

Buchanan Reservoir

2019 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

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Survey and Management Summary

Fish populations in Buchanan Reservoir were surveyed in 2019 using electrofishing and in 2018 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 with a drainage area of 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 2015 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. Florida Largemouth Bass were stocked in the reservoir in the late 1970's and stocked again in 2008 and 2015 - 2019 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 The regulation was rescinded after analysis indicated environmental factors, not angler harvest, were probably more influential in determining White Bass population density.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:** A new sampling approach for gill netting in 2016 collected baseline catch rates for Blue Catfish, Channel Catfish, and Flathead Catfish for future trend analyses. Due to COVID-19 travel restrictions, gill netting for Blue, Channel and Flathead Catfishes did not occur in 2020 for this report. In 2018, Blue Catfish was the predominant catfish species present. Channel Catfish were present in lower abundance and smaller size structure. Flathead Catfish were present in low densities.
- **Temperate basses:** A new sampling approach for gill netting in 2016 collected baseline catch rates for White Bass, Striped Bass, and Sunshine Bass for future trend analyses. Due to COVID-19 travel restrictions, gill netting for White, Striped, and Sunshine Basses did not occur in 2020 for this report. In 2018, White Bass abundance decreased, but remained moderate and similar to catch rates from previous surveys/Striped Bass gill net average catch increased over the 2016 survey. Sunshine Bass gill netting catches decreased in 2018 but still remained consistent with previous gill net surveys.
- **Black basses:** Largemouth Bass catch remained consistent in 2019 compared to the 2015 survey; most likely a reflection of stable water levels in the waterbody following the 2011 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 faster growth. Gill netting should be conducted biennially to monitor *Morone* spp. abundance, growth and condition. Conduct general monitoring surveys with gill nets, and electrofishing surveys in 2023-2024, with a supplemental gill net survey in 2021 to replace the missed survey of 2020. Access, habitat, and

vegetation surveys will be conducted in 2023. 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 2018 and 2019. 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 2018 and 2019 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 nearly filled in 2015-16. Remnants of this terrestrial vegetation still exists in the reservoir at the time of the writing of this report. 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 (msl). When water level fell below 1,004 feet above msl, 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 msl. The White Bluff (Burnet County) boat ramp was improved to be more accessible at low water levels down to 963 ft. above 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. ADA 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, 2016) included:

1. Stock Striped Bass (5/acre) and continue to encourage and granting a permit to the LBCC for stocking Sunshine Bass fry at the equivalent rate of 10 fingerlings/acre. Monitor the *Morone* fishery by conducting a stratified random sampling scheme using gill nets on a biennial basis. 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.

Action: Striped Bass were stocked at full rate in 2013, 2014, and at a reduced rate in 2015 - 2019. Annual gill net sampling was conducted in 2013–2016 and in 2018. The 2020 gill net survey was cancelled due to travel restrictions associated with the COVID-

19 outbreak. 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 and has continued through the present. Sunshine Bass fry had been stocked every year since 2015. A creel survey was conducted for three quarters from summer 2019 through winter of 2020. The creel survey was stopped in March of 2020 due to travel restrictions associated with the COVID-19 outbreak.

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

Action: Fish attractor projects ceased during a prolonged drought that rendered sites exposed on dry land. An effort to install artificial attractors (Mossback) was completed in 2016. Additional refurbishment is scheduled to occur in 2020/2021.

3. 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. Live zebra mussels have not been found in Buchanan Reservoir at the time of this report writing.

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 have been requested since 2004. Florida Largemouth Bass were stocked in 2008 and in 2015, 2016 and 2019 to increase Florida Largemouth Bass genetic influence by utilizing newly-flooded habitat. The LBCC continues to stock Sunshine Bass fry on an annual basis. A complete stocking history is in Table 4.

Vegetation/habitat management history: Buchanan Reservoir had no aquatic vegetation coverage during the 2019 survey. Most of the shoreline habitat was comprised of sand and rock. Restored water levels from multiple flood events in 2015, 2016, and 2018 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 (*Tamarix* spp) 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 (De Jesus and Farooqi 2016). 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 2017).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (1.5 hours at 18, 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-2 evaluation (using otoliths from 14 randomly-selected fish ranging 13.0 to 14.9 inches; TPWD, Inland Fisheries Division, unpublished manual revised 2017).

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) in 2018. A 2020 gill netting survey was cancelled due to travel restrictions associated with the COVID-19 outbreak. Using the stratified random sampling approach that was implemented in 2016, stations were randomly selected within three strata (upper, mid, and lower lake) that were delineated by examining catch rates from historic standardized surveys. CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn). All temperate bass captured were aged.

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

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 (Wr)] were calculated for target fishes according to Anderson and Neumann (1996). Index of vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error ($RSE = 100 \times SE$ of the estimate/estimate) was calculated for all CPUE and creel statistics.

Creel survey – A three-quarter roving creel survey was conducted from June 2019 through February 2020. The creel survey was originally planned for an entire year (four quarters) but the final quarter (March – May 2020) was cancelled due to travel restrictions associated with the COVID-19. Angler interviews were conducted on 5 weekend days and 4 weekdays per quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Habitat – A structural habitat and vegetation survey was conducted in 2019. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Water level - Source for water level data was the Lower Colorado River Authority (LCRA 2020).

Results and Discussion

Habitat: In 2019, 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 continues to be 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 various locations from 2008-2010. Currently, sixteen of these habitat sites have received refurbishment (in 2016) using artificial (Mossback) structures (Appendix C and D). Global positioning system (GPS) coordinates of the locations of these sixteen sites were made available to the public (Appendix E).

Creel: Total fishing effort for all species at Buchanan Reservoir was 113,877 h (5.1h/acre) from June 2019 through February 2020. Eighty-three percent of total fishing effort was from boat anglers. Directed fishing effort by all anglers was highest for Largemouth Bass (26.8%), followed by anglers fishing for anything (16.6%), White Bass (16.5%) and Crappies (14.0%); however, directed effort for all black bass species combined accounted for 35.2% (Table 7). Striped Bass effort accounted for 8.6% of total angler effort. Directed effort for White Bass (0.84 h/acre) accounted for 16.5% of total angler effort. Lake Buchanan has a popular White Bass run up-river to Colorado Bend State Park that occurs in the spring quarter (March – May). Had the final quarter of the creel survey not been cancelled, total directed angler effort for the entire creel period toward White Bass would have been much higher. Overall angler compliance was excellent, as most species observed harvested during the creel survey period were of legal length. Blue Catfish provided the best catch rate (2.2/h) among all species to which anglers directed their efforts. An estimated total of \$1,052,531 in direct expenditures related to fishing trips was made by anglers during the 9-month creel period (Table 8). Direct expenditures estimate, as described here, relates to expenses for a single day of fishing. Most anglers were local, with 58% traveling less than 50 miles to reach Buchanan Reservoir (Appendix F).

Prey species: Electrofishing catch rates of Gizzard Shad, Threadfin Shad, Redbreast Sunfish, and Bluegill were 207.3/h, 19.3/h, 27.3/h and 58.0/h, respectively. Total catch rate of Gizzard Shad was more than twice of what was recorded in 2015 (101.0/h) and the rebound was likely due to an increase in water level. Index of Vulnerability (IOV) for Gizzard Shad noticeably decreased to 22 since 2015 (73), indicating that 22% of Gizzard Shad were vulnerable (≤ 8 inches) to existing predators (Figure 2). Threadfin Shad were present and provided forage for existing predators. Total catch rates of Redbreast Sunfish have ranged from 53.3/h (2011), 62.0/h (2015), and 27.3/h (2019) (Figure 3). The highest total catch rate for Redbreast Sunfish was seen in 2003, when it was 259.0/h (De Jesus and Farooqi 2012). Total CPUE of Bluegill in 2019 (58.0/hr) was lower than the 2015 catch rate (107.5/h), and it was predominantly structured by small individuals ≤ 5 inches (PSD = 27; Figure 4). Pre-determined objectives were not met for Bluegill (Table 5).

Blue Catfish: Due to the cancellation of non-essential field work during the COVID-19 outbreak, gill netting was not attempted in 2020. However, the previous gill net survey revealed that Blue Catfish total catch rates fluctuated slightly between 2016 (5.7/nn) and 2018 (3.1/nn; Figure 5). Before stratified random gill netting was implemented in 2016, annual surveys revealed trophy specimens (≥ 36 inches) available to anglers; most in good condition, with average relative weight (*Wr*) values above 90 for most length classes. It is assumed these larger fish were still present and available to anglers. In the 2018 survey, the population structure remained good with quality specimens recorded with good body condition (most *Wr* values above 90). Most fish sampled were of legal harvest length (≥ 12 inches). Whether or not this increase was due to a population increase or sampling efficiency will be determined in surveys to come. Anecdotal reports indicate the Blue Catfish fishery had 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-length (≥ 36 inches) individuals. The lake record was caught in 2008, which weighed 65.2 pounds at 44 inches. The creel survey did not document any directed effort toward Blue Catfish but this may be an underrepresentation due to a greater number of hours directed towards all catfish species combined (Table 7). Blue Catfish were targeted by harvest-oriented anglers, as few of

the legal-length caught were released (Table 9). Observed harvest during the creel surveys showed excellent angler compliance and harvested fish ranged from 13 to 21 inches (Figure 6).

Channel Catfish: Due to the cancellation of non-essential field work during the COVID-19 outbreak, gill netting was not attempted in 2020. However, since 2010, a declining abundance trend was noticed for Channel Catfish at Buchanan Reservoir (De Jesus and Farooqi 2012, De Jesus and Farooqi 2016). This trend continued in following surveys through 2015, when the lowest catch rate ever was recorded at 0.4/nn. It has been thought that the thriving Blue Catfish population had been outcompeting the Channel Catfish in this reservoir. In 2018, the stratified random gill netting survey revealed an increase of total catch rate at 1.5/nn for Channel Catfish (Figure 7). The population structure was mostly comprised of harvest-length (≥ 12 inches) individuals with good body condition (most *Wr* values above 90). 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 7). Catch rate was high (1.7/h) and total harvest for Channel Catfish showed that anglers were utilizing this species (Table 10). Channel Catfish were targeted for harvest by anglers, as only 4.7% of the legal-length fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fish ranged from 12 to 24 inches (Figure 8).

Flathead Catfish: Flathead Catfish were present in low density at Buchanan Reservoir in 2018. The 2018 total gill net catch rate was 0.5/nn with seven individuals sampled, all but one were harvestable length (≥ 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 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. Due to the cancellation of non-essential field work during the COVID-19 outbreak, gill netting was not attempted in 2020 for temperate basses, including White Bass. However, previous surveys showed the total gill net catch rate fluctuating between 5.3/nn (2016) and 2.8/nn (2018) (Figure 9). Similar catch rate variability was revealed in surveys performed in 2013 (3.3/nn), 2014 (3.9/nn), and 2015 (2.7/nn). Body condition was fair in 2016 and 2018, with mean relative weights (*Wr*) around 85 for most adult length-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. 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.

Directed fishing effort from June 2019 through February 2020 was 18,832.6 hours (Table 11). It is possible this species would be the most sought-after if the data reflected a full survey year including the popular spring spawning run. Angler success was good (CPUE = 1.29/h) and total harvest for White Bass showed that anglers heavily seek this species (Table 11). White Bass were targeted by harvest-oriented anglers as only 11.8% of the legal-length fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance, and harvested fish ranged from 10 to 16 inches (Figure 10). Combined age-and-growth data from annual surveys (2014 – 2018) 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).

Striped Bass: Due to the cancellation of non-essential field work during the COVID-19 outbreak, gill netting was not attempted in 2020. However, previous surveys showed that Striped Bass total catch rates

increased from 2.9/n in 2016 to 4.7/n in 2018 (Figure 12). These catch rates are higher than the average catch rate of 1.4/n documented in the gill netting surveys from 2013-2015. Body condition in 2018 was generally poor, with relative weights (*Wr*) declining below 90 for fish above 20 inches (Figure 12). Chronic poor body condition of older 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).

The stratified random gill netting survey approach implemented in 2016 was performed at Buchanan Reservoir as part of an objective-based sampling approach, designed to increase statistical confidence of our survey results (De Jesus and Farooqi 2016). This approach has revealed an improved catch rate for Striped Bass at Buchanan Reservoir. It is too early to imply that the new approach rendered improved catch rates without further survey attempts to establish a trend. It should be noted that increased stocking rates have not 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.

Directed fishing effort was fifth highest among all species during the summer through winter quarters, accounting for 8.6% of all directed effort (Table 7). Angler catch rates were 0.8/h and total harvest for Striped Bass showed that anglers utilize this species (Table 12). Striped Bass were targeted for harvest by anglers as only 7.3% of the legal-length fish caught were released. Observed harvest during the creel surveys showed excellent angler compliance and harvested fish range from 20 to 22 inch (Figure 13). Furthermore, supplemental questions asked during the creel survey indicated some level of directed effort for Striped Bass at Buchanan Reservoir. When asked "Do you fish or have you fished for Striped Bass at Buchanan Reservoir?"; 83 (44%) replied "Yes" and 104 (56%) replied "No." To the 83 individuals that replied "Yes," we asked, "If so; do you prefer catching numbers or size?"; 31 (37%) replied "numbers" and 52 (63%) replied size.

Combined age-and-growth data from annual surveys (2014 – 2018) revealed that, on average, Striped Bass reached legal length (18 inches) between age 2 and 3 (Figure 14); similar to 2016. 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). Results like this may justify fry stockings as an option to relieve hatchery production challenges in future years.

Largemouth Bass: The total electrofishing catch rate of Largemouth Bass was 50.7/h in 2019, which was consistent with what was recorded in 2015 (55.5/h) but was more than twice than what was recorded in 2011 (24.0/h; Figure 15). Catch rates for stock-length fish (8 inches) increased 2019 (38.7/h) from what was recorded in 2015 (25.5/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. However, the 2019 survey revealed an improvement in the population structure (PSD = 57) compared to the 2015 survey (PSD = 16). Good reproduction was evident from the pronounced presence of young-of-year fish in the 2015 sample and the sustained and consistent water levels may be attributable to the population structure recorded in 2019. Body condition was excellent, as average relative weights (*Wr*) for all stock-length inch groups were around 100.

