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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2011 Survey Report

Buchanan Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Lake Buchanan were surveyed in 2011 using electrofishing and in 2012 using gill nets. This report summarizes the results of the surveys and contains a fisheries management plan for the reservoir based on those findings.

- **Reservoir Description:** Lake Buchanan is a 22,211-acre impoundment of the Colorado River located in Burnet and Llano counties. It was constructed in 1937 by the Lower Colorado River Authority (LCRA) for purposes of hydroelectric power, water supply, flood control, and recreation. The reservoir lies within the Edwards Plateau ecological area. Its drainage area is approximately 31,250 square miles. Shoreline length is approximately 140.6 miles. Only small amounts (<1 acre) of aquatic vegetation have ever been documented in the reservoir.

- **Management History:** Important sport fish include white bass, striped bass, sunshine bass, largemouth bass, and catfish species. The management plans for 2007 were to: continue annual stockings of striped bass; monitor the striped bass population with additional gill netting; and, permit the stocking of sunshine bass by the Lake Buchanan Conservation Corporation (LBCC). Striped bass have been stocked almost annually since 1977, and the reservoir is regarded as one of the best striped bass fisheries in Texas. Sunshine bass were first stocked in 2006 by the LBCC. The Florida subspecies of largemouth bass was stocked in the reservoir in the late 1970's and once again in 2008 to increase Florida largemouth bass genetic influence in the population. Blue catfish were stocked in 1989 and 1990 to help establish a sustainable population. White bass were managed under an experimental 12-inch minimum length limit from 1995 to 2003. The regulation was rescinded after analysis indicated environmental factors, not angler harvest, were probably more influential in determining white bass population density.

- **Fish Community**
  - **Prey species:** Gizzard shad, threadfin shad, redbreast sunfish and bluegill were the predominant sources of forage.

  - **Catfishes:** Blue catfish surpassed channel catfish as the predominant catfish species present in our surveys. Flathead catfish were present in low densities.

  - **Temperate basses:** White bass abundance decreased in 2012, but still remained moderate. Striped bass gill net average catch slightly decreased since 2008, remaining below historical average. Stress due to high water temperature and low dissolved oxygen in the summer months may be causing decreased body condition and growth of striped bass. Sunshine bass showed an increasing trend in abundance, with many legal-size (≥18 inches) individuals present.

  - **Black basses:** Largemouth bass catch decreased noticeably in 2011, most likely a reflection of record-low water levels at the time of survey. Largemouth bass reach 14 inches by age-2.

Management Strategies

The reservoir should continue to be managed with existing fishing regulations. It is still uncertain if sunshine bass are out-performing striped bass, especially during thermally stressful summer months. Further catch evaluations should be conducted before considerations are taken to shift to stocking solely hybrid striped bass into Buchanan Reservoir. Sunshine bass should continue to be allowed for stocking to supplement the *Morone* fishery, especially since recent state hatchery production has been hindered by natural causes. Gill netting should be conducted annually to monitor *Morone* spp. abundance.

INTRODUCTION

This document is a summary of fisheries data collected from Lake Buchanan in 2011 and 2012. 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 (Appendix A), this report deals primarily with major sport species and important prey species. Fisheries management strategies are included to address existing problems or opportunities. Historical data is presented with the 2011 and 2012 data for comparison.

Reservoir Description

Lake Buchanan is a 22,211-acre impoundment of the Colorado River located in Burnet and Llano counties. It was constructed in 1937 by the Lower Colorado River Authority (LCRA) for purposes of hydroelectric power, water supply, flood control, and recreation. The reservoir lies within the Edwards Plateau ecological area. Its drainage area is approximately 31,250 square miles. Shoreline length is approximately 140.6 miles. This reservoir experiences extreme water level fluctuations (Figure 1). Shoreline habitat at the time of sampling consisted mostly of sandy and rocky bank. No aquatic vegetation was present. Angler access was adequate for boat anglers when the water level remained at least 1,004 feet above mean sea level. When water level fell below 1,004 feet above mean sea level, boat access became poor. As water level declined, the number of usable boat ramps available declined. Increased municipal water demand and effects of climate change (i.e. less rainfall) may make future recreational boating access to Buchanan Reservoir difficult (Daugherty et. al. 2011). Four public and some pay-access private boat ramps were available (Appendix B). The Llano County boat ramp and White Bluff (Burnet County) boat ramp were improved to be more accessible at low water levels. Bank fishing was available at four public parks. Handicapped access was poor with no specific handicap accessible fishing sites available. Other descriptive characteristics for Lake Buchanan are in Table 1.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Magnelia and De Jesus 2008) included:

1. Stock striped bass (15/acre) and monitor the population with annual gill net surveys.

   Action: Striped bass were stocked at full rate in 2009 and at a reduced rate in 2010. No fish have been stocked since, due to statewide Morone production problems. Annual gill net sampling was conducted in 2009–2012. Gill netting effort (N = 30 net nights), was doubled from the required 15 net nights to improve the precision of relative abundance, except in 2012, when reservoir levels dropped and decreased accessibility.

2. Permit the stocking of sunshine bass by the Lake Buchanan Conservation Corporation (LBCC).

   Action: Sunshine bass were permitted and fry and fingerlings were stocked in 2006–2012 by the LBCC.

Harvest Regulation History: Sportfish in Lake Buchanan are currently managed with statewide regulations (Table 2). The white bass minimum length limit was reduced to 10 inches in September 2003 since analyses suggested that population densities were probably determined by environmental factors rather than angler harvest.

Stocking History: Annual striped bass stockings at a rate of 15/acre have been requested since 2004 to maintain this popular fishery. Florida largemouth bass were stocked in 2008 to increase Florida largemouth bass genetic influence. A complete stocking history is in Table 3.

Aquatic Vegetation/habitat history: Lake Buchanan had no aquatic vegetation coverage. Most of the shoreline habitat was comprised of sand and rock (Table 4).

METHODS

Fishes were collected by non-standard daytime electrofishing (1.5 hours at 18 stations), due to reduced acreage and hazardous conditions presented by record-low water levels; and standardized gill netting (15 net nights at 15 stations). Catch-per-unit-effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing, and for gill netting as the number of fish caught in one net set overnight (fish/nn). All survey sites were randomly selected and all surveys, except electrofishing, were conducted according to the Texas Parks and Wildlife Department Inland Fisheries Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual, revised 2011). White crappie were monitored through gill net surveys, which yielded better catch rates than historical trap netting. A two-quarter roving creel survey was conducted during spring and summer 2011 to evaluate angling statistics and direct expenditure (TPWD, Inland Fisheries Division, unpublished manual, revised 2011). A follow-up mail-out survey was conducted to assess economic impact and angler attitude and opinions. To calculate the economic impact of angling at Lake Buchanan, anglers' direct expenditures were multiplied by industry-level multiplier coefficients in IMPLAN (Minnesota IMPLAN Group, 2010). Only expenditures by non-locals were used in the calculations as they represented new money into the local area. Impact analysis details how money spent in a region stimulates additional economic activity for that region. In other words, how a dollar spent at a grocery store not only impacts that business, but has impact to their suppliers, workers (income), tax revenues, etc. This multiplier effect shows that the effect on output, employment, income, and government revenue is larger than the initial money spent (Schuett et al., 2012). While some money may leave the defined region, the money that stays represents the economic impact. Attitudes and opinion data were analyzed using SAS Enterprise Guide (2011). An access survey was conducted during site visits and supplemented with current web-available aerial imagery (Google Earth). Habitat data used were from most recent survey performed in 2004. No large-scale structural habitat changes have occurred in the interim.

Sampling statistics (CPUE for various length categories) and structural indices [Proportional Size Distribution (PSD); as defined by Guy et al. (2007)], and condition indices [relative weights (W_r)] were calculated for target fishes according to Anderson and Neumann (1996). Sunshine bass structural and condition indices were calculated using palmetto bass literature values in assumption that they would be similar (confirmed by Dr. Michael Brown of South Dakota State University, personal communications). The Index of Vulnerability (IOV) was used to determine the percentage of gizzard shad vulnerable to predation (DiCenzo et al. 1996). Relative standard error (RSE = 100 x SE of the estimate/estimate) was calculated for all CPUE statistics and for creel statistics, and SE was calculated for structural indices and IOV. Ages for temperate basses were obtained using otoliths from all individuals sampled. Ages were determined for largemouth bass using otoliths from all individuals greater than 14 inches sampled (N = 12), in lack of enough fish to conduct a category 2 analysis (TPWD, Inland Fisheries Division, unpublished manual, revised 2011). Water level data were provided by the LCRA through their website.

RESULTS AND DISCUSSION

Habitat: In 2004 shoreline habitat was comprised mostly of sand and rock (Table 4). Submerged, floating and emergent aquatic vegetation were absent throughout the reservoir; hence not optimal for fish production (Durocher et al. 1984, Dibble et al. 1996). Fish in this reservoir relate mainly to topographical gradients or irregular contours found throughout the lake. A fish attractor project was initiated in 2009 to help concentrate cover-seeking species and increase angler catch rates. Juniper trees (*Juniperus ashei*) sunken with tied cinder blocks were installed at eight sites in 2008, six sites in 2009 and three sites in 2010, five sites in 2011, for a total of 22 fish attractor sites throughout the lake (Appendix C). Global positioning system (GPS) coordinates were made available to the public (Appendix D). Attractors

received refurbishment as needed during these years as well.

Creel Survey: Total fishing effort for all species at Buchanan Reservoir was 162,592 h (7.3 h/acre) from March 2011 through August 2011. Sixty-one percent of total fishing effort was from boat anglers. Directed fishing effort by all anglers was highest for white bass (39.9%), followed by anglers fishing for striped bass and sunshine bass (21.1%), and largemouth bass (10.4%); however directed effort for all catfish species combined accounted for 14.1% (Table 5). Directed effort for white bass (2.9 h/acre) accounted for 41% of the total effort, and reflected the popular white bass run up-river to Colorado Bend State Park, occurring in the spring quarter (March – May). Overall mean catch rate for all species targeted by bank and boat anglers was 0.7/h and 1.6/h, respectively. Overall angler compliance was excellent, as most species observed harvested during the creel period were of legal size. The only exception was one instance when 2 under-sized sunshine bass that were mistaken for white bass. Blue catfish provided the best catch rate (2.2/h) among all species to which anglers directed their efforts. An estimated total of $1,786,718 in direct expenditures related to fishing trips was made by anglers during the 6-month creel period (Table 6). Direct expenditures estimate, as described here, relates to expenses for a single day of fishing.

Economic Impact: Direct expenditures estimates, described here, relate to expenses from complete fishing trips reported by anglers in a mail-out survey. Total direct expenditures resulting from fishing at Lake Buchanan, both local (residents of Burnet and Llano counties) and non-locals were estimated at $5.2 million between March 1 and August 31, 2011. Local spending (Burnet and Llano counties) was estimated at $2.1 million, while another $3.1 million was spent elsewhere in Texas. Median expenditures from non-local anglers were $75.00 per trip in the local area, with an additional $100.00 spent elsewhere in Texas. Spending by non-locals generated more than $250,000 of labor income, generating the full-time equivalent of 9.1 jobs in Burnet and Llano counties. Total economic value relating from the direct expenditures of non-locals in Burnet and Llano counties was $571,772. Total local and state taxes were estimated at $201,000 generated by all anglers. Additionally, direct expenditures by non-locals generated more than $404,000 of labor income, generating the full-time equivalent of 12.0 jobs elsewhere in Texas. Total economic value relating from the direct expenditures of non-locals elsewhere in Texas was $934,046.60. See Appendix E for complete results.

Attitudes and Opinions: Of the 194 mail-out surveys distributed to anglers as follow-up to their creel interviews, 85 replies were received. These accounted for a 44% response rate, which was excellent when compared to TPWD historic mail-out response rates (<20%). Most (>75%) responders were between the ages of 45 and 65 (range 25–85), and have been fishing Buchanan Reservoir from zero to 60 years (all responders). Responders claimed that they had fished an average of 18.9 days (s.d. = 35.6; range (0–300) from a boat within the full year previous to the survey; and an average of 13.2 days (s.d. = 38.2; range (0–300) during the creel time period. This suggests a good number of new and returning anglers to Buchanan Reservoir. Over half (56%) of responders claimed to fish Buchanan Reservoir during both weekdays and weekends; followed by 22% that only fished weekends. Most (58%) responders said they fished Buchanan Reservoir during multiple seasons; however 38% claimed to strictly fish during the spring season, more than any other season. No anglers claimed to just fish during the winter season, leaving near 4% strictly fishing the reservoir during summer or fall. When asked of their top three preferences of species to catch at Buchanan Reservoir, they preferred catching white bass the most, followed by any catfish and striped bass. These results may reflect a heavy presence of white bass anglers targeting the white bass run up at Colorado Bend State Park during the spring quarter creel. If hybrid striped bass were to be combined with striped bass, it would take second preference over any catfish. Only about 6% of responders claimed to have participated in black bass tournaments anywhere within the previous year prior to the survey.

Seventy-nine percent (79%) of responders agreed or strongly agreed to being satisfied overall with their fishing experience at Buchanan Reservoir (Appendix F). Seventy-two percent (72%) agreed or strongly agreed that fishing for the species they were most interested in was good. Only 41% agreed or strongly agreed that boat ramp facilities and associated parking was adequate. Only 35% agreed or strongly agreed that bank fishing opportunities were adequate. About 9% agreed or strongly agreed that convenient and economical lodging facilities were readily available; while 47% were neutral. Seventy-

eight percent (78%) agreed or strongly agreed that Buchanan Reservoir was close to home and convenient. Only about 6% agreed or strongly agreed that their primary purpose of their fishing trip was to fish or pre-fish for a black bass tournament; while no one agreed to do so for striped bass tournaments. Still, 85% agreed or strongly agreed that their main purpose to visit Buchanan reservoir was to go fishing; while about 12% claimed their main purpose was for another activity, but decided to fish last minute while there. Twenty-eight percent (28%) agreed or strongly agreed that their main purpose for coming to the lake was for an activity other than fishing, but fishing was definitely a part of the listed activities intended during their stay. Only 34% agreed to some extent that they only fished Buchanan Reservoir seasonally for a certain species, such as white bass during the spring run.

Prey species: Electrofishing catch rates of gizzard shad**,** threadfin shad**,** redbreast sunfish and bluegill were 261.3/h, 94.67/h, 53.3/h and 5.3.0/h, respectively. Total catch rate of gizzard shad remained similar to that in 2007 (268.0/nn); however IOV for gizzard shad noticeably declined to 21, indicating that 21% of gizzard shad were vulnerable (≤8 inches) to existing predators (Figure 2). Threadfin shad were abundant and provided vulnerable forage for existing predators. Total catch rates of redbreast sunfish in 2011 slightly increased from the 2007 survey (45.5/h), but not as high as seen in 2003 (259.0/h) (Figure 3). Total CPUE of bluegill in 2011 noticeably dropped from the 2007 survey (107.0/h) with only eight individuals sampled (Figure 4). Sunfish abundance can be related to habitat availability, which is consequentially affected by water levels. Buchanan Reservoir experienced record-low water levels during recent extreme drought conditions in 2009 and 2011.

Blue catfish: Blue catfish total catch rate has gradually increased to 4.0/nn in 2012 from 2.7/nn 2008 (Figure 5); in fact, this increasing trend is seen further back into our survey history (Appendix G). The blue catfish fishery has become very popular among local fishing guides, who offer to target them in lieu or as part of striped bass charter trips. This is due to increased opportunity of catching large (≥30 inches) or trophy-sized (≥36 inches) individuals. The lake record was caught in 2008, which weighed 65.2 pounds at 44 inches. Body condition in 2012 remained similar to body condition from previous surveys and was considered good; as relative weights were above 90 for most inch groups of stock-sized fish (85–120). Directed fishing effort was low, relative to other species, but may be underrepresented due to a greater number of hours directed towards all catfish species combined (Table 5). Catch rate was high (2.2/h) and total harvest for blue catfish showed that anglers were utilizing this species (Table 7). Blue catfish were a harvest-oriented fish, as none of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fish ranged from 12 to 24 inches (Figure 6). The development of this blue catfish fishery has brought up the issue of protecting the quality-size fish through more restrictive harvest regulations. Three questions pertaining to blue catfish regulations were asked of anglers during the mail-out survey in 2011. The first question asked if they would be in favor of a more restrictive bag limit for trophy-size fish: Thirty-eight percent (38%) of responders said they would be in favor; while 28% would not be in favor; and 34% had no opinion. The second question asked anglers what they would consider to be the length and weight of a trophy-size blue catfish: The average minimum length at which responders felt blue catfish should be considered trophy size was 31.5 inches (+/- 6.5; range 18 to 42 inches); while the average minimum weight was 32.5 pounds (+/- 13.9; range 10 to 60 pounds). The third question was compounded, and asked how they felt about several blue catfish regulation options presented. Only about 35% agreed to keep the current blue catfish regulation at Buchanan Reservoir. Sixteen percent (16%) agreed to reducing the blue catfish bag limit; 12% agreed to a slot length limit; 22% agreed to reducing the bag of large fish down to one or two; and 21% agreed to increase the minimum length limit. For all questions pertaining to blue catfish regulations, most responders answered “neutral”, which on average accounted for about 55% of the responses.

