Canyon Reservoir

2019 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-4

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

Prepared by:

Patrick A. Ireland, District Management Supervisor

Mukhtar Farooqi, Assistant District Management Supervisor

Inland Fisheries Division
San Marcos/Austin District, San Marcos, Texas

Carter Smith
Executive Director

Craig Bonds
Director, Inland Fisheries

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Survey and Management Summary

Fish populations in Canyon Reservoir were surveyed in 2019 using electrofishing and in 2020 using gill nets. Historical data are presented with the 2019-2020 data for comparison. This report summarizes results of the surveys and contains a fisheries management plan for the reservoir based on those findings.

Reservoir Description: Canyon Reservoir is an 8,308-acre impoundment of the Guadalupe River located in Comal County. It was constructed in 1964 by the U.S. Army Corp of Engineers (USACE) for purposes of flood control, water conservation and recreation. Canyon Reservoir has a drainage area of approximately 1,452 square miles and a shoreline length of 90.5 miles. The reservoir lies within the Edwards Plateau ecological area.

Management History: Important sport fish include Largemouth Bass, Striped Bass, White Bass and catfish species. Striped Bass were introduced in 1973 and stocked until 1983, then restocked at a lower rate (5/acre) in 1989. White Bass were managed under an experimental 12-inch minimum length limit. The regulation was rescinded in 2004 after analysis indicated environmental factors, not angler harvest, were probably more influential in determining White Bass population density. Largemouth Bass were present in the reservoir and have been managed under statewide regulations. Florida Largemouth Bass were stocked in 2008, 2010, and 2014 through 2019 to influence genetics. Blue Catfish were introduced in 1991 to provide enhanced catfish opportunities for anglers.

Fish Community

- **Prey species:** Sunfishes and Gizzard Shad were the dominant prey species available. Threadfin Shad and Inland Silversides were present in low densities.
- **Catfishes:** Channel, Blue, and Flathead Catfish were present in low densities.
- **Temperate basses:** Striped Bass and White Bass were present in the reservoir. A fish consumption advisory was placed on Striped Bass in 2006, but limited consumption was allowed and the species still offered excellent catch-and-release opportunity. Striped Bass abundance remained relatively consistent from 2016, 2018, and 2020 with legal-size (≥18 inches) Striped Bass still present. White Bass abundance declined in 2010 and has remained low.
- **Black basses:** Largemouth Bass abundance was moderate, rebounding slightly from previous surveys. Smallmouth Bass were present in low densities and have declined since 2007.

Management Strategies: Annual Striped Bass stockings should continue to be requested at the present stocking rate of 5/acre. Fish attractor sites should continue to be replenished with brush and artificial structure as needed. Inform the public about the negative impacts of aquatic invasive species. Conduct general monitoring surveys with electrofishing (2023) and gill nets (2022, 2024). Access and habitat surveys will be conducted in 2023.

Introduction

This document is a summary of fisheries data collected from Canyon Reservoir from 2019–2020. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fisheries. While information on other fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2019-2020 data for comparison.

Reservoir Description

Canyon Reservoir is an 8,308-acre impoundment of the Guadalupe River located in Comal County. It was constructed in 1964 by the U.S. Army Corps of Engineers for purposes of flood control, water conservation and recreation. Canyon Reservoir has a drainage area of approximately 1,452 square miles and a shoreline length of 90.5 miles. The reservoir lies within the Edwards Plateau ecological area. Other descriptive characteristics for Canyon Reservoir are in Table 1.

Angler Access

Canyon Reservoir has twenty-two public boat ramps, of which fifteen offered bank angling opportunities. Shoreline access at many of the parks was excellent. One public fishing pier was available at Cranes Mill Park, on the upper end of the reservoir. White Bass anglers could access the Guadalupe River above the reservoir using the Rebecca Creek boat ramp. Reservoir water levels are subject to frequent fluctuations (Figure 1), which may impact access during extreme conditions. Additional boat ramp characteristics are in Table 2.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Cummings and De Jesus 2016) included:

1. Monitor Striped Bass population density with gill net surveys and continue annual stocking requests at 5/acre.

   Action: Striped Bass were stocked in 2016, 2017, and 2019 at 5/acre. Striped bass were surveyed with gill nets in 2018 and 2020.

2. Continue to maintain fish attractor sites. When possible, create new sites.

   Action: Attractor sites were refurbished from 2017-2019. Sites were scheduled to be refurbished in May of 2020 but this was postponed due to the coronavirus pandemic.

3. Inform the public about invasive species threats to Canyon Reservoir.

   Action: Zebra mussel signage has been added to the two main marinas on the reservoir and at all public boat ramps. Partnership with Water-Oriented Recreation District (WORD) has provided $5,000 annually since 2014 for TPWD invasive species awareness campaign, including a billboard in San Marcos. Zebra mussels were discovered in Canyon Reservoir in 2017.

Harvest regulation history: Sport fishes in Canyon Reservoir are currently managed with statewide regulations (Table 3).

Stocking history: Florida Largemouth Bass were stocked in 2016-2019 to increase genetic influence and promote growth potential. Striped bass were an important species requested for annual stockings. Blue Catfish were stocked in 1991-92. A complete stocking history is in Table 4.

Vegetation/habitat management history: Canyon Reservoir has historically lacked aquatic vegetation due to its rocky and steep shoreline. A vegetation survey in August 2019 detected a small amount of Hydrilla in the back of several cove areas. Littoral zone structural habitat was primarily rocky shoreline, natural shoreline, and rock bluff. Standing timber and marinas provided some cover for centrarchids. Artificial fish attractors have been installed and maintained around the reservoir (Appendix C through E) to provide habitat for cover-seeking species and to help improve angler success.

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

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective based sampling (OBS) plan for Canyon Reservoir (Cummings and De Jesus 2015). 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, and Gizzard and Threadfin Shad were collected by electrofishing (1.5 hours at 18, 5-min stations). Catch-per-unit-effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. A category-2 age and growth evaluation (using otoliths from 13 randomly selected fish ranging 13.0 to 14.9 inches) was completed for Largemouth Bass (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Gill netting – Channel, Blue, and Flathead Catfish, and Striped and White Bass were collected by gill netting (15 net nights at 15 stations). For gill netting CPUE was recorded as the number of fish caught per net night (fish/nn). In 2016, a stratified random sampling strategy was employed for gill nets targeting Striped Bass as part of the 2016-2020 objective-based sampling plan. Stratified sampling was one option to reach target relative standard error (RSE) while minimizing effort. Additional surveys will allow further evaluation of this method. Canyon Reservoir was divided into three sections (upper, middle, lower) with approximately equal area. Historic gill net catch rates (2004-2014) were used to determine how much each section contributed to total catch of Striped Bass. Proportions of total catch for each section were: upper = 25%, middle = 30%, lower = 45%. The closest arrangement of gill nets to these proportions was: upper = 4 nets, middle = 5 nets, lower = 6 nets. Gill nets were randomly distributed in each section. White Bass and catfish species were collected under this sampling regime. All Striped 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), and 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 statistics.

Habitat – A structural habitat survey and vegetation survey were 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 United States Geological Survey (USGS 2020).

Results and Discussion

Habitat: In 2019, littoral zone habitat consisted primarily of rocky shoreline, natural shoreline, and rock bluff. Standing timber and marinas provided cover for centrarchids (Table 6). A very small amount of aquatic vegetation, in the form of non-native Hydrilla was found but not mapped due to its very low coverage. Reports in 2019 revealed that anglers were seeing more hydrilla in the reservoir. Overall, the low amount of aquatic vegetation is not optimal for fish production (Durocher et al. 1984, Dibble et al. 1996). Fish in this reservoir relate mainly to irregular topographical features and available cover. A fish attractor project was initiated in 2005 to help concentrate cover-seeking species and increase angler catch rates. Juniper trees (*Juniperus ashei*) and fabricated polyethylene fish attractors were installed at 19 sites in 2005. Since 2005, 24 sites have been added for a total of 44 fish attractor sites throughout the reservoir. Attractor sites are refurbished annually with assistance from partner organizations and volunteers. In June of 2019, these sites were evaluated by divers to document their placement, condition, and the numbers and species of fish they attracted (Appendix C and D). Global positioning system (GPS) coordinates were made available to the public (Appendix E), and direct observation through scuba diving revealed that cover-seeking species were attracted to these structures.

Prey species: Electrofishing catch rates of Gizzard Shad in 2019, 2015, and 2011 were 66.7/h, 192.0/h, and 42.7/h, respectively. Threadfin Shad and other sunfish species were also available as forage. Index of Vulnerability for Gizzard Shad noticeably decreased from 79 to 44 since 2015, indicating that 44% of Gizzard Shad were vulnerable (≤8 inches) to existing predators (Figure 2). Redbreast Sunfish was the dominant sunfish species in Canyon Reservoir with the majority of the sampled population consisting of small individuals (PSD = 20; Figure 3). Total CPUE in 2019 for Redbreast Sunfish was 192.0/h which was consistent with 2015 (199.3/h) and 2011 (201.0/h). Total CPUE of Bluegill in 2019 (72.7/h) was noticeably less than the survey in 2015 (154.0/h), and size structure continued to be dominated by small individuals (PSD = 7; Figure 4). Overall, the forage abundance appears to be reduced when compared to the sampling years prior to 2011. We did not meet our objective of RSE ≤ 25 for Gizzard Shad (Table 5).

Blue Catfish: Blue Catfish gill net catch rate (2.1/nn) in 2020 was nearly double that of 2018 (1.2/nn). The 2018 gill net catch rate, though low, was consistent with the 2016 catch rate of 1.1/nn (Figure 5). For both 2018 and 2020, all individuals sampled were ≥12 inches, and larger individuals (≥25 inches) were present. Aging from otoliths in 2008 revealed that Blue Catfish were reproducing in Canyon Reservoir with individual ages ranging from 3 to 17 years (N=13) (De Jesus and Magnelia 2008). Body condition has remained relatively consistent since 2016 as average relative weights (Wr) ranged from 75-103 in 2018 and 88-106 in 2020. Average relative weights for 2016 ranged from 85-109.

Channel Catfish: The gill net catch rates for Channel Catfish were 1.1/nn and 0.9/nn in 2018 and 2020, respectively. This is consistent with the 2016 survey (1.1/nn; Figure 6). Individuals <12 inches in length indicated reproduction was occurring. Large Channel Catfish (≥20 inches) were present in this survey. Condition was good as average relative weights (W_r) of fish generally remained above 85 (range: 80-107 in 2018 and 89-96 in 2020). The population structure was mostly comprised of harvest-size (≥12 inches) individuals.

Flathead Catfish: Flathead Catfish were present in low density (0.6/nn in 2018 and 0.9/nn in 2020). However, this was consistent with the 2016 survey (0.7/nn; Figure 7). All individuals were over 18 inches, and large individuals (≥30 inches) were present. Body condition (W_r) ranged from 61 to 109 for both 2018 and 2020.

White Bass: The gill net catch rate of White Bass was 1.7/nn in 2020, an increase from 2018 (0.5/nn), but less than 2016 (3.0/nn; Figure 8). Canyon Reservoir is well known for its White Bass spring spawning migrations, which provide great angling opportunities for this species in the upper portion of the reservoir.

Striped Bass: The gill net catch rate of Striped Bass was 2.5/nn in 2020, an increase from 2018 (0.5/nn), but less than 2016 (3.4/nn; Figure 9). Missing year classes of two-year-old individuals in the 2020 survey were due to missed stockings in 2018. Body condition (W_r) was below average for most inch groups (range 67-105) and may be the result of stress from elevated water temperature and low dissolved oxygen conditions during the summer months (Magnelia and De Jesus 2008). From 2012 to 2016, Striped Bass reached the legal length limit (18 inches), on average between two and three years of

age (Figure 10). In 2016, a stratified random sampling strategy was employed for gill nets targeting Striped Bass. The resulting catch was 3.4/nn (Figure 9), which was the highest CPUE for this species since 1986 (when online records began). High CPUE can be attributed to high catch rates of 2- and 3-year-old Striped Bass, which likely correlates to a double stocking rate in 2013, followed by a normal stocking event in 2014. This was reflected by 39 Striped Bass (2.6/nn) that were over 18 inches in the 2016 survey (also the highest since 1986). Body condition (W_r) decreased as fish length increased, likely due to summer stress. In October 2006, the Texas Department of State Health and Human Services issued a fish consumption advisory for Striped Bass. Elevated mercury levels were detected and it was advised that consumption be limited to two 8-oz. portions for adults and two 4-oz. portions for children per month. Striped Bass still provide a popular catch-and-release fishing opportunity at Canyon Reservoir (De Jesus and Magnelia 2008). Guides, angler reports, and tournament results attest to the availability of quality- to trophy-sized fish.

Smallmouth Bass: Electrofishing catch rates have been highly variable over the last three surveys. In 2011, Smallmouth Bass total catch was 12 fish (8.0/h), in 2015 it was 2 fish (1.3/h), and in 2019 it was 28 fish (18.7/h; Figure 11). All but one fish sampled in 2011, 2015, 2019 were below the legal size limit (14 inches). Smallmouth Bass were initially stocked in the Guadalupe River Basin in 1974. Due to introgression with Guadalupe Bass, TPWD ceased stockings of Smallmouth Bass in this reservoir in 1989. Natural reproduction has been documented in Canyon Reservoir and in the Guadalupe River Basin. This natural reproduction was evidenced by 16 individuals sampled in 2019 that were under 7 inches.

Largemouth Bass: Largemouth Bass have historically been the most sought after sport fish species in Canyon Reservoir (Magnelia and Bonds 2004). Largemouth Bass electrofishing total catch rates increased in 2019 (90.7/h) from 2015 (80.0/h) which was a further increase from 2011 (51.3/h; Figure 12). This was likely due to high water levels that began in May 2015 and continued through 2019, providing optimal littoral habitat. The 2019 and 2015 catch rates were less than 2007 (113.3/h) when another high water event produced a strong year class (De Jesus and Magnelia 2008). The catch rate for legal-size fish (≥14 inches) increased to 16.0/h (24% of stock CPUE) since 2015, which was 9.3/h (29% of stock CPUE). Body condition (W_r) was good in 2019, with most inch groups averaging above 95. Largemouth Bass reached 14 inches between ages 2 and 3, but growth rates leveled off for older fish (N = 13; Figure 13). This is similar to the findings of previous surveys (De Jesus and Magnelia 2008, De Jesus and Farooqi 2012, Cummings and De Jesus 2015). Florida Largemouth Bass (FLMB) genetic influence in the population stayed relatively constant at 68% in 2019 from 70% in 2015 (Table 7). No pure FLMB or pure Northern Largemouth bass were sampled in 2019.

