PERFORMANCE REPORT

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2014 Fisheries Management Survey Report

Belton Reservoir

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TABLE OF CONTENTS

SURVEY AND MANAGEMENT SUMMARY

Fish populations in Belton Reservoir were surveyed in 2014 using electrofishing and in 2015 using gill netting. Anglers were surveyed from June 2014 through May 2015 with a creel survey. Historical data are presented with the 2014-2015 data for comparison. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** 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 six 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 Catfishes. The management plan from the 2010 survey report included the continued evaluation of fry versus fingerling Palmetto Bass stockings, spring-time collection efforts for Smallmouth Bass for the hatchery program, working with the U. S. Army Corps of Engineers and bass tournament directors to improve the survivability of tournament-caught fish, improving habitat by introducing and monitoring native vegetation, and monitoring the reservoir for invasive species (e.g., Zebra Mussels) and educating marina owners and constituents about their issues and threats. Despite efforts, Zebra Mussels were confirmed in Belton Reservoir in August 2013, and the reservoir is now infested. Recent efforts have included a comprehensive public relations campaign to further educate Belton stakeholders about Zebra Mussels, how to inspect and clean, drain and dry their watercraft, and the new statewide water draining laws meant to prevent the spread of Zebra Mussels to other Texas waters.

- **Fish Community**
  - **Prey species:** Threadfin Shad catch rates were near historical averages while Gizzard Shad catch rates were well below historical averages. Other forage species included Bluegill, Longear Sunfish, Green Sunfish, Redear Sunfish, Redbreast Sunfish and Warmouth. Larger-sized sunfishes (particularly Redear Sunfish) were observed.

  - **Catfishes:** The Blue and Channel Catfish populations are good, with fair catch rates and good body condition. Over 17% of all anglers at Belton Reservoir fished for some species of catfish.

  - **Temperate Bass:** White and Palmetto Bass were abundant in gill net samples, and had average body condition. Together, they accounted for 8.6% of the fishing effort in the reservoir.

  - **Black Bass:** Largemouth Bass were collected at near historical low catch rates, while Smallmouth Bass were collected at historical high catch rates. These populations had good size structure, and individuals generally had good body condition. Largemouth and Smallmouth Bass angling accounted for 40.4% of the fishing effort in the reservoir.

  - **White Crappie:** White Crappie were relatively abundant in the 2013 and 2015 gill net surveys, and had good body condition. White Crappie comprised 8.5% of the total angling effort in the reservoir.

  - **Management Strategies:** Manage sport fishes at Belton with statewide regulations. Plant additional native vegetation as water levels allow. Maintain invasive species

signage at boat ramps and inform the public about the negative impacts of aquatic invasive species when presenting to Belton user groups. Conduct access and vegetation surveys during summer 2018. Survey with trap nets, gill nets, and electrofishing in 2018-2019. Obtain a Category 3 age-and-growth sample for Palmetto Bass in 2019 to test the effects of stocking two different fry stocking rates. Obtain a Category 3 age-and-growth sample for Smallmouth Bass in 2018 to test the effects of increased water levels and fingerling stocking on year-class strength. Work with the USACE and constituent groups to inform and educate about best practices for tournament weigh-ins.

INTRODUCTION

This document is a summary of fisheries data collected from Belton Reservoir in 2014-2015. 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 2014-2015 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 ten to eleven feet low during 2014 and 2015 surveys (Figure 1; Table 1; Appendix C). Fish habitat at time of sampling consisted primarily of natural and rocky shorelines, with limited standing timber and little to no aquatic vegetation (Table 5). Bank fishing and boat access is excellent with numerous parks and seventeen public boat ramps (Table 2; Appendix C).

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Tibbs and Baird 2010) included:

1. Request Palmetto Bass fry stockings at 100 fish/acre in 2012 and 2013 and fingerling stockings at 10 fish/acre in 2014 and 2015. 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. Work with two other districts that have Palmetto Bass fisheries to evaluate the viability of fry stockings in other reservoirs.
   Action: Requests were initially made according to the plan; however, Palmetto Bass were unavailable during 2012. Palmetto Bass were then stocked at 100 fry/acre in 2013, three fingerlings/acre in 2014 and 40 fry/acre in 2015. Supplemental Sunshine Bass were stocked at two fingerlings/acre in 2014 also. Standard gill netting was conducted in spring 2015 and supplemental gill netting in spring 2013. Recruitment data from these surveys are included in this report. Belton Reservoir's Palmetto Bass fishery is slated for inclusion in a multi-reservoir research project currently under review.
2. Request Smallmouth Bass stockings at 25 fish/acre annually. Continue spring time collection efforts for Smallmouth Bass to be used by hatcheries as brood stock when requested. Conduct additional electrofishing during fall 2012, and collect a category III age-and-growth sample during fall 2014 to document year class strength and relate to stocking densities. Publicize the excellent Smallmouth Bass fishing through news releases.
   Action: Smallmouth Bass have been requested annually; fingerlings were stocked at

2/acre in 2012 and 14/acre in 2014. No Smallmouth Bass brood fish have been requested from hatcheries since the 2010 survey report was written. Standard and non-standard electrofishing was conducted (category III age-and-growth sample collected) during fall 2014 and supplemental electrofishing was conducted in fall 2012. Data from these surveys are included in this report. Smallmouth Bass fishing at Belton Reservoir has been publicized consistently while speaking to constituent groups such as the Central Texas Flyrodders, Legacy Outfitters, and Brazos River Sportsman's Club over the past several years.

3. Conduct an angler creel in 2014-2015 to determine if tournament angling pressure changed, and use this information along with population sampling data to determine if additional strategies are necessary to protect the black bass fishery. Request historical data on tournament permits issued by the U.S. Army Corps of Engineers (USACE), and determine if the data are suitable for examining trends. Discuss best practices for tournament weigh-ins with USACE personnel and suggest requiring it of tournaments held on the reservoir; suggest the USACE house one or more weigh-in kits if they would be used. 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.

   Action: A roving angler creel was conducted from June 1st, 2014 through May 31st, 2015, and the black bass population was surveyed by electrofishing in fall 2014. Results from the creel and electrofishing surveys are included in this report. Tournament permit numbers were obtained from the USACE in 2015 and compared over the period represented. No formal meeting with the USACE was held to discuss best practices for tournaments. A tournament weigh-in kit was borrowed from another office in 2015 to use in presentations to area bass clubs in the future.

4. Form a partnership with the USACE and interested user groups to introduce native vegetation to Belton Reservoir. Request species of native vegetation from The Freshwater Fisheries Center (TFFC) in Athens and utilize partners to plant when appropriate. Monitor the plantings annually pending observations, review the program at the next report writing, and make recommendations.

   Action: A partnership was formed with the USACE and interested user groups to introduce native vegetation into Belton Reservoir. Three sites were planted with approximately 100 Water Willow plants each with the help of Student Conservation Association (SCA) volunteers. The sites were planted during late summer 2012 and monitored once during late summer 2013. Additional monitoring was difficult because water levels fell from that point forward until rains filled the reservoir to 15' over conservation pool in late spring, 2015 (Figure 1). Plantings are scheduled to continue when the reservoir reaches normal elevations again.

5 Cooperate with the controlling authority to post appropriate invasive species signage at access points throughout the reservoir. Educate the public about invasive species through the use of media and the internet. Make a speaking point about invasive species when presenting to constituent and user groups. Keep track of (i.e., map) all existing and future inter-basin water transfer routes to facilitate potential invasive species responses.

   Action: Invasive species signage was posted at Belton access points during summer 2013. District biologists have made a speaking point about invasive species (e.g., Zebra Mussels), how to prevent their spread, and potential effects on Belton Reservoir, while speaking to constituent groups such as the Central Texas Flyrodders, Legacy Outfitters, and Brazos River Sportsman's Club, since the last report. Zebra Mussels were confirmed in Belton Reservoir in August 2013 and the reservoir is now infested. Details on the infestation can be found in this report.

Harvest Regulation History: Sportfishes in Belton Reservoir have always been managed with statewide regulations (Table 3).

Stocking History: Smallmouth and Palmetto Bass stockings are requested every year. Historical stockings of Palmettos have been consistent, with a few exceptions. Sunshine Bass fingerlings were stocked to supplement Palmetto Bass in 2014. Smallmouth Bass fingerlings were stocked in 2012 (20,225) and 2014 (171,381). The complete stocking history is in Table 4.

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 reports of hydrilla in the past, but none confirmed by TPWD surveys. A grass roots initiative began in 2006 by Centex Bass Hunters, in conjunction with Bass Anglers Sportsman's Society (BASS), Texas Parks and Wildlife Department (TPWD), and the USACE aquatic research laboratory in Lewisville, to establish native aquatic vegetation in Belton Reservoir. Funding contributions from that effort fell short of expectations, yet the interest and need to try and improve fish habitat in Belton remained. A second effort to introduce native vegetation into Belton Reservoir was initiated by TPWD in 2012, and three sites were planted with approximately 100 Water Willow plants each later that year. Water levels steadily dropped ever since, and the planted sites were well above the current reservoir elevation (Figure 1) until heavy rains filled the reservoir to 15' over conservation pool in late spring, 2015. Plantings are scheduled to continue once the reservoir reaches normal elevations again. Currently, no noxious vegetation is known to exist in the reservoir.

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 were completed by the Texas Water Development Board (TWDB) on Belton since impoundment; one in 1994 and one in 2003. The 1994 survey calculated a volume of 434,500 acre-feet and a surface area of 12,385 acres at conservation pool (TOL), whereas the 2003 survey calculated a volume of 435,225 acre-feet and surface area of 12,135 acres. According to the TWDB, the two surveys are within the margin of error and are essentially identical.

Water Transfer: Belton Reservoir is primarily used for flood control, municipal water supply, and recreation. There are three raw water intake stations on the reservoir which transfer water offsite to water treatment facilities. 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 was a 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. However the recent Zebra Mussel infestation in Belton makes implementation of this proposal unlikely.

Zebra Mussels: Zebra Mussel monitoring began on Belton Reservoir in 2012. Signage was posted at the 17 public boat ramps to make boaters aware of the threat of aquatic invasive species including Zebra Mussels, yet by the end of summer 2013, Zebra Mussels were found throughout the reservoir. Educational signage posted in 2013 was then replaced with new signage and boat ramp stencils warning boaters that the reservoir was infested with Zebra Mussels. During summer, 2014, TPWD continued the public awareness campaign by hiring two interns to educate boaters and other watercraft users about Zebra Mussels, the new water draining rules in Texas public waters, how to properly inspect a watercraft, and the importance of the campaign slogan "Clean Drain and Dry" in maintaining their watercraft. Interns educated 945 watercraft owners at Belton and 256 watercraft owners at Stillhouse Hollow access points during weekends and holidays, 2014. The 2015 internships are slated to focus on Belton and other at-risk reservoirs throughout central Texas.

METHODS

Fishes were collected by electrofishing (2.0 hours at 24 5-minute stations) and gill netting (15 net nights at 15 stations). An additional 10.0 hours of non-standard daytime electrofishing and 8.0 net nights of gill netting were conducted in order to collect category III age and growth samples for Smallmouth and

Palmetto Bass. 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). Surveys were conducted to achieve survey and sampling objectives in accordance with Belton's Objective-Based Sampling Plan (FY 2015) (Appendix E). All standard survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2014).

A year-long roving creel survey was conducted from June 1, 2014 through May 31, 2015. Angler interviews were conducted on 5 weekend days and 4 weekdays per quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2014).

Belton Reservoir's average surface area was below 90 percent of surface area at conservation pool during the 2014/2015 creel period. So, TWDB data were used to derive an appropriate average surface area for Belton Reservoir during the creel period, for the purpose of determining creel statistics such as directed effort/acre and harvest/acre. Surface area data among creel quarters did not vary by more than five percent (e.g., summer 2014 (10,220 acres), fall 2014 (9,772 acres), winter 2014/2015 (9,695 acres) and spring 2015 (9,868 acres), therefore a single average surface area was used (i.e., 9,888 acres). (Creel Survey Procedures; TPWD, Inland Fisheries Division, unpublished manual revised 2014)

A structural habitat survey was conducted in 2010. A vegetation survey was conducted in 2014, however there was no aquatic/littoral vegetation observed due to low water levels. Habitat was assessed with the digital shape file method (TPWD, Inland Fisheries Division, unpublished manual revised 2014).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), terminology modified by Guy et al. 2007], and condition indices [relative weight (W_r)] were calculated for target fishes according to Anderson and Neumann (1996). Palmetto Bass PSD was calculated according to Dumont and Neely (2011). Index of vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE and creel statistics. Largemouth, Smallmouth and Palmetto Bass ages were determined using otoliths from 5 to 10 fish per inch group.

Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2014). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2014 and by electrophoresis for previous years.

Source for water level data was the United States Geological Survey (USGS 2015) and Texas Water Development Board (TWDB 2015).

RESULTS AND DISCUSSION

Habitat: A habitat survey was last conducted in 2010 (Tibbs and Baird 2011) (Table 5).

Creel: Directed fishing effort by anglers was highest for black bass spp. (40.4%), followed by anglers fishing for anything (24.3%), catfish spp., Blue Catfish, Channel Catfish, and Flathead Catfish combined (17.4%), temperate bass spp., Palmetto Bass and White Bass combined (8.6%), and lastly crappie spp., Black and White Crappie combined (8.5%; Table 6). Total fishing effort for all species at Belton Reservoir

was 227,085 hours from June 2014 to May 2015, which is lower than the previous creel survey from June 2010 to May 2011 (315,021 hours). Anglers spent an estimated $1,648,189 on direct expenditures in '14-'15, compared to $2,590,627 in '10-'11. These declines are likely due to lower water levels during the creel period. Bank anglers contributed 35% of the total fishing effort and $285,368 of the total expenditures in '14-'15 as compared to 32% and $660,284 in '10-11".(Table 7).

Prey species: The objective-based sampling plan for Belton Reservoir included collecting size and availability data for the major prey species (i.e., Bluegill, Longear Sunfish, Gizzard Shad and Threadfin Shad; Appendix E). The electrofishing catch rates of Threadfin and Gizzard Shad were 33.0/h and 30.5/h respectively, and were well below those from the previous survey (Figure 2; Appendices A and B). Index of vulnerability (IOV) for Gizzard Shad was poor, and only 67% of Gizzard Shad were available to existing predators as forage. Bluegill catch rates remained good at 161.5/h, comparable to the historical average of 164.0/h (Figure 3; Appendices A and B). The proportional size distribution (PSD) for Bluegill is defined as the proportion of 3" and longer individuals which are also 6" and longer within the population. Proportional size distribution remained poor (5) and was similar to the PSD of the previous two surveys (Figure 3; Appendices A and B). Longear Sunfish catch rates were above the historical average (85.5 /h) (Figure 4; Appendices A and B). Other forage species collected were Green Sunfish (100.0/h), Redear Sunfish (2.5/h), Redbreast Sunfish (0.5/h), and Warmouth (0.5/h). Panfish seldom reach preferred size classes in Belton and few anglers actively seek them; however good catches of Redear Sunfish in the preferred size class, were observed during 2015 gill netting. Thus, some large panfish are available for anglers in Belton Reservoir.

Catfishes: The objective-based sampling plan for Belton Reservoir's Blue and Channel Catfish included collecting a minimum of 50 stock length fish for each species, in order to allow comparison of trend data and length-frequency histograms among years (Appendix E). Blue Catfish catch rates were 3.1/nn (2013) and 2.3/nn (2015), both higher than the historical average (Figure 5; Appendices A and B). These catch rates equated to 47 and 35 fish in 2013 and 2015 respectively, so the Objective Based Sampling (OBS) plan's target was not met during spring 2015 sampling. The PSD for Blue Catfish is defined as the percentage of 12" and longer individuals which are also 20" and longer. The PSD improved from 2013 to 2015, but was still low (i.e., 20), illustrating an imbalanced population, perhaps due to high or variable recruitment or slow growth (Figure 5). Body condition, expressed as relative weight (Wr), averaged around 80 during 2013 and 85 during 2015. One sampled fish approached the memorable size category of 35" (Figure 5).

Channel Catfish catch rates were 1.4/nn (2013) and 1.3/nn (2015), both well below the historical average (Figure 7; Appendices A and B). These catch rates equated to 21 and 19 fish in 2013 and 2015 respectively, so the OBS target was not met in 2015. The PSD for Channel Catfish is defined as the percentage of 11" and longer individuals which are also 16" and longer. Proportional size distribution was good to fair over the past two surveys (i.e., 39 and 69 respectively), illustrating a balanced population (Figure 7). Body condition (Wr) was excellent, averaging from 90 to 100 during 2013 and 2015 (Figure 7).

The Flathead Catfish population is a low density one and only eight individuals were collected over the past two surveys (Appendices A and B).

Creel data from 2014-2015 demonstrated that catfishes are an important component of Belton's fishery. A total of 5,276 Channel Catfish were caught, of which 3,790 were harvested. Blue Catfish surpassed Channel Catfish with 7,616 caught of which 6,009 were harvested. Directed fishing effort, catch per hour, and total catch for all catfish showed a thriving catfish fishery (Tables 6, 8 and 9; Figures 6 and 8).

Temperate bass: The OBS plan for Belton Reservoir's White Bass included collecting a minimum of 50 stock length fish, in order to allow comparison of trend data and length-frequency histograms among years, and to inform anglers about the upcoming White Bass population (Appendix E). The gill net catch

rate for White Bass was 6.7/nn in both 2013 and 2015 (Figure 9; Appendices A and B). These catch rates equated to 101 fish in each year, so the OBS target was met during both surveys (Figure 9). Over 60 percent of the population has been legally harvestable for the past three surveys, and body condition (Wr) has averaged 85 during the same time period (Figure 9).

Creel data from 2014-2015 demonstrated that White Bass are an important component of the temperate bass fishery. A total of 24,543 White Bass were caught, of which 8,955 were harvested (Tables 6 and 10; Figure 10).

The OBS plan for Belton Reservoir's Palmetto Bass included collecting a category III age and growth sample (200 stock-sized fish) in order to compare recruitment between years where fry versus fingerlings were stocked, and is a continuation of work begun in 2011 (Appendix E). The standard gill net catch rate for Palmetto Bass was 8.9/nn in 2013 (N = 133) and 7.7/nn in 2015 (N = 177) (Figure 11). A total of 23 randomly placed gill nets was the effort required to collect the category III sample in 2015 (Figure 11; Appendices A and B). Although the 2015 sample size is below the target mentioned in the OBS plan for this species, virtually all sampled size classes of Palmetto Bass exceeded the 5 fish per cm threshold with the exception of the very oldest fish. Thus, most fish collected in the last few nets were surplus to our sampling needs. Proportional size distribution (PSD, 50) was excellent in 2015, indicating a balanced population, and 27 percent of stock-size fish (PSD-18) was of harvestable size (i.e., 18"). Body condition (Wr) averaged around 80 (Figure 11). Growth was excellent, with all collected fish exceeding 18" after four growing seasons (Age-4) with a mean length of 19.9" (Figure 13, Table 12). This was very similar to the 2011 gill netting survey, in which the vast majority of fish exceeded 18" after four growing seasons, and mean length was also 19.9". Relative weight (Wr) appeared to decrease from 2011 through 2015, indicating that increased Palmetto Bass densities may be adversely impacting prey availability. This pattern was not manifested in other predator species.

Creel data from 2014-2015 demonstrated that Palmetto Bass are an important component of the temperate bass fishery. A total of 22,664 Palmetto Bass were caught, of which 6,381 were harvested (Tables 6 and 11; Figure 12).

