PERFORMANCE REPORT

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2015 Fisheries Management Survey Report

Buchanan Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Buchanan Reservoir were surveyed in 2015 using electrofishing and in 2016 using gill netting. This report summarizes the results of the surveys and contains a fisheries management plan for the reservoir based on those findings.

- **Reservoir Description:** Buchanan Reservoir 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 plan for 2011 included: continuing annual stockings of Striped Bass; monitoring the Striped Bass population with additional gill netting; and, permitting the stocking of Sunshine Bass by the Lake Buchanan Reservoir 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 have been stocked annually since 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 and 2015 to increase Florida Largemouth Bass genetic influence in the population. Blue Catfish were stocked in 1989 and 1990 to help establish a naturally-reproducing 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 The regulation was rescinded after analysis indicated environmental factors, not angler harvest, were probably more influential in determining White Bass population density.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 was the predominant catfish species present in our survey. Channel Catfish were present in lower abundance and smaller size structure than Blue Catfish. Flathead Catfish were present in low densities.

  - **Temperate basses:** White Bass reproduced successfully, despite low water levels during a prolonged drought event impeding spring spawning runs. Striped Bass gill netting catches remained consistent from 2012 – 2015, but varied for Sunshine Bass during the same period. A new sampling approach in 2016 collected baseline catch rates for both species for future trend analyses.

  - **Black basses:** Largemouth Bass catch decreased noticeably in 2015 compared to previous standard surveys; most likely a reflection of record-low water levels caused by a prolonged drought. Largemouth Bass growth remained similar to previous surveys. Guadalupe Bass were present in the reservoir.

Management Strategies

The reservoir should continue to be managed with existing fishing regulations. Combined *Morone* stocking rates will be modified to prevent forage competition and restore better growth. Gill netting should be conducted bi-annually to monitor *Morone* spp. abundance, growth and condition. Conduct general monitoring surveys with gill nets, and electrofishing surveys in 2019-2020, with a supplemental gill net survey in 2018 and a full-year creel survey in 2018/2019. Access, habitat and vegetation surveys will be conducted in 2019. Continue to cultivate invasive species awareness to prevent spread. Implanted habitat sites for cover-seeking species should be maintained or restored.

INTRODUCTION

This document is a summary of fisheries data collected from Buchanan Reservoir in 2015 and 2016. 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 are presented with the 2015 and 2016 data for comparison.

Reservoir Description

Buchanan Reservoir 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, but plenty of flooded terrestrial vegetation was present after the reservoir filled in 2015-16. Other descriptive characteristics for Buchanan Reservoir are in Table 1.

Angler Access

Historically, angler access has been adequate for boat anglers when the water level reached 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, but not impossible off hard-bottom shorelines. Increased municipal water demand and effects of prolonged droughts, caused by cyclical rain events, may make future recreational boating access to Buchanan Reservoir challenging. During extreme low water levels in 2012 and 2013, improvements were made to prolong boat access. Four public and several pay-access private boat ramps were available. A public low-water emergency ramp was constructed in 2013 to aid access to the lake down to 964 ft. above mean sea level (msl). The White Bluff (Burnet County) boat ramp was improved to be more accessible at low water levels down to 963 ft. msl. Both access improvements and new courtesy docks were installed at several public boat ramps, courtesy of the Lake Buchanan Conservation Corporation (LBCC), the Burnet County Commissioners Office and the LCRA. For a complete list of ramps, see Table 2. Bank fishing was available at four public parks. Handicapped access was poor with no specific handicap accessible fishing sites available.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (De Jesus and Farooqi, 2012) 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 2013, 2014, and at a reduced rate in 2015. Annual gill net sampling was conducted in 2013–2016. In 2012, gill netting effort was reduced to 15 sites from a previously-increased effort of 30 sites when reservoir levels dropped and decreased accessibility. A new stratified random approach was taken in 2016 under the current objective-based sampling scheme.

2. Permit the stocking of Sunshine Bass by the LBCC, monitor fry stocking success, and year-class survival.

   Action: Sunshine Bass were permitted and fry/fingerling combinations were stocked in 2013–2014 by the LBCC. Fry-only stockings took place in 2015 and 2016. The

population was monitored in conjunction with Striped Bass.

3. Continue to manage Blue Catfish under statewide regulations and promote the fishery if the opportunity arises.

   Action: Blue Catfish fishing at Buchanan Reservoir was promoted using media outlets, including social media.

4. Continue to create and maintain fish attractor sites for cover-seeking species.

   Action: Fish attractor projects ceased during prolonged drought that rendered sites exposed on dry land. An effort to install artificial attractors (Mossback) is underway in 2016.

5. Work with local government authorities and the LBCC to address poor access by coordinating new public ramp construction or extending existing ramps during low-water conditions.

   Action: LBCC and Burnet County collaborated to construct a new low-water emergency ramp on LCRA public property in 2012 and extended the Burnet County boat ramp in 2011. In 2015, the LBCC installed courtesy docks at several ramps around the lake.

6. Monitor and help prevent spread of invasive species by conducting surveys and outreach.

   Action: Zebra mussel signage was installed around lake access points with the help of LBCC. Summer interns conducted zebra mussel surveys at public ramps to help create awareness among boaters. Exposed lake-bottom from the drought served host to a salt cedar invasion at the reservoir, which was mapped and chemically treated before it was completely flooded in 2015.

Harvest Regulation History: Sportfish in Buchanan Reservoir are currently managed with statewide regulations (Table 3). 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 and 2015 to increase Florida Largemouth Bass genetic influence by utilizing newly-flooded habitat. A complete stocking history is in Table 4.

Vegetation/habitat management history: Buchanan Reservoir had no aquatic vegetation coverage during the 2015 survey. Most of the shoreline habitat was comprised of sand and rock. Restored water levels from multiple flood events in 2015 and 2016 created vast areas of flooded terrestrial vegetation, which will provide excellent habitat for fish populations. TPWD and LBCC have partnered to install a network of fish habitat attractors since 2008. Saltcedar invaded exposed stretches of lake-bottom during the drought, requiring mapping in 2014 and chemical treatment in 2015.

Water transfer: There are no inter-basin water diversion structures at Buchanan Reservoir.

METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Buchanan Reservoir (TPWD unpublished). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected and all surveys were conducted

according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Electrofishing – Largemouth Bass, Sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (2 hours at 24, 5-min stations; Appendix B). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Ages for Largemouth Bass were determined by a category-1 evaluation (using otoliths from 13 randomly-selected fish ranging 13.0 to 14.9 inches; TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Gill netting – Striped Bass, Sunshine Bass, White Bass, Blue Catfish and Channel Catfish were collected by gill netting (15 net nights at 15 stations; Appendix B). Stations were randomly selected based on catch proportions within three strata (upper, mid, and lower lake) that were delineated by examining catch rates from historic standardized surveys (Appendix C). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn). All temperate bass captured were aged.

Electrofishing was used to supplement the gill net collection of White Bass to conduct year-class strength evaluation (200 fish in total, 10 per 10 mm group).

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2015 and by electrophoresis for previous years.

Statistics – 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). 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.

Habitat – A structural habitat and vegetation survey was conducted in 2015. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Water level - Source for water level data was the Lower Colorado River Authority (LCRA 2016).

RESULTS AND DISCUSSION

Habitat: In 2015, littoral zone structural habitat was mainly natural shoreline, comprised mostly of sand and rock (Table 6). 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). However, heavy rain events in 2015 and 2016 filled the lake from a record-long dry spell that exposed significant acres of lake-bottom to the growth of terrestrial vegetation (trees and shrubs). This terrestrial vegetation has now been flooded and provides ample littoral habitat for fish species. Fish in this reservoir usually relate to topographical gradients or irregular contours found throughout the lake. A fish habitat 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, three sites in 2010, and five sites in 2011, for a total of 22 fish attractor sites throughout the lake (Appendix D). Global positioning system (GPS) coordinates were made available to the public (Appendix E). Unfortunately, these habitat sites have not received refurbishment since 2011 due to extremely-reduced lake levels. With newly-restored water levels, this effort can resume. During the four years (2011 – 2015) of exposed lake-bottom, saltcedar (*Tamarix* sp.) became established in Buchanan Reservoir. A comprehensive survey was conducted to map the presence of this invasive species for a treatment plan in 2014 (Appendix F). An effort to treat this nuisance was made in 2015, but fortunately

these areas were flooded when the lake rose to near conservation level, completely submerging the trees.

Prey species: Electrofishing catch rates of Gizzard Shad**,** Threadfin Shad**,** Redbreast Sunfish and Bluegill were 101.0/h, 118.0/h, 62.0/h and 107.5/h, respectively. Total catch rate of Gizzard Shad was less than half of what was recorded in 2007 (268.0/h) and the 2011 non-standard survey (261.0/h); however it is expected to rebound to historic values with elevated water levels. Index of Vulnerability (IOV) for Gizzard Shad noticeably increased to 73 since 2011 (21), indicating that 73% of Gizzard Shad were vulnerable (≤8 inches) to existing predators (Figure 2). Threadfin Shad were abundant and provided forage for existing predators. Total catch rates of Redbreast Sunfish have increased since 2007(45.5/h) to 62.0/h in 2015 (Figure 3); but not as high as seen in 2003, when it was 259.0/h (De Jesus and Farooqi 2012). Total CPUE of Bluegill in 2015 (107.5/hr) was similar to the 2007 catch rate (107.0/h), and it was predominantly structured by small individuals ≤5 inches (PSD = 6; Figure 4). Sunfish abundance is correlated to habitat availability, which is consequentially affected by water levels. Buchanan Reservoir experienced record-low water levels in 2009 and 2011 through 2015. If high water levels remain consistent, all forage species are expected to increase in abundance.

Blue Catfish: Blue Catfish total catch rates fluctuated slightly between 2012 (4.0/nn) and 2015 (1.9/nn; Figure 5). Annual surveys revealed trophy specimens (≥36 inches) available to anglers; most in good condition, with average relative weight (W_r) values above 90 for most size classes. In 2016, the stratified random gill netting survey revealed the highest total catch rate (5.7/nn) for Blue Catfish at Buchanan Reservoir (Figure 6). The population structure remained good with quality specimens recorded with good body condition (most W_r values above 90). Most fish sampled were of legal harvest size (≥12 inches). Whether or not this increase is due to a population increase or sampling efficiency will be determined in surveys to come. The Blue Catfish fishery has become very popular among local fishing guides, who offer to target them in lieu of or as part of Striped Bass charter trips. This is due to the 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.

Channel Catfish: Since 2010, a declining abundance trend was noticed for Channel Catfish at Buchanan Reservoir (De Jesus and Farooqi 2012). This trend continued in following surveys through 2015, when the lowest catch rate ever was recorded at 0.4/nn (Figure 7). It has been thought that the thriving Blue Catfish population has been outcompeting the Channel Catfish in this reservoir. In 2016, the stratified random gill netting survey revealed no difference, with a total catch rate of 0.8/nn for Channel Catfish (Figure 8). The population structure was mostly comprised of harvest-size (≥12 inches) individuals with good body condition (most W_r values above 90).

Flathead Catfish: Flathead Catfish were present in low density at Buchanan Reservoir in 2016. The 2016 total gill net catch rate was 0.3/nn with five individuals sampled, all of harvestable size (≥18 inches).

White Bass: De Jesus and Farooqi (2012) reported that White Bass were a highly sought-after species by anglers during the spring creel quarter; generating significant economic revenue for the local economy. The loss of river-reservoir connectivity between summer 2011 and spring 2015 was detrimental to not only the springtime spawning runs but also recreational access upriver. Close evaluations of White Bass at Buchanan Reservoir revealed this species is resilient to extreme drought conditions. The total gill net catch rate fluctuated between 2.7/nn and 3.9/nn, between 2013 and 2015 (Figure 9). This was similar to what was reported in the last survey in 2012 (3.0/nn). In 2016, the stratified random gill netting survey revealed a catch rate of 5.3/nn, an improvement in relation to historical sampling surveys (Figure 10). Still, whether or not this increase is due to a population increase or sampling efficiency will be determined in surveys to come. Combined age-and-growth data from annual surveys (2013 – 2016) revealed that, on average, White Bass reached legal length (10 inches) between age-1 and -2 (Figure 11); similar to that reported in 2012. This is considered fast growth compared to other eco-regions of Texas (Prentice 1987). Body condition was fair in 2016, with mean relative weights (W_r) around 85 for most adult size-groups.

DiCenzo and Duval (2002) related inflows to year-class recruitment of White Bass. Loss of flow for consecutive spawning seasons has been detrimental to short-lived White Bass populations in many

reservoirs. A strong year-class at least every 3 to 4 years is required to maintain quality White Bass fisheries (Daugherty and Smith 2012). Two sampling efforts to evaluate White Bass year-class strength were conducted in 2014 and 2016 to determine impacts of prolonged drought conditions at Buchanan Reservoir. Unexpectedly; the White Bass population revealed no evidence of weak year-classes caused by extreme drought conditions. Sampling data showed above-average recruitment from 2011 through 2015 when river connectivity was lost (Appendix G). Their resilience was likely attributable to environmental conditions at Buchanan Reservoir, where White Bass likely spawn on wind-blown sandy shorelines in the main lake as an alternative to making spawning runs which require flow and river-reservoir connectivity.

Striped Bass: Striped Bass total catch rates remained stable from 2012 (1.4/nn) through 2015, when it was 1.1/nn (Figure 12). This catch rate remained below the mean historical catch rate of 2.7/nn; however low catch rates were expected because of two consecutive missed stockings. Several factors may have affected catch rates in recent surveys. Sampling inaccessibility to the upper areas of the reservoir, due to drought conditions, may have rendered surveying less effective. The same drought conditions exacerbated challenges during Striped Bass production at the hatcheries, limiting statewide stockings. In 2011 and 2012, Striped Bass were not stocked into Buchanan Reservoir. These missing year classes were most noticeable through the 2015 gill netting surveys. Magnelia and De Jesus (2008) revealed that the Striped Bass fishery was dominated by 3- and 4-year-old fish; meaning that the lack of these fish in the population would be noticed by anglers in 2013 - 2016. Gill net sampling methodology changes (subjective versus random sampling site selection), which were first implemented at Buchanan Reservoir in 2004, was thought to also be partly responsible for decreased gill net catch rates in recent years (Appendix H). Increased stocking rates didn't necessarily account for increased gill net catch rates, even though it was speculated it might (Magnelia and De Jesus 2008). Gill netting catch rates tend to be highly variable, especially when surveying populations that are not self-sustainable like Striped Bass. In 2016, a stratified random gill netting survey was performed at Buchanan Reservoir as part of an objective-based sampling approach, designed to increase statistical confidence of our survey results. This gill netting survey revealed an improved catch rate (2.9/nn) for Striped Bass at Buchanan Reservoir (Figure 13). It is too early to imply that the new approach rendered improved catch rates without further survey attempts to establish a trend.