Fisheries Management Plan for Canyon Reservoir, Texas

Prepared – July 2020

ISSUE 1: Striped Bass provide quality catch-and-release opportunities for recreational anglers at Canyon Reservoir, with limited harvest due to the current consumption advisory. Low stocking rates combined with low harvest allow for some fish to live long and grow well, providing trophy opportunities. Since 2013, hatchery production has allowed stockings to resume on an annual basis. This fishery is contingent on supplemental stockings.

MANAGEMENT STRATEGIES

1. Continue to request annual Striped Bass stockings at a rate of 5/acre.
2. Continue to monitor Striped Bass abundance with randomly stratified gill net surveys in 2022 and 2024

ISSUE 2: Largemouth Bass are the reservoir's most sought after sport fish, but angler catch rates have traditionally been poor. The installation of fish attractors was successful at attracting Largemouth Bass and other cover-seeking species. Anecdotal reports indicated this program was very popular with Canyon Reservoir anglers, however, the longevity of Juniper tree fish attractors is four years. Trees are locally available in several public parks on the reservoir at no cost and volunteers are readily available to provide labor.

MANAGEMENT STRATEGY

1. Continue to take advantage of the opportunities present to maintain fish attractor sites. When possible, coordinate efforts to create new sites or replenish existing sites utilizing artificial trees.

ISSUE 3: Florida Largemouth Bass were stocked into Canyon Reservoir in 2008, 2010, and 2014-2019 to increase genetic influence for growth. Recent stockings were conducted during high water level to take advantage of flooded shoreline habitat.

MANAGEMENT STRATEGY

1. Monitor genetic influence in Largemouth Bass collected during standard fall electrofishing survey in 2023.

ISSUE 4: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (*Dreissena polymorpha*) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches and plugging engine cooling systems. Giant Salvinia (*Salvinia molesta*) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

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

Objective-Based Sampling Plan and Schedule (2020–2024)

Sport Fish, forage fish, and other important fishes

Sport fishes in Canyon Reservoir include Largemouth, Smallmouth, and Guadalupe Bass, Blue, Channel,and Flathead Catfish, White and Black Crappie, and Striped and White Bass. Known important forage species include Redbreast Sunfish, Bluegill, and Gizzard Shad. A summary of objective-based sampling components is in Table 5.

Low-density fisheries

Channel catfish: Channel Catfish were stocked in 1966 and are present in Canyon Reservoir, but population abundance is low. Water clarity is high and predation on juvenile catfish is likely high. Catch per unit effort from gill netting surveys conducted every two years from 2004-2020 averaged 1.1/nn. Channel Catfish accounted for 5.9% of the directed fishing effort in the last creel survey conducted on the reservoir (1999). General monitoring trend data (without precision or sample size requirements) can be gathered for this species while sampling for Striped and White Bass with gill nets as outlined below.

Blue Catfish: Blue Catfish were stocked in Canyon Reservoir in 1991 and 1992. Catch per unit effort (CPUE) from gill netting surveys conducted every two years from 2004-2020 averaged 1.3/nn. Blue Catfish accounted for 0.5% of the directed fishing effort in the last creel survey conducted on the reservoir (1999). General monitoring trend data (without precision or sample size requirements) can be gathered for this species while sampling for Striped and White Bass with gill nets as outlined below.

Flathead Catfish: Flathead Catfish are present in low abundance based on gill netting surveys. Catch per unit effort (CPUE) from gill netting surveys conducted every two years from 2004-2020 averaged 0.5/nn. General monitoring trend data (without precision or sample size requirements) can be gathered for this species while sampling for Striped and White Bass with gill nets as outlined below.

Crappie: No trap netting has been conducted for crappie since 2003 (0.5/nn) because of historically low catch rates. During a 1999 creel survey, White Crappie angling activity accounted for only 3.6% of the total directed fishing effort, or 0.5 h/acre. Crappie will not be sampled in the 2020-2024 period.

Smallmouth Bass: Smallmouth Bass were initially stocked in the Guadalupe River Basin in 1974. The last stocking was in 1989. Catch per unit effort from electrofishing surveys in Canyon Reservoir in 2015, 2019 were 1.3 and 18.7/h respectively. This species does not provide a significant fishery. We will still monitor presence/absence with practical effort estimates from electrofishing surveys (without precision or sample size requirements).

Guadalupe Bass: Catch per unit effort from electrofishing surveys in 2003, 2007, 2011, 2015, and 2019 were 5.3, 4.0, 1.3, 7.3, and 0.0, respectively. This species does not provide a significant fishery. We will still monitor presence/absence with practical effort estimates from electrofishing surveys (without precision or sample size requirements).

Survey objectives, fisheries metrics, and sampling objectives

Largemouth Bass: In a 1999 creel survey, Largemouth Bass was the most sought-after sport fish with 46% of the total fishing effort directed toward this species. Canyon Reservoir is relatively clear and lacks vegetation and woody cover. A fish attractor project was initiated in 2005 to help concentrate cover seeking species and increase angler catch rates. Anecdotal reports indicated this program was very popular with Canyon Reservoir anglers. Largemouth Bass are managed with the statewide 14-inch minimum length regulation. Catch per unit effort from electrofishing surveys in 2003, 2007, and 2011 were 203.3, 113.3, and 51.3/h respectively. The reduced abundance in the 2011 survey may have reflected the impact of extreme drought conditions in 2009 and 2011. Trend data on CPUE, size structure, and body condition have been collected every four years since 1999 with fall nighttime electrofishing. Continuation of quadrennial trend data in this clear reservoir with night electrofishing in the

fall will be sufficient to allow for determination of any large-scale changes in the Largemouth Bass population that may spur further investigation. A minimum of 18 randomly selected 5-min electrofishing sites will be sampled in 2023 (Table 8), but sampling will continue at random sites until 50 stock-size fish are collected and the RSE of CPUE-S is ≤ 25. 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). Exclusive of the original 18 random stations, six additional random stations will be pre-determined in the event extra sampling is necessary. If failure to achieve either objective has occurred after one night of sampling and objectives can be attained with up to six 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

Striped Bass: Canyon Reservoir supports a low-density Striped Bass fishery. In 1999, Striped Bass were the third most sought-after species comprising 8.3% of the total directed fishing effort. Trend data on CPUE, size structure, and body condition have been collected biennially since 2000 with spring gill netting. Catch per unit effort from gill netting surveys in 2016, 2018, and 2020 were 3.4, 0.5, and 2.4/nn respectively. Due to production issues, Canyon Reservoir was not stocked in 2011 and 2012, but has since been stocked in 2013-2017 and 2019. Variation in RSE values can be attributed to random sampling and weak or missing year classes when Striped Bass are not produced at hatcheries. It is believed that RSE values of 25 can be achieved with consistent sampling with stratified random sampling sites selected from historical catch data which was initiated in 2016. Collecting a minimum of 50 stock-length Striped Bass during spring 2022 and 2024 gill netting (Table 8) will allow us to calculate proportions (i.e., size structure indices) with a 70% confidence interval. In other area lakes, catch rates from previous sample years indicate that this is an achievable goal if the standard sampling effort is doubled (30 net nights). However, a minimum of 15 stratified random gill net sites should help achieve this goal in this smaller reservoir. Due to low catch rates, we did not meet the survey objectives to collect 50 stock size fish and it was unlikely additional sampling would have achieved this objective with reasonable effort.

White Bass: In 1999, White Bass were the second most sought-after species comprising 24.8% of the total directed fishing effort. Catch per unit effort from gill netting surveys in 2016, 2018, and 2020 were 3.0, 0.5, and 1.7/nn respectively. Collecting a minimum of 50 stock-length White Bass during spring 2022 and 2024 gill netting (Table 8) will allow us to calculate proportions (i.e., size structure indices) with a 70% confidence interval. A minimum of 15 stratified random gill net sites should help achieve this goal. In addition to the original 15 stratified random stations, 5 additional stratified random stations will be pre-determined in the event extra sampling is necessary. Due to low catch rates, we did not meet the survey objectives to collect 50 stock size fish and it was unlikely additional sampling would have achieved this objective with reasonable effort.

Redbreast Sunfish, Bluegill, and Gizzard Shad: Redbreast Sunfish, Bluegill, and Gizzard Shad are the primary forage at Canyon Reservoir. Trend data on CPUE and size structure of Redbreast Sunfish, Bluegill, and Gizzard Shad have been collected quadrennially since 1999. Continuation of sampling for 2023, as per Largemouth Bass above, will allow for monitoring of large-scale changes in Redbreast Sunfish, Bluegill, and Gizzard Shad relative abundance and size structure. Sampling effort based on achieving sampling objectives for Largemouth Bass will result in sufficient numbers of Redbreast Sunfish, Bluegill, and Gizzard 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; 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 30 for Redbreast Sunfish and Bluegill, and 35 for Gizzard Shad. No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of Redbreast Sunfish, Bluegill, and Gizzard Shad. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density

Literature Cited

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Cummings, G. A. and De Jesus. 2016. Inland Fisheries Division monitoring and management program survey report for Canyon Reservoir, 2015. Texas Parks and Wildlife Department, Federal Aid Report F-221-M-6, Austin, TX. 36 pp.

DiCenzo, V. J., M. J. Maceina, and M. R. Stimert. 1996. Relations between reservoir trophic state and gizzard shad population characteristics in Alabama reservoirs. North American Journal of Fisheries Management 16:888-895.

Dibble, E. D., K. J. Killgore, and S. H. Harrel. 1996. Assessment of fish-plant interactions. American Fisheries Society Symposium 16:357-372

Durocher, P. P., W. C. Provine, and J. E. Kraai. 1984. Relationship between abundance of largemouth bass and submerged vegetation in Texas reservoirs. North American Journal of Fisheries Management 4:84-88.

De Jesus, M. J., and S. J. Magnelia. 2008. Statewide freshwater fisheries monitoring and management program survey report for Canyon Reservoir, 2007. Texas Parks and Wildlife Department, Federal Aid Report F-30-R-33, Austin, TX. 33 pp.

De Jesus, M. J., and M. A. Farooqi. 2012. Inland Fisheries Division monitoring and management program survey report for Canyon Reservoir, 2011. Texas Parks and Wildlife Department, Federal Aid Report F-221-M-2, Austin, TX. 36 pp.

Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional Size Distribution (PSD): A Further Refinement of Population Size Structure Index Terminology. Fisheries 32(7):348.

Magnelia, S. J., and C. C. Bonds. 2004. Statewide freshwater fisheries monitoring and management program survey report for Canyon Reservoir, 2004. Texas Parks and Wildlife Department, Federal Aid Report F-30-R-29, Austin, TX. 29 pp.

United States Geological Survey (USGS). 2020. National water information system: Web interface. Available: http://waterdata.usgs.gov/tx/nwis (May 2020).

Tables and Figures

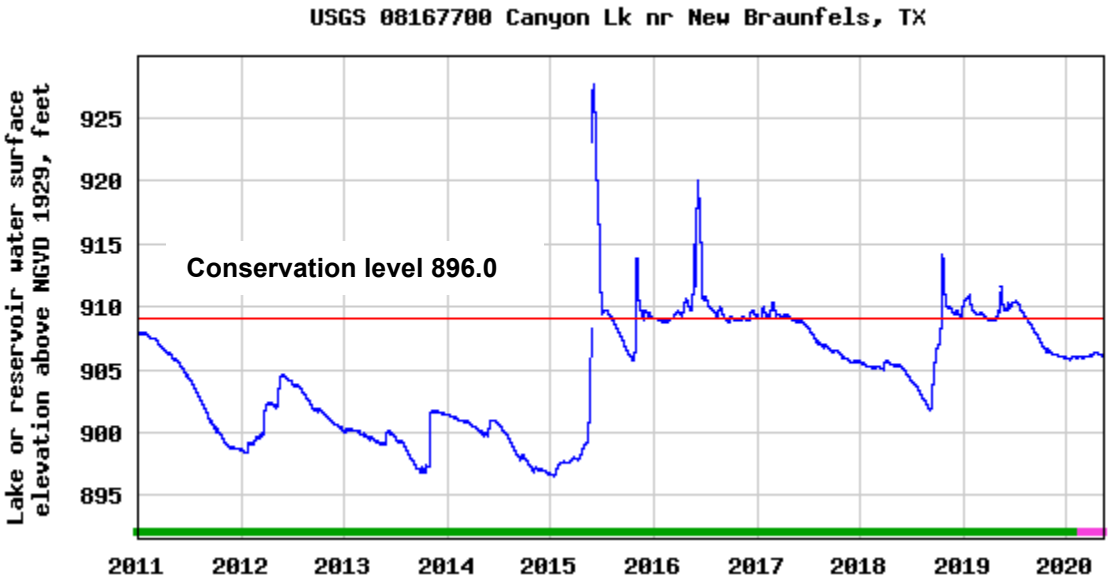


Figure 1. Water level elevations in feet above mean sea level (MSL) recorded for Canyon Reservoir, January 2011 to May 2020.

Table 1. Characteristics of Canyon Reservoir, Texas.

Characteristic	Description
Year constructed	1964
Controlling authority	USACE
County	Comal
Reservoir type	Mainstem
Shoreline Development Index	6.30
Conductivity	320 µS/cm

Table 2. Boat ramp characteristics for Canyon Reservoir, Texas, August, 2019. Reservoir was near conservation elevation (896 ft. above MSL) at time of survey.

Boat ramp	Latitude Longitude (dd)	Public	Parking Capacity (N)	Closure Elevation (ft.)	Condition
Skyline Park	29.85029 -98.20791	Y	17	897.60	Good
Turkey Cove	29.86019 -98.22567	Y	25	898.50	Good
Comal Park ramp #1	29.86093 -98.25168	Y	16	898.00	Good
Comal Park ramp #2	29.86289 -98.24555	Y	54	902.50	Good
Tom Creek #1	29.86994 -98.25478	Y	16	905.80	Good
Tom Creek #2	29.87279 -98.26378	Y	13	890.00	Good
Canyon Lake Hills 1 East	29.87292 -98.26385	Y	40	890.00	Good
Canyon Lake Hills 2 West	29.89537 -98.26787	Y	11	904.76	Good
Canyon Springs Resort	29.88326 -98.28489	Y	10	899.86	Good
Cranes Mill Marina	29.88870 -98.29066	Y	30	899.00	Good
Cranes Mill Park	29.89537 -98.29247	Y	45	903.00	Good
Cypress Cove (Rebecca Creek)	29.91364 -98.33871	Y	8	901.60	Good
Sunny Side (Joint Base S.A. East)	29.88230 -98.21728	Y	20	Unknown	Good
Hancock Cove (Joint Base S.A. West)	29.89081 -98.21742	Y	10	Unknown	Good
Jacobs Creek #1	29.88241 -98.22359	Y	22	878.00	Good
Jacobs Creek #2	29.88307 -98.22304	Y	22	893.00	Good
Jacobs Creek North	29.89372 -98.21424	Y	55	889.00	Good

Table 2. Boat ramp characteristics continued.

