PERFORMANCE REPORT

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2016 Fisheries Management Survey Report

Brownwood Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Brownwood Reservoir were surveyed in 2016 by electrofishing and trap netting and in 2017 by gill netting. Historical data are presented with the 2016-2017 data for comparison. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Brownwood Reservoir is a 6,814-acre impoundment constructed on Pecan Bayou and its tributary, Jim Ned Creek, in the Colorado River Basin about 70 miles southeast of Abilene, Texas. The reservoir was constructed in 1933 and is used for municipal water supply, flood control, and recreation. The reservoir is controlled by the Brown County Water Improvement District. Land use within the watershed is primarily agricultural, residential, and ranching. Water level declined from 2007 to 2012, and reduced to nearly 16 feet below conservation pool elevation. From 2012 to 2015, water level remained low but fluctuated between 11 and15 feet below conservation elevation. Rainfall during 2015-2016 refilled the reservoir and increased water level to over conservation pool elevation. Habitat during the survey period was primarily inundated terrestrial vegetation, buttonbush, black willow, small boulders, and cobble. Boater access was limited to two of five ramps during most of the survey period, and bank angler access was limited to areas near the boat ramps and Lake Brownwood State Park.

- **Management History:** Palmetto Bass were regularly stocked from the 1980's through mid-1990's, but stockings were discontinued because of the lack of directed fishing effort. Largemouth Bass were managed with a 16-inch minimum length limit (MLL) from 1 September 1993 to 1 September 1999; the regulation reverted to the 14-inch MLL. Blue Catfish were stocked in 2007, 2010, and 2016 to improve the catfish fishery.

- **Fish Community**
  - **Prey Species:** Bluegill, Gizzard Shad, and Longear Sunfish comprised a majority of the prey species community. Shad and sunfish were available as prey to most sport fish.
  - **Catfishes:** Blue Catfish and Channel Catfish had low relative abundance in monitoring surveys. Exploratory low-frequency electrofishing in 2014 yielded a sample of only five Blue Catfish. Similar to previous gill netting surveys, most Blue Catfish sampled were legal size. Channel Catfish catch in 2017 was relatively similar to previous gill netting surveys. Flathead Catfish were surveyed with exploratory low frequency electrofishing, and half of fish surveyed were legal-sized.
  - **White Bass:** White Bass catch rate in the 2017 gill netting survey declined since previous gill netting surveys, and most fish caught were legal-sized.
  - **Largemouth Bass:** Largemouth Bass relative abundance was high, but it fluctuated in biennial surveys since 2012. Similar fluctuations were observed for stock-sized fish. Catch of legal-sized fish in 2016 somewhat similar to the 2014 and 2012 surveys, and ample harvestable fish were available to anglers. Water level fluctuations likely influenced catch rates and production of Largemouth Bass.
  - **White Crappie:** Catch rates for White Crappie in trap netting surveys have increased since 2009. In 2016, an increased catch rate of legal-sized crappie was observed. Catch rates and production of White Crappie appeared to be influenced by water level and availability of structural habitat and vegetation.

- **Management Strategies:** Continue developing and maintaining partnerships for improving fish habitat within the reservoir. Monitor salt cedar coverage and work with controlling authority and other experts and stakeholders to identify possible control measures.

INTRODUCTION

This document is a summary of fisheries data collected from Brownwood Reservoir in 2016-2017. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve existing sport fisheries. While information on other fisheries was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2016-2017 data for comparison.

Reservoir Description

Brownwood Reservoir is a 6,418-acre impoundment of Pecan Bayou in the Colorado River Basin about 70 miles southeast of Abilene, Texas. The reservoir was constructed in 1933 and has been used for municipal water supply, flood control, and recreation. The reservoir is controlled by the Brown County Water Improvement District. Land use within the watershed is primarily agricultural, residential, and ranching. Brownwood Reservoir was classified as eutrophic per the Carlson's Trophic State Index for Chlorophyll-a (TSI Chl-*a*) with a TSI Chl-*a* of approximately 46.8 (Texas Commission on Environmental Quality 2011). Water level declined from 2007 to 2012, and reached near 16 feet below conservation pool elevation. From 2012 to 2015, water level remained low but fluctuated between 11 and 15 feet below conservation elevation. Rainfall during 2015-2016 refilled the reservoir and increased water level to over conservation pool elevation (Figure 1). Habitat during the survey period was primarily inundated terrestrial vegetation, buttonbush, black willow, small boulders, and cobble. Other descriptive characteristics for Brownwood Reservoir are in Table 1.

Angler Access

Brownwood Reservoir has five public boat ramps (Table 2). From 2013 to summer 2016, three ramps were closed because of low water level, and boater access was limited to the dam ramp and Lake Brownwood State Park Ramp #1. Heavy rains in summer and fall 2015 increased water level to near full, and all ramps were useable as of fall 2015. Public bank fishing access was limited to areas near the boat ramps and Lake Brownwood State Park.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Scott and Dumont 2013) included:

1. Work with area angler groups to install brush piles and/or other artificial cover in the reservoir.
   Action: During fall 2015, a collaborative artificial habitat enhancement project was completed at the reservoir. Collaborators included TPWD Inland Fisheries, Brown County Water Improvement District, Brownwood Bass Club, and Still Waters Bass Club. Habitat structures and brush piles were deployed at 12 locations and two fishing piers at Lake Brownwood State Park (Appendix A).
2. Conduct a creel survey and an intensive age-and-growth sample to investigate possible growth bottleneck of Largemouth Bass.
   Action: Biennial electrofishing was conducted from 2014-2016, and Category II age-and-growth samples were taken in 2014 and 2016. Growth of Largemouth Bass to the 14-inch MLL was similar to other district lakes. Thus, a more intensive age-and-growth survey and creel survey were not conducted.
3. Educate public about invasive species and their threats to Texas water bodies.
   Action: Various efforts have been made to educate several groups and individuals about invasive species. Examples include social media posts, popular press articles, providing literature, posting signage at boat ramps, and making speaking points while speaking to groups and individuals.

Harvest regulation history: Prior to 1993, all species were managed with statewide fishing regulations. From 1 September 1993 to 31 August 1999, Largemouth Bass were managed with a 16-inch MLL. However, the regulation reverted to the statewide 14-inch MLL on 1 September 1999. Other species have

always been managed with statewide regulations (Table 3).

Stocking History: Historical infrequent stockings have included Threadfin Shad, Walleye, and Hybrid Green x Redear Sunfish. Largemouth Bass were also stocked numerous times since 1969, which most common stockings were Florida Largemouth Bass. Palmetto Bass were stocked from the 1980's to 2002. Blue Catfish were stocked in 2007, 2010, and 2016. The complete stocking history for Brownwood Reservoir is displayed in Table 4.

Vegetation/habitat management history: A collaborative artificial fish habitat enhancement project was completed during fall 2015. Artificial habitat structures and Christmas tree brush piles were deployed at 12 locations throughout the reservoir and along two of the fishing piers at Lake Brownwood State Park (Appendix A).

Water transfer: No interbasin water transfers are known to exist.

METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with an objective-based sampling (OBS) plan for this waterbody during 2016-2017 (Table 5; TPWD unpublished). All survey sites were randomly selected, and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Electrofishing - Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (2 hours at 24, 5-min stations) during 2014 and 2016. 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 using otoliths from 11 fish collected from 2014 electrofishing and 19 fish from 2016 electrofishing (range 13.0 to 14.9 inches).

Low-frequency electrofishing - Blue Catfish and Flathead Catfish were collected by exploratory low-frequency electrofishing for 1 hour at 20, 3-minute stations during summer 2014. Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

Trap netting - Crappie were collected by using single-cod trap nets (10 net nights at 10 stations). Catch per unit effort (CPUE) for trap netting was recorded as the number of fish caught per net night (fish/nn). Ages for White Crappie were determined using otoliths from 16 fish that ranged 9.0 to 10.9 inches.