Percent directed effort and catch per hour for temperate bass spp. declined in the 2014-2015 creel as compared to the 2010-2011 creel. Additionally, total harvest of White Bass and Palmetto Bass declined over the same time period (Table 6). Low water levels and lack of inflow in the spring likely reduced angling effort for White Bass in particular, and reduced catch of both White and Palmetto Bass.

Tibbs and Baird (2006) included a management strategy of alternating Palmetto Bass stockings between fry and fingerlings in order to determine which stocking methodology contributed most efficiently to the fishery. The strategy called for fry stockings at 100 fish/acre in 2009 and 2011 and fingerling stockings at 15 fish/acre in 2008 and 2010. Although requests were initially made according to plan, fry and fingerling Palmetto Bass were received and stocked according to availability (Table 4). In 2011, a sample of 232 Palmetto Bass was collected and aged or assigned ages from a length-age key (Tibbs and Baird 2010). Dominant year classes identified from this sample were 2004 and 2007, both years in which fry were stocked. Due to potential confounding factors affecting recruitment (i.e., water levels and possible intraspecific competition), additional evaluations were recommended. Two additional category III age and growth samples have been collected since the 2010 survey report: 133 individuals during spring 2013 and 177 individuals during spring 2015. Collectively, dominant year classes of Palmetto Bass have been observed for 2004, 2007, 2010 and 2013, all years when fry were stocked. These observations validate that fry stocking is the more effective of the two strategies. Appendix D contains results and additional discussion that culminates in a suggestion for future refinement in our fry stocking strategy.

Black bass: The OBS plan for Belton Reservoir's Smallmouth Bass included collecting a category III age and growth sample in order to calculate precise length-at-age, year class strength, and mortality rates (Appendix E). Smallmouth Bass were collected by standard electrofishing at 39.0/h in 2012 and 49.0/h in

2014; these catch rates equate to 78 and 98 collected individuals and was well above the historical average for the reservoir (Figure 14 and Appendices A and B). Figure 15 shows two hours of supplemental electrofishing data for the 2012 survey as well as 10 additional hours of non-standard electrofishing (n=374 collected individuals) necessary to collect the category III sample during fall 2014 (Figure 15; Appendices A and B). Population size structure for the standard survey was good with good recruitment (presumably from stockings) and good numbers of legal-sized fish (PSD = 48; PSD-14 = 19) (Figure 14). Body condition ranged from good to poor, and generally decreased with increasing size class; this is the third consecutive survey in which this trend was evident (Figure 14). Smallmouth Bass growth was adequate with a mean total length of 15.4" after four growing seasons (Age-3) (Figure 17; Table 14). Smallmouth Bass brood stock were last collected from Belton in 2011 (N = 200; total length 6"-16") and provided to hatcheries in an effort to rebuild the Smallmouth Bass hatchery program.

Creel data from 2014-2015 demonstrated that Smallmouth Bass are an important component of the black bass fishery. A total of 13,799 Smallmouth Bass were caught, of which 3,677 were retained, most for weigh-in at tournaments before release (Tables 6 and 13; Figure 16).

The OBS plan for Belton Reservoir's Largemouth Bass included collecting a minimum of ten times the number of expected length classes in order to allow comparison of length-frequency histograms among years and augment the category IV age and growth sample collected in 2010 (Appendix E). Largemouth Bass were collected by standard electrofishing at a rate of 127.5/h in 2010 and 41.0/h in 2014. These catch rates equate to 255 and 82 collected individuals (Figure 18 and Appendices A and B). Figure 19 shows 2.8 hours of bass-only electrofishing data for 2010 which augmented standard electrofishing to collect a category IV age and growth sample (n=374 collected individuals), and a 2012 supplemental electrofishing survey (2.0 h of effort) (Figure 19; Appendices A and B). The OBS target of ten times the expected number of size classes (i.e., 10 times 20 length classes = 200) was not met during the 2014 survey, most likely due to low water levels and lack of good habitat to electrofish which reduced catch rates. However, the CPUE RSE was less than 25, meeting minimum requirements for comparing CPUE among years. The PSD for the standard survey was excellent with steady recruitment and fair numbers of legal-sized fish (PSD = 58; PSD-14 = 13) (Figure 18). Body condition (Wr) in 2014 was good, and typically averaged around 90 (Figure 18). Largemouth Bass growth was good with a mean total length of 14.1" after four growing seasons (Age-4) (Figure 21; Table 16). Largemouth Bass genetics were analyzed in 2014 and showed good Florida influence (46%; Table 17). The downward trend in Florida influence is of some concern. Belton is capable of producing trophy Largemouth Bass, as evidenced by the 13.0 lb lake record, set in 2006.

Creel data from 2014-2015 demonstrated that Largemouth Bass are heavily utilized. A total of 51,293 Largemouth Bass were caught, of which 8,400 were retained, most for weigh-in at tournaments before release (Tables 6 and 15; Figure 20). However, these numbers are much less than the previous creel.

The number of bass tournament permits for each calendar year represented in this report was obtained from the USACE (Ronald L. Bruggman, pers. comm. 2015) (Table 18). Not all tournaments were permitted, so the numbers should be viewed as an index of tournament pressure over time. The number of permits for calendar year 2010 (55) and 2011 (52) are the highest on record. This encompasses the period of our previous creel survey, where we documented much higher numbers of Largemouth and Smallmouth Bass retained for weigh-in as compared to the most recent creel survey.

White crappie: The OBS plan for Belton Reservoir's White Crappie included collecting a minimum of 50 stock length fish, in order calculate proportions (e.g., PSD, PSD-10) and allow comparison of trend data and length-frequency histograms among years, and to inform anglers about the White Crappie population (Appendix E). Historical trap netting catch rates for White Crappie were low, and trap netting is no longer a standard sampling method for this species in Belton. Instead, gill netting is currently being evaluated as a non-standard gear to collect data on this population. The gill net catch rate for White Crappie was 2.7/nn and 0.7/nn in 2013 and 2015 respectively (Figure 22; Appendices A and B). These catch rates

equate to 41 and 11 fish, so the OBS target was not met during either survey. Body condition (Wr) averaged 90 or better during 2015.

The Black Crappie population is a low density one with very few individuals sampled in 2011 and 2015 (Appendices A and B).

Creel data from 2014-2015 demonstrated that Crappie Spp. angling was exceptionally good. A total of 66,763 Crappie spp. were caught, of which 27,351 were retained. (Tables 6 and 19; Figure 23). This was an increase over 2010-2011, and was likely the result of low water concentrating Crappie Spp. in submerged timber along the shoreline that was visible to anglers.

Fisheries management plan for Belton Reservoir, Texas

Prepared – July 2015

ISSUE 1: A partnership was formed with the USACE and interested user groups to introduce native vegetation into Belton Reservoir. Three sites were planted with approximately 100 Water Willow plants each with the help of Student Conservation Association (SCA) volunteers. The sites were planted during late summer 2012 and monitored once during late summer 2013. However Belton Reservoir's water level following the planting continued to decrease through 2014 until heavy rains increased water levels to 15' over conservation pool as of late spring, 2015.

MANAGEMENT STRATEGIES

1. Continue plantings with the help of interns, volunteers and other interested groups when water levels are appropriate.
2. Request appropriate species of native vegetation from the Texas Freshwater Fisheries Center (TFFC) aquatic plant nursery if local sources are insufficient.
3. Monitor native vegetation plantings on an annual basis and review the program during the next report year.

ISSUE 2: Despite preventative efforts, Zebra Mussels were found throughout Belton Reservoir in August 2013. Educational signage previously posted was replaced with new signage, warning boaters that the reservoir was infested with Zebra Mussels. During summer, 2014, TPWD continued public awareness efforts with the help of interns, hired to educate boaters and other watercraft users about Zebra Mussels, the new water draining rules, and how to inspect and maintain watercraft. Waco Inland Fisheries District interns educated 945 watercraft owners on Belton during weekends and holidays, 2014, yet many constituents are still unfamiliar with Zebra Mussels, and the threat of contaminating other Texas reservoirs with Belton water, veligers and zebra mussels still exists.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to maintain warning signage at access points.
2. Maintain contact with marina owners about invasive species, and provide them with posters, literature, etc. so that they can continue to educate their customers.
3. Continue to educate the public about invasive species (e.g., Zebra Mussels) through the use of direct contacts at ramps, 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.

ISSUE 3: Collectively, dominant year classes of Palmetto Bass have been observed for 2004, 2007, 2010 and 2013, all years when fry were stocked (See Appendix D for results and discussion). 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. It is possible that the standard stocking rate of 100 fry/acre exceeds what is needed to maintain Belton's Palmetto Bass fishery.

MANAGEMENT STRATEGIES

1. Discontinue Palmetto Bass fingerling stockings and request Palmetto Bass fry to be stocked at 50 or 100/acre in alternating years.
2. Share data or work with other districts to evaluate the viability of Palmetto Bass fry stockings in other Texas reservoirs.
3. Collect a Category 3 age sample in 2019 to evaluate the effects of lower density fry stockings on recruitment.

ISSUE 4: The objective-based sampling plan for Belton Reservoir's Smallmouth Bass included collecting a category III age and growth sample in order to calculate precise length-at-age, year class strength, and mortality rates (Appendix E). Smallmouth Bass were collected by standard electrofishing at a rate of 49.0/h in 2014. That standard sample, plus ten hours of bass-only day-time electrofishing collected a category III sample of 287 individuals during fall 2014. Results from that evaluation indicated that stocking had no impact on the number of Smallmouth Bass recruiting to the population, indicating that other factors were limiting the Smallmouth Bass population (See Appendix D for results and additional discussion). It was hypothesized that rearing habitat during the first year of life was limiting, and that high water could positively impact availability.

MANAGEMENT STRATEGIES

1. Continue to request Smallmouth Bass stockings on an annual basis.
2. Collect a Category 3 age sample in 2018 to evaluate the effects of high water levels on recruitment in 2015 and subsequent years.
3. Continue collection efforts for Smallmouth Bass to be used by hatcheries as brood stock when requested.
4. Make a speaking point about the excellent Smallmouth Bass fishery in Belton Reservoir when presenting to constituent and user groups.

ISSUE 5: Tibbs and Baird (2010) determined that black bass was the most heavily-used sport fish group in Lake Belton, and many tournaments were held on the reservoir. A total of 43,139 Largemouth and 4,706 Smallmouth Bass were harvested or retained in tournaments during 2010-2011 compared to 8,400 Largemouth and 3,677 Smallmouth harvested or retained in tournaments during 2014-2015. Despite this decline, total catch-per-hour remained similar between creel surveys (0.7 in 2010-2011 compared to 0.8 in 2014-2015), indicating that most fish were being released. Black bass continued to be the number one sought after species group in Lake Belton. However, Florida genetics continued to decline and the lake record of 13.0 lbs was set a while back in 2006.

MANAGEMENT STRATEGIES

1. Stock Florida Largemouth bass in 2016 according to established procedures.
2. Discuss best practices for tournament weigh-ins with USACE personnel and suggest requiring it of tournaments held on the reservoir. Include the results of this report in those discussions. Suggest the USACE house one or more weigh-in kits if they would be used.
3. 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.
4. Request data on the number of tournament permits issued by the USACE in the future.

Objective-Based Sampling Plan and Schedule

Sport fish, forage fish, and other important fishes: Sport fishes include Largemouth and Smallmouth Bass, Palmetto and White Bass, Channel and Blue Catfish, and White Crappie. Important forage species include Gizzard and Threadfin Shad, Bluegill, Green, Redear and Longear Sunfish.

Negligible fishery: Spotted Bass, Flathead Catfish, and Black Crappie occur in very low abundance in Belton Reservoir and are generally caught incidentally to other targeted species. We will still collect them with relevant sampling gear, length and weight will be recorded in the FMF, and CPUE will be recorded in the management report.

Survey objectives, fisheries metrics, and sampling objectives

Largemouth and Smallmouth Bass: The Black Bass are the most popular species group targeted by anglers in Belton Reservoir. The popularity of bass fishing at this reservoir, including tournaments, justifies sampling time and effort. Results from the 2014 creel survey showed directed angling effort for Black Bass to be 10.8 hours/acre which represented 40.4% of total angling effort. Trend data on CPUE, size structure, and body condition have been collected biennially since 2006 with fall nighttime electrofishing. It is important to note here that the Smallmouth Bass population is the best in the state.

Because of the importance of Largemouth Bass in this reservoir to both recreational and tournament anglers, comparing current sampling data to previously collected data is important. After reviewing historical efforts, electrofishing catch rates of Largemouth Bass in 2008 and 2010 exceeded ten times the number of length classes, which should result in a mean weighted CV of 0.25 or less over the entire range of size classes in a length distribution. The OBS target of ten times the expected number of size classes (i.e., 10 times 20 length classes = 200) was not met in the 2014 survey, although the CPUE precision target of RSE $\leq$ 25 was achieved. Low water levels reduced catch rates to a third of previous standard surveys, making collection of 200 fish at random sites impractical. Additionally, the sample in 2012 did not contain enough fish to meet the minimum for size structure comparisons. Collecting a minimum of ten times the number of expected length classes in 2018 will allow comparison of size structure among years to determine changes over time. A minimum of 24 randomly selected 5-min electrofishing stations will be sampled at night in fall 2018, but sampling will continue at random stations until a minimum of 200 fish of all sizes (10 times 20 length classes) have been collected. In addition to the original 24 random stations, 24 additional random stations will be pre-determined in the event extra sampling is necessary. This information will allow more robust comparisons of size structure between the 2018 electrofishing sample and the 2010 sample, during which a Category 4 age sample was also completed. Genetics will also be collected.

A Category 3 age sample of Smallmouth Bass was obtained during 2014 which raised serious questions about the need for supplementary stocking (see Appendix D). One confounding factor was the fact that water levels were chronically low during the previous four years. It was hypothesized that rearing habitat for Age-0 fish may be a limiting factor. High water during late spring, 2015 may increase rearing habitat and with a stocking of 54,573 fingerlings, year class strength may be positively affected. Significant effort is required for a Category 3 sample of Smallmouth Bass. Two hours of night electrofishing of random stations as well as 10 hours of non-random daytime electrofishing was required to obtain the previous sample. Collecting an additional Category 3 age sample (200 stock size fish) will allow precise calculation of length-at-age, as well as year-class strength and mortality. A minimum of 24 randomly selected 5-min electrofishing sites will be sampled at night in fall, 2018, with up to 24 additional randomly selected sites also sampled. When these efforts are completed, the catch rate will be evaluated to determine if 200 stock size fish is an attainable objective. Alternatives such as non-random sites, sites with longer duration (15 minutes or more), and daytime electrofishing will be explored if needed to obtain this age sample. Although the full-year creel survey information in 2010 and 2014 was very useful to management efforts on Belton Reservoir, a four quarter survey is unnecessary in 2018. The number of bass tournament

permits issued by the USACE will be used as one indicator of angling pressure for bass.

Palmetto and White Bass: Temperate Bass are the third most sought species group by anglers in Belton Reservoir. Results from the 2014 creel survey showed directed angling effort for Temperate Bass to be 2.0 hours per acre, which represented 8.6% of total angling effort. Trend data on CPUE, size structure, and body condition have been collected biennially since 2007 with spring gill netting. Our primary goal for the Palmetto Bass fishery in 2019 is comparing recruitment from years where fingerlings were stocked to years where fry were stocked at 100/acre and 50/acre rates. Collecting a Category 3 age sample (200 stock size fish) will allow precise calculation of length-at-age, as well as year-class strength and mortality. Aging structures will be collected from a minimum of 5 per cm group with the remainder assigned ages using an age-length key. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2019, but sampling will continue at random stations until a minimum of 200 stock size fish have been collected. If continued sampling results in >75% of collected fish measurements falling into already completed cm groups, discontinuing sampling should be considered rather than continuing to collect fish that won't increase precision. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. If catch rates are low, strong consideration should be given to sampling at non-random sites.

White Bass numbers have varied widely among gill net collections. When good numbers are present in the reservoir, they can be one of the most-harvested fish species. For example, gill net catch rates of White Bass in 2011 were well above the historical average for the reservoir and the corresponding creel survey showed White Bass to be the most harvested fish species. In contrast, the 2014 gill net catch rates of white bass were even higher as compared to 2011, but harvest was much lower, likely due to low water levels and low inflows from tributaries. The goal of this survey in regards to White Bass is determining whether anglers will have a large or small population of legal-sized White Bass to fish for in the next two years. Calculating proportions such as PSD will allow us to characterize the White Bass population, compare it to historical data, and provide information to anglers on what to expect when fishing for White Bass. Collecting a minimum of 50 stock length fish in spring 2019 gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2019, but sampling will continue at random stations until a minimum of 50 stock size fish have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more White Bass if additional gill netting to meet objectives for other species is required.

Channel and Blue Catfish: Catfish as a group are the second most sought by anglers in Belton reservoir. Results from the 2014 creel survey showed directed angling effort for the Catfish group to be 4.0 hours per acre, which represented 17.4% of total angling effort. Trend data on CPUE, Size structure, and body condition have been collected biennially since 2007 with spring gill netting. The goal of this survey would be to characterize the Channel and Blue Catfish populations and make comparison to historical and future data. This would also allow us to identify if a need exists for additional stocking of Blue Catfish. Collecting a minimum of 50 stock length fish in spring 2019 gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2019, but sampling will continue at random stations until a minimum of 50 stock size fish of each species have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more Channel and Blue Catfish if additional gill netting to meet objectives for other species is required. Length and weight of Flathead Catfish will be collected if any are encountered.

White Crappie: White Crappie are the dominant Crappie species in Belton Reservoir. The 2014 creel survey showed directed angling effort for White Crappie to be 2.0 hours per acre, representing 8.5 percent of total angling effort. Historically, White Crappie data was collected with trap netting. The number of fish collected was generally very low, averaging less than 1 fish per net-night in trap net sampling over the past 15 years. However, gill netting has proved useful in collecting White Crappie in recent surveys. We plan

to continue evaluating the use of this non-standard gear in sampling the White Crappie population. If this effort is successful, it will allow us to characterize the White Crappie population and make comparisons across years. Collecting a minimum of 50 stock length fish in 2015 spring gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2019, but sampling will continue at random stations until a minimum of 50 stock size fish have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more White Crappie if additional gill netting to meet objectives for other species is required. Length and weight of Black Crappie will be collected if any are encountered.

Bluegill, Longear Sunfish, Gizzard Shad, and Threadfin Shad: Bluegill, Longear Sunfish, Gizzard Shad and Threadfin Shad are the primary forage at Belton Reservoir. Trend data on CPUE and size structure have been collected biennially since 2006 with fall nighttime electrofishing. Creel surveys show that few anglers fish for these species in Belton Reservoir. The goal of this survey would be to collect prey size and availability information. Calculating proportions such as PSD and IOV will allow us to characterize the prey-fish population and determine prey abundance. A total of 20 randomly selected 5-min electrofishing stations will be sampled at night in fall 2018. Additional prey fish will not be collected if additional electrofishing is needed to meet objectives for other sport fish species. Relative weights of collected predator species will also be used as an index of prey availability.