Boat ramp	Latitude Longitude (dd)	Public	Parking Capacity (N)	Closure Elevation (ft.)	Condition
Canyon Park	29.89391 -98.23027	Y	100	883.00	Good
Potters Creek Park	29.90534 -98.26747	Y	30	895.00	Good
Potter Creek Park West	29.90638 -98.27645	Y	30	893.00	Good
North Cranes Mill Road	29.91455 -98.29238	Y	40	905.15	Good
Canyon Lake Marina	29.90030 -98.23381	Y	75	884.00	Good

Table 3. Harvest regulations for Canyon Reservoir, Texas.

Species	Bag Limit	Length Limit (inches)
Catfish: Channel Catfish, Blue Catfish, hybrids and subspecies	25 (in any combination)	12 minimum
Catfish, Flathead	5	18 minimum
Bass, White	25	10 minimum
Bass, Striped	5	18 minimum
Black bass: Largemouth, Smallmouth, Guadalupe	5 (in any combination)	14 minimum*
Crappie: White and Black Crappie, their hybrids and subspecies	25 (in any combination)	10 minimum

*Guadalupe Bass have no minimum length limit.

Table 4. Stocking history of Canyon Reservoir, Texas. FGL = fingerling; FRY = fry; AFGL = advanced fingerling; ADL = adult; UNK = unknown.

Species	Year	Number	Life Stage	Mean TL (in)
Black Crappie	1967	5,000		
	1988	57,446		1
	Total	62,446		
Blue Catfish	1991	79,991	FGL	2.5
	1992	179,804	FGL	2.4
	Total	259,795		
Channel Catfish	1966	19,200	AFGL	7.9
	Total	19,200		
Florida Largemouth Bass	1987	34,320	FGL	2
	2008	407,962	FGL	1.6
	2010	294,856	FRY	0.3
	2014	240,199	FGL	1.5
	2015	84,009	FGL	1.7
	2016	147,541	FGL	1.8
	2017	148,529	FRY	0.3
	2018	423,765	FRY	0.3
	2019	152,606	FGL	1.6
	Total	1,933,787		
Largemouth Bass	1987	30,380	FGL	2
	Total	30,380		
Rainbow Trout	2016	200	ADL	12
	Total	200		
Smallmouth Bass	1974	85,000	UNK	
	1975	100,000	UNK	
	1976	125,000	UNK	
	1988	416,226	FRY	0.5
	1989	1,879	FGL	1.1
	1989	3,907	FRY	
	Total	732,012		
	1973	19,750	FGL	1.7

Table 4, continued.

Striped Bass				
	1974	13,290	FGL	1.7
	1976	88,317	UNK	
	1977	100,169	UNK	
	1981	42,852	UNK	
	1983	40,000	UNK	
	1989	40,500	FRY	1
	1990	41,985	FGL	1.3
	1991	42,525	FGL	1.6
	1993	64,993	FGL	1.1
	1994	124,406	FGL	1.1
	1994	1,575,581	FRY	0.8
	1995	42,052	FGL	1.2
	1997	41,441	FGL	1.1
	1998	41,267	FGL	1.3
	1999	41,630	FGL	1.4
	2000	42,000	FGL	1.6
	2002	39,156	FGL	1.5
	2005	43,970	FGL	1.6
	2006	42,980	FGL	1.7
	2007	42,751	FGL	1.9
	2008	41,664	FGL	1.7
	2009	48,546	FGL	1.8
	2010	42,210	FGL	1.9
	2013	75,810	FGL	1.9
	2013	495,000	FRY	0.2
	2014	36,439	FGL	1.6
	2015	39,212	FGL	1.6
	2016	31,131	FGL	1.6
	2017	43,222	FGL	1.6
	2019	43,561	FGL	2.1
	Total	3,468,410		
Walleye	1965	500,000	FRY	0.2
	1973	1,068,920	FRY	0.2
	1974	371,080	FRY	0.2
	1981	4,370,000	FRY	0.2
	1984	3,925,000	FRY	0.2
	1985	48,910	FGL	2
	1985	17,203	FRY	0.6
	Total	10,301,113		

Table 4, continued.

White Crappie	1966	2,000	UNK
	1967	5,000	UNK
	Total	7,000	

Table 5. Objective-based sampling plan components for Canyon Reservoir, Texas 2019 - 2020.

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
Redbreast Sunfish [a]	Abundance	CPUE – Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
Bluegill [a]	Abundance	CPUE – Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
Gizzard Shad [a]	Abundance	CPUE – Total	RSE ≤ 25
	Size structure	PSD, 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	Length-at-age	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)
White Bass	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, Canyon Reservoir, Texas, 2019. Shoreline habitat type units are in miles and standing timber is acres.

Habitat Type	Estimate	% of total
Rocky	20.6 miles	29.09
Natural	20.0 miles	28.30
Natural with boat docks	2.0 miles	2.84
Rock bluff	17.1 miles	24.98
Gravel shore	9.00 miles	12.70
Gravel shore with boat docks	0.7 mile	1.04
Rock bluff with boat docks	0.7 mile	1.05

Gizzard Shad

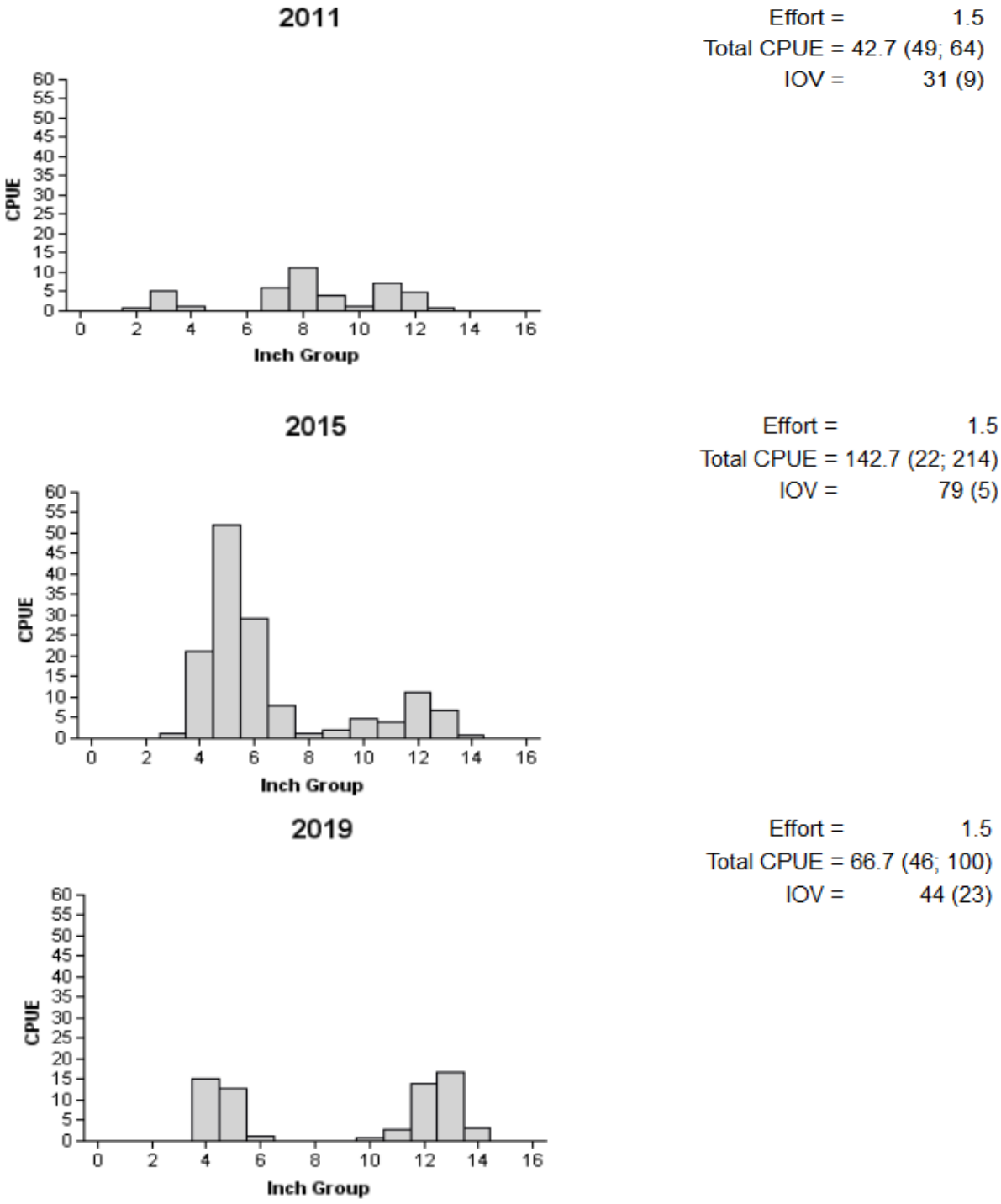


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV and size structure are in parentheses) for fall electrofishing surveys, Canyon Reservoir, Texas, 2011, 2015, and 2019.

Redbreast Sunfish

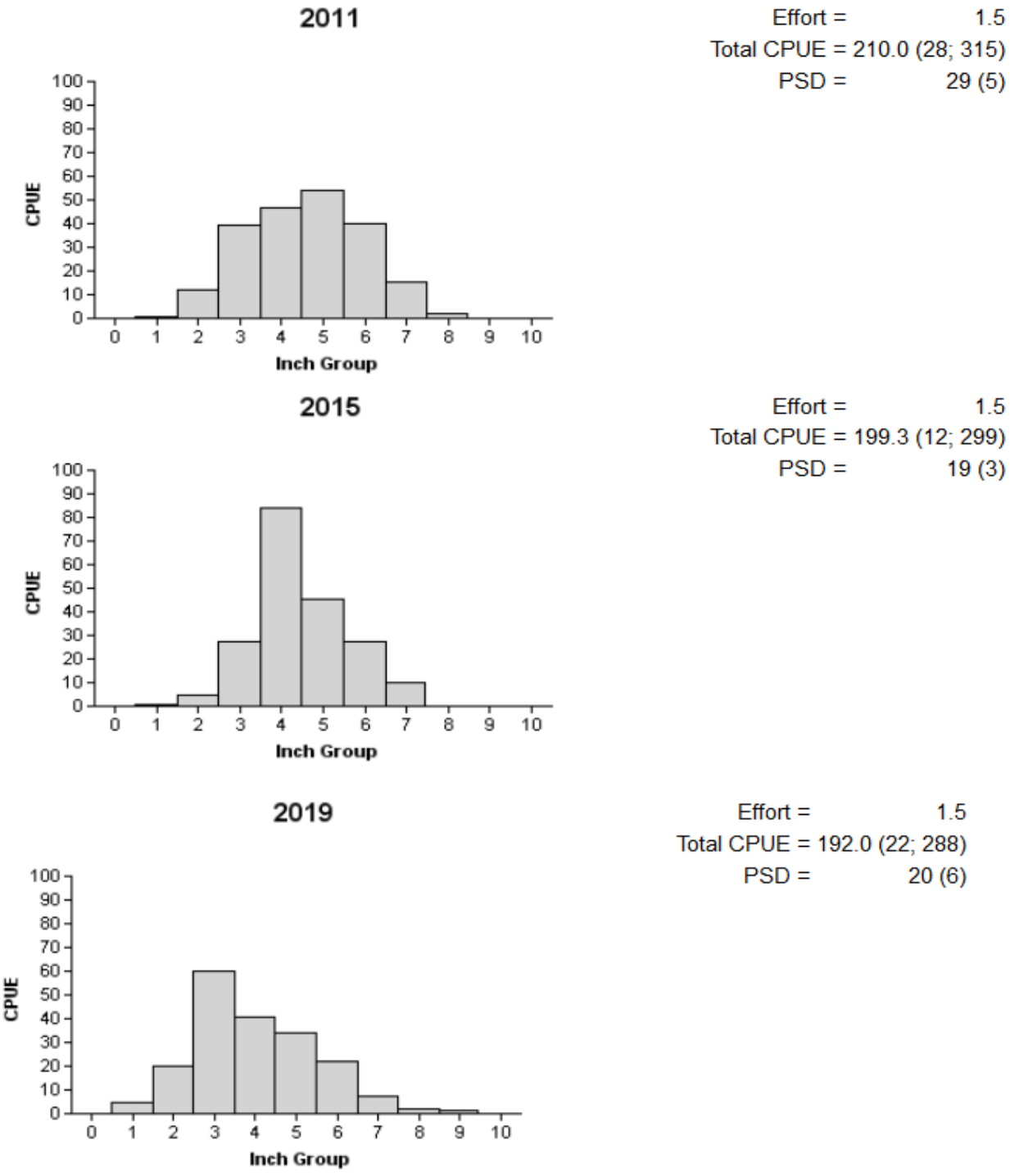


Figure 3. Number of Redbreast Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Canyon Reservoir, Texas, 2011, 2015, and 2019.