Channel catfish: The total gill net catch rate of channel catfish was 1.7/nn in 2012, dropping almost by half compared to 3.1/nn in 2008 (Figure 7). This decline in abundance was first noticed in the 2011 survey, when catch rate dropped to 1.9/nn, and is an inverse trend when compared to blue catfish. Only 15% of the total gill net catch exceeded the legal harvest size of 12 inches. Body condition in 2012 was good (relative weights above 85) for nearly all size classes, which was similar to previous surveys (Figure 7). Directed fishing effort was low, relative to other species and almost half that of blue catfish, but may be underrepresented due to a greater number of hours directed towards all catfish species combined

(Table 5). Catch rate was high (1.9/h) and total harvest for channel catfish showed that anglers are utilizing this species (Table 8). Channel catfish were a harvest-oriented fish, as only 18.1% of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fished ranged from 12 to 22 inches (Figure 8).

Flathead catfish: Only one flathead catfish was sampled in 2012, dropping the total gill net catch rate to 0.1/nn from 0.4/nn in 2008 (Figure 9). The flathead catfish population continued to show low relative abundance, with a population structure dominated by large individuals (Figure 9). Directed fishing effort was the lowest among catfish species, and no catch was reported for this species.

White bass: The total gill net catch rate of white bass was 3.0/nn in 2012, down from the 7.3/nn in 2008 (Figure 10). Lower catch rate may reflect our inability to sample the upper third of the lake due to extreme drought conditions during spring 2012 (Figure 1). Connectivity between the lake and river was not lost, and white bass were able to stage and run in waters that were too shallow to set gill nets. Directed fishing effort was high (64,832 h; Table 5), with most occurring in the spring, reflecting the popular spring spawning run. Angler success was good (CPUE = 0.7/h) and total harvest for white bass showed that anglers heavily seek this species (Table 8). White bass were a harvest-oriented fish, as only 27.8% of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fished ranged from 10 to 15 inches (Figure 11). Age and growth data revealed that, on average, white bass reach harvest size (10 inches) between 1 and 2 years (Figure 12), which is considered fast growth compared to other eco-regions of Texas (Prentice 1987).

Striped bass: The total gill net catch rate of striped bass was 1.4/nn in 2012, which was almost half of the 2.6/nn recorded in 2008 (Figure 13). This catch rate was below the mean historical catch rate of 3.4/nn. Reduced total gill net catch may be the result of sampling inaccessibility to the upper reservoir as well as missed or reduced stockings in 2010 and 2011. Hatchery production of striped bass fingerlings has been affected by golden alga (*Prymnesium parvum*) toxicity, drought and wildfires in recent years. Gill net sampling methodology changes (subjective versus random sampling site selection), which were first implemented at Lake Buchanan in 2004, may also be responsible for decreased gill net catch rates seen in recent years (Appendix H). Prior to the methodology change, the average catch rate for striped bass was 4.0/nn and 2.3/nn since the change. Magnelia and De Jesus (2008) revealed that the striped bass fishery was dominated by 3- and 4-year-old fish; however, increased stocking rates didn't necessarily account for increased gill net catch rates, even though it was speculated it might. Only one legal-size (≥18 inches) striped bass was collected in the 2012 gill net survey. Sampling variability and recently reduced stockings may explain the low catch rate, but there was also a substantial kill of larger striped bass in the mid to lower lake in fall 2011. A reduced stocking of striped bass fingerlings in 2010 and unfilled stocking requests in 2011 and 2012 will have a negative impact on the fishery in the next few years.

Directed fishing effort was the second highest among all species during the spring and summer quarters, accounting for 20% of all directed effort (Table 5). It is possible this species would be the most sought-after if the data reflected a full survey year. Angler catch rates were 0.3/h and total harvest for striped bass showed that anglers utilize this species (Table 9). Striped bass were a harvest-oriented fish, as only 7.8% of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fish ranged from 18 to 24 inches (Figure 14). Age and growth data in 2012 revealed that, on average, striped bass reached legal length (18 inches) after age 2 (Figure 15); similar to results when all age and growth data from 2009 to 2012 were combined (Appendix I). Growth beyond age three was slow and might be attributed to stress in the summer months from high water temperatures and low dissolved oxygen levels (Magnelia and De Jesus 2008). Adult striped bass will seek water temperature less than 25 C and oxygen levels greater than 3-4 mg/L (Coutant 1985), but they can tolerate higher temperatures for brief periods if dissolved oxygen concentrations remain above 2 mg/L (Farquhar and Gutreuter 1989: Zale et al. 1990). Bettoli (2005) indicated that preferred temperatures might be even lower than previously reported in the literature (18-24 C), with a mean preferential temperature during the growing season of only 17.5 C. Stress related to temperature/dissolved oxygen squeeze, observed as seasonally poor body condition, was documented in striped bass from Buchanan Reservoir, (Smith, 2009B). At Lake Buchanan it appeared that August and

September conditions at the dam, where one would expect the best temperature and dissolved oxygen-at-depth, were stressful to adult striped bass (Magnelia and De Jesus 2008). A reported striped bass fish kill in September 2011, during extreme drought conditions, support this statement. This kill coincided with a period of low water levels and drastic fluctuation in temperature within a short time frame (David Buckmeier, TPWD, personal communication). Body condition for most inch groups remained similar in 2012 to previous surveys (Figure 13), as reported previously (Bonds and Magnelia 2004) body condition for larger fish (>20 inches), while better, was still suboptimal and showed somewhat a declining pattern (Appendix J). Chronic poor body condition of older adult striped bass may be a symptom of annual temperature/dissolved oxygen squeeze, rather than high stock densities of predators or prey deficiencies as reported in 2004 and 2008 (Magnelia and De Jesus 2008; Bonds and Magnelia 2004).

Largemouth bass: The total electrofishing catch rate of largemouth bass was 24.0/h in 2011, which was much lower than the previous two surveys (Figure 16). The non-standard daytime electrofishing survey, combined with low water levels, due to extreme drought conditions most likely lead to low catch rates. Two extreme drought seasons (2009 and 2011) since the last survey period, may have taken a toll on largemouth bass recruitment. Strong year classes of largemouth bass are often positively correlated with reservoir water levels and inflow (Smith 2009A). On other reservoirs on the Colorado River system included in this study (e.g., O. H. Ivie) a positive correlation between largemouth bass year class strength and water level was detected. Chronically low water levels may be the norm on Buchanan Reservoir in the future. This may ultimately decrease overall abundance of largemouth bass and other species dependent on littoral zone habitat (Daugherty 2009). Size structure was decent (PSD = 44), but a poor year class affected this value as few 8- to 10-inch fish were present in the survey. The percentage of legal length bass was 33%. Body condition was good, as average relative weights (W_r) for most stock size inch groups remained above 85 (range 81–118). Directed fishing effort was the third highest (10%) among all species, and catch per hour was high (1.0/h); while total harvest (3,745) for largemouth bass showed that only few anglers are utilizing this species for consumption (Table 11). In relevance to other lake species surveyed, largemouth bass was not a harvest-oriented species, as 73.2% of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fished ranged between 14 and 18 inches (Figure 17). Legal length (14 inches) was attained, on average, by age 2 (Figure 18), but only 2 fish in the sample (N = 12; range 14–22 inches) were 14 inches.

White Crappie: The total gill net catch rates of white crappie were 1.5/nn and 1.3/nn in 2012 and 2011, respectively (Figure 19). Size structure was excellent as PSD-10 was 78 and 92 in 2012 and 2011, respectively; larger (≥13 inches) fish were present. Body condition was superb, as average relative weights exceeded 100 for every stock-size inch group; however these were spring values, likely inflated due to the proximity to spawning season. Directed fishing effort was low relevant to other species pursued by anglers (Table 5). Angler success was decent (CPUE = 0.6/h) and total harvest for white crappie showed that anglers utilize this species (Table 12). White crappie was a harvest-oriented fish, as only 1.4% of the legal-size fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fished ranged from 10 to 14 inches (Figure 20).

Sunshine bass: Sunshine bass (fry and fingerlings) have been stocked in Buchanan Reservoir every year since 2006 by the LBCC. A population has been established, supplementing the already existent striped bass fishery. Total gill net catch rate in 2012 was 4.9/nn (Figure 21), which was the second highest catch rate since 2008, when they started to appear in our samples. The highest catch rate was in 2011, when they were captured at a rate of 6.0/nn. Increased catch rates reflect the increased fingerling/fry combination stocking rates of 32/acre in 2008 and 115/acre in 2009, as 92% off all sunshine bass collected in 2012 were of age 3 and 4. Unlike striped bass catch rates, sunshine bass catch rates have been showing an increasing trend (Appendix H). Sunshine bass were recommended for stocking into Buchanan Reservoir after historical surveys showed a decreasing trend in striped bass catch rates and poor striped bass condition of larger individuals. It appears that conditions at Buchanan Reservoir

may be at the limits of striped bass thermal tolerances and may be unfavorable for maintaining a striped bass fishery (Smith 2009B). It is believed that hybrid striped bass are more tolerable to stressful summer lake conditions, unfavorable for striped bass. Body condition for sunshine bass was sub-optimal in 2012, as mean relative weights remained below 100 for all stock-size inch groups (range 76–90). Historical mean relative weights for sunshine bass indicate good body condition ($W_r \geq 85$) is maintained at all stock-size inch groups collected (10 to 21 inches), similar to striped bass at the same size groups (Appendix J). Future catches will have to reveal if sunshine bass will maintain good body condition at larger sizes, unlike striped bass, which show declining condition at larger sizes.

Amazingly, there was no directed fishing effort recorded for sunshine bass during the spring and summer creel survey in spite of recognition among anglers. This is due to anglers assimilating this fish as part of the popular striper fishery at Buchanan Reservoir. Anglers seemed to know of hybrid striper opportunities at the reservoir, but did not distinguish them from striped bass, most likely due to identical harvest regulations and techniques to catch them. Under these circumstances, anglers always answered "stripers" when asked of their species targeted during the creel surveys. Some anglers answered both, and were categorized under a general temperate bass code. While catch rates were not calculable, total harvest for sunshine bass was estimated at 2,163.0 for the creel period, and showed that anglers utilize this species (Table 13). Sunshine bass were a harvest-oriented fish, as none of the legal-size fish caught were released. Observed harvest during the creel surveys showed decent angler compliance, and harvested fished ranged from 18 to 24 inches (Figure 22). This species was the only one to exhibit non-compliance (13%), as two fish were observed harvested under the legal length limit by one angler. These fish were confused for white bass, a common problem where hybrid stripers are stocked in waters containing white bass (De Jesus and Magnelia 2011). The LBCC has made an effort to post identification signage at lake access points to help educate anglers to identify these species. Age and growth analysis in 2012 revealed that, on average, sunshine bass reached legal length (18 inches) near age 3 (Figure 23); similar to results when all age and growth data from 2008 to 2012 were combined (Appendix K). Growth beyond age 3 and 4 was hard to determine, as only one older fish (5 year-old) has been captured during gill net surveys. Only six year classes have been stocked into Buchanan Reservoir, with the first (2006) consisting of fry only, not many 5+ year-old fish are expected. However, this brings the question of how many will survive to older ages as the fingerling stockings come of age. Harvest will be an issue to consider in coming years, as we compare their performance with striped bass. It will be important to determine if exploitation will hinder the production of large individuals. Creel survey harvest estimates revealed that 15,233 sunshine bass were caught during the spring quarter; of which 14% were harvested (All fish released were below the legal length limit). This indicates that when legal-size fish are caught, they will most likely be harvested, not including the 13% non-compliance registered. Summer quarter catches were considerably lower, as only 416 sunshine bass were estimated caught; all released as undersized individuals. It is hard to determine if low summer catches are related to stressful thermal conditions or the fact that overall fishing effort declined due to extreme drought conditions, very poor access and high gas prices in 2011. Still, one of the main reasons for recommending this species was to enhance summer fishing opportunities during striped bass impairment. Further evaluations will help determine the situation.

The mail-out survey inquired about angler's perception of hybrid striped bass in Buchanan Reservoir. Seventy-three (73%) percent of responders agreed about supporting further stockings of hybrid striped bass into Buchanan Reservoir; 13% were neutral, while 14% disagreed. When asked if they would specifically fish for hybrid striped bass in Buchanan Reservoir; only 31% agreed, 35% were neutral, and 34% disagreed. When asked if they like to catch hybrid striped bass, even though they probably wouldn't fish for them specifically; 65% agreed, 13% were neutral, and 22% disagreed. When asked if they would support stocking <u>only</u> hybrid striped bass instead of striped bass, if they prove to provide higher catch

rates; only 32% agreed, while 35% were neutral and 33% disagreed. When asked if they would support stocking a combination of hybrid striped bass and pure striped bass (current scenario); 67% agreed, while 21% remained neutral and only 12% disagreed. When asked if they do not support future stockings of pure striped bass or hybrid striped bass; only 8% agreed, while 14% remained neutral and 78% disagreed. Finally, when asked if they support stocking pure striped bass, but not hybrid striped bass in Buchanan Reservoir; only 6% agreed, while 26% remained neutral and 68% disagreed. Responses favor maintaining the current management scheme of stocking both *Morone* species in combination. While anglers support hybrid striped bass stockings, they don't want to convert to only hybrid striped bass.

Fisheries management plan for Buchanan Reservoir, Texas

Prepared - July 2012.

ISSUE 1: Buchanan Reservoir is renowned for being one of the best striped bass fisheries in Texas. Consistent annual stockings are essential to maintaining the integrity of this fishery. Striped bass gill net catch rates have shown an overall declining trend. Fingerling stocking rates were increased to improve abundance, but successful results have been barely noticed. Natural challenges like golden alga *Prymnesium parvum*, extreme drought conditions and wildfires have negatively impacted the striped bass production at state hatcheries in recent years, leading to missing year classes or reduced stockings. Furthermore older striped bass in the reservoir are stressed by a thermal "squeeze" during late summer months. A striped bass kill was reported in September 2011 due to this issue combined with record-low water levels. Although this scenario is thought to be unfavorable for this species, anglers still want pure striped bass to continue to be stocked, as they provide a significant economic impact to the local economy.

MANAGEMENT STRATEGIES

1. Request striped bass fingerlings be stocked annually at a rate of 15/acre.
2. Annual gill netting should be conducted to monitor striped bass abundance.

ISSUE 2: The effect of summer temperature/oxygen stress on striped bass was evident, and anecdotal reports from striped bass guides indicate catch rates for striped bass in the summer are poor. Sunshine bass have been stocked in efforts to provide better fishing opportunities in the summer months as they are not thought to be as temperature sensitive as striped bass. A creel survey revealed that angler catch estimates for sunshine bass during the 2011 summer quarter were significantly lower than that of pure striped bass. This even though gill net catch rates for sunshine bass in spring 2012 was almost six times greater than that of striped bass; leaving us uncertain of sunshine bass summer performance. Furthermore, the past two surveys have been dominated by year classes that have mostly been stocked as fry in combination with fingerlings. Earlier data suggested that fingerling stockings would be the best alternative, and was recommended in the previous management plan. Anglers show great acceptance for hybrid striped bass, but are not necessarily willing to switch to only stocking this species, even if it meant increased catch rates. It seems they prefer the current scheme of stocking both species in combination.

MANAGEMENT STRATEGIES

1. Continue to encourage and granting a permit to the Lake Buchanan Conservation Corporation for stocking sunshine bass.
2. Investigate if sunshine bass fry stockings are a more efficient option for Buchanan Reservoir.
3. Try to coordinate with local fishing guides to gather summer catch data to supplement TPWD surveys.
4. Monitor the development of the sunshine bass population with annual gill netting.
5. Age all sunshine bass collected to monitor year class strength and growth.

ISSUE 3: Buchanan Reservoir provides good opportunities for three species of catfish. Blue catfish abundance has increased and large (≥30 inches in length) individuals are available for anglers. Awareness of blue catfish trophy catch potential has increased, but anglers were not necessarily willing to support more restrictive regulations.

MANAGEMENT STRATEGY

1. Continue to manage blue catfish under statewide regulations.
2. Continue to promote the catfish fishery when the opportunity arises.

ISSUE 4: Largemouth bass accounted for 10% of the total direct angler effort during the spring and summer quarters of 2011. The reservoir has a history of producing large fish, and efforts to stock the Florida strain of largemouth bass are expected to improve the potential to increase large fish in the future. The lake attracts its fair share of black bass tournaments, and many anglers enjoy fishing for this species. Even so, there still exists a misconception that *Morone* stockings have a negative impact on the bass fishery. Fluctuating water levels due to recent droughts have a significant impact on largemouth bass habitat and its availability. The installation of fish attractors has been successful at attracting largemouth bass and *Lepomis* spp. in other district lakes. The popularity of this program has spread to Buchanan Reservoir, where 22 attractor sites have been established. Juniper trees are abundant close to the reservoir shoreline and are always available at no cost. Volunteers are readily available to provide labor for these types of projects.

MANAGEMENT STRATEGY

1. Continue to take advantage of the opportunities present to create or maintain fish attractor sites at Buchanan Reservoir. When possible, coordinate efforts to create new sites or replenish existing sites with the Lake Buchanan Conservation Corporation and local stakeholders.

ISSUE 5: Buchanan Reservoir has been heavily affected by recent extreme drought conditions. Low water levels have rendered the lake inaccessible as public boat ramps were subject to closures during long period of times. Weather patterns are projected to change little and drought conditions may become a common scenario.

MANAGEMENT STRATEGY

1. Work with local government authorities and the Lake Buchanan Conservation Corporation to address this issue by coordinating new public ramp construction or extending existing ramps during low-water conditions.

ISSUE 6: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (*Dreissena polymorpha*) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches and plugging engine cooling systems. Giant Salvinia (*Salvinia molesta*) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.
2. Contact and educate marina owners about invasive species, and provide them with posters, literature, etc… so that they can in turn educate their customers.
3. Educate the public about invasive species through the use of media and the internet.
4. Make a speaking point about invasive species when presenting to constituent and user groups. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.