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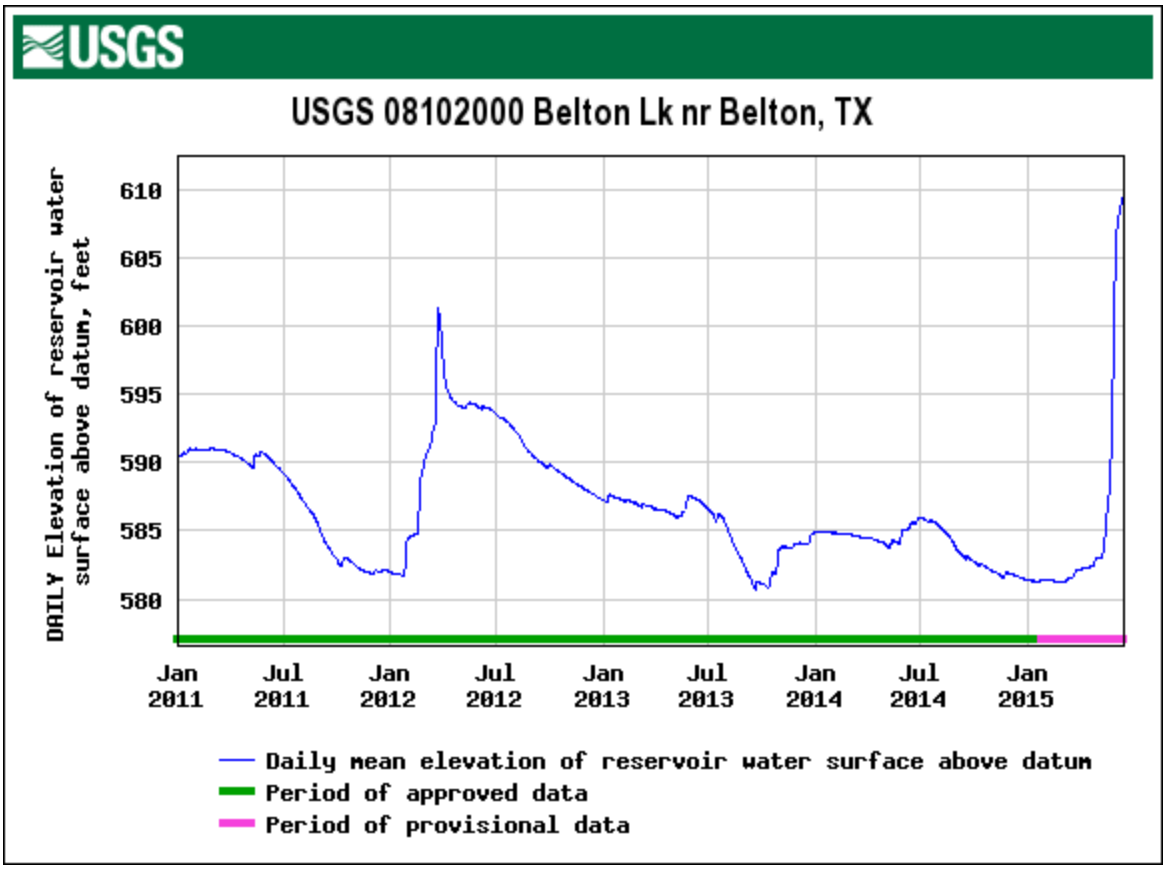


Figure 1. Daily mean water levels for Belton Reservoir from January 1, 2011 through June 15, 2015. Conservation pool level is 594 feet above mean sea level. Figure from USGS website.

Table 1. Characteristics of Belton Reservoir, Texas.

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

Table 2. Boat ramp characteristics for Belton Reservoir, Texas, October, 2014. Reservoir elevation at time of survey was approximately 582.0 feet above mean sea level (12' below conservation pool).

Boat ramp	Latitude/Longitude (dd)	Parking capacity (N)	Condition
Temples Lake Park (N)	31.13833/-97.49645	40	Good
Temples Lake Park (S)	31.12794/-97.49581	41	Out of water
Arrowhead Point	31.12317/-97.48866	30	Good
Live Oak Ridge	31.11661/-97.47684	24	Good
Lakeview Park	31.10460/-97.48495	68	Good
Westcliff Park	31.12094/-97.51823	41	Good
Sparta Valley Park	31.13461/-97.52651	19	Good
BLORA (E)	31.38483/-97.54581	50	Good
BLORA (W)	31.14826/-97.55858	16	Good
Rogers Park	31.16089/-97.48048	33	Good
Cedar Ridge Park (W)	31.16710/-97.45373	63	Good
Cedar Ridge Park (E)	31.16519/-97.44086	22	Good
McGregor Park	31.21159/-97.48188	12	Out of water
Leona Park	31.22018/-97.46734	32	Good
White Flint Park	31.22632/-97.47418	27	Out of water
Owl Creek Park	31.21750/-97.51383	30	Out of water
Iron Bridge Park	31.28071/-97.47229	18	Out of water

Table 3. Harvest regulations for Belton Reservoir, 2014-2015.

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 and Sunshine	5	18 - No Limit
Bass: Largemouth, Smallmouth, Spotted	5	14 – No Limit
Crappie: White and Black Crappie, their hybrids and subspecies	25 (in any combination)	10 - No Limit

Table 4. Stocking history for Belton Reservoir (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	0.0
	1969	350,000	FRY	0.7
	1970	100,000	UNK	0.0
	1972	225,000	UNK	0.0
	Total	679,600		
Palmetto Bass (Striped X White Bass hybrid)	1977	60,455	UNK	0.0
	1979	65,518	UNK	0.0
	1981	120,625	UNK	0.0
	1983	125,550	UNK	0.0
	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

Table 4. Stocking history for Belton Reservoir (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)
	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
	2011	88,000	FGL	1.5
	2013	1,243,445	FRY	0.2
	2014	36,136	FGL	1.9
	2015	494,926	FRY	0.2
	Total	8,746,768		
Sauger	1985	54,113		1.5
	Total	54,113		
Smallmouth Bass	1978	99,850	UNK	0.0
	1979	100,000	UNK	0.0
	1980	101,320	UNK	0.0
	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
	2012	20,225	FGL	2.1
	2014	171,381	FGL	1.4
	2015	54,573	FGL	UNK
	Total	1,775,549		
Sunshine Bass (White x Striped Bass hybrid)	2014	21,699		1.5
	Total	21,699		
Walleye	1973	493,000	FRY	0.2
	1974	327,000	FRY	0.2
	Total	820,000		

Table 5. Survey of structural 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.

Habitat type	Estimate (miles)	% of total
Natural/Rock shoreline	148.2	93.7
Rock Bluff	9.6	6.0
Piers and boat docks	N = 32	

Table 6. Percent directed angler effort, directed catch per hour, and total harvest for all anglers by species for Belton Reservoir, Texas, 2010-2011 and 2014-2015.

Species	Percent directed effort		Directed catch per hour		Total harvest	
Year	2014-2015	2010-2011	2014-2015	2010-2011	2014-2015	2010-2011
Blue Catfish					6,009	3,780
Channel Catfish					3,790	6,257
Flathead Catfish					342	988
Catfish spp.	17.4	20.3	0.2	0.3		
White Bass					8,955	52,243
Palmetto Bass					6,381	13,389
Temperate Bass spp.	8.6	12.2	2.0	2.6		
Panfish spp.	0.3	0.7	1.7	1.1		3,851
Smallmouth Bass					3,677	4,706
Largemouth Bass					8,400	43,139
Black Bass spp.	40.4	40.5	0.8	0.7		
White Crappie					27,350	16,895
Crappie spp.	8.5	5.1	1.5	0.9		
Anything	24.3	20.9	0.4	0.6		

Table 7. Total fishing effort (h) for all species and total directed expenditures at Belton Reservoir, Texas, 2010-2011 and 2014-2015. Relative standard errors (RSE) are in parentheses.

Creel Statistic	Year	
	2014-2015	2010-2011
Total fishing effort (hours)	227,085 (12)	315,021 (10)
Total directed expenditures	$1,648,189 (22)	$2,590,627 (41)

Gizzard Shad

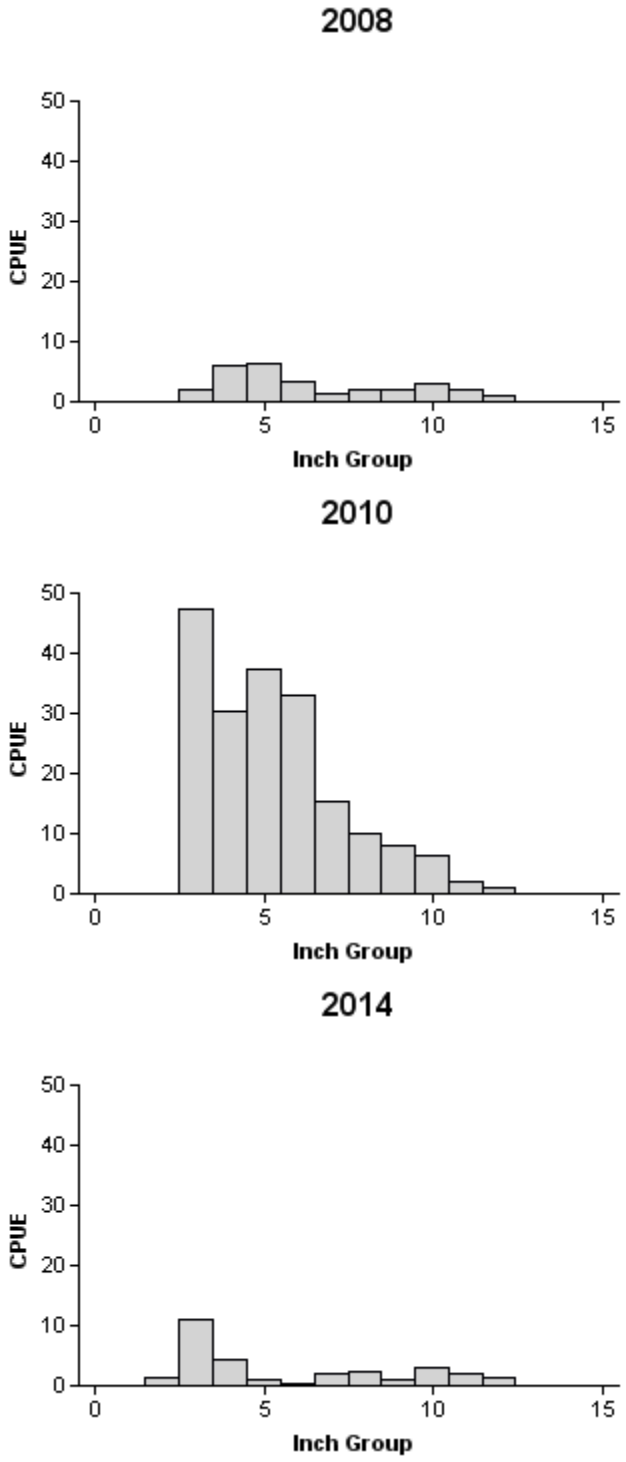


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2008, 2010, and 2014.

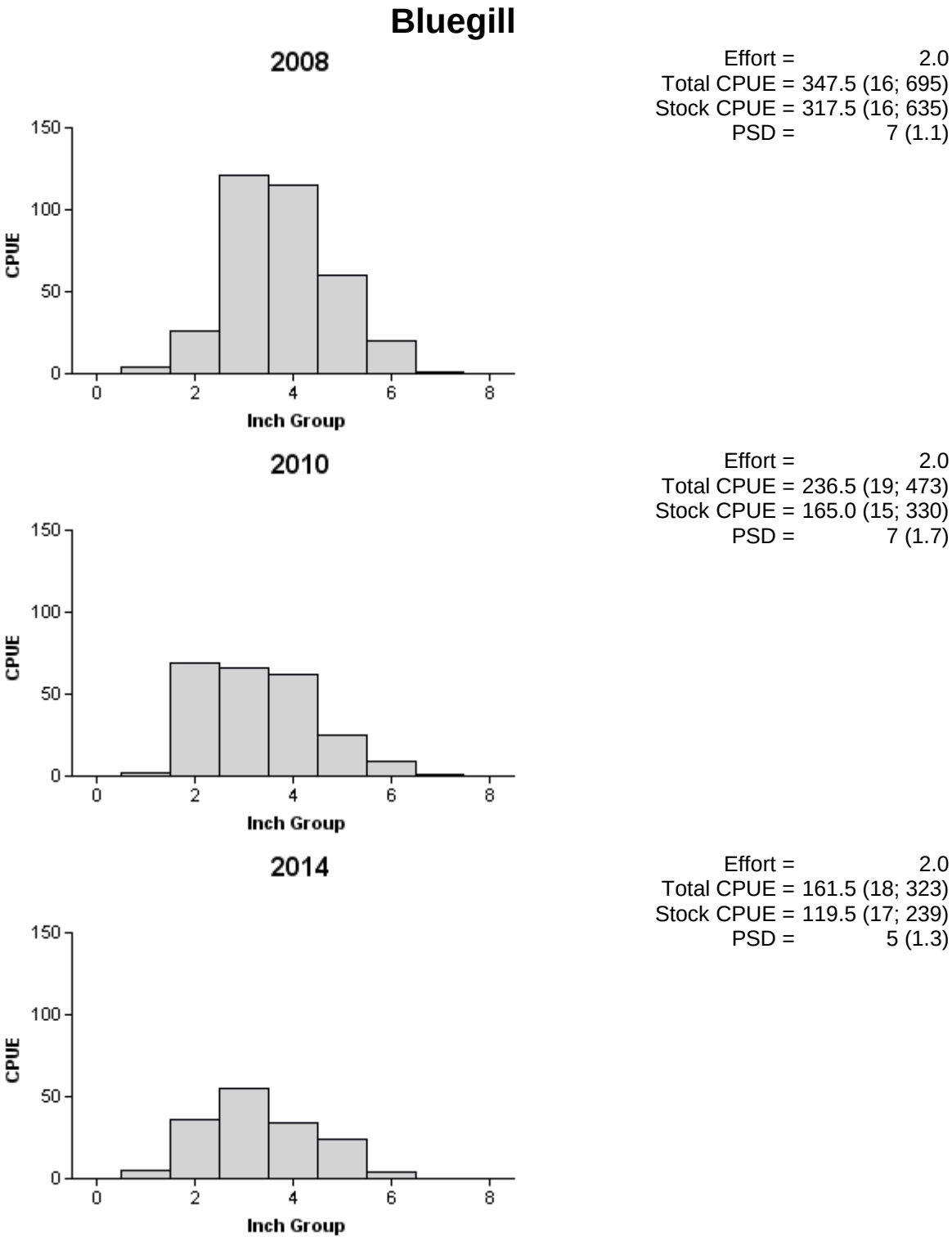


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2008, 2010, and 2014.

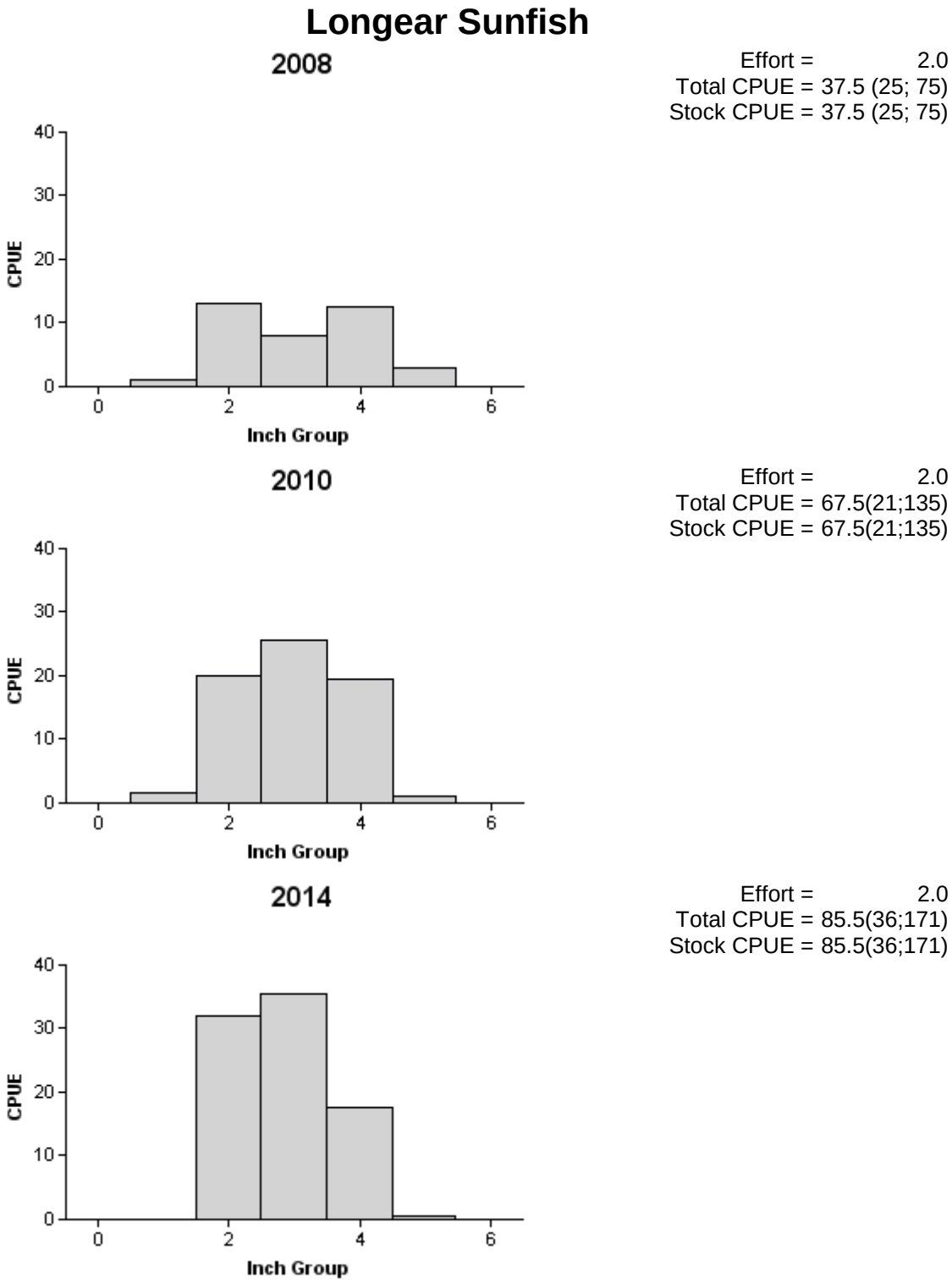


Figure 4. Number of Longear Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2008, 2010, and 2014.