Bluegill

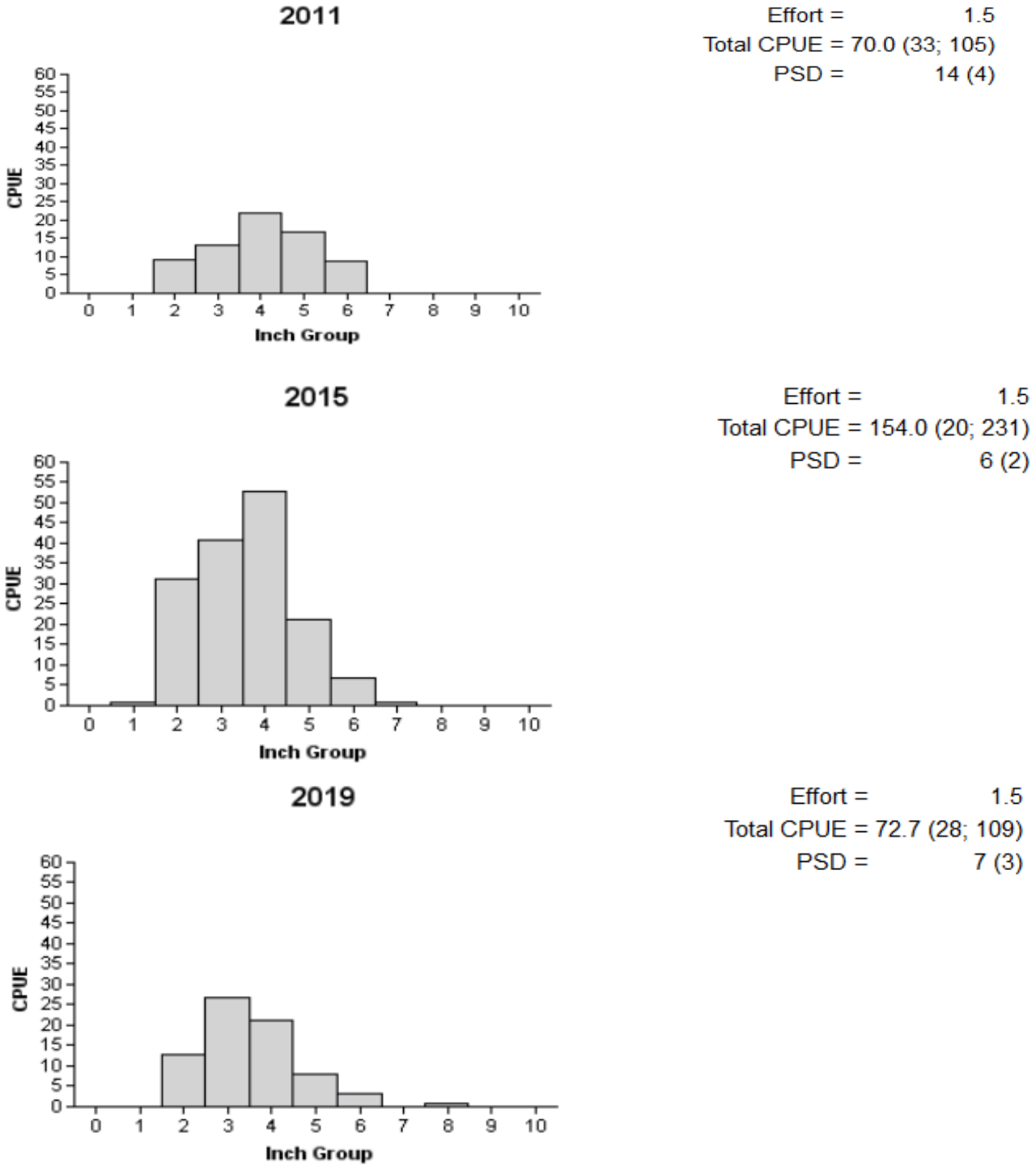


Figure 4. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Canyon Reservoir, Texas, 2011, 2015, and 2019.

Blue Catfish

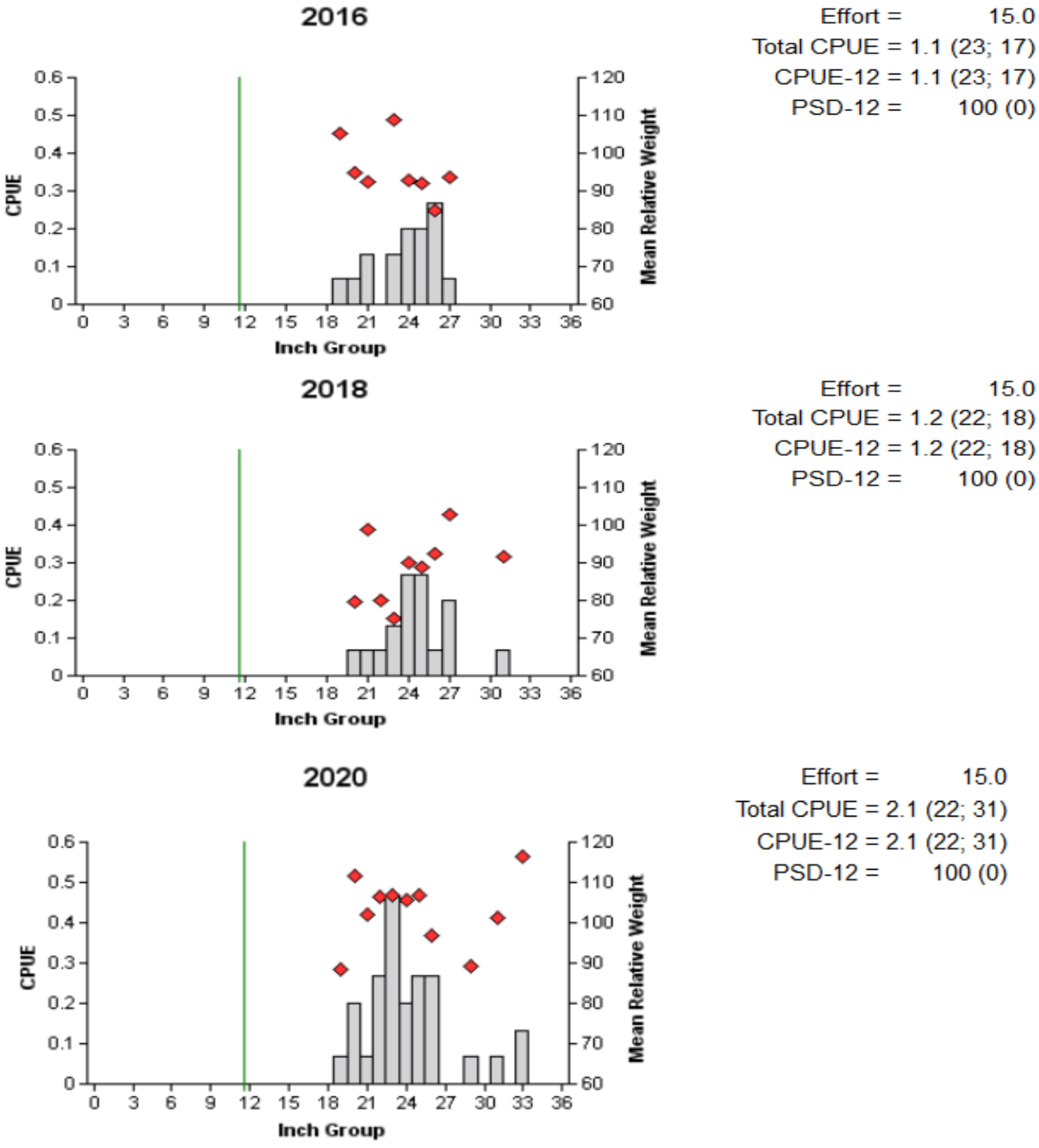
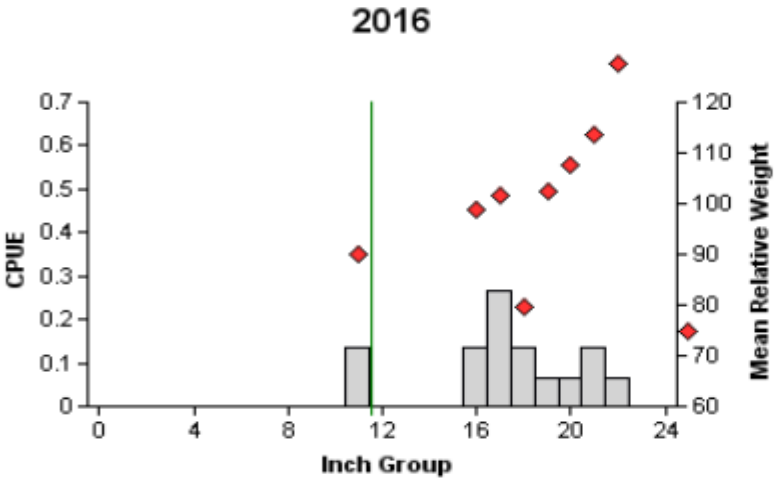
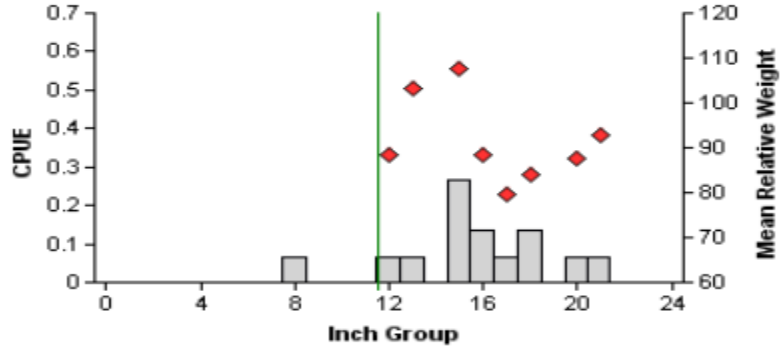


Figure 5. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Canyon Reservoir, Texas, 2016, 2018, and 2020. Vertical line represents minimum length limit at the time of the survey.

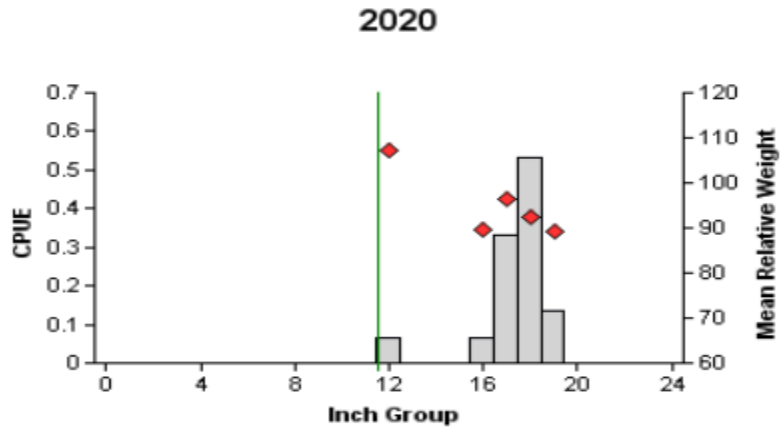
Channel Catfish



Effort = 15.0
Total CPUE = 1.1 (32; 16)
CPUE-12 = 0.9 (30; 14)
PSD-12 = 88 (6)



Effort = 15.0
Total CPUE = 0.9 (22; 14)
CPUE-12 = 0.9 (22; 13)
PSD-12 = 100 (0)



Effort = 15.0
Total CPUE = 1.1 (24; 17)
CPUE-12 = 1.1 (24; 17)
PSD-12 = 100 (0)

Figure 6. 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, Canyon Reservoir, Texas, 2016, 2018, and 2020. Vertical line represents minimum length limit at the time of the survey.

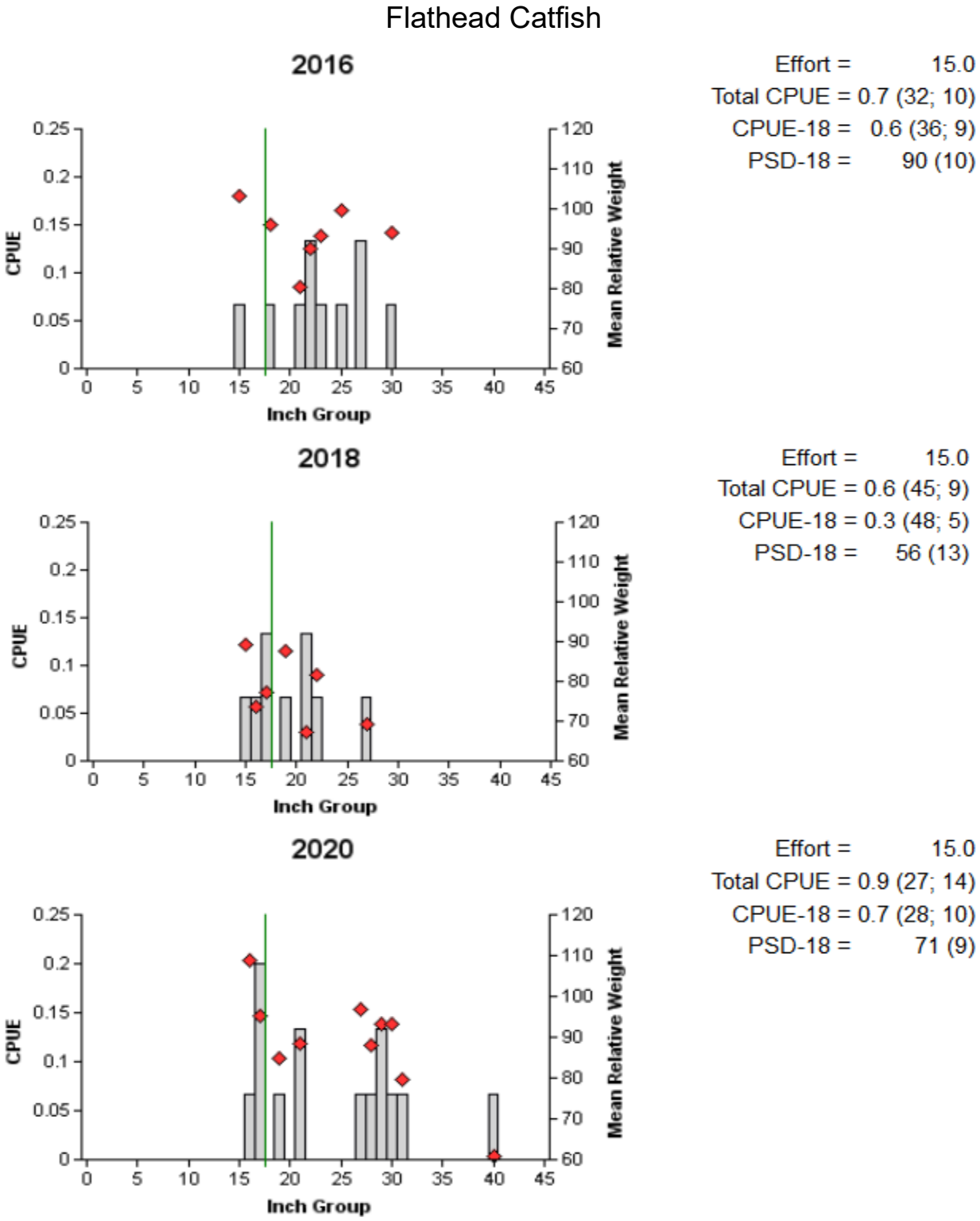


Figure 7. Number of Flathead Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N are in parentheses) for spring gill net surveys, Canyon Reservoir, Texas, 2016, 2018, and 2020. Vertical line represents the minimum length limit at the time of the survey.