Combined age-and-growth data from annual surveys (2013 – 2016) revealed that, on average, Striped Bass reached legal length (18 inches) by age 3 (Figure 14); similar to 2012. Growth beyond age-three has been historically slow, and has been thought to be attributed to stress in the summer months from high water temperatures and low dissolved oxygen levels (Magnelia and De Jesus 2008; De Jesus and Farooqi 2012). However in 2015, in the absence of two younger year classes, four 5-year-old fish were captured averaging 26 inches in length; higher than the historic average size at this age. This suggests intra-specific competition might be affecting growth potential. Also worth mentioning; the 2010 year-class was composed mostly of stocked fry; which apparently responded well according to good representation at age 3 through 5 in age and growth surveys conducted in 2013, 2014, and 2015 (Figure 14). Results like this may justify fry stockings as an option to relieve hatchery production challenges in future years. Body condition in 2016 was also poor, with relative weights (W_r) for most size classes of adult fish below 85 (Figure 13).

Largemouth Bass: The total electrofishing catch rate of Largemouth Bass was 55.5/h in 2015, which was a little less than half (125.0/h) of what was recorded in 2007 (Figure 15). Similarly, catch rates for stock-size fish (8 inches) was a little over half (25.5/h) of what it was in 2007 (43.0/h). A non-standard daytime electrofishing survey, conducted in 2011, revealed closer results to those seen in the 2015 survey, but these non-standardized data serve best as anecdotal evidence, rather than provide viable comparisons with standardized surveys. Significant lake level fluctuations 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 (2009) found that other reservoirs on the Colorado River system (e.g., O. H. Ivie) had a positive correlation between Largemouth Bass year class strength and water level. Prolonged chronically-low water levels, between 2011 and 2015 in Buchanan Reservoir, would have depleted littoral zone habitat and impacted recruitment of Largemouth Bass. This was reflected in the reduced relative abundance of stock-size fish and harvest-size fish (CPUE-14 = 1.5/hr).

However, newly-flooded lake conditions and wide-spread flooded habitat during the time of survey may have also reduced our sampling efficiency. Regardless, good reproduction was evident from the pronounced presence of young-of-year fish in the 2016 sample; and a reduced size structure (PSD = 15). With sustained and consistent water levels, this population structure is expected to improve over the next few years. Body condition was excellent, as average relative weights (W_r) for all stock-size inch groups were above 100.

Largemouth Bass growth analysis revealed that they grow to harvestable size (14 inches) by age-2 (Figure 16). The small sample size could lead to less precision, but these figures were similar to previous growth analyses for this species. Florida Largemouth Bass genetic influence (67.0%) in 2015 was moderate, and remained similar to the last sample taken in 2007 (63%; Table 7). Since Florida Largemouth Bass were first introduced to Buchanan Reservoir in 1978, genetic influence has increased until reaching its highest value in 2015 (Appendix I); however, as allele frequencies approached 1 (100%; not probable), increases became less pronounced.

Sunshine Bass: Sunshine Bass (fry and fingerlings) have been stocked in Buchanan Reservoir every year since 2006 by the LBCC. A viable fishery has been established, supplementing the Striped Bass fishery. Increased fry stockings in combination with fingerlings seem to have resulted in good recruitment (De Jesus and Farooqi 2012). 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 due to restricted thermal tolerances. It is believed that hybrid Striped Bass are more tolerable to stressful summer lake conditions that are unfavorable for Striped Bass. Total gill net catch rate fluctuated between 1.8/nn and 4.5/nn between 2013 and 2015 (Figure 17). These values were lower than the 4.9/nn sampled during the last standardized survey in 2012. While Sunshine Bass historic catch rates averaged higher than those of Striped Bass, these rates were highly variable; though showing an increasing trend over time (Appendix H). In 2016, a stratified random gill netting survey was performed at Buchanan Reservoir as part of an objective-based sampling approach, designed to increase statistical confidence of our survey results. This gill netting survey revealed a catch rate of 3.8/nn, which was right around the average (3.3/nn) for historic standardized random sampling surveys (Figure 18). Similar to Striped Bass, body condition for Sunshine Bass was poor in 2016, as mean relative weights (W_r) remained below 85 for all stock-size inch groups. Intra- and inter-specific competition with other *Morone* species for a reduced shad forage base over the extended drought period was likely reflected here. The decision to maintain stocking rates of *Morone* species to meet catch demand during a period of reduced reservoir capacity likely proved detrimental to the condition and growth of these species. Historical mean relative weights for Sunshine Bass revealed good body condition ($W_r \geq 85$), similar to Striped Bass at similar size groups (De Jesus and Farooqi 2012). Future stocking adjustments might be required to restore historical growth and condition trends. Combined age-and-growth data from annual surveys (2013 – 2016) revealed that, on average, Sunshine Bass reached legal length (18 inches) between age-3 and -4 (Figure 19); slower than reported in 2012. Growth slows down after age-3, similar to Striped Bass; however, thermal tolerance is not likely the culprit for Sunshine Bass. This may be related to a density-dependent issue, which can be corrected with stocking adjustments. Sunshine Bass have been readily accepted by the traditional striper anglers at Buchanan Reservoir. They have adapted well and have helped sustain the harvest-oriented *Morone* fishery during years when Striped Bass year classes could not be produced.

Fisheries management plan for Buchanan Reservoir, Texas

Prepared - July 2016.

ISSUE 1: Buchanan Reservoir is renowned for its *Morone* fisheries. Striped Bass and Sunshine Bass, combined, have successfully sustained a harvest-oriented fishery for the last decade, providing a significant economic impact for the region. A decade of observations have proven that Sunshine Bass perform well in Buchanan Reservoir, complementing the traditional Striped Bass fishery that helped give the lake its great reputation. Consistent annual stockings are essential to maintaining the integrity of this fishery. The strong forage base in the lake has justified high stocking rates in past years. Drought conditions from 2011 to 2015 reduced the lake surface area to about 40% of full capacity. Stocking rates were not modified during this time, which might have led to increased intra- and inter-specific competition during reduced forage production. While anecdotal reports of high angler catch rates revealed angler satisfaction, data revealed that growth and condition might have been impacted by a crowded stock. While good catch rates are important for the local economy; improving the condition and size structure of these Moronids is now a priority, and would also be appreciated by anglers. With a reliable feel for this tandem fishery and the implementation of objective-based sampling approaches, we can move forward with more efficient monitoring efforts.

MANAGEMENT STRATEGIES

1. Request Striped Bass fingerlings be stocked annually at a reduced rate of 5/acre.
2. Continue to encourage and granting a permit to the LBCC Corporation for stocking Sunshine Bass fry at the equivalent rate of 10 fingerlings/acre.
3. Monitor the *Morone* fishery by conducting a stratified random sampling scheme using gill nets on a biennial basis.
4. Conduct a year-long creel survey in 2018 – 2019 to determine angler catch rates for these species and determine if any further stocking adjustments are needed to balance catch rates and growth trends.

ISSUE 2: Largemouth Bass present good fishing opportunities for anglers; though not the most sought-after species in the reservoir. The reservoir has a history of producing large fish, and efforts to stock the Florida strain of Largemouth Bass may improve the potential to produce large fish in the future. The lake attracts its fair share of black bass tournaments, and many anglers enjoy fishing for this species. 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 other centrarchids in other district lakes. Juniper trees are abundant close to the reservoir shoreline and are always available at no cost. Artificial options are also available and more durable. Volunteers are readily available to provide labor for these types of projects.

MANAGEMENT STRATEGY

1. Continue to take advantage of the opportunities present to maintain fish attractor sites at Buchanan Reservoir with the help of LBCC and local stakeholders. When possible, coordinate efforts to replenish 22 existing sites with brush or artificial structures.

ISSUE 3: 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. Salt cedar became established in the dry lakebed 2013. It is expected that all of the surveyed trees were inundated and killed by 2016. 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 and maintain 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.
5. Work with our Invasive Species Program coordinator to conduct another salt cedar survey to confirm their status at the reservoir.

Objective-Based Sampling Plan for Buchanan Reservoir

2016 - 2020

Sport fish, forage fish, and other important fishes

Sport fishes in Buchanan Reservoir include Largemouth Bass, Guadalupe Bass, Striped Bass, Sunshine Bass, White Bass, White Crappie, Black Crappie, Channel Catfish and Blue Catfish. Important forage fish species include Gizzard Shad, Threadfin Shad, Redbreast Sunfish, and Bluegill.

Negligible or low-density fisheries

Channel Catfish: Channel Catfish abundance has been steadily declining in recent years to a historical low represented by a catch rate of 0.4/nn in 2015 since 2010, when it was 4.1/nn. Channel Catfish only accounted for 1.4% of all directed effort during a spring and summer creel survey in 2011. Anglers at Buchanan Reservoir tend to be generalists when targeting catfishes and other species. Catfishes in general comprised 8.6% of the total directed effort in spring and summer 2011. This was fourth-best behind temperate bass and Largemouth Bass; becoming third-best if combining directed effort for specific catfish species. While a standard annual creel survey could not be completed due to extreme drought conditions; a future year-long creel survey could better identify the popularity of all individual catfish species. Declining abundance of Channel Catfish also coincided with reduced gear effort when the surface area of the lake was reduced to less than half of its capacity at full pool during the recent drought years. With increasing lake levels and changes in objective-based sampling, gill netting efforts for other target species might reveal changes for this species incidentally; however sampling for this species will be limited in 2016 – 2020. We will monitor presence/absence while conducting gill netting surveys for other species. A creel survey in 2018 – 2019 will provide complimentary catch data to supplement gill netting data.

Flathead Catfish: Flathead Catfish are present in low density in Buchanan Reservoir. Little directed effort (1.1% of total directed effort) was identified for this species in a 2011 creel survey. Catch rates for this species has consistently remained near 1.0/nn. Sampling for this species will be limited in 2016 – 2020. We will monitor presence/absence while conducting gill netting surveys for other species. A creel survey in 2018 – 2019 will provide complimentary catch data to supplement gill netting data.

Crappie: White and Black Crappie are present in low densities in Buchanan Reservoir. This is based on poor catch rates rendered by trap netting. Historic trap netting surveys failed to capture enough fish to generate a confident estimate. By-catch of these species during gill netting surveys produced better catch rates, leading us to consider this method as an alternate survey from 2011 to 2015. Still, their dispersed distributions and high variability of gill netting catch rates within this large reservoir led to erratic catches during random sets; hence high RSE. The 2011 creel survey identified that directed effort for these species combined accounted for 6.1% of the total directed effort for all species targeted. While these species are targeted by anglers, they are difficult to sample effectively at this reservoir; therefore sampling for this species will be limited in FYs 2016 – 2020. We will monitor presence/absence while conducting gill netting surveys. A creel survey in 2018 – 2019 will provide complimentary catch data to supplement gill netting data.

Guadalupe Bass: Guadalupe Bass are present in low density in Buchanan Reservoir, based on historic catch rates generated by electrofishing surveys. As a riverine species, few anglers, if any, target them at this reservoir. No directed effort was identified in the 2011 creel survey. Sampling for this species will be limited in 2016 – 2020. We will monitor presence/absence while conducting electrofishing surveys for other species.

Survey objectives, fisheries metrics, and sampling objectives

Striped Bass: Temperate basses were the most sought species group by anglers in Buchanan Reservoir during the 2011 spring/summer creel survey, accounting for 61.0% of total directed effort (39.9% for White Bass, 20.0% for Striped Bass, 1.1% for stripers in general, and 0.0% for Sunshine Bass). Trend data on CPUE, size structure, and body condition have been collected annually for Striped Bass since 2006 with spring gill netting. Variation in RSE values can be attributed to random sampling and weak or missing year classes when Striped Bass aren't produced at hatcheries. Catch rates from previous sample years indicate that CPUE-stock RSE ≤ 30 is an achievable goal if the standard sampling effort is doubled (30 net nights). It is believed that RSE values of ≤ 30 can be achieved by conducting sampling at driven by stratified random sampling sites, determined from historical catch data. We reached our goal with fifteen stratified random gill netting stations in spring 2016, with an RSE-stock = 24. Collecting a minimum of 50 stock-length Striped Bass during winter/spring gill netting in 2018 and 2020 should allow us to calculate size structure indices with a 70% confidence interval. In addition to the original 15 stratified random stations, five additional stratified random stations will be pre-determined in the event extra sampling is necessary. If this approach does not achieve the goal; then we will consider increasing to 30 stratified random sites in following surveys.

Sunshine Bass: Sunshine Bass have been stocked into Buchanan Reservoir annually since 2006 by the LBCC under TPWD approval. Trend data on CPUE, size structure, and body condition have been collected biennially since 2008, when they first recruited to the gear, with spring gill netting. This species has flourished simultaneously with the Striped Bass fishery, losing its identity among anglers that refer to this historically-popular fishery as a "striper fishery." The 2011 creel survey failed to identify directed effort for Sunshine Bass because the species is considered no different than Striped Bass by anglers targeting both species equally. This is similar to what was described above for catfishes, where most anglers did not differentiate between the species.

Gill netting catch rates from previous sample years indicate that CPUE-stock RSE ≤ 30 is an achievable goal if the standard sampling effort is doubled (30 net nights). It is believed that RSE values of ≤ 30 can be achieved with stratified random sampling sites, determined from historical catch data. We reached our goal with fifteen stratified random gill netting stations in spring 2016, with an RSE-stock = 30. Collecting a minimum of 50 stock-length Sunshine Bass during winter/spring gill netting in 2018 and 2020 should allow us to calculate size structure indices with a 70% confidence interval. In addition to the original 15 stratified random stations, five additional stratified random stations will be pre-determined in the event extra sampling is necessary. If this approach does not achieve the goal; then we will consider increasing to 30 stratified random sites in following surveys.