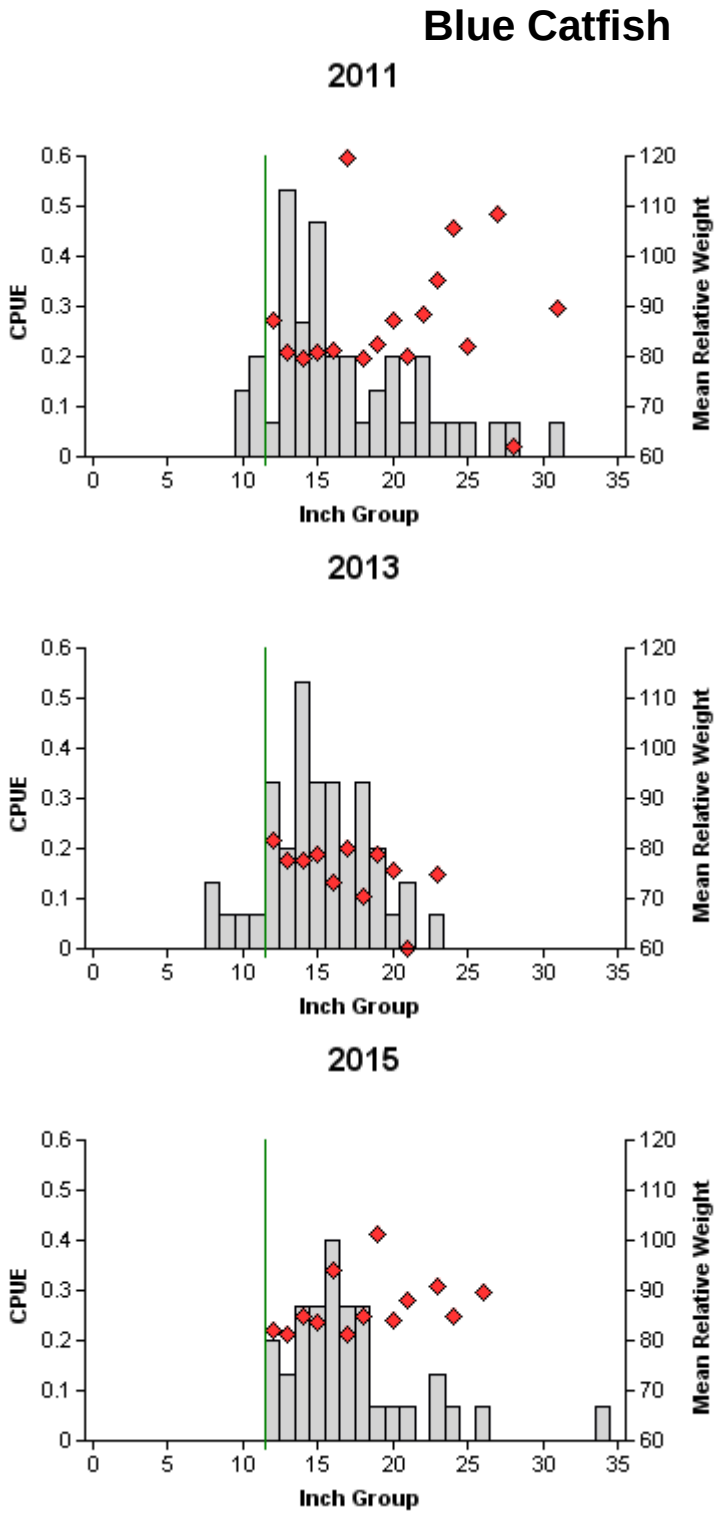


Figure 5. Number of Blue Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas 2011, 2013 and 2015.

Blue Catfish

Table 8. Creel survey statistics for catfish spp. at Belton Reservoir from June 2014 through May 2015, 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)	39,474 (16)
Directed effort/acre	4.0
Total catch per hour	0.2 (58)
Total catch	7,616 (80)
Total harvest	6,009 (61)
Harvest/acre	0.6

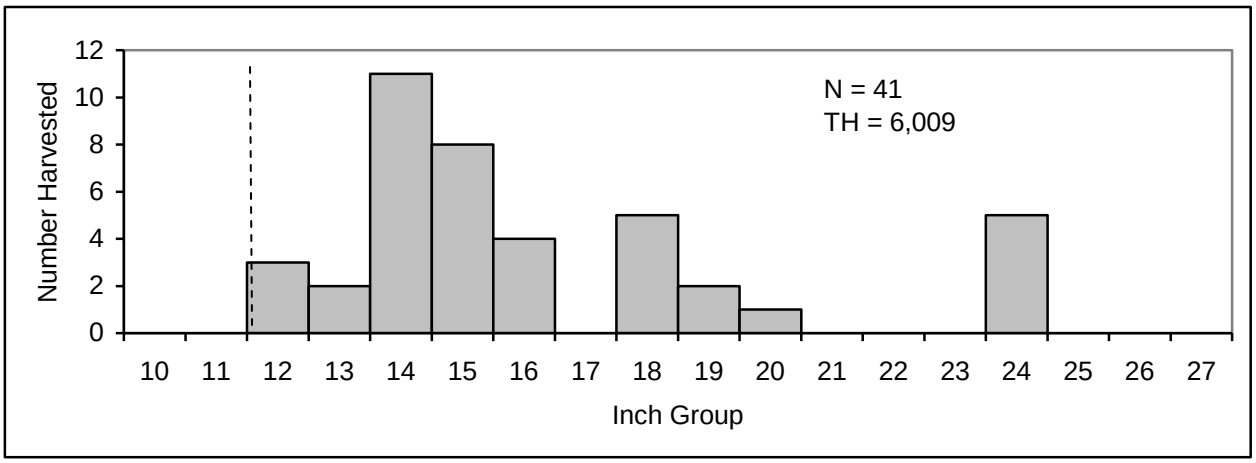


Figure 6. Length frequency of harvested Blue Catfish observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested Blue Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

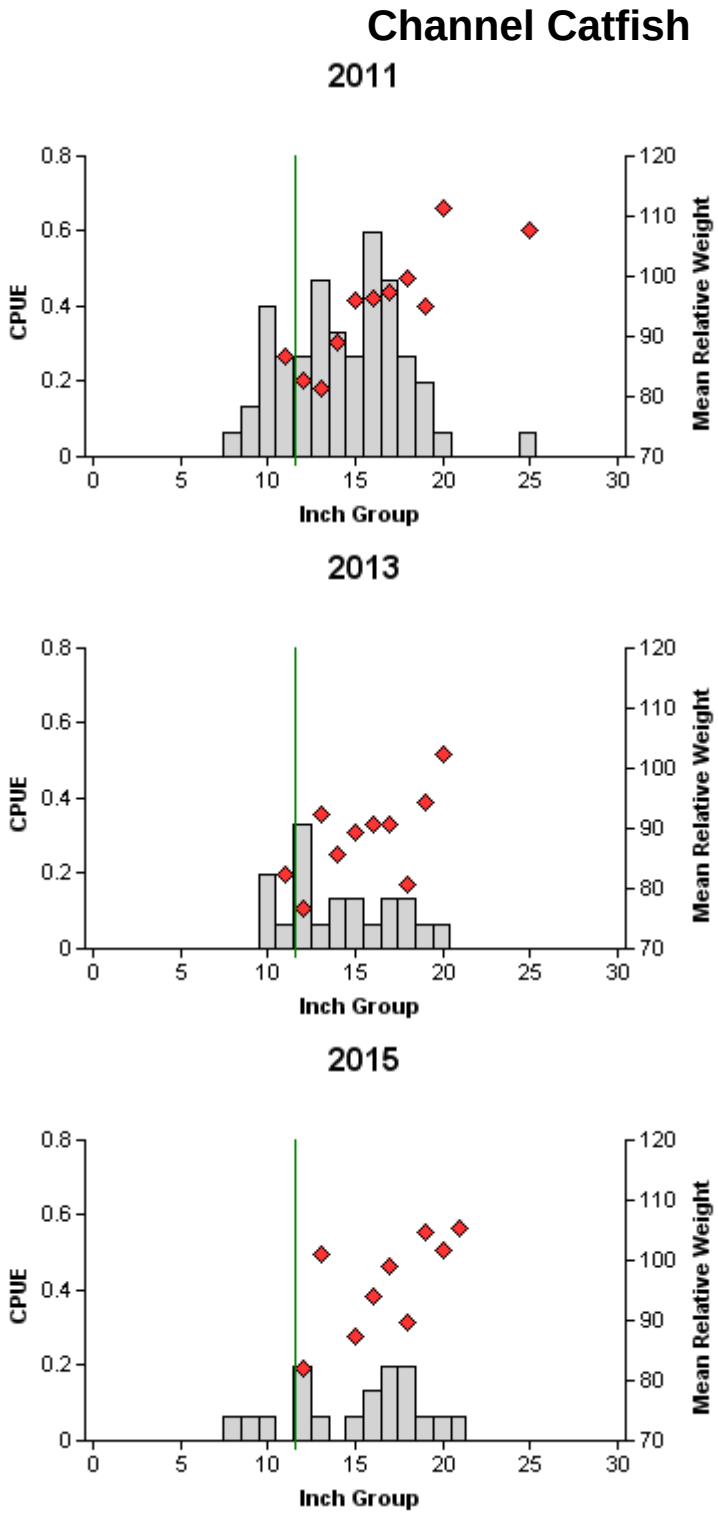


Figure 7. Number of Channel Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2011, 2013, and 2015.

Channel Catfish

Table 9. Creel survey statistics for catfish spp. at Belton Reservoir from June 2014 through May 2015, 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)	39,474 (16)
Directed effort/acre	4.0
Total catch per hour	0.2 (58)
Total catch	5,276 (59)
Total harvest	3,790 (63)
Harvest/acre	0.4

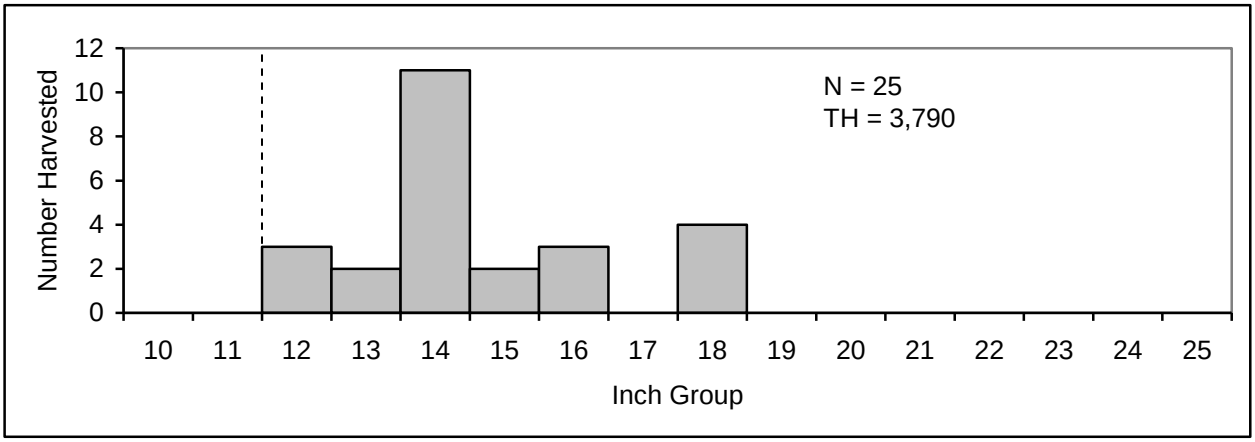


Figure 8. Length frequency of harvested Channel Catfish observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested Channel Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

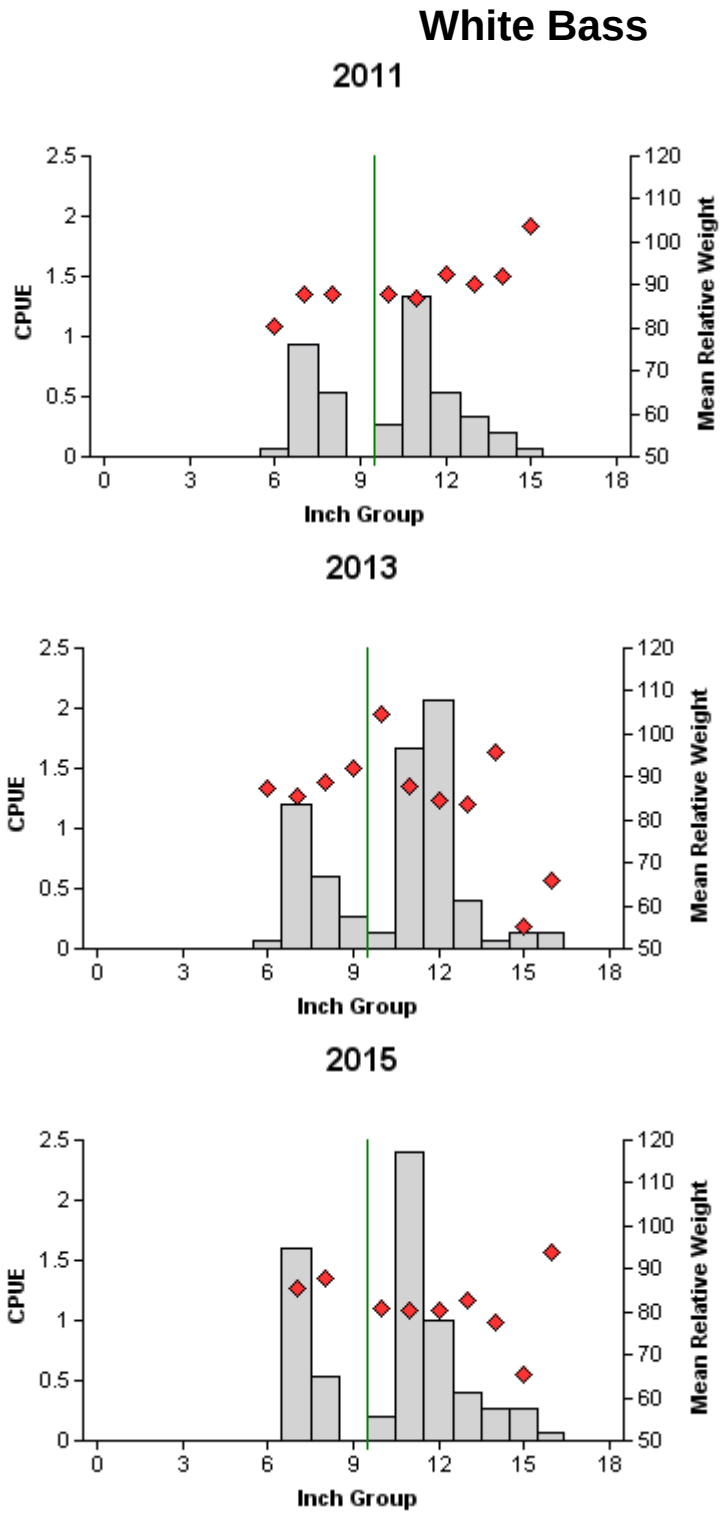


Figure 9. Number of White Bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2011, 2013, and 2015.

White Bass

Table 10. Creel survey statistics for temperate bass spp. at Belton Reservoir from June 2014 through May 2015, 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)	19,550 (21)
Directed effort/acre	2.0
Total catch per hour	2.0 (45)
Total catch	24,543 (37)
Total harvest	8,955 (53)
Harvest/acre	0.9

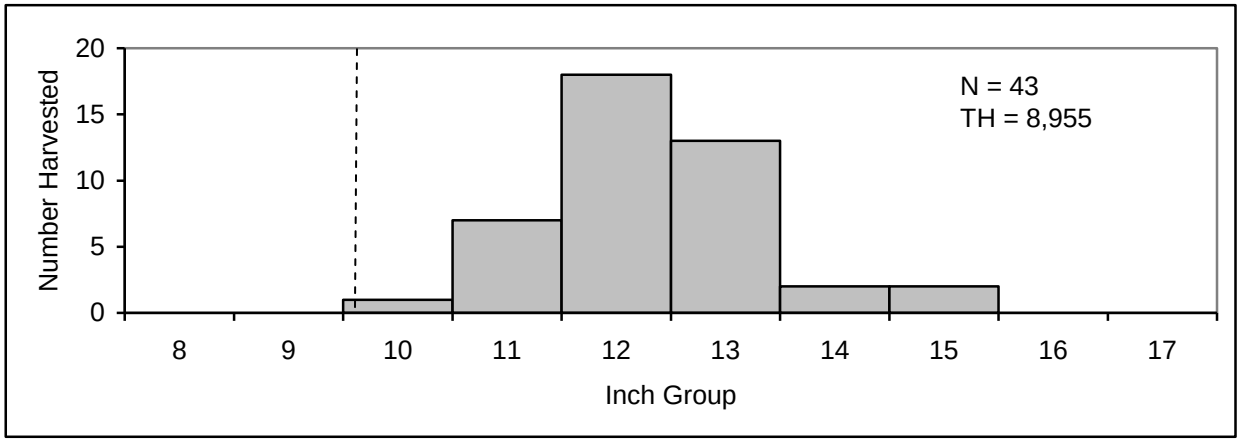


Figure 10. Length frequency of harvested White Bass observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

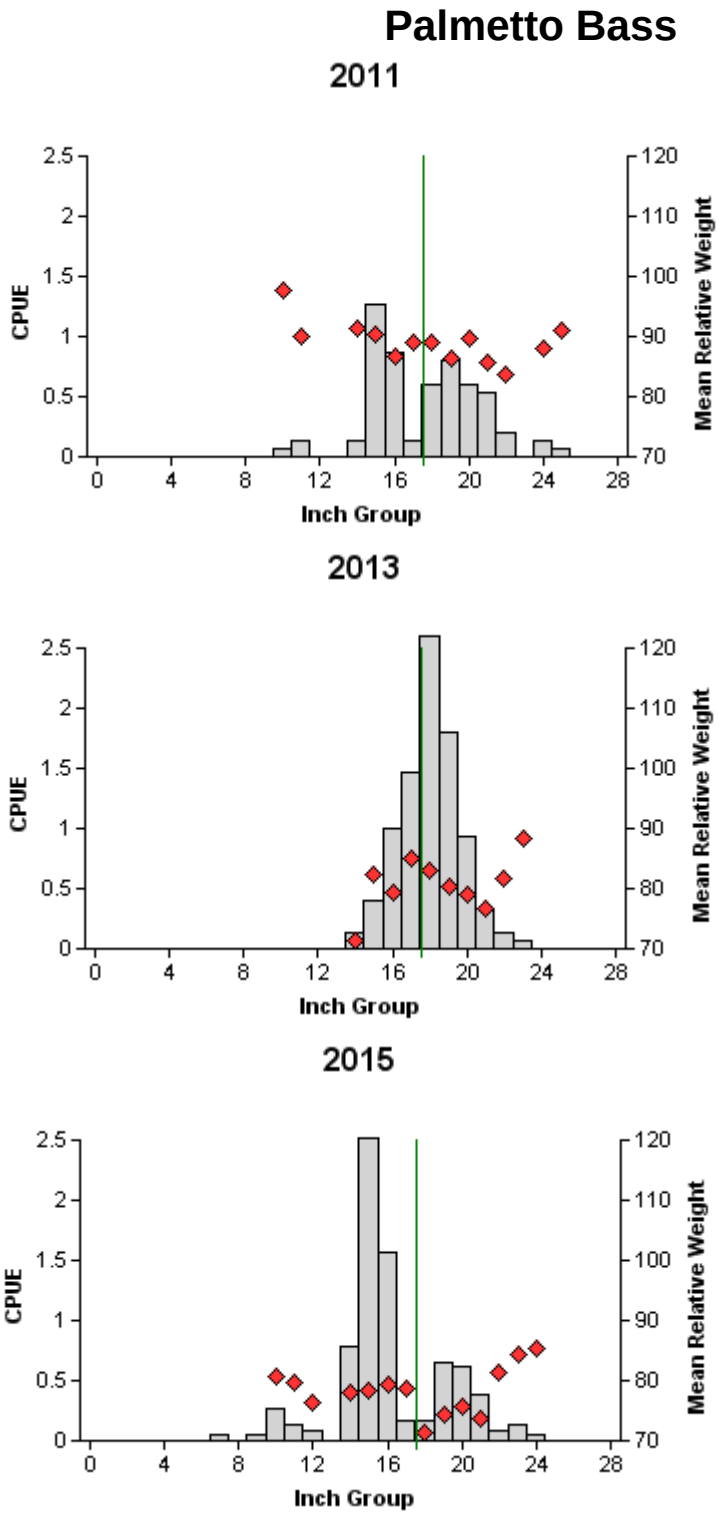


Figure 11. Number of Palmetto Bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Belton Reservoir, Texas, 2011, 2013, and 2015. Objective-based sampling goals required additional effort in 2015.

