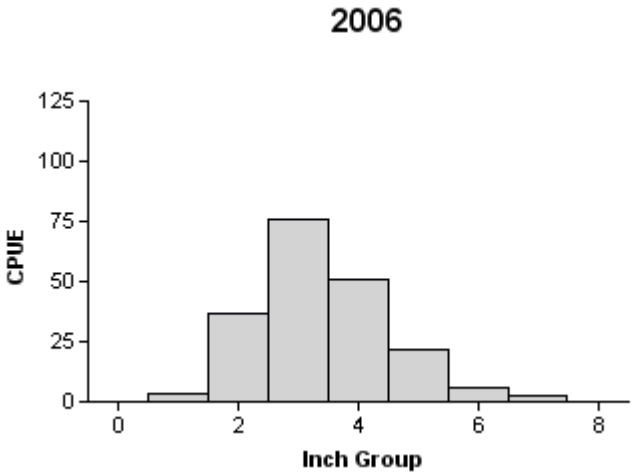
Effort = 2.0
Total CPUE = 29.5 (24; 59)
Stock CPUE = 11.5 (26; 23)
IOV = 66 (11.8)



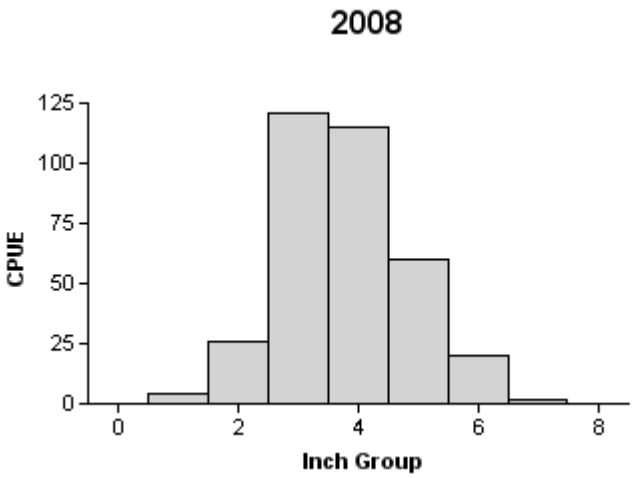
Effort = 2.0
Total CPUE = 191.5(50;383)
Stock CPUE = 43.0 (25; 86)
IOV = 86 (8.4)

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, Belton Reservoir, Texas, 2006, 2008, and 2010.

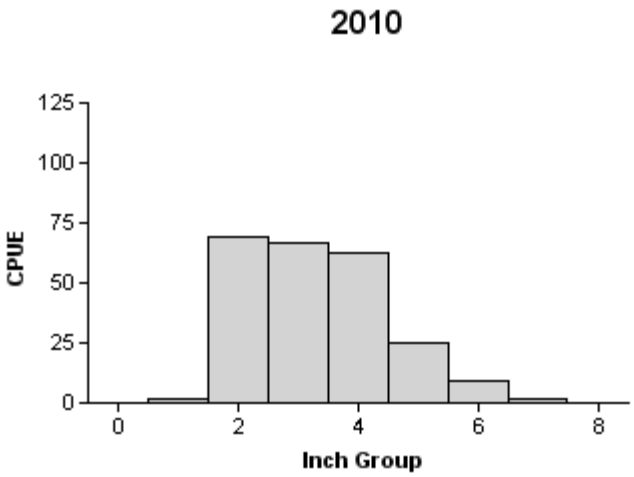
Bluegill



Effort = 2.0
Total CPUE = 196.5 (28; 393)
Stock CPUE = 156.0 (29; 312)
PSD = 5 (1.9)



Effort = 2.0
Total CPUE = 347.5 (16; 695)
Stock CPUE = 317.5 (16; 635)
PSD = 7 (1.1)



Effort = 2.0
Total CPUE = 236.5 (19; 473)
Stock CPUE = 165.0 (15; 330)
PSD = 7 (1.7)

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, Belton Reservoir, Texas, 2006, 2008, and 2010.

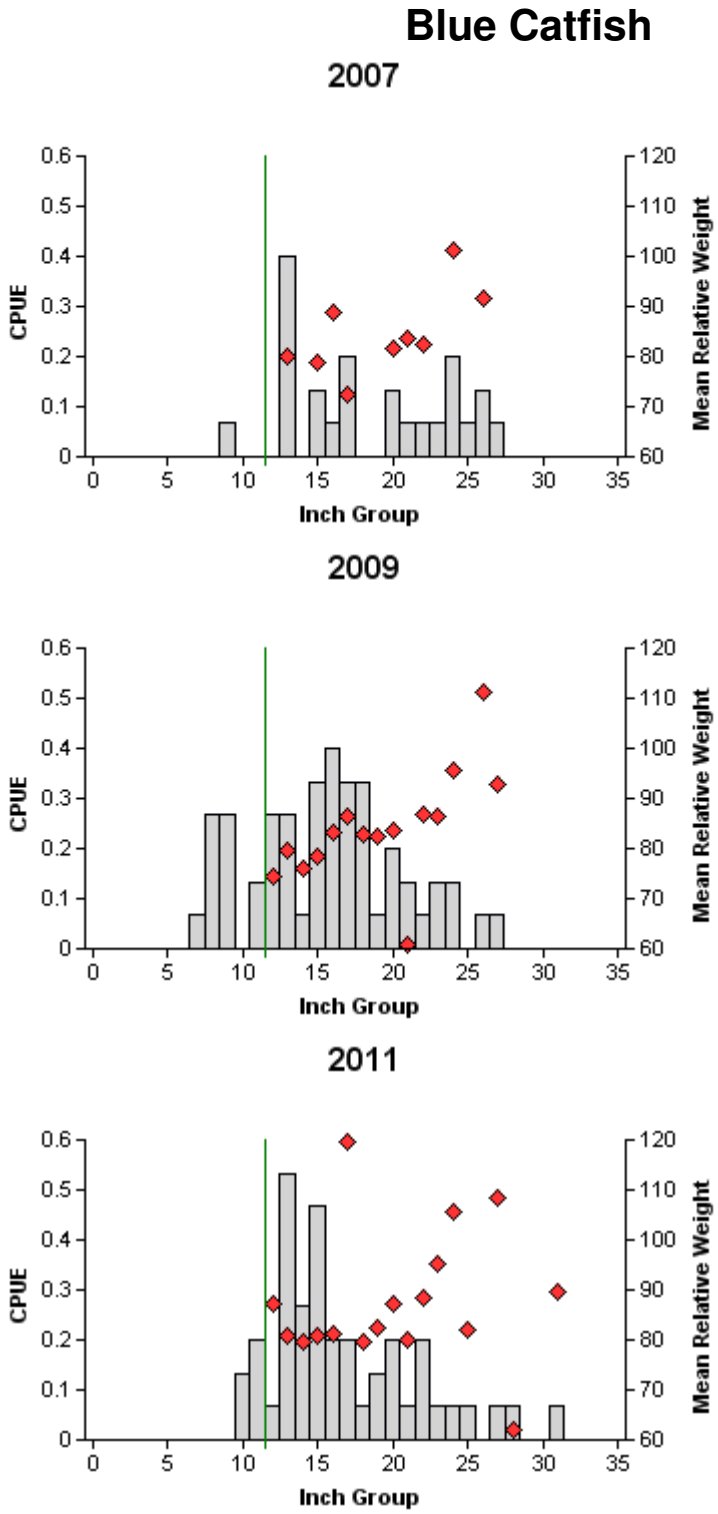


Figure 4. Number of blue catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2007, 2009, and 2011.