Gill netting - Blue Catfish, Channel Catfish, Hybrid Striped Bass, and White Bass were collected by gill netting (10 net nights at 10 stations). Catch per unit effort (CPUE) for gill netting was recorded as the number of fish caught per net night (fish/nn). Otoliths and fin clips were collected from two Hybrid Striped Bass that were caught during 2017 gill netting.

Tandem hoop netting - Channel Catfish were collected during an exploratory tandem hoop netting survey conducted during summer 2013 (6 tandem series for two-night sets at 6 random stations). Catch per unit effort (CPUE) for tandem hoop netting was recorded as the number of fish caught per tandem series set (fish/tandem series set).

Genetics - Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2016 and by electrophoresis for previous years. Fin clips were collected from two Hybrid Striped Bass caught during 2017 gill netting. Genetic analysis was conducted for discerning between Palmetto Bass and Sunshine Bass by using the reaction MPX1-Morone (Msa5-11 and Msa5-71) (Dijar Lutz-Carrillo, personal communication).

Statistics - Sampling statistics (CPUE for various length categories), structural indices [Proportional Size

Distribution (PSD), terminology modified by Guy et al. 2007], and body 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 vegetation and structural habitat survey was conducted in August 2016 by using the random point method (TPWD unpublished manual, TPWD 2015). A total of 400 random points throughout the reservoir, and presence/absence was determined for vegetative and structural habitat types identified at or below the waterline at all stations. Twenty-eight stations were discarded because they could not be sampled. Percent occurrence (% = [# stations habitat present / total stations sampled] X 100) and associated Wilson 95% confidence intervals (AusVet 2017) were calculated for each habitat feature type (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Water level - Source for water level data was the United States Geological Survey (USGS 2017).

RESULTS AND DISCUSSION

Habitat: Since the most recent survey reported in Scott and Dumont (2013), occurrence of vegetation has improved. Scott and Dumont (2013) did not encounter any vegetation during the habitat survey that was conducted in summer 2012. During the 2016 survey, most locations surveyed at the reservoir were featureless (53.0%; Table 6). However, flooded terrestrial vegetation occurred at 36.0% of the random locations sampled. Notable vegetation observed included buttonbush (18.5%), black willow (13.7%), waterwillow (8.9%), and exotic salt cedar (7.8%). Other structural habitat features observed included small boulders (12.4%), cobble (11.3%), fallen and standing timber (11.3%), and docks (7.8%).

Prey species: The prey base of Brownwood Reservoir was primarily comprised of Bluegill, Gizzard Shad, and Longear Sunfish. From 2012-2016, total catch rates for Gizzard Shad slightly increased from 230.7 fish/h (RSE=22) to 267.0 fish/h (RSE=18) (Figure 2). From 2012 to 2016, Gizzard Shad IOV decreased from 88 (SE=4) in 2012 to 46 (SE=7) in 2016, which suggested less individuals were optimal prey sizes for sport fishes. In 2016, Threadfin Shad catch rate was 5.0 fish/h (RSE=52), which was a substantial decrease from the 282.0 fish/h reported in 2012. From 2012-2016, electrofishing catch rates for Bluegill increased from 122.0 fish/h to 330.5 fish/h (Figure 3). The size structure of Bluegill remained similar from 2012 to 2016 and was comprised of small fish. Most individuals were ≤ 4 inches, and PSDs ranged from 3-7. Electrofishing catch rates for Longear Sunfish fluctuated from 74.0 fish/h (RSE=30) in 2012, to 141.5 fish/h in 2014, and to 66.0 fish/h in 2016. During both the 2014 and 2016 surveys, all Longear Sunfish caught were ≤ 5 inches.

Catfishes: Five Blue Catfish were sampled by low-frequency electrofishing in 2014, and they ranged from 6-22 inches. Gill net CPUE-Total for Blue Catfish in 2017 (2.2 fish/nn; RSE=32) was similar to that reported in 2013 (2.9 fish/nn; RSE=27) and greater than the rate reported in 2009 (0.6 fish/nn; RSE=67) (Figure 4). From 2009 to 2017, the catch rate of legal-sized Blue Catfish increased from 0.0 fish/nn to 2.0 fish/nn (RSE=32).

In the 2013 tandem hoop net survey, the catch rate of Channel Catfish was low (1.3 fish/tandem series; RSE=13), and fish ranged from 9-12 inches. The catch rate of Channel Catfish in the 2017 gill netting survey was 2.0 fish/nn (RSE=20), which was relatively consistent to prior surveys in 2013 (1.8 fish/nn; RSE=20) and 2009 (2.5 fish/nn; RSE=25) (Figure 5). Catch rates for legal-sized Channel Catfish fluctuated somewhat from 2009-2017 and ranged from 0.6-2.1 fish/nn.

A low-frequency electrofishing survey was conducted for Flathead Catfish to collect baseline data during summer 2014. Flathead Catfish were captured at a rate of 18.0/h (RSE=39); Stock CPUE was 12.0 fish/h (RSE=49); and catch of legal-sized fish (CPUE-18) was 9.0 fish/h (RSE=44) (Figure 6). Sizes of Flathead Catfish caught in the 2014 survey ranged from 4 to 37 inches, and half of the individuals were harvestable size. The presence of large Flathead Catfish may be promising for the promotion of the fishery to anglers. During spring 2016, a 46.25-inch and 41-lb. Flathead was caught by a local angler by rod-and-reel, and

the fish shattered the previous record that was set in 2010 by 10 lbs. and 7.25 inches.

White Bass: From 2009-2017, the total catch rate for White Bass decreased from 6.7 fish/nn to 3.9 fish/nn (Figure 7). Similarly, catch rate of legal-sized individuals (i.e., CPUE-10) decreased from 5.1 fish/nn (RSE=33) in 2009 to 2.8 fish/nn (RSE=40) in 2017. Catch of stock-sized White Bass has traditionally been low (i.e., < 50 fish) in gill netting surveys, but in 2009 and 2013 there were > 50 stock-sized fish caught. PSDs have fluctuated from 79 (SE=9) in 2009 to 69 (SE=10) in 2013 to 87 (SE=8) in 2017, and values suggested that the population was likely comprised of larger individuals during these years. The average age for the 2017 sample of White Bass ranging 9.0-10.9 inches (n=7) was approximately 3.7 years old (SD=0.8).

Largemouth Bass: Largemouth Bass catch rates were variable from 2012-2016 (Figure 8). In 2012, CPUE-Total was 66.0 fish/h (RSE=18) and increased to 112.0 fish/h (RSE=16) in 2014, but it decreased to 94.0 fish/h (RSE=16) in 2016. Stock CPUE increased from 37.3 fish/h to 83.5 fish/h in 2014 and decreased to 72.0 fish/h in 2016. In 2016, CPUE-14.was 8.0 fish/h, which was similar to 9.0 fish/h in 2014 and larger than 6.7 fish/h in 2012. Proportional Size Distributions shifted from 55 in 2012 to 23 in 2016, suggesting increased proportions of sub-stock sized fish over the survey period. Mean relative weights for stock-sized Largemouth Bass ranged from poor to fair. Average age at 14 inches (13.0-14.9) was 2.9 years (SD=1.6; Range: 2-7 years old) for the 11 fish collected in 2014; whereas, mean age near legal length was approximately 1.6 years old (SD=0.5; Range: 1-2 years old) for the 19 fish collected in 2016. Florida Largemouth Bass (FLMB) genetic influence has varied somewhat since 1997 (Table 7). Prevalence of FLMB alleles have ranged from 40.6-51.5% and prevalence of pure FLMB in samples has ranged from 3.3-13.3%. Recruitment and production of Largemouth Bass in the reservoir has likely been linked to the periodic water level fluctuations (Figure 9). Specifically, increases in catch rates of sub-stock bass occurred during multiple years following substantial rainfall and increases in water level. Conversely, catch rate declines for sub-stock bass were seen during periods of prolonged drought and drops in water level. After substantial water level increases, increased coverage of inundated terrestrial vegetation and structural habitat could be attributed to improved production, survival, and recruitment. Declines in relative abundance after extreme drops in water level and prolonged drought could be attributed to a reduction in available habitat, increased interspecific and intraspecific competition for resources, and predation pressure.