Palmetto Bass

Table 11. Creel survey statistics for temperate bass spp. at Belton Reservoir from June 2014 through May 2015, 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)	19,550 (21)
Directed effort/acre	2.0
Total catch per hour	2.0 (45)
Total catch	22,664 (40)
Total harvest	6,381 (46.5)
Harvest/acre	0.6

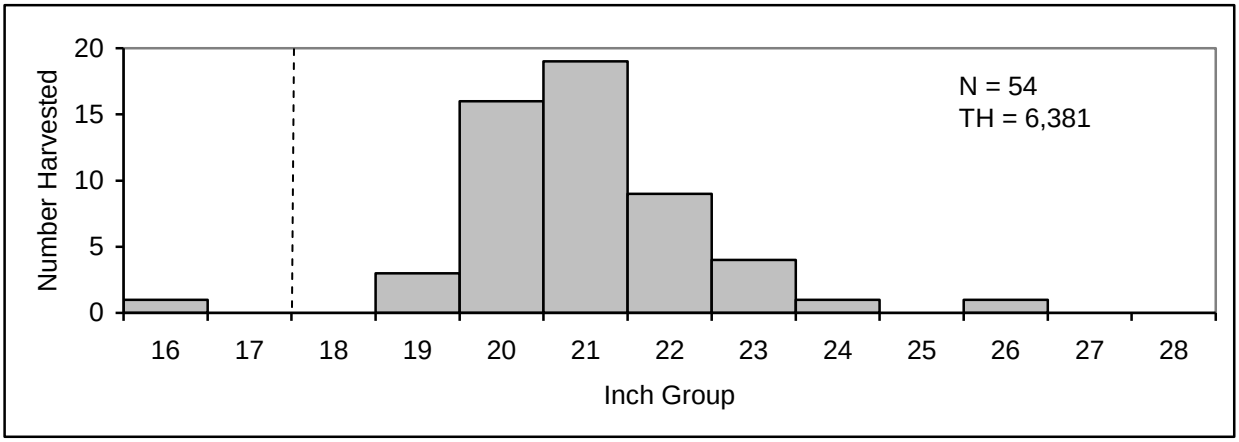


Figure 12. Length frequency of harvested Palmetto Bass observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested Palmetto Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Dashed line indicates minimum length limit.

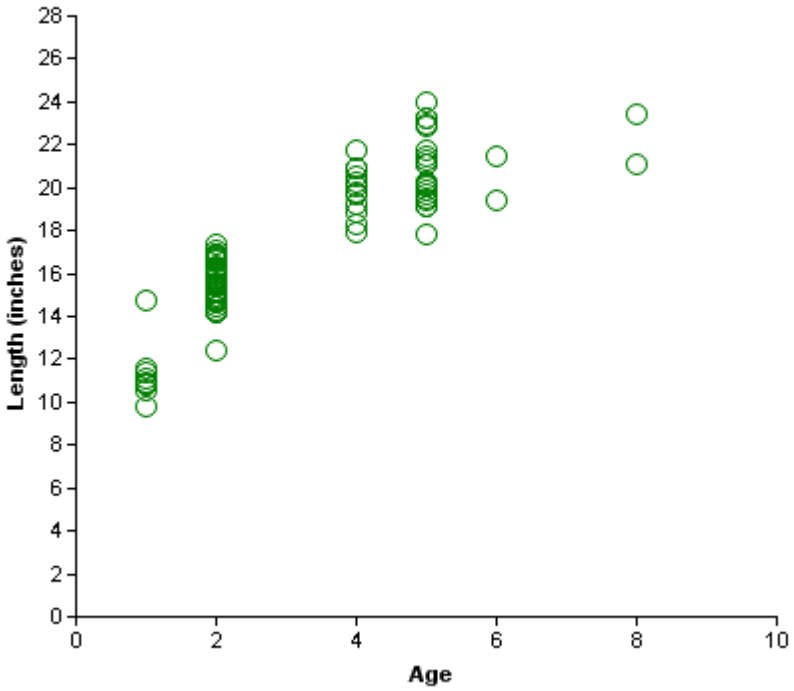


Figure 13. Length at age for Palmetto Bass collected by gill netting, Belton Reservoir, Texas, 2015.

Table 12. Average length at capture for Palmetto Bass (sexes combined) ages 1 – 7 collected in gill netting surveys, Belton Reservoir, 2015. 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.

Total Length	Survey Year	Age	Number of Fish
11.263779	2015	1	10
15.632873	2015	2	40
19.855642	2015	4	12
20.860516	2015	5	21
20.413385	2015	6	2
22.244094	2015	8	2

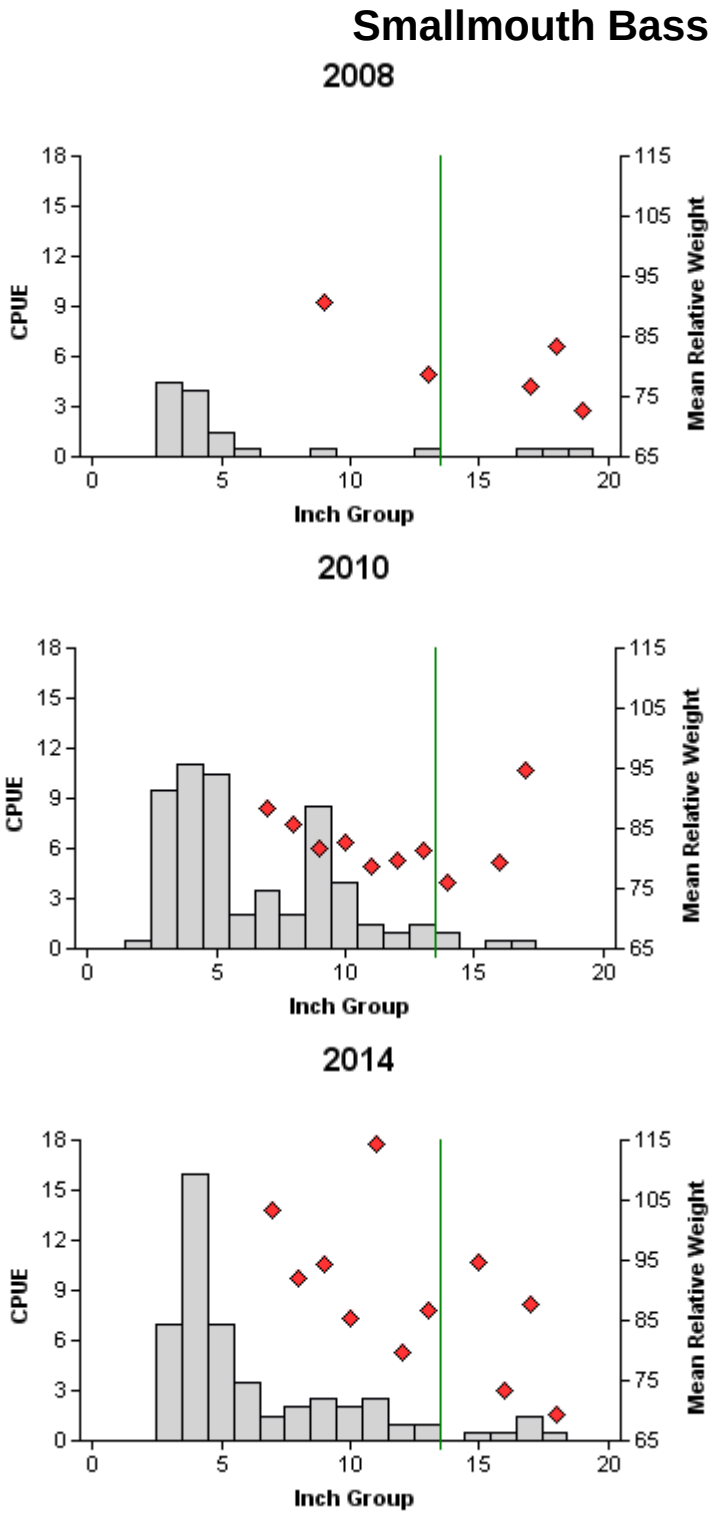
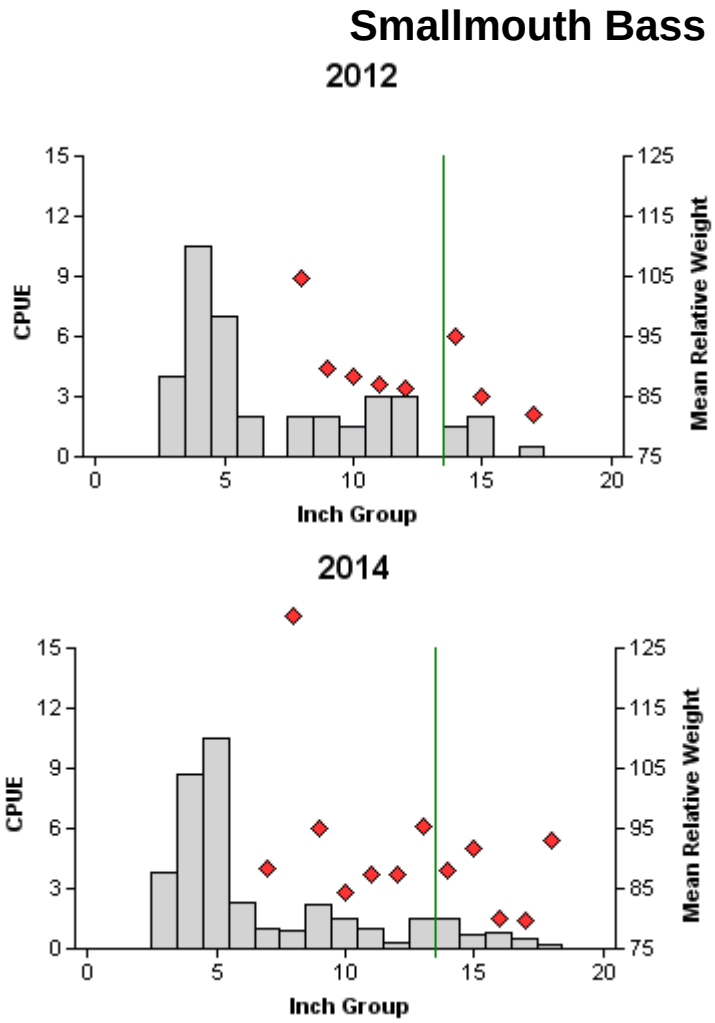


Figure 14. Number of Smallmouth Bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2008, 2010, and 2014.



Effort =	2.0
Total CPUE =	39.0 (23; 78)
Stock CPUE =	15.5 (28; 31)
PSD =	65 (10.4)
PSD-14 =	26 (7.2)
PSD-17 =	3 (3.4)
PSD-20 =	0 (0)

Effort =	10.0
Total CPUE =	37.4 (10; 374)
Stock CPUE =	12.1 (13; 121)
PSD =	54 (6)
PSD-14 =	31 (4.4)
PSD-17 =	6 (2)
PSD-20 =	0 (0)

Figure 15. 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 daytime bass-only electrofishing surveys, Belton Reservoir, Texas, 2012 and 2014. The 2012 survey (2.0 h of effort) was used to monitor the population while the 2014 survey (10.0 h of effort) was used to collect a category III age and growth sample.

Smallmouth Bass

Table 13. Creel survey statistics for black bass spp. at Belton Reservoir from June 2014 through May 2015, 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)	91,852 (14)
Directed effort/acre	10.8
Total catch per hour	0.8 (28)
Total catch	13,799 (43)
Total harvest	3,677 (85)
Harvest/acre	0.4

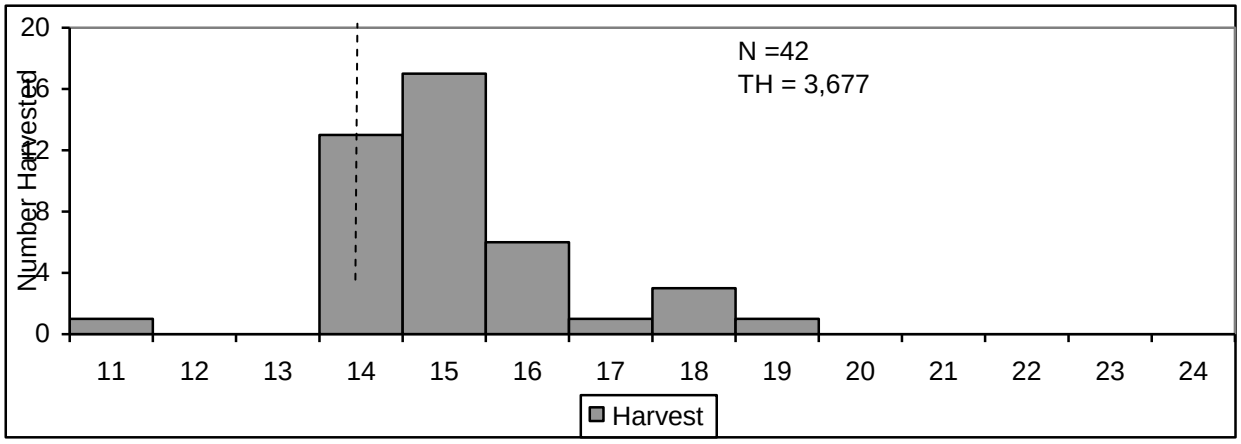


Figure 16. Length frequency of harvested Smallmouth Bass observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested Smallmouth Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Fish retained during catch-weigh-release tournaments were included in harvest numbers in accordance with established procedures. Dashed line indicates minimum length limit.

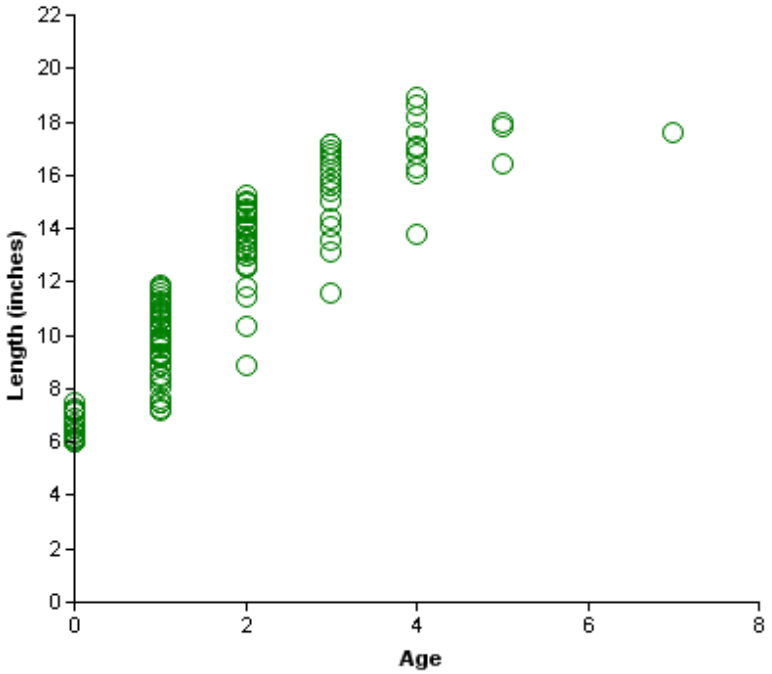


Figure 17. Length at age for Smallmouth Bass collected by fall electrofishing surveys, Belton Reservoir, Texas, 2014.

Table 14. Average length at age for Smallmouth Bass (sexes combined; ages 0 – 7) collected by fall electrofishing surveys, Belton Reservoir, 2014. Age-0 data may not be representative of the actual size distribution because of gear bias against smaller fish.

Total Length	Survey Year	Age	Number of Fish
6.582184	2014	0	16
9.727759	2014	1	47
13.501475	2014	2	32
15.409010	2014	3	18
17.035432	2014	4	10
17.401574	2014	5	3
17.598425	2014	7	1

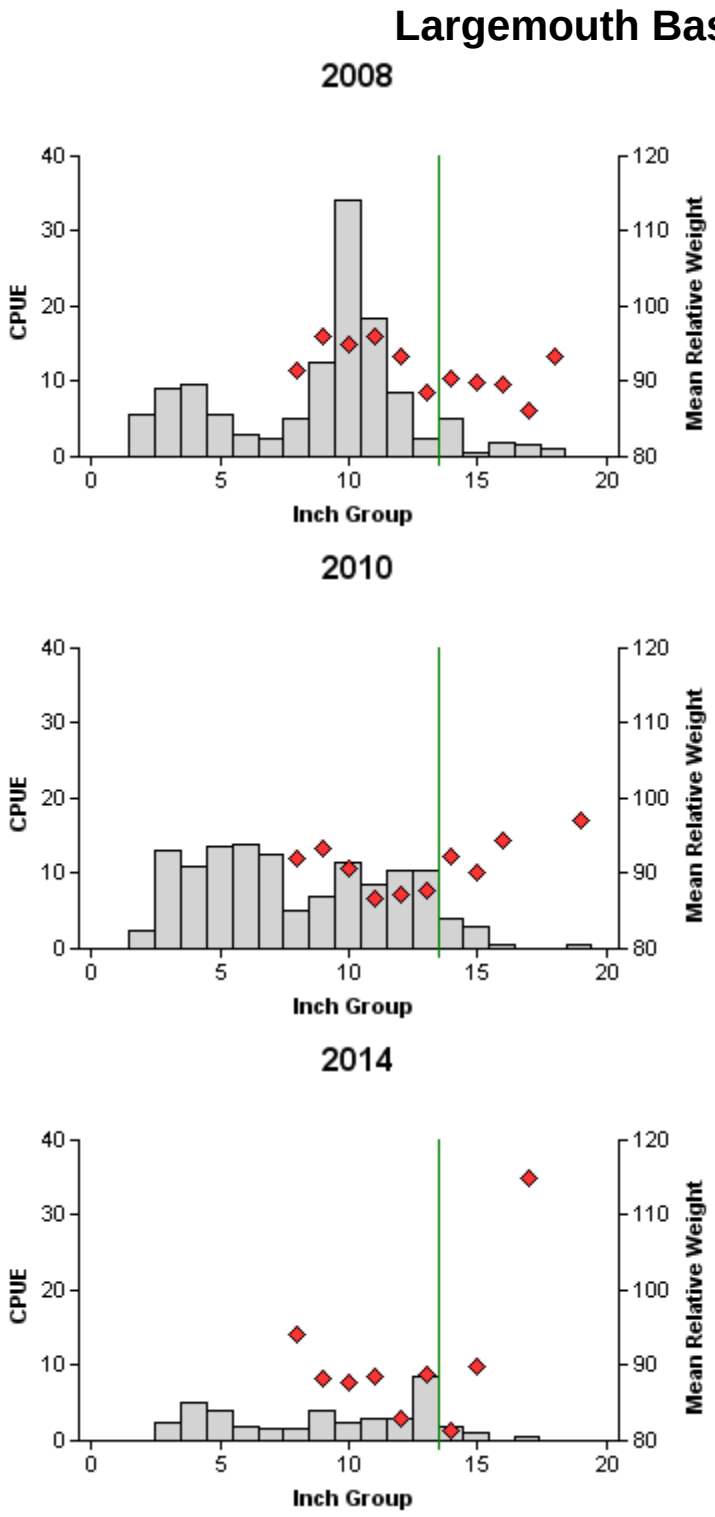


Figure 18: Number of Largemouth Bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Belton Reservoir, Texas, 2008, 2010, and 2014.