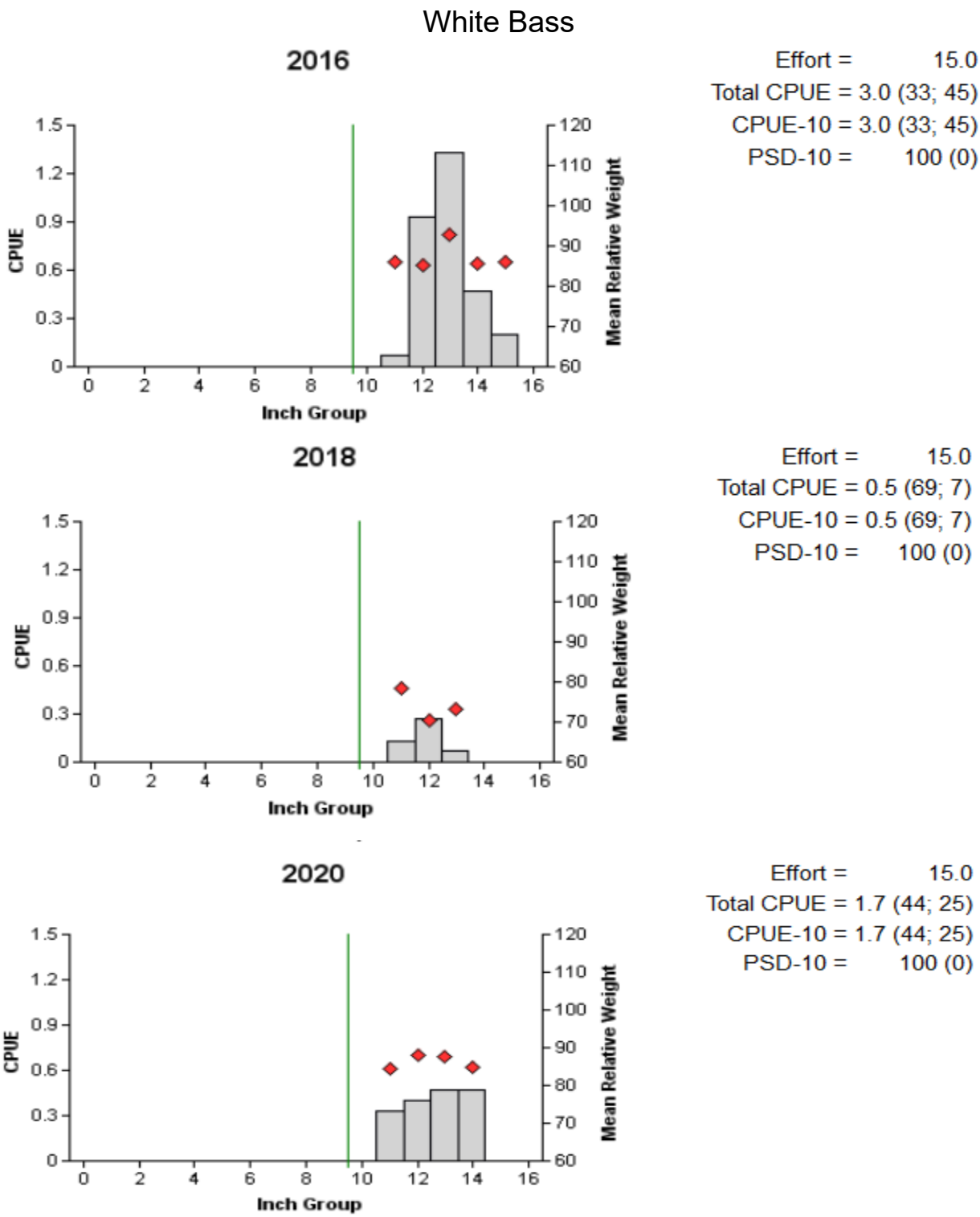


Figure 8. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Canyon Reservoir, Texas, 2016, 2018, and 2020. Vertical line represents minimum length limit at the time of the survey.

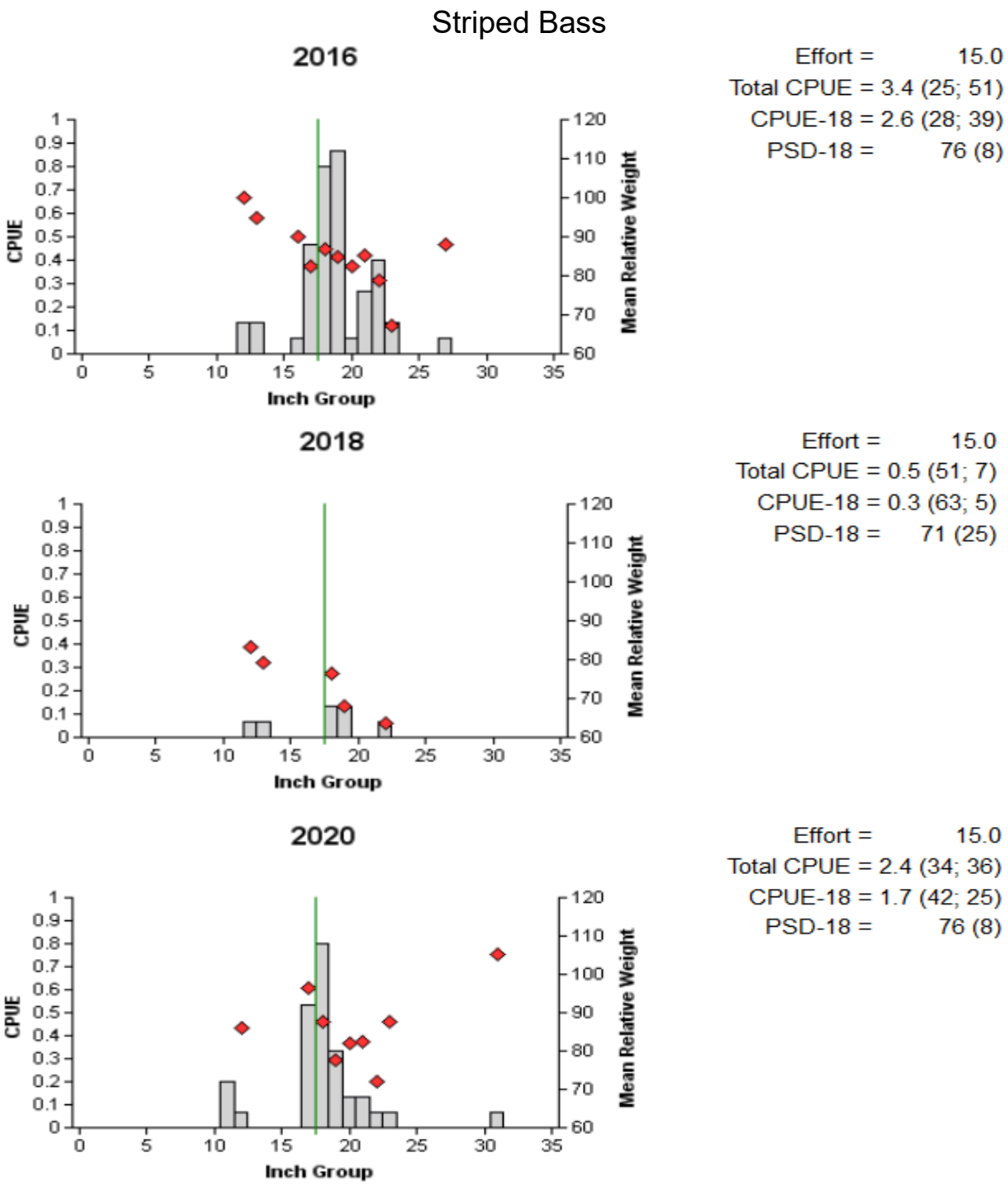


Figure 9. Number of Striped Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Canyon Reservoir, Texas, 2016, 2019, and 2020. Vertical line represents minimum length limit at the time of the survey.

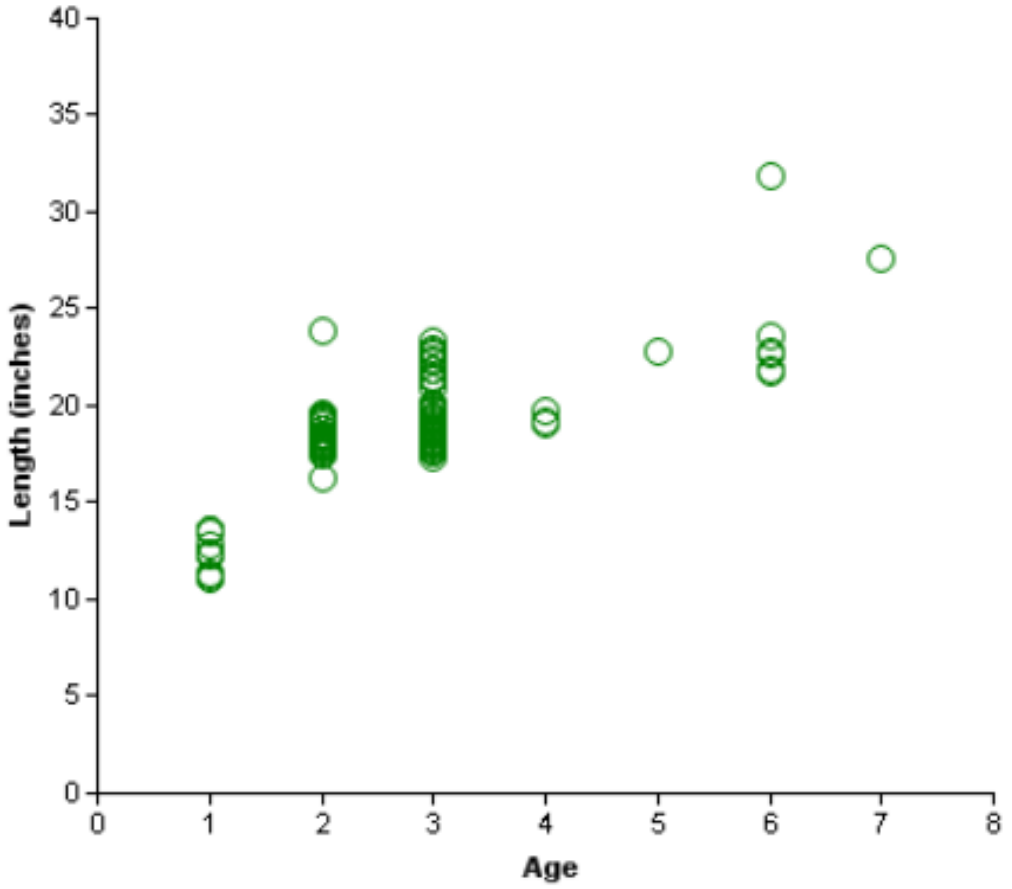


Figure 10. Length at age for Striped Bass collected during gill netting, Canyon Reservoir, Texas, March 2016 (N = 51), April 2018 (N=7) and March 2020 (N = 36).

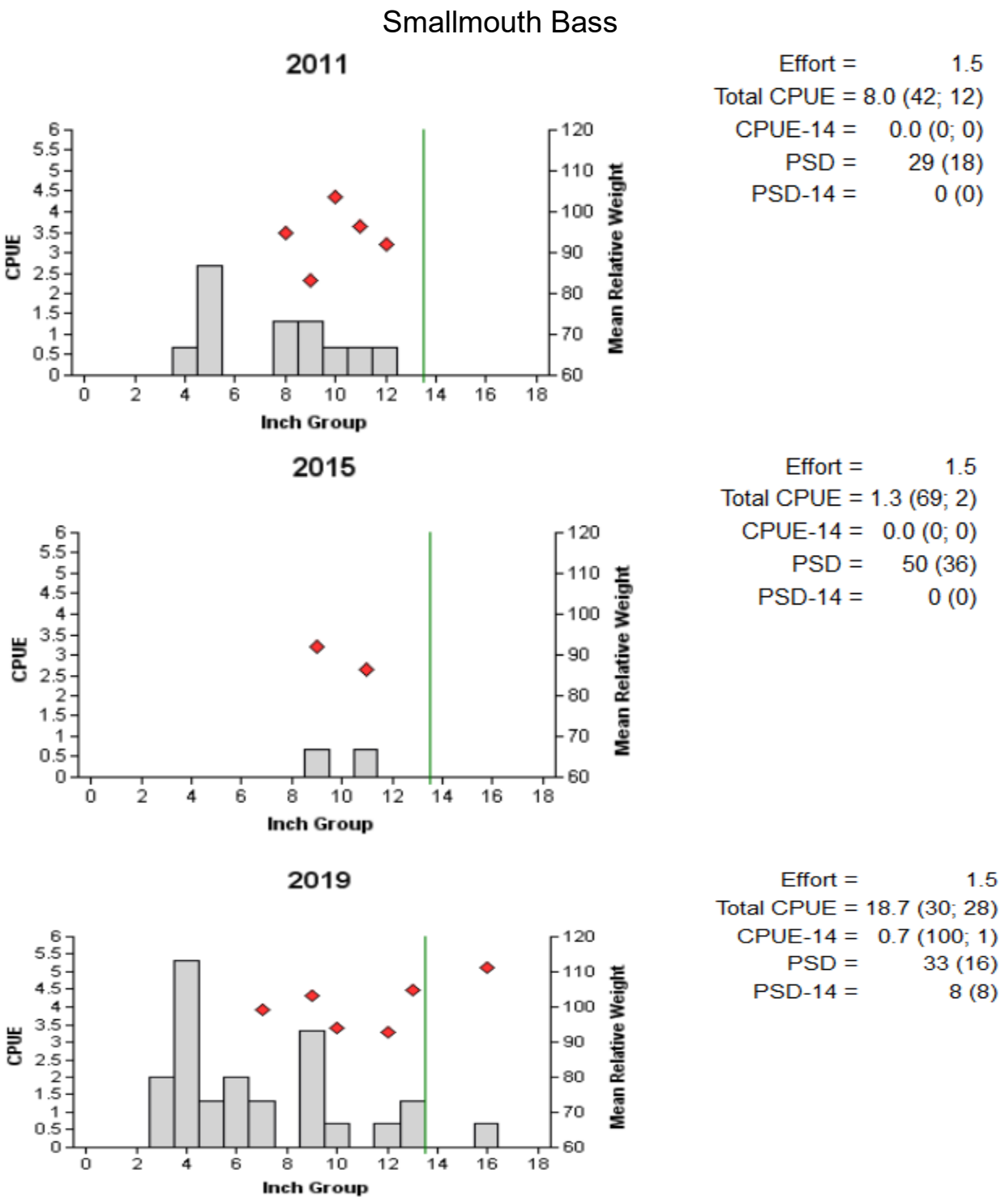


Figure 11. Number of Smallmouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys 2011, 2015, and 2019, Canyon Reservoir, Texas. Vertical line represents minimum length limit at the time of survey.