Black bass were the most sought-after species group by anglers in Buchanan Reservoir during the 2019/2020 creel survey (35.2% of the total directed effort). Surprisingly, Largemouth Bass had not ranked as the most popular species to target in Buchanan Reservoir with it being the third most popular species

during a 2011 creel survey (De Jesus and Farooqi 2012). Directed effort was 30,503 hours for the three-quarter creel period and angler catch rates were 0.31/h (Table 13). Surprisingly, the creel surveys revealed that only 17.2% of the legal-length Largemouth Bass caught were released and a notable number of fish harvested (Figure 16). However, this is likely due to several creel surveys occurring during bass tournaments in which anglers were holding fish in their live-wells until the final weigh-in.

Largemouth Bass growth analysis revealed that they grow to harvestable length (14 inches) by age-2 (Figure 17). 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 (69.3%) in 2019 was moderate and remained similar to the last sample taken in 2015 (67.0%; Table 14). Pre-determined sampling objectives for Largemouth Bass were met for all metrics (Table 5).

White Crappie: Crappies were the fourth most sought-after species by anglers in Buchanan Reservoir during 2019/2020 creel survey (14% of total directed effort). Angler catch rate was high (3.02/h) for crappie during the creel survey. Anglers harvested approximately 12,320 crappie during the creel survey period (Table 15, Figure 18). The 2011 creel survey identified that directed effort for crappie combined accounted for 6.1% of the total directed effort for all species targeted. Historic trap netting surveys have shown that crappie are difficult to sample effectively at Buchanan Reservoir. Therefore, in lieu of trap netting, the monitoring of presence/absence of crappie has been done while conducting gill net surveys. No crappie were sampled during the 2018 gill netting.

Sunshine Bass: Sunshine Bass (fry and fingerlings) have been stocked in Buchanan Reservoir every year since 2006 by the LBCC except for 2020 when TPWD provided and stocked the fry. 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. Due to the cancellation of non-essential field work during the COVID-19 outbreak, gill netting was not attempted in 2020. However, total gill net catch rate fluctuated between 3.8/nn and 1.5/nn between 2016 and 2018 (Figure 19). While Sunshine Bass historic catch rates averaged higher than those of Striped Bass, these rates were highly variable, but did show an increasing trend over time (Appendix G). Body condition for Sunshine Bass increased in 2018 over 2019, as mean relative weights (W_r) were generally above 85 for all stock-length inch groups. The increase in W_r may be due an increase in water level which reduced intra- and inter-specific competition with other *Morone* species that occurred during an extended drought period. Historical mean relative weights for Sunshine Bass revealed good body condition ($W_r \geq 85$), similar to Striped Bass at similar length groups (De Jesus and Farooqi 2012). Future stocking adjustments might be required to restore historical growth and condition trends.

The creel survey did not document any directed effort toward Sunshine Bass, but this may be an underrepresentation due to a greater number of hours directed toward Striped Bass (Table 7). Sunshine Bass were targeted by harvest-oriented anglers, as few of the legal-length fish were released (Table 16). Observed harvest during the creel surveys showed excellent angler compliance and harvested fish ranged from 18 to 19 inches (Figure 20).

Combined age-and-growth data from annual surveys (2013 – 2018) revealed that, on average, Sunshine Bass reached legal length (18 inches) between age-3 and -4 (Figure 21); 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 2020

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 *Moronidae* is now a priority and would also be appreciated by anglers. With a reliable understanding of 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.

ISSUE 2: Largemouth Bass present good fishing opportunities for anglers. 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 had a significant impact on Largemouth Bass habitat 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 16 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. Saltcedar 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 and Schedule (2020–2024)

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: Prior to the 2016 and 2018 surveys, Channel Catfish abundance had been steadily declining with a historical low catch rate of 0.4/nn in 2015. Channel Catfish only accounted for 1.7% of all directed effort during a three-quarter creel surveys in 2019/2020. Anglers at Buchanan Reservoir tend to be generalists when targeting catfishes and other species. Catfishes in general comprised 6.8% of the total directed effort in the three-quarter creel surveys in 2019/2020. This was sixth-best behind Largemouth Bass, temperate bass, and crappie. Gill netting efforts for other target species appear to have revealed a positive population change for this species incidentally. It is thought that this is due to the increased lake levels since 2015 and the changes in objective-based sampling that was implemented in 2016. Continuing with our biennial gill netting, in 2022, we will monitor presence/absence while conducting gill netting surveys for other species.

Flathead Catfish: Flathead Catfish are present in low density in Buchanan Reservoir. No directed effort was identified for this species in the 2019/2020 creel survey. Catch rates for this species has consistently remained near 1.0/nn. Sampling for this species will be limited in 2020 - 2024. We will monitor presence/absence while conducting gill netting surveys for other species.

Crappie: White and Black Crappie are present in low densities in Buchanan Reservoir demonstrated by 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 2020. Still, dispersed distributions of crappie coupled with high variability of gill netting catch rates within this large reservoir led to erratic catches during random sets leading to high RSE. The 2020 creel survey identified that directed effort for these species combined accounted for 14.0% of the total directed effort for all species targeted. However, while crappie are an important angling target, they are difficult to sample effectively at this reservoir, therefore sampling for this species will be limited in FYs 2020 – 2024. Therefore, we will monitor presence/absence while conducting gill netting surveys.

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 2019/2020 creel survey. Sampling for this species will be limited in 2020 – 2024. 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 second-most sought-after species group by anglers in Buchanan Reservoir during the 2019/2020 creel surveys, accounting for 25.1% of total directed effort (16.5% for White Bass, 8.6% for Striped Bass, and 0.0% for Sunshine Bass). Trend data on CPUE, size structure, and body condition have been collected with gill netting annually for Striped Bass from 2006

through 2015 and biennially starting in 2016 (except for the cancelled survey in 2020). Variation in RSE values can be attributed to random sampling and weak or missing year classes when Striped Bass are not produced at hatcheries. Catch rates from previous sample years indicate that CPUE-stock $RSE \leq 30$ 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 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. However, this goal was missed in the 2018 gill netting survey with an RSE-stock = 35. Collecting a minimum of 50 stock-length Striped Bass during winter/spring gill netting in 2022 and 2024 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 (except in 2020, when TPWD provided and stocked the fry). Trend data on CPUE, size structure, and body condition had been collected annually from 2008, when they first recruited to the gear, through 2015. Biennial gill netting began in 2016 and will continue in 2022 and 2024. 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 2020 creel survey failed to identify directed effort for Sunshine Bass because the species is typically considered no different than Striped Bass by anglers targeting both species equally. This is similar the catfishes, where most anglers did not claim to prefer one species over another while fishing.

Gill netting catch rates from previous sample years indicate that CPUE-stock $RSE \leq 30$ 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. However, this goal was missed in the 2018 gill netting survey in 2018 with an RSE-stock = 45. Collecting a minimum of 50 stock-length Sunshine Bass during winter/spring gill netting in 2022 and 2024 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 third most sought-after species at Buchanan Reservoir during the 2019/2020 creel survey, accounting for 16.5% of the total directed effort. However, since this creel survey did not cover the spring quarter of 2020, directed angler effort is likely substantially higher due the popularity of the spring spawning run. Results from a 2016 evaluation 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). However, the gill netting effort in spring, 2018 showed improvement with an RSE-stock = 24 (N = 42). We will continue to 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.

Blue Catfish: Blue Catfish showed no directed effort in the 2019/2020 creel surveys. Anglers at Buchanan Reservoir tend to be generalists when targeting catfishes and other species. Creel survey data in the 2019/2020 surveys identified that directed effort for catfishes was 6.8% of the total directed effort. Catfish in general are the sixth most sought-after fish by anglers in Buchanan Reservoir. Anecdotal reports of guides targeting trophy-length 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 $RSE \leq 30$ 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 2022 and 2024 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 and Largemouth Bass, combined, were the most sought-after species group by anglers in Buchanan Reservoir during the 2019/2020 creel surveys (35.2% of the total directed effort). Trophy-length specimens are regularly reported from this reservoir, which is also popular with tournament 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-length 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 2023 to collect a minimum of 50 stock-length 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. Fin clips from 30 Largemouth Bass (of all sizes) will be collected in 2023 to assess Florida Largemouth Bass stockings

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 [$RSE \leq 25$ 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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Tables and Figures

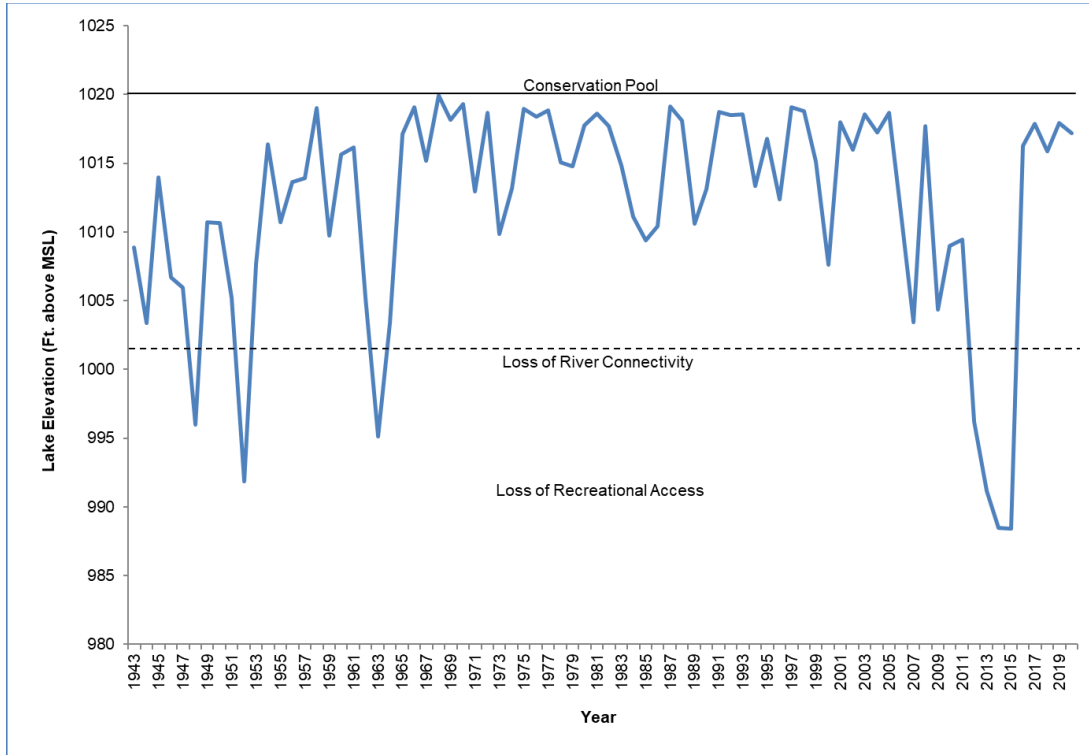


Figure 1. Mean spring (March – May) water level elevations in feet above mean sea level (msl) recorded for Buchanan Reservoir, Texas from 1943 to 2020. Solid line is elevation when full (1,020 msl). Other line indicates the elevation of when there is a loss of river-reservoir connectivity (1,002 feet 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 $\mu\text{S/cm}$

Table 2. Boat ramp characteristics for Buchanan Reservoir, Texas, August 2019. Reservoir elevation at time of survey was 1,020 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	1,004	Good
Thunderbird Lodge	30.83896 -98.34208	N	10	1,000	Good
Burnet County Park	30.84754 -98.38997	Y	15	993	Good
Painted Sky Inn	30.86093 -98.4167	N	10	1,000	Fair
Colorado Bend SP	31.01818 -98.44657	Y	10	Unknown	Unimproved
Cedar Point	30.86858 -98.45183	Y	10	1,007	Fair
Llano County	30.76668 -98.45122	Y	30	1,006	Good
Edgewater	30.75578 -98.45309	N	12	Unknown	Good
Shaw Island	30.83342 -98.42693	Y	N/A	994	Good

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 for Buchanan, 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
	2012	74,637	AFGL	5.7
	2016	13,173	AFGL	7
	2016	38,095	FGL	1.9
	2018	14,815	FGL	3.6
	Total	202,130		
Florida Largemouth Bass	1978	32,000	FGL	2
	1978	318,400	FRY	0.9
	2008	507,165	FGL	1.8
	2015	132,914	FGL	1.6

Table 4, Continued

Species	Year	Number	Life Stage	Mean TL (in)
	2015	40,656	FRY	0.3
	2016	173,757	FGL	1.6
	2019	193,167	FGL	1.7
	Total	1,398,059		
Largemouth Bass	1969	500,000	FRY	0.7
	Total	500,000		
Striped Bass	1977	231,726	UNK	0
	1978	153,400	UNK	0
	1979	69,228	UNK	0
	1980	285,046	UNK	0
	1983	229,638	UNK	0
	1984	343,178	FGL	2
	1985	587,950	FGL	2
	1986	37,300	FGL	2
	1986	260,172	FRY	1
	1987	232,608	FRY	1
	1988	230,728	FRY	1
	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
	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
	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

Table 4, Continued

Species	Year	Number	Life Stage	Mean TL (in)
	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	93,809	FGL	1.6
	2017	94,920	FGL	1.7
	2018	119,200	FGL	1.6
	2019	116,671	FGL	1.5
	Total	12,832,442		
Sunshine Bass (White Bass x Striped Bass hybrid)	2006	500,000		0.2
	2007	128,400		5.4
	2008	706,971		0.8
	2009	2,605,948		1.8
	2010	1,310,000		1.5
	2011	85,000		2
	2012	75,000		2.2
	2013	283,244		1.7
	2014	1,035,172		1.6
	2015	1,000,000		0
	2016	1,000,000		0.2
	2017	1,000,000		0
	2018	1,000,000		0
	2019	1,000,000		0.1
	Total	11,729,735		
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 2019–2020.

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

^a No additional effort will be expended to achieve an RSE ≤ 25 for CPUE and $N \geq 50$ 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, 2019. Shoreline habitat type units are in miles.