Blue Catfish

Table 7. Creel survey statistics for catfish spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting catfish spp. and total catch and total harvest is the estimated number of blue catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	64,027 (15)
Directed effort/acre	5.2
Total catch per hour	0.3 (50)
Total catch	8,210 (78)
Total harvest	3,780 (108)
Harvest/acre	0.3

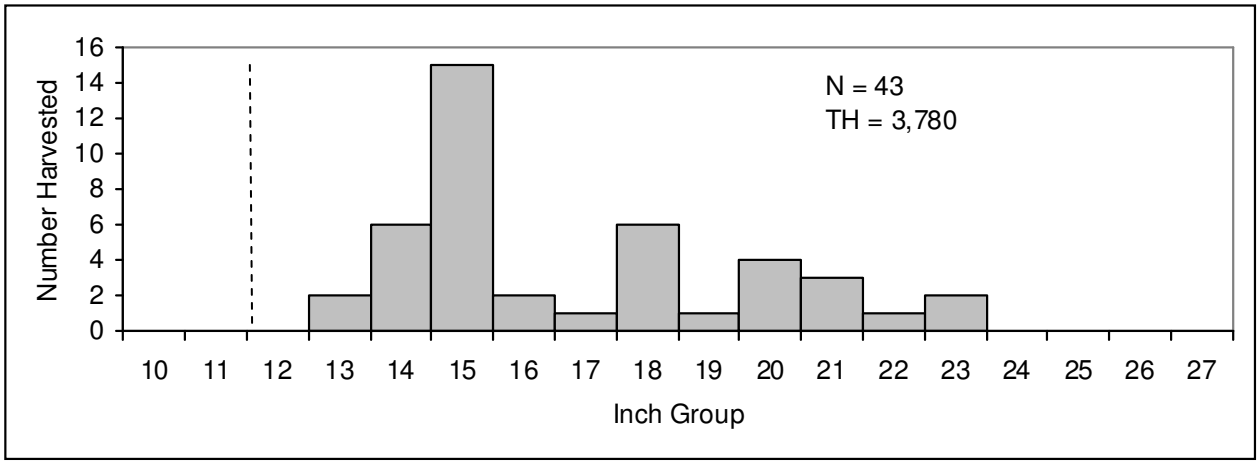


Figure 5. Length frequency of harvested blue catfish observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

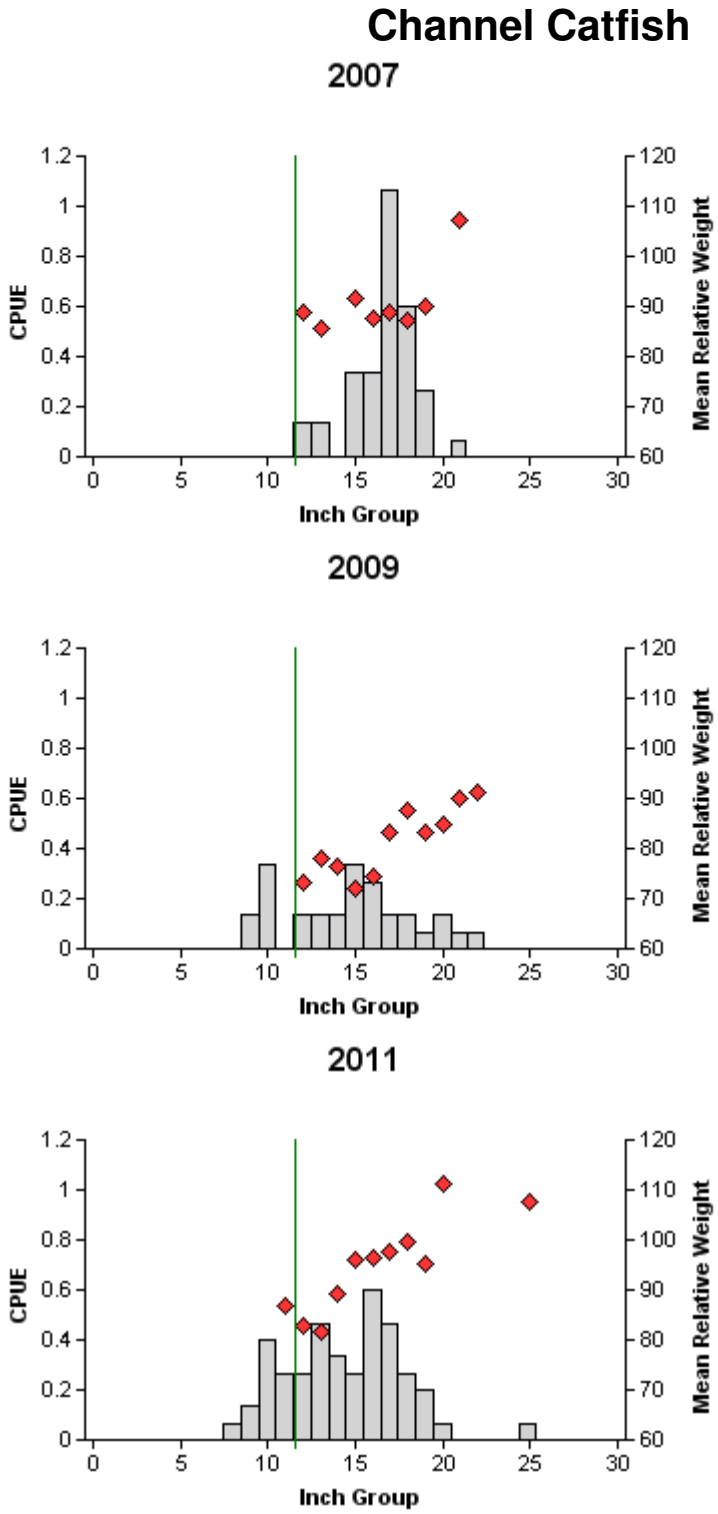


Figure 6. Number of channel catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2007, 2009, and 2011.

Channel Catfish

Table 8. Creel survey statistics for catfish spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting catfish spp. and total catch and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	64,027 (15)
Directed effort/acre	5.2
Total catch per hour	0.3 (50)
Total catch	25,633 (29)
Total harvest	6,257 (49)
Harvest/acre	0.5

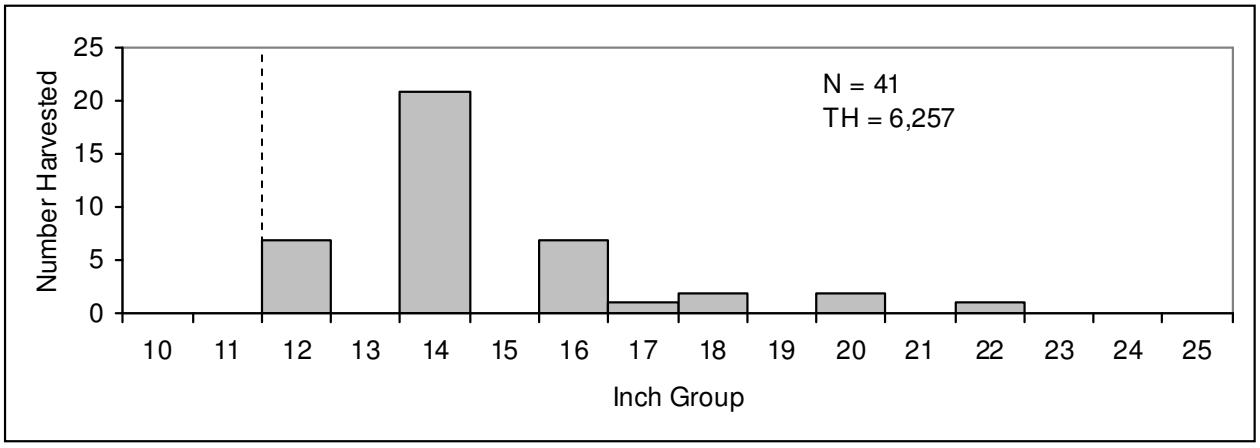


Figure 7. Length frequency of harvested channel catfish observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested channel catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