SAMPLING SCHEDULE JUSTIFICATION:
The proposed sampling schedule will constitute mandatory sampling in 2015/2016; with additional gill netting surveys each year to mainly assess the abundance and condition of striped and sunshine bass; though other target species also will be monitored (Table 14). A habitat survey should be conducted in 2014 to update most recent survey conducted in 2004.

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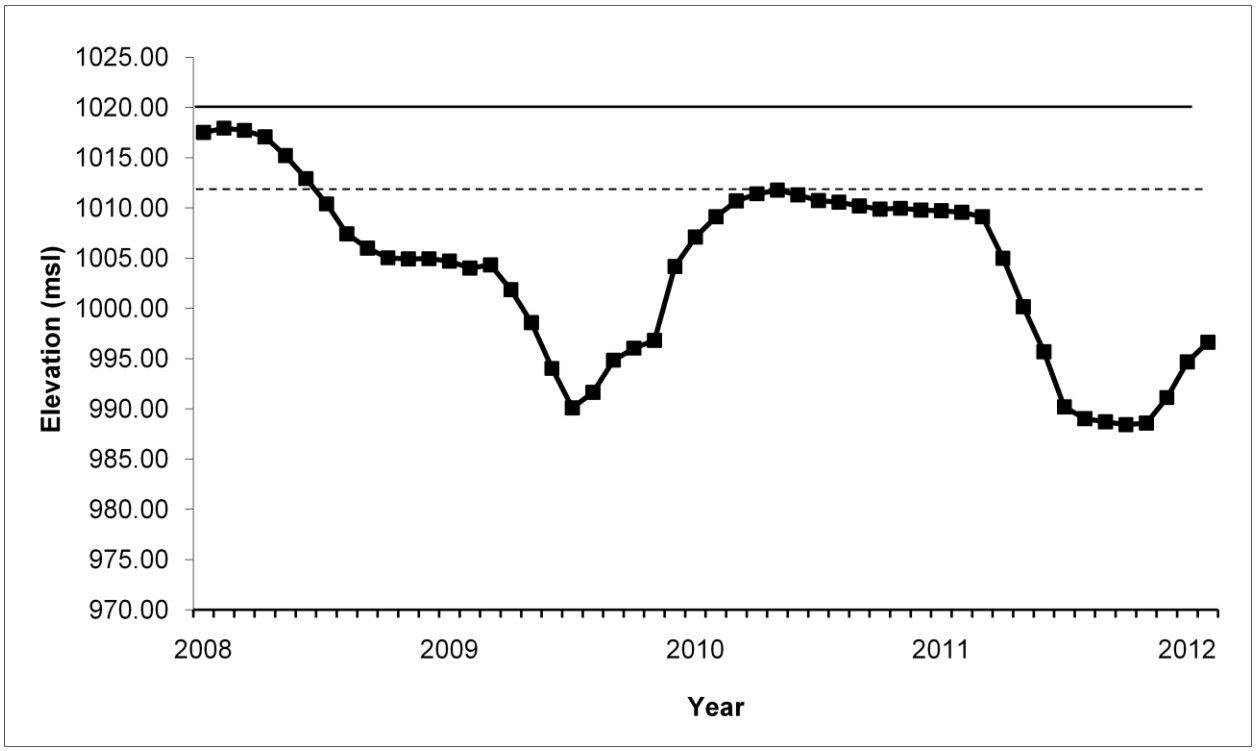


Figure 1. Mean monthly water level elevations in feet above mean sea level (msl) recorded for Buchanan Reservoir, Texas from March 2008 to April 2012. Solid line is elevation when full (1020 msl). Dashed line is historical average (1012.09 msl) from January 1943 to April 2012.

Table 1. Characteristics of Buchanan Reservoir, Texas

Characteristic	Description
Year constructed	1937
Controlling authority	LCRA
Counties	Burnet and Llano
Reservoir type	Mainstream river system: Colorado
Shoreline development index (SDI)	5.8
Conductivity	1,000 µmhos/cm

Table 2. Harvest regulations for Buchanan Reservoir, Texas.

Species	Bag limit	Length limit (inches)
Catfish: channel and blue catfish	25 (in any combination)	12 minimum
Flathead catfish	5	18 minimum
White bass	25	10 minimum
Striped bass and hybrid striped bass	5 (in any combination)	18 minimum
Bass: largemouth	5*	14 minimum
Bass: Guadalupe	5*	No minimum limit
White crappie	25	10 minimum

*Five largemouth and Guadalupe bass in any combination.

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

Species	Year	Number	Life Stage	Mean TL (in)
Blue catfish	1989	230,662	FGL	2.3
	1990	235,378	FGL	2.1
	Total	466,040		
Channel catfish	1969	61,410	AFGL	7.9
	Total	61,410		
Florida Largemouth bass	1978	32,000	FGL	2.0
	1978	318,400	FRY	0.9
	2008	507,165	FGL	1.8
	Total	857,565		
Largemouth bass	1969	500,000	FRY	0.7
	Total	500,000		
Striped bass	1977	231,726	UNK	UNK
	1978	153,400	UNK	UNK
	1979	69,228	UNK	UNK
	1980	285,046	UNK	UNK
	1983	229,638	UNK	UNK
	1984	343,178	FGL	2.0
	1985	587,950	FGL	2.0
	1986	37,300	FGL	2.0
	1986	260,172	FRY	1.0
	1987	232,608	FRY	1.0
	1988	230,728	FRY	1.0
	1989	232,608	FGL	1.2
	1990	238,908	FGL	1.6
	1991	350,706	FGL	1.5
	1992	93,450	ADL	31.7
	1992	60,223	FGL	1.4
	1993	117,410	FGL	1.3
	1993	145,119	FRY	1.0
	1994	1,000	AFGL	7.4
	1994	464,297	FGL	1.2
	1995	236,210	FGL	1.2
	1996	128,052	FGL	1.3
	1997	232,705	FGL	1.2
	1998	215,000	FGL	1.3
	1999	239,870	FGL	1.4
	2000	235,733	FGL	1.6
	2002	580,900	FGL	1.4
	2003	137,472	FGL	1.5

Species	Year	Number	Life Stage	Mean TL (in)
	2004	127,512	FGL	1.6
	2005	150,100	FGL	1.1
	2006	270,729	FGL	1.8
	2006	1,070,311	FRY	0.3
	2007	333,549	FGL	1.7
	2007	1,333,875	FRY	0.2
	2008	339,076	FGL	1.6
	2009	351,722	FGL	1.7
	2010	167,645	FGL	1.8
	2010	1,253,384	FRY	0.2
	Total	11,768,540		
Sunshine Bass (white bass x striped bass hybrid)	2006	500,000	FRY	0.2
	2007	128,400	FGL	5.4
	2008	707,000	FRY/FGL	0.7
	2009	2,605,448	FRY/FGL	1.6
	2010	1,310,000	FRY/FGL	1.5
	2011	42,500	FGL	2.0
	2012	75,000	FGL	2.5
	Total	5,368,348		
Walleye	1975	265,000	FRY	0.2
	1976	205,000	FRY	0.2
	1977	4,843,332	FRY	0.2
	Total	5,313,332		

Table 4. Survey of shoreline habitat types, Buchanan Reservoir, Texas, 2004. A linear shoreline distance (miles) was recorded for each habitat type found.

Shoreline habitat type	Shoreline distance	
	Miles	Percent of total
Sandy bank	45.0	62
Rock	25.0	35
Rock bluff	1.9	3
Concrete	0.2	<1

Table 5. Percent directed angler effort by species for Buchanan Reservoir, Texas, April to August, 2011.

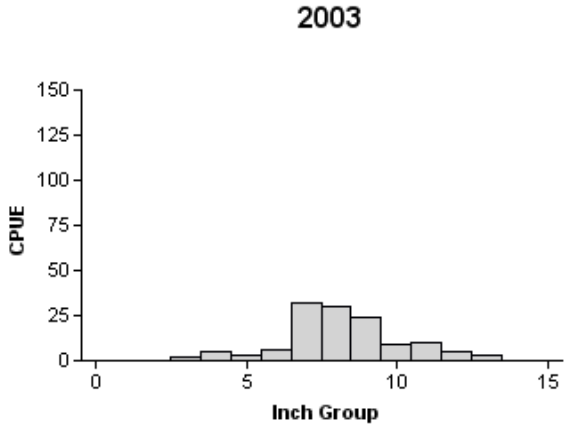
Species	Year
	2011
Blue catfish	3.2
Channel catfish	1.4
Flathead catfish	1.1
White bass	39.9
Striped bass	20.0
Largemouth bass	10.4
White crappie	5.7
Anything	7.0
Crappies (general)	0.4
Catfishes (general)	8.6
Stripers (general)	1.1
Sunfishes (general)	0.4
Sunshine bass*	0.0

*Anglers are aware of the presence of hybrid striped bass, but seem to categorize them as stripers, possibly due to the longer history of the pure striped bass fishery. Angling techniques are identical for both species.

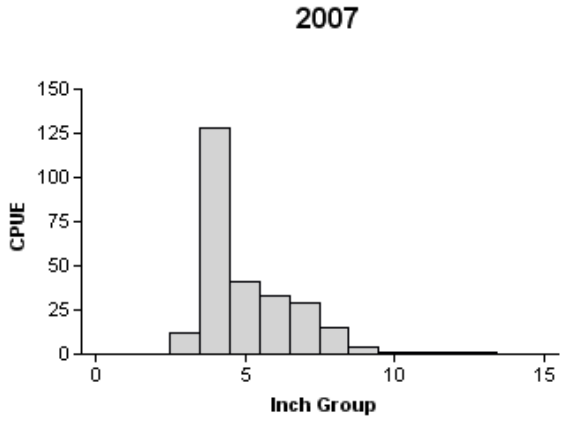
Table 6. Total fishing effort (h) for all species and total directed expenditures at Buchanan Reservoir, Texas, April to August 2011.

Creel Statistic	Year
	2011
Total fishing effort (h)	162,591
Total directed expenditures	$1,786,718

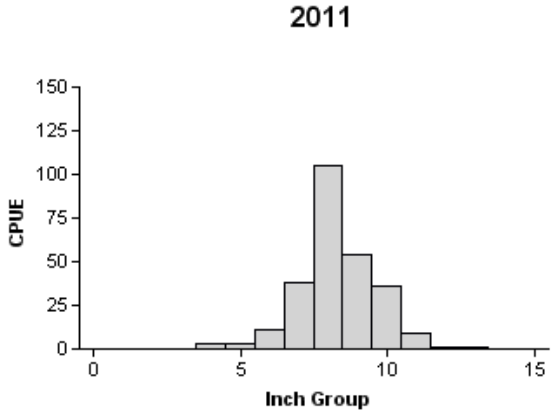
Gizzard Shad



Effort =	2.0
Total CPUE =	132.0 (18; 264)
IOV =	38 (5)



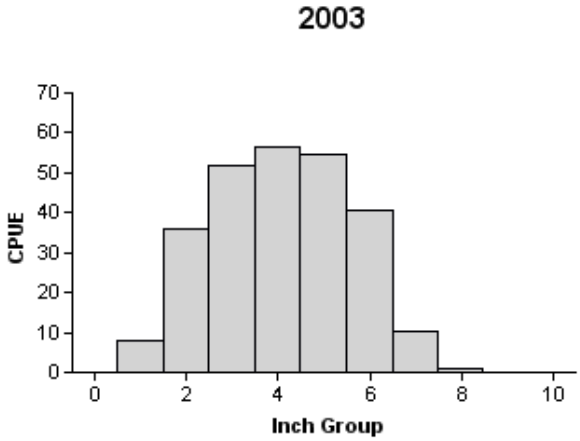
Effort =	2.0
Total CPUE =	268.0 (25; 536)
IOV =	91 (3)



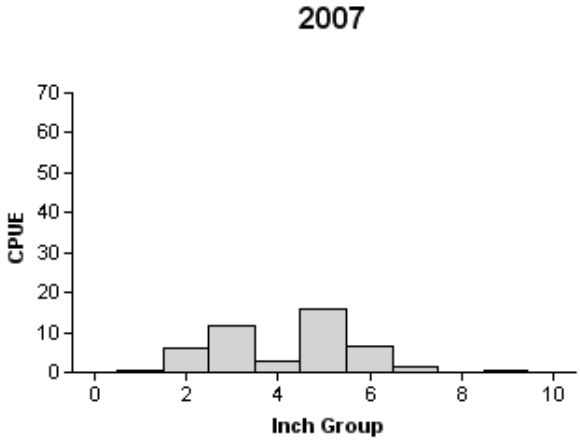
Effort =	1.5
Total CPUE =	261.3 (21; 392)
IOV =	21 (5.8)

Figure 2. Number of gizzard shad caught per hour (CPUE) population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2003, 2007 and 2011. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

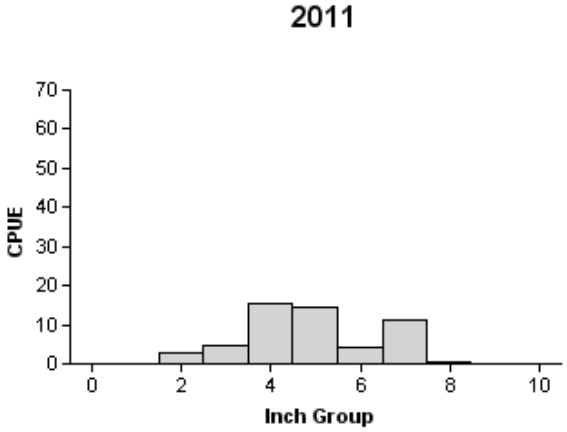
Redbreast Sunfish



Effort =	2.0
Total CPUE =	259.0 (21; 518)
PSD =	24 (4.5)



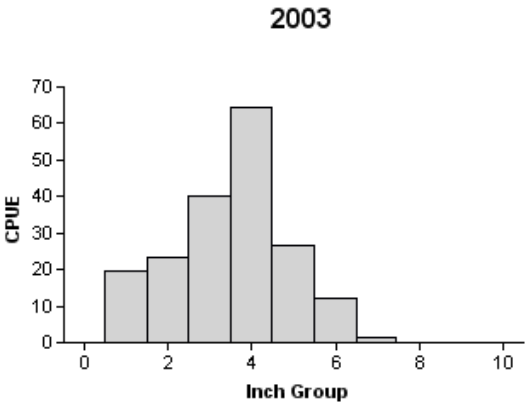
Effort =	2.0
Total CPUE =	45.5 (33; 91)
PSD =	22 (4.9)



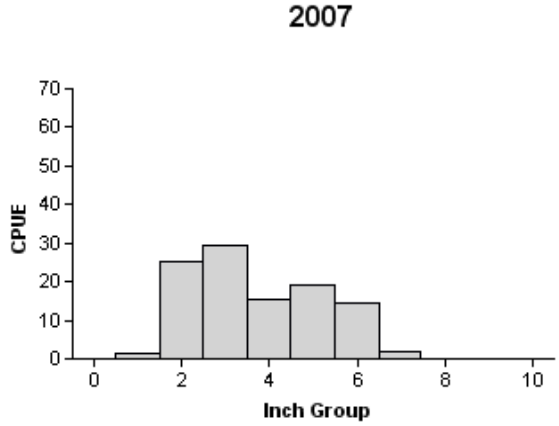
Effort =	1.5
Total CPUE =	53.3 (38; 80)
PSD =	32 (13.9)

Figure 3. Number of redbreast sunfish caught per hour (CPUE) population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2003, 2007 and 2011. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

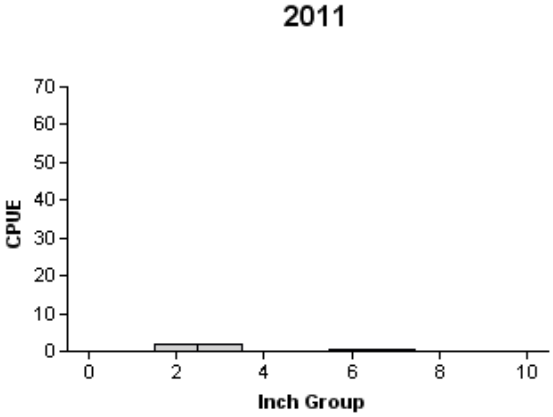
Bluegill



Effort =	2.0
Total CPUE =	187.5 (21; 375)
PSD =	9 (1.5)



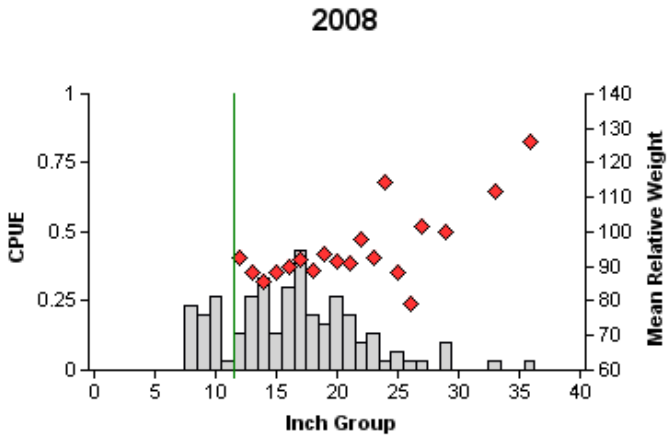
Effort =	2.0
Total CPUE =	107.0 (18; 214)
PSD =	20 (4.8)