Habitat type	Estimate	% of total
Bulkhead	4.2 miles	3.5
Bulkhead w/ piers	9.3 miles	6.7
Gravel Shoreline	31.3 miles	22.4
Gravel Shoreline w/ piers	21.2 miles	15.2
Natural Shoreline	20.2 miles	14.4
Natural Shoreline w/ piers	2.3 miles	1.8
Rocky Bluff	1.9 miles	1.7
Rocky Bluff w/ piers	4.6 miles	3.5
Rocky Shoreline	33.5 miles	22.9
Rockly Shoreline w/ piers	11.3 miles	8.0

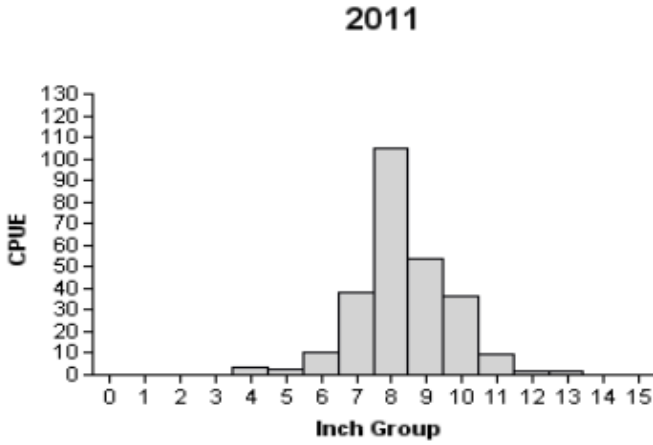
Table 7. Percent directed angler effort by species for Buchanan Reservoir, Texas, 2019/2020. Relative standard error is in parentheses. Survey periods were from 1 June through 29 February.

Species	2019/2020
Channel Catfish	1.7 (62)
White Bass	16.5 (39)
Striped Bass	8.6 (50)
Largemouth Bass	26.8 (33)
Anything	16.6 (33)
Sunfishes	0.3 (115)
Black Basses	8.4 (51)
Crappies	14.0 (31)
Catfishes	6.8 (33)
Panfishes	0.2 (147)

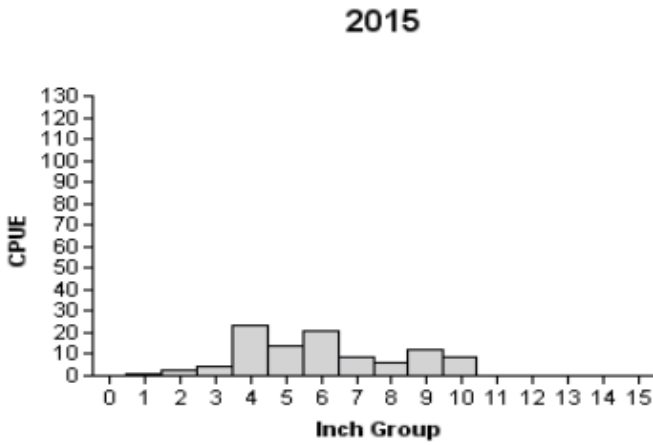
Table 8. Total fishing effort (h) for all species and total directed expenditures at Buchanan Reservoir, Texas, 2019-2020. Survey periods were from 1 June through 29 February. Relative standard error is in parentheses.

Creel statistic	2019/2020
Total fishing effort	113,877 (29)
Fishing from bank	18,980 (36)
Fishing from boat	94,897 (31)
Total directed expenditures	\$1,052,531 (40)

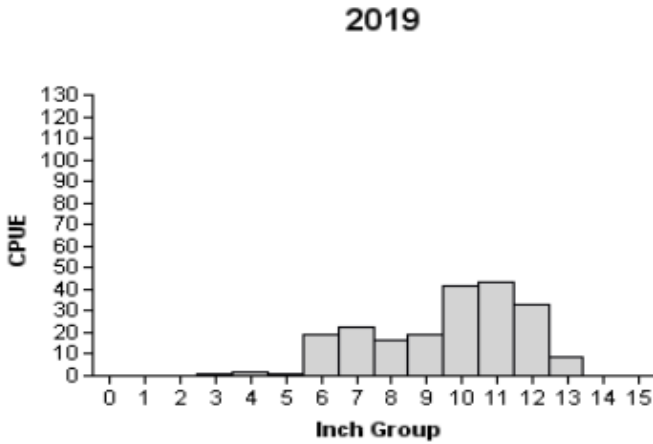
Gizzard Shad



Effort = 1.5
 Total CPUE = 261.3 (21; 392)
 IOV = 21 (6)



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



Effort = 1.5
 Total CPUE = 207.3 (19; 311)
 IOV = 22 (5)

Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2011, 2015, and 2019. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

Redbreast Sunfish

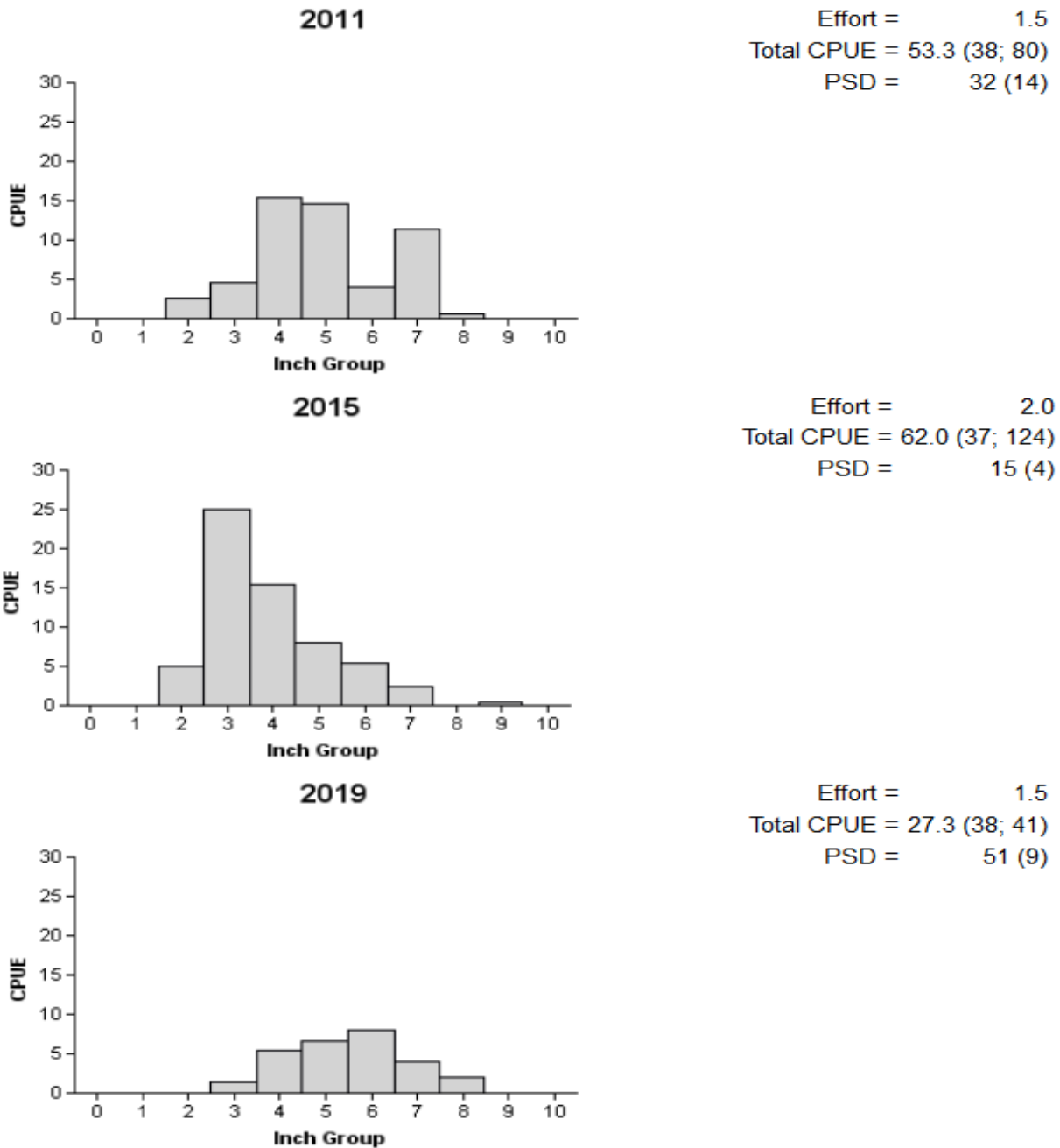


Figure 3. Number of Redbreast Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2011, 2015, and 2019. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

Bluegill

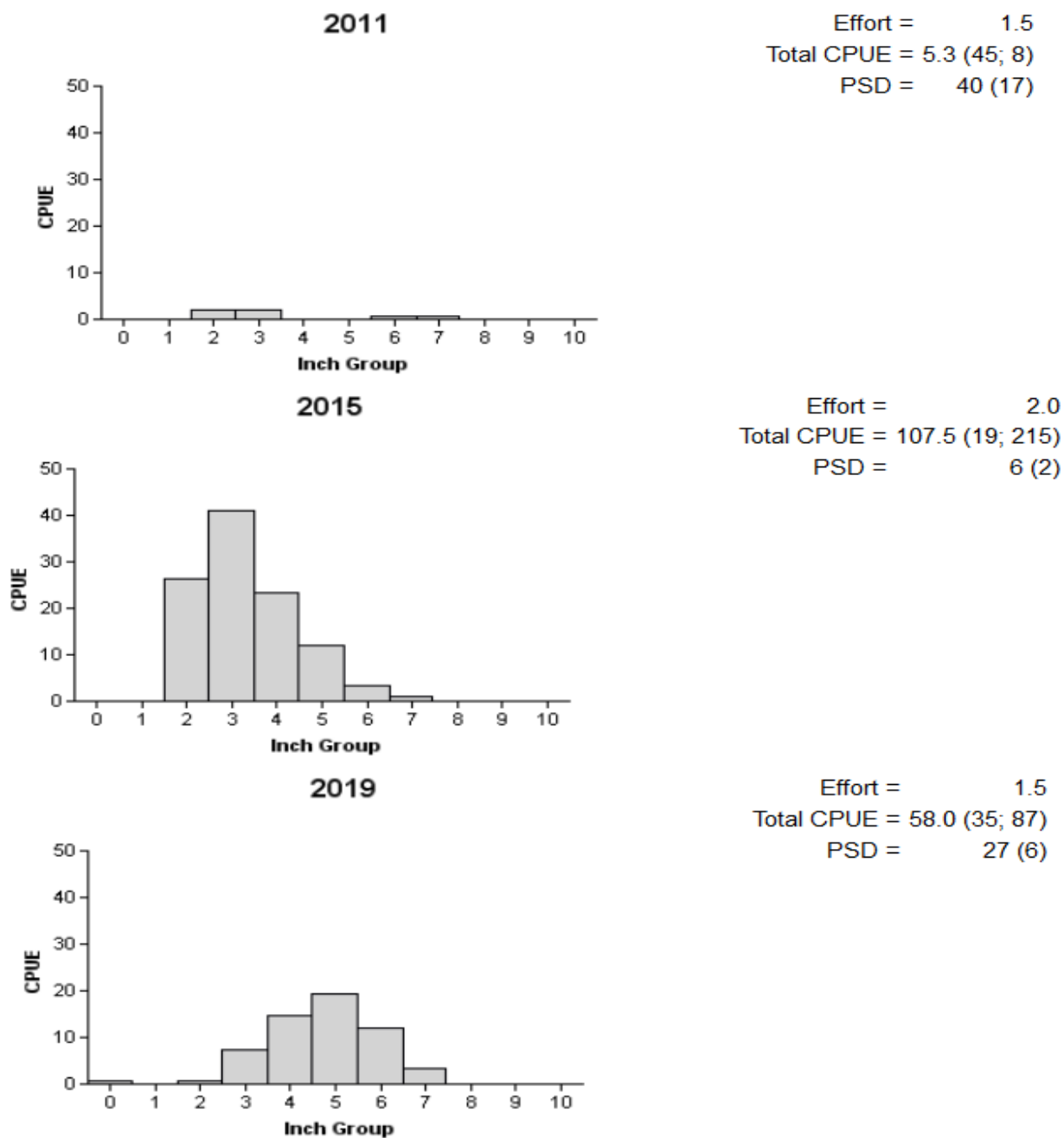


Figure 4. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2011, 2015, and 2019. Daytime reduced-effort electrofishing conducted in 2011 due to lake conditions.

Blue Catfish

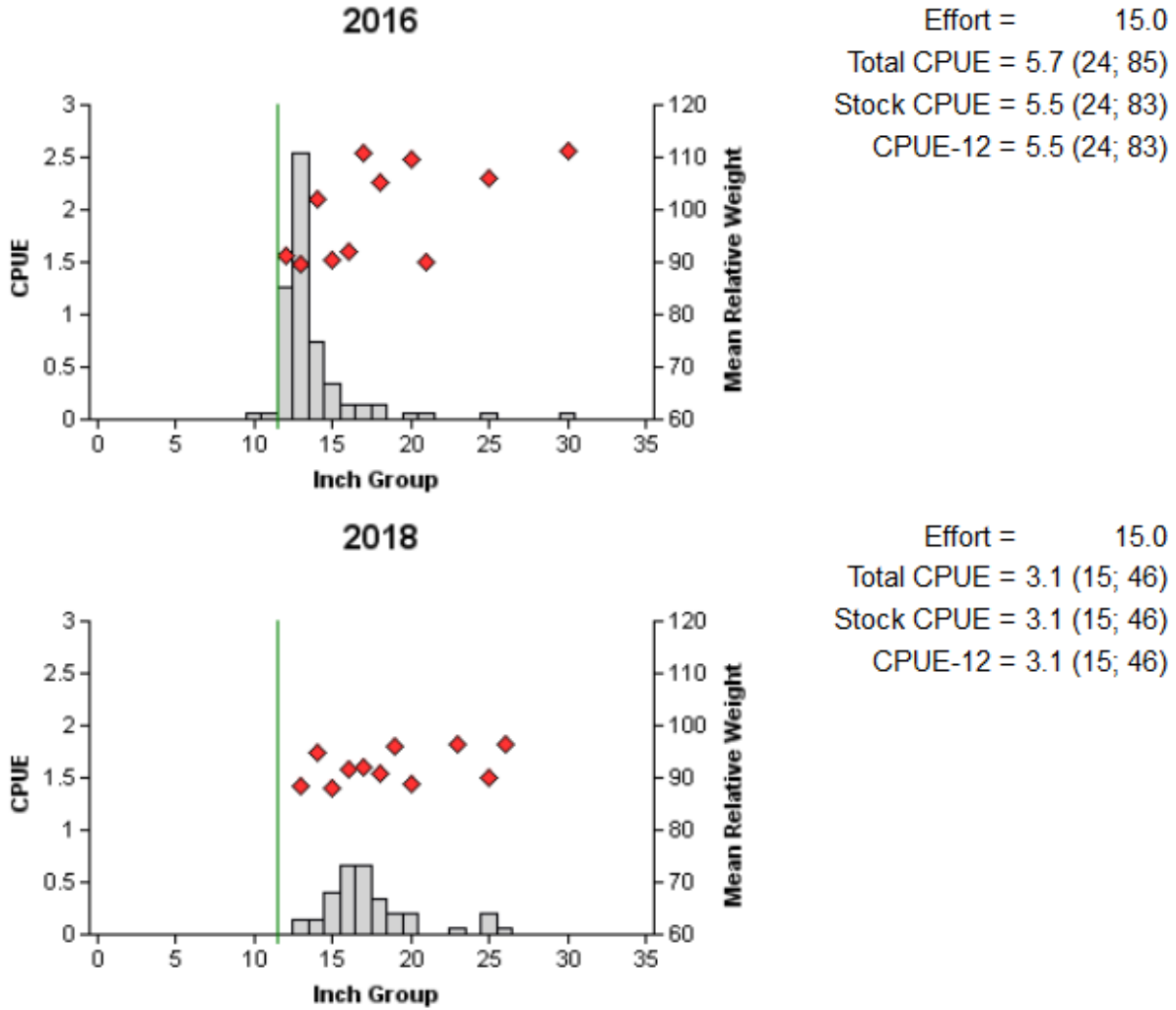


Figure 5. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2016 and 2018. Vertical line indicates minimum length limit.