White Bass: White Bass at Buchanan Reservoir offer one of the most popular White Bass fisheries in Texas. The spring run up through Colorado Bend State Park has been known as one of the top runs for generations. Loss of river-reservoir connectivity has had a crucial impact on these runs, leading to potentially weak year classes and a negative impact on the tremendous economic revenue the fishery brings to the local economy. This species was the most sought-after species at Buchanan Reservoir during spring 2011, accounting for 40% of the total directed effort. The environmental impact of the prolonged drought since 2011 has become a concern for the White Bass population at Buchanan Reservoir. A year-class strength evaluation was completed in spring 2016 using gill netting and electrofishing to assess how this species coped with the drought. Over 200 fish were collected and combined with a sample collected in 2014 to meet the required number (200-400 total) for an adequate confidence interval for relative recruitment estimates. While results revealed that White Bass reproduced successfully during lost river connectivity, year class recruitment can be highly variable. Fifteen stratified random gill netting stations were sampled in spring, 2016, revealing that a goal identical to the other *Morone* species was not achievable, with an RSE-stock = 53 (N = 80). We will still monitor presence/absence while conducting gill netting surveys for the other species. If Striped Bass and Sunshine Bass collection effort is increased to 30 nets, we will consider addressing the same goal for White Bass. A creel survey in 2018 – 2019 will also help reveal White Bass catch statistics that will compliment data from gill netting surveys.

Blue Catfish: Blue Catfish accounted for 3.2% of the total directed effort in the 2011 creel survey. Anglers at Buchanan Reservoir tend to be generalists when targeting catfishes and other species; identifying a directed effort for catfishes in general of 8.6% of the total directed effort in spring and summer 2011. Catfish in general are the fourth most sought-after fish by anglers in Buchanan Reservoir. Anecdotal reports of guides targeting trophy-size Blue Catfish for customers lead us to believe this species serves as an important attraction to this reservoir. Trend data on CPUE, size structure, and body condition have been collected annually since 2006 with spring gill netting. Gill netting catch rates from previous sample years indicated that CPUE-stock RSE ≤ 30 was achievable during standard sampling (15 net nights). It is believed that RSE values of ≤ 30 can be achieved using stratified random sampling sites, determined from historical catch data. We reached our goal with fifteen stratified random gill netting stations in spring 2016, with an RSE-stock = 24. Collecting a minimum of 50 stock-length Blue Catfish during winter/spring gill netting in 2018 and 2020 should allow us to calculate size structure indices with a 70% confidence interval. In addition to the original 15 stratified random stations, five additional stratified random stations will be pre-determined in the event extra sampling is necessary. If this approach does not achieve the goal; then we will consider increasing to 30 stratified random sites in following surveys.

Largemouth Bass: Black bass were the third most sought species group by anglers in Buchanan Reservoir during the 2011 creel survey (10.4% of the total directed effort) behind White Bass and Striped Bass. While Largemouth Bass doesn't rank most popular in Buchanan Reservoir, like in most Texas reservoirs, it still provides important fishing opportunities. Tournament anglers do compete on this

reservoir, and regularly, trophy-size specimens are reported caught by anglers. Trend data on CPUE, size structure, and body condition have been collected every four years since 1999 with fall nighttime electrofishing, except for 2011 (daytime sample collected for safety reasons under drought conditions).

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 stock-size Largemouth Bass since 1999 (except in 2011) were sufficient to meet minimal requirements in 24 stations, which should result in a mean weighted CV of 0.25 or less. A minimum of 24 randomly selected 5-min electrofishing sites will be sampled in fall 2019 to collect a minimum of 50 stock-size fish, with an RSE of CPUE-stock ≤ 25. If failure to achieve either objective has occurred after one night of sampling and objectives can be attained with up to 12 additional random stations, another night of effort will be expended.

Gizzard Shad, Threadfin Shad, and sunfishes: Gizzard Shad, Threadfin Shad, Redbreast Sunfish, and Bluegill are the primary forage at Buchanan Reservoir. Like Largemouth Bass, trend data on CPUE and size structure of these sunfish have been collected every four years since 1999. Abundance of Threadfin Shad was also measured as a function of CPUE during those surveys, and will remain the main sampling objective to measure Threadfin Shad abundance. Continuation of sampling, as per Largemouth Bass above, will allow for monitoring of large-scale changes in forage relative abundance and size structure. Sampling effort based on achieving sampling objectives for Largemouth Bass will result in sufficient numbers of sunfish and shad for size structure estimation (PSD and IOV; 50 fish minimum at 5-12 stations with 80% confidence) but not for relative abundance estimates (RSE ≤ 25 of CPUE-Total (CPUE-T); anticipated effort is 25-30 stations). At the sampling effort needed to achieve sampling objectives for Largemouth Bass, the expected RSE for CPUE-T is 25 for sunfish species combined. No additional effort will be expended to achieve an RSE-25 for CPUE of sunfish. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density. Relative weight of Largemouth Bass ≥ 8” TL will be determined from their length/weight data (maximum of 10 fish weighed and measured per inch class).

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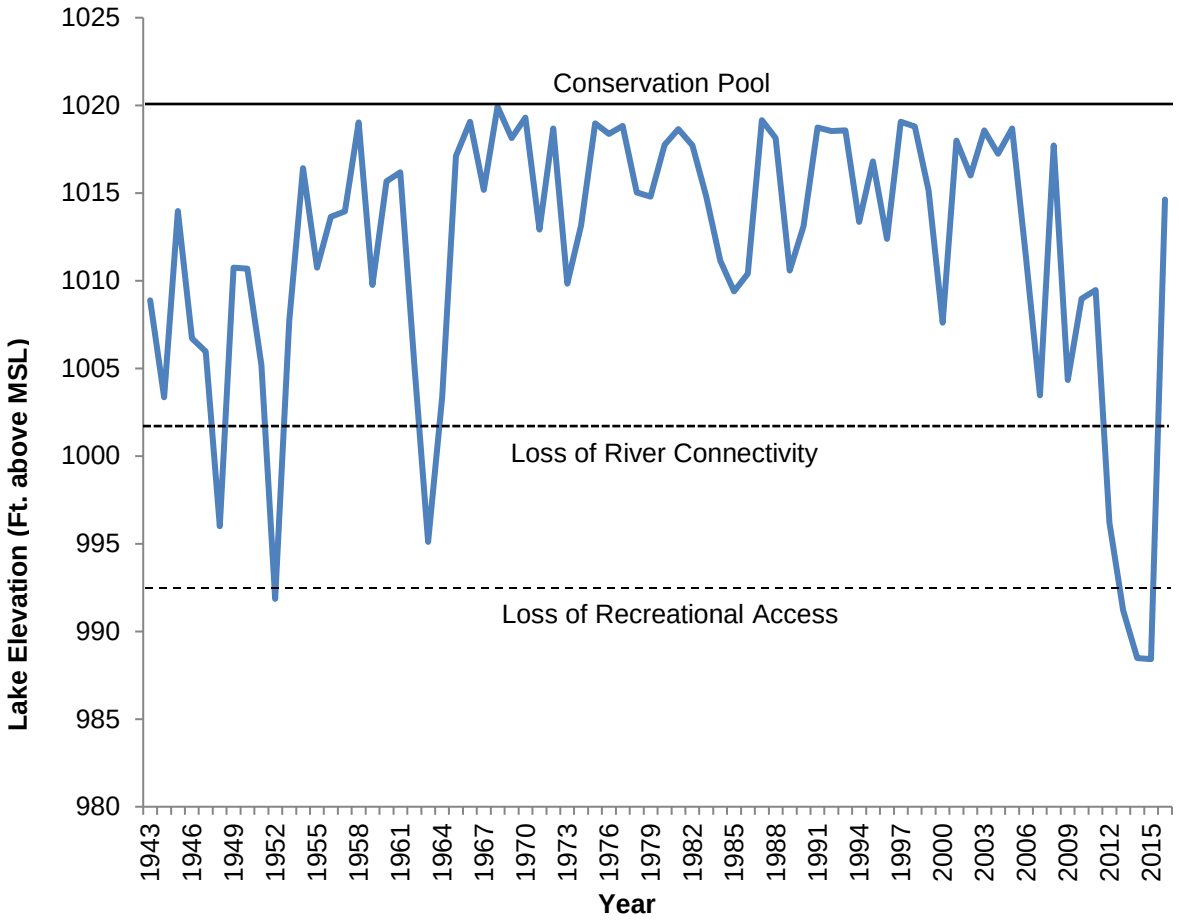


Figure 1. Mean spring (March – May) water level elevations in feet above mean sea level (msl) recorded for Buchanan Reservoir, Texas from 1943 to 2016. Solid line is elevation when full (1020 msl). Other line indicate the elevation of when there is a loss of river-reservoir connectivity (1002 feet above msl) and loss of recreational access (993 feet above msl).

Table 1. Characteristics of Buchanan Reservoir, Texas

Characteristic	Description
Year constructed	1937
Controlling authority	LCRA
Counties	Burnet and Llano
Reservoir type	Mainstem river system: Colorado
Shoreline development index (SDI)	5.8
Conductivity	397.9 µS/cm

Table 2. Boat ramp characteristics for Buchanan Reservoir, Texas, August, 2015. Reservoir elevation at time of survey was 1007 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft.)	Condition
Buchanan Dam	30.76817 -98.40778	N	10	1004	Good. Open.
Thunderbird Lodge	30.83896 -98.34208	N	10	1000	Good. Open.
Burnet County Park	30.84754 -98.38997	Y	15	993	Good. Open. Extended in 2012.
Painted Sky Inn	30.86093 -98.4167	N	10	1000	Fair. Closed.
Colorado Bend SP	31.01818 -98.44657	Y	10	Unknown	Unimproved.
Cedar Point	30.86858 -98.45183	Y	10	1007	Fair. Closed.
Llano County	30.76668 -98.45122	Y	30	1006	Good. Open.
Edgewater	30.75578 -98.45309	N	12	Unknown	Good. Open
Shaw Island	30.83342 -98.42693	Y	N/A	994	Good. Emergency low-water access only. Built in 2013.

Table 3. 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 4. Stocking history of Buchanan Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), fry/fingerling mix (MIX), 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
	2012	74,637	AFGL	5.7
	Total	136,047		
Florida Largemouth Bass	1978	32,000	FGL	2.0
	1978	318,400	FRY	0.9
	2008	507,165	FGL	1.8
	2015	132,914	FGL	1.6
	2015	40,656	FRY	0.3
	Total	1,031,135		
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

Species	Year	Number	Life Stage	Mean TL (in)
	1999	239,870	FGL	1.4
	2000	235,733	FGL	1.6
	2002	580,900	FGL	1.4
	2003	137,472	FGL	1.5
	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
	2013	224,619	FGL	1.4
	2014	294,763	FGL	1.4
	2015	119,920	FGL	1.8
	2016	93,816	FGL	1.7
	Total	12,501,658		
Sunshine Bass (White Bass x Striped Bass hybrid)	2006	500,000	FRY	0.2
	2007	128,400	FGL	5.4
	2008	706,971	MIX	0.8
	2009	2,605,948	MIX	0.3
	2010	1,310,000	MIX	0.4
	2011	85,000	FGL	2.0
	2012	75,000	FGL	2.2
	2013	1,235,600	MIX	0.4
	2014	1,035,172	MIX	0.4
	2015	1,000,000	FRY	0.2
	2016	1,000,000	FRY	0.2
	Total	9,682,091		
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 5. Objective-based sampling plan components for Buchanan Reservoir, Texas 2015 – 2016.

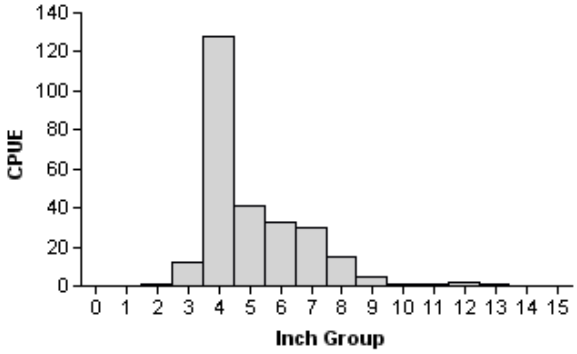
Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	Abundance	CPUE – stock	RSE-stock ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Age-and-growth	Age at 14 inches	N = 13, 13.0 – 14.9 inches
	Condition	W_r	10 fish/inch group (max)
	Genetics	% FLMB	N = 30, any age
Bluegill [a]	Abundance	CPUE – total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
Gizzard Shad [a]	Abundance	CPUE – total	RSE ≤ 25
	Size structure	Length frequency	N ≥ 50
	Prey availability	IOV	N ≥ 50
Gill netting			
Striped Bass	Abundance	CPUE – stock	RSE-stock ≤ 30
	Size structure	Length frequency	N ≥ 50 stock
	Age and growth	Age at 18 inches	N = all fish sampled
	Condition	W_r	10 fish/inch group (max)
Sunshine Bass	Abundance	CPUE - stock	RSE-stock ≤ 30
	Size structure	Length frequency	N ≥ 50 stock
	Age and growth	Age at 18 inches	N = all fish sampled
	Condition	W_r	10 fish/inch group (max)
White Bass	Abundance	CPUE - stock	RSE-stock ≤ 30
	Size structure	Length frequency	N ≥ 50 stock
	Age and growth	Year-class strength	N = 200 (size classes)
	Condition	W_r	10 fish/inch group (max)
Blue Catfish	Abundance	CPUE - stock	RSE-stock ≤ 30
	Size structure	Length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)

[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE and N ≥ 50 for Bluegill and Gizzard Shad if not reached from designated Largemouth Bass sampling effort. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density.

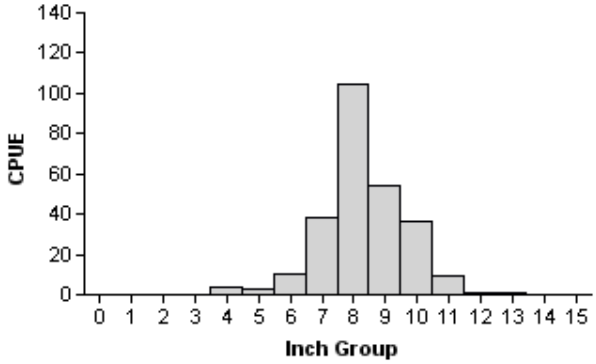
Table 6. Survey of structural habitat types, Buchanan Reservoir, Texas, 2015. Shoreline habitat type units are in miles.