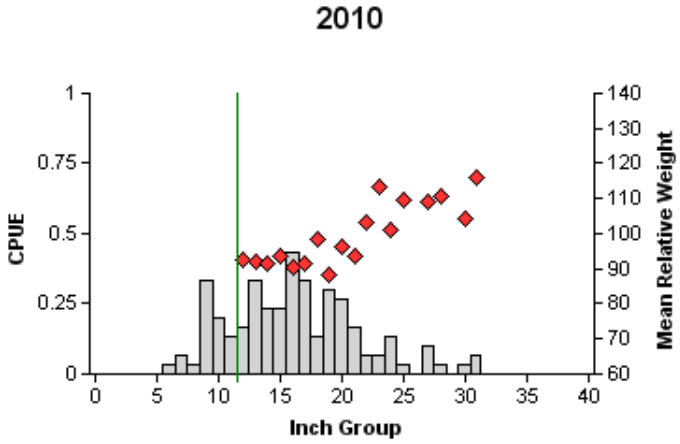
Effort =	1.5
Total CPUE =	5.3 (45; 8)
PSD =	40 (17.5)

Figure 4. Number of bluegill caught per hour (CPUE) population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2003, 2007 and 2011. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

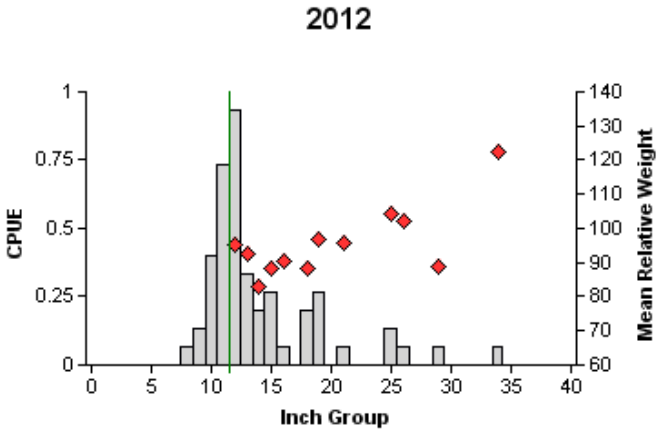
Blue Catfish



Effort =	30.0
Total CPUE =	2.7 (21; 81)
CPUE-12 =	2.4 (22; 72)
PSD =	26 (5.6)
PSD-P =	1 (1.4)



Effort =	30.0
Total CPUE =	3.7 (15; 112)
CPUE-12 =	3.0 (14; 90)
PSD =	34 (4.3)
PSD-P =	2 (1.6)



Effort =	15.0
Total CPUE =	4.0 (36; 60)
CPUE-12 =	2.7 (39; 40)
PSD =	15 (7.8)
PSD-P =	2 (2.7)

Figure 5. Number of blue catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2010 and 2012. Minimum length limit indicated by vertical line.

Blue Catfish

Table 7. Creel survey statistics for blue catfish at Buchanan Reservoir, Texas from March to August 2011, where total catch per hour is for anglers targeting blue catfish and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	5,234.9 (46)
Directed effort/acre	0.2 (46)
Total catch per hour	2.2 (84)
Total harvest	4,790.5 (88)
Harvest/acre	0.2 (88)
Percent legal released	0.0

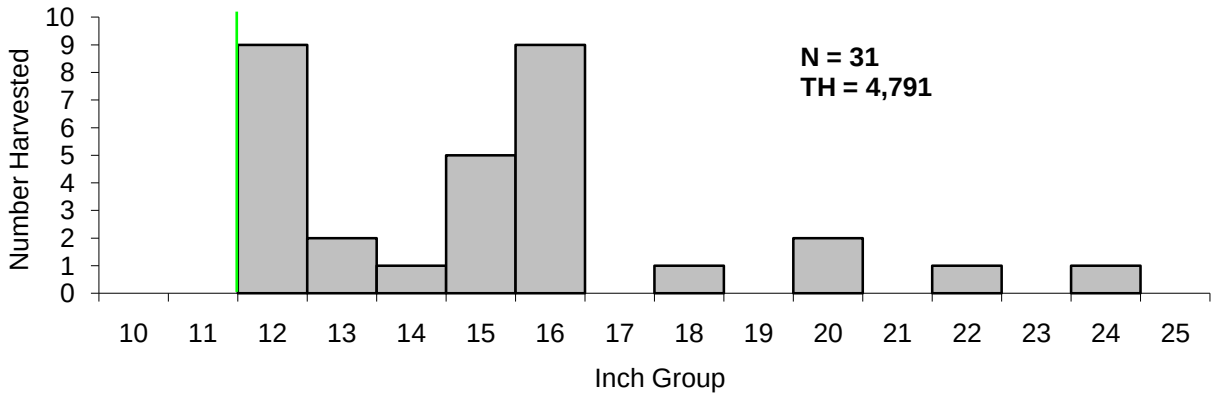
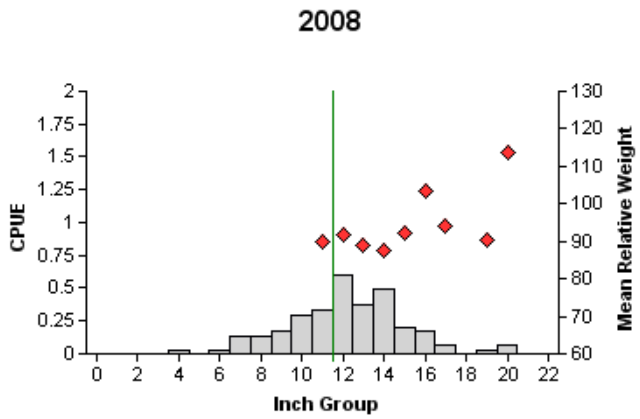
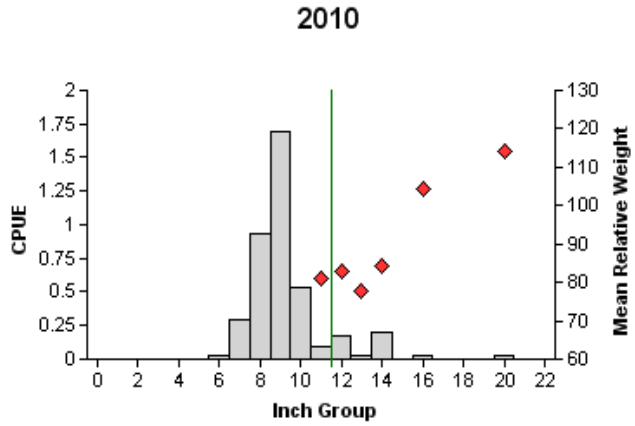


Figure 6. Length frequency of harvested blue catfish observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical line represents length limit at the time of survey.

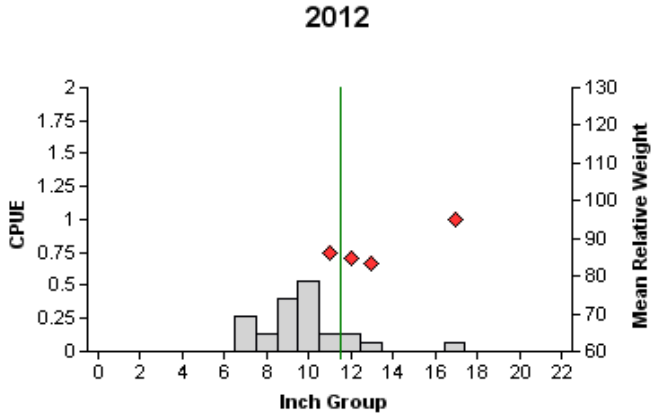
Channel Catfish



Effort =	30.0
Total CPUE =	3.1 (16; 94)
CPUE-12 =	2.0 (17; 60)
PSD =	14 (4.5)



Effort =	30.0
Total CPUE =	4.1 (23; 122)
CPUE-12 =	0.5 (27; 14)
PSD =	12 (7.8)



Effort =	15.0
Total CPUE =	1.7 (27; 26)
CPUE-12 =	0.3 (57; 4)
PSD =	17 (13.5)

Figure 7. Number of channel catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2010 and 2012. Vertical line represents minimum length limit at the time of sampling.

Channel Catfish

Table 8. Creel survey statistics for channel catfish at Buchanan Reservoir, Texas from March to August 2011, where total catch per hour is for anglers targeting channel catfish and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	2,317.7 (62)
Directed effort/acre	0.1 (62)
Total catch per hour	1.9 (100)
Total harvest	7,151.7 (51)
Harvest/acre	0.3 (51)
Percent legal released	18.1

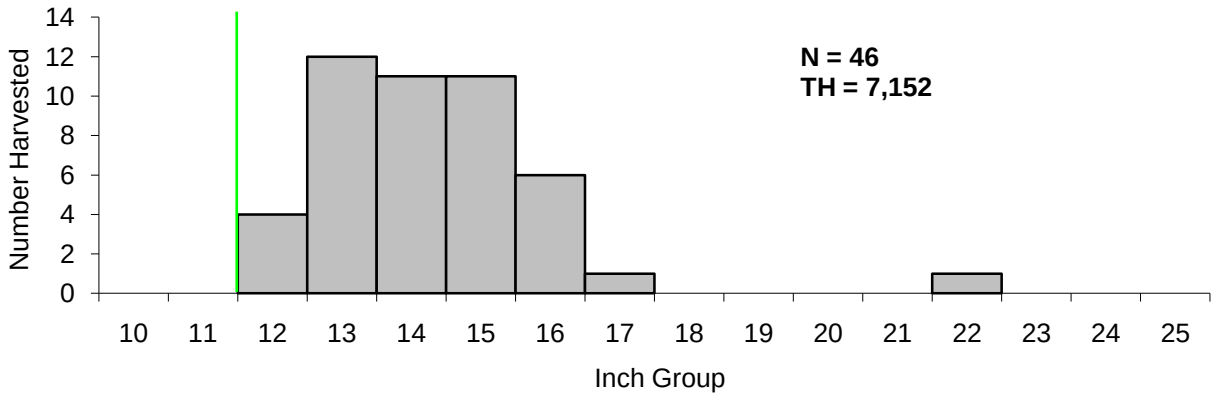
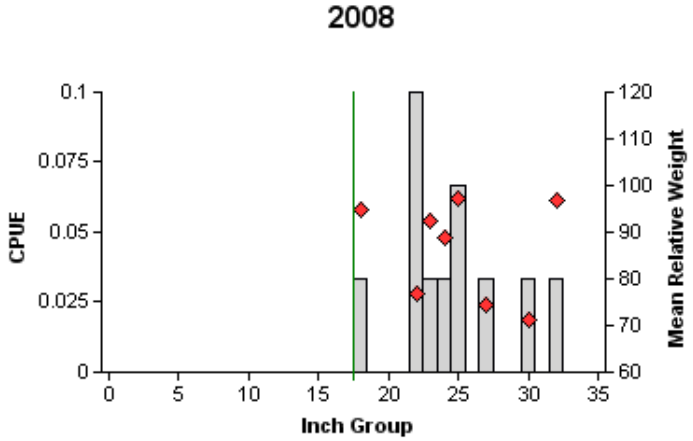
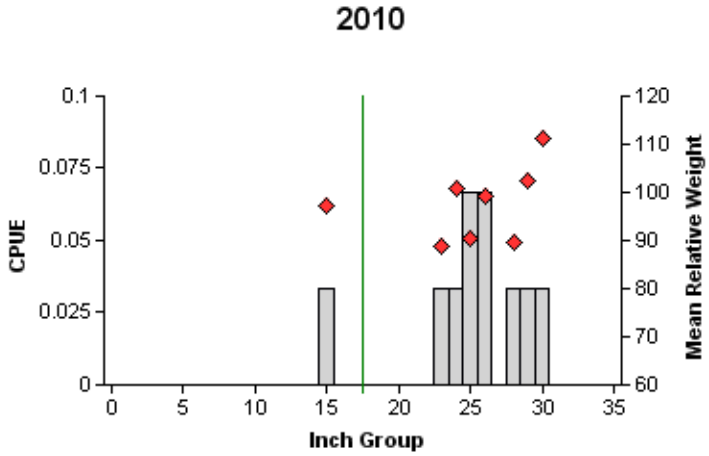


Figure 8. Length frequency of harvested channel catfish observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested channel catfish observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical line represents length limit at the time of survey.

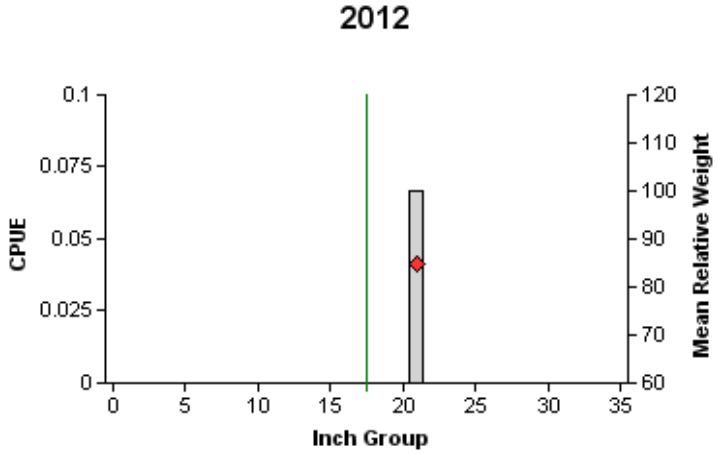
Flathead Catfish



Effort =	30.0
Total CPUE =	0.4 (38; 11)
CPUE-18 =	0.4 (38; 11)
PSD =	91 (9.2)



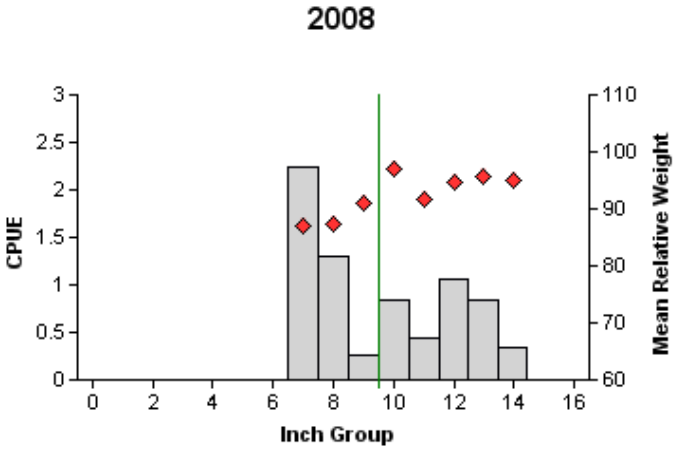
Effort =	30.0
Total CPUE =	0.3 (26; 10)
CPUE-18 =	0.3 (28; 9)
PSD =	90 (9.7)



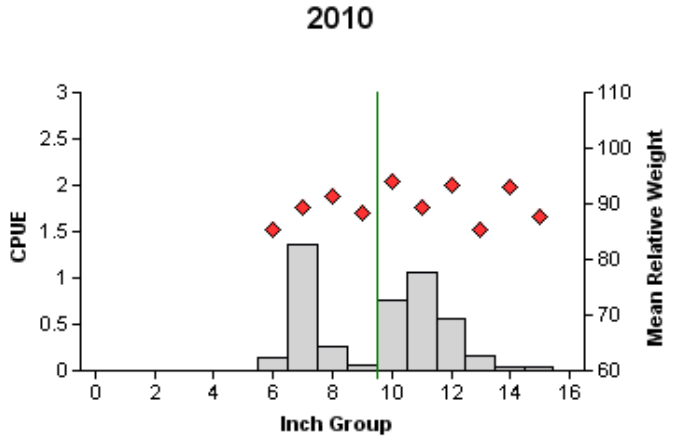
Effort =	15.0
Total CPUE =	0.1 (100; 1)
CPUE-18 =	0.1 (100; 1)
PSD =	100 (0)

Figure 9. Number of flathead catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2010 and 2012. Minimum length limit indicated by vertical line.

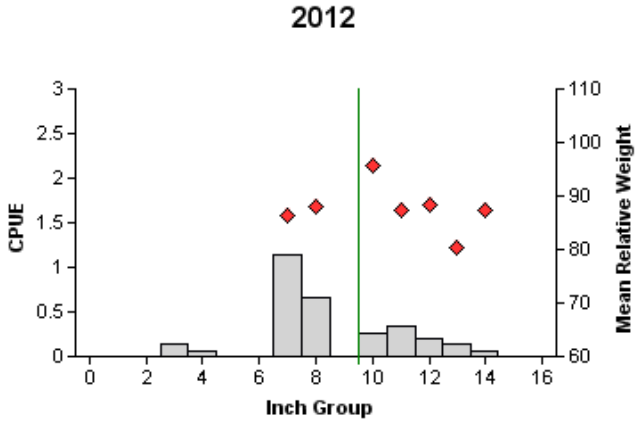
White Bass



Effort =	30.0
Total CPUE =	7.3 (15; 219)
CPUE-10 =	3.5 (19; 105)
PSD =	52 (4.6)



Effort =	30.0
Total CPUE =	4.5 (17; 134)
CPUE-10 =	2.6 (21; 79)
PSD =	60 (5.1)



Effort =	15.0
Total CPUE =	3.0 (27; 45)
CPUE-10 =	1.0 (34; 15)
PSD =	36 (8.9)

Figure 10. Number of white bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2010 and 2012. Vertical line represents minimum length limit at the time of sampling.