Table 9. Creel survey statistics for Blue Catfish at Buchanan Reservoir, Texas, from June 2019 through February 2020. Total catch per hour is for anglers targeting catfish and total harvest is the estimated number of Blue Catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	0.0
Directed effort/acre	0.0
Total catch per hour	0.0
Total harvest	6,376.6 (96)
Harvest/acre	0.29 (96)
Percent legal released	8.7

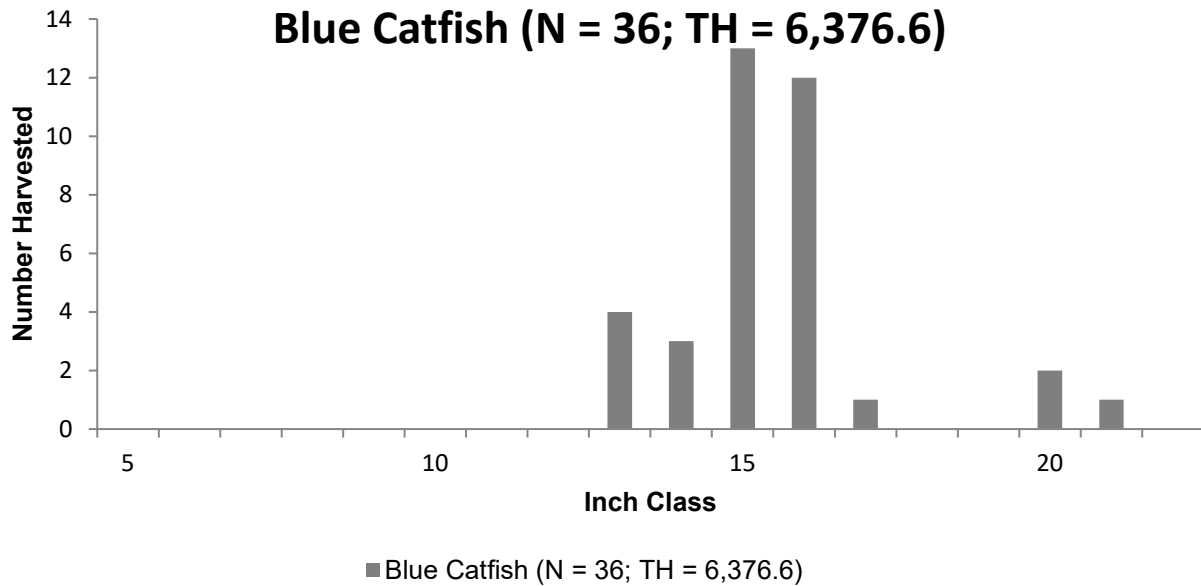


Figure 6. Length frequency of harvested Blue Catfish observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through February 2020, all anglers combined. N is the number of harvested catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

Channel Catfish

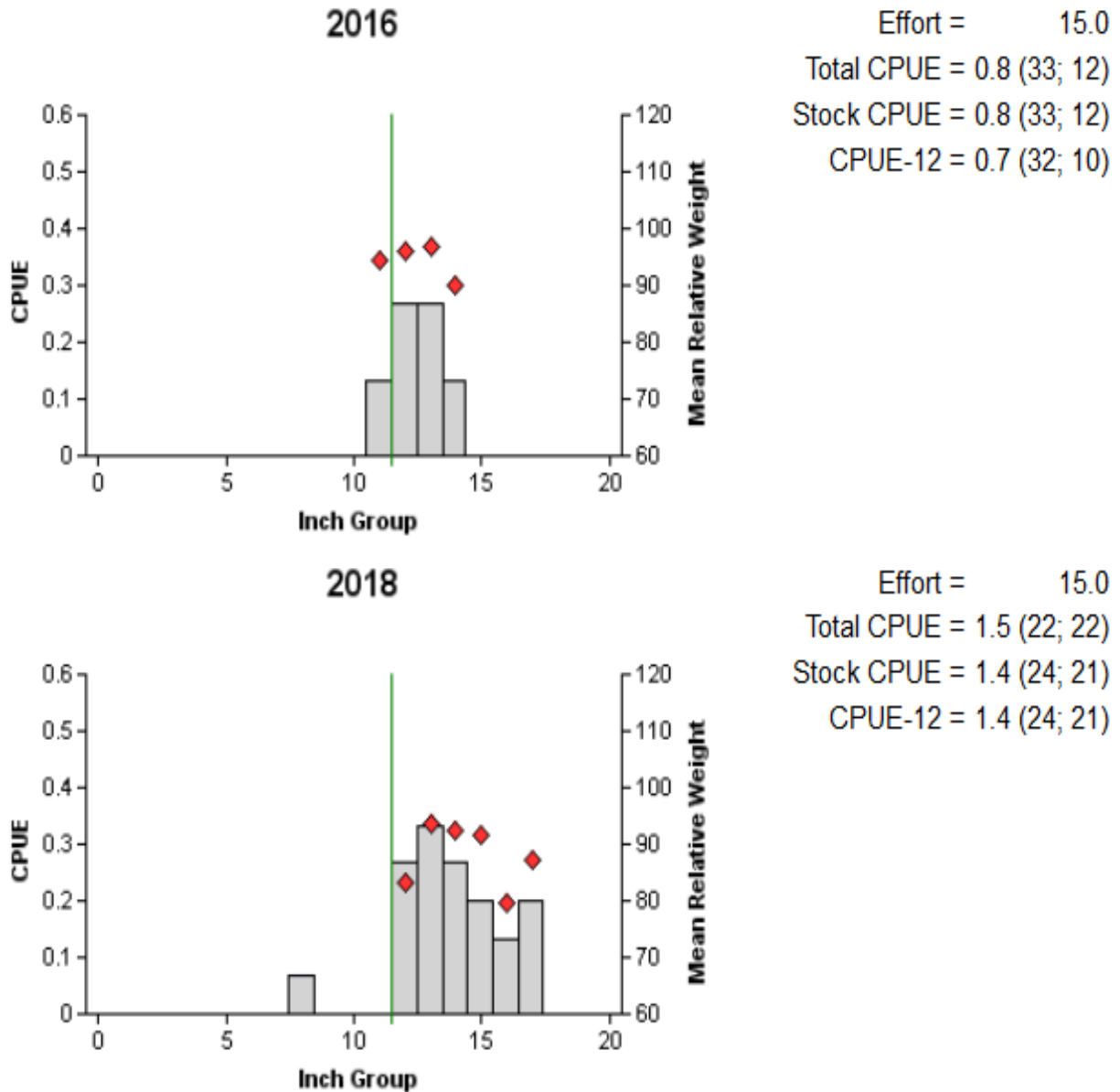


Figure 7. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2016 and 2018. Vertical line indicates minimum length limit.

Table 10. Creel survey statistics for Channel Catfish at Buchanan Reservoir, Texas, from June 2019 through February 2020. Total catch per hour is for anglers targeting 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
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	1,924.5 (62)
Directed effort/acre	0.09 (62)
Total catch per hour	1.7 (105)
Total harvest	9,415.3 (83)
Harvest/acre	0.42 (83)
Percent legal released	4.7

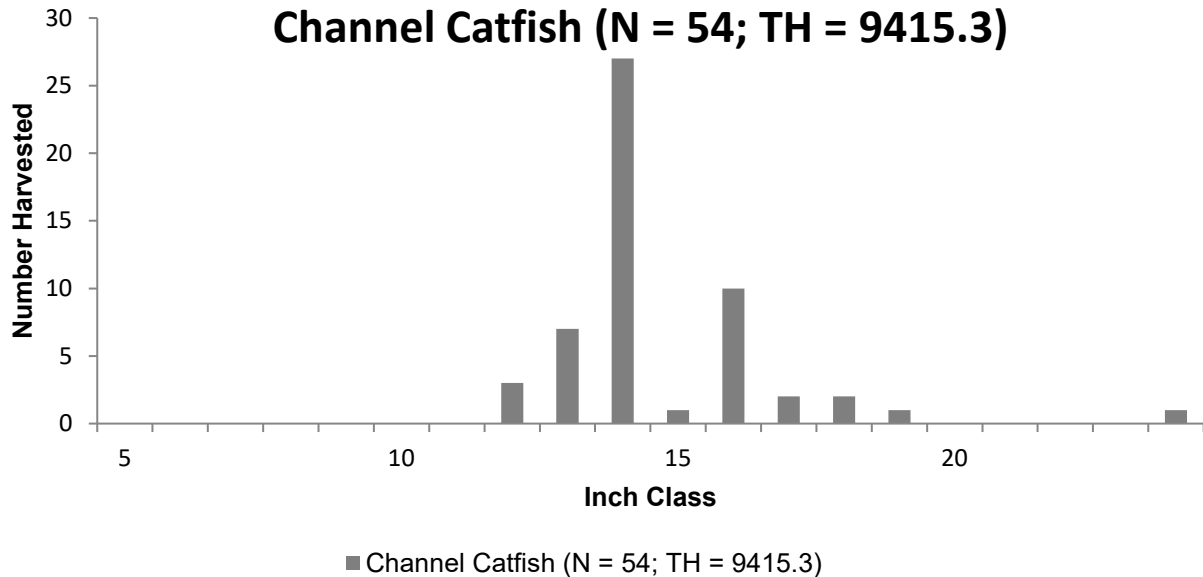


Figure 8. Length frequency of harvested Channel Catfish observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through February 2020, all anglers combined. N is the number of harvested catfish observed during creel surveys, and TH is the total estimated harvest for the creel survey period.

White Bass

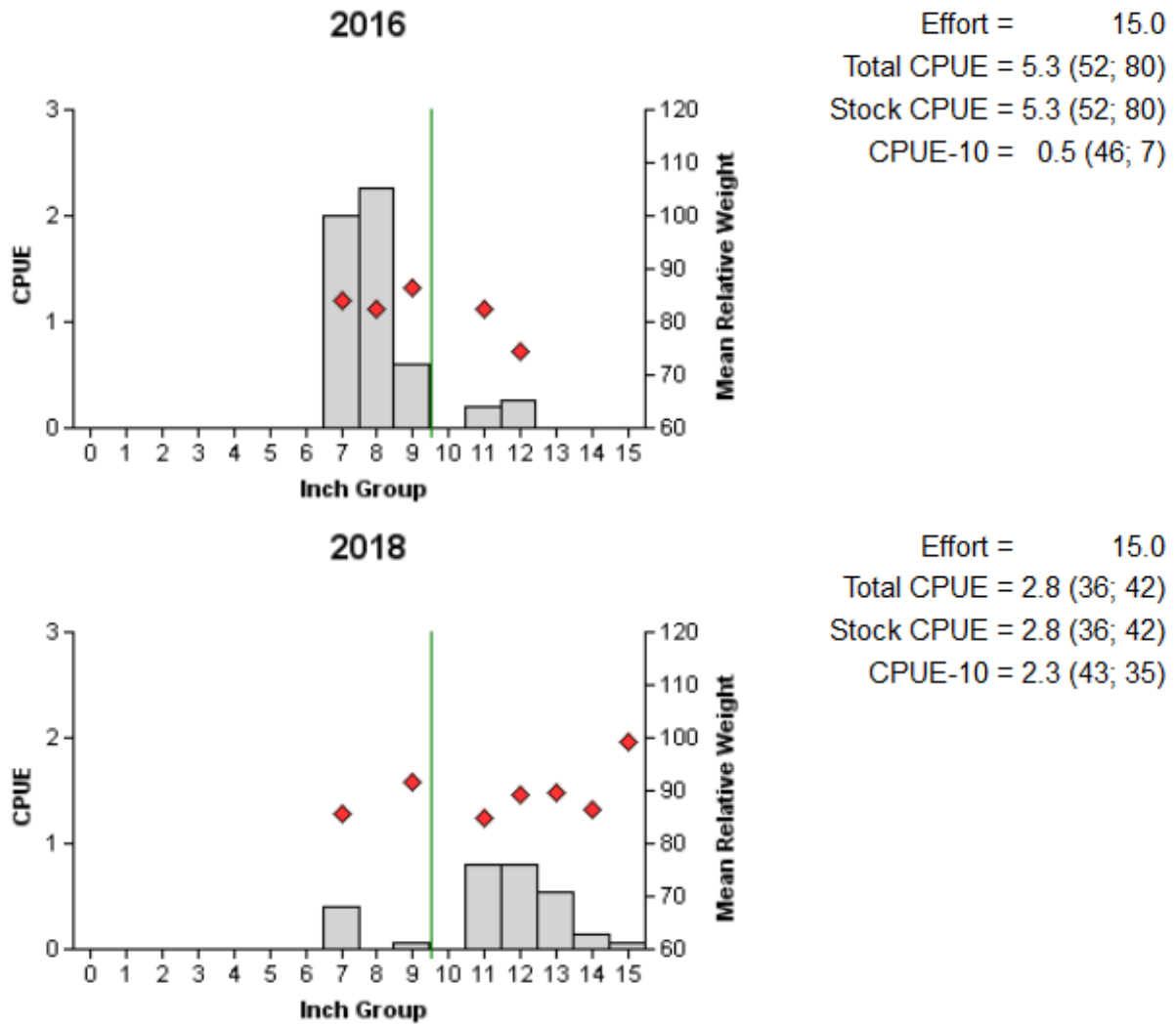


Figure 9. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2016 and 2018. Vertical line indicates minimum length limit.