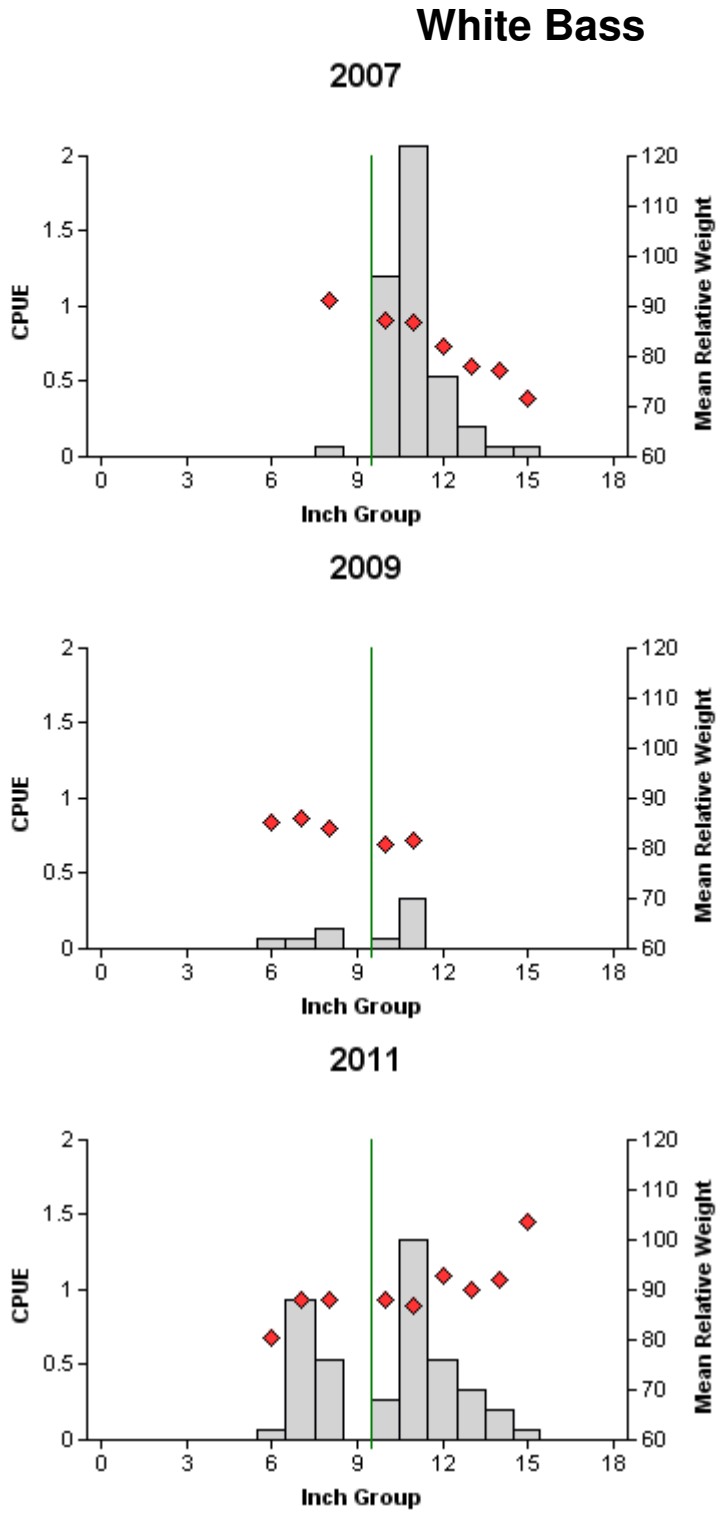


Figure 8. Number of white bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2007, 2009, and 2011.

White Bass

Table 9. Creel survey statistics for temperate bass spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting temperate bass spp. and total catch and total harvest is the estimated number of white bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	38,525 (16)
Directed effort/acre	3.1
Total catch per hour	2.6 (33)
Total catch	113,121 (19)
Total harvest	52,243 (31)
Harvest/acre	4.2

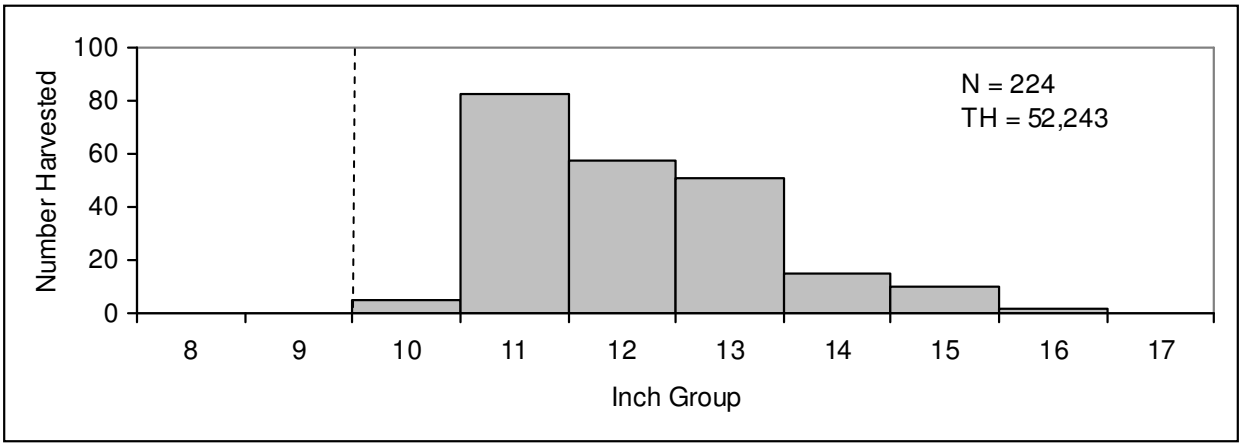


Figure 9. Length frequency of harvested white bass observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

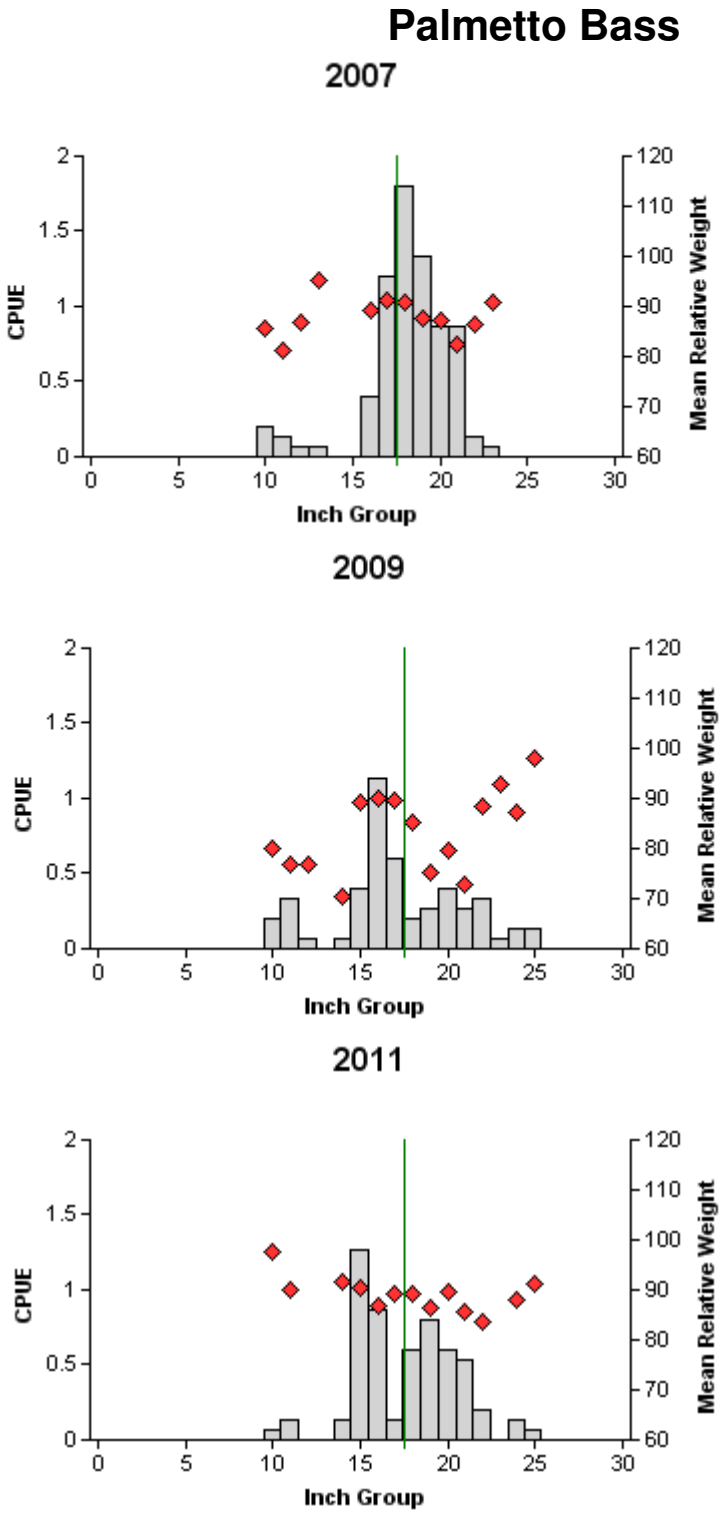


Figure 10. Number of palmetto bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2007, 2009, and 2011.