White Bass

Table 9. Creel survey statistics for white bass at Buchanan Reservoir, Texas from March to August 2011 where total catch per hour is for anglers targeting channel catfish and total harvest is the estimated number of white bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	64,831.6 (27)
Directed effort/acre	2.9 (27)
Total catch per hour	0.7 (38)
Total harvest	29,162.5 (34)
Harvest/acre	1.3 (34)
Percent legal released	27.8

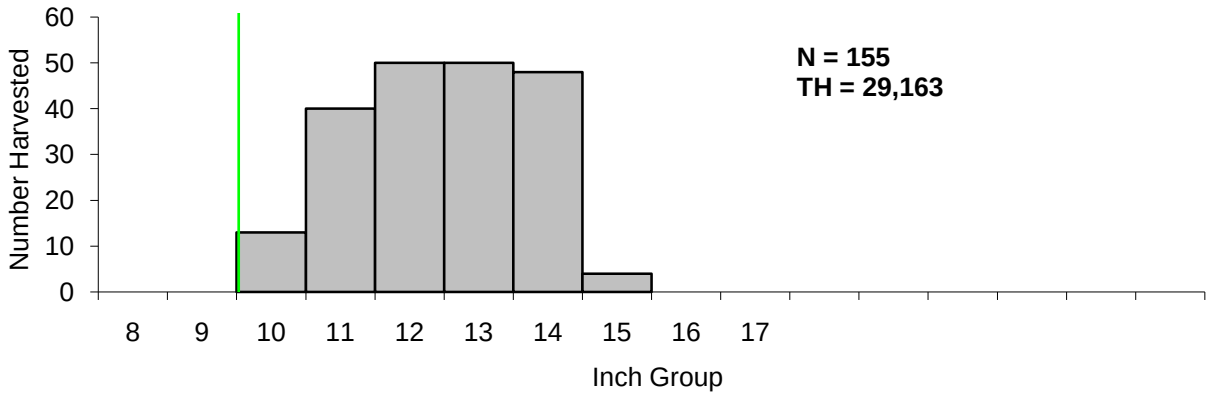


Figure 11. Length frequency of harvested white bass observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical line represents length limit at the time of survey.

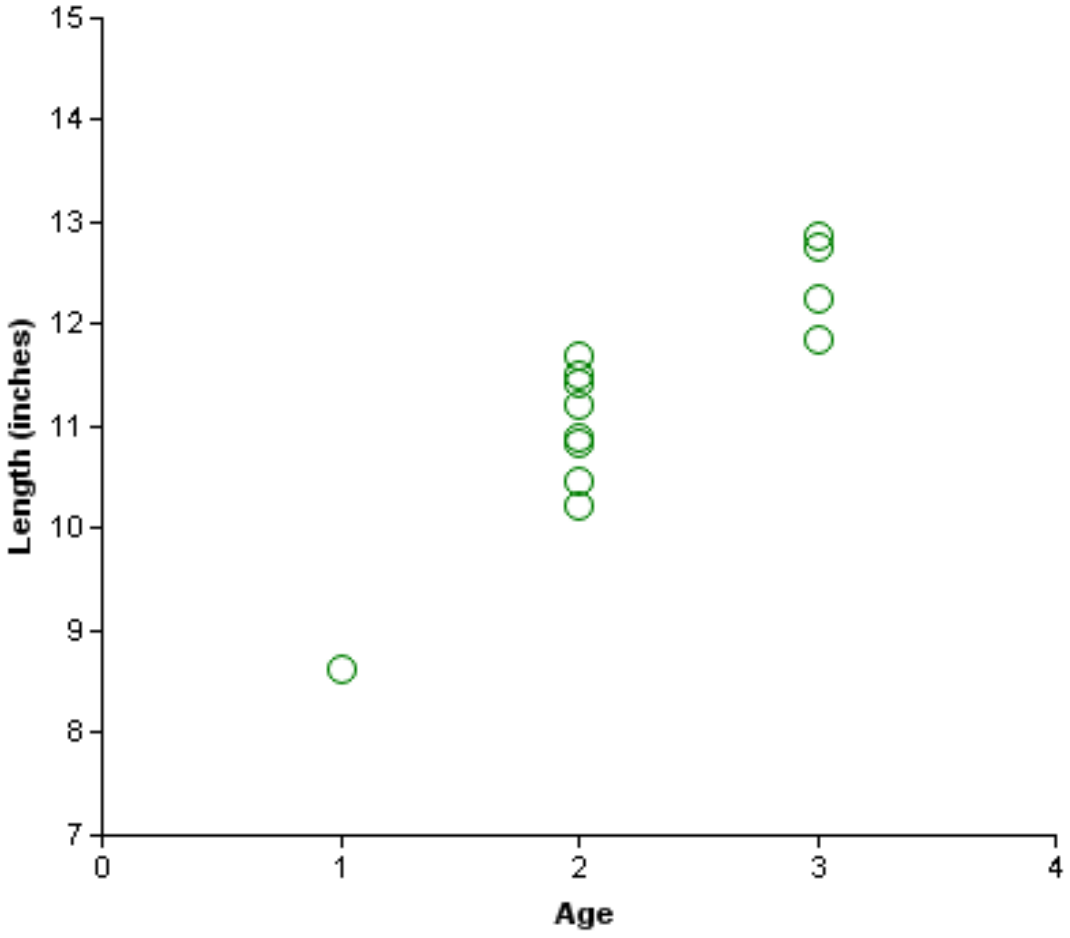
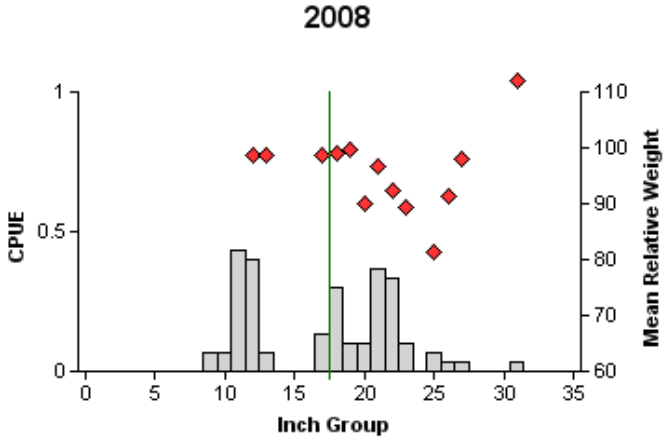
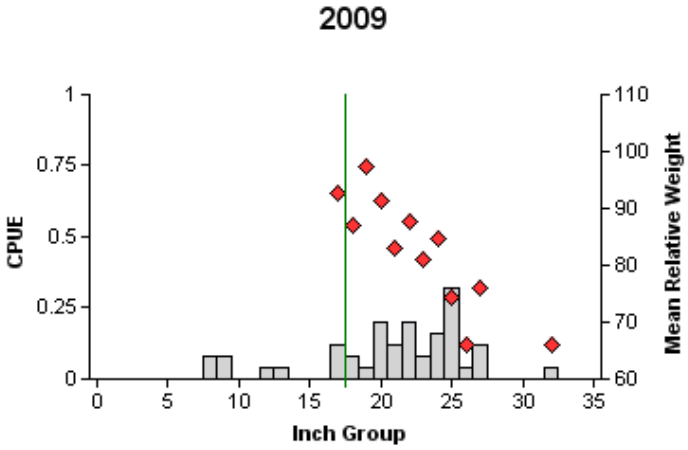


Figure 12. Length at age for white bass collected by gill nets at Lake Buchanan, Texas, February, 2012 (N = 13).

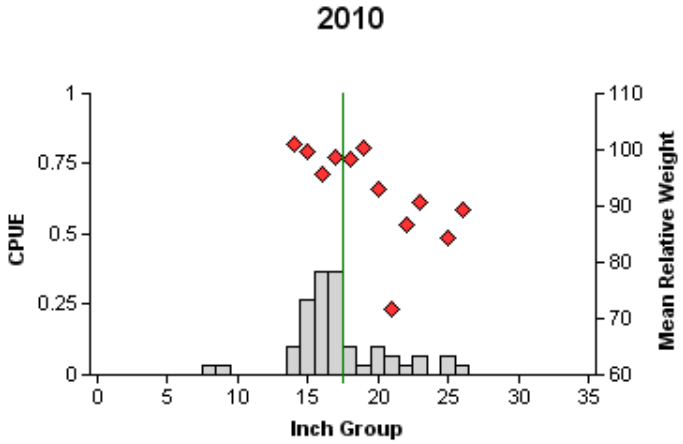
Striped Bass



Effort =	30.0
Total CPUE =	2.6 (20; 79)
CPUE-18 =	1.5 (21; 44)
PSD =	52 (8)



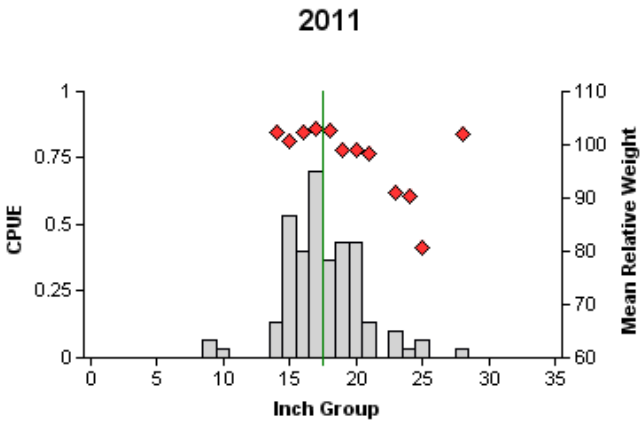
Effort =	25.0
Total CPUE =	1.8 (19; 44)
CPUE-18 =	1.4 (22; 35)
PSD =	80 (9.2)



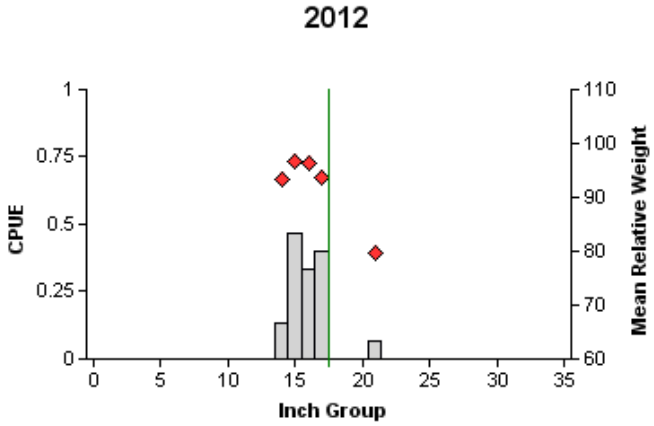
Effort =	30.0
Total CPUE =	1.7 (22; 50)
CPUE-18 =	0.5 (31; 15)
PSD =	23 (6.7)

Figure 13. Number of striped bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2009, 2010, 2011 and 2012. Minimum length limit indicated by vertical line.

Striped Bass



Effort =	30.0
Total CPUE =	3.5 (21; 104)
CPUE-18 =	1.6 (30; 48)
PSD =	24 (5)



Effort =	15.0
Total CPUE =	1.4 (28; 21)
CPUE-18 =	0.1 (100; 1)
PSD =	5 (4.6)

Figure 13 (continued). Number of striped bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2008, 2009, 2010, 2011 and 2012. Minimum length limit indicated by vertical line.

Striped Bass

Table 10. Creel survey statistics for striped bass at Buchanan Reservoir, Texas from March to August 2011 where total catch per hour is for anglers targeting striped bass and total harvest is the estimated number of striped bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	32,443.2 (35)
Directed effort/acre	1.5 (35)
Total catch per hour	0.3 (61)
Total harvest	2,990.0 (71)
Harvest/acre	0.1 (71)
Percent legal released	7.8

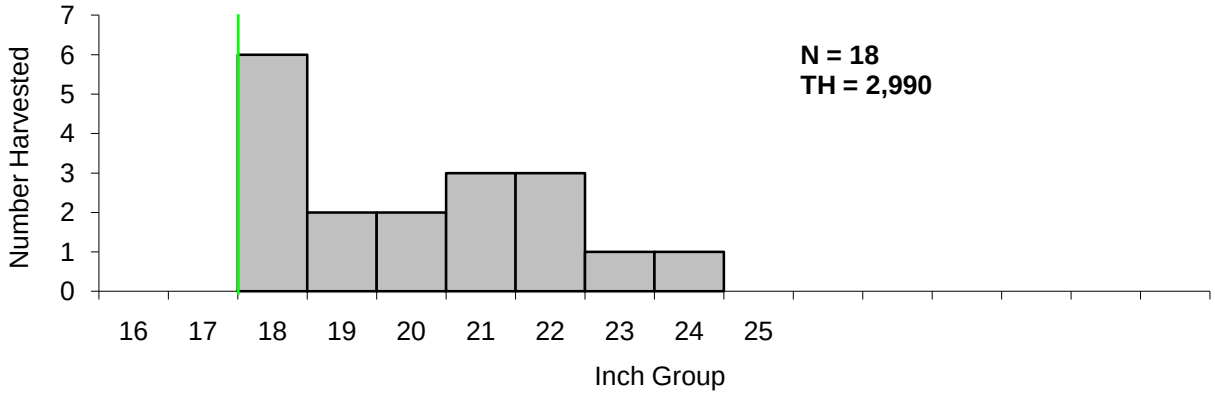


Figure 14. Length frequency of harvested striped bass observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested striped bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical line represents length limit at the time of survey.

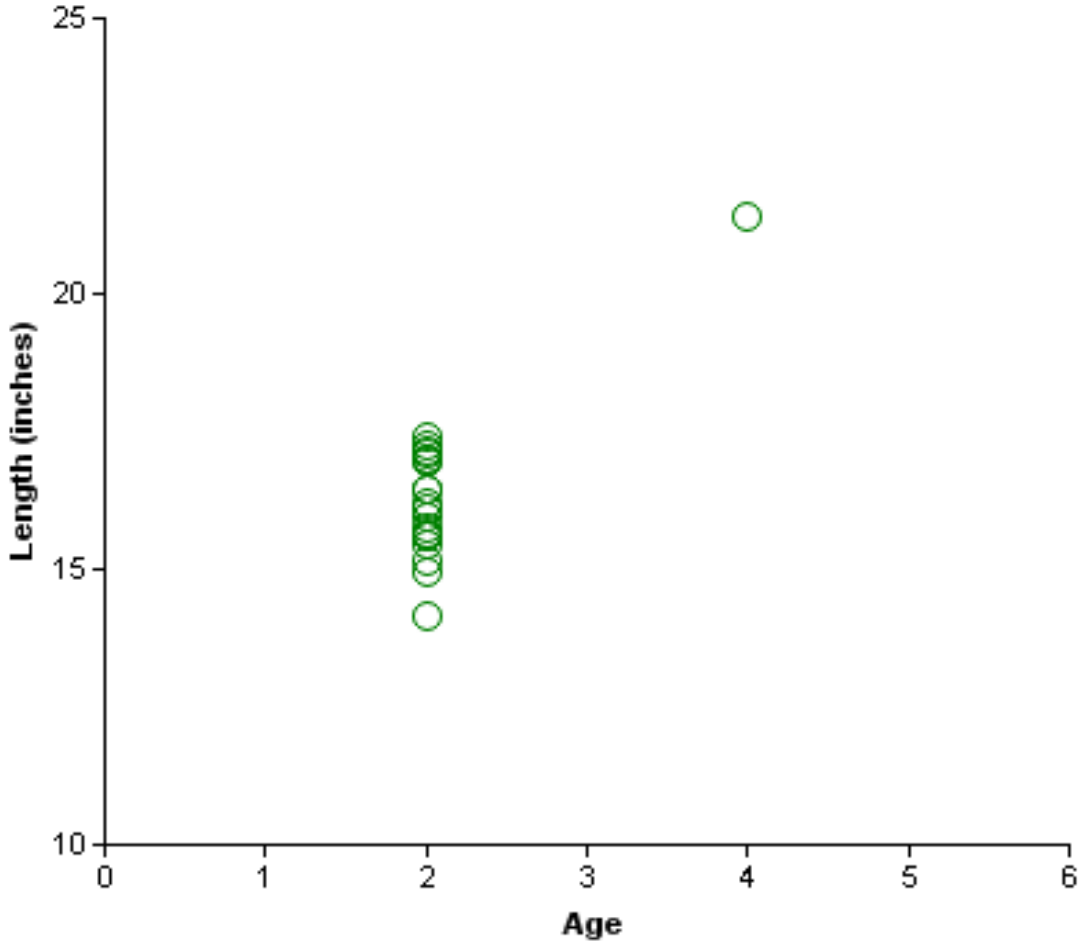
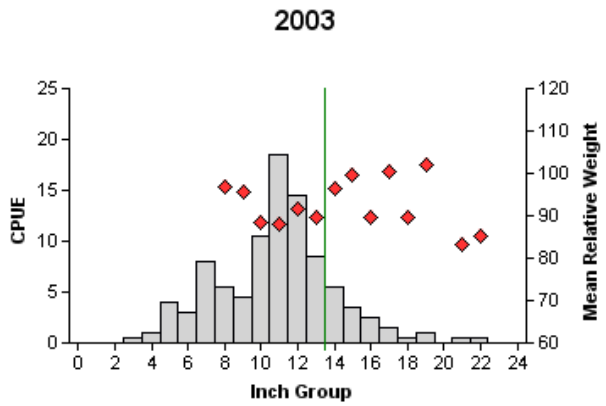
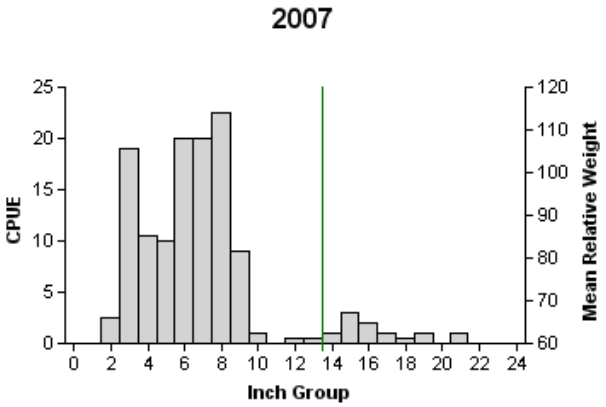


Figure 15. Length at age for striped bass collected by gill nets at Buchanan Reservoir, Texas, February 2012 (N = 21).