Table 11. Creel survey statistics for White Bass at Buchanan Reservoir, Texas, from June 2019 through February 2020. Total catch per hour is for anglers targeting White Bass and total harvest is the estimated number of White Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	18,832.6 (39)
Directed effort/acre	0.84 (39)
Total catch per hour	1.29 (36)
Total harvest	26,426.5 (47)
Harvest/acre	1.19 (47)
Percent legal released	11.8

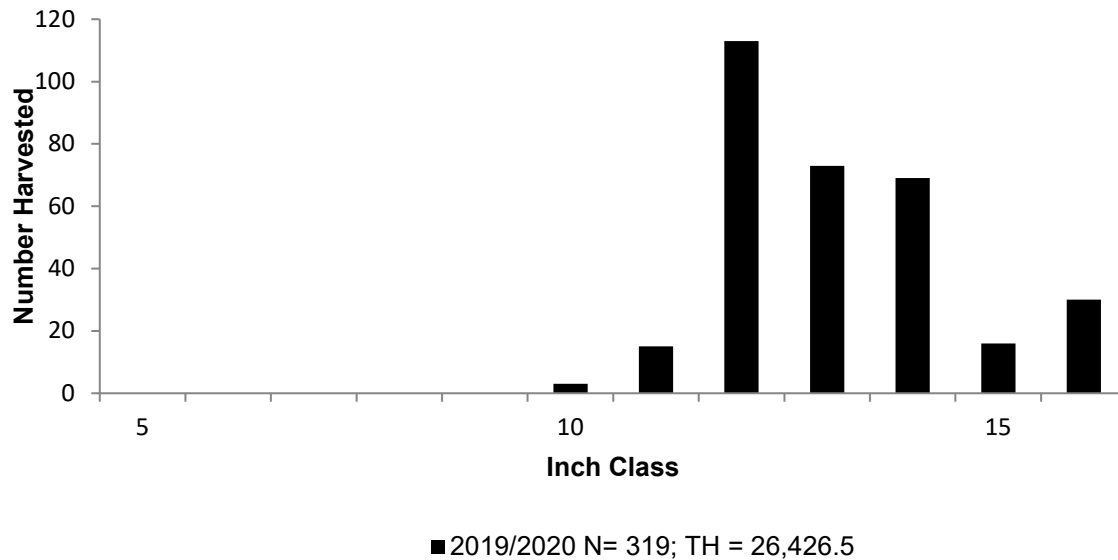


Figure 10. Length frequency of harvested White Bass observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through February 2020, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel survey period.

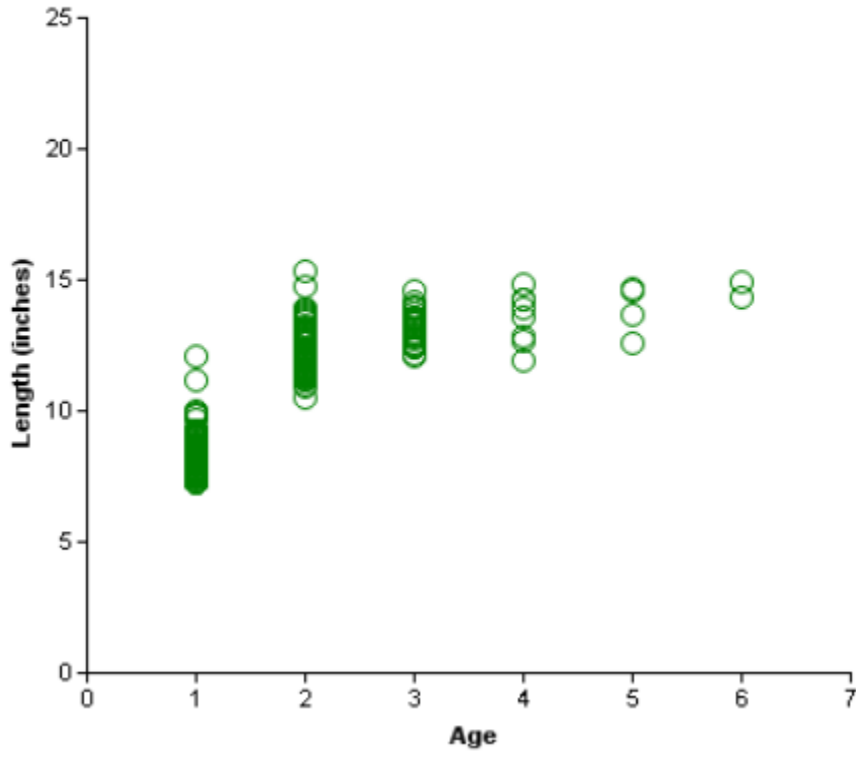


Figure 11. Length at age for White Bass collected during gill netting, Buchanan Reservoir, Texas, 2014 – 2018 (N = 195).

Striped Bass

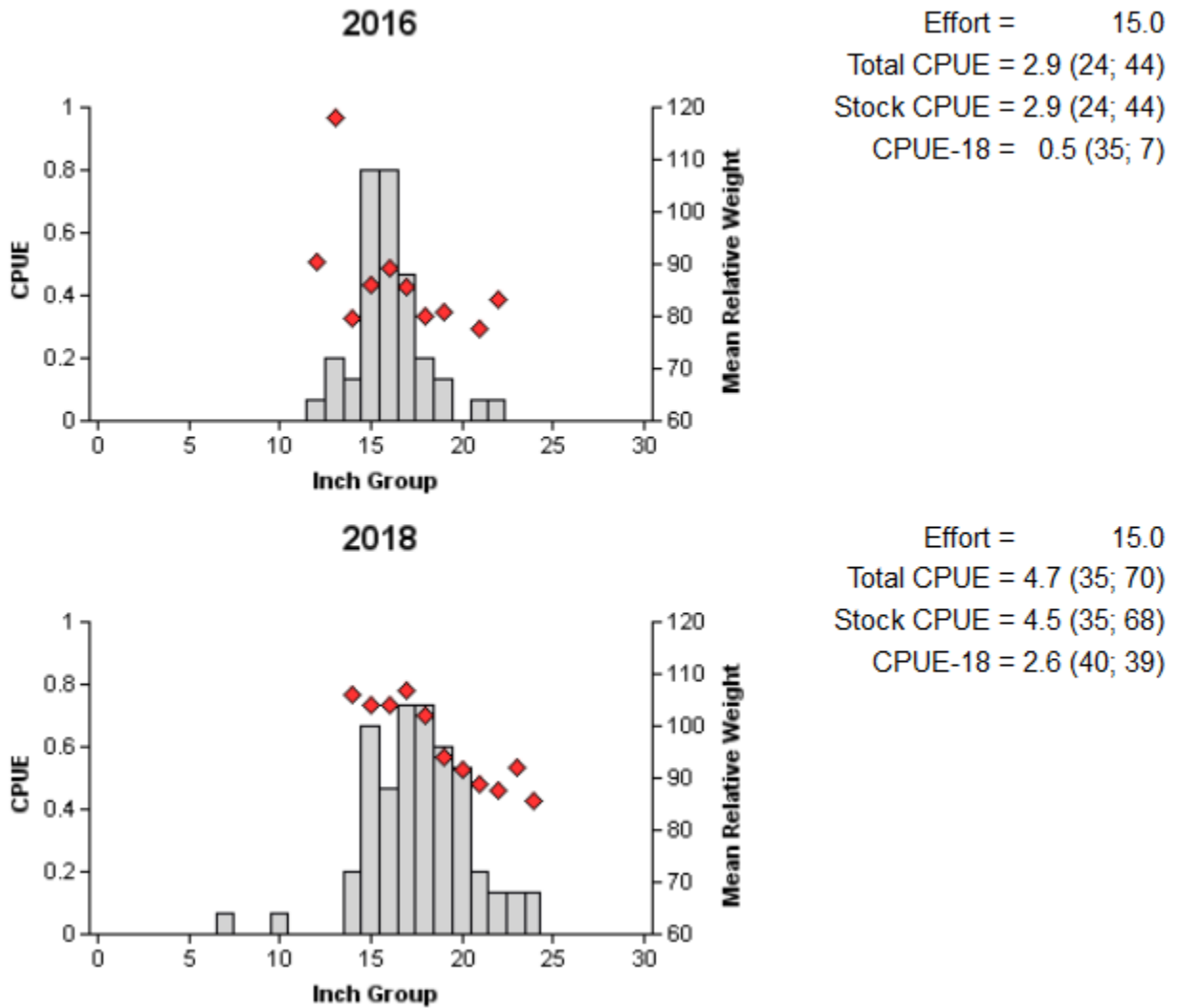


Figure 12. Number of Striped Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2016 and 2018.

Table 12. Creel survey statistics for Striped Bass at Buchanan Reservoir, Texas, from June 2019 through February 2020. 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
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	9,834.2 (50)
Directed effort/acre	0.44 (50)
Total catch per hour	0.18 (49)
Total harvest	2,395.8 (138)
Harvest/acre	0.11 (138)
Percent legal released	7.3

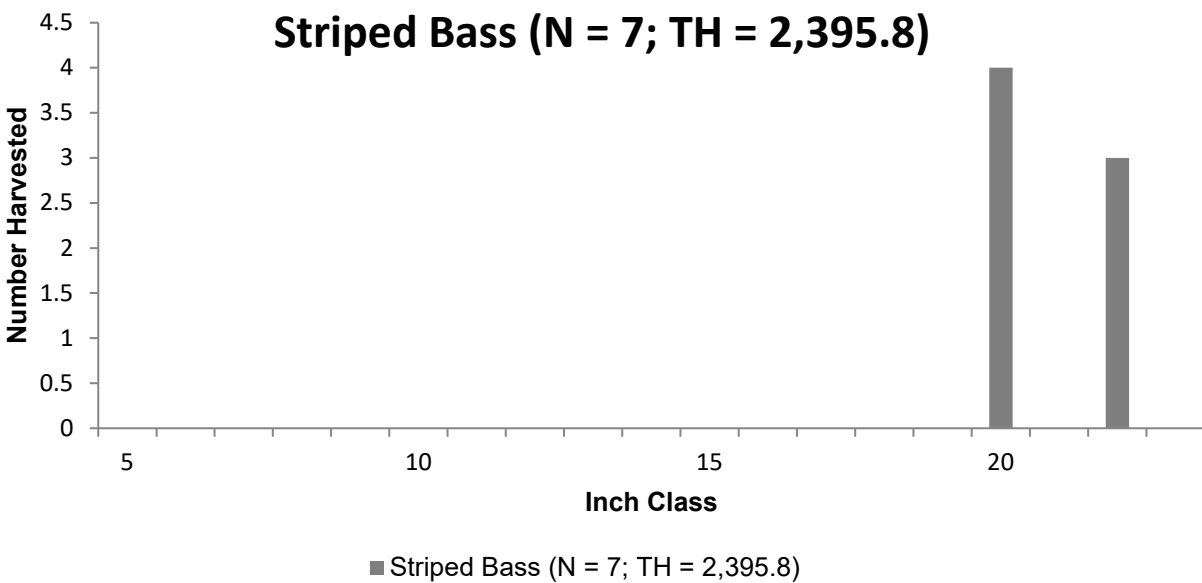


Figure 13. Length frequency of harvested Striped Bass observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through February 2020, all anglers combined. N is the number of harvested Striped Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

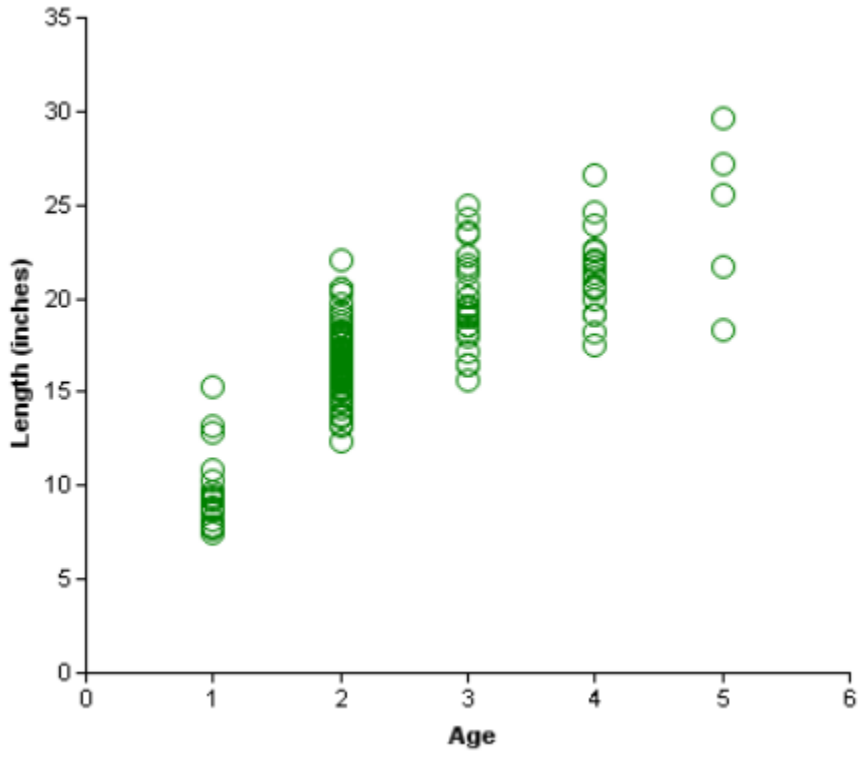


Figure 14. Length at age for Striped Bass collected during gill netting, Buchanan Reservoir, Texas, 2014 – 2018 (N = 154).