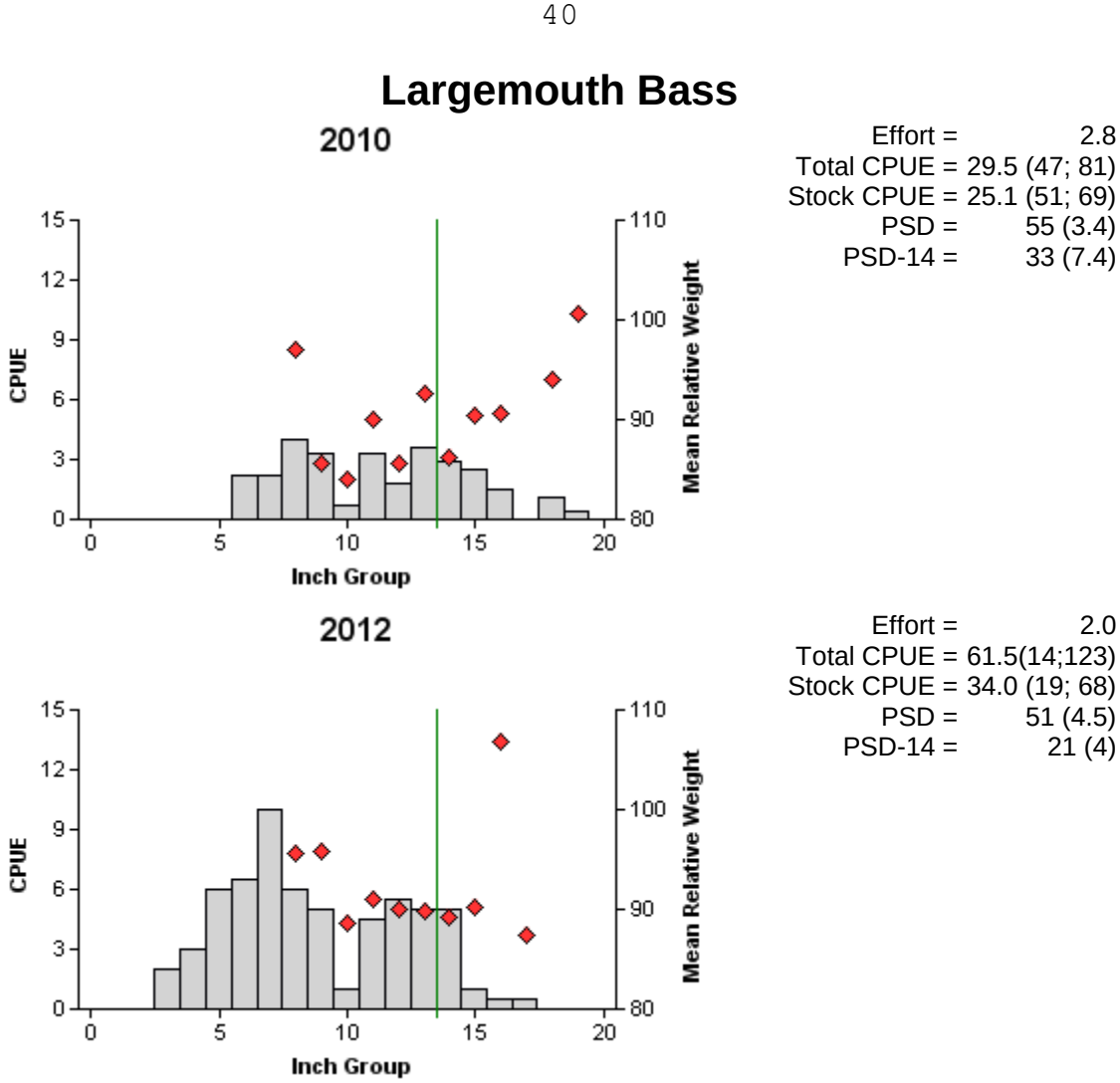


Figure 19. Number of Largemouth Bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall daytime bass-only electrofishing surveys, Belton Reservoir, Texas, 2010 and 2012. The 2010 survey (2.8 h of effort) was used in conjunction with 2.0 h of standard sampling to collect a category IV age and growth sample, while the 2012 survey (2.0 h of effort) was used to monitor the Largemouth Bass population.

Largemouth Bass

Table 15. Creel survey statistics for black bass spp. at Belton Reservoir from June 2014 through May 2015, 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)	91,852 (14)
Directed effort/acre	10.8
Total catch per hour	0.8 (28)
Total catch	51,293 (25)
Total harvest	8,400 (46)
Harvest/acre	0.8

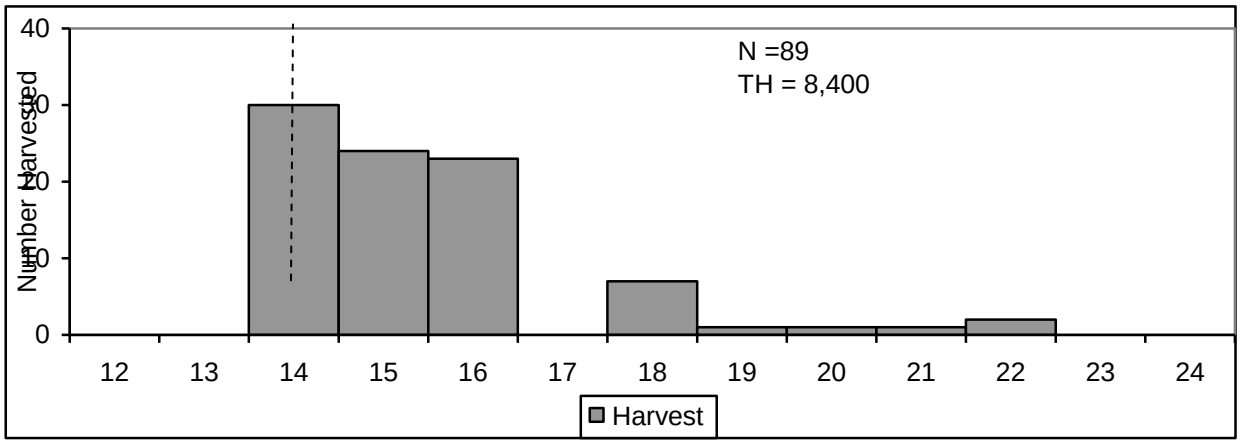


Figure 20. Length frequency of harvested Largemouth Bass observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Fish retained during catch-weigh-release tournaments were included in harvest numbers in accordance with established procedures. Dashed line indicates minimum length limit.

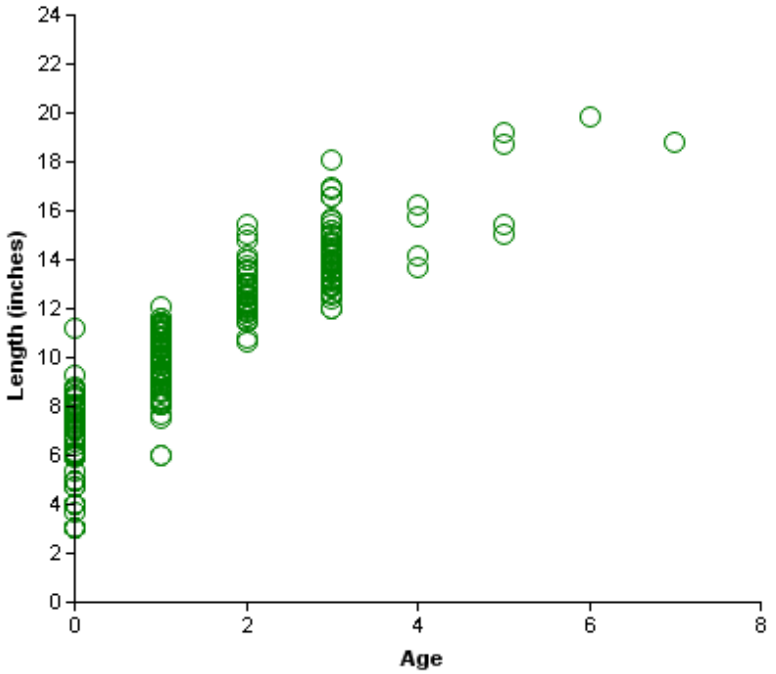


Figure 21. Length at age for Largemouth Bass collected by fall electrofishing surveys, Belton Reservoir, Texas, 2010.

Table 16. Average length at age for Largemouth Bass (sexes combined; ages 0 – 7) collected by fall electrofishing surveys, Belton Reservoir, 2010. Age-0 data may not be representative of the actual size distribution because of gear bias against smaller fish.

Total Length	Survey Year	Age	Number of Fish
6.260737	2010	0	88
9.842519	2010	1	79
12.722440	2010	2	40
14.128025	2010	3	54
14.960629	2010	4	4
17.106298	2010	5	4
19.803149	2010	6	1
18.818897	2010	7	1

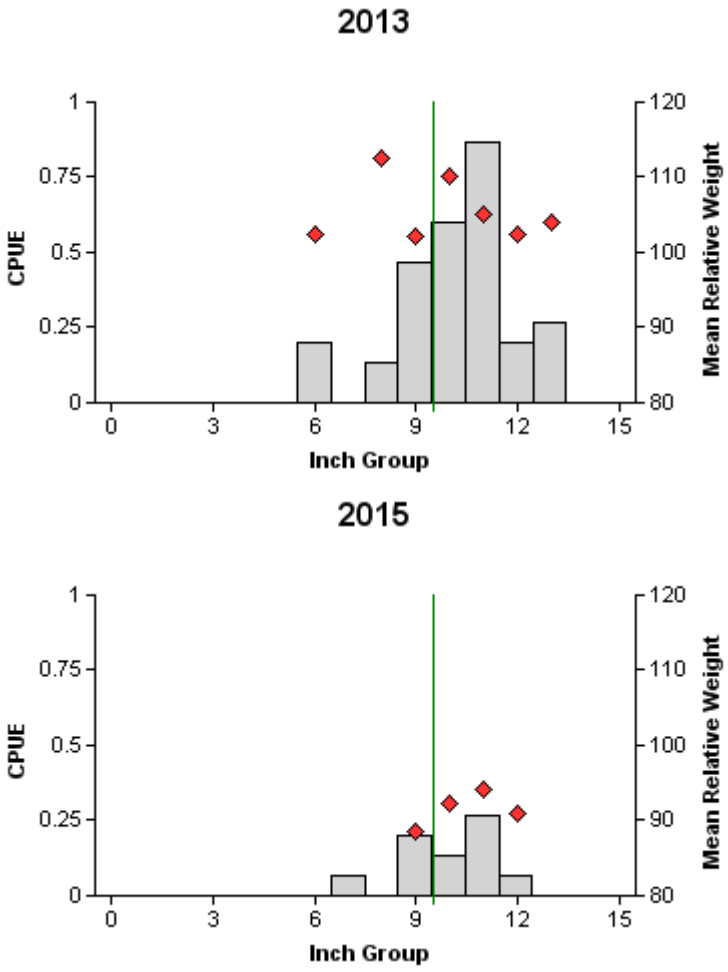
Table 17. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Belton Reservoir, Texas, 2002, 2006 and 2014. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined by electrophoresis prior to 2005 and with micro-satellite DNA analysis since 2005.

		Genotype				
Year	Sample size	%FLMB	%Hybrid	%NLMB	% FLMB alleles	% Northern alleles
2002	30	17	80	3	57	43
2006	30	7	93	0	49	51
2014	30	0	100	0	46	54

Table 18. Tournament permits issued by the United States Corps of Engineers at Belton Lake from 1999 through 2014 (Ronnie L. Bruggman, pers. comm. 2015). Although permitting is a requirement, not all tournaments were permitted. Thus these numbers should be viewed as an index of tournament pressure.

Year	Number of Permits
1999	2
2000	2
2001	1
2002	4
2003	4
2004	5
2005	12
2006	20
2007	3
2008	12
2009	31
2010	55
2011	52
2012	41
2013	40
2014	36

White Crappie



Effort = 15.0
Total CPUE = 2.7 (38; 41)
Stock CPUE = 2.7 (38; 41)
PSD = 93 (3.6)
PSD-10 = 71 (6.2)

Effort = 15.0
Total CPUE = 0.7 (45; 11)
Stock CPUE = 0.7 (45; 11)
PSD = 91 (6.9)
PSD-10 = 64 (11)

Figure 22. 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 2013 and 2015.

Table 19. Creel survey statistics for White Crappie at Belton Reservoir from June 2014 through May 2015, 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)	19,374 (23)
Directed effort/acre	2.0
Total catch per hour	1.5 (47)
Total catch	66,763 (29)
Total harvest	27,351 (32)
Harvest/acre	2.8

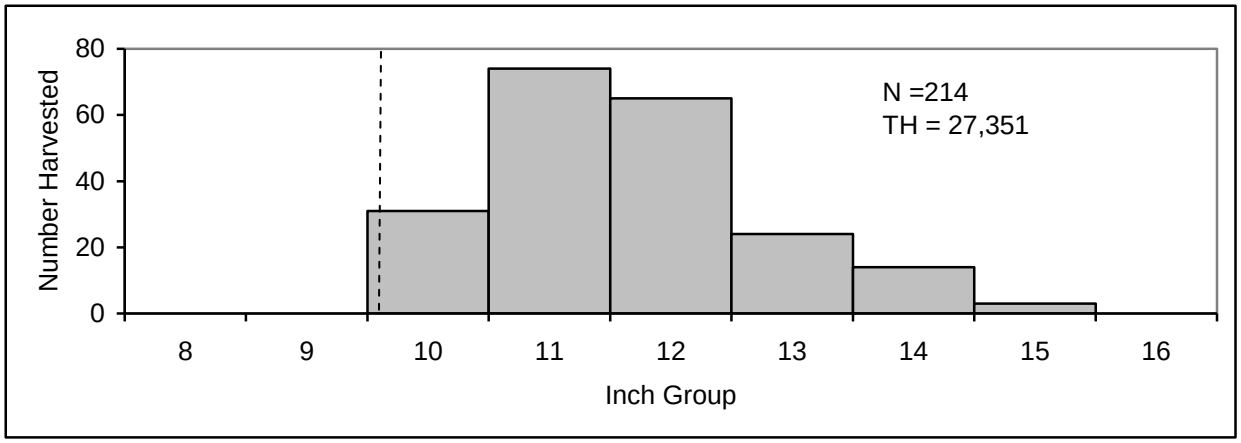


Figure 23. Length frequency of harvested White Crappie. observed during creel surveys at Belton Reservoir, Texas, June 2014 through May 2015, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Table 20. Proposed sampling schedule for Belton Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A. Structural habitat surveys are required only if large changes in structural habitat are suspected, i.e. increases in bulkhead, loss of standing timber, etc.

				Habitat				
Survey year	Electrofish Fall	Trap net	Gill net	Structural	Vegetation	Access	Creel survey	Report
2015-2016								
2016-2017								
2017-2018								
2018-2019	S		S		S	S		S

APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Belton Reservoir, Texas, 2014-2015. Asterisk denotes collection by a non-standard gear.

Species	Gill Netting		Electrofishing	
	N	CPUE	N	CPUE
Gizzard Shad			61	30.5
Threadfin Shad			66	33.0
Blue Catfish	35	2.3		
Channel Catfish	19	1.3		
Flathead Catfish	4	0.3		
White Bass	101	6.7		
Palmetto Bass	177	8.4		
Green Sunfish			200	100.0
Warmouth			1	0.5
Bluegill			323	161.5
Longear Sunfish			171	85.5
Redbreast Sunfish			1	0.5
Redear Sunfish			5	2.5
Smallmouth Bass			98	49.0
Largemouth Bass			82	41.0
White Crappie	*11	0.7		
Black Crappie	*1	0.1		

APPENDIX B

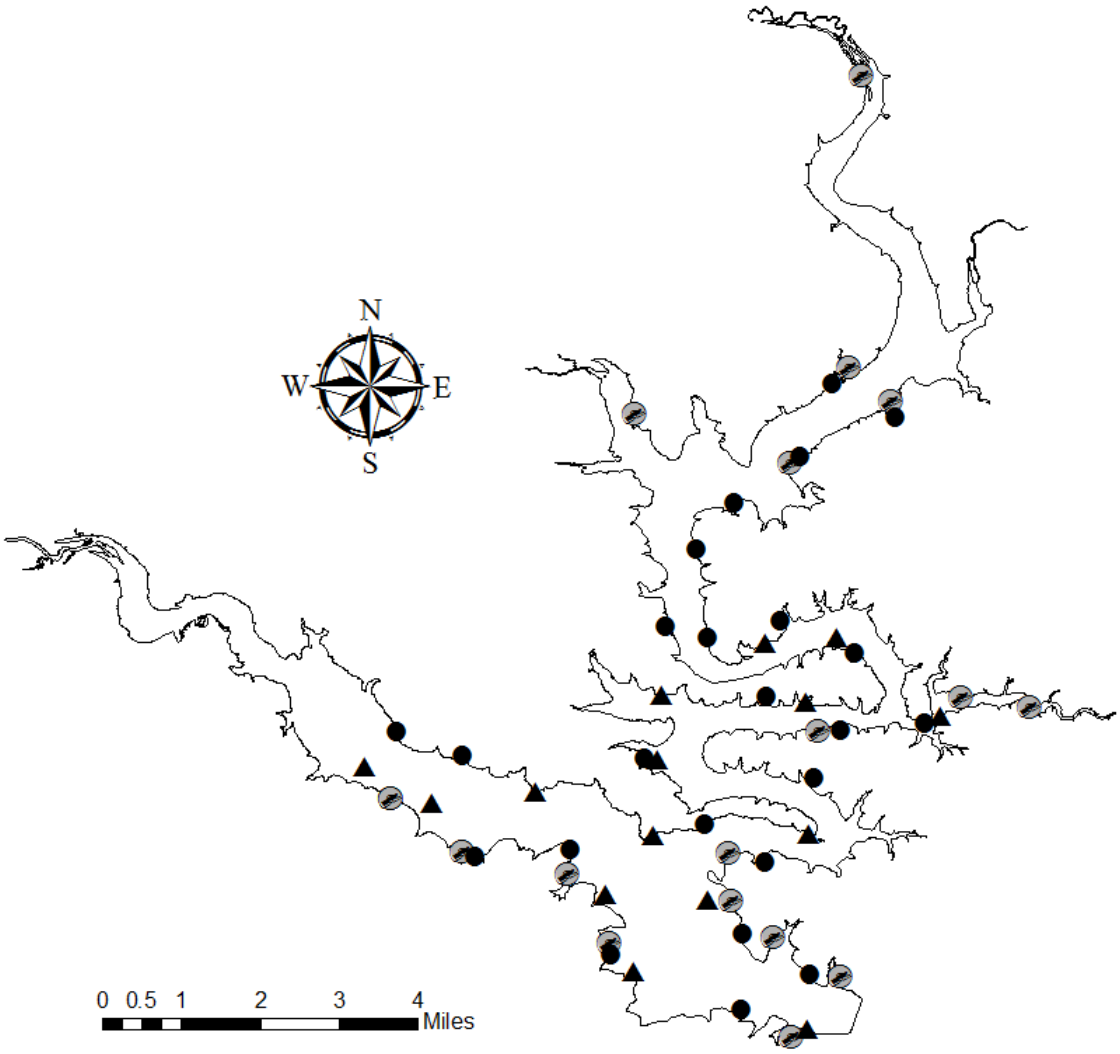
Catch rates (CPUE) of targeted species by gear type for standard surveys on Belton Reservoir, Texas, 1991 to present. Surveys prior to 1996 utilized biologist-selected stations while those after 1996 utilized randomly-selected stations. Electrofishing stations were shocked with a 5.0 Smith-Root GPP (Gas Powered Pulsator) until 2010, when a 7.5 Smith-Root GPP was used. Species averages are in bold. Asterisk denotes collection by a non-standard gear; historic crappie averages are for both gear types combined.