White Crappie: White Crappie catch rates in fall trap net surveys fluctuated during the survey period (Figure 10). CPUE-Total in 2009 was 16.2 fish/nn (RSE=17), and it decreased to 7.3 fish/nn (RSE=19) in 2012 and increased to 28.6 fish/nn (RSE=34) in 2016; Stock CPUE had similar variability. From 2012-2016, availability of legal-sized White Crappie improved; CPUE-10 increased to 3.0 fish/nn (RSE=39) from 0.7 fish/nn (RSE=48). Sizes of White Crappie caught in the 2016 survey ranged from 2-14 inches. Sixteen White Crappie from 9.0-10.9 inches collected during the 2016 trap netting survey were aged to 1-3 years old and had a mean age of 1.9 years old (SD=0.6). Since 2009, White Crappie PSDs have fluctuated and suggested that the population has been dominated by smaller fish. Relative weights for White Crappie in 2016 were variable, ranged from 80-99, and suggested that body conditions of individuals were poor to fair. Similar to what was observed for Largemouth Bass and sunfishes, White Crappie recruitment and catch rates in Brownwood Reservoir have likely been influenced by the fluctuations in water level and habitat availability (Figure 11). Catch rates of sub-stock White Crappie in fall trap net surveys appeared to increase in years following rises in water level, and declines in catch rates were observed during years when substantial water level drops occurred.

Fisheries management plan for Brownwood Reservoir

Prepared – July 2017

ISSUE 1: Brownwood Reservoir has been subjected to extreme fluctuations of its water level and prolonged droughts. During these periods of drought and low water level, vegetation and structural habitat become unavailable to popular sport fish and their prey.

MANAGEMENT STRATEGY

1. Continue to establish and maintain partnerships to conduct fisheries habitat establishment and enhancement projects.

ISSUE 2: Salt cedar (*Tamarix* sp) has become established at Brownwood Reservoir. Coverage of salt cedar is not known.

MANAGEMENT STRATEGIES

1. Map coverage of salt cedar within the reservoir.
2. Discuss salt cedar establishment and potential control strategies with the controlling authority and Texas Parks and Wildlife Department invasive species experts.

ISSUE 3: Existing information regarding the popularity of fisheries and angler harvest and expenditures are outdated and lacking for Brownwood Reservoir. Prioritization for fisheries management at the reservoir can be improved with collection of creel data.

MANAGEMENT STRATEGIES

1. Conduct a year-long roving creel survey from June 2020-May 2021 to gain a current understanding of angler effort, harvest, species preference, and expenditures at Brownwood Reservoir.
2. Contact bass clubs for historical weigh-in data to identify trends in catch and weigh-ins.

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 were 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 Brown County Water Improvement District to maintain appropriate signage to inform the constituents about invasive species threats at access points around the reservoir.
2. Contact and educate marina owners about invasive species, and provide them with posters, literature, and other informative materials 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 constituents.
5. Map existing and future interbasin water transfers to facilitate potential invasive species responses.

Objective-based Sampling Plan and Schedule

Sport fish, prey fish, and other important fishes: Important sport fishes present in Brownwood Reservoir include White Crappie, Blue Catfish, Channel Catfish, Flathead Catfish, Largemouth Bass, and White Bass. Important prey species include Bluegill, Gizzard Shad, and Longear Sunfish.

Low-density fisheries: Channel Catfish, Hybrid Striped Bass, and White Bass are present in the reservoir, but they have been in low relative abundance in previous monitoring surveys. Hybrid Striped Bass have not been stocked into Brownwood Reservoir since 2002. Hybrid Striped Bass will likely not be included in future monitoring reports given the most recent stocking will have surpassed the oldest documented individuals. Monitoring for Channel Catfish and White Bass presence/absence will be conducted during sampling efforts for important sport fishes.

Survey objectives, fisheries metrics, and sampling objectives

The survey schedule is displayed in Table 8.

Prey Species: Sunfishes (i.e., Bluegill and Longear Sunfish), Gizzard Shad, and Threadfin Shad are the primary prey species at Brownwood Reservoir. Monitoring surveys for prey have traditionally been conducted biennially while sampling for Largemouth Bass. Historical sampling effort of 1.5-2.0 hours has yield desirable precision for relative abundance estimates as well as sample sizes for evaluating the size structure for prey species. The next electrofishing surveys will be conducted in fall 2018 and 2020 at 24, 5-minute randomly selected stations for a total of two hours of sampling effort. Trend data for CPUE and size structure will be collected. During sampling, target precision will be RSE ≤ 25% for CPUE-Total. A target of ≥ 50 stock-sized fish will be sampled to evaluate size structure of sunfishes. Index of vulnerability will be calculated for Gizzard Shad to assess the relative proportion of individuals in the population that are of suitable prey sizes for sport fish. A target of 50 Gizzard Shad will be sampled to evaluate IOV. Additional sampling effort will not be given to achieve target precision for prey species.

Blue Catfish: The Blue Catfish population is likely growing slowly, and the population does support a fishery. Blue Catfish were stocked in 2007, 2010, and 2016 to support the existing catfish fishery. As of late, monitoring data suggest that recruitment may be poor. Low-frequency electrofishing in 2014 resulted in only five captured Blue Catfish, and the utility of this gear for future surveys is questionable. Use of low-frequency electrofishing to monitor Blue Catfish is a potentially promising method of sampling that will reduce bycatch of other non-target species. Addition sampling with this gear is necessary to evaluate its utility for the Brownwood Reservoir Blue Catfish population as well as to continue building a better dataset to evaluate trends in relative abundance and size structure. To continue monitoring Blue Catfish, low-frequency electrofishing will be conducted during summer 2020 for 1.0 hour at 20 randomly selected 3-minute stations. A sample of 13 fish 11.0-12.9 inches will be collected to evaluate growth to legal length. If the desired age-and-growth sample is not achieved, non-random sampling will be used to collect the additional specimens. Gill net sampling will also be conducted during spring of 2021 to continue monitoring trends with this sampling gear. Despite gill nets yielding low catch rates ranging from 0.6-2.9 fish/nn, better total sample sizes in comparison to low-frequency electrofishing have been achieved with traditional effort of 10 net nights. Catch rates for CPUE-Total and CPUE-12 will be calculated with no target levels for precision. A target of ≥ 50 stock-sized fish will be attempted to be sampled to evaluate size structure. If desired sample size is not achieved, up to 10 additional gill nets will be set if deemed feasible.

Flathead Catfish: The most recent creel survey conducted during 1996 suggested that anglers seldom target Flathead Catfish. However, traditional creel survey methods likely underrepresent the users of the fishery given that these fish are targeted by passive gears, hand-fishing, as well as rod-and-reel. The rod-and-reel lake record Flathead Catfish was broken in 2016, and the fish weighed approximately 41 lbs. Additional monitoring of the fishery is necessary for informing fisheries biologists on the status of the population as well as to market the fishery to anglers. Historical monitoring has been conducted during spring gill netting surveys. However, this sampling method has been ineffective in collecting ample numbers of individuals to obtain precise estimates of relative abundance. Low-frequency electrofishing in

2014 yielded a catch rate of 18.0 fish/h. To monitor Flathead Catfish, low-frequency electrofishing will be conducted in summer 2020 for 1.0 hour at 20 randomly selected 3-minute stations. Stratified random sampling will be conducted at stations selected within 15 feet maximum depth, and CPUE-Total, Stock CPUE, and CPUE-18 will be estimated. Desired precision will be RSE ≤ 25 for CPUE-Total and CPUE-18. A target of ≥ 50 stock-sized fish will be attempted to evaluate size structure. Weight will also be measured for ≥ 5 fish per inch group ≥ stock-size for assessing body condition. A Category II age sample will be collected from 13 fish at 17.0-18.9 inches to assess age at legal length. If desired precision for CPUE-Total and CPUE-18 or sample sizes are not achieved during sampling, up to 1 hour of additional sampling may be conducted. If desired precision has been met for CPUE estimates, body condition, and size structure but other objectives have not been met, non-random sampling may be conducted to collect individuals for age and growth.