Largemouth Bass

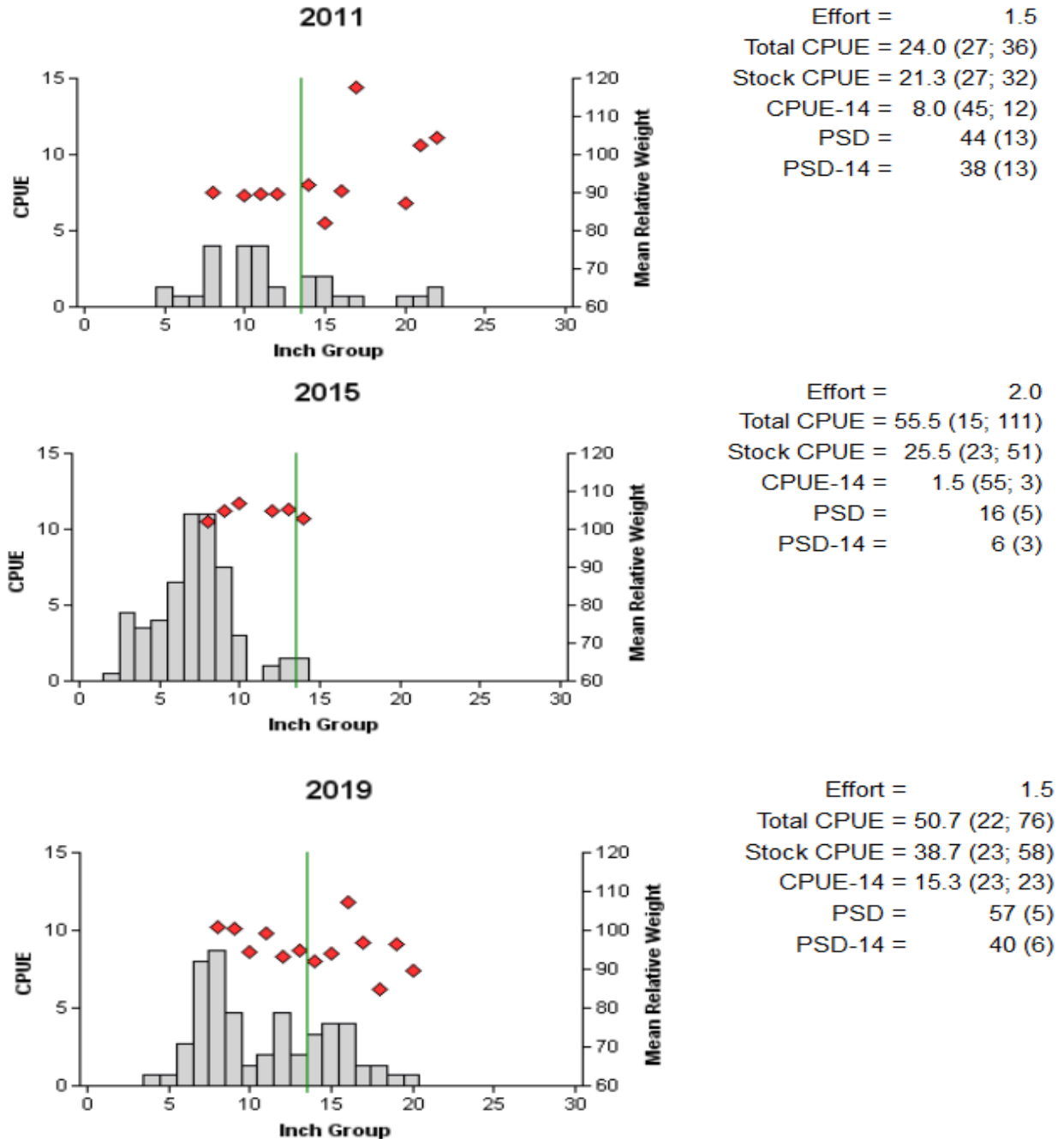


Figure 15. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Buchanan Reservoir, Texas, 2011, 2015, and 2019. Vertical line indicates minimum length limit. Daytime reduced-effort electrofishing conducted in 2011 due to hazardous lake conditions.

Table 13. Creel survey statistics for Largemouth Bass at Buchanan Reservoir, Texas, from June 2019 through February 2020. 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
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	30,503.6 (33)
Directed effort/acre	1.37 (33)
Total catch per hour	0.31 (31)
Total harvest	11,094.5 (68)
Harvest/acre	0.50 (68)
Percent legal released	17.2

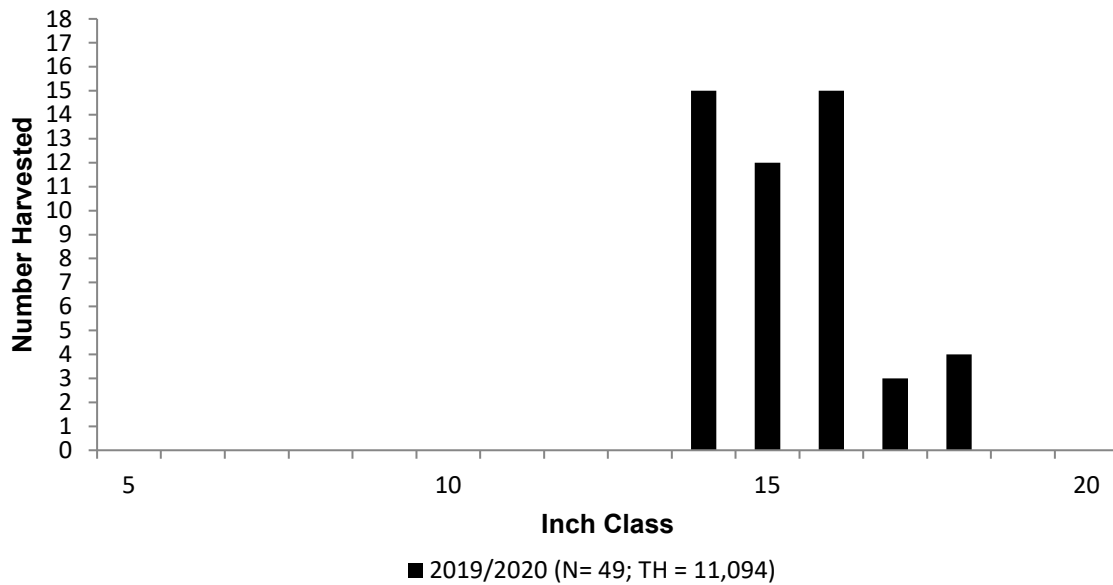


Figure 16. Length frequency of harvested Largemouth Bass observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through May 2020, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and TH is the estimated non-tournament harvest for the creel period.

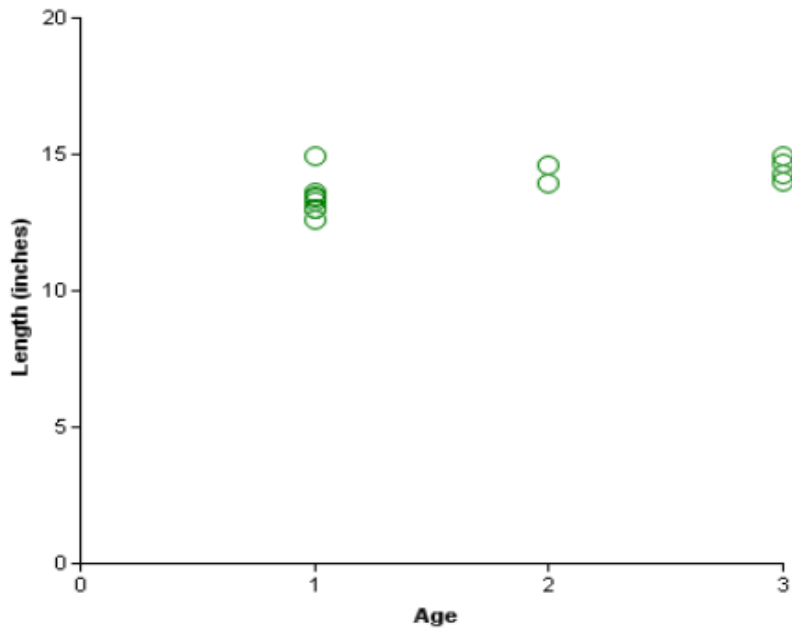


Figure 17. Length at age for Largemouth Bass collected during electrofishing, Buchanan Reservoir, Texas, 2015 and 2019 (N = 14).

Table 14. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Buchanan Reservoir, Texas, 2007, 2015, and 2019. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, F1 = first generation hybrid between a FLMB and NLMB, Fx = second or higher generation hybrid between a FLMB and NLMB. Genetic composition was determined by micro-satellite DNA analysis.

Year	Sample size	Number of fish				% FLMB alleles	% pure FLMB
		FLMB	F1	Fx	NLMB		
2007	30	3	NA	26 ^a	1	63.0	10.0
2015	30	3	NA	26 ^a	1	67.0	10.0
2019	30	3	2	25	0	69.3	10.0

^a Determination of hybrid status not conducted.

White Crappie

Table 15. Creel survey statistics for White Crappie at Buchanan Reservoir, Texas, from June 2019 through February 2020. Total catch per hour is for anglers targeting White Crappie and total harvest is the estimated number of White Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	15,973.5 (31)
Directed effort/acre	0.72 (31)
Total catch per hour	3.02 (36)
Total harvest	12,319.7 (59)
Harvest/acre	0.55 (59)
Percent legal released	4.6

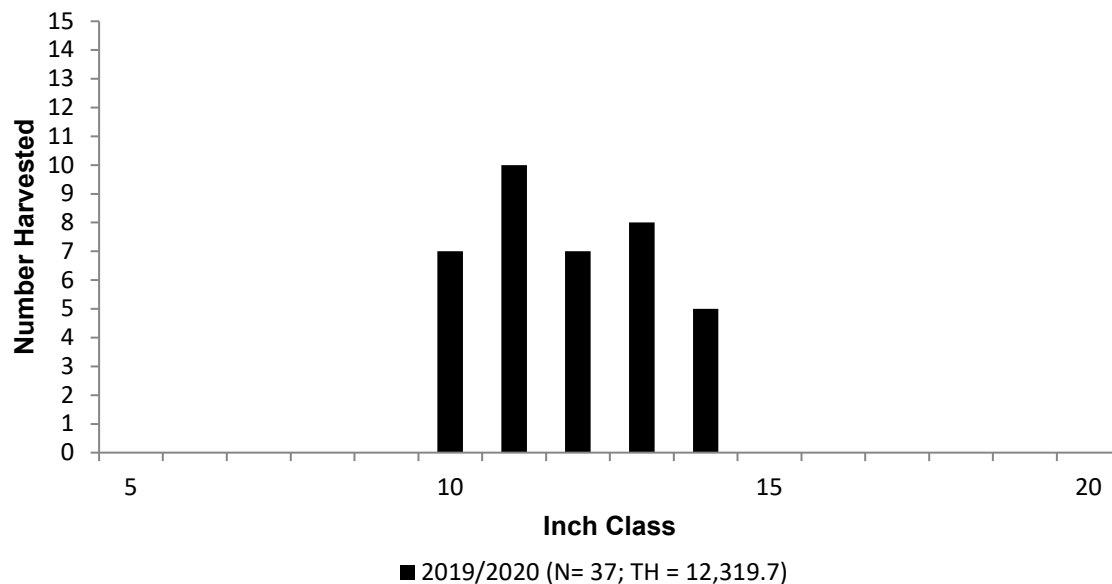


Figure 18. Length frequency of harvested White Crappie observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through May 2020, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the estimated non-tournament harvest for the creel survey period.

Sunshine Bass

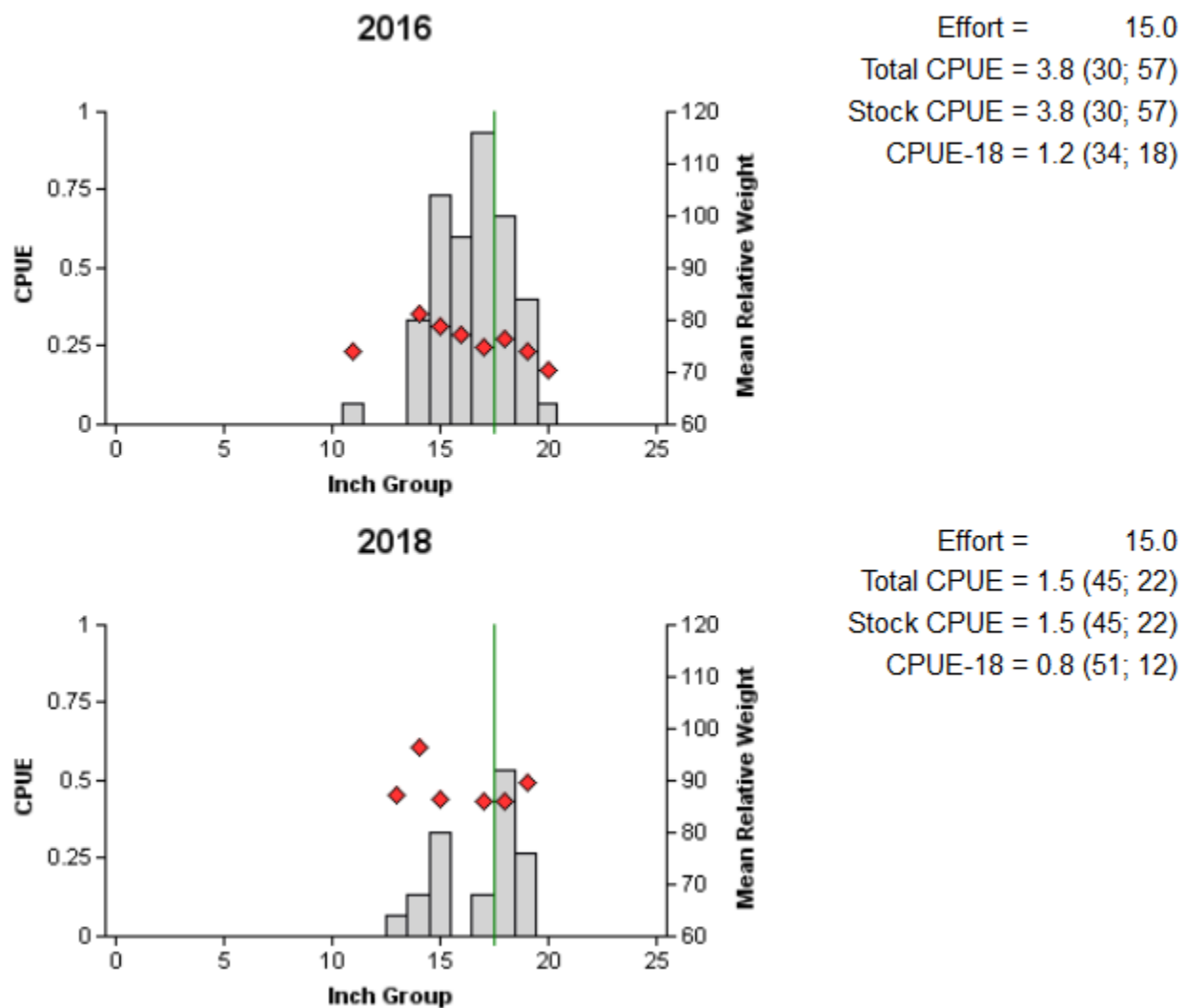


Figure 19. Number of Sunshine Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Buchanan Reservoir, Texas, 2016 and 2018. Vertical line indicates minimum length limit.