Habitat type	Estimate	% of total
Natural shoreline	58.1 miles	72.0
Rocky shoreline	7.1 miles	8.9
Rocky bluff	1.2 miles	1.5
Bulkhead	1.7 miles	2.1
Natural shoreline w/ piers	4.0 miles	5.0
Rocky shoreline w/ piers	5.4 miles	6.7
Rocky bluff w/ piers	3.1 miles	3.8

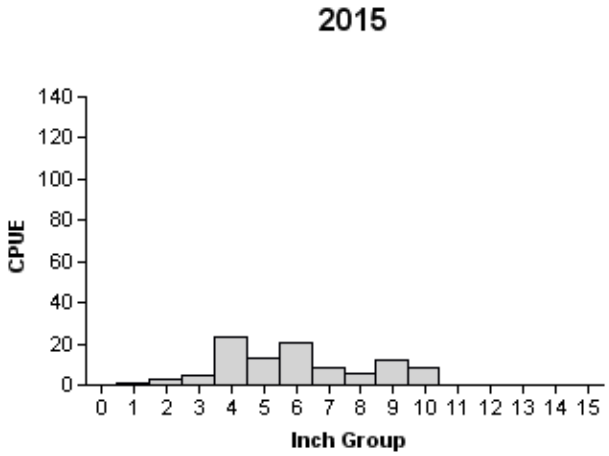
Gizzard Shad



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



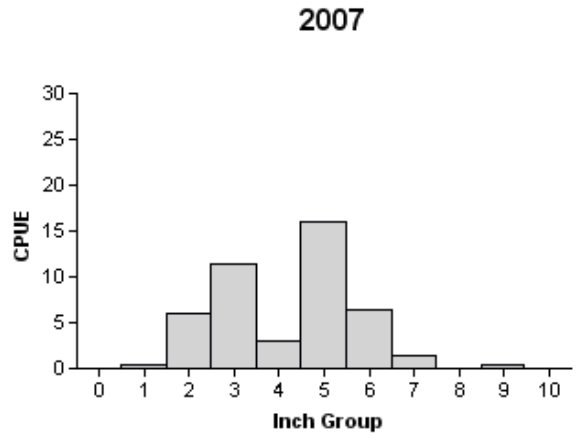
Effort =	1.5
Total CPUE =	261.3 (21; 392)
IOV =	21 (5.8)



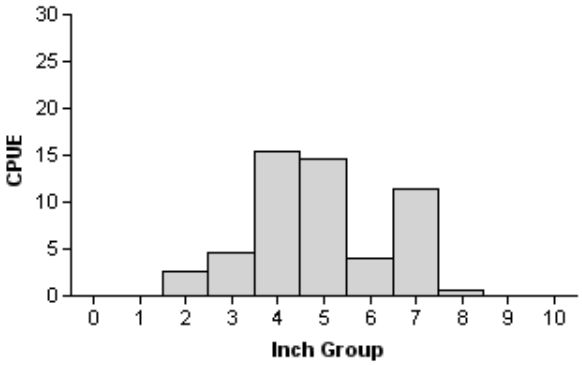
Effort =	2.0
Total CPUE =	101.0 (28; 202)
IOV =	73 (11)

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, 2007, 2011 and 2015. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

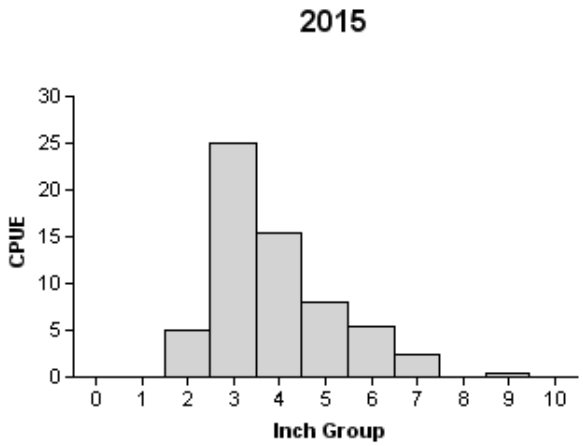
Redbreast Sunfish



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



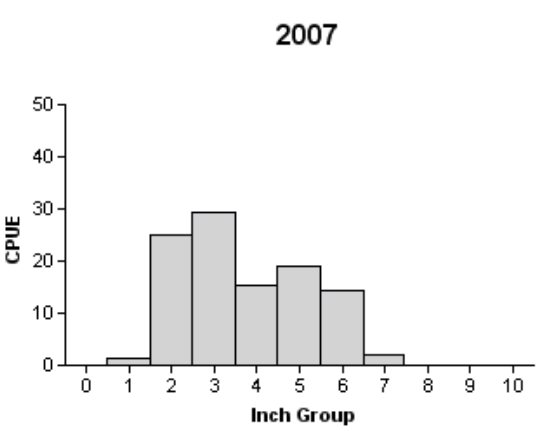
Effort =	1.5
Total CPUE =	53.3 (38; 80)
PSD =	32 (13.9)



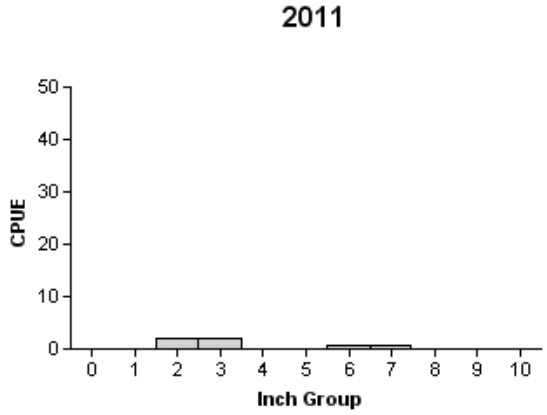
Effort =	2.0
Total CPUE =	62.0 (37; 124)
PSD =	15 (4)

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, 2007, 2011 and 2015. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

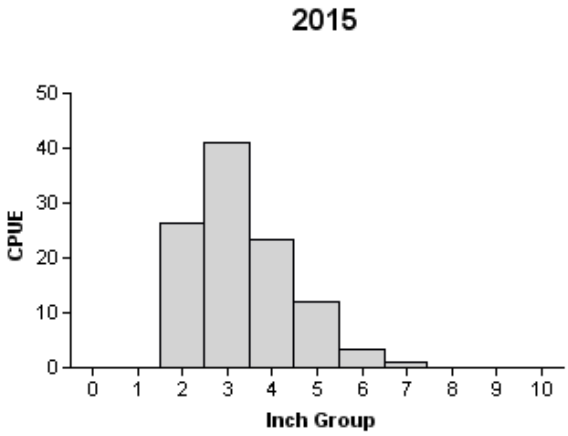
Bluegill



Effort = 2.0
Total CPUE = 107.0 (18; 214)
PSD = 20 (5)



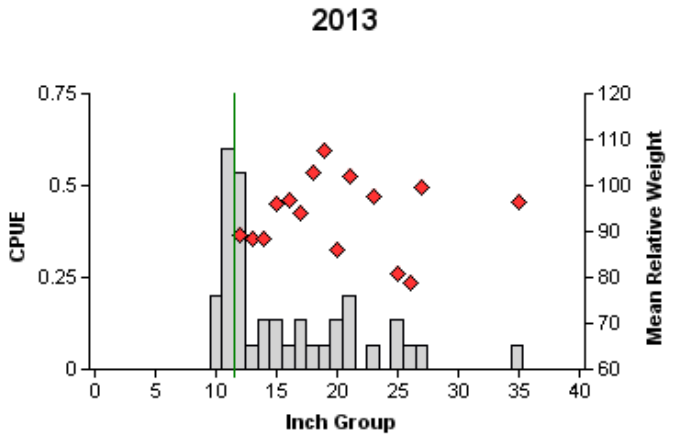
Effort = 1.5
Total CPUE = 5.3 (45; 8)
PSD = 40 (17)



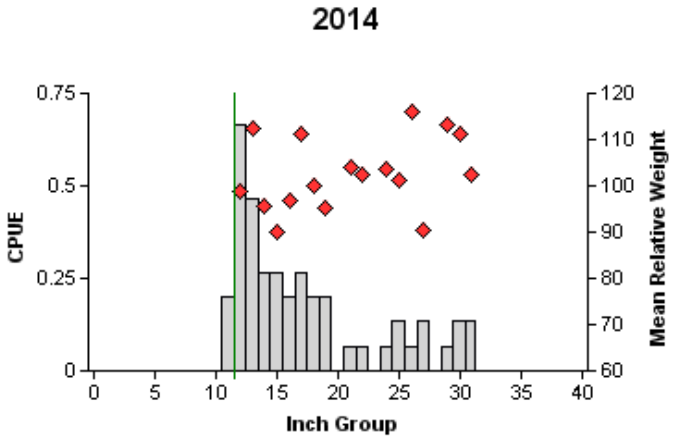
Effort = 2.0
Total CPUE = 107.5 (19; 215)
PSD = 6 (2)

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, 2007, 2011 and 2015. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

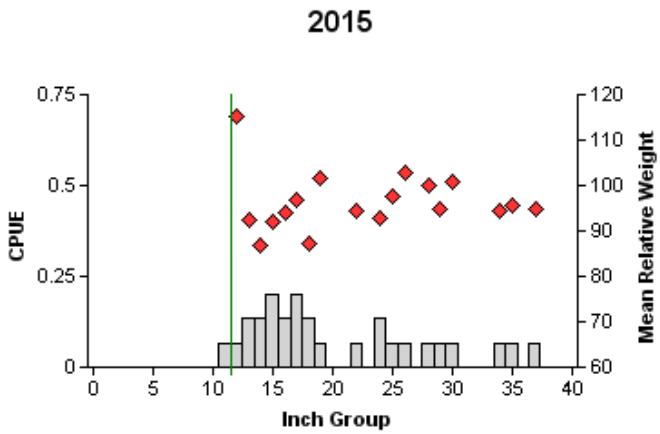
Blue Catfish



Effort =	15.0
Total CPUE =	2.7 (27; 41)
Stock CPUE =	1.9 (29; 29)
CPUE-12=	1.9 (29; 29)



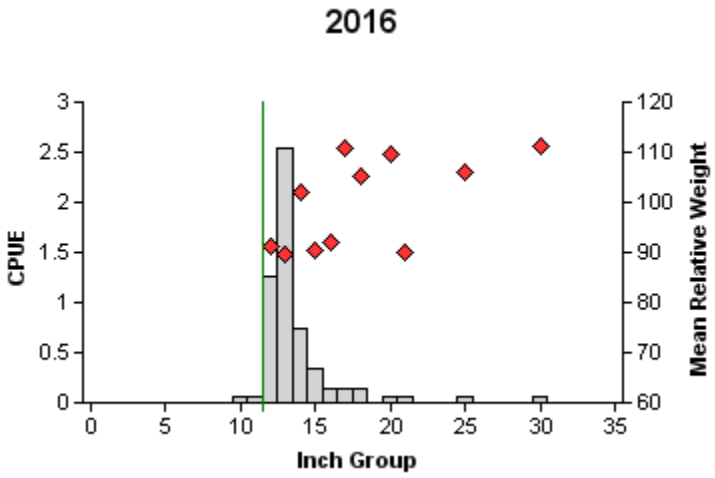
Effort =	15.0
Total CPUE =	3.6 (27; 54)
Stock CPUE =	3.4 (23; 51)
CPUE-12=	3.4 (23; 51)



Effort =	15.0
Total CPUE =	1.9 (23; 28)
Stock CPUE =	1.8 (24; 27)
CPUE-12=	1.8 (24; 27)

Figure 5. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2013, 2014 and 2015. Minimum length limit indicated by vertical line.

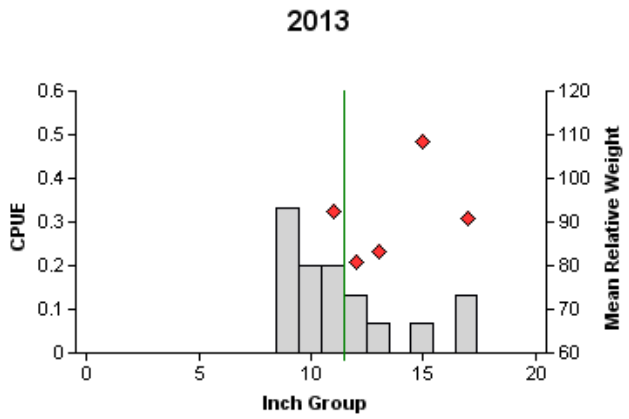
Blue Catfish



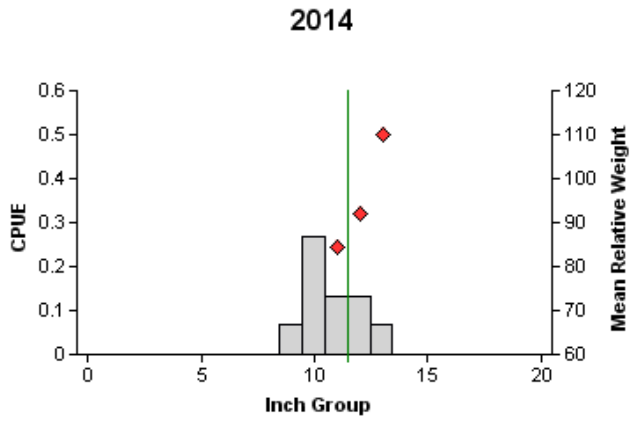
Effort =	15.0
Total CPUE =	5.7 (24; 85)
Stock CPUE =	5.5 (24; 83)
CPUE-12=	5.5 (24; 83)

Figure 6. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for a randomly stratified spring gill net survey, Buchanan Reservoir, Texas, 2016. Minimum length limit indicated by vertical line.