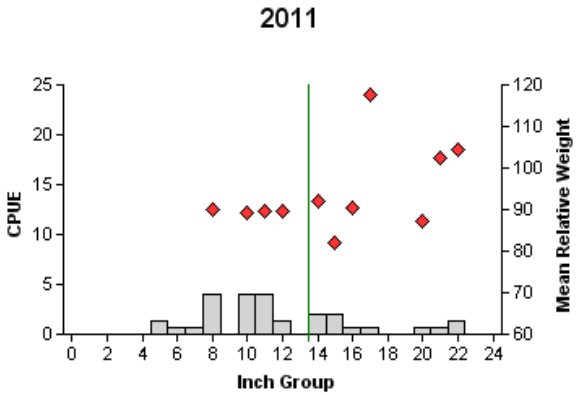
Largemouth Bass



Effort =	2.0
Total CPUE =	94.0 (17; 188)
Stock CPUE =	77.5 (18; 155)
CPUE-14 =	15.5 (20; 31)
PSD =	50 (3.9)
PSD-14 =	20 (2.5)



Effort =	2.0
Total CPUE =	125.0 (21; 250)
Stock CPUE =	43.0 (18; 86)
CPUE-14 =	9.5 (28; 19)
PSD =	24 (4)
PSD-14 =	22 (4.8)



Effort =	1.5
Total CPUE =	24.0 (27; 36)
Stock CPUE =	21.3 (27; 32)
CPUE-14 =	8.0 (45; 12)
PSD =	44 (12.5)
PSD-14 =	38 (12.9)

Figure 16. Number of largemouth bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Buchanan, Texas, 1999, 2003 and 2007. Minimum length limit indicated by vertical line. No weight data was collected in 2007. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

Largemouth Bass

Table 11. Creel survey statistics for largemouth bass at Buchanan Reservoir, Texas from March to August 2011, where total catch per hour is for anglers targeting largemouth bass and total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	16,877.72 (33)
Directed effort/acre	0.8 (33)
Total catch per hour	1.0 (34)
Total harvest	3,745.4 (56)
Harvest/acre	0.2 (56)
Percent legal released	73.2

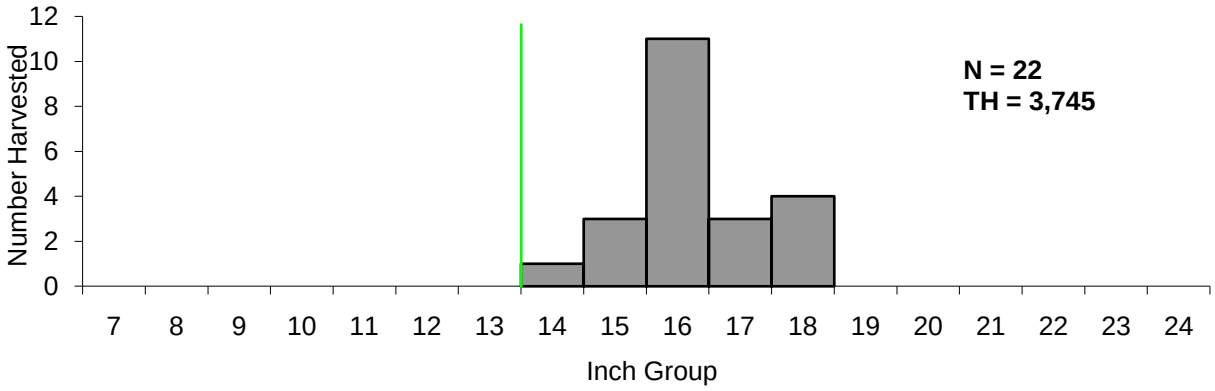


Figure 17. Length frequency of harvested largemouth bass observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical lines represent length limit at the time of survey.

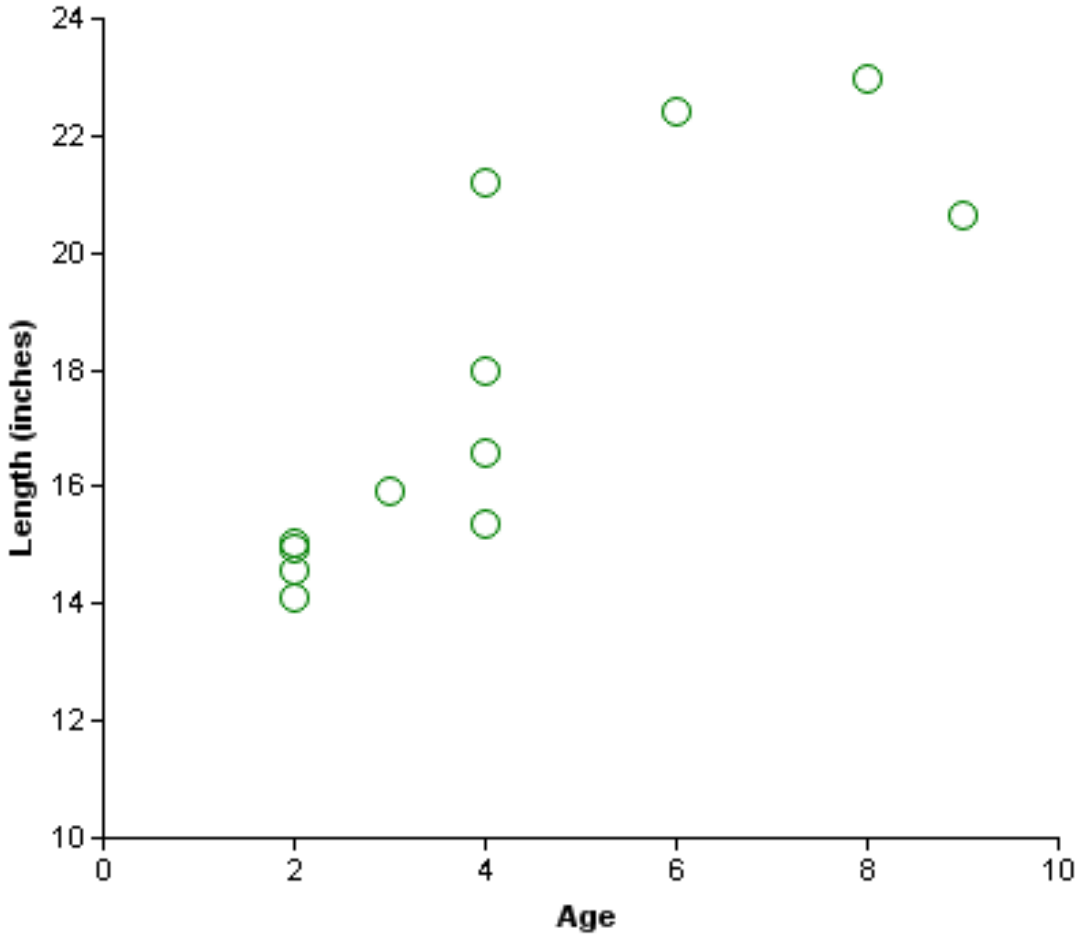
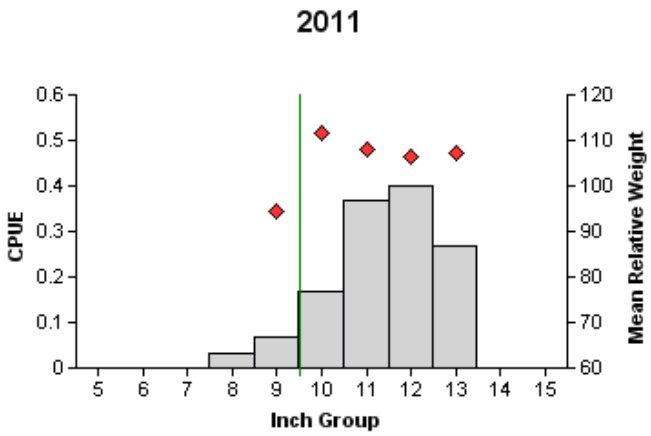
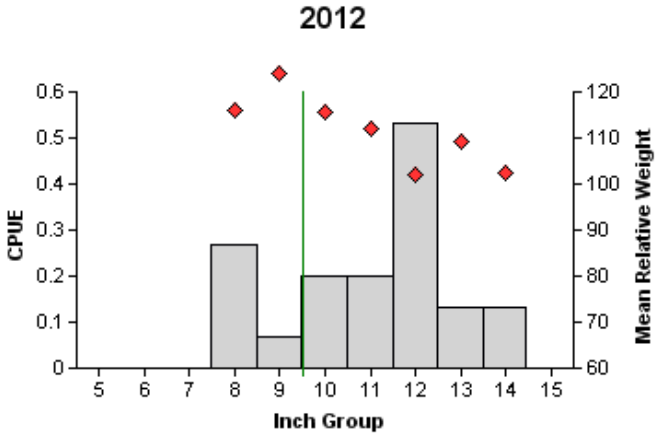


Figure 18. Length at age for largemouth bass collected during electrofishing at Buchanan Reservoir, Texas, October 2012 (N = 12).

White Crappie



Effort =	30.0
Total CPUE =	1.3 (26; 39)
CPUE-10 =	1.2 (29; 36)
PSD =	100 (0)
PSD-10 =	92 (4.7)



Effort =	15.0
Total CPUE =	1.5 (30; 23)
CPUE-10 =	1.2 (32; 18)
PSD =	100 (0)
PSD-10 =	78 (7.8)

Figure 19. Number of white crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2011 and 2012. Vertical line represents minimum length limit at the time of sampling.

White Crappie

Table 12. Creel survey statistics for white crappie at Buchanan Reservoir, Texas from March to August 2011, where total catch per hour is for anglers targeting white crappie and total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	9,336.4 (42)
Directed effort/acre	0.4 (42)
Total catch per hour	0.6 (42)
Total harvest	7941.5 (66)
Harvest/acre	0.4 (66)
Percent legal released	1.4

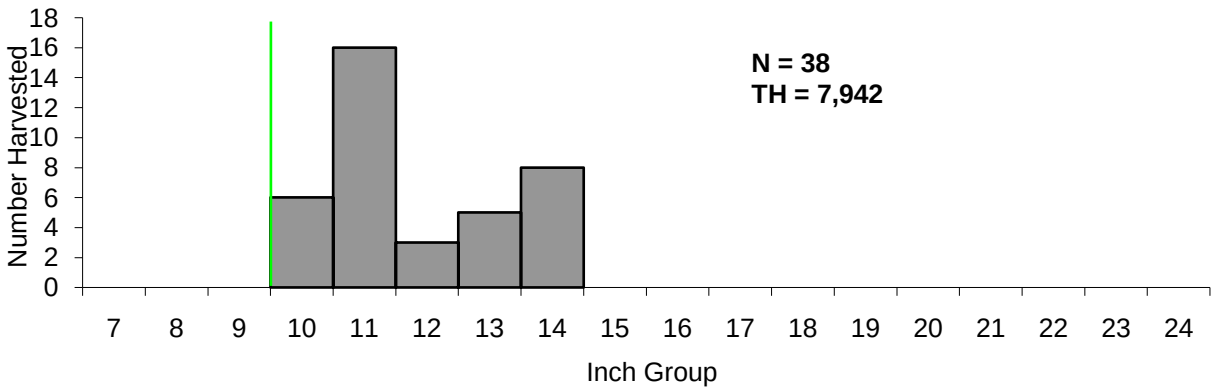
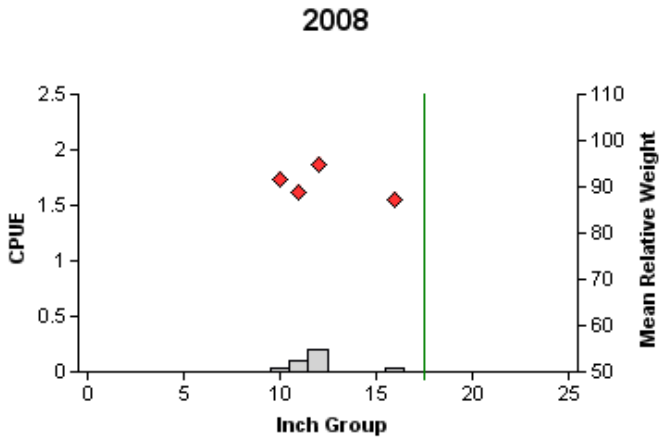
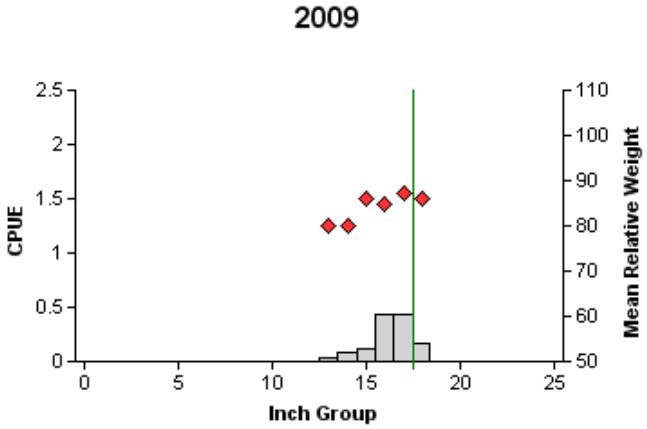


Figure 20. Length frequency of harvested white crappie observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested white crappie observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical lines represent length limit at the time of survey.

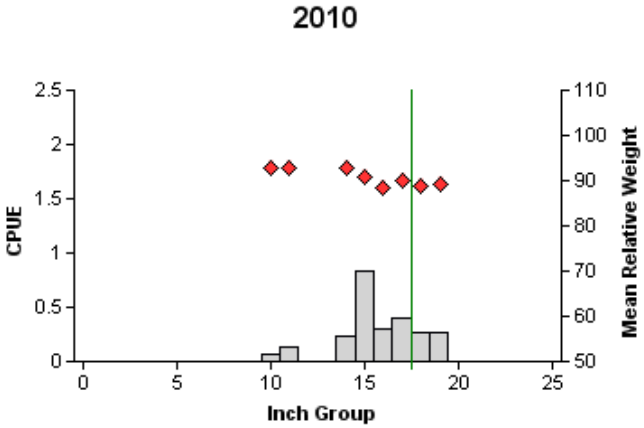
Sunshine Bass



Effort =	30.0
Total CPUE =	0.4 (41; 12)
CPUE-18 =	0.0 (100; 1)
PSD =	17 (12.4)



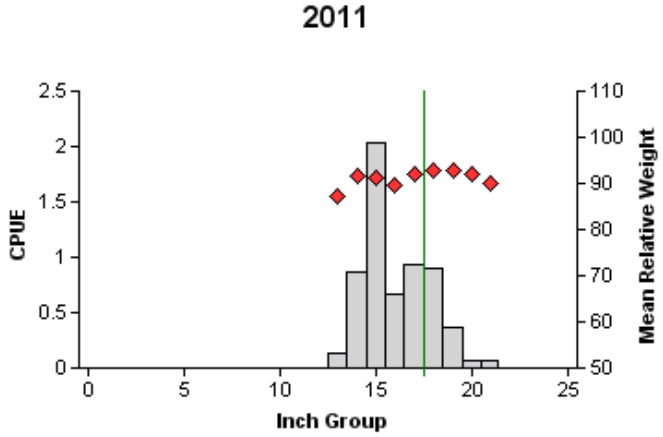
Effort =	25.0
Total CPUE =	1.3 (29; 32)
CPUE-18 =	0.2 (100; 4)
PSD =	81 (7.5)



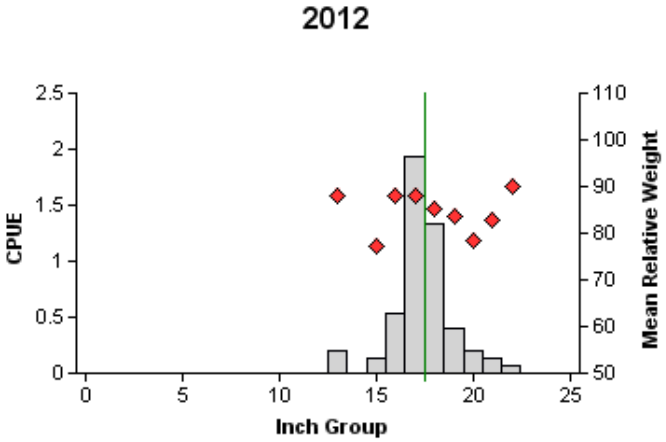
Effort =	30.0
Total CPUE =	2.5 (17; 75)
CPUE-18 =	0.6 (27; 18)
PSD =	49 (6.2)

Figure 21. Number of sunshine bass caught per net night (CPUE, bars) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Walter E. Long Reservoir, Texas, 2008, 2009, 2010, 2011 and 2012. Vertical line represents minimum length limit at the time of sampling.