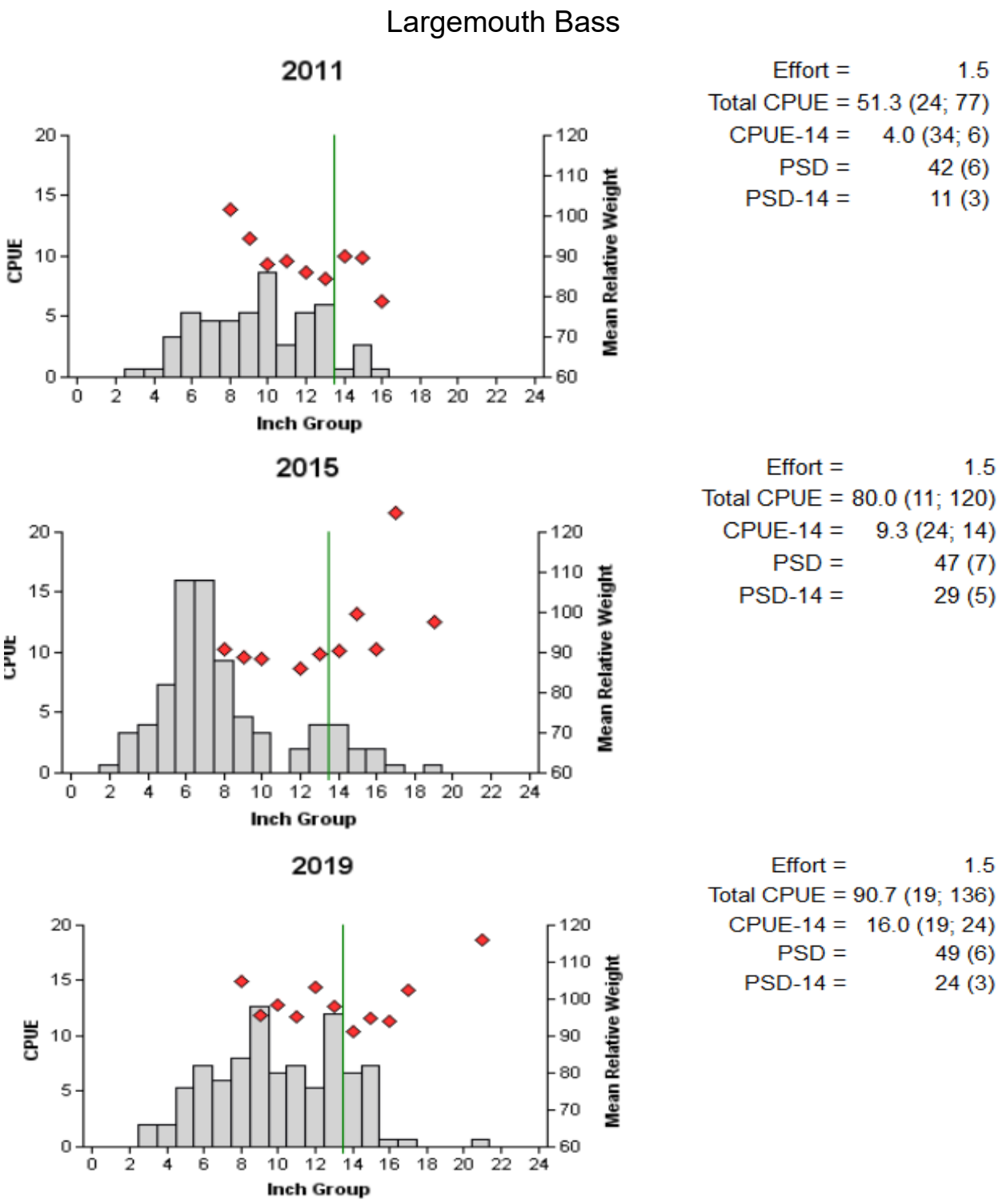


Figure 12. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Canyon Reservoir, Texas, 2011, 2015, and 2019. Vertical line represents minimum length limit at time of survey.

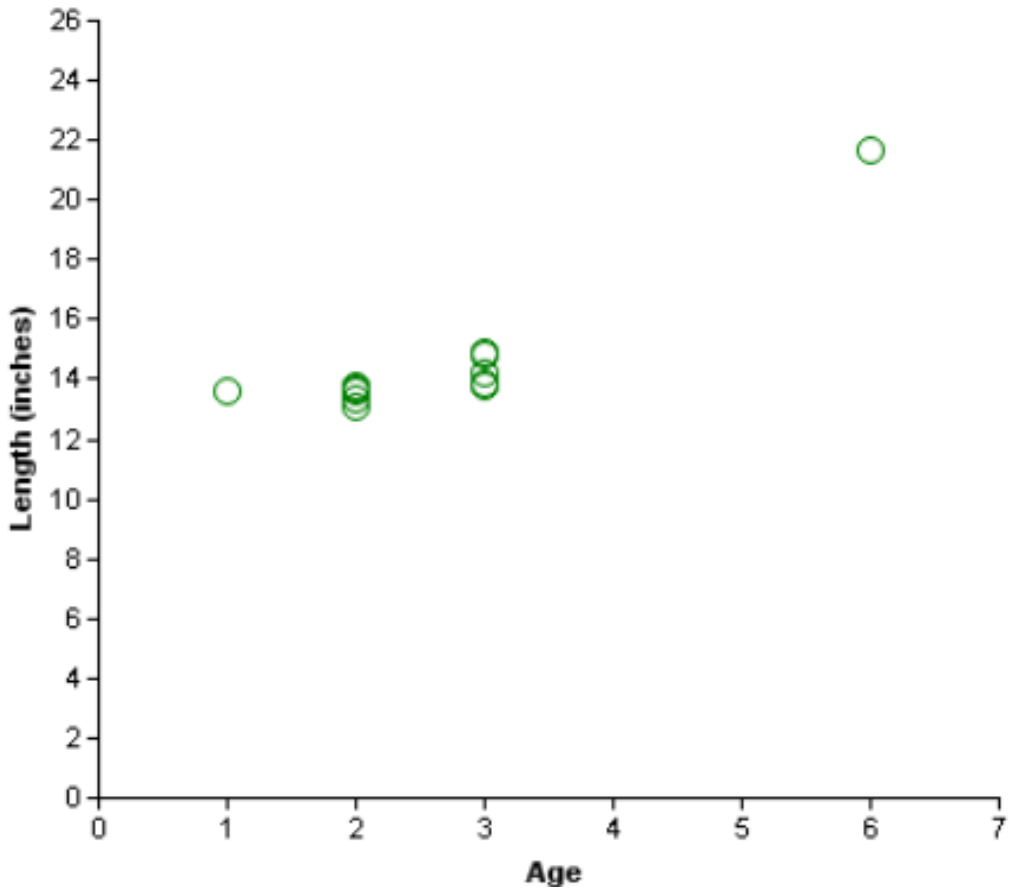


Figure 13. Length at age for Largemouth Bass collected electrofishing, Canyon Reservoir, Texas, November 2019 (N = 13).

Table 7. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Canyon 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.

		Number of fish					
Year	Sample size	FLMB	F1	Fx	NLMB	% FLMB alleles	% pure FLMB
2007	30	0	NA	30[a]	0	59.0	0.0
2015	30	1	NA	29[a]	0	70.0	3.0
2019	30	0	3	0	0	68.0	0.0

[a] Determination of hybrid status not conducted.

Proposed Sampling Schedule

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

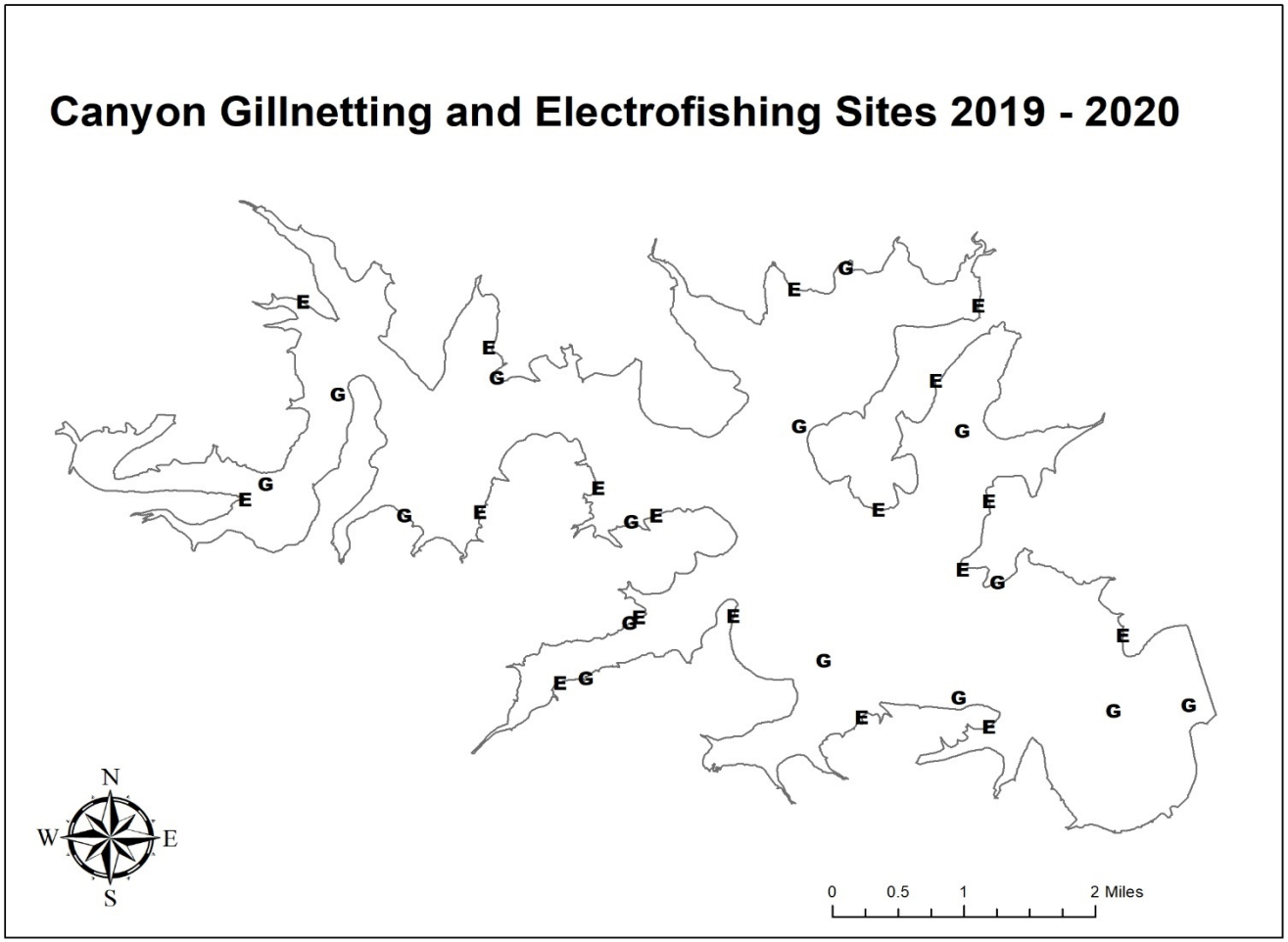
	Survey year			
	2020-2021	2021-2022	2022-2023	2023-2024
Angler Access				S
Structural Habitat				S
Vegetation				S
Electrofishing – Fall				S
Gill netting		S		S
Report				S

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

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Canyon Reservoir, Texas, 2019-2020. 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			100	66.7
Threadfin Shad			1.33	2
Blacktail Shiner			0.67	1
Blue Catfish	31	2.07		
Channel Catfish	17	1.13		
Flathead Catfish	14	0.93		
White Bass	25	44		
Striped Bass	36	2.4		
Redbreast Sunfish			288	192
Green Sunfish			42	28
Warmouth			7	4.67
Bluegill			72.67	109
Longear Sunfish			7	4.67
Redear Sunfish			36	24
Smallmouth Bass			28	18.67
Largemouth Bass			136	90.67
Logperch			1	0.67
Rio Grande Cichlid			3	2
Unclassified tilapia			2	1.33

APPENDIX B – Map of sampling locations



Location of sampling sites, Canyon Reservoir, Texas, 2019 and 2020. Gill net and electrofishing stations are indicated by G and E, respectively. Water level was near full pool at time of sampling.

APPENDIX C – Canyon Lake Habitat Assessment (2019)

Canyon Lake Habitat Enhancement Assessment

Prepared by: Dillan Wulf, Marcos De Jesus, and Mukhtar Farooqi - TPWD Inland Fisheries Division – San Marcos / Austin District

Introduction:

Artificial fish habitat structures have been submerged in Canyon Reservoir, Comal County, Texas, since 2005 to add beneficial aquatic habitat to an environment that is predominantly limestone. The main type of artificial fish habitat structure used at Canyon Reservoir between 2005 and 2018 has been Ashe juniper brush piles. A prior study on these juniper brush piles mentions that fish counts trends decreased as brush complexity decreased over time, and have been recommended to be replenished every 4 years (Pavliska and De Jesus, 2016). To help maintain habitat availability between brush pile refurbishment intervals, Trophy Tree (Mossback) artificial fish habitat structures made of polyethylene were added to existing sites on Canyon Reservoir in 2018 and 2019. A SCUBA diving project was conducted by Texas Parks and Wildlife Department (TPWD) personnel on June 26th and June 27th of 2019 to assess fish utilization of these supplemental Mossback artificial fish habitat structures placed at existing juniper brush piles in the lower half of Canyon Reservoir. These Mossback artificial fish habitat structures have been submerged for approximately 1-year, giving them adequate time to attract various species of fish. The juniper brush piles have been in place from two to five years, depending on location.

Methods:

Two divers visited each site for a duration ranging between 15 and 25 minutes, with the exception of one dive lasting less than 5 minutes due to poor visibility. The divers searched for the Mossback artificial fish habitat structures and the juniper brush piles at each site at depths ranging from 20 to 35 feet. A total of 14 sites were inspected with Mossback artificial fish habitat structures being present at 8 out of the 14 sites. Underwater Writing slates were used to record fish species, numbers of fish, and approximate size of fish in the area, as well as the condition of the existing brush piles. Photographs were also taken on sites with adequate visibility. An effort to locate the 6 missing Mossback artificial fish habitat structures was made by TPWD personnel following the SCUBA assessment, using side-scan sonar.