	Electrofisher									
	Bass			Shad		Sunfish				
Year	Largemouth	Smallmouth	Spotted	Gizzard	Threadfin	Bluegill	Redear	Longear	Green	Warmouth
1991	15.5	5.5	3	9.5	33	25	7.5	34.5	26	2
1993	51.5	17	10.5	330.5	6.5	206	32	100.5	33	2.5
1996	45.5	13.5	8.5	157	1	169	7	59.5	24.5	1.5
1999	87	2.5	1.5	30.5	0	35	1.5	49	10	0.5
2000	72	11.5	1	85	8	114.5	12	76.5	50.5	1
2001	-	-	-	-	-	-	-	-	-	-
2002	139.5	8	1.5	221.5	11	147.5	11.5	69	79	1
2003	-	-	-	-	-	-	-	-	-	-
2006	64	11	0	56.5	24.5	196.5	13	39	23.5	1.5
2007	-	-	-	-	-	-	-	-	-	-
2008	126	13	0	29.5	48.5	347.5	18	37.5	30	1
2009	-	-	-	-	-	-	-	-	-	-
2010	127.5	57.5	2	191.5	61	236.5	12	67.5	110	2.5
2011	-	-	-	-	-	-	-	-	-	-
2012	61.5	39.0	0							
2014	41.0	49.0	0	30.5	33.0	161.5	2.5	85.5	100.0	0.5
Avg.	**75.5**	**20.7**	**2.5**	**114.2**	**22.7**	**164.0**	**11.7**	**61.9**	**48.7**	**1.4**

APPENDIX B CONTINUED

	Gill nets					Trap nets	
	Catfish			Bass		Crappie	
Year	Blue	Channel	Flathead	White	Palmetto	White	Black
1991	0.1	7.1	0.1	9.3	3.5	9.7	0
1993	0	4.1	0.5	2.5	6.6	4.4	0
1996	0.1	2.5	0.1	5.9	4.9	9.2	0
1999	0.1	4	0.5	0.3	4.7	0.4	0
2000	-	-	-	-	-	-	-
2001	0.5	2.1	0.7	0.2	1.7	-	-
2002	-	-	-	-	-	0.9	0
2003	1.1	1.9	0.1	2.8	2.4	-	-
2006	-	-	-	-	-	1.4	0
2007	1.7	2.9	0.5	4.2	7.1	-	-
2008	-	-	-	-	-	-	-
2009	3.6	2.1	0.1	0.7	4.6	-	-
2010	-	-	-	-	-	-	-
2011	3.1	3.9	0.1	4.3	5.5	*1.8	*0.1
2013	3.1	1.4	0.2	6.7	9.6	*3.0	*0
2015	2.3	1.3	0.3	6.7	8.4	*0.7	*.07
Avg.	**1.5**	**3.0**	**0.3**	**3.9**	**5.4**	**3.5**	**0.02**

APPENDIX C



Location of sampling sites, Belton Reservoir, Texas, 2014-2015. Standard electrofishing and gill netting stations are indicated by circles and triangles respectively. Water level was 12' low 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) 2014 (Smallmouth Bass) and 2011, 2013, and 2015 (Palmetto Bass) using Fishery Analysis and Simulation Tools (FAST, Slipke and Maceina, 2000).

Methods

Largemouth Bass and Smallmouth Bass otoliths were collected using a stratified random approach in which ten fish per centimeter group were selected for otolith extraction. Palmetto Bass otoliths were collected using a stratified random approach in which five 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 and Smallmouth Bass to calculate total annual mortality and theoretical maximum age 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-8 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

Summary results for all species are shown in Table A. The Largemouth Bass population exhibited the lowest total mortality calculated to date among reservoir Largemouth Bass populations (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 Smallmouth Bass population exhibited a 48.8% mortality rate, with a maximum predicted size of 18.8” and age of 7.4 (Table A). The hypothesis of consistent recruitment was supported by un-weighted catch-curve regression ($p \leq 0.0002$), indicating that stocking did not have an effect on year-class strength. When the number of Smallmouth Bass for each cohort were graphed against the number predicted and compared to stocking years and densities, this statistical finding was also visually observable (Figure A). Caution should be used in interpreting this to mean that stocking should be discontinued. A possible reason for the observed distribution include finite rearing habitat for Age-0 fish, possibly due to prolonged drought (See Figure 1 earlier in the report). An increase in rearing habitat due to high water levels or other

factors may improve survival of Age-0 fish and subsequent numbers of fish within affected cohorts as they get older. Opportunities to test this hypothesis should be pursued in the future if there is reason to believe that rearing habitat availability has increased. High water in late Spring, 2015 may provide this opportunity. Table B contains additional information relevant to Figure A.

The results for Palmetto Bass were very interesting. Total mortality calculated in the 2011, 2013, and 2015 gill net surveys ranged from 36.4% to 52.2% (Table A). Maximum size was consistent among surveys, ranging from 22.2" to 22.5". Maximum age ranged from 7.1 to 9.5 years. The hypothesis of consistent recruitment was not supported by un-weighted catch-curve regression (2011, $p \leq 0.15$; 2013, $p \leq 0.14$; 2015, $p \leq 0.21$), indicating that stocking did have an effect on year-class strength. Two stocking regimes were tested from 2005 through 2013. Fingerlings were stocked in 2005, 2006, 2008, 2009, and 2011 at a rate of 10 per acre, whereas fry were stocked in 2007, 2010, and 2013 at a rate of 100 per acre (Table 4 earlier in report). In 2004 both fingerlings and fry were stocked at those densities, and in 2012, neither were stocked. Residuals calculated from un-weighted catch-curve regression are an indicator of year-class strength, with positive residuals indicating stronger year classes than would be expected if recruitment were equal across years. Log-transformed residuals were determined to be normally distributed when they were graphed against log-transformed numbers of fish observed, allowing direct comparisons of residuals among surveys and across years. Figure B graphically represents the log transformed residuals for each cohort compared to the two stocking regimes. Five cohorts were collected once in a gill net survey, two were collected twice, and three were collected three times. Collecting representatives from a cohort at more than one time during their lifespan reduces the possible influence of gear bias due to fish size, as well as environmental factors that might influence catchability during a survey. It is clear from the figure that higher densities of fry are more than sufficient to offset the perceived advantages of stocking larger fingerlings in Belton Reservoir. In fact, it appears that reduced fry stocking densities and discontinuing fingerling stocking altogether should be considered. Figures C,D and E and Tables C,D, and E contain information calculated from each gill-net survey.

Table A: Population parameters of Largemouth Bass, Smallmouth Bass, and Palmetto Bass in Belton Reservoir, 2010-2015. Estimates were obtained using the Fast Modeling Program.

Species	N aged	Total Mortality	Exploitation rate	Maximum size (L-infinity)	Maximum age	Sample year
Largemouth Bass	425	29.3%	3.48/acre	23.4"	14.6	2010
Smallmouth Bass	287	48.8%	0.37/acre	18.8"	7.4	2014
Palmetto Bass	232	45.1%	1.48/acre	22.5"	9.5	2011
Palmetto Bass	133	52.2%	n.a.	22.5"	7.1	2013
Palmetto Bass	163	36.4%	0.65/acre	22.2"	9.2	2015

Figure A: Number of Smallmouth Bass collected by age in 2014. Diamonds represent actual numbers of fish collected by age, and the line represents the number of fish expected to be collected if recruitment remained constant across years. Squares represent numbers of Smallmouth Bass fingerlings stocked by year, and reference the secondary vertical axis on the right.

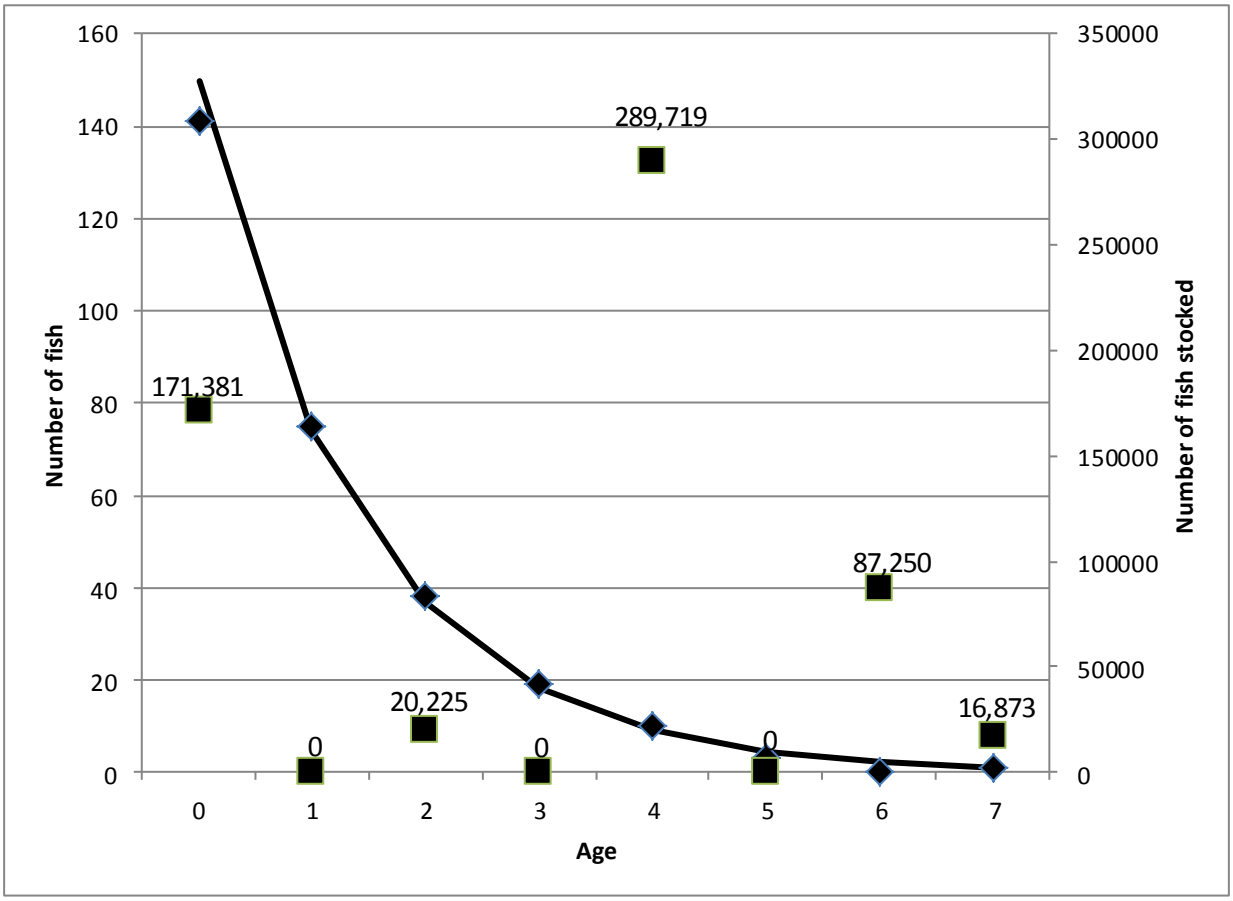


Table B: Number of Smallmouth Bass collected by age in 2014 with residuals calculated from linear regression (Fishery Analysis and Simulation Tools (FAST), Slipke and Maceina, 2000). A positive residual indicates a stronger than expected cohort, whereas a negative residual indicates a weaker than expected cohort, assuming equal recruitment across years.

Age	Number	Ln(Number)	Predicted Number	Predicted Ln(Number)	Residual
0	141	4.956	149.603	5.008	-0.052
1	75	4.331	74.183	4.307	0.024
2	38	3.664	36.785	3.605	0.058
3	19	2.996	18.24	2.904	0.092
4	10	2.398	9.045	2.202	0.196
5	3	1.386	4.485	1.501	-0.114
6	0	0	2.224	0.799	-0.799
7	1	0.693	1.103	0.098	0.595

Figure B: Residuals from three Palmetto Bass gill netting surveys (vertical bars) plotted on years when each represented cohort was produced. Shaded areas indicate years where only fingerlings were stocked. The crosshatched area represent when both fry and fingerlings were stocked (2004) or none were stocked (2012). Unshaded areas represent when only fry were stocked. Positive residuals indicate stronger year classes than would be expected if recruitment were equal across years.

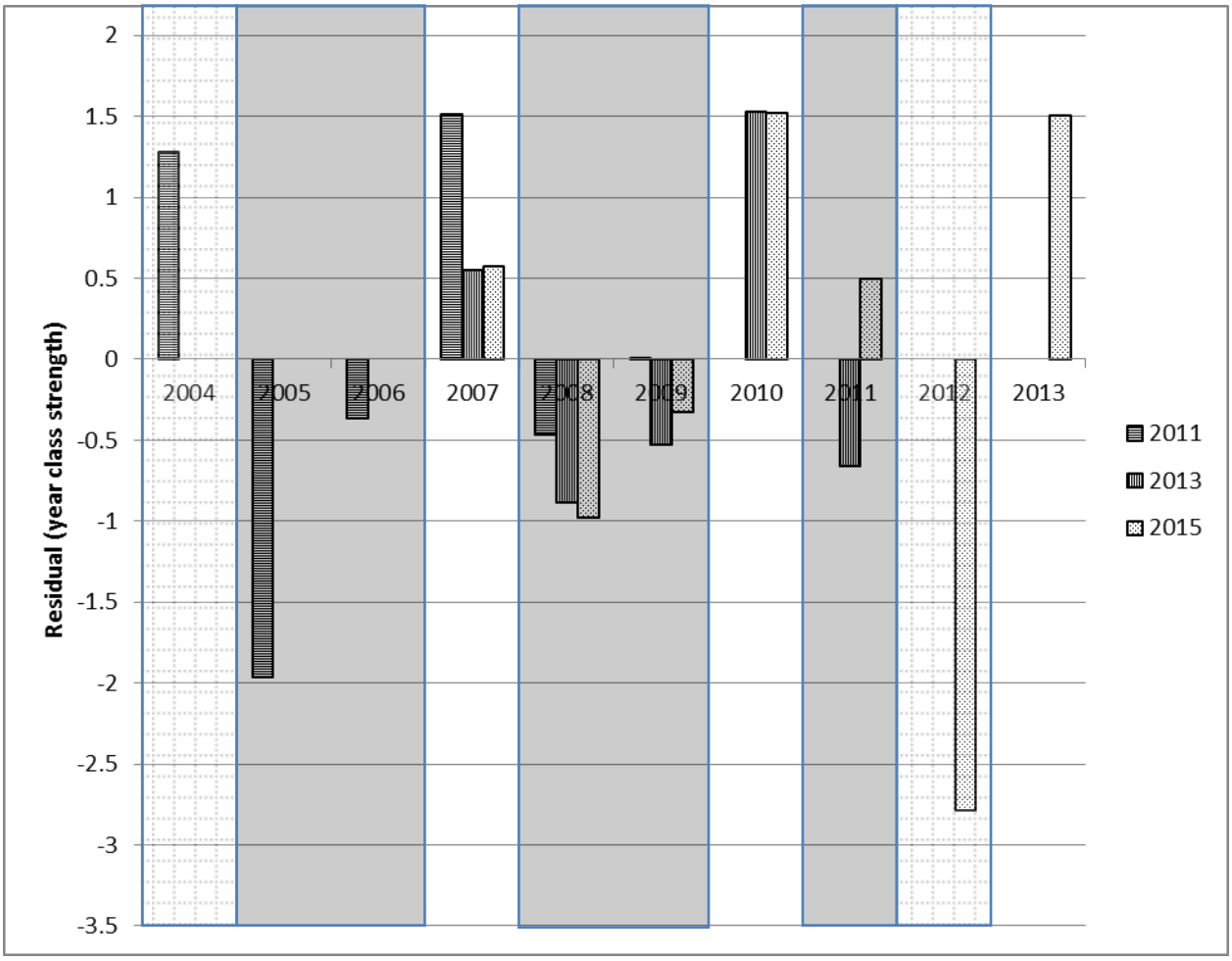


Figure C: Number of Palmetto Bass collected by age in 2011. Diamonds represent actual numbers of fish collected by age, and the line represents the number of fish expected to be collected if recruitment remained constant across years. Fry = fry stocking; Fgl = fingerling stocking; Fry/Fgl = both fry and fingerling stocked.

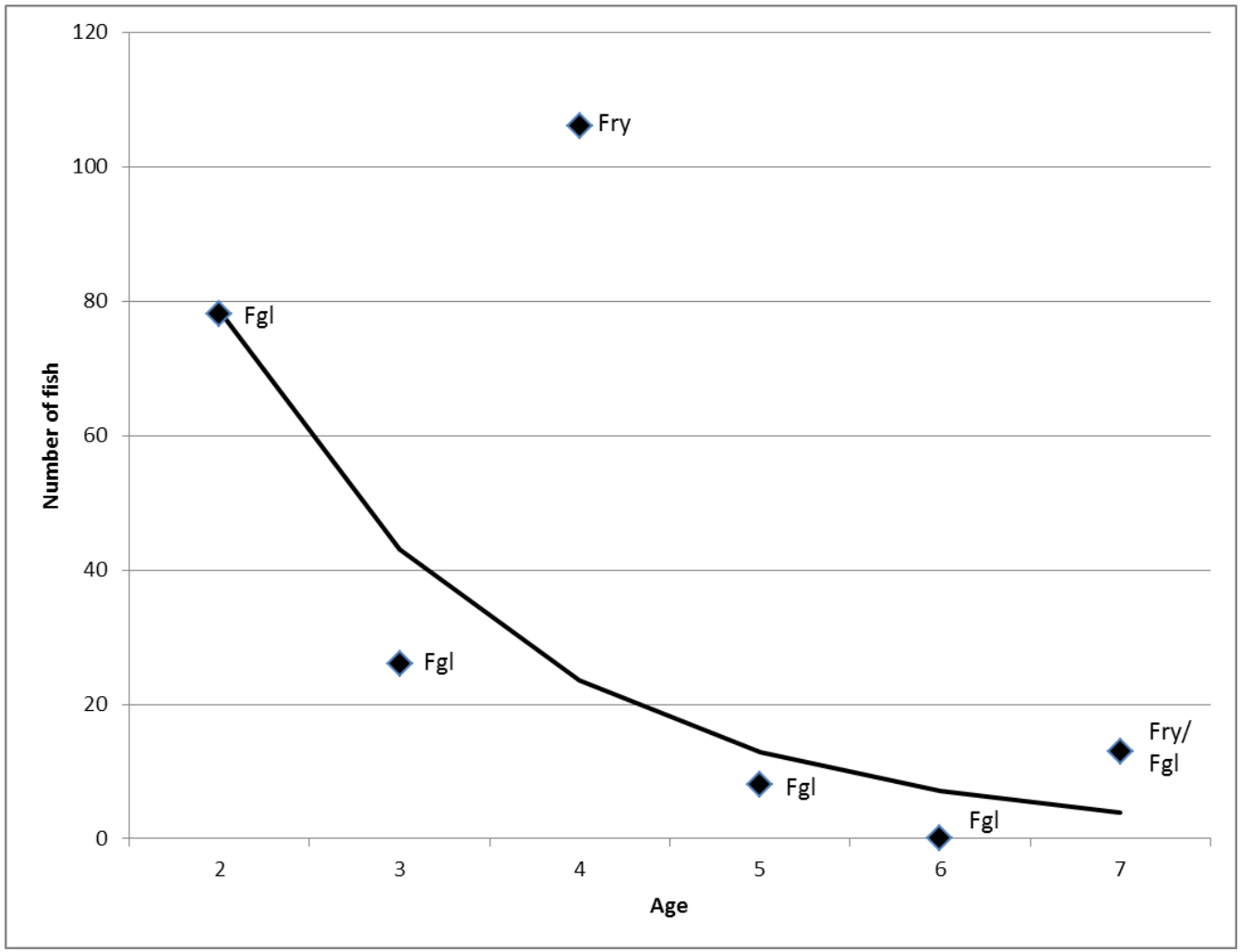


Table C: Number of Palmetto Bass collected by age in 2011 with residuals calculated from linear regression (Fishery Analysis and Simulation Tools (FAST), Slipke and Maceina, 2000). A positive residual indicates a stronger than expected cohort, whereas a negative residual indicates a weaker than expected cohort, assuming equal recruitment across years.