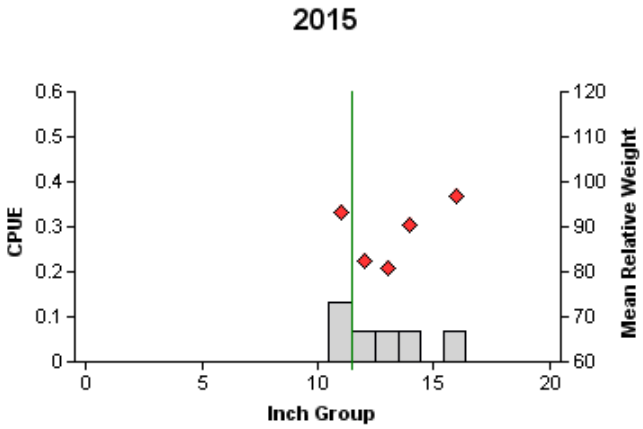
Channel Catfish



Effort =	15.0
Total CPUE =	1.1 (30; 17)
Stock CPUE =	0.6 (27; 9)
CPUE-12=	0.4 (33; 6)



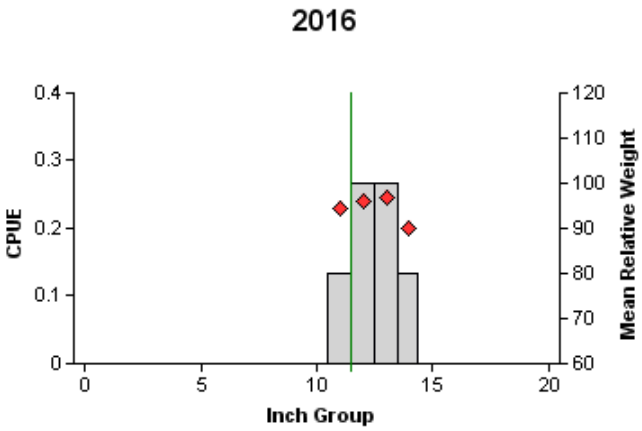
Effort =	15.0
Total CPUE =	0.7 (32; 10)
Stock CPUE =	0.3 (41; 5)
CPUE-12=	0.2 (53; 3)



Effort =	15.0
Total CPUE =	0.4 (48; 6)
Stock CPUE =	0.4 (48; 6)
CPUE-12=	0.3 (57; 4)

Figure 7. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2013, 2014 and 2015. Vertical line represents minimum length limit at the time of sampling.

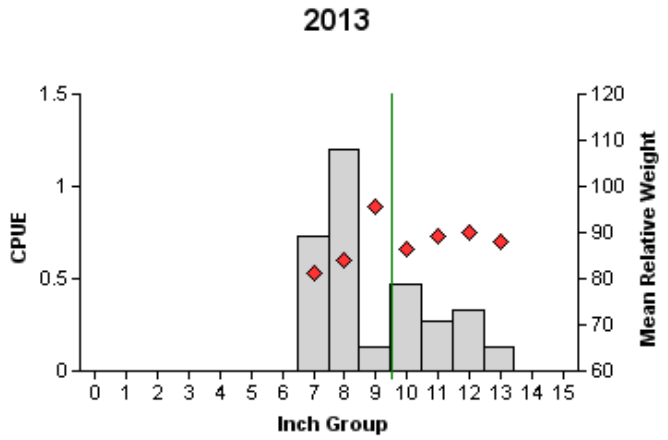
Channel Catfish



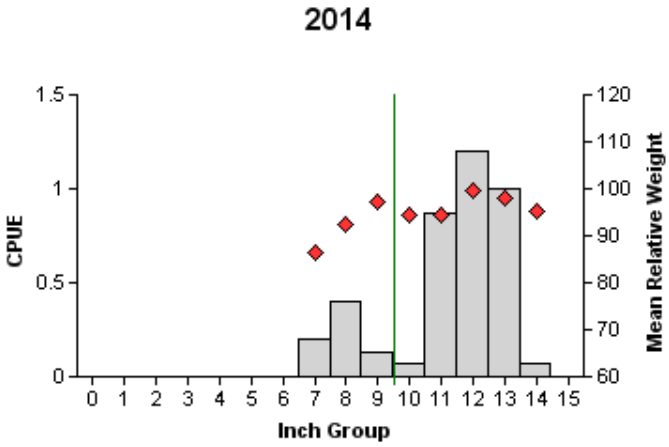
Effort =	15.0
Total CPUE =	0.8 (33; 12)
Stock CPUE =	0.8 (33; 12)
CPUE-12=	0.7 (32; 10)

Figure 8. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for a randomly stratified spring gill net survey, Buchanan Reservoir, Texas, 2016. Vertical line represents minimum length limit at the time of sampling.

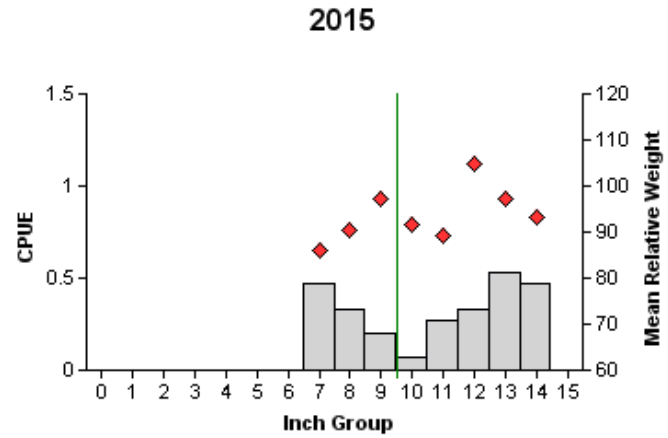
White Bass



Effort =	15.0
Total CPUE =	3.3 (30; 49)
Stock CPUE =	3.3 (30; 49)
CPUE-10 =	1.2 (42; 18)



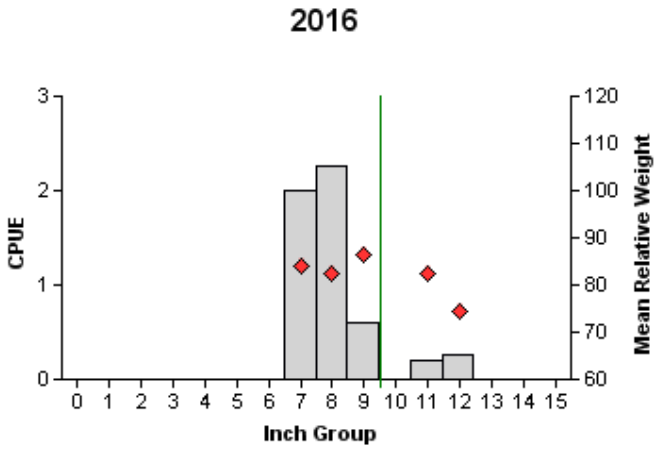
Effort =	15.0
Total CPUE =	3.9 (34; 59)
Stock CPUE =	3.9 (34; 59)
CPUE-10 =	3.2 (40; 48



Effort =	15.0
Total CPUE =	2.7 (43; 40)
Stock CPUE =	2.7 (43; 40)
CPUE-10 =	1.7 (55; 25)

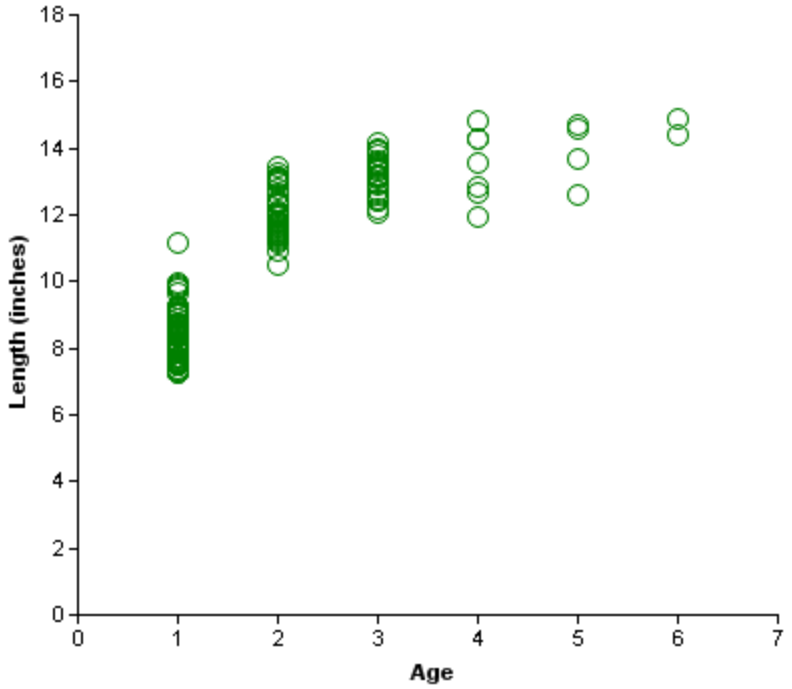
Figure 9. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2013, 2014 and 2015. Vertical line represents minimum length limit at the time of sampling.

White Bass



Effort =	15.0
Total CPUE =	5.3 (52; 80)
Stock CPUE =	5.3 (52; 80)
CPUE-10 =	0.5 (46; 7)

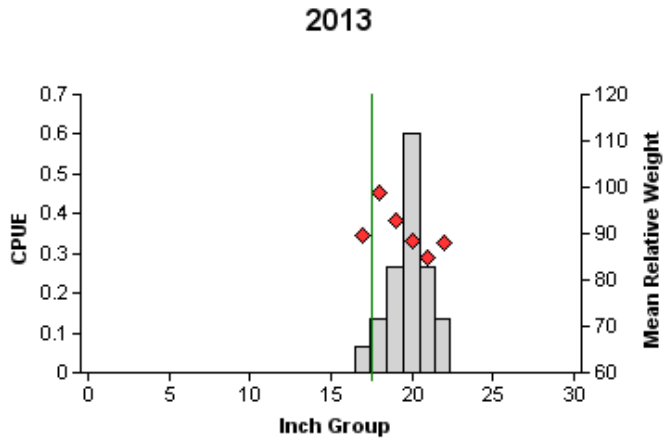
Figure 10. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for a randomly stratified spring gill net survey, Buchanan Reservoir, Texas, 2016. Vertical line represents minimum length limit at the time of sampling.



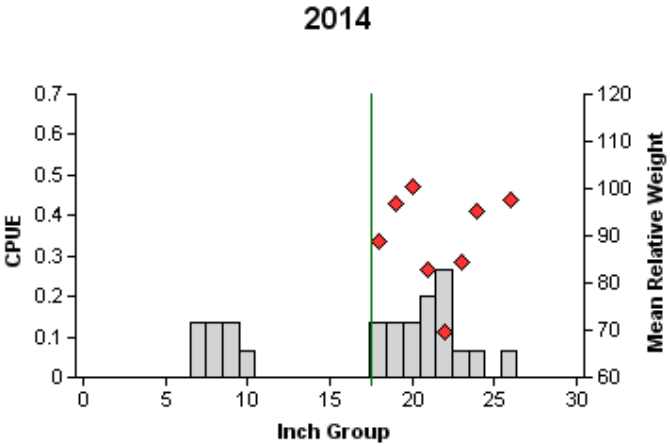
Total Length	Survey Year	Age	Number of Fish
8.317823	2014	1	11
12.080989	2014	2	28
12.942912	2014	3	16
13.503936	2014	4	3
13.700787	2014	5	1
8.191600	2015	1	15
11.907261	2015	2	9
13.735235	2015	3	8
13.976377	2015	4	3
13.950131	2015	5	3
14.625983	2015	6	2
8.429828	2016	1	51
12.234251	2016	2	4
12.480314	2016	3	1
11.929133	2016	4	1

Figure 11. Mean length at age for White Bass collected by gill nets at Buchanan Reservoir, Texas, February, 2014 – 2016 (N = 158). Mean length at age by survey year displayed in the table below graph.

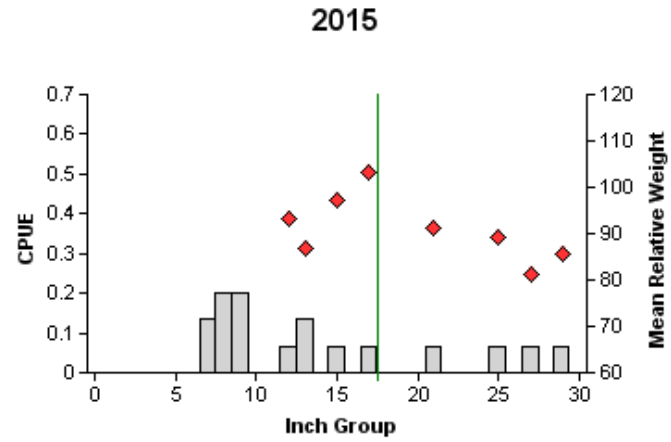
Striped Bass



Effort =	15.0
Total CPUE =	1.5 (40; 22)
Stock CPUE =	1.5 (40; 22)
CPUE-18 =	1.4 (42; 21)



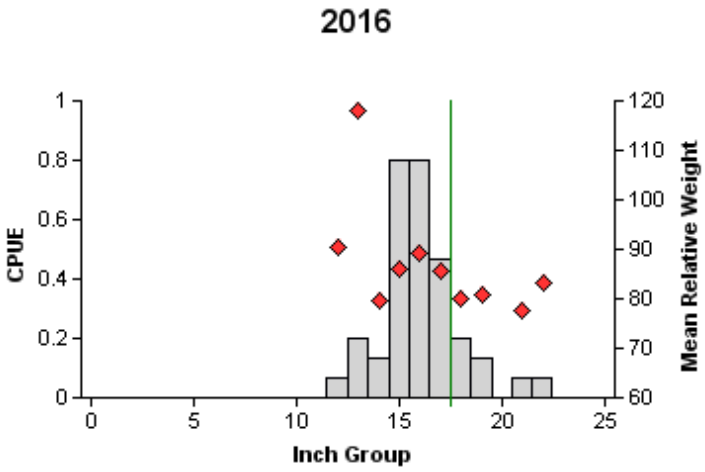
Effort =	15.0
Total CPUE =	1.5 (28; 23)
Stock CPUE =	1.1 (28; 16)
CPUE-18 =	1.1 (28; 16)



Effort =	15.0
Total CPUE =	1.1 (31; 17)
Stock CPUE =	0.6 (42; 9)
CPUE-18 =	0.3 (77; 4)

Figure 12. Number of Striped Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2013, 2014, and 2015. Minimum length limit indicated by vertical line.