Palmetto Bass

Table 10. Creel survey statistics for temperate bass spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting temperate bass spp. and total catch and total harvest is the estimated number of palmetto bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	38,525 (16)
Directed effort/acre	3.1
Total catch per hour	2.6 (33)
Total catch	25,508 (34)
Total harvest	13,389 (47)
Harvest/acre	1.1

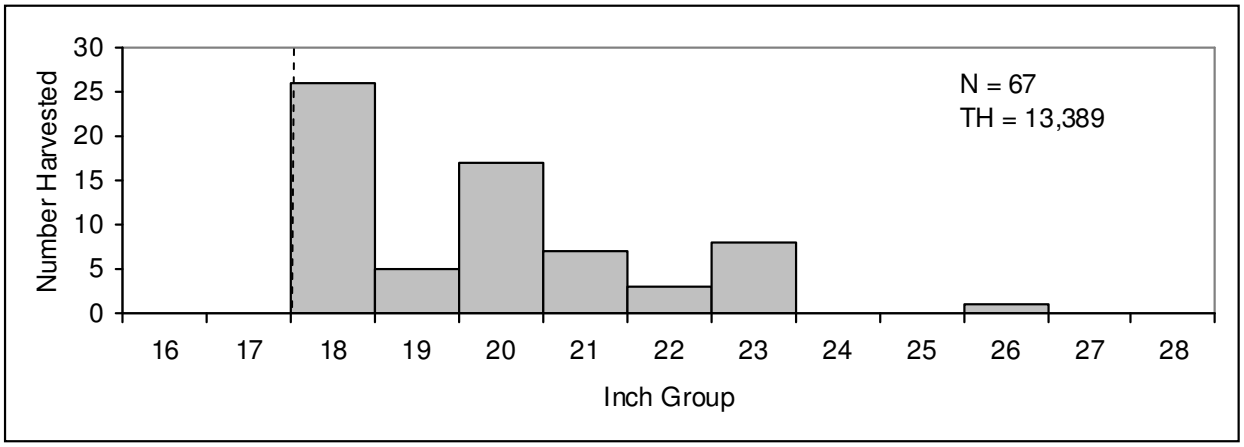


Figure 11. Length frequency of harvested palmetto bass observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested palmetto bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

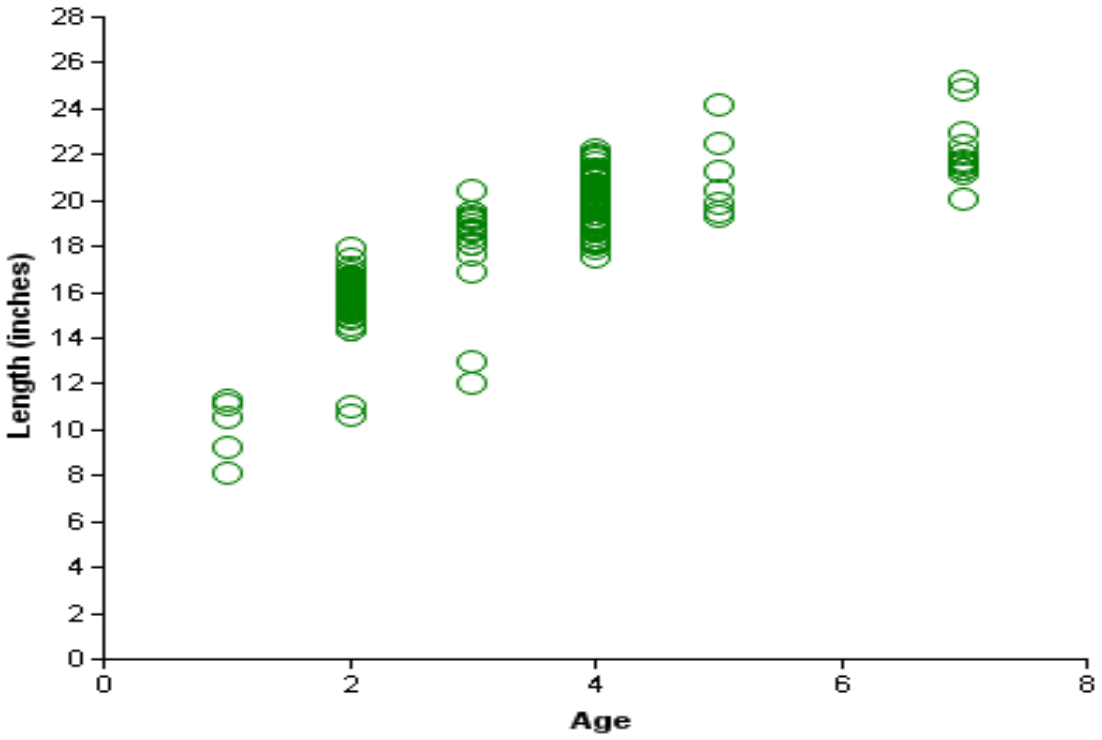


Figure 12. Length at age for palmetto bass collected by gill netting at Belton Reservoir, Texas, 2011.

Table 11. Average length at capture for palmetto bass (sexes combined) ages 1 – 7 collected in gill netting surveys, Belton Reservoir, 2011. Lengths are followed by the sample size. Note that the age-1 data may not be representative of the actual size distribution because of gear bias against smaller fish.

	Growth	
Age	Total Length	Number of fish
1	10.0	5
2	15.8	55
3	18.0	17
4	19.9	71
5	21.0	7
6		0
7	22.1	13

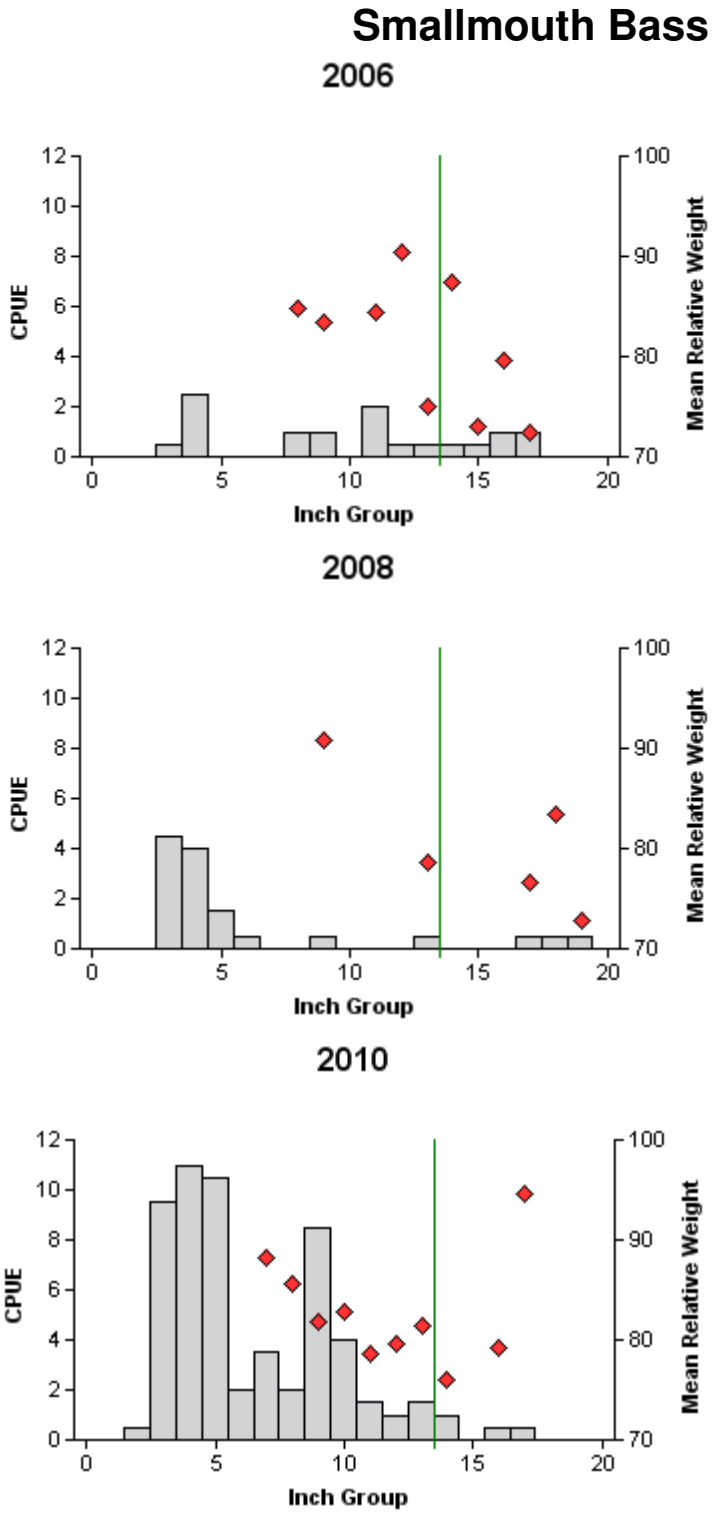


Figure 13. Number of smallmouth bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2006, 2008, and 2010.