Results and Discussion:

Of the 8 sites where both Mossback artificial fish habitat structures and juniper brush piles were located, generally more fish were found to be on or near the juniper brush piles. However, sport fish including Largemouth Bass were observed on the Mossback artificial fish habitat structures. A comparison of these 8 sites yielded an approximate total of 212 fish and 6 different species identified on or near the Mossback artificial fish habitat structures, while the juniper brush piles held an estimated 1,491 fish and 7 different species identified. The singular difference in species diversity was attributed to the presence of a Rio Grande Cichlid that was present on the brush at site number 4.

In cases where the Mossback artificial fish habitat structures were on top of or very near the juniper brush piles, it was difficult to discern which type of cover was attracting and holding the fish. Also, it should be noted that the generally higher fish counts on juniper brush piles may be attributable to these piles occupying more area than the Mossbacks. The sample size for this assessment was also relatively small, but still provided useful data in assessing the efficacy of the Mossback artificial fish habitat structures. One of the 6 missing Mossback artificial fish habitat structures was found at site 19, roughly 30 feet from the site. The remaining 5 sites with missing Mossback structures were located near steep underwater slopes. It is a possibility that the missing Mossback structures were drug down these steep slopes with anchors used by anglers at these sites. It should be noted that these sites experience frequent fishing

pressure from anglers, leading to the belief that the anchors could be responsible for moving the Mossback structures.

To gather improved future data, it is recommended that additional Mossback artificial fish habitat structures be submerged in the same area to provide greater coverage similar to that of the juniper brush piles. Also, spacing the Mossbacks at greater distances from the juniper brush piles would help divers better discern fish preference between Mossback and the juniper brush piles. A summary of the underwater observations is provided in Table 1. Representative underwater photographs of some of the sites, and a map of artificial fish habitat structures sites are provided at the end of this document.

Table 1. Fish Counts on Mossback and Brush Piles

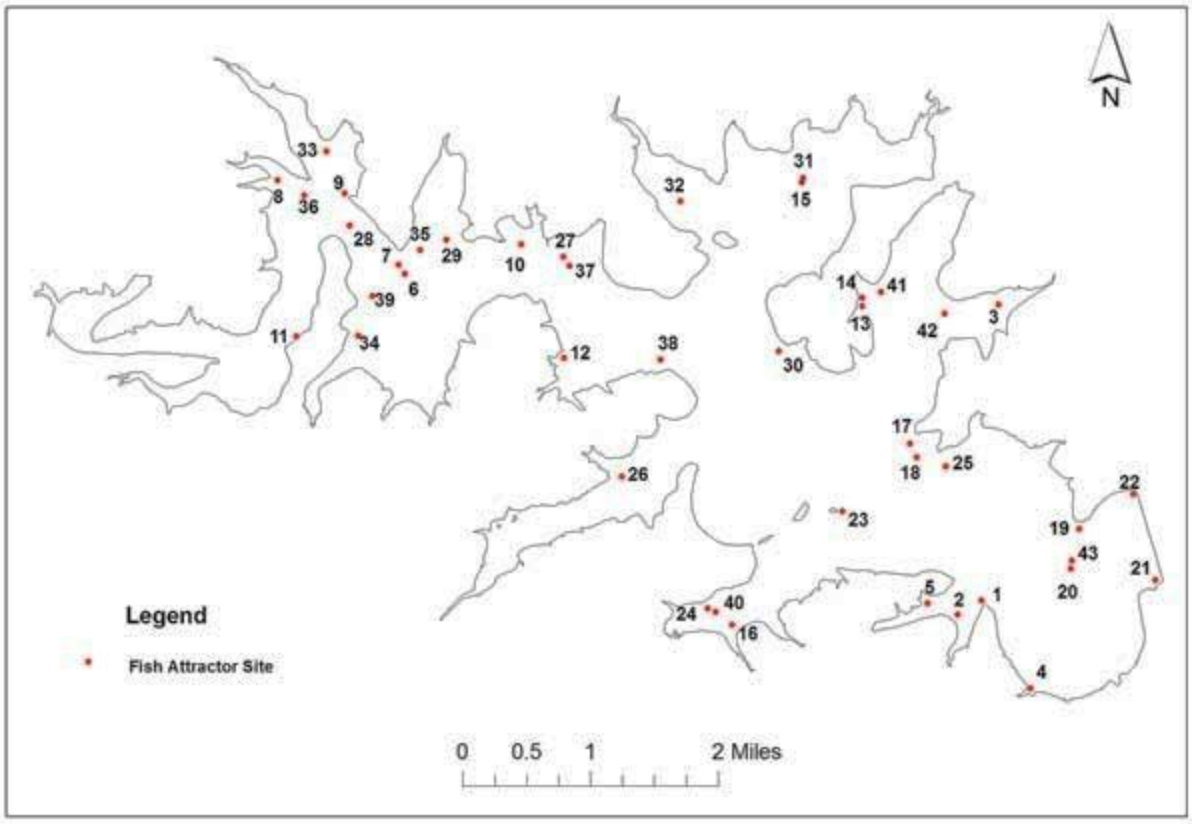
Site #	Lat/Long	Last supplemented with brush	Last supplemented with artificial	Key notes and species identified
1	N 29°51.697′ W -98°13.027′	2014	2018	**Mossback:** Sunfish: 8 Largemouth < 8”: 15 **Brush:** Sunfish: 200 Largemouth < 8”: 6 Smallmouth > 8”: 2 Flathead Catfish: 1 Common Carp: 1 Brush was still in good condition.
2	N 29°53.631′ W -98°13.278′	2014	2018	**Mossback:** Sunfish: 100 Largemouth < 8”: 12 Largemouth > 8”: 1 **Brush:** Sunfish: 50 Channel Catfish: 1 Common Carp: 1 Brush was still in good condition.
4	N 29°51.096′ W -98°12.693′	2014	2018	**Mossback:** Zero fish on mossback attractor.

				Brush: Sunfish: 300 Rio Grande: 1 Largemouth <8”: 10 Largemouth > 8”: 2 Flathead: 1 Brush in this location had begun to degrade, but still held fish.
5	N 29°13.394′ W -98°13.394′	2017	2018	**Mossback:** Sunfish: 20 Largemouth > 8”: 1 **Brush:** Sunfish: 75 Largemouth < 8”: 3 Largemouth > 8”: 3 Brush was in excellent condition still.
13	N 29°53.698′ W -98°13.840′	2014	2018	**Mossback:** Sunfish: 30 Largemouth < 8”: 2 Flathead: 1 **Brush:** Sunfish: 50 Common Carp: 2 Brush was greatly degraded at this location.
14	N 29°53.756′ W -98°13.839′	2014	2018	**Mossback:** Sunfish: 2 Largemouth < 8”: 1 Smallmouth > 8’: 1

				Flathead: 1 **Brush:** Sunfish: 30 Common Carp:1 Brush was greatly degraded at this location.
16	N 29°51.530′ W -98°14.722′	2014	2018	Mossback attractor and brush were both not found, water visibility was about 6 inches.
18	N 29°52.669′ W -98°13.467′	2015	2018	**Mossback:** Attractor was not located at this site. **Brush:** Sunfish: 10 Largemouth < 8”: 3 Largemouth > 8”: 2 Smallmouth > 8”: 2 Flathead: 1 Common Carp: 2 Brush was in good condition towards the middle of the patch but was degraded on the outskirts of the area.
19	N 29°52.181′ W -98°12.362′	2015	2018	**Mossback:** Attractor was not located at this site due to poor visibility. **Brush:** Sunfish: 6 Largemouth < 8”: 1 Smallmouth < 8”: 2 Brush was in poor condition.
20	N 29°51.913′ W -98°12.422′	2017	2018	**Mossback:** Attractor was not located at this site. **Brush:**

				Sunfish: 25 Largemouth < 8”: 4 Largemouth > 8”: 1 Smallmouth < 8”: 2 Smallmouth > 8”: 2 White Bass > 8”: 1 Common Carp: 2 Brush was in good condition.
21	N 29°51.835′ W -98°11.844′	2015	2018 and 2019	**Mossback:** Attractors were not located at this site. **Brush:** Sunfish: 1000 Largemouth < 8”: 2 Largemouth > 8”: 1 Channel Catfish: 1 Gizzard Shad: 3 Common Carp: 1 Brush was in excellent condition.
22	N 29°52.419′ W -98°11.994′	2015	2018 and 2019	**Mossback:** Sunfish: 30 Largemouth < 8”: 1 Channel Catfish: 1 **Brush:** Sunfish:800 Largemouth > 8”: 3 Flathead: 1 Attractors were located on top of the brush, making it difficult to tell if the fish were more attracted to the brush

				or mossback. The brush was also in excellent condition.
23	N 29°52.301′ W -98°13.973′	2014	2018	**Mossback:** Sunfish: 1 Largemouth < 8”: 2 Common Carp: 3 **Brush:** Sunfish: 25 Largemouth > 8”: 2 Channel Catfish: 1 The brush was in good condition and a sunken boat located nearby the brush that was also holding about 10 sunfish and 1 channel catfish about 12 inches long. Brush was in good condition.
43	N 29°51.968′ W -98°12.313′	2014	2018	**Mossback:** Attractors were not found at this location. **Brush:** Sunfish: 15 Largemouth < 8”: 2 Largemouth > 8”: 2 Smallmouth < 8”: 1 White Bass > 8”: 1 Common Carp: 3 Brush was degrading significantly at this location.



(Map of Canyon Reservoir showing attractor sites)

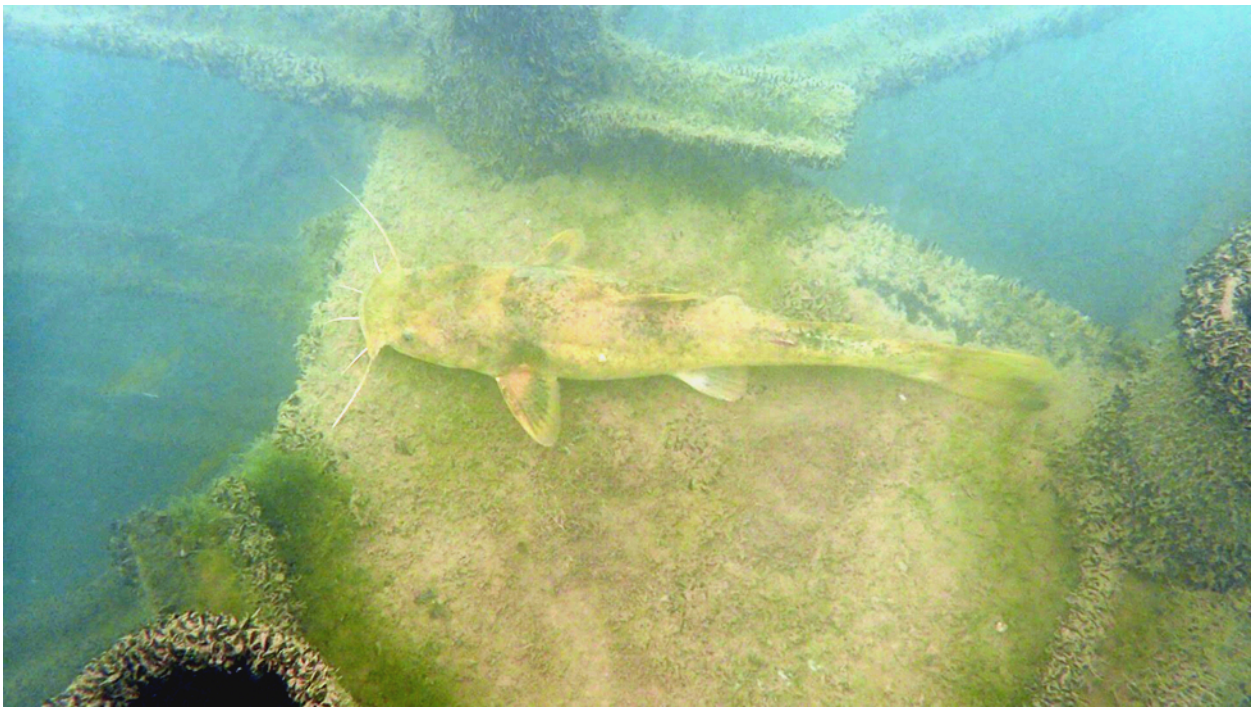
Site #1 (Smallmouth Bass utilizing brush structure)

Site #1 (Various sunfish utilizing brush structure)

Site #2 (Bluegill sunfish utilizing Mossback attractor)

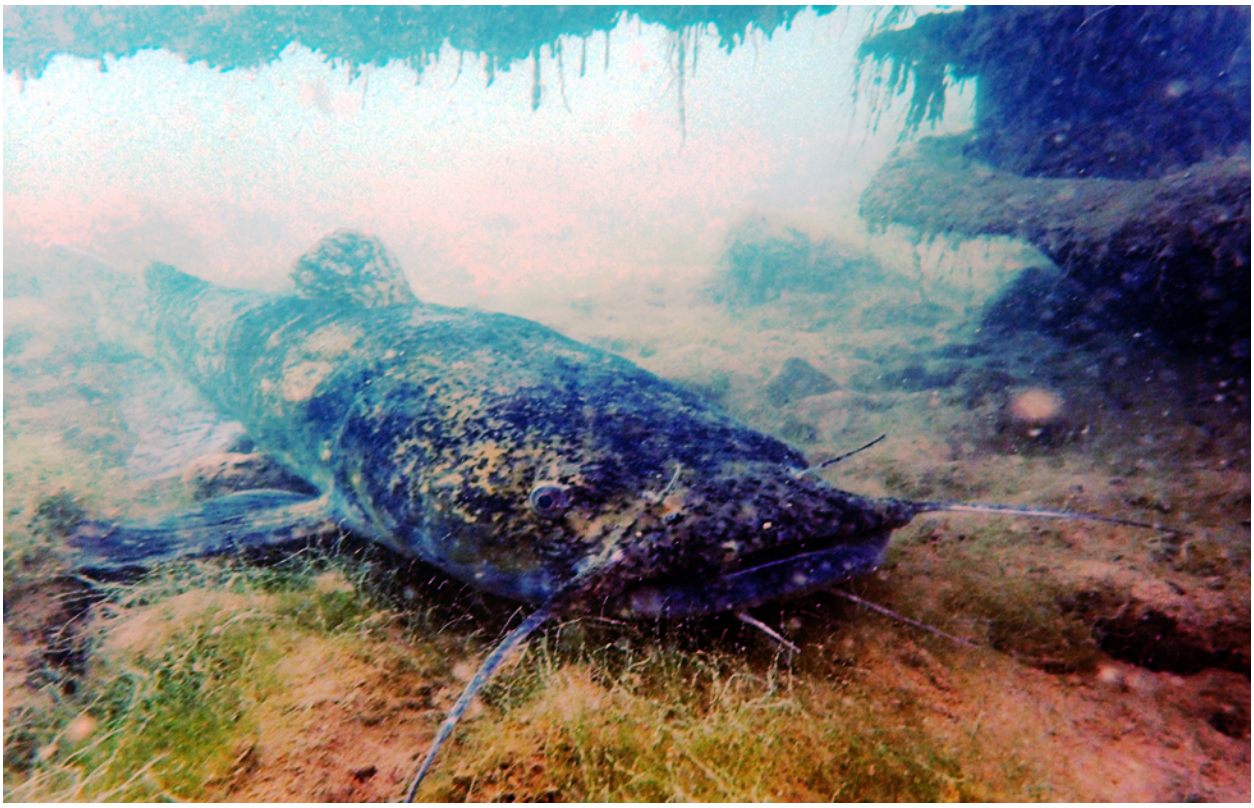
Site #4 (Various sunfish utilizing brush structure)