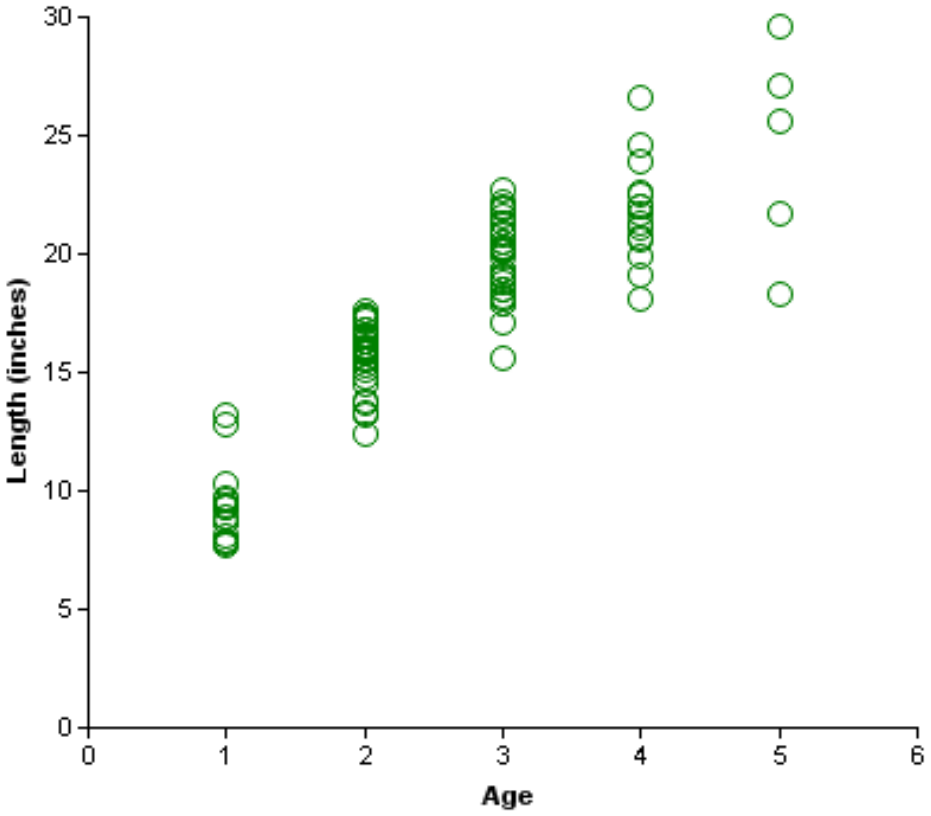
Striped Bass



Effort =	15.0
Total CPUE =	2.9 (24; 44)
Stock CPUE =	2.9 (24; 44)
CPUE-18 =	0.5 (35; 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 are in parentheses) for a randomly stratified spring gill net survey, Buchanan Reservoir, Texas, 2016. Minimum length limit indicated by vertical line.

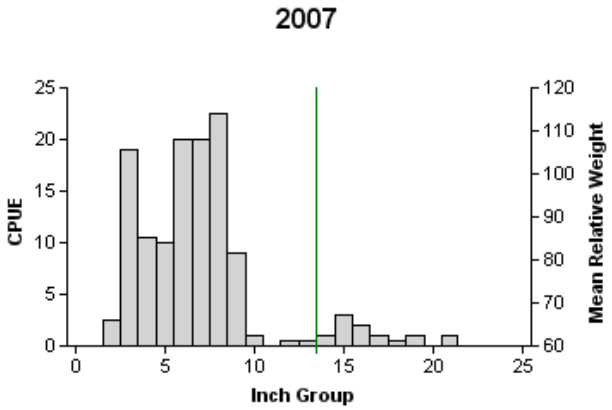
Striped Bass



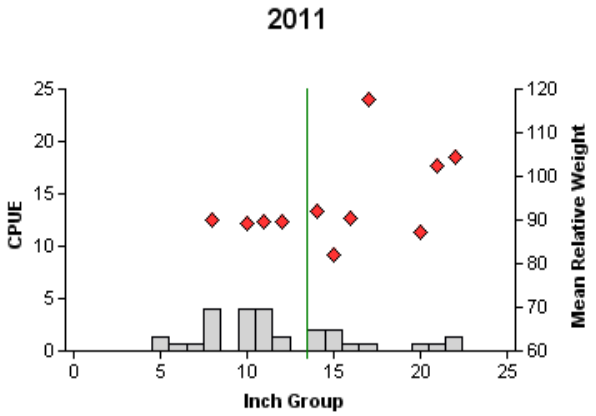
Mean Length	Survey Year	Age	Number of Fish
20.322118	2013	3	22
8.948256	2014	1	7
21.787401	2014	4	15
18.307086	2014	5	1
8.671259	2015	1	8
14.417322	2015	2	5
26.003936	2015	5	4
13.011810	2016	1	2
16.034694	2016	2	32
18.795275	2016	3	10

Figure 14. Mean length at age for Striped Bass collected by gill nets at Buchanan Reservoir, Texas, 2013 – 2016 (N = 106). Mean length at age by survey year displayed in the table below graph.

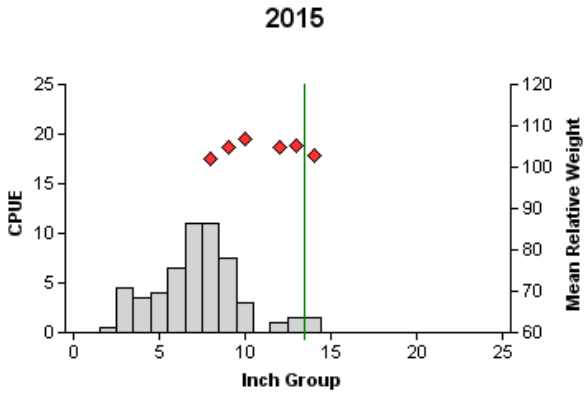
Largemouth Bass



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 (5)

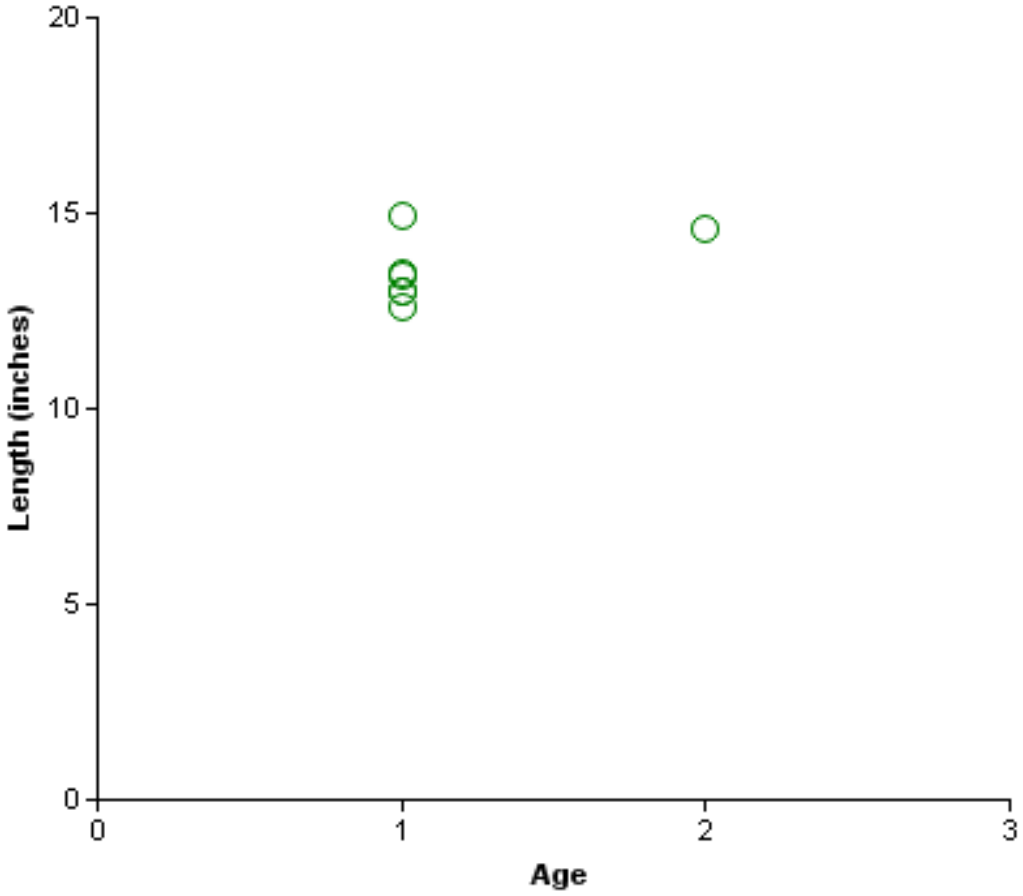


Effort =	1.5
Total CPUE =	24.0 (27; 36)
Stock CPUE =	21.3 (27; 32)
CPUE-14 =	8.0 (45; 12)
PSD =	44 (13)
PSD-14 =	38 (13)



Effort =	2.0
Total CPUE =	55.5 (15; 111)
Stock CPUE =	25.5 (23; 51)
CPUE-14 =	1.5 (55; 3)
PSD =	16 (5)
PSD-14 =	6 (3)

Figure 15. 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, Buchanan Reservoir, Texas, 2007, 2011 and 2015. Minimum length limit indicated by vertical line. No weight data were collected in 2007. Daytime reduced-effort electrofishing conducted in 2011 due to hazardous lake conditions.



Mean Length	Survey Year	Age	Number of Fish
13.405511	2015	1	6
14.606299	2015	2	1

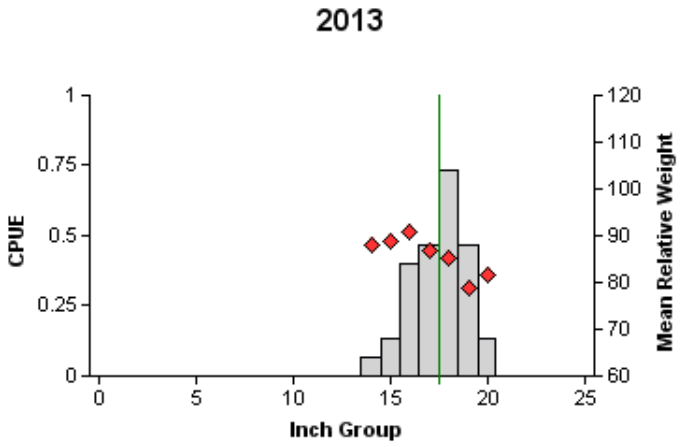
Figure 16. Length at age for Largemouth Bass collected during electrofishing at Buchanan Reservoir, Texas, October 2015 (N = 7). Mean length at age by survey year displayed in the table below graph.

Largemouth Bass

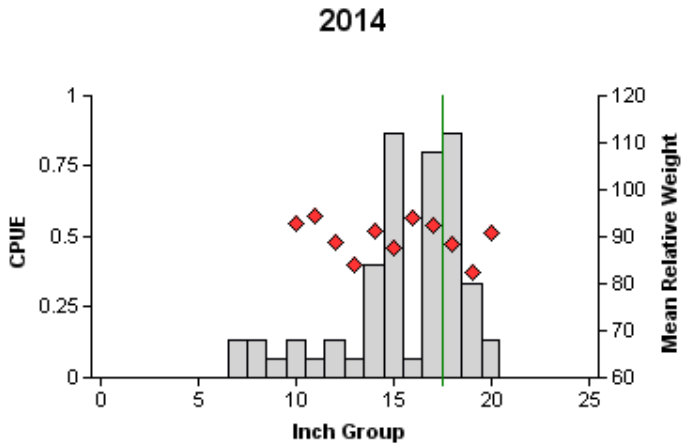
Table 7. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Buchanan Reservoir, Texas, 2003, 2007, and 2015. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined by electrophoresis prior to 2005 and with micro-satellite DNA analysis since 2005.

		Number of fish				
Year	Sample size	FLMB	Intergrade	NLMB	% FLMB alleles	% FLMB
2003	30	4	25	1	57.0	13.3
2007	30	3	26	1	63.0	10.0
2015	30	3	26	1	67.0	10.0

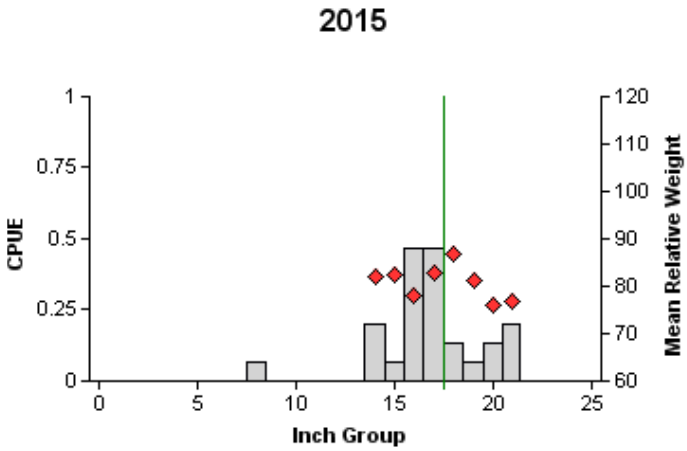
Sunshine Bass



Effort = 15.0
Total CPUE = 2.4 (20; 36)
Stock CPUE = 2.4 (20; 36)
CPUE-18 = 1.4 (24; 21)



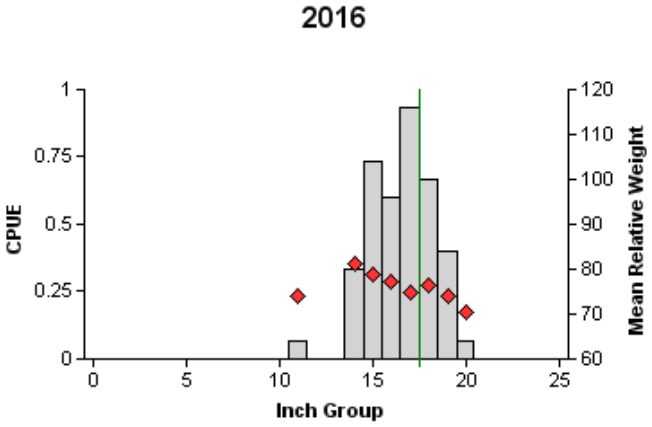
Effort = 15.0
Total CPUE = 4.2 (29; 63)
Stock CPUE = 3.9 (31; 58)
CPUE-18 = 1.3 (36; 20)



Effort = 15.0
Total CPUE = 1.8 (30; 27)
Stock CPUE = 1.7 (32; 26)
CPUE-18 = 0.5 (44; 8)

Figure 17. Number of Sunshine Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2013, 2014, and 2015. Vertical line represents minimum length limit at the time of sampling.