Table 12. Creel survey statistics for black bass spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting black bass spp. and total catch and harvest is the estimated number of smallmouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	127,541 (13)
Directed effort/acre	10.3
Total catch per hour	0.7 (18)
Total catch	11,064 (48)
Total harvest	4,706 (70)
Harvest/acre	0.4

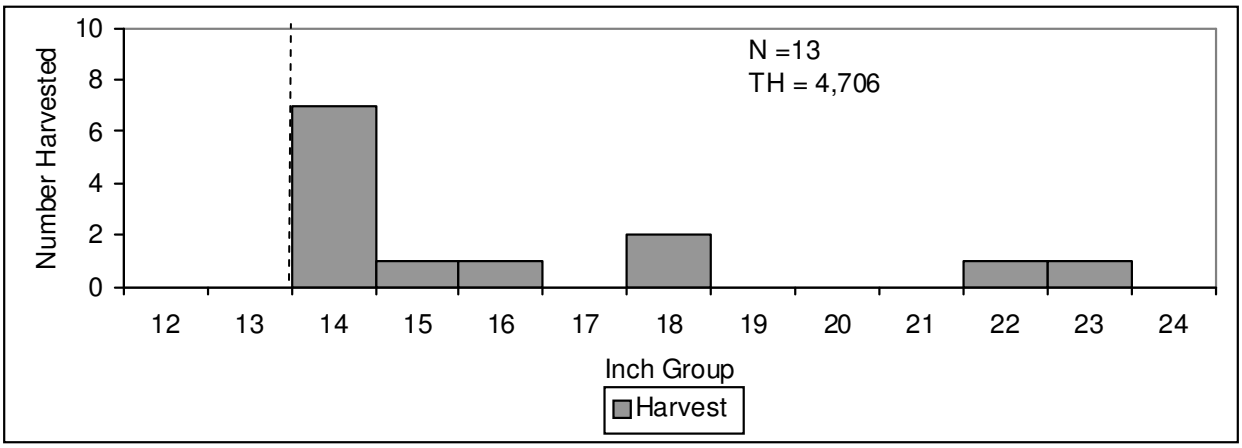
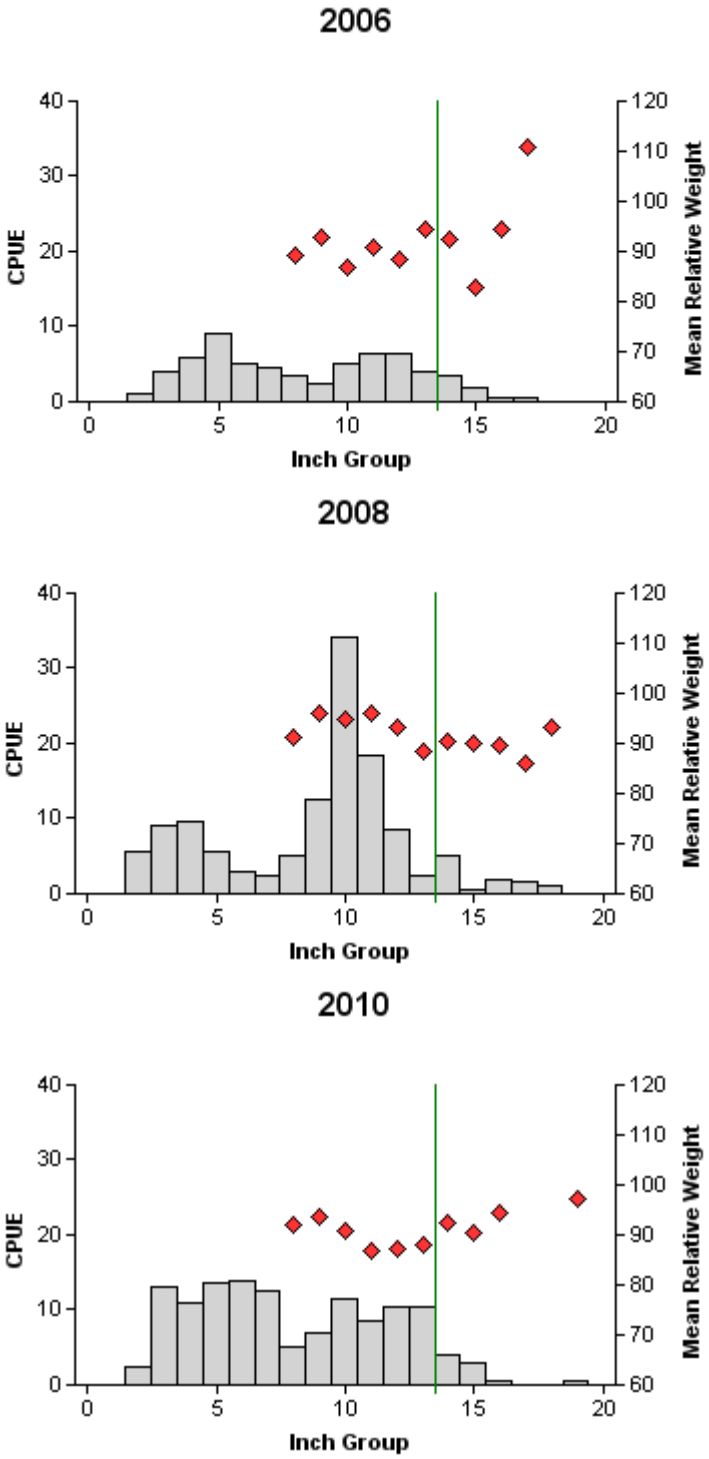


Figure 14. Length frequency of harvested smallmouth bass observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested smallmouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Fish retained during catch-weigh-release tournaments were included in harvest numbers in accordance with established procedures. Dashed line indicates minimum length limit.

Largemouth Bass



Effort =	2.0
Total CPUE =	64.0 (23; 128)
Stock CPUE =	34.5 (23; 69)
PSD =	49 (5.7)
PSD-P =	9 (2.6)
PSD-14 =	19 (5.5)

Effort =	2.0
Total CPUE =	126.0 (17; 252)
Stock CPUE =	91.0 (21; 182)
PSD =	23 (4.4)
PSD-P =	5 (2.4)
PSD-14 =	11 (3.6)

Effort =	2.0
Total CPUE =	127.5 (20; 255)
Stock CPUE =	61.0 (17; 122)
PSD =	48 (5.1)
PSD-P =	7 (2.1)
PSD-14 =	13 (2.9)

Figure 15: Number of largemouth bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2006, 2008, and 2010.

Largemouth Bass

Table 13. Creel survey statistics for black bass spp. at Belton Reservoir from June 2010 through May 2011, where total catch per hour is for anglers targeting black bass spp. and total catch and total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	127,541 (13)
Directed effort/acre	10.3
Total catch per hour	0.7 (18)
Total catch	100,164 (21)
Total harvest	43,139 (42)
Harvest/acre	3.5

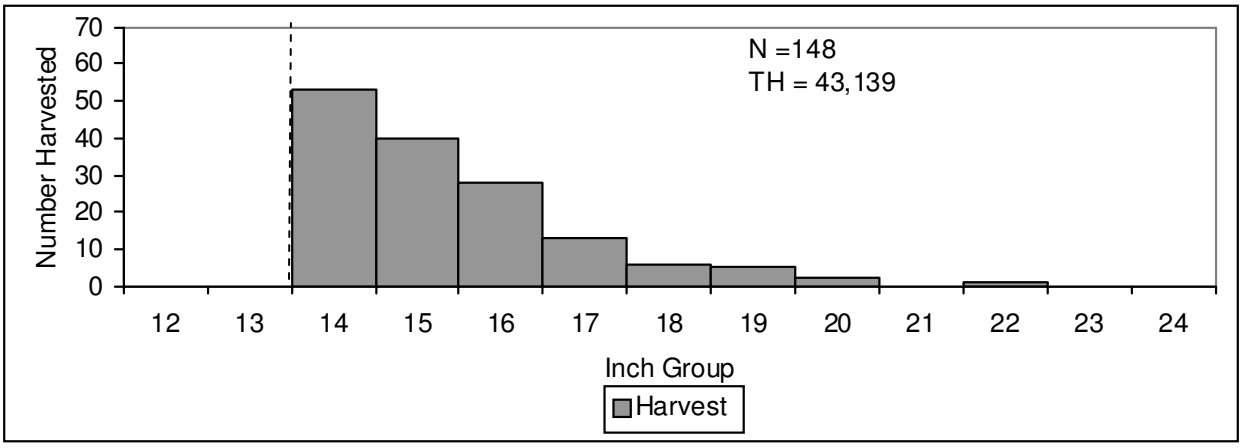


Figure 16. Length frequency of harvested largemouth bass observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Fish retained during catch-weigh-release tournaments were included in harvest numbers in accordance with established procedures. Dashed line indicates minimum length limit.