Largemouth Bass: According to the 1996 creel survey, Largemouth Bass support greater than 90% of the directed angler effort at the reservoir. Further, the reservoir is a popular destination for Largemouth Bass fishing tournaments. Given the importance of this fishery, more frequent monitoring is necessary to monitor trends in the population to better inform fisheries biologists on the status of the fisheries and disseminating the information to constituents. Biennial electrofishing will be conducted in fall 2018 and fall 2020 for 2 hours at 24, 5-minute randomly selected stations. Sampling effort of 1.5-2.0 hours has yielded suitable levels of precision for relative abundance estimates and sample sizes for evaluating size structure, body conditions, and age and growth. Target precision will be RSE ≤ 25 for CPUE-Total and Stock CPUE. A target sample of ≥ 50 stock-sized fish will be sampled to determine size structure. Lengths and weights will be measured from a target of 5 fish per represented inch group > stock-size to calculate mean relative weights. In 2020, fin clips will be collected from a random sample of 30 fish to evaluate prevalence of Florida Largemouth Bass and Northern Largemouth Bass alleles. If objectives are not achieved, up to one hour of additional electrofishing may be conducted to improve data precision and/or sample size.

White Crappie: White Crappie support a fishery at Brownwood Reservoir. Monitoring relative abundance of White Crappie every four years has been adequate to evaluate trends in relative abundance, size structure, body condition, and growth. Trap netting will be conducted in fall 2020 at 10 randomly selected stations. Target precision will be RSE ≤ 25 for CPUE-Total, Stock CPUE, and CPUE-10. At least 50 fish ≥ stock-size will be collected to evaluate size structure by calculating PSD. Measurements of length and weight for ≥ 5 fish per inch group will be taken to assess body condition. Up to five additional trap nets may be set if desired precision and/or sample size are not met. Growth to legal length has been evaluated and data suggest that crappie reach legal size in roughly two years. Dumont and Neely (2009) reported that White Crappie achieve legal length (i.e., 10 inches) in about 2.3 years. The most recent sample of White Crappie of legal-length had an average age of 1.9 years old. During the upcoming monitoring period, White Crappie will not be aged.

Creel Survey:
The last creel survey was last conducted from 1 January 1996 to 31 May 1996. The previous creel data is dated and likely does not accurately represent the fisheries at the reservoir. A creel survey is necessary to gather current information regarding the popularity of fisheries, angler harvests/releases, expenditures, and anglers' demographics to prioritize management needs. A year-long roving creel survey will be conducted from 1 June 2020 – 31 May 2021 to collect data for directed angler hours, angler harvests/releases, expenditures, and demographics. The creel will be conducted for a minimum of five weekend days and four 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 2015).

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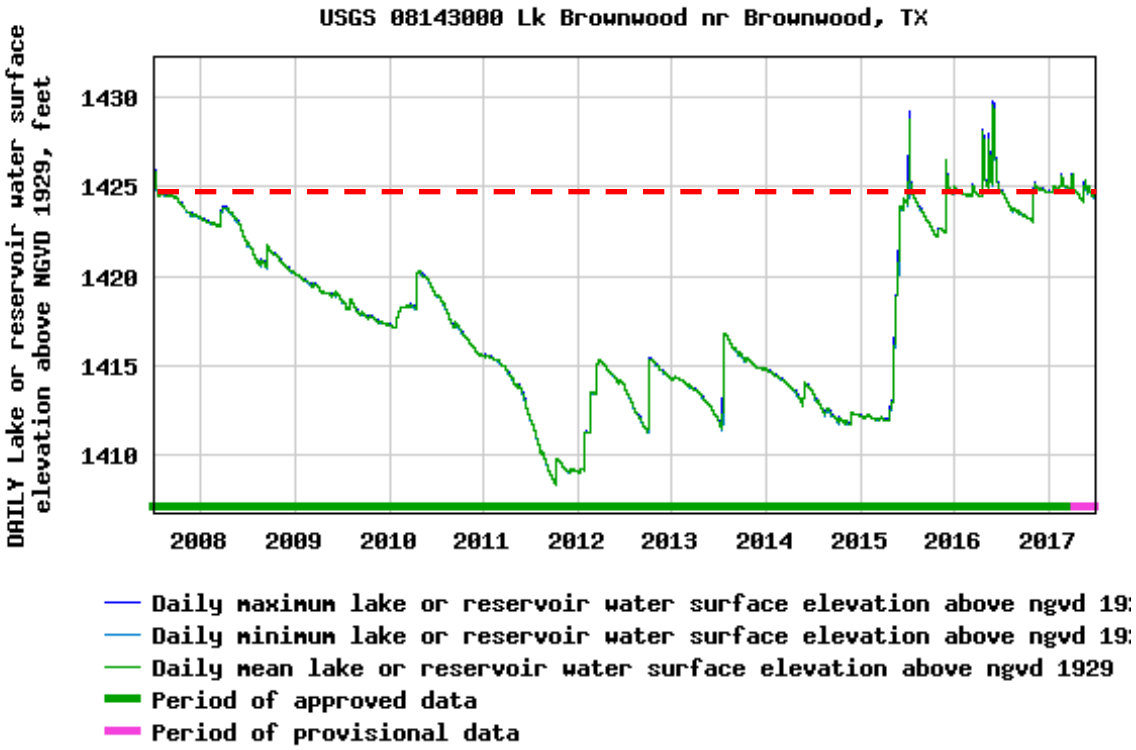


Figure 1. Mean daily water level elevations in feet above mean sea level (MSL) recorded for Brownwood Reservoir, Texas, 7/1/2007-7/1/2017 (USGS 2017). The dashed line indicates the reservoir's conservation pool elevation at 1,424.6 feet above MSL.

Table 1. Characteristics of Brownwood Reservoir, Texas.

Characteristic	Description
Year constructed	1933
Controlling authority	Brown County Water Improvement District
County	Brown
Reservoir type	Tributary
Shoreline Development Index	4.1
Conservation Pool Elevation (ft. above mean sea level)	1,424.6
Conductivity	407-577 µS/cm
River Basin	Colorado
USGS 8- Digit Hydrologic Unit Code Watersheds	12090108 (Jim Ned) 12090107 (Pecan Bayou)

Table 2. Boat ramp characteristics for Brownwood Reservoir, Texas, October 2016. Reservoir elevation at the time of the survey was about 1,424 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	No. of Lanes	Elevation at end of boat ramp (ft.)	Condition
Lake Brownwood State Park Ramp 1	31.86161° -99.01931°	Y	10	1	1,412	Excellent; no access issues
Lake Brownwood State Park Ramp 2	31.86186° -99.01958°	Y	10	1	1,418	Excellent; no access issues
Lake Brownwood State Park Ramp 3	31.86161° -99.01993°	Y	10	1	1,421	Excellent; no access issues
Flatrock Park	31.82419º -99.05103º	Y	20	1	1,417	Excellent; no access issues
Mountain View	31.81661º -99.07008º	Y	15	1	1,416	Excellent, no access issues
Dam	31.84161º -99.00350º	Y	35	1	1,410	Excellent; no access issues

Table 3. Harvest regulations for Brownwood, Reservoir, Texas.

Species	Bag limit	Length limit
Catfish: Channel and Blue, their hybrids and subspecies	25 (in any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Hybrid Striped	5	18-inch minimum
Bass, Largemouth	5	14-inch minimum
Crappie: White and Black, their hybrids and subspecies	25 (in any combination)	10-inch minimum

Table 4. Stocking history for Brownwood Reservoir, Texas. FGL=fingerlings; FRY=fry; ADL=adults; UNK = Unknown.