Sunshine Bass



Effort =	15.0
Total CPUE =	3.8 (30; 57)
Stock CPUE =	3.8 (30; 57)
CPUE-18 =	1.2 (34; 18)

Figure 18. Number of Sunshine Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE are in parentheses) for a randomly stratified spring gill net survey, Buchanan Reservoir, Texas, 2016. Vertical line represents minimum length limit at the time of sampling.

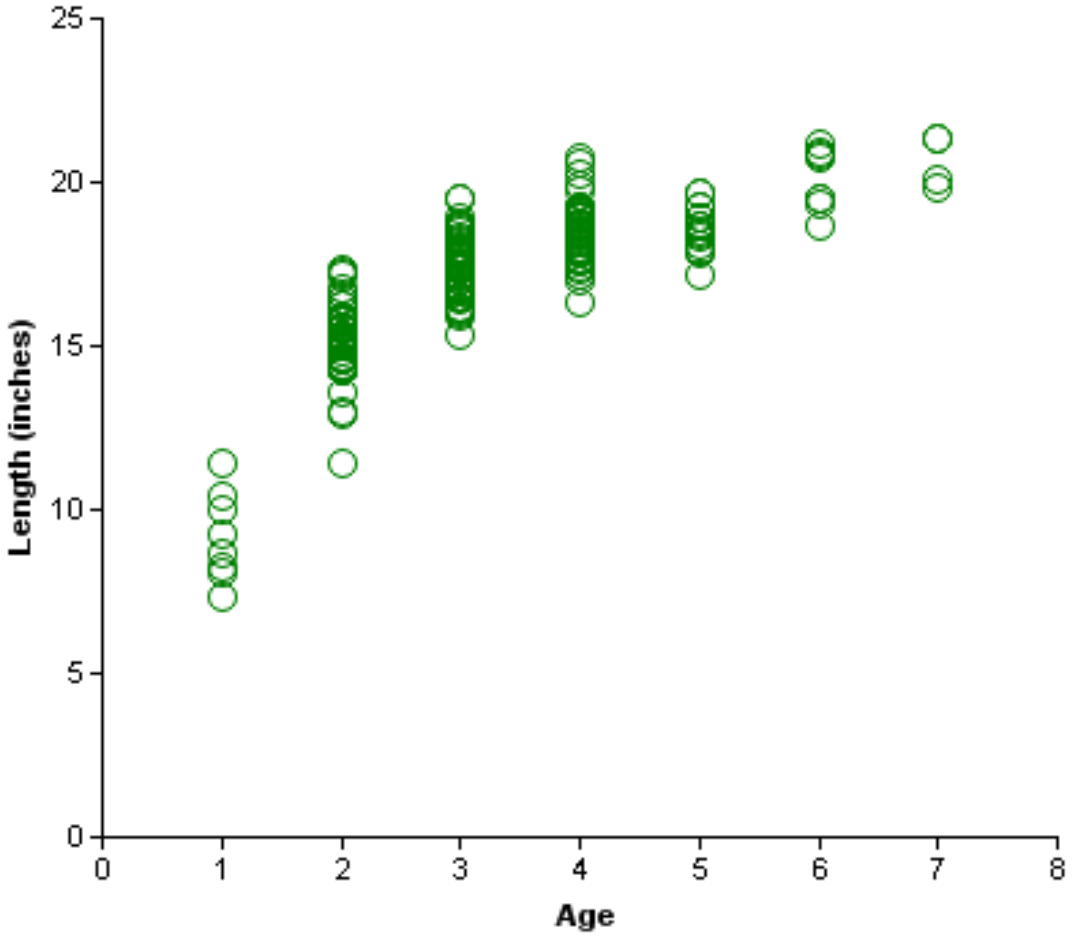


Figure 19. Mean length at age for Sunshine Bass collected by gill nets at Buchanan Reservoir, Texas, 2013 – 2016 (N = 182). Mean length at age by survey year displayed in the table (next page).

Mean Length	Survey Year	Age	Number of Fish
15.850393	2013	2	5
17.519684	2013	3	6
18.468145	2013	4	22
19.619422	2013	6	3
8.956692	2014	1	6
14.714138	2014	2	23
17.692913	2014	3	10
18.554555	2014	4	7
18.602361	2014	5	14
20.196849	2014	6	2
8.267716	2015	1	1
15.086613	2015	2	5
17.097862	2015	3	14
18.622047	2015	4	1
20.446193	2015	6	3
20.905511	2015	7	3
11.417322	2016	1	1
15.529308	2016	2	18
17.322834	2016	3	22
18.594790	2016	4	13
18.405511	2016	5	2
19.803149	2016	7	1

Figure 19 (Continued). Mean length at age for Sunshine Bass by survey year at Buchanan Reservoir, Texas, 2013 – 2016 (N = 182).

Table 8. Proposed sampling schedule for Buchanan Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

Survey year	Electrofish Fall(Spring)	Trap net	Gill net	Habitat		Access	Creel survey	Report
				Structural	Vegetation			
2016-2017								
2017-2018			A					
2018-2019							S	
2019-2020	S		S	S	S	S		S

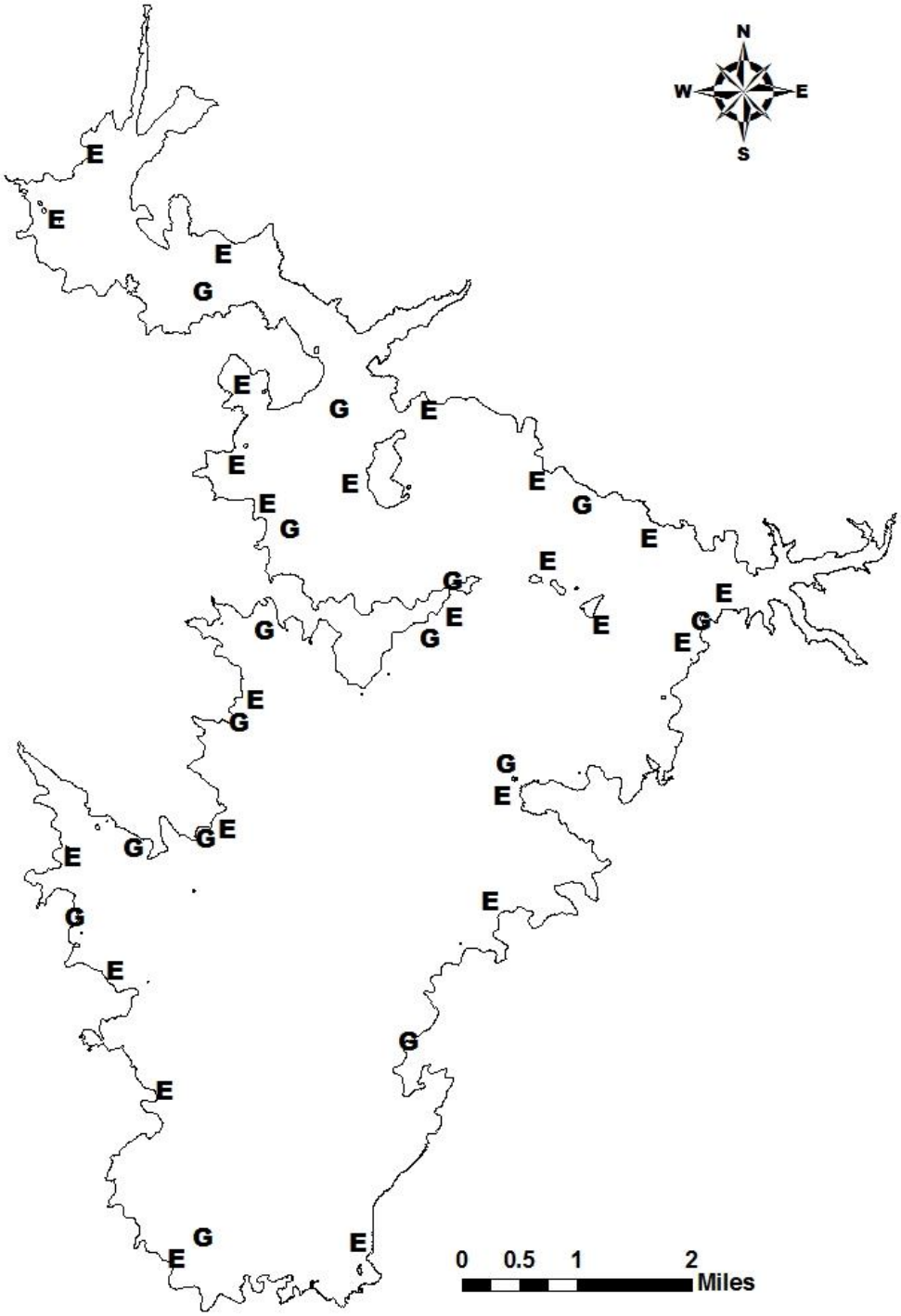
APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected by electrofishing in October 2015 and gill netting in February 2016 from Buchanan Reservoir, Texas. Sampling effort was 15 net nights for gill netting and 2 hours for electrofishing.

	Gill Netting		Electrofishing	
Species	N	CPUE	N	CPUE
Gizzard Shad			202	101.0
Threadfin Shad			236	118.0
Inland Silverside			13	6.5
Blue Catfish	85	5.7		
Channel Catfish	12	0.8		
Flathead Catfish	5	0.3		
White Bass	80	5.3		
Striped Bass	44	2.9		
Redbreast Sunfish			124	62.0
Green Sunfish			10	5.0
Warmouth			1	0.5
Bluegill			215	107.5
Longear Sunfish			49	24.5
Redear Sunfish			2	1.0
Largemouth Bass			111	55.5
Guadalupe Bass			19	9.5
Freshwater Drum			3	1.5
Sunshine Bass (White Bass x Striped Bass hybrid)	57	3.8		

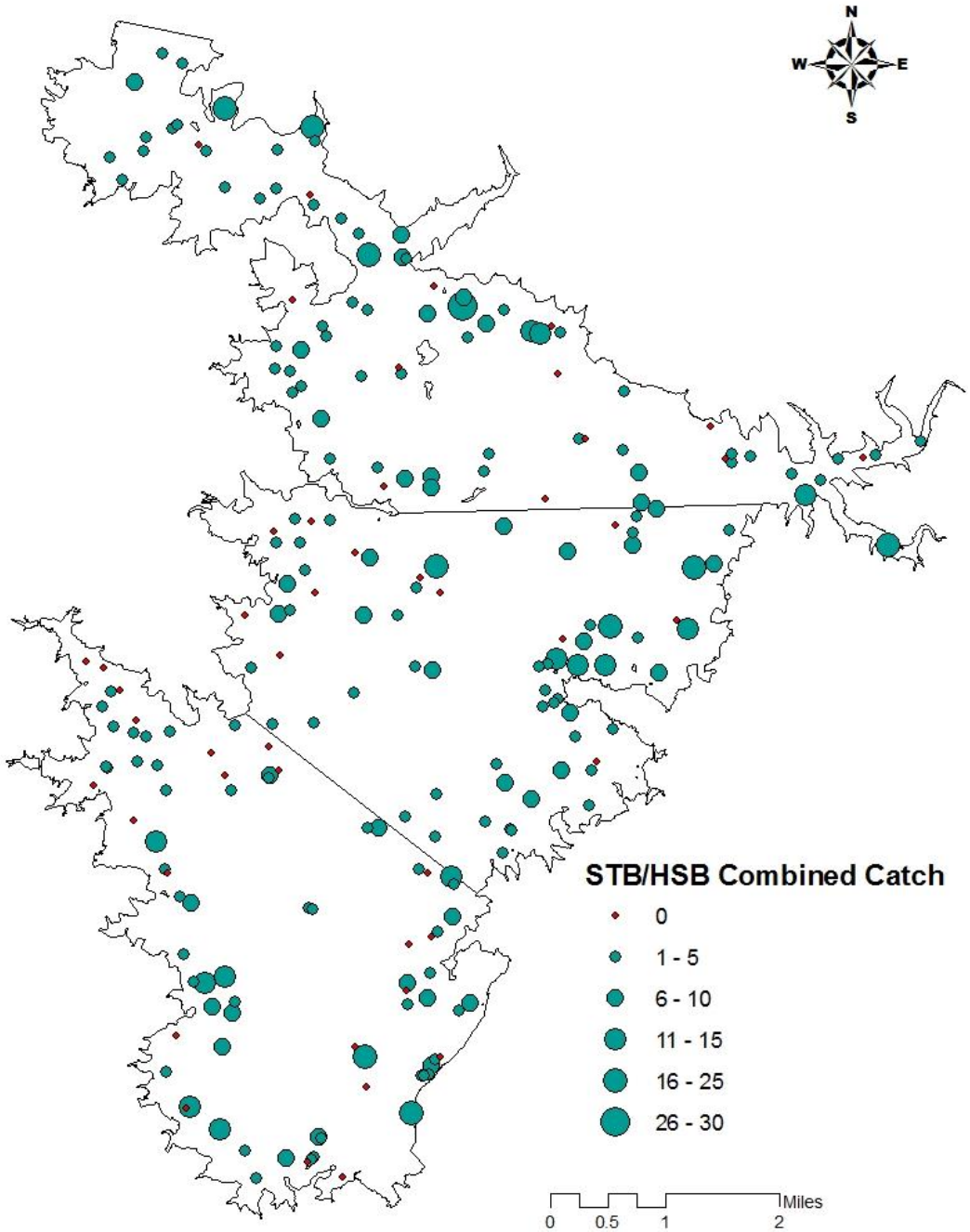
APPENDIX B

Location of sampling sites, Buchanan Reservoir, Texas, 2015-2016. Gill netting and electrofishing stations indicated by G and E, respectively.