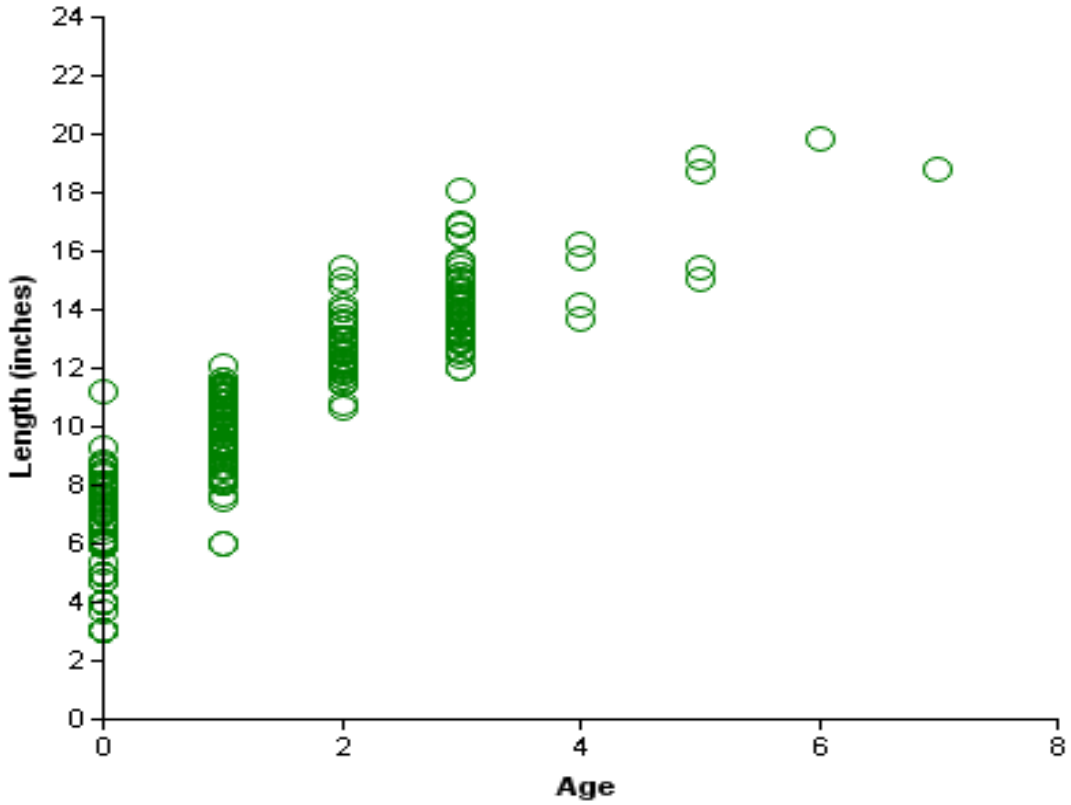


Figure 17. Length at age for largemouth bass collected by electrofishing at Belton Reservoir, Texas, Fall, 2010.

Table 14. Average length at capture for largemouth bass (sexes combined) ages 0 – 7 collected by electrofishing, Belton Reservoir, fall 2010. Lengths are followed by the sample size. Note that the age-0 data may not be representative of the actual size distribution because of gear bias against smaller fish.

	Growth	
Age	Total Length	Number of fish
0	6.3	88
1	9.8	79
2	12.7	40
3	14.1	54
4	15.0	4
5	17.1	4
6	19.8	1
7	18.8	1

Table 15. Results of genetic analysis of largemouth bass collected by fall electrofishing, Belton Reservoir, Texas, 2000, 2002, and 2006. Analysis conducted in 2004 or earlier are based on Allozyme testing, while later analysis are based on Microsatellite DNA testing. Genetic information was not collected during the 2010 electrofishing season. FLMB = Florida largemouth bass, NLMB = Northern largemouth bass, Hybrid = bass with both FLMB and NLMB alleles.

		Genotype				
Year	Sample size	%FLMB	%Hybrid	%NLMB	% FLMB alleles	% Northern alleles
2000	30	4	71	25	34	76
2002	30	17	80	3	57	43
2006	30	7	93	0	49	51

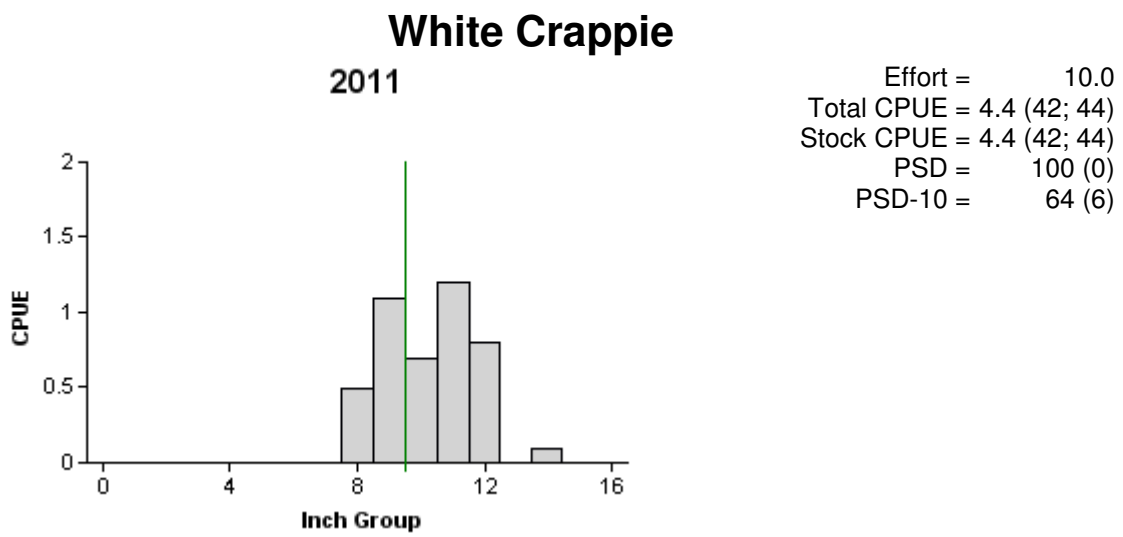


Figure 18. Number of white crappie caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2011.

Table 16. Creel survey statistics for white crappie at Belton Reservoir from June 2010 through May 2011, 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.

Directed effort (h)	16,061 (19)
Directed effort/acre	1.3
Total catch per hour	0.9 (71)
Total catch	22,404 (41)
Total harvest	16,895 (48)
Harvest/acre	1.4

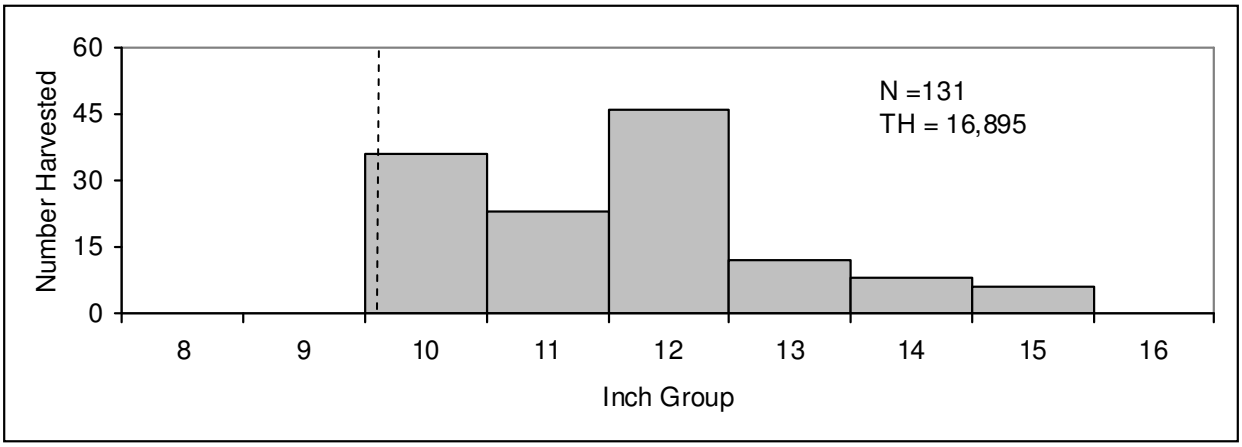


Figure 19. Length frequency of harvested white crappie. observed during creel surveys at Belton Reservoir, Texas, June 2010 through May 2011, all anglers combined. N is the number of harvested white crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Table 17. Proposed sampling schedule for Belton 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	Vegetation Survey	Access Survey	Report
Fall 2011-Spring 2012							
Fall 2012-Spring 2013	A		A				
Fall 2013-Spring 2014							
Fall 2014-Spring 2015	S		S	A	S	S	S

APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Belton Reservoir, Texas, 2010-2011. Asterisk denotes collection by a non-standard gear.