Species	Year	Number	Size
Threadfin Shad	1984	1,000	ADL
Blue Catfish	1988	17	ADL
	2007	326,174	FGL
	2010	325,761	FGL
	2016	324,616	FGL
	Total	976,568	
Channel Catfish	1972	72,000	ADL
	1980	150	UNK
	2005	304	ADL
	2006	300	ADL
	2007	556	ADL
	2008	300	ADL
	2009	301	ADL
	2010	300	ADL
	2011	302	ADL
	2012	300	ADL
	2013	301	ADL
	2014	306	ADL
	2015	321	ADL
	2016	305	ADL
	Total	76,046	
Green x Redear Hybrid Sunfish	1971	5,000	UNK
	1972	22,500	UNK
	1978	7,000	UNK
	1980	150	UNK
	Total	34,650	
Florida Largemouth Bass	1975	200,956	FGL
	1976	118,000	FRY
	1976	238,000	FGL
	1977	367,545	FGL
	1978	218,975	FGL
	1996	177,163	FGL
	2007	326,520	FGL
	2012	327,352	FGL
	2016	141,355	FGL
	Total	2,115,866	
Largemouth Bass	1969	10,000	UNK
	1970	500,000	FRY
	1994	169	ADL
	1995	86	ADL
	1996	50	ADL
	Total	510,305	
Smallmouth Bass	1980	72,950	UNK
	1982	70,000	UNK
	Total	142,950	

Table 4 (continued). Stocking history for Brownwood Reservoir, Texas.

Palmetto Bass	1980	73,850	UNK
	1983	75,600	UNK
	1986	145,601	FGL
	1987	145,101	FGL
	1988	148,325	FGL
	1989	154,470	FGL
	1991	39,600	FGL
	1992	40,500	FGL
	1994	45,006	FGL
	1995	89,970	FGL
	1996	36,869	FGL
	2002	36,680	FGL
	Total	1,031,572	
Walleye	1976	75,000	FRY
	1977	1,500,000	FRY
	1978	1,550,000	FRY
	Total	3,125,000	

Table 5. Objective-based sampling plan (OBS) for Brownwood Reservoir, Texas, 2016-2017.

Gear/target species	Survey Objective	Metrics	Sampling Objective
Electrofishing			
Gizzard Shad [a]	Relative Abundance	CPUE-Total	RSE ≤ 25
	Size Structure	Length frequency	N ≥ 50
	Prey Availability	IOV	N ≥ 50
Threadfin Shad [a]	Relative Abundance	CPUE-Total	RSE ≤ 25
Bluegill [a]	Relative Abundance	CPUE-Total	RSE ≤ 25
	Size Structure	Length frequency, PSD	N ≥ 50 stock
Longear Sunfish [a]	Relative Abundance	CPUE-Total	RSE ≤ 25
Largemouth Bass	Relative Abundance	CPUE-Total; Stock CPUE; CPUE-14	RSE ≤ 25
	Size Structure	Length frequency, PSD	N ≥ 50 stock
	Age and Growth	Age at legal length	N = 13, 13.0-14.9 inches
	Body Condition	W_r	5 fish / inch group
	Genetics	% FLMB	N = 30
Gill netting			
Blue Catfish	Relative Abundance	CPUE-Total; CPUE-12	RSE ≤ 25
	Size Structure	Length frequency, PSD	Achieved sample
	Age and Growth	Age at legal length	N= 13, 11.0-12.9 inches
Channel Catfish	Relative Abundance	CPUE-Total; Stock CPUE; CPUE-12	RSE ≤ 25
White Bass	Relative Abundance	CPUE-Total; Stock CPUE	RSE ≤ 25
	Size Structure	Length frequency, PSD	50 fish > stock size
	Body Condition	W_r	5 fish / inch group
	Age and Growth	Age at legal length	N= 13, 9.0-10.9 inches
Trap netting			
White Crappie	Relative Abundance	CPUE-Total; Stock CPUE	RSE ≤ 25
	Body Condition	W_r	5 fish / inch group
	Age and growth	Age at legal length	N = 13, 9.0-10.9 inches
	Size Structure	Length frequency, PSD	Achieved sample

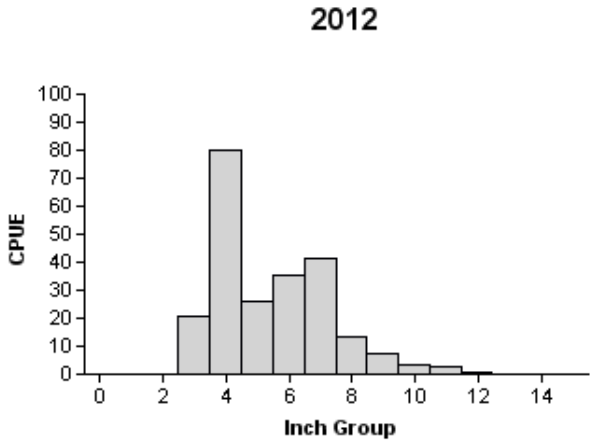
[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE for each prey species if not reached from designated Largemouth Bass sampling effort. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to prey density.

Table 6. Percent occurrences with lower and upper 95% confidence limits (CL) for vegetation and structural habitat features at 372 random sites in Brownwood Reservoir, Texas, August 2016. Water level at the time was about 0.5 feet below conservation pool elevation.

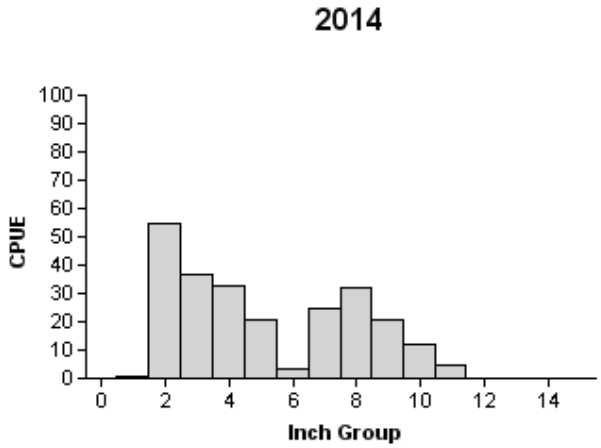
Structural habitat type	Percent occurrence	Lower CL	Upper CL
Featureless	53.0	47.9	58.0
Vegetation			
Flooded Terrestrial Vegetation	36.0	31.3	41.0
Buttonbush	18.5	14.9	22.8
Black Willow	13.7	10.6	17.6
Salt Cedar*	7.8	5.5	11.0
Waterwillow	8.9	6.4	12.2
Chara sp.	1.9	0.9	3.8
Water Primrose	1.6	0.7	3.5
American Lotus	1.6	0.7	3.5
Bulrush	1.1	0.4	2.7
Cattail	0.8	0.3	2.3
Cutgrass	0.8	0.3	2.3
Unknown Emergent	0.5	0.1	1.9
Pondweed	0.3	0.0	1.5
Duckweed	0.3	0.0	1.5
Giant African Cane*	0.3	0.0	1.5
Structural Habitat			
Small Boulders (10.0-24.0 in.)	12.4	9.4	16.1
Cobble (2.5-10.0 in.)	11.3	8.5	14.9
Boat Docks	7.8	5.5	11.0
Fallen Timber/ Woody Debris	6.5	4.4	9.4
Standing Timber	4.8	3.1	7.5
Large Boulders (>24.0 in.)	4.6	2.9	7.2
Bedrock	4.6	2.9	7.2
Bulkhead	3.8	2.3	6.2
Fence	3.2	1.9	5.6
Pebbles (<2.5 inches)	2.4	1.3	4.5
Boat Ramp	0.3	0.0	1.5
Bridge Piling	0.3	0.0	1.5

*Exotic species

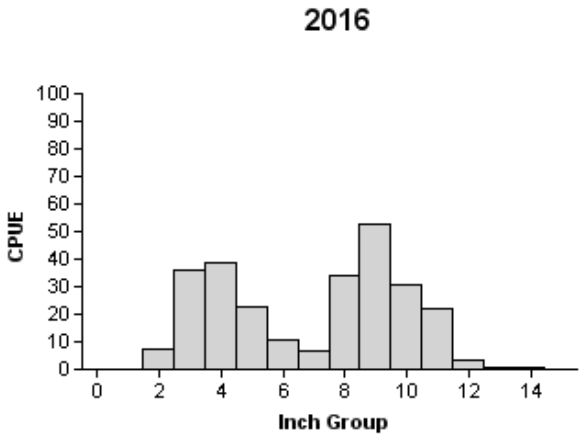
Gizzard Shad



Effort = 1.5
Total CPUE = 230.7 (22; 346)
IOV = 88 (4)