Table 16. Creel survey statistics for Sunshine Bass at Buchanan Reservoir, Texas, from June 2019 through February 2020. Total catch per hour is for anglers targeting Sunshine Bass and total harvest is the estimated number of Sunshine Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year
	2019/2020
Surface area (acres)	22,211
Directed effort (h)	0
Directed effort/acre	0
Total catch per hour	0
Total harvest	1,155.03(175)
Harvest/acre	0.05 (175)
Percent legal released	6.7

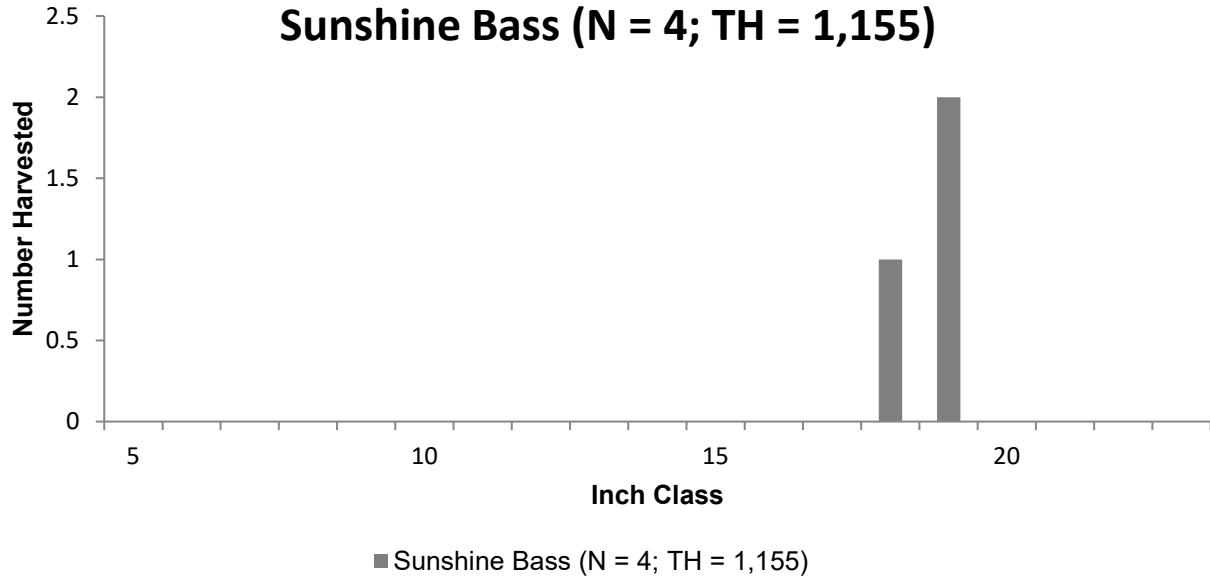


Figure 20. Length frequency of harvested Sunshine Bass observed during creel surveys at Buchanan Reservoir, Texas, June 2019 through May 2020, all anglers combined. N is the number of harvested Sunshine Bass observed during creel surveys, and TH is the estimated non-tournament harvest for the creel survey period.

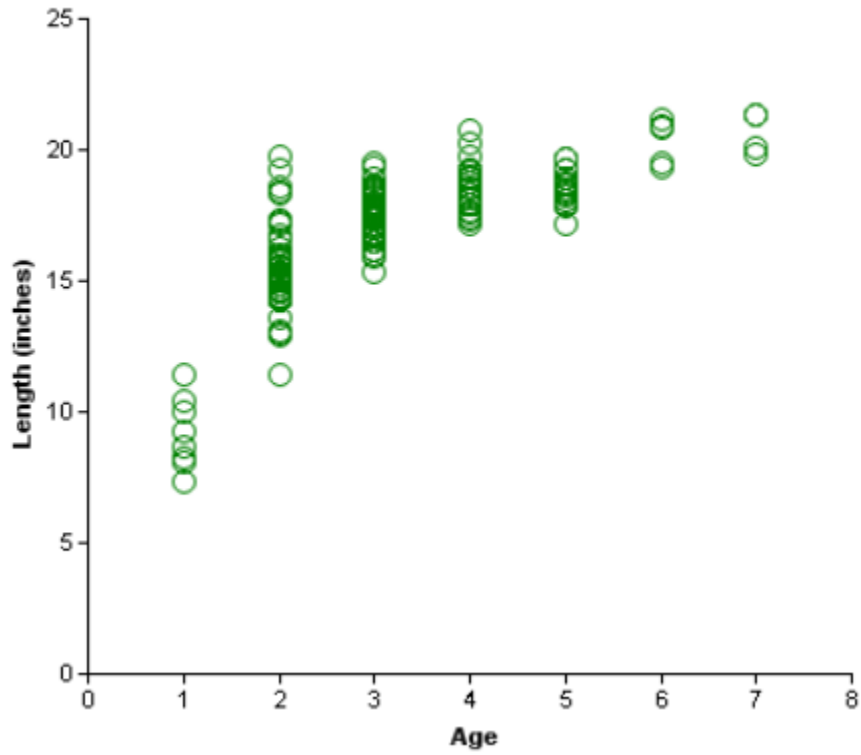


Figure 21. Length at age for Sunshine Bass collected during gill netting, Buchanan Reservoir, Texas, 2014 – 2018 (N = 168).

Proposed Sampling Schedule

Table 17. Proposed sampling schedule for Buchanan Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing and surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

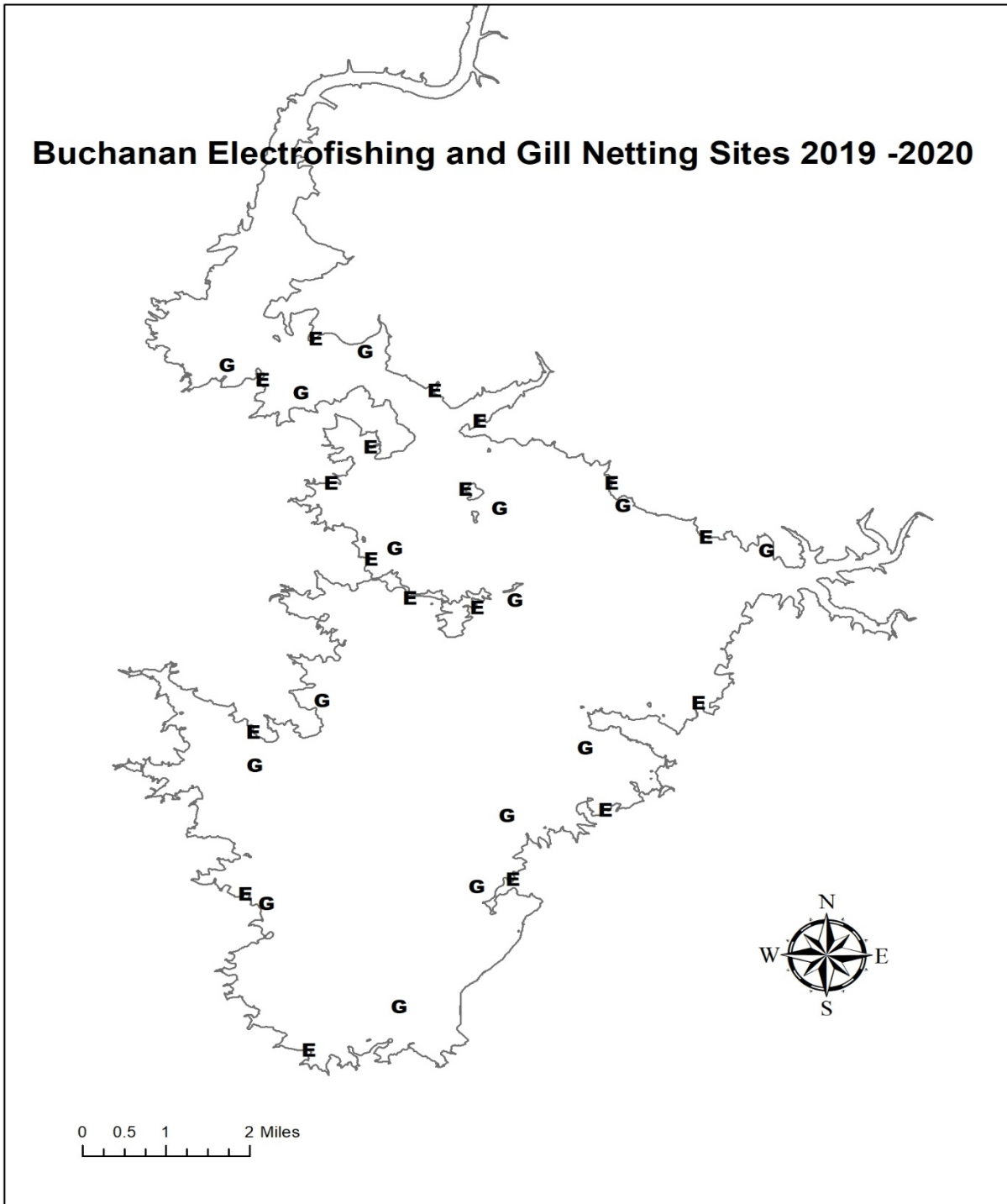
	Survey year			
	2020-2021	2021-2022	2022-2023	2023-2024
Angler Access				S
Structural Habitat				S
Vegetation				S
Electrofishing – Fall				S
Trap netting				
Gill netting	A	A		S
Creel survey				

APPENDIX A – Catch rates for all species from all gear types

Number (N) and catch rate (CPUE) (RSE in parentheses) of all target species collected from all gear types from Buchanan Reservoir, Texas, 2018-2019. Sampling effort was 15 net nights for gill netting and 1.5 hours for electrofishing.

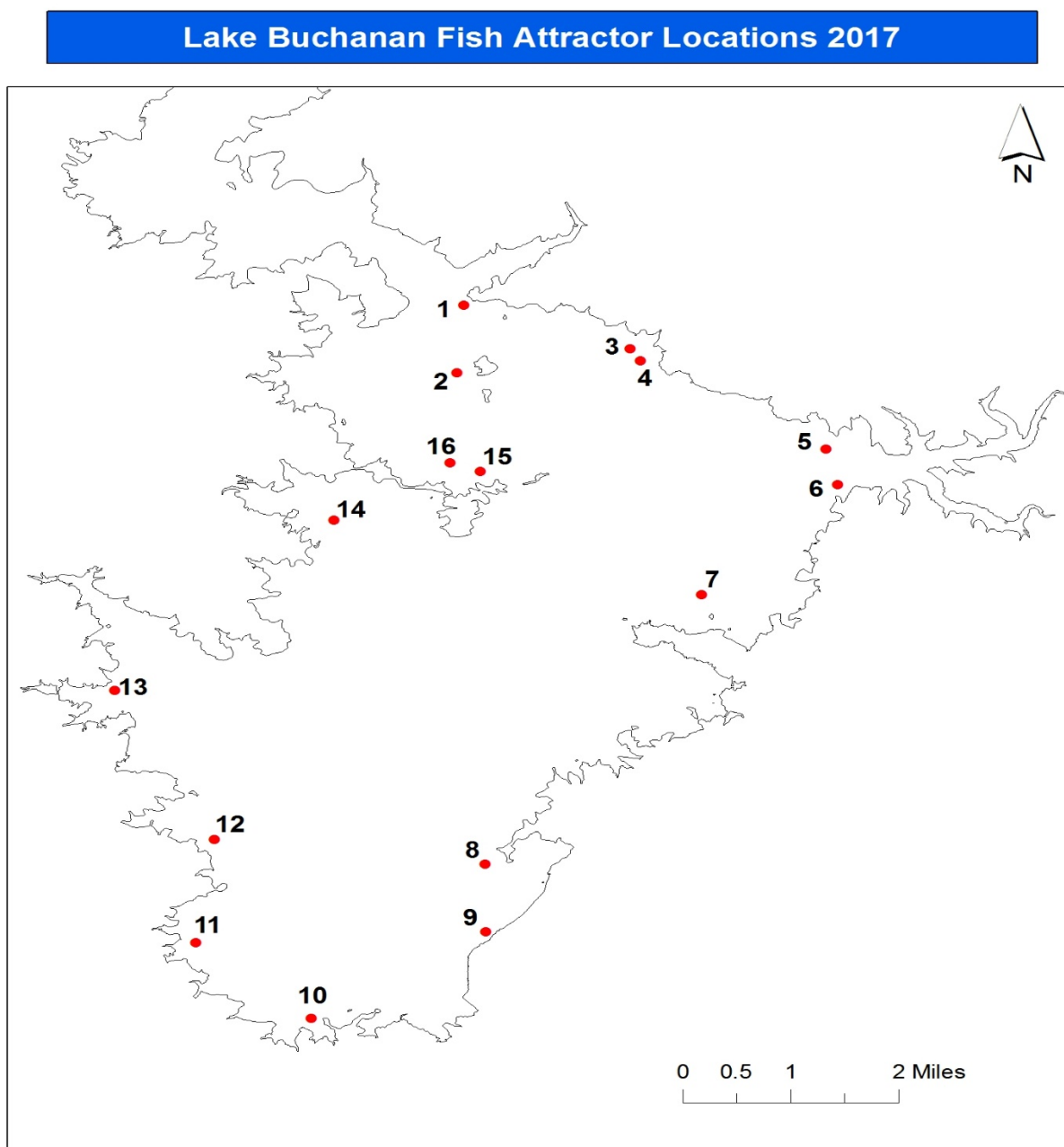
Species	Gill Netting		Electrofishing	
	N	CPUE	N	CPUE
Gizzard Shad			311	207.33
Threadfin Shad			29	19.33
Inland Silverside			1	0.67
Blue Catfish	46	3.07		
Channel Catfish	22	1.47		
Flathead Catfish	7	0.47		
White Bass	42	2.80		
Striped Bass	70	4.67		
Redbreast Sunfish			41	27.33
Green Sunfish			2	1.33
Bluegill			87	58.00
Longear Sunfish			20	13.33
Redear Sunfish			1	0.67
Largemouth Bass			76	50.67
Guadalupe Bass			3	2.00
Sunshine Bass (White Bass x Striped Bass hybrid)	22	1.74		

APPENDIX B – Map of sampling locations



Location of sampling sites, Buchanan, Texas, 2019-2020. Electrofishing and gill net stations are indicated by E and G, respectively. Water level was near full pool at time of sampling. Gill netting was not performed in 2020.