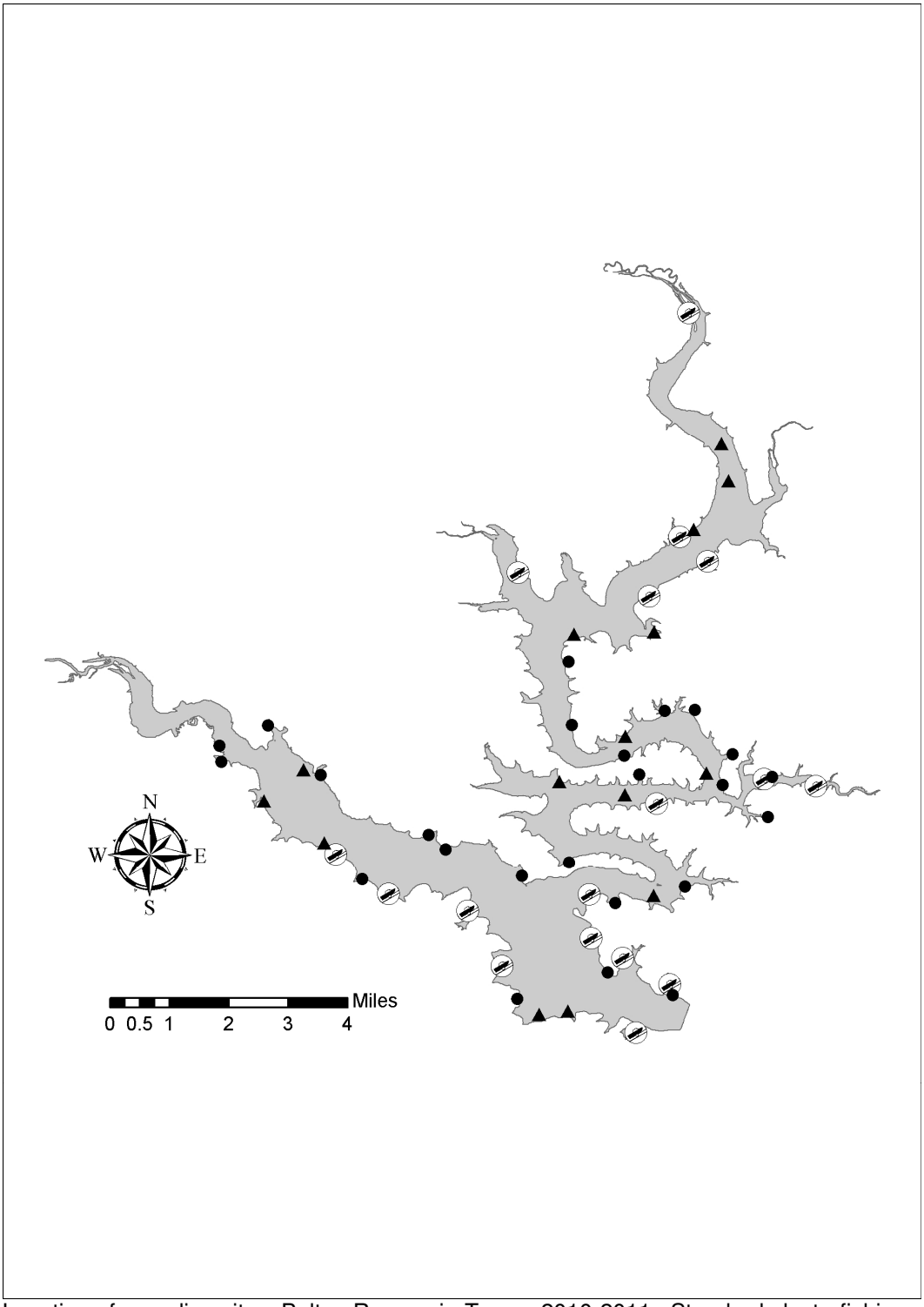
Species	Gill Netting		Electrofishing	
	N	CPUE	N	CPUE
Gizzard shad			383	191.5
Threadfin shad			122	61.0
Blue catfish	47	3.1		
Channel catfish	58	3.9		
Flathead catfish	1	0.1		
White bass	64	4.3		
Palmetto bass	83	5.5		
Green sunfish			220	110.0
Warmouth			5	2.5
Bluegill			473	236.5
Longear sunfish			135	67.5
Redear sunfish			24	12.0
Spotted bass			4	2.0
Smallmouth bass			115	57.5
Largemouth bass			255	127.50
White crappie	*44	4.4		
Black crappie	*1	0.1		

APPENDIX B

Catch rates (CPUE) of targeted species by gear type for standard surveys on Belton Reservoir, Texas, 1996 to present. All stations were randomly selected. Electrofishing stations were shocked with a 5.0 Smith-Root GPP (Gas Powered Pulsator) until 2010, when a 7.5 Smith-Root GPP began being used. Species averages are in bold. Asterisk denotes collection by a non-standard gear.

Gear	Species	1996	1999	2000	2001	2002	2003	2006	2007	2008	2009	2010	2011	Avg.
Electrofisher														
	Largemouth bass	45.5	87.0	72.0		140.0		64.0		126.0		127.5		**94.6**
	Smallmouth bass	13.5	2.5	11.5		8.0		11.0		13.0		57.5		**16.7**
	Spotted bass	8.5	1.5	1.0		1.5						2.0		**2.9**
	Gizzard shad	157.0	30.5	85.0		224.0		56.0		29.5		191.5		**110.5**
	Threadfin shad			8.0		11.0		24.5		48.5		61.0		**30.6**
	Bluegill sunfish	169.0	35.0	115.0		143.0		197.0		347.5		236.5		**177.6**
	Redear sunfish	7.0	1.5	12.0		11.0		13.5		18.0		12.0		**10.7**
	Longear sunfish		49.0	76.5		69.0		45.5		37.5		67.5		**57.5**
	Green sunfish		10.0	50.5		79.0		23.5		30.0		110.0		**50.5**
	Warmouth		0.5	1.0		1.0		1.5		1.0		2.5		**1.3**
Gill nets														
	Blue catfish	0.1	0.1		0.5		1.1		1.7		3.6		3.1	**1.5**
	Channel catfish	2.5	4.0		2.1		1.9		2.9		2.1		3.9	**2.8**
	White bass	5.5	0.3		0.2		2.8		4.2		0.7		4.3	**2.6**
	Palmetto bass	5.3	4.7		1.7		2.4		7.1		4.6		5.5	**4.5**
	Flathead catfish	0.1	0.5		0.7		0.1		0.5		0.1		0.1	**0.3**
Trap nets														
	White crappie	9.2	0.4			0.9		1.4					*1.8	**3.0**
	Black crappie												*0.1	

APPENDIX C



Location of sampling sites, Belton Reservoir, Texas, 2010-2011. Standard electrofishing and gill netting stations are indicated by circles and triangles respectively. Water level was near full pool at time of sampling.

APPENDIX D

Results from FAST modeling

Introduction

Recruitment, growth, exploitation, total mortality, and maximum size are all important population statistics to have when managing a reservoir. We calculated these statistics from data collected during management surveys in 2010 (largemouth bass) and 2011 (palmetto bass) using Fishery Analysis and Simulation Tools (FAST, Slipke and Maceina, 2000).

Methods

Largemouth bass and palmetto bass otoliths were collected using a stratified random approach in which ten fish per centimeter group were selected for otolith extraction. Additional fish within each centimeter group were assigned ages using a length-age key. Fish were initially collected during standardized sampling. Supplementary sampling to obtain more fish was conducted at non-random locations selected to maximize catch rates. Collection and processing of otoliths was conducted according to the Texas Parks and Wildlife Department Inland Fisheries Assessment Procedures (unpublished, revised manual 2009).