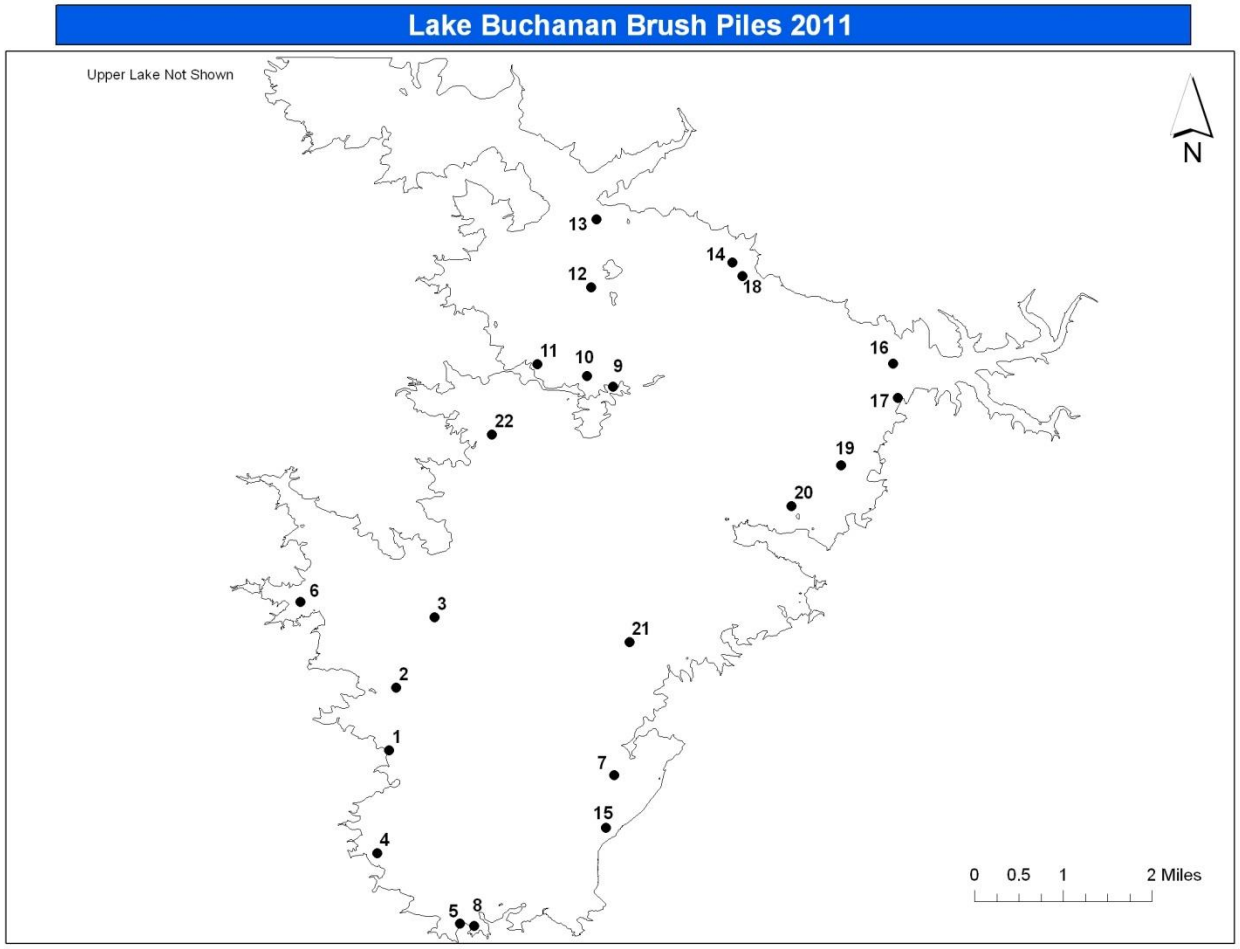
APPENDIX C

Historic catch frequencies of Striped Bass and Sunshine Bass (combined) from standardized gill netting surveys at Buchanan Reservoir, Texas from 2006 to 2015. The reservoir was stratified into upper, mid, and lower (transecting lines) for determination of site frequencies during stratified random gill netting survey in spring 2016. Resulting breakdown was five upper, five mid, and five lower sets of gill nets.



APPENDIX D

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



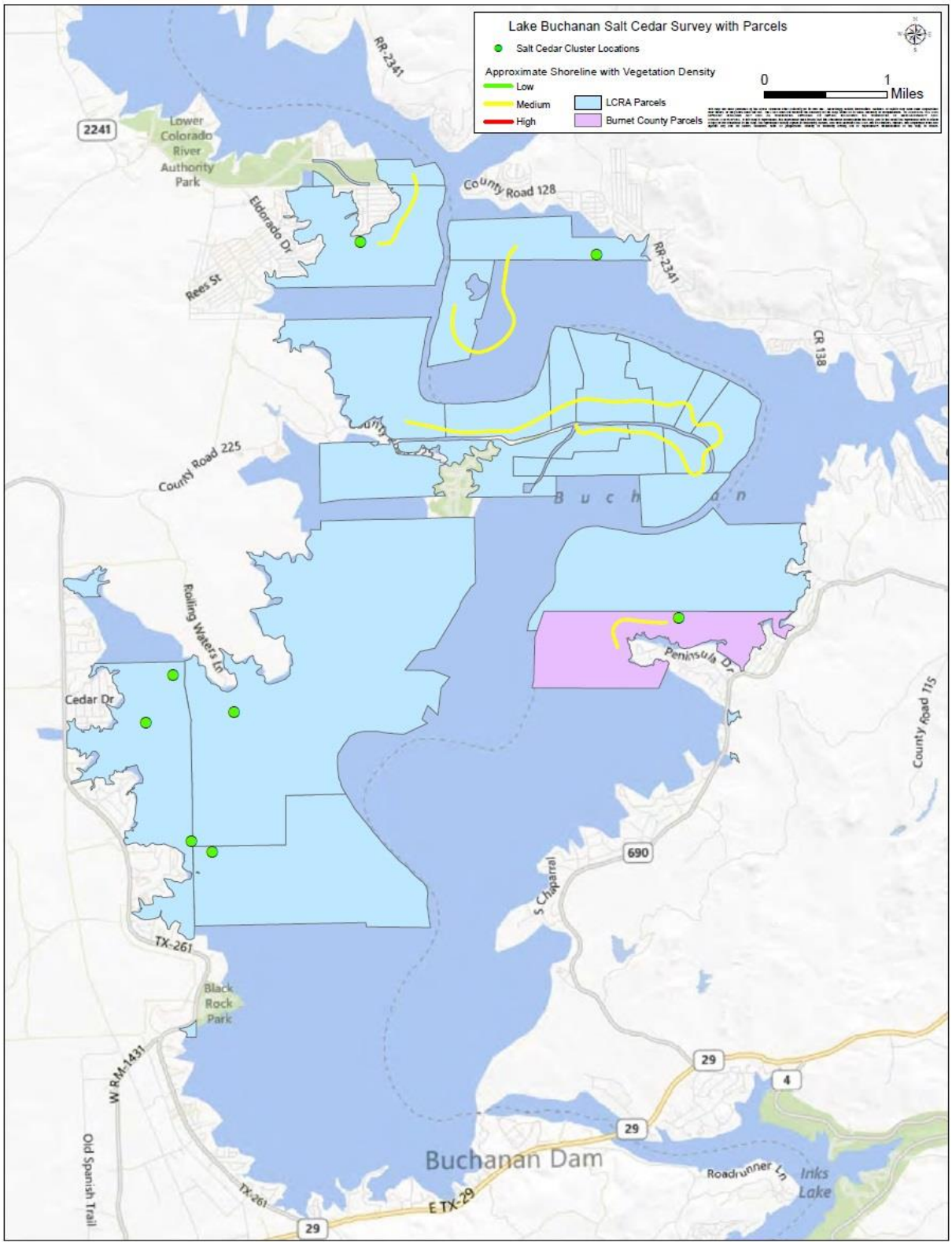
APPENDIX E

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	

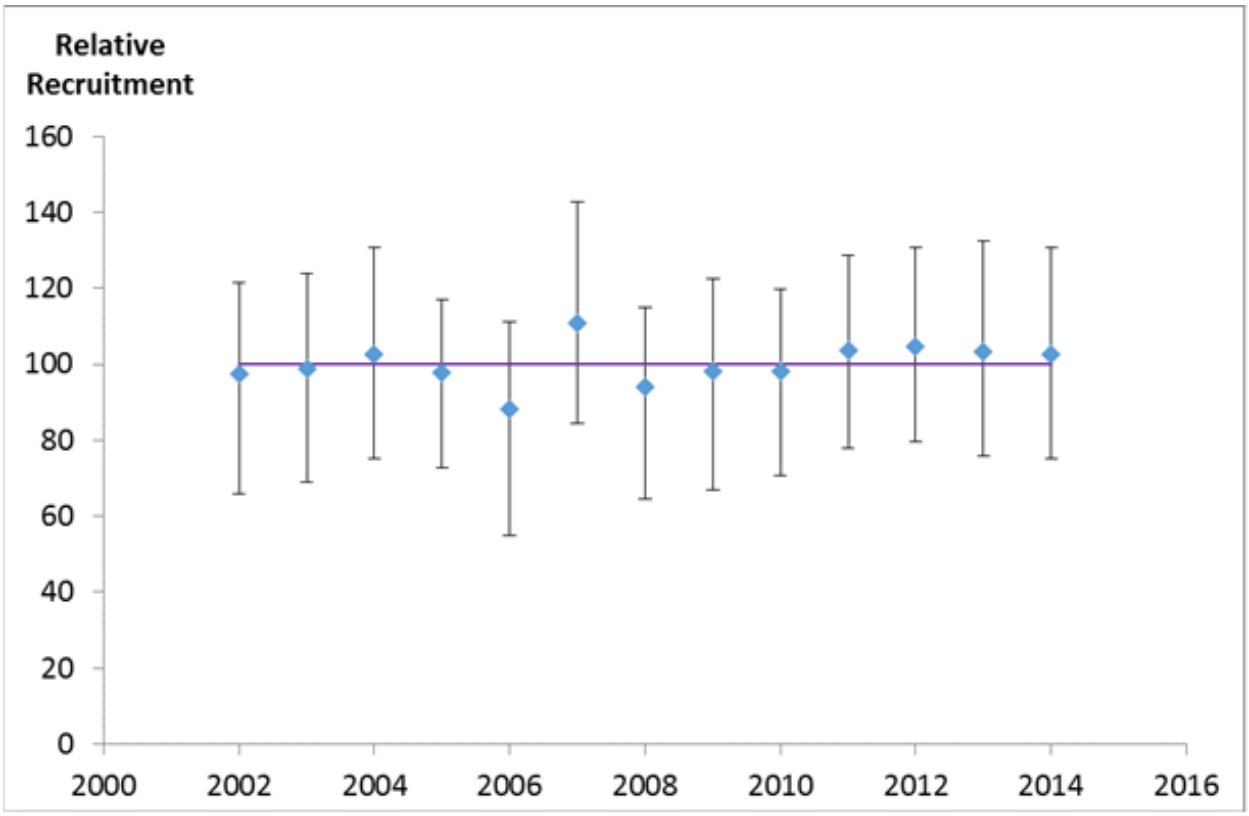
APPENDIX F

Map of saltcedar (*Tamarix* sp.) occurrences in Buchanan Reservoir, Texas, March 2014.



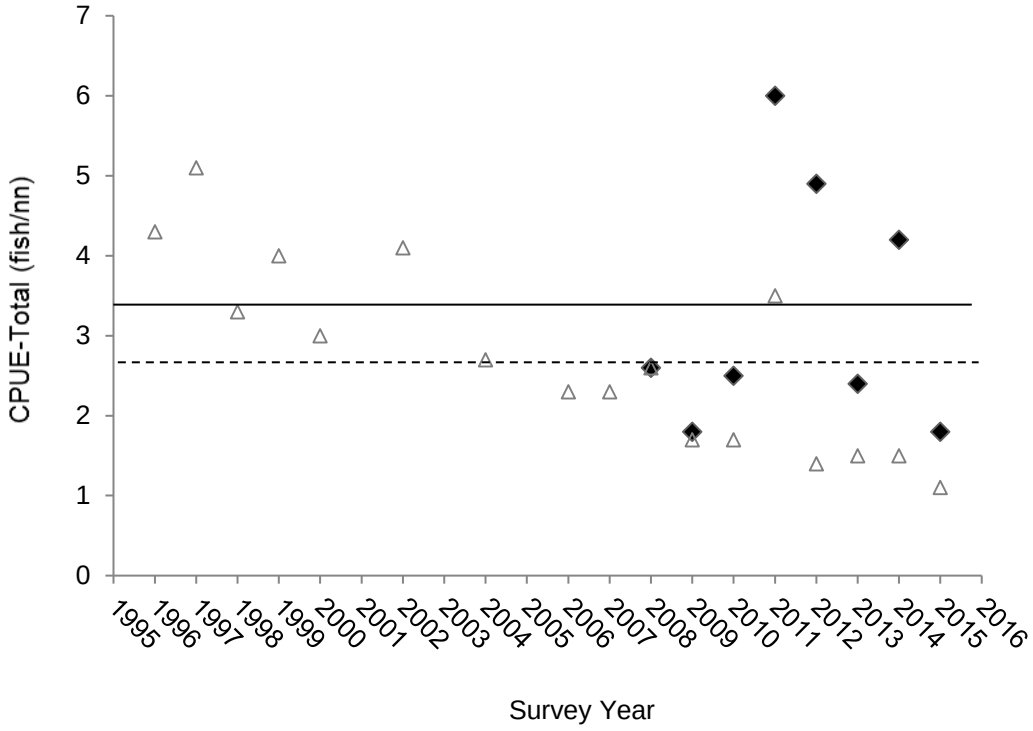
APPENDIX G

Estimated White Bass relative recruitment at Buchanan Reservoir, Texas. A linearized Bayesian model, standardized to a value of 100, was used to look at scaled recruitment at age-1. The 100% value (horizontal line) represents expected average recruitment. Actual recruitment estimates from sampled fish are represented by diamonds, with respective error values. Values above 100 represent good recruitment, while values below 100 are poor.



APPENDIX H

Historical total catch rates of Striped Bass (triangles) and Sunshine Bass (diamonds) from gill net surveys at Buchanan Reservoir, Texas from 1996 to 2015. Average catch rate (CPUE-Total; fish/nn) for Striped Bass is denoted by the dashed line (2.7/nn) and Sunshine Bass by the solid line (3.3/nn). Random surveying began in 2004. Sunshine Bass were first stocked in 2006, and recruited to the gear in 2008.



APPENDIX I

Florida Largemouth Bass allele proportions in population samples over time at Buchanan Reservoir, Texas. Proportion of Florida Largemouth Bass alleles in the genetic sample represented by dots during years samples were taken. Florida Largemouth Bass were initially stocked into Buchanan Reservoir in 1978 by TPWD.