Age	Number	Ln(Number)	Predicted Number	Predicted Ln(Number)	Residual
2	78	4.369	78.53	4.363	0.006
3	26	3.296	43.079	3.763	-0.467
4	106	4.673	23.632	3.163	1.51
5	8	2.197	12.964	2.562	-0.365
6	0	0	7.112	1.962	-1.962
7	13	2.639	3.901	1.361	1.278

Figure D: Number of Palmetto Bass collected by age in 2013. Diamonds represent actual numbers of fish collected by age, and the line represents the number of fish expected to be collected if recruitment remained constant across years. Fry = fry stocking; Fgl = fingerling stocking.

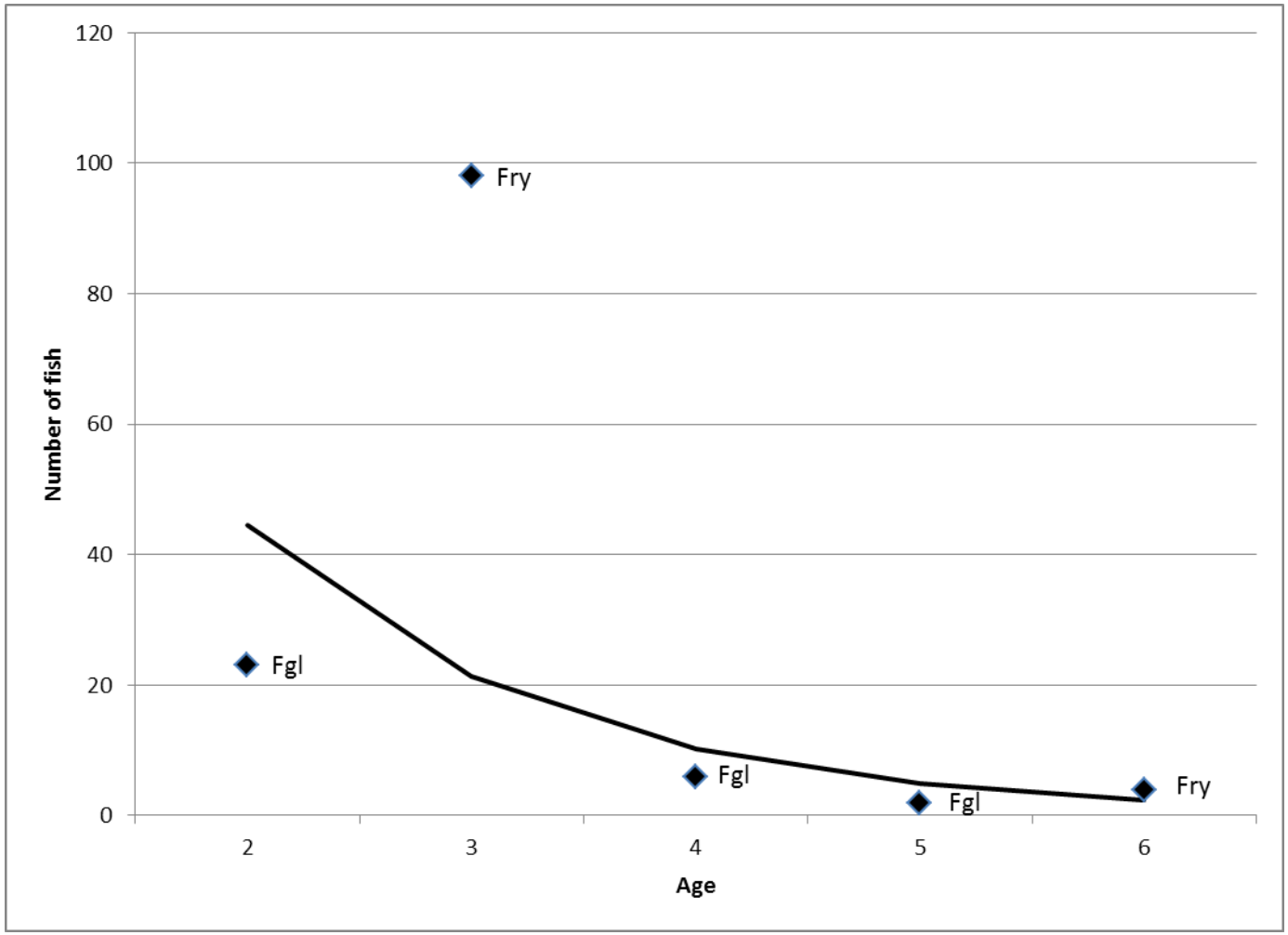


Table D: Number of Palmetto Bass collected by age in 2013 with residuals calculated from linear regression (Fishery Analysis and Simulation Tools (FAST), Slipke and Maceina, 2000). A positive residual indicates a stronger than expected cohort, whereas a negative residual indicates a weaker than expected cohort, assuming equal recruitment across years.

Age	Number	Ln(Number)	Predicted Number	Predicted Ln(Number)	Residual
2	23	3.135	44.54	3.796	-0.661
3	98	4.585	21.271	3.057	1.528
4	6	1.792	10.159	2.318	-0.527
5	2	0.693	4.852	1.579	-0.886
6	4	1.386	2.317	0.84	0.546

Figure E: Number of Palmetto Bass collected by age in 2015. Diamonds represent actual numbers of fish collected by age, and the line represents the number of fish expected to be collected if recruitment remained constant across years. Fry = fry stocking; Fgl = fingerling stocking; No stk = no stocking.

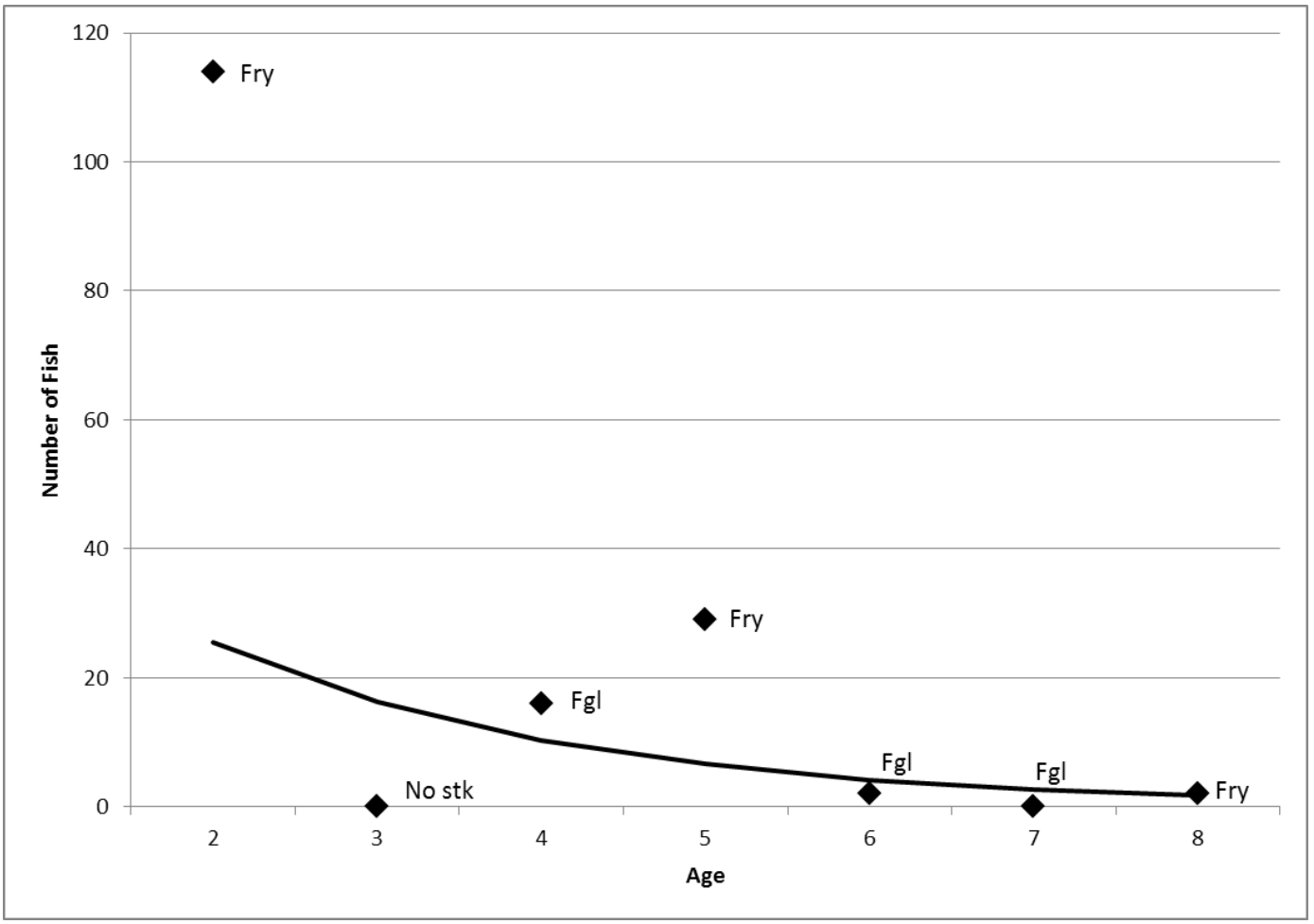


Table E: Number of Palmetto Bass collected by age in 2015 with residuals calculated from linear regression (Fishery Analysis and Simulation Tools (FAST), Slipke and Maceina, 2000). A positive residual indicates a stronger than expected cohort, whereas a negative residual indicates a weaker than expected cohort, assuming equal recruitment across years.

Age	Number	Ln(Number)	Predicted Number	Predicted Ln(Number)	Residual
2	114	4.745	25.54	3.24	1.505
3	0	0	16.242	2.788	-2.788
4	16	2.833	10.329	2.335	0.498
5	29	3.401	6.569	1.882	1.519
6	2	1.099	4.178	1.43	-0.331
7	0	0	2.657	0.977	-0.977
8	2	1.099	1.69	0.524	0.574

APPENDIX E

Objective-Based Sampling Plan (FY 2015)

Sampling Plan for Belton Reservoir
FY 2015

Sport fish, forage fish, and other important fishes: Sport fishes in Belton Reservoir include Largemouth Bass, Smallmouth Bass, Palmetto Bass, White Bass, Channel Catfish, Blue Catfish, and White Crappie. Important forage fish species include Gizzard Shad, Threadfin Shad, Bluegill, and Longear Sunfish.
Negligible fishery: Spotted Bass, Flathead Catfish, and Black Crappie occur in very low abundance in Belton Reservoir and are generally caught incidentally to other targeted species. We will still collect them with relevant sampling gear, length and weight will be recorded in the FMF, and CPUE will be recorded in the management report.
Survey objectives, fisheries metrics, and sampling objectives

Largemouth and Smallmouth Bass: The Black Bass as a group are sought most often in Belton Reservoir. The popularity of bass fishing at this reservoir, including tournaments, justify sampling time and effort. Results from the 2010 creel survey showed directed angling effort for Black Bass to be 10.3 hours/acre which represented 40.5% of total angling effort. Trend data on CPUE, size structure, and body condition have been collected biennially since 2006 with fall nighttime electrofishing. It is important to note here that the Smallmouth Bass population is the best in the district.
Because of the importance of Largemouth Bass in this reservoir to both recreational and tournament anglers, comparing current sampling data to previously collected data is important. After reviewing historical efforts, electrofishing catch rates of Largemouth Bass in 2008 and 2010 exceeded ten times the number of length classes, which should result in a mean weighted CV of 0.25 or less over the entire range of size classes in a length distribution. Collecting a minimum of ten times the number of expected length classes will allow comparison of length-frequency histograms among years to determine changes in the population over time. A minimum of 20 randomly selected 5-min electrofishing stations will be sampled at night in fall 2014, but sampling will continue at random stations until a minimum of 200 fish of all sizes (10 times 20 length classes) have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. This information will augment a Category 4 age sample that was completed in 2010.
Electrofishing catch rates of Smallmouth Bass have historically been insufficient to make any statistical comparisons or obtain meaningful growth or mortality estimates. However, catch rates in 2010 and 2012 were four to six times higher than historical catch rates, raising the possibility that we might be able to collect enough fish to provide statistically meaningful growth information. Collecting a Category 3 age sample (200 stock size fish) will allow precise calculation of length-at-age, as well as year-class strength and mortality. A minimum of 20 randomly selected 5-min electrofishing sites will be sampled at night in fall, 2014, with up to 20 additional randomly selected sites also sampled. When these efforts are completed, the catch rate will be evaluated to determine if 200 stock size fish is an attainable objective. Alternatives such as non-random sites, sites with longer duration (15 minutes or more), and daytime electrofishing will be explored if needed to obtain this age sample.
Creel survey information has been very useful on Belton Reservoir, and was collected in 2003 and 2010. The number of Black Bass taken to tournament weigh-ins increased from 7,813 in 2003 to 42,273 in 2010. Our concern is that the number of bass weighed-in during recent years may have continued to increase and may begin to adversely impact the fishery. Collection of creel information in 2014 will allow comparison to previous years, and indicate whether angling pressure has changed. We will complete a full 36 day creel over 12 months to examine this issue.

Palmetto and White Bass: Temperate Bass as a group is the third most sought by anglers in Belton Reservoir. Results from the 2010 creel survey showed directed angling effort for Temperate Bass to be

3.1 hours per acre, which represented 12.2% of total angling effort. Harvest of White Bass and Palmetto Bass combined exceeded all other species groups. Trend data on CPUE, Size structure, and body condition have been collected biennially since 2007 with spring gill netting.

Our primary goal for the Palmetto Bass fishery in this survey is comparing recruitment from years where fingerlings were stocked to years where fry were stocked. Collecting a Category 3 age sample (200 stock size fish) will allow precise calculation of length-at-age, as well as year-class strength and mortality. This was done in 2011, when 15 random sites and 10 non-random sites were gill netted, collecting 83 and 154 Palmetto Bass respectively. Fish in the sample were aged according to TPWD procedures. A supplementary sample of 133 Palmetto Bass was collected in 2013 at 15 random sites and aged as well. Collecting a minimum of 200 stock-size fish in spring, 2015 will allow us to calculate length-at-age as well as year class strength and mortality at a similar level of precision to 2011. This will greatly aid our efforts to compare the results of fry and fingerling stockings over multiple years. In addition, collecting a minimum of ten times the number of expected length classes will result in a more precise length-frequency histogram. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2015, but sampling will continue at random stations until a minimum of 200 stock size fish have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. If catch rates are low, strong consideration should be given to sampling at non-random sites rather than falling short of the 200 fish goal.

White Bass numbers have varied widely among gill net collections. When good numbers are present in the reservoir, they are one of the most-harvested fish species. For example, gill net catch rates of White Bass in 2011 were well above the historical average for the reservoir and the corresponding creel survey showed White Bass to be the most harvested fish species. The goal of this survey in regards to White Bass is determining whether anglers will have a large or small population of legal-sized White Bass to fish for in the next two years. Calculating proportions such as PSD will allow us to characterize the White Bass population, compare it to historical data, and provide information to anglers on what to expect when fishing for White Bass in the near future. Collecting a minimum of 50 stock length fish in 2015 spring gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2015, but sampling will continue at random stations until a minimum of 50 stock size fish have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more White Bass if additional gill netting to meet objectives for other species is required.

There is a cost associated with stocking Palmetto Bass into Belton Reservoir, and it is incumbent on us to evaluate whether the benefit of the stocking justifies the cost. Accordingly, creel information collected during 2014 will be compared to historical creel information to determine if anglers are using the Palmetto Bass fishery. Creel information on White Bass will be compared to previous years as well. Linking the angler catch rates with the gill net catch rates will allow us to generally predict angler success in future years when we do not have creel information. This would be useful when writing a news release discussing possible “hot spots” for Palmetto and White Bass fishing using gill net catch data.

Channel and Blue Catfish: Catfish as a group are the second most sought by anglers in Belton reservoir. Results from the 2010 creel survey showed directed angling effort for the Catfish group to be 5.2 hours per acre, which represented 20.3% of total angling effort. Trend data on CPUE, Size structure, and body condition have been collected biennially since 2007 with spring gill netting. The goal of this survey would be to characterize the Channel and Blue Catfish populations and make comparison to historical and future data. This would also allow us to identify if a need exists for additional stocking of Blue Catfish. Collecting a minimum of 50 stock length fish in 2015 spring gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2015, but sampling will continue at random stations until a minimum of 50 stock size fish of each species have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more Channel and Blue Catfish if additional gill netting to meet objectives for other species is required. Length and weight of Flathead Catfish will be collected if any are encountered.

White Crappie: White Crappie are the dominant Crappie species in Belton Reservoir, and Black Crappie occur only rarely. The 2010 creel survey showed directed angling effort for White Crappie to be 1.3 hours per acre, representing 5.1 percent of total angling effort. Historically, White Crappie data was collected with trap netting. The number of fish collected was generally very low, averaging less than 1 fish per net-night in trap net sampling over the past 15 years. However, gill netting in spring 2011 yielded 4.4 fish per net-night. We plan to continue evaluating the use of this non-standard gear in sampling the White Crappie population. If this effort is successful, it will allow us to characterize the White Crappie population and make comparison to the 2011 and future data. Collecting a minimum of 50 stock length fish in 2015 spring gill netting will allow us to calculate proportions (e.g. PSD) with an 80% confidence interval. A minimum of 20 randomly selected gill net stations will be sampled in spring, 2015, but sampling will continue at random stations until a minimum of 50 stock size fish have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. We will continue to collect more White Crappie if additional gill netting to meet objectives for other species is required. Length and weight of Black Crappie will be collected if any are encountered.

Bluegill, Longear Sunfish, Gizzard Shad, and Threadfin Shad: Bluegill, Longear Sunfish, Gizzard Shad and Threadfin Shad are the primary forage at Belton Reservoir. Trend data on CPUE, size structure, and body condition have been collected biennially since 2006 with fall nighttime electrofishing. The goal of this survey would be to collect prey size and availability information. Calculating proportions such as PSD and IOV will allow us to characterize the prey-fish population and determine prey availability. Collecting a minimum of 50 stock length fish in 2014 fall electrofishing will allow us to calculate proportions (e.g. PSD, IOV) with an 80% confidence interval. A minimum of 20 randomly selected 5-min electrofishing stations will be sampled at night in fall 2014, but sampling will continue at random stations until 50 stock size fish for each species (if applicable) have been collected. In addition to the original 20 random stations, 20 additional random stations will be pre-determined in the event extra sampling is necessary. Additional prey fish beyond 50 stock size fish will not be collected if additional electrofishing is needed to meet the Largemouth or Smallmouth Bass objectives. No additional effort will be expended to achieve an RSE25 for CPUE of bluegill and gizzard shad. Instead, Largemouth Bass body condition can provide additional information on forage abundance.