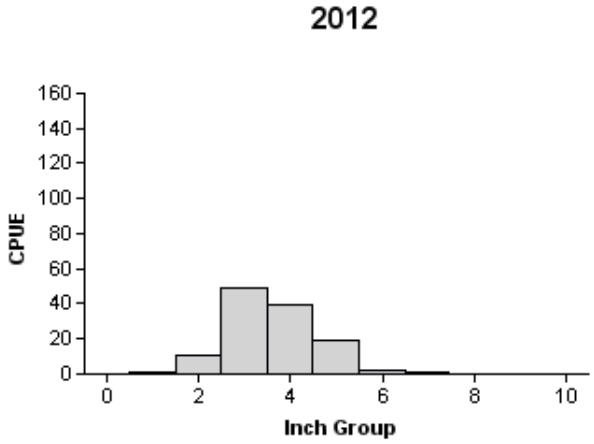
Effort = 2.0
Total CPUE = 243.0 (21; 486)
IOV = 72 (6)



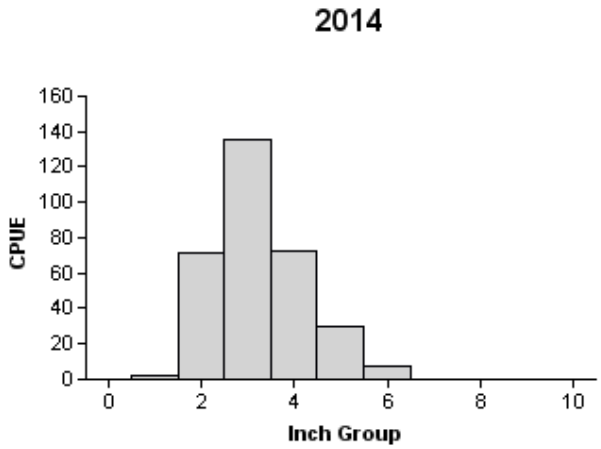
Effort = 2.0
Total CPUE = 267.0 (18; 534)
IOV = 46 (7)

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, Brownwood Reservoir, Texas, 2012, 2014, and 2016.

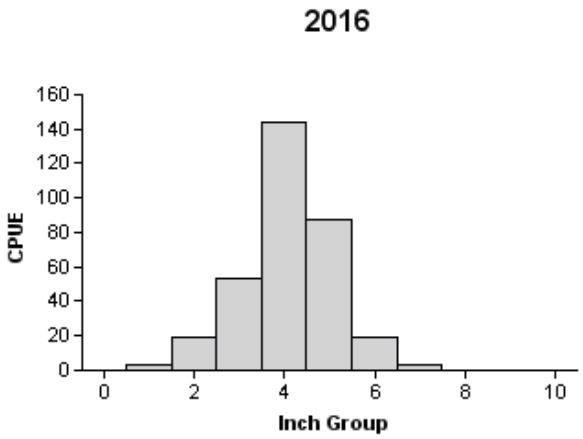
Bluegill



Effort =	1.5
Total CPUE =	122.0 (20; 183)
Stock CPUE =	110.7 (20;166)
PSD =	3 (2)



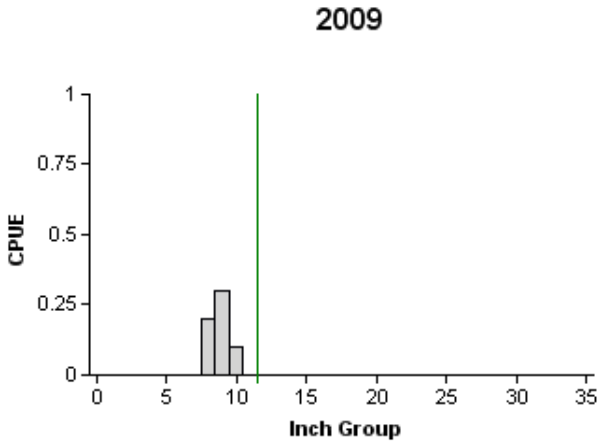
Effort =	2.0
Total CPUE =	320.5 (30; 641)
Stock CPUE =	246.0 (27; 492)
PSD =	3 (1)



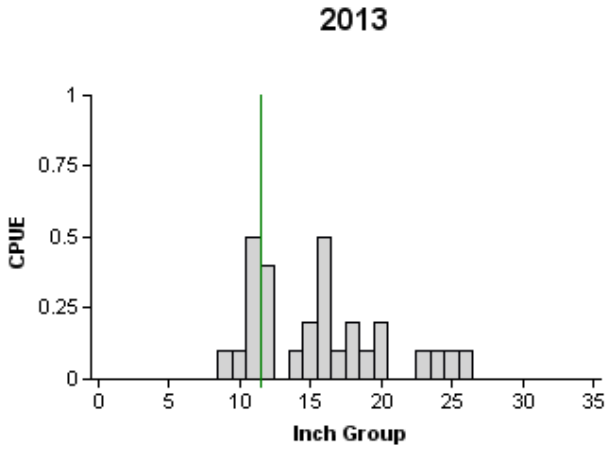
Effort =	2.0
Total CPUE =	330.5 (17; 661)
Stock CPUE =	308.5 (17; 617)
PSD =	7 (2)

Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Brownwood Reservoir, Texas, 2012, 2014, and 2016.

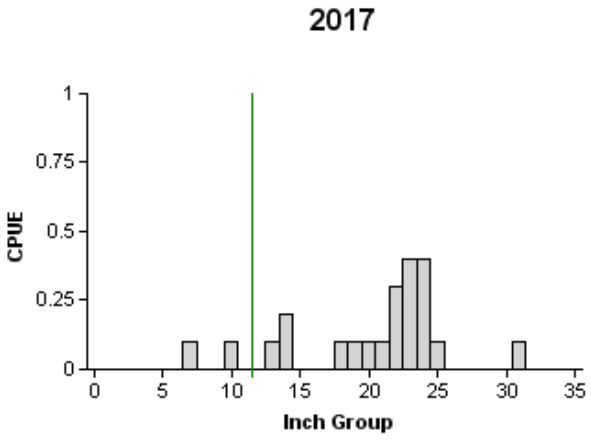
Blue Catfish



Effort =	10.0
Total CPUE =	0.6 (67; 6)
CPUE-12 =	0.0 (0, 0)
PSD =	0 (0)



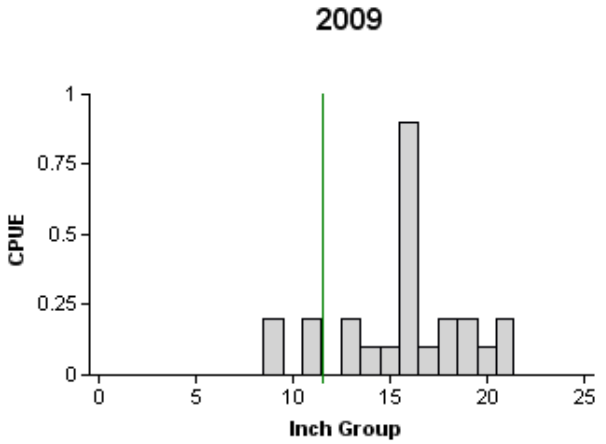
Effort =	10.0
Total CPUE =	2.9 (27; 29)
CPUE-12 =	2.2 (27; 22)
PSD =	27 (8)



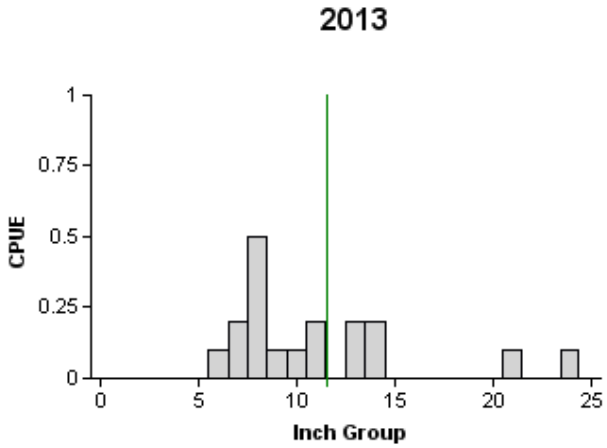
Effort =	10.0
Total CPUE =	2.2 (32; 22)
CPUE-12 =	2.0 (32; 20)
PSD =	75 (8)

Figure 4. Number of Blue Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Brownwood Reservoir, Texas, 2009, 2013, and 2017. The vertical green line indicates the 12-inch minimum length limit.