APPENDIX C – Map of Fish Attractor Locations



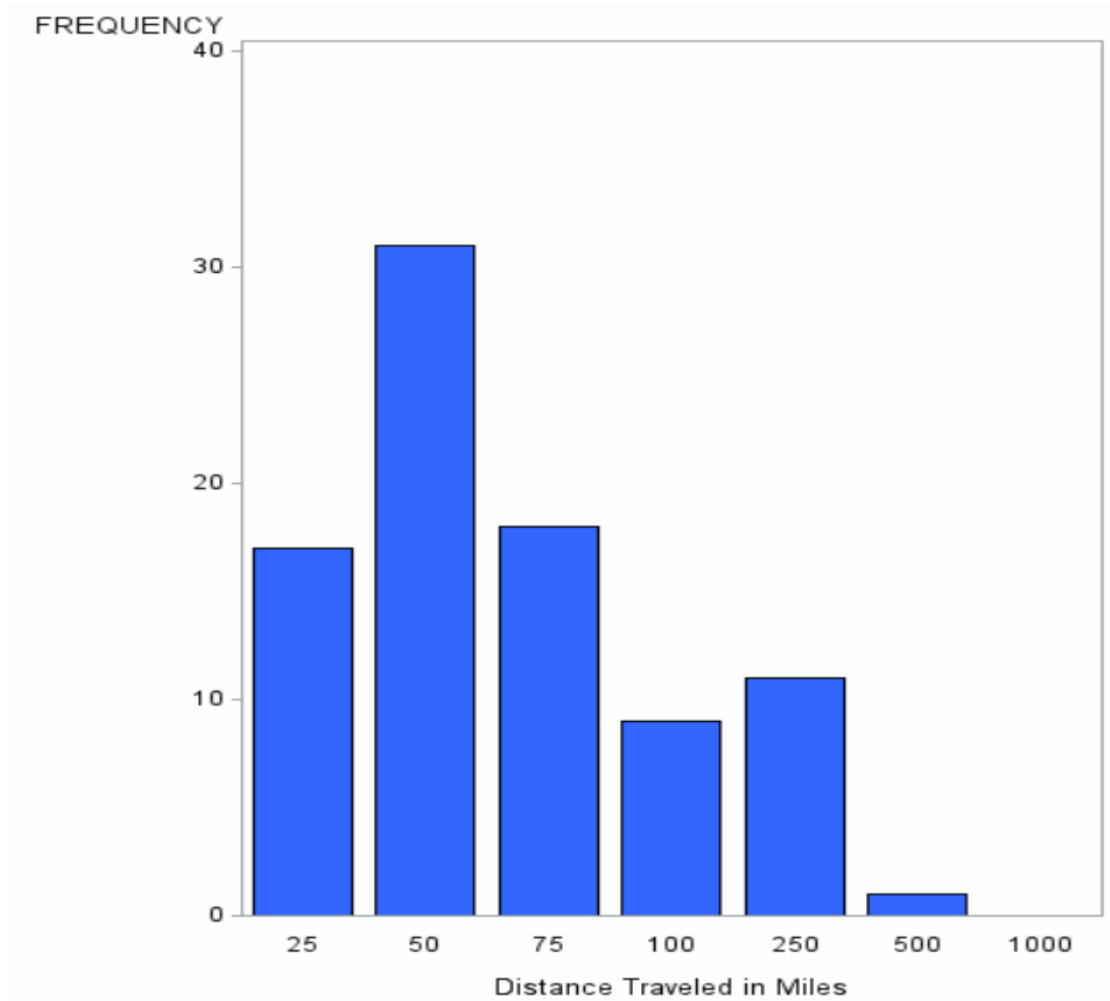
Map of Buchan Reservoir, Texas showing existing brush pile sites that were refurbished with artificial attractors (Mossbacks) in 2016.

APPENDIX D – GPS Coordinates of Fish Attractors

GPS coordinates for Buchanan Reservoir, Texas fish attractor locations that were refurbished with artificial structure (Mossback) in 2016. GPS coordinates are in degree decimal minutes.

Lake Buchanan Fish Attractor Locations		
January 2017		
Site #	Lat/Long	Site Description
1	N 30 51.506'	Rocky point near the mouth of Silver Creek
	W -98 25.107'	
2	N 30 50.857'	Long point off Garrett Island
	W -98 25.164'	
3	N 30 51.084'	Side of long point west of Burnet County Ramp
	W -98 23.769'	
4	N 30 50.969'	Main lake point west of Burnet County Ramp
	W -98 23.683'	
5	N 30 50.119'	North point at mouth of Morgan and Council Creeks
	W -98 22.194'	
6	N 30 49.775'	South point at mouth of Morgan and Council Creeks
	W -98 22.100'	
7	N 30 48.715'	Long point north of Windy Point
	W -98 23.201'	
8	N 30 46.112'	Long point west of dam
	W -98 24.935'	
9	N 30 45.462'	Near rocky shoreline on dam.
	W -98 24.926'	
10	N 30 44.630'	Next to standpipe in cove
	W -98 26.333'	
11	N 30 45.356'	Rockpile with 55 gallon barrel on pole
	W -98 27.264'	
12	N 30 46.354'	Rock hump north of Llano County ramp
	W -98 27.114'	
13	N 30 47.792'	Creek channel edge
	W -98 27.913'	
14	N 30 49.435'	Hump at mouth of Campground Creek
	W -98 26.151'	
15	N 30 49.905'	Rocky outcrop north of Shaw Island
	W -98 24.976'	
16	N 30 49.983'	End of long point north of Shaw Island
	W -98 25.214'	
1) GPS coordinates are in degree decimal minutes		
2) Bouys were installed in 2017 to mark fish attractor locations		
3) Artificial fish attractors are attached to bouy lines		
4) Coordinates and site numbering have been updated for bouy locations		

APPENDIX F – Reporting of creel ZIP code data



Frequency of anglers that traveled various distances (miles) to Buchanan Reservoir, Texas, as determined from the June 2019 through February 2020 creel survey.

Distribution by Zip Code and Distance Traveled for angler access for Lake 0118 from
01Jun2019 to 29Feb2020

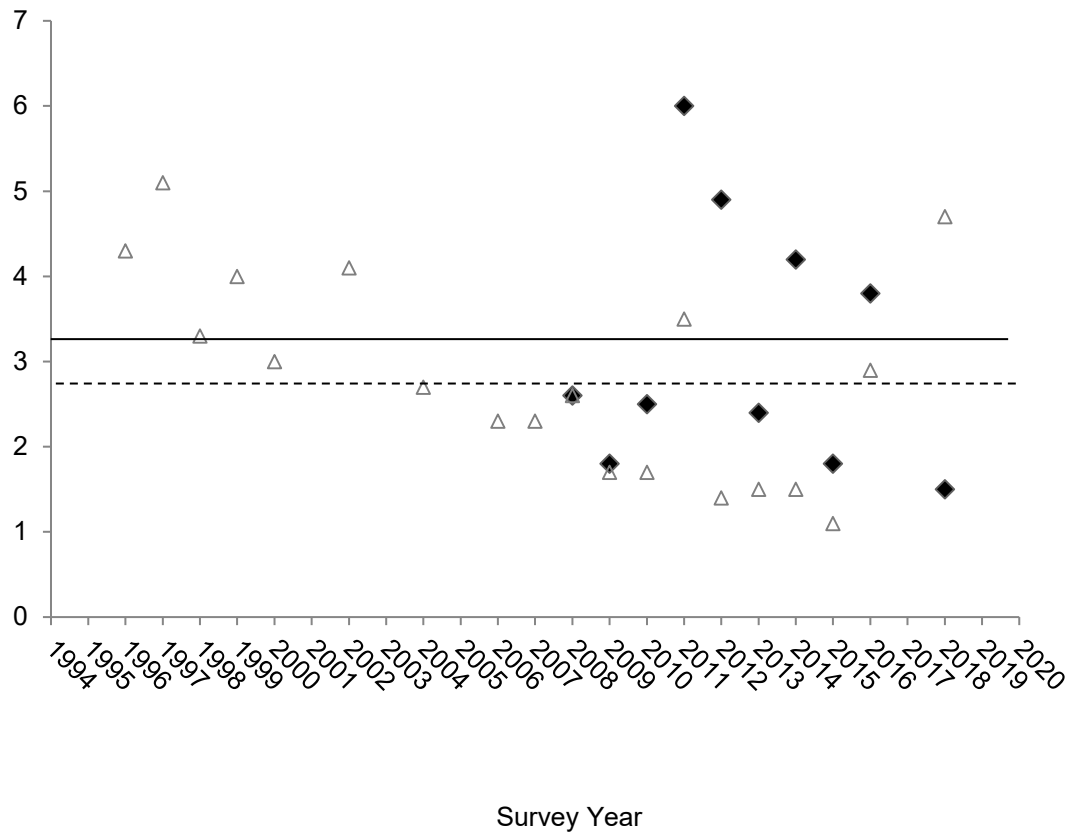
ZipCode	CITY	State	Count	Percent	Distance (miles)
71433	Glenmora	Louisiana	3	1%	343
75158	Scurry	Texas	3	1%	168
75877	Scurry	Texas	2	1%	168
76008	Aledo	Texas	2	1%	142
76248	Keller	Texas	1	0%	166
76384	Vernon	Texas	3	1%	240
76502	Temple	Texas	2	1%	66
76511	Bartlett	Texas	2	1%	59
76513	Belton	Texas	4	1%	61
76522	Copperas Cove	Texas	7	2%	39
76527	Florence	Texas	2	1%	38
76528	Gatesville	Texas	3	1%	62
76530	Granger	Texas	3	1%	58
76539	Kempner	Texas	7	2%	34
76543	Killeen	Texas	1	0%	52
76548	Harker Heights	Texas	2	1%	48
76550	Lampasas	Texas	12	3%	26
76552	Lampasas	Texas	3	1%	26
76554	Little River Academy	Texas	2	1%	65
76567	Rockdale	Texas	5	1%	84
76579	Troy	Texas	3	1%	73
76825	Brady	Texas	2	1%	72
76832	Cherokee	Texas	3	1%	23
76842	Fredonia	Texas	2	1%	44
76844	Goldthwaite	Texas	6	2%	48
76853	Lometa	Texas	2	1%	32
76872	Rochelle	Texas	2	1%	59
76877	San Saba	Texas	20	5%	36
77096	Houston	Texas	2	1%	191
77327	Cleveland	Texas	2	1%	204
77399	Livingston	Texas	1	0%	207
77995	Yoakum	Texas	3	1%	126
78006	Boerne	Texas	3	1%	73
78013	Comfort	Texas	3	1%	59
78015	Boerne	Texas	1	0%	68
78020	Boerne	Texas	4	1%	68

78026	Jourdanton	Texas	3	1%	127
78028	Kerrville	Texas	5	1%	66
78070	Spring Branch	Texas	6	2%	63
78121	La Vernia	Texas	4	1%	100
78133	Canyon Lake	Texas	3	1%	61
78152	Saint Hedwig	Texas	4	1%	92
78154	Schertz	Texas	2	1%	81
78155	Seguin	Texas	1	0%	86
78163	Bulverde	Texas	1	0%	74
78209	San Antonio	Texas	2	1%	88
78216	San Antonio	Texas	6	2%	84
78255	San Antonio	Texas	2	1%	78
78258	San Antonio	Texas	2	1%	75
78542	Edinburg	Texas	1	0%	308
78549	Hargill	Texas	2	1%	301
78605	Bertram	Texas	2	1%	22
78606	Blanco	Texas	1	0%	45
78607	Bluffton	Texas	1	0%	7
78609	Buchanan Dam	Texas	23	6%	4
78610	Buda	Texas	3	1%	58
78611	Burnet	Texas	43	11%	11
78612	Cedar Creek	Texas	3	1%	71
78613	Cedar Park	Texas	5	1%	39
78620	Dripping Springs	Texas	8	2%	39
78624	Fredericksburg	Texas	12	3%	53
78626	Georgetown	Texas	4	1%	46
78633	Georgetown	Texas	3	1%	45
78634	Hutto	Texas	2	1%	54
78639	Kingsland	Texas	8	2%	7
78641	Leander	Texas	6	2%	36
78642	Liberty Hill	Texas	12	3%	31
78643	Llano	Texas	5	1%	11
78644	Lockhart	Texas	1	0%	75
78645	Leander	Texas	2	1%	33
78650	McDade	Texas	6	2%	78
78654	Marble Falls	Texas	3	1%	13
78660	Pflugerville	Texas	14	4%	52
78664	Round Rock	Texas	4	1%	47
78672	Tow	Texas	16	4%	10
78675	Willow City	Texas	2	1%	28
78681	Round Rock	Texas	2	1%	45

78717	Austin	Texas	3	1%	44
78731	Austin	Texas	1	0%	48
78733	Austin	Texas	3	1%	43
78734	Austin	Texas	1	0%	42
78736	Austin	Texas	1	0%	45
78745	Austin	Texas	5	1%	53
78749	Austin	Texas	1	0%	50
78901	Austin	Texas	2	1%	50
79603	Abilene	Texas	2	1%	143
79703	Midland	Texas	5	1%	234
79735	Fort Stockton	Texas	4	1%	265
79763	Odessa	Texas	1	0%	249
80758	Wray	Colorado	1	0%	688
88240	Hobbs	New Mexico	2	1%	309

APPENDIX G – Historical Catch Rates for Striped and Sunshine Bass

Historical total catch rates of Striped Bass (triangles) and Sunshine Bass (diamonds) from gill net surveys at Buchanan Reservoir, Texas from 1996 to 2018. 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.





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