Site #4 (Mossback attractor with no fish present)



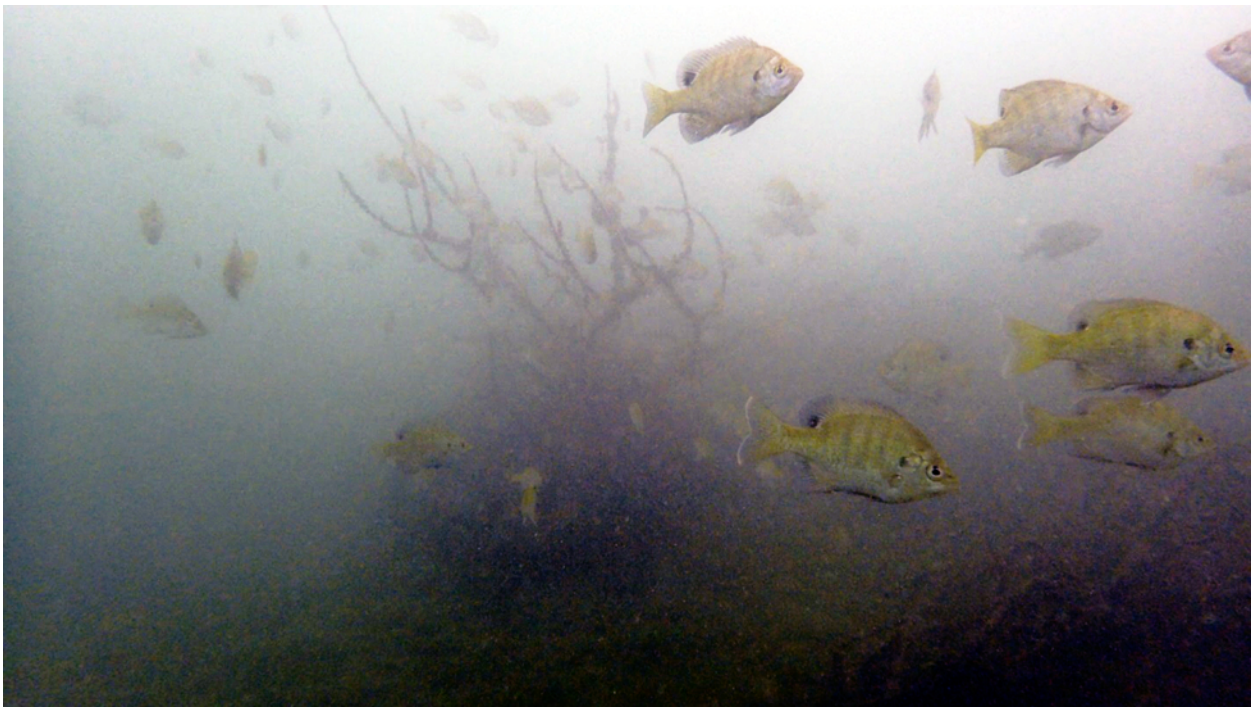
Site #13 (Flathead catfish utilizing Mossback attractor)

Site #14 (Smallmouth bass utilizing Mossback attractor)



Site #14 (Flathead catfish utilizing Mossback attractor)

Site #20 (Largemouth Bass utilizing brush structure)



Site #21 (Sunfish utilizing brush structure)

Site #22 (Mossback attractor that has been placed on top of brush)

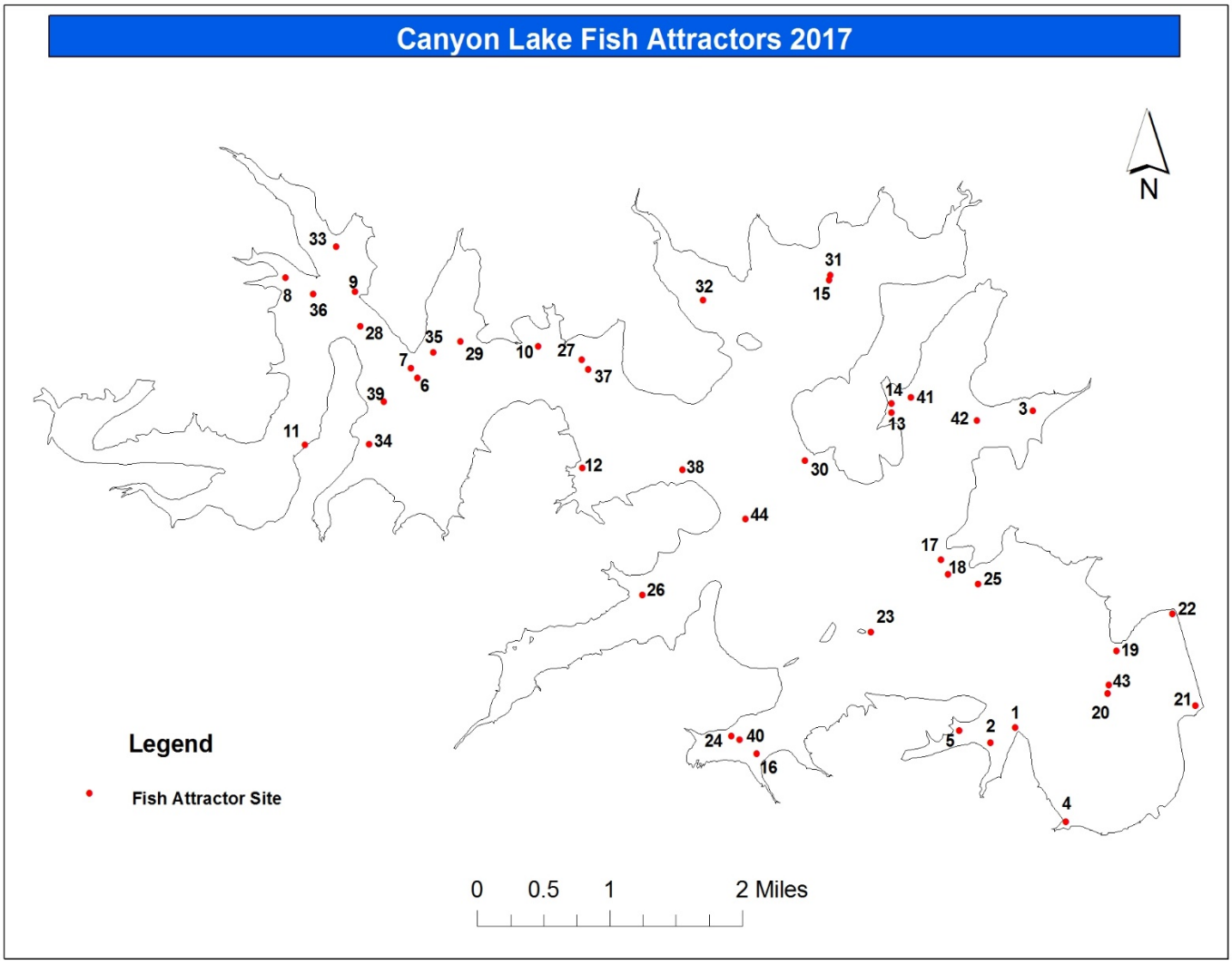
Acknowledgements

Funding for the purchase of these attractors and this study was provided by the Water Oriented Recreation District of Comal County. This assessment was completed during an internship that was funded by the Guadalupe River Trout Unlimited. Assembly and deployment of these artificial fish habitat structures was conducted by the Canyon Lake Bass Club. The authors acknowledge TPWD Inland Fisheries Management staff Patrick Ireland, Darin Gossett, Austin Orr, and Niki Ragan for assistance in project logistics and data collection.

Reference

Pavliska, C., and M. De Jesus. 2016, August 22. Evaluating Degradation and Temporal Effectiveness of Juniperus Ashei Used As Fish Habitat in a Texas Hill Country Reservoir. 146th Annual AFS meeting, Kansas City, Missouri.

APPENDIX D – Map of Fish Attractor Locations at Canyon Reservoir (2017)



APPENDIX E – Global Positioning System Coordinates for Fish Attractors (2019)

Site #	Lat/Long	Attractor Location	Installed	Last Supplemented with Brush	Last Supplemented with Artificial
1	N 29°51.697' W -98°13.027'	Mouth of Turkey Cove on east main lake point along river channel drop.	2005	2014	2018
2	N 29°53.631' W -98°13.278'	In Turkey Cove on rocky bald Y-point splitting cove.	2005	2014	2018
3	N 29°53.818' W -98°13.745'	Along Jacobs Creek channel drop off.	2005	2016	2018
4	N 29°51.096' W -98°12.693'	Along creek channel drop in small cove uplake from dam.	2005	2014	2018
5	N 29°51.676' W -98°13.394'	Bald secondary point on North side of Turkey Cove east of ramp.	2005	2017	2018
6	N 29°53.918' W -98°16.949'	West side of long rocky point between Cranes Mill and Potters Creek along river channel drop.	2005	2015	2019
7	N 29°53.979' W -98°16.994'	West side of long rocky point between Cranes Mill and Potters Creek along river channel drop.	2005	2016	2019
8	N 29°54.554' W -98°17.814'	On main point splitting north side cove along deep ledge.	2005	2017	2019
9	N 29°54.467' W -98°17.361'	Main lake point up-river from water pipeline along deep river channel drop.	2005	2017	2019
10	N 29°54.118' W -98°16.157'	End of bald clay point at Potter's Creek Park near river channel drop.	2005	2015	2019
11	N 29°53.492' W -98°17.690'	Cranes Mill fishing pier. Along North edge of pier and in middle pier hole.	2005	2017	2019
12	N 29°53.343' W -98°15.866'	Ledge along steep bank near point.	2005	2015	2019
13	N 29°53.698' W -98°13.840'	Ledge on rocky bank along east side of Canyon Park in ramp cove.	2005	2014	2018
14	N 29°53.756' W -98°13.839'	Ledge on rocky bank along east side of Canyon Park in ramp cove.	2005	2014	2018

15	N 29°54.539' W -98°14.247'	End of extended point west of Canyon Park area near drop off.	2005	2015	2019
16	N 29°51.530' W -98°14.722'	On southeast side of Comal Park cove along creek channel drop.	2005	2014	2018
17	N 29°52.762' W -98°13.514'	End of west Jacobs Creek main lake point.	2005	2015	2018
18	N 29°52.669' W -98°13.467'	End of east Jacobs Creek main lake point.	2005	2015	2018
19	N 29°52.181' W -98°12.362'	East side of North Park main lake point.	2007	2015	2018
20	N 29°51.913' W -98°12.422'	Along drop off on North Park extended main lake point.	2007	2017	2018
21	N 29°51.835' W -98°11.844'	Southeast corner of dam.	2007	2015	2019
22	N 29°52.419' W -98°11.994'	Northeast corner of dam.	2007	2015	2019
23	N 29°52.301' W -98°13.973'	On the end of island/hump marked with buoy.	2007	2014	2018
24	N 29°51.642' W -98°14.892'	Along creek channel near Comal Park.	2007	2015	2018
25	N 29°52.608' W -98°13.269'	East side of Jacobs Creek main lake point.	2007	2017	2018
26	N 29°52.538' W -98°15.475'	On the end of point northeast of Tom Creek boat ramp.	2007	2016	2019
27	N 29°54.033' W -98°15.873'	Along ledge on east side of Potters Creek Park.	2007	2014	2019
28	N 29°54.246' W -98°17.323'	Along ledge between Cranes Mill Park and water pipelines.	2007	2016	2019
29	N 29°54.150' W -98°16.668'	On point south of Potters Creek West boat ramp.	2007	2016	2019
30	N 29°53.392' W -98°14.405'	On Canyon Park main lake point.	2007	2017	2019

31	N 29°54.571' W -98°14.239'	End of extended point west of Canyon Park area near drop off.	2007	2016	2019
32	N 29°54.416' W -98°15.077'	Along creek channel northwest of island across from Canyon Lake marina.	2007	2016	2019
33	N 29°54.754' W -98°17.483'	On submerged Cranes Mill Road Bed, south of County Ramp 23.	2008	2016	2019
34	N 29°53.496' W -98°17.268'	Near Cranes Mill Park, north of marina.	2008	2017	2019
35	N 29°54.079' W -98°16.844'	Off east side of point, on opposite side of cove from Potters Creek ramp.	2008	2017	2019
36	N 29°54.442' W -98°17.619'	Hump near river channel, south of Mystic Shores.	2009	2016	2019
37	N 29°53.974' W -98°15.828'	River channel edge, east of Potters Creek.	2009	2016	2019
38	N 29°53.334' W -98°15.211'	Flat point near river channel ledge.	2009	2016	2019
39	N 29°53.768' W -98°17.171'	Hump North of Cranes Mill Marina.	2010	2016	2019
40	N 29°51.619' W -98°14.837'	Creek channel bend near Comal Park.	2010	2014	2018
41	N 29°53.794' W -98°13.711'	Hump on end of point near Canyon Park boat ramps.	2010	2017	2018
42	N 29°53.648' W -98°13.278'	On big point in Jacobs Creek splitting arms	2011	2014	2018
43	N 29°51.968' W -98°12.413'	Near drop off on extended main lake point near North Park.	2014	2014	2018
44	N 29°53.020' W -98°14.797'	On edge of hump extending from main lake point near Tom Creek	2017	2017	2019

GPS coordinates are in degree decimal minutes.

Some sites have been removed/renumbered from previous years.

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