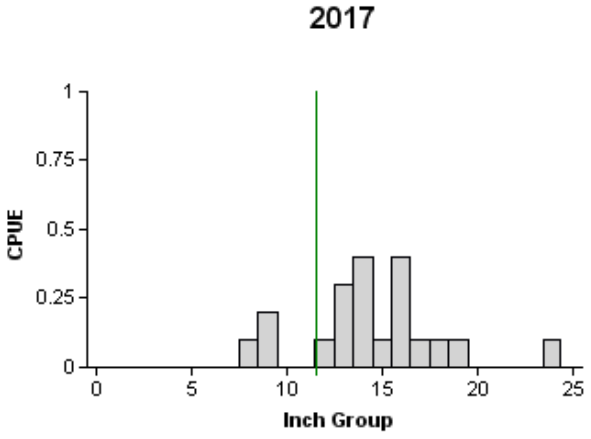
Channel Catfish



Effort =	10.0
Total CPUE =	2.5 (25; 25)
Stock CPUE =	2.3 (28; 23)
CPUE-12 =	2.1 (27; 21)
PSD =	74 (10))



Effort =	10.0
Total CPUE =	1.8 (20; 18)
Stock CPUE =	0.8 (31; 8)
CPUE-12 =	0.6 (44; 6)
PSD =	25 (22)



Effort =	10.0
Total CPUE =	2.0 (20; 20)
Stock CPUE =	1.7 (22; 17)
CPUE-12 =	1.7 (22; 17)
PSD =	47 (11)

Figure 5. Number of Channel Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Brownwood Reservoir, Texas, 2009, 2013, and 2017. The vertical green line indicates the 12-inch minimum length limit.

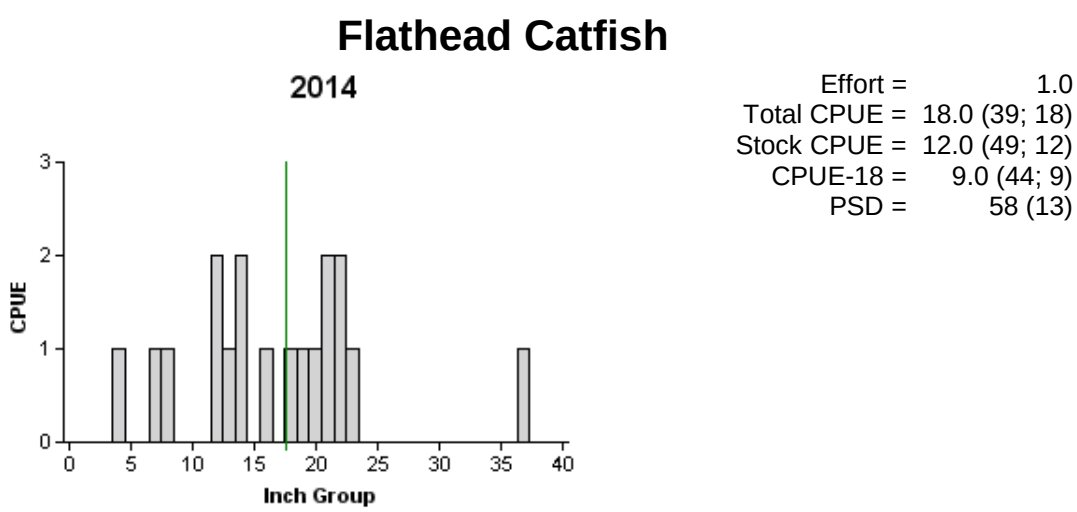


Figure 6. Number of Flathead Catfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) during a summer exploratory low-frequency electrofishing survey, Brownwood Reservoir, Texas, 2014. The vertical green line indicates the 18-inch minimum length limit.

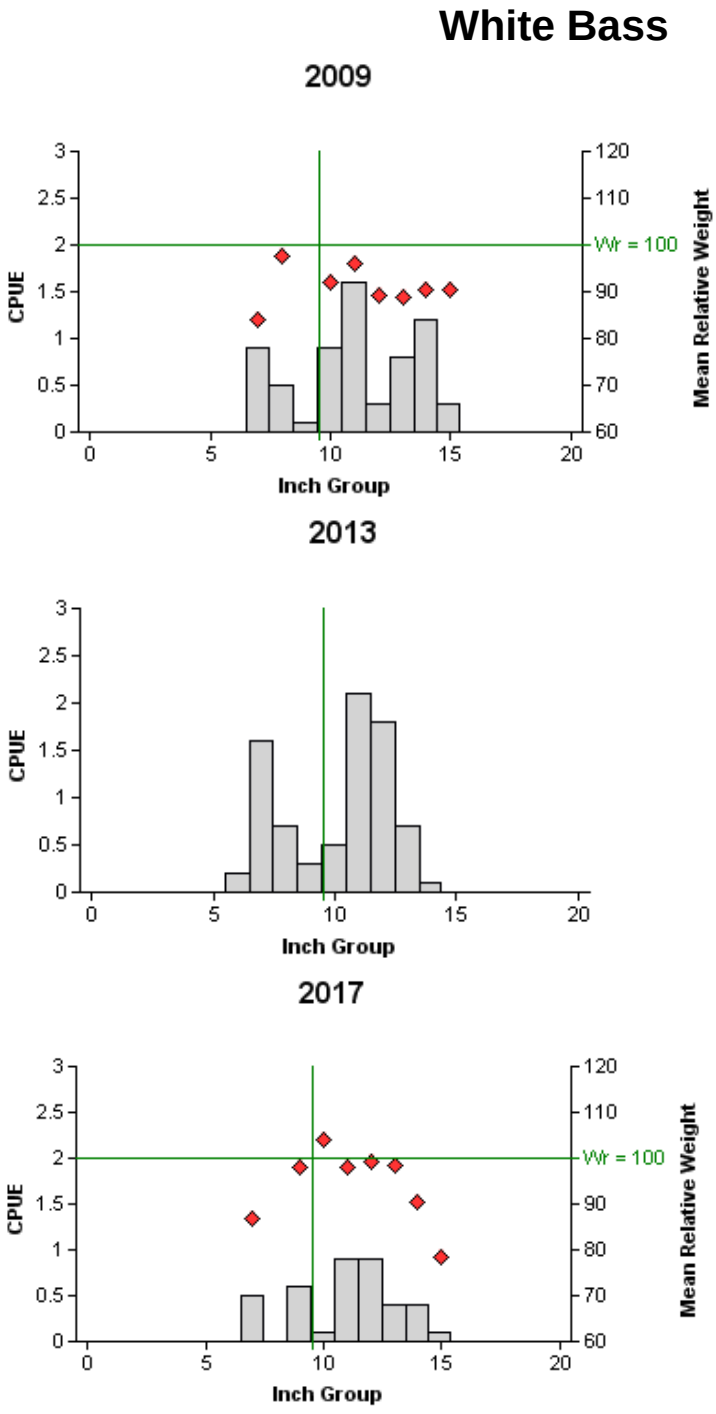
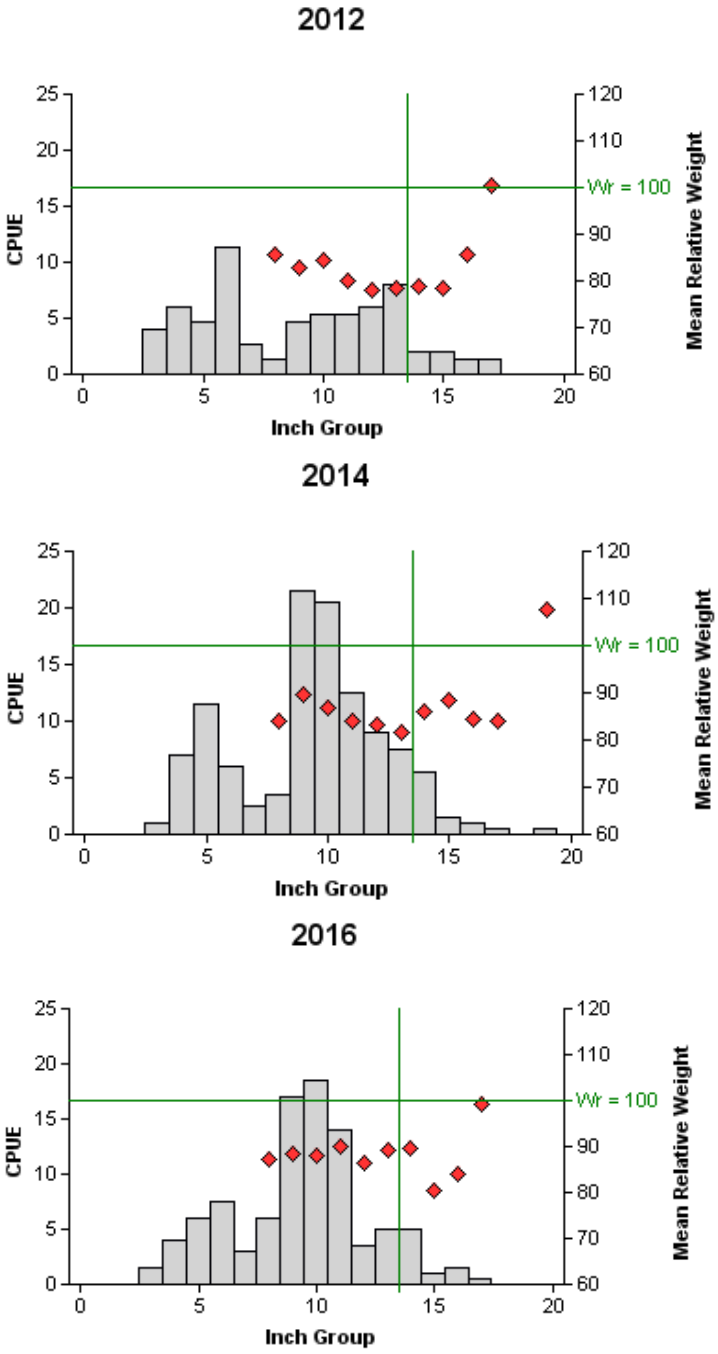