Sunshine Bass



Effort =	30.0
Total CPUE =	6.0 (19; 181)
CPUE-18 =	1.5 (29; 45)
PSD =	50 (6.3)



Effort =	15.0
Total CPUE =	4.9 (24; 74)
CPUE-18 =	2.2 (30; 33)
PSD =	93 (3.2)

Figure 21 (continued). Number of sunshine bass caught per net night (CPUE, bars) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Walter E. Long Reservoir, Texas, 2008, 2009, 2010, 2011 and 2012. Vertical line represents minimum length limit at the time of sampling.

Sunshine Bass

Table 13. Creel survey statistics for sunshine bass at Buchanan Reservoir, Texas from March to August 2011 where total catch per hour is for anglers targeting sunshine bass and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year
	2011
Directed effort (h)	0.0 (0)
Directed effort/acre	0.0 (0)
Total catch per hour	0.0 (0)
Total harvest	2,162.7 (101)
Harvest/acre	0.1 (101)
Percent legal released	0.0

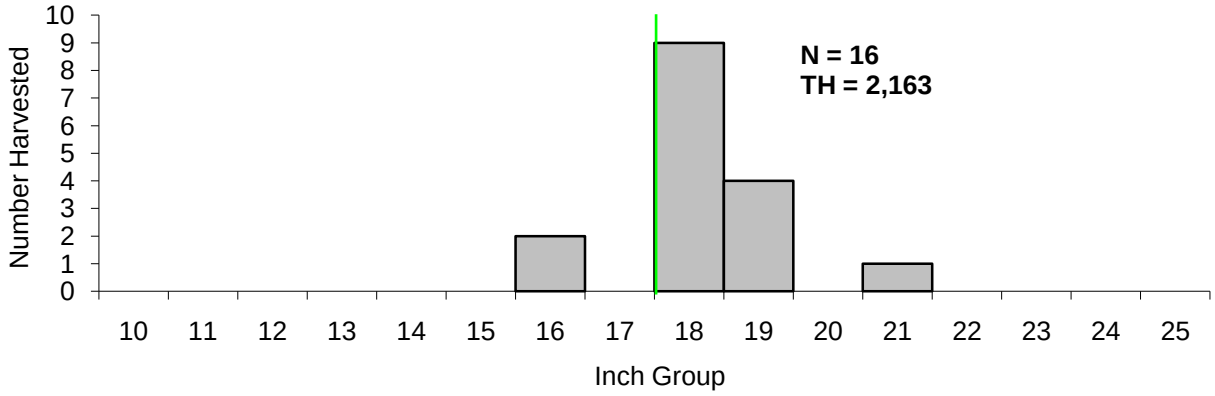


Figure 22. Length frequency of harvested sunshine bass observed during creel surveys at Buchanan Reservoir, Texas, March to August 2011, all anglers combined. N is the number of harvested sunshine bass observed during creel surveys, and TH is the total estimated harvest for the creel period. Vertical line represents length limit at the time of survey.

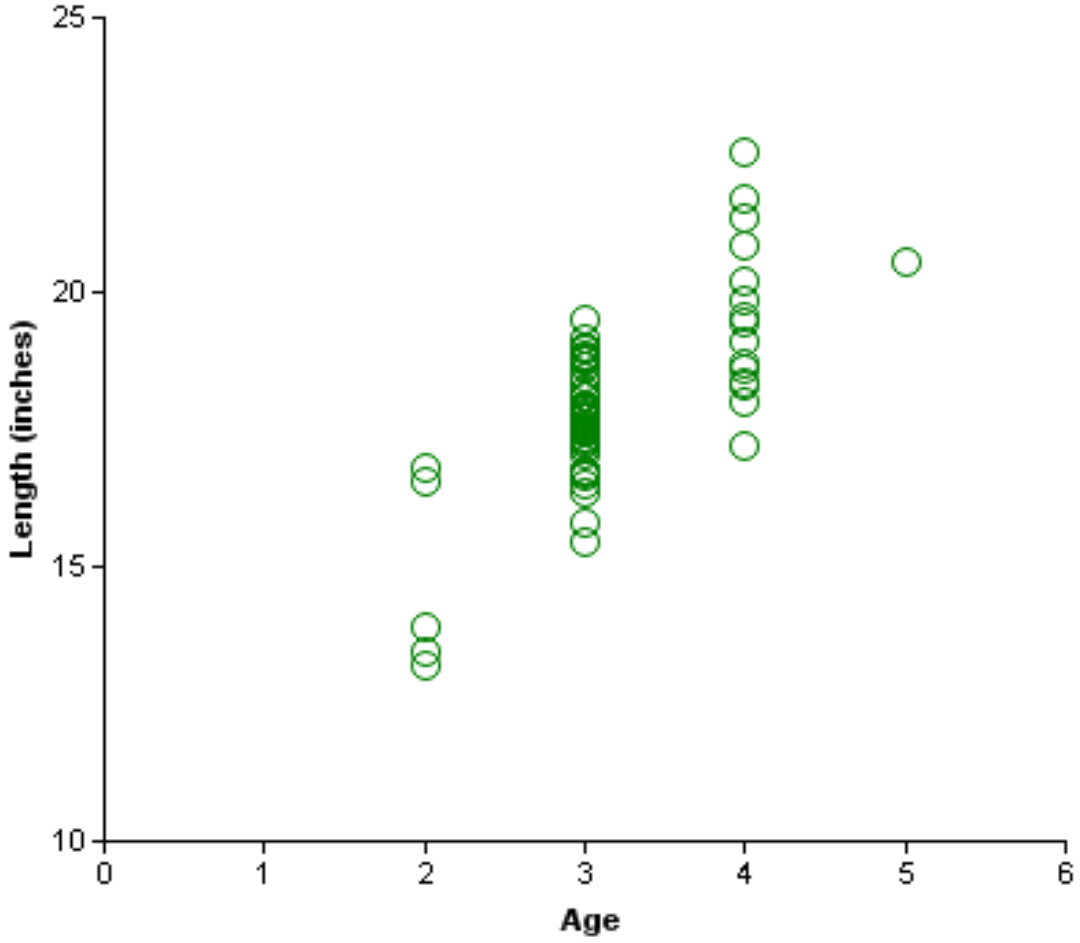


Figure 23. Length at age for sunshine bass collected by gill nets at Lake Buchanan, Texas, February 2012 (N = 74).

Table 14. Proposed sampling schedule for Buchanan Reservoir, Texas. Gill netting surveys are conducted in the spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S. Additional survey denoted by A.

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

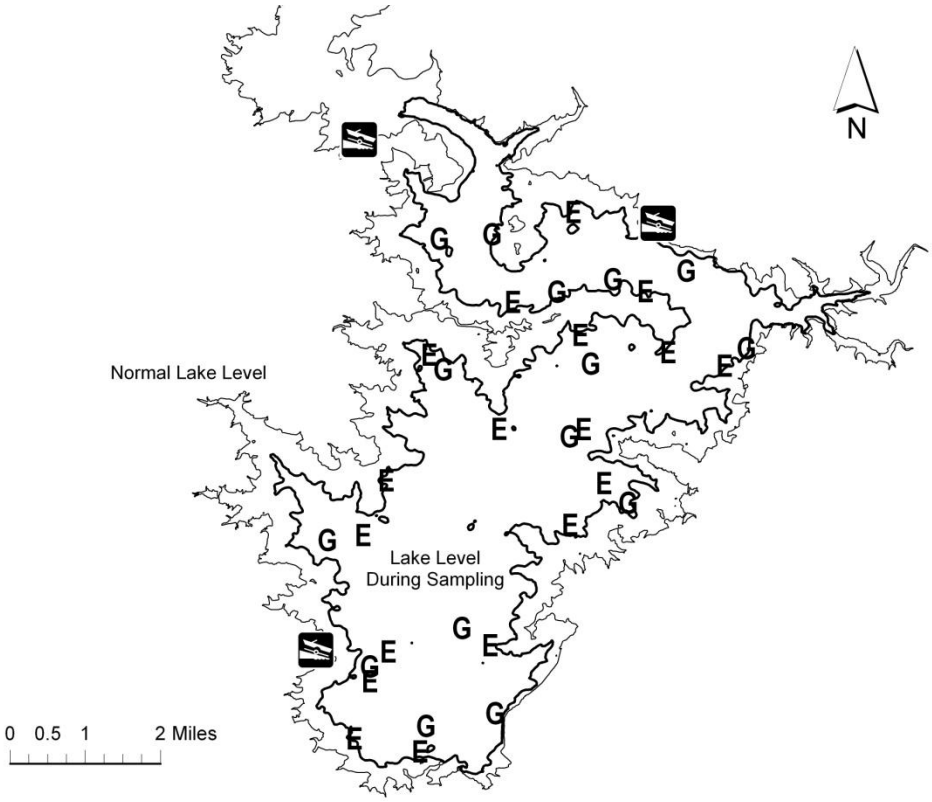
APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected by electrofishing in October 2011 and gill netting in February 2012 from Buchanan Reservoir, Texas.

	Gill Netting		Electrofishing	
Species	N	CPUE	N	CPUE
Gizzard shad			392	261.3
Threadfin shad			142	94.7
Inland silverside			12	8.0
Blacktail shiner			7	4.7
Blue catfish	60	4.0		
Channel catfish	26	1.7		
Flathead catfish	1	0.1		
White bass	45	3.0		
Striped bass	21	1.4		
Redbreast sunfish			80	53.3
Green sunfish			1	0.7
Bluegill			8	5.3
Longear sunfish			3	2.0
Largemouth bass			36	24.0
Guadalupe bass			9	6.0
White crappie	23	1.53		
Logperch			1	0.7
Sunshine bass (white bass x striped bass hybrid)	74	4.93		

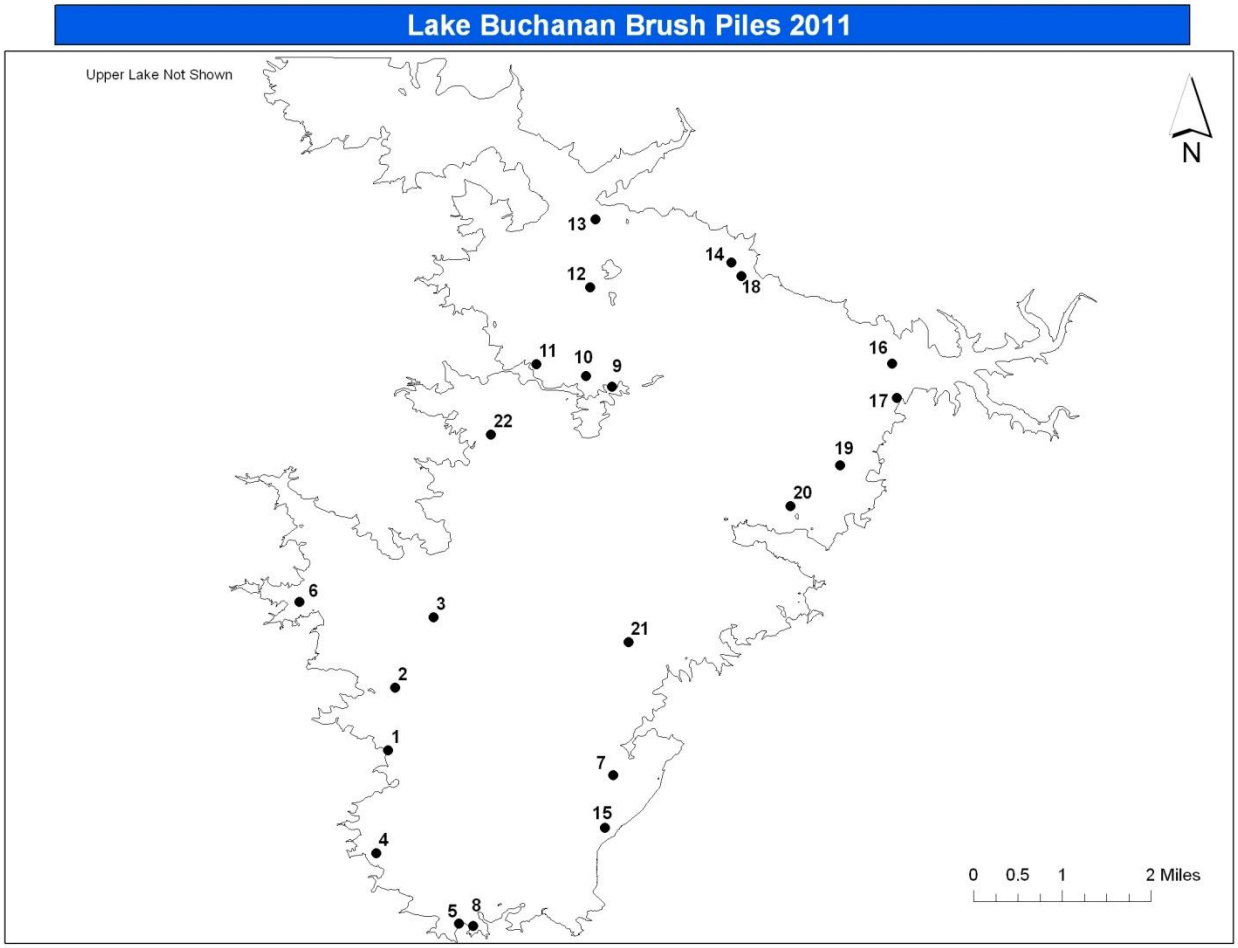
APPENDIX B

Location of sampling sites, Buchanan Reservoir, Texas, 2011-2012. Gill netting and electrofishing stations indicated by G and E, respectively. Boat ramps are indicated by icon. Darker inner lake outline represents lake level during time of sampling.



APPENDIX C

Map of Buchanan Reservoir, Texas with fish attractor locations (2011). Attractors have been installed and refurbished since winter 2008. Sunken ash juniper (*Juniperus ashei*) brush piles were used at the sites.



APPENDIX D

GPS coordinates for Buchanan Reservoir, Texas fish attractor locations. GPS coordinates are in degree decimal minutes. Attractors were either installed or refurbished from 2008–2011. Ash juniper (*Juniperus ashei*) brush piles, a.k.a. cedar trees, sunken with cinder blocks, were used to build the attractors.

Site #	Latitude	Longitude	Location Description	Installed	Refurbished
1	N 30 46.329'	W -98 27.133'	Rock hump north of Llano County ramp	2008	2010
2	N 30 46.943'	W -98 27.074'	Point off rock formation	2008	2010
3	N 30 47.630'	W -98 26.698'	Flag Island drop off	2008	2010
4	N 30 45.320'	W -98 27.259'	Rock pile with 55 gallon barrel on pole	2008	2010
5	N 30 44.634'	W -98 26.446'	End of long point	2008	2010
6	N 30 47.776'	W -98 28.008'	Creek channel edge	2008	
7	N 30 46.085'	W -98 24.938'	Long point west of dam	2008	2010
8	N 30 44.610'	W -98 26.310'	Next to standpipe in cove	2008	2010
9	N 30 49.887'	W -98 24.950'	Rocky outcrop north of Shaw Island	2009	2011
10	N 30 49.989'	W -98 25.204'	End of long point	2009	2011
11	N 30 50.106'	W -98 25.689'	Point off rock pile	2009	2011
12	N 30 50.857'	W -98 25.164'	Long point off Garrett Island	2009	2011
13	N 30 51.519'	W -98 25.114'	Rocky point near the mouth of Silver Creek	2009	2011
14	N 30 51.099'	W -98 23.780'	Side of long point west of Burnet County Ramp	2009	2011
15	N 30 45.471'	W -98 24.913'	Underwater rock formation on dam.	2010	
16	N 30 50.113'	W -98 22.208'	Long point at mouth of Morgan and Council Creeks	2010	
17	N 30 49.777'	W -98 22.160'	Long point at mouth of Morgan and Council Creeks	2010	
18	N 30 50.969'	W -98 23.683'	On main lake point near brushpile 14	2011	
19	N 30 49.117'	W -98 22.719'	On long point southwest of Morgan/Council Creeks	2011	
20	N 30 48.715'	W -98 23.201'	On long point north of Windy Point	2011	
21	N 30 47.385'	W -98 24.790'	On rock hump southwest of Windy Point	2011	
22	N 30 49.417'	W -98 26.133'	On hump at mouth of Campground Creek	2011	

APPENDIX E

Economic impact estimates for complete fishing trips at Buchanan Reservoir, Texas, from March 1, 2011 to August 31, 2011. Median values were expanded to represent estimated total anglers during this creel survey period. IMPLAN© software was used to apply economic multipliers for the analysis.