Total annual mortality, theoretical maximum age, L-infinity (theoretical maximum length), and residuals (year class strength) were calculated using FAST. Unweighted catch-curve regression was used to examine annual mortality, theoretical maximum age, and year class strength. The Von Bertalanffy growth function was used to determine L-infinity. Only data from age-0 through age-3 were used for largemouth bass to calculate total annual mortality, theoretical maximum age, and year class strength, because of possible gear bias for older fish described in the Texas Parks and Wildlife Department Inland Fisheries Assessment Procedures (unpublished, revised manual 2009). Theoretical maximum length was calculated using length data from all ages, as length-at-age is less affected by gear bias than other variables. Not including all data results in a very different and much lower estimate of theoretical maximum length. Only data from age-2 through age-7 were used for palmetto bass because it was clear from the data that age-1 fish were not fully recruited to the sampling gear. Fish were not segregated by sex during the analyses. Creel data were collected according to the Texas Parks and Wildlife Department Inland Fisheries Assessment Procedures (unpublished, revised manual 2009). Estimates of exploitation were determined from this information.

Results and Discussion

The results are shown in the accompanying table. The largemouth bass population was sampled in 2010 and the palmetto bass population in 2011.

The largemouth bass population exhibited the lowest total mortality calculated to date among reservoirs (N=6, range 34% - 71%) in the district. Projected maximum size and age were also relatively high. However, the large cohort from the high water year in 2007 violated the assumption of equal recruitment required by the FAST model. If we include only Age-0 through Age-2 data in the model, and the Age-3 (2007) year class is removed, the mortality rate is 43.6% which is much more comparable to other reservoirs in the district. The mortality observed appears to be due to reasons other than angling as most age-0 to age-3 largemouth bass are not vulnerable to angling. Few bass larger than 14” total length were collected.

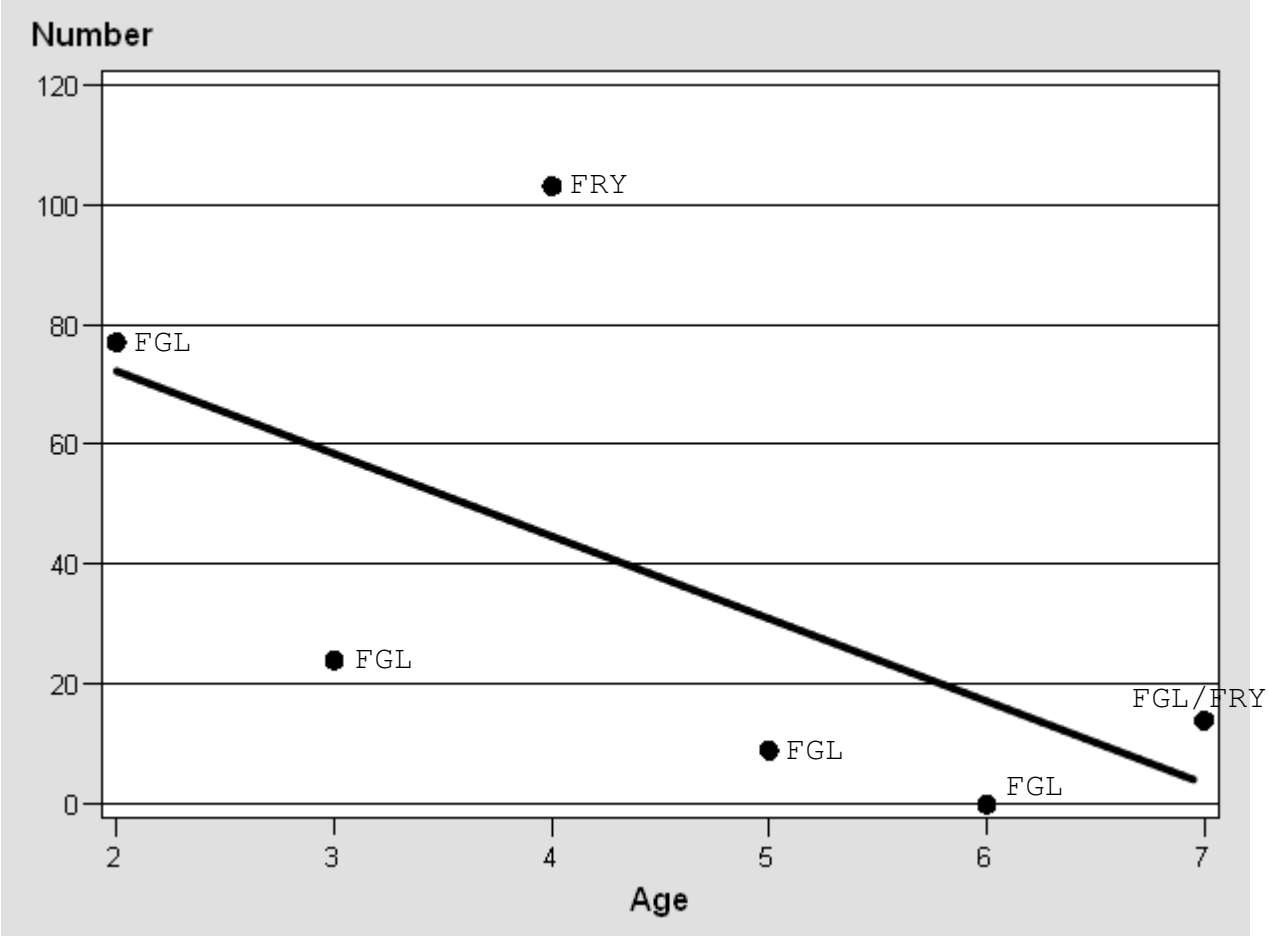
The calculated total mortality, maximum size and maximum age of the palmetto bass population was within the range expected. The total mortality was similar to estimates of white bass mortality calculated in Limestone and Waco reservoirs in 2005 and 2008 respectively. The maximum size and age illustrates the reservoirs potential for a quality palmetto bass fishery.

The residuals from the linear regression allowed us to compare the relative success of our fingerling and

fry stockings (see Table 3 for complete stocking information). The following graph and table shows the cohorts with the highest success. The age-7 fish were from a mixed fingerling/fry stocking in 2004 that did extremely well. The only other obvious difference during 2004 compared to other years was a high water spike in November that lasted about a month and peaked at 17' above conservation pool (Baird and Tibbs, 2007). Spring water levels were similar to other years. Poor recruitment was observed from 2005 and 2006 fingerling stockings, with low lake levels starting in October, 2005 and continuing until April, 2007. Fry were stocked again in 2007 and recruitment was excellent. However, another confounding factor was the high lake levels starting in June 2007, and continuing through October with a peak of 36' above conservation pool (Figure 1). Recruitment was again poor from the 2008 fingerling stockings although water levels were more "normal". In 2009, recruitment from the fingerling stocking was slightly higher than expected based on the regression line although water levels were below conservation pool most of the year. Although they aren't shown on the graph or table because they weren't fully vulnerable to our sampling gear, some fish from 2010 fry were collected, indicating some level of success with that fry stocking.

In summary, fry stockings show a great deal of promise in Belton, but the confounding factor of water level makes a clear determination difficult at this time. It is also possible that highly successful year classes (2004, 2007) depressed the numbers of fish recruited from stockings the year following (2005, 2008). Further evaluation is required and is detailed in the management strategies section of this report.

Number of palmetto bass collected by age with linear regression line fitted to data (Graph generated by SAS Enterprise Guide plug-in for Excel). FRY = fry stocking; FGL = fingerling stocking.



Number of palmetto bass collected by age with residuals calculated from linear regression (Fishery Analysis and Simulation Tools (FAST), Slipke and Maceina, 2000). A positive residual indicates a stronger than expected cohort, whereas a negative residual indicates a weaker than expected cohort.

Age	Number	Ln(Number)	Predicted Number	Predicted Ln(Number)	Residual
2	77	4.357	75.009	4.318	0.039
3	24	3.219	42.067	3.739	-0.52
4	103	4.644	23.593	3.161	1.483
5	9	2.303	13.232	2.583	-0.28
6	0	0	7.421	2.004	-2.004
7	14	2.708	4.162	1.426	1.282

Population parameters of largemouth bass and palmetto bass in Belton Reservoir, 2010-2011. Estimates were obtained using the Fast Modeling Program.

Species	N aged	Total Mortality	Exploitation rate	Maximum size (L-infinity)	Maximum age	Residuals
Largemouth bass	425	29.3%	3.48/acre	23.4”	14.6	-0.362 to 0.226
Palmetto bass	232	43.9%	1.48/acre	22.5”	9.5	-2.004 to 1.483