Table A. Total Direct Expenditures at Lake Buchanan

Angler Segment	Direct Expenditures Made in Local Economy (Burnet and Llano Counties)	Direct Expenditures Made Outside the Local Area
All Anglers	$2,115,405	$3,126,553
Local Anglers	$597,330	$40,653
Non-Local Anglers	$1,518,075	$3,085,900

Table B. Median Trip-Related Expenditures by Anglers at Lake Buchanan

Angler Segment	Direct Expenditures Made in Local Economy (Burnet and Llano Counties)	Direct Expenditures Made Outside the Local Area
Local Anglers	$70.00	$18.00
Non-local Anglers	$75.00	$100.00

Table C. Economic Impact Generated by Non-local Anglers within Burnet and Llano Counties

Impact Type	Employment[1]	Labor Income[2]	Value Added[3]	Output[4]
Direct[5]	7.5	$197,836.10	$318,699.60	$400,958.30
Indirect[6]	0.4	$17,845.20	$31,526.90	$52,798.50
Induced[7]	1.2	$38,392.50	$74,991.50	$118,015.30
Total	9.1	$254,073.80	$452,218.00	$571,772.00

Table D. Economic Impact Generated by Non-local Anglers Elsewhere in Texas

Impact Type	Employment	Labor Income	Value Added	Output
Direct	9.0	$270,369.20	$438,512.80	$516,153.30
Indirect	0.7	$33,347.00	$62705.00	$104,707.00
Induced	2.4	$100,923.90	$186,067	$313,183.40
Total	12.0	$404,640.20	$687,285.00	$934,046.60

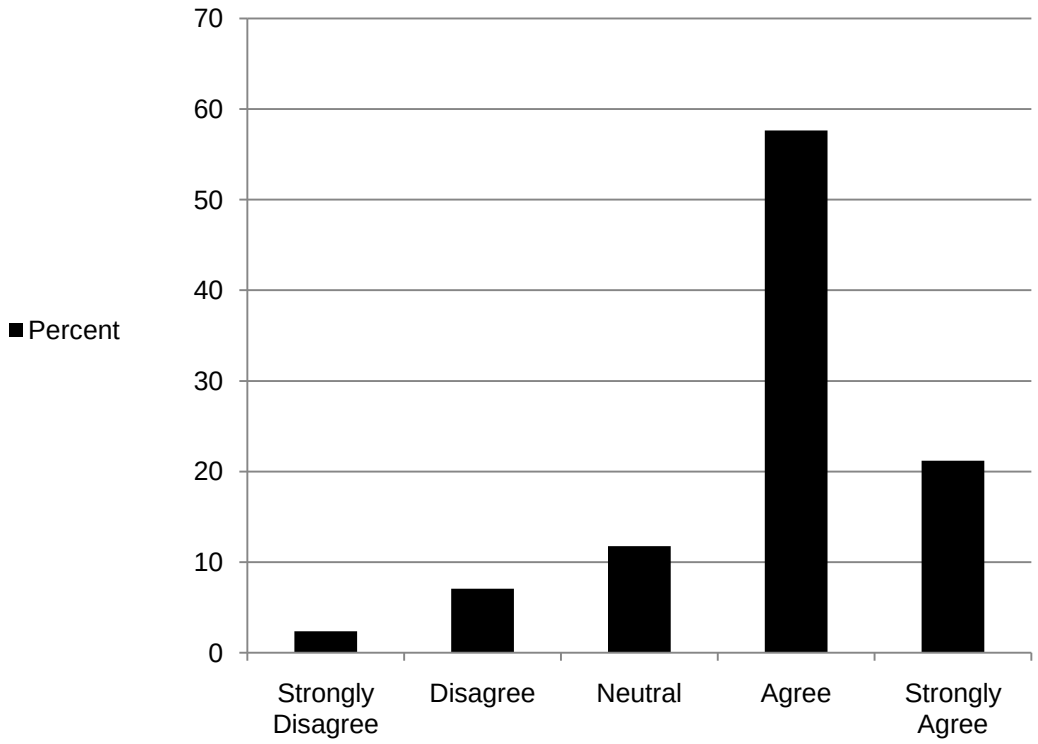
Table E. Local and State Sales Tax Generated by Anglers in Burnet and Llano Counties

Angler Segment	Sales Tax Generated in Local Area	Sales Tax Generated Elsewhere in Texas	Total State Sales Taxes Generated
Local Anglers	$22,712	$2,955	$25,667
Non-local Anglers	$70,095	$105,879	$175,974
Total	$92,807	$108,834	$201,641

[1] Employment shows the number of employees needed to support the economic activity in the local area
[2] Labor income is equal to employee compensation and proprietor income
[3] Value added shows the total income the event generates in the local economy
[4] Output refers to the total economic value of the project in the local economy
[5] Direct impact refers to the dollar value of economic activity available to circulate through the economy
[6] Indirect impacts refer to the inter-industry impacts of the IMPLAN analysis
[7] Induced impacts refer to the impacts of household spending by the employees generated by the direct and indirect impacts

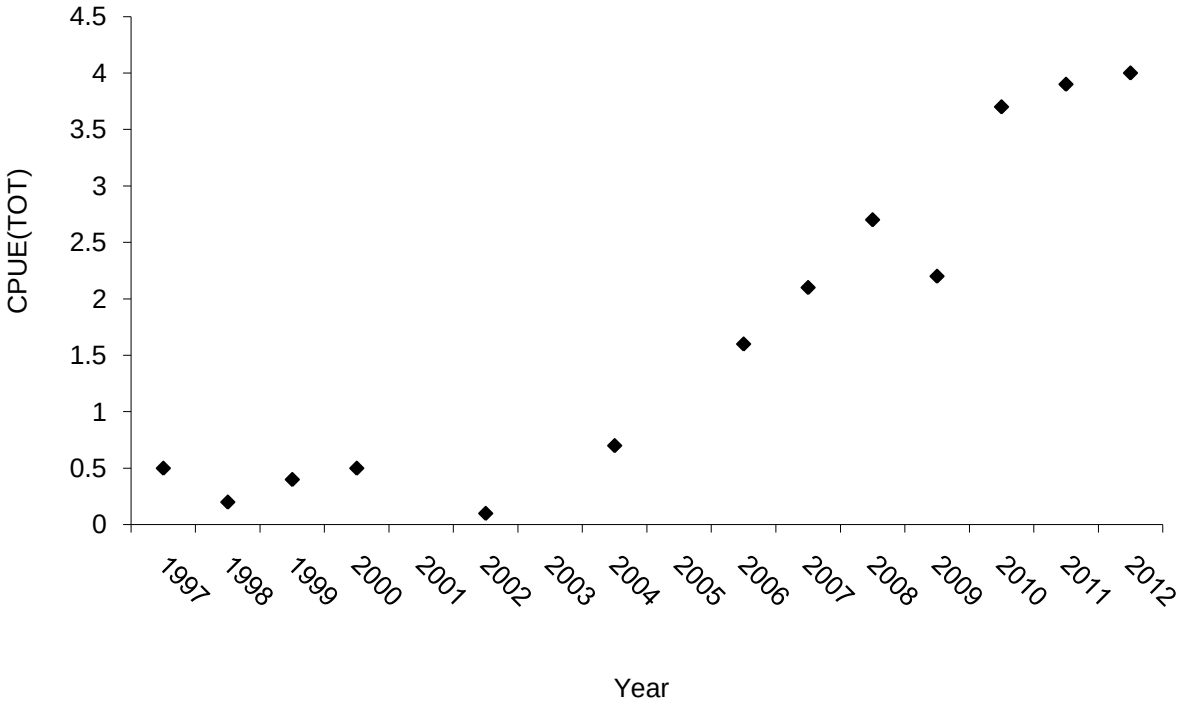
APPENDIX F

Angler satisfaction with overall fishing experience at Buchanan Reservoir, Texas during mail-out survey 2011. Level of satisfaction rated on a 1 to 5 scale, in which 1 is strongly disagree, 5 is strongly agree and 3 is neutral (N = 85).



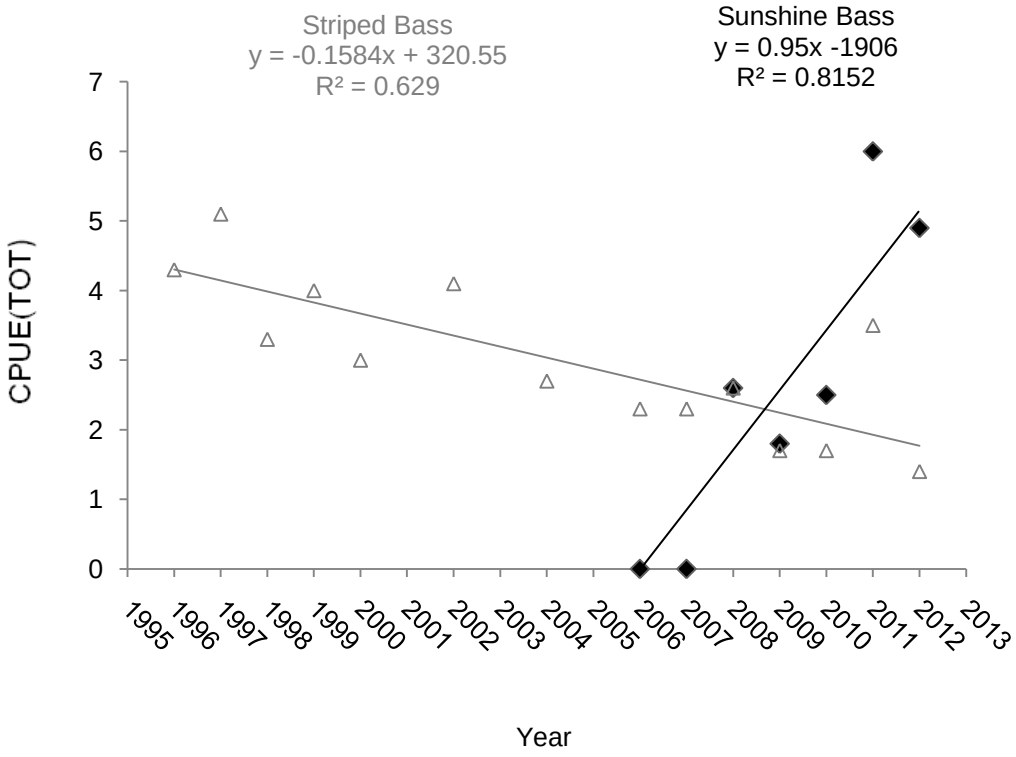
APPENDIX G

Historical trend of blue catfish total catch rate [CPUE(TOT)] from gill net surveys conducted on Buchanan Reservoir, Texas from 1997 to 2012. Blue catfish were stocked by TPWD in 1989 and 1990. Dashed line represents the mean total catch rate (1.73/nn) for all samples collected.



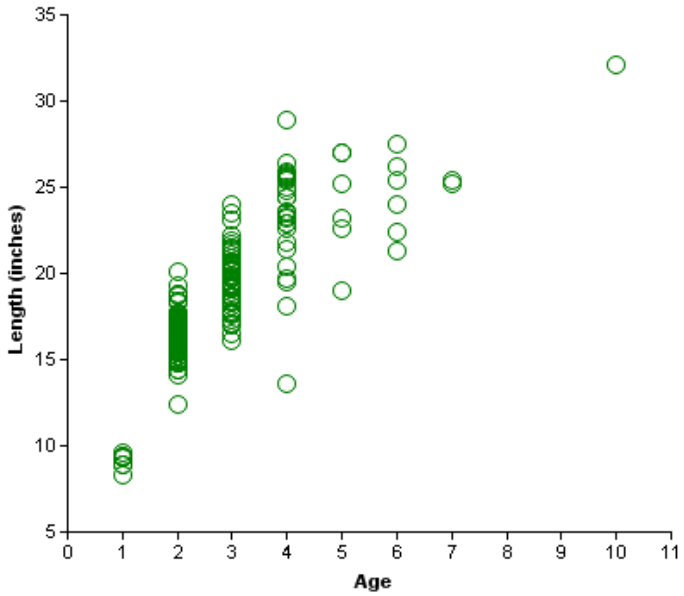
APPENDIX H

Historical trend of striped bass (triangles) and sunshine bass (diamonds) total catch rate [CPUE(TOT)] from gill net surveys conducted on Buchanan Reservoir, Texas from 1996 to 2012. Linear trend lines were added to compare temporal trends between both species.



APPENDIX I

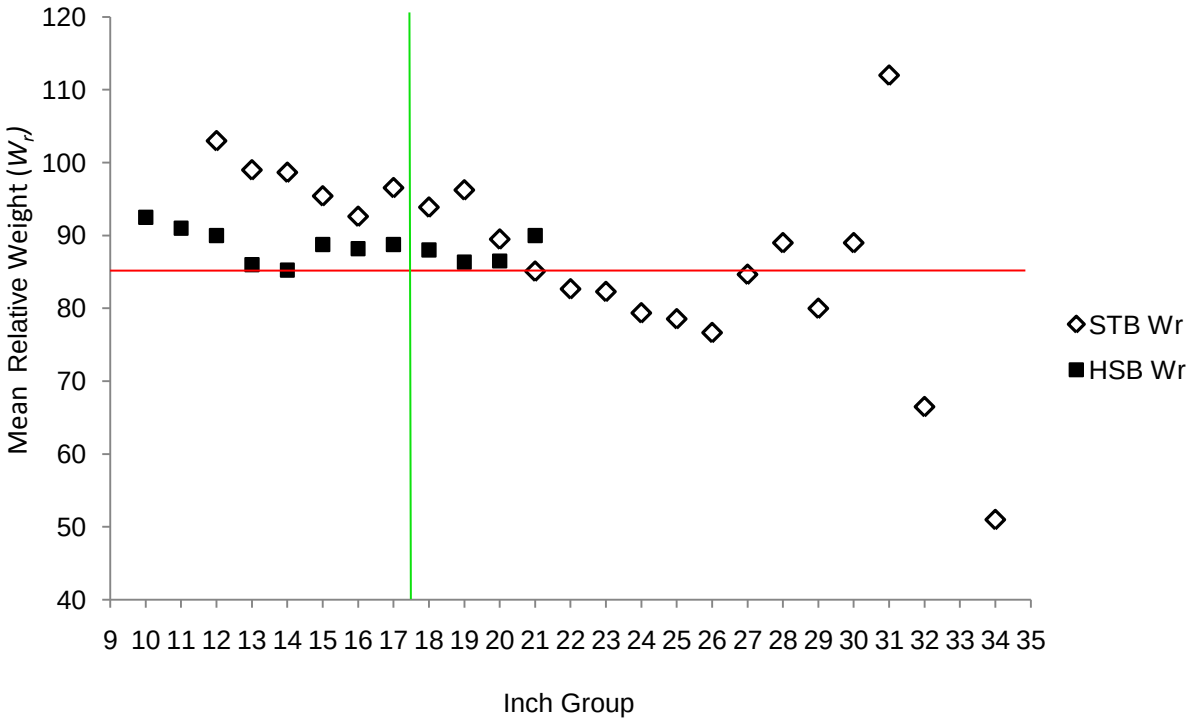
Cumulative length at age for striped bass collected by gill nets at Buchanan Reservoir, Texas, during winter 2009–2012 (N = 217).



Total Length	Survey Year	Age	Number of Fish
9.242125	2009	1	4
17.731298	2009	2	8
21.745406	2009	3	6
23.163666	2009	4	14
25.577427	2009	5	3
24.488188	2009	6	6
25.295275	2009	7	2
32.086614	2009	10	1
8.759842	2010	1	2
16.501530	2010	2	36
21.107283	2010	3	8
25.984251	2010	4	2
24.212598	2010	5	2
9.350393	2011	1	2
16.181101	2011	2	43
19.218589	2011	3	46
23.224409	2011	4	10
18.976377	2011	5	1
16.165353	2012	2	20
21.417322	2012	4	1

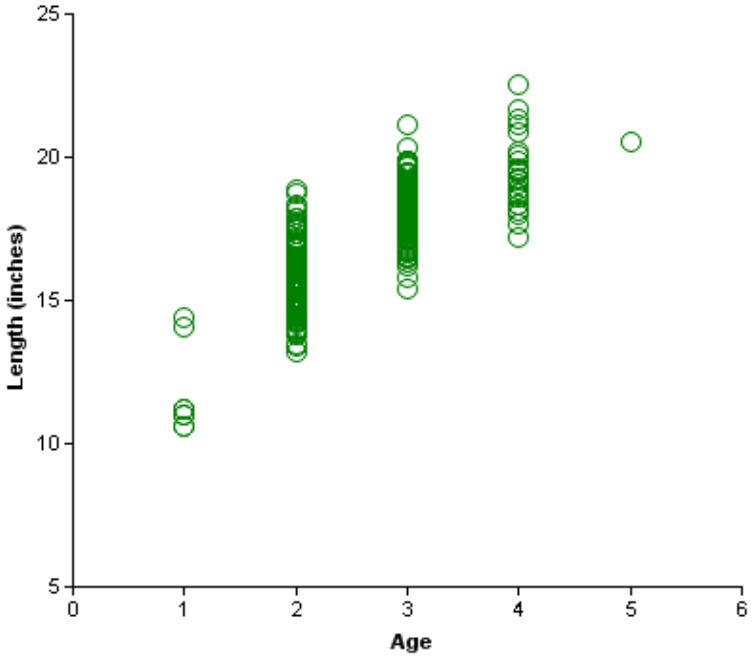
APPENDIX J

Historical mean relative weights by size groups of striped bass (diamonds) and sunshine bass (HSB; squares) collected from gill netting surveys conducted on Buchanan Reservoir, Texas from 1999 to 2012. Sunshine bass means were calculated from 2008 to 2012. Relative weights are calculated for stock-size fish only, which starts at 10 inches for sunshine bass and 12 inches for striped bass. The horizontal line represents an 85% relative weight value, which generally indicates the minimum acceptable value for condition. The vertical line represents the statewide minimum length limit for harvest (18 inches).



APPENDIX K

Cumulative length at age for sunshine bass collected by gill nets at Buchanan Reservoir, Texas, during winter 2009–2012 (N = 217).



Total Length	Survey Year	Age	Number of Fish
16.871308	2009	2	32
10.958005	2010	1	6
15.483544	2010	2	39
18.202099	2010	3	30
14.212598	2011	1	2
15.457050	2011	2	110
18.268383	2011	3	59
19.216535	2011	4	10
14.779527	2012	2	5
17.758133	2012	3	53
19.580052	2012	4	15
20.551181	2012	5	1