Figure 7. Number of White Bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Brownwood Reservoir, Texas, 2009, 2013, and 2017. The vertical green line indicates the 10-inch minimum length limit. The horizontal green line represents a mean relative weight threshold of 100 for the 2009 and 2017 samples.

Largemouth Bass



Effort =	1.5
Total CPUE =	66.0 (18; 99)
Stock CPUE =	37.3 (24; 56)
CPUE-14 =	6.7 (42; 10)
PSD =	55 (7)

Effort =	2.0
Total CPUE =	112.0 (16; 224)
Stock CPUE =	83.5 (17; 167)
CPUE-14 =	9.0 (28; 18)
PSD =	31 (4)

Effort =	2.0
Total CPUE =	94.0 (16; 188)
Stock CPUE =	72.0 (20; 144)
CPUE-14 =	8.0 (32; 16)
PSD =	23 (3)

Figure 8. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weights by inch group (red diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Brownwood Reservoir, Texas, 2012, 2014, and 2016. The vertical green line indicates the 14-inch minimum length limit. The horizontal green line represents a mean relative weight threshold of 100.

Largemouth Bass

Table 7. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Brownwood Reservoir, Texas. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, F1 = first generation hybrid between a FLMB and a NLMB, Fx = second or higher generation hybrid between a FLMB and a NLMB. NA = F1 hybrids were not determined in samples from 1997-2006. Genetic composition was determined by electrophoresis prior to 2005 and with micro-satellite DNA analysis since 2005.

Year	Sample size	FLMB	F1	Fx	NLMB	% FLMB alleles	% pure FLMB
1997	24	2	NA	20	2	45.8	8.3
2000	60	8	NA	47	5	47.4	13.3
2002	31	4	NA	20	7	44.4	12.9
2006	30	0	NA	30	0	41.0	0.0
2014	30	2	1	27	0	51.5	6.7
2016	30	1	1	27	1	40.6	3.3

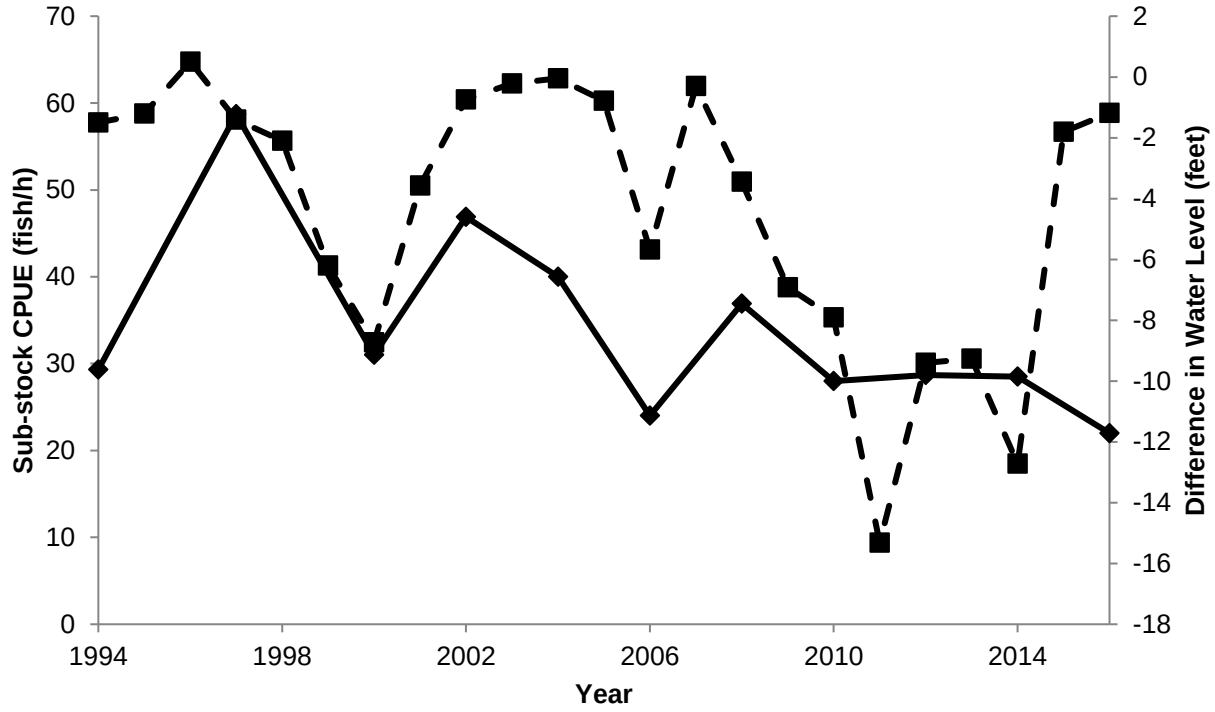


Figure 9. Sub-stock CPUE of Largemouth Bass (fish/h; solid line) caught during fall electrofishing surveys and difference between beginning October water level elevation and conservation pool elevation (feet; dashed line), Brownwood Reservoir, Texas, 1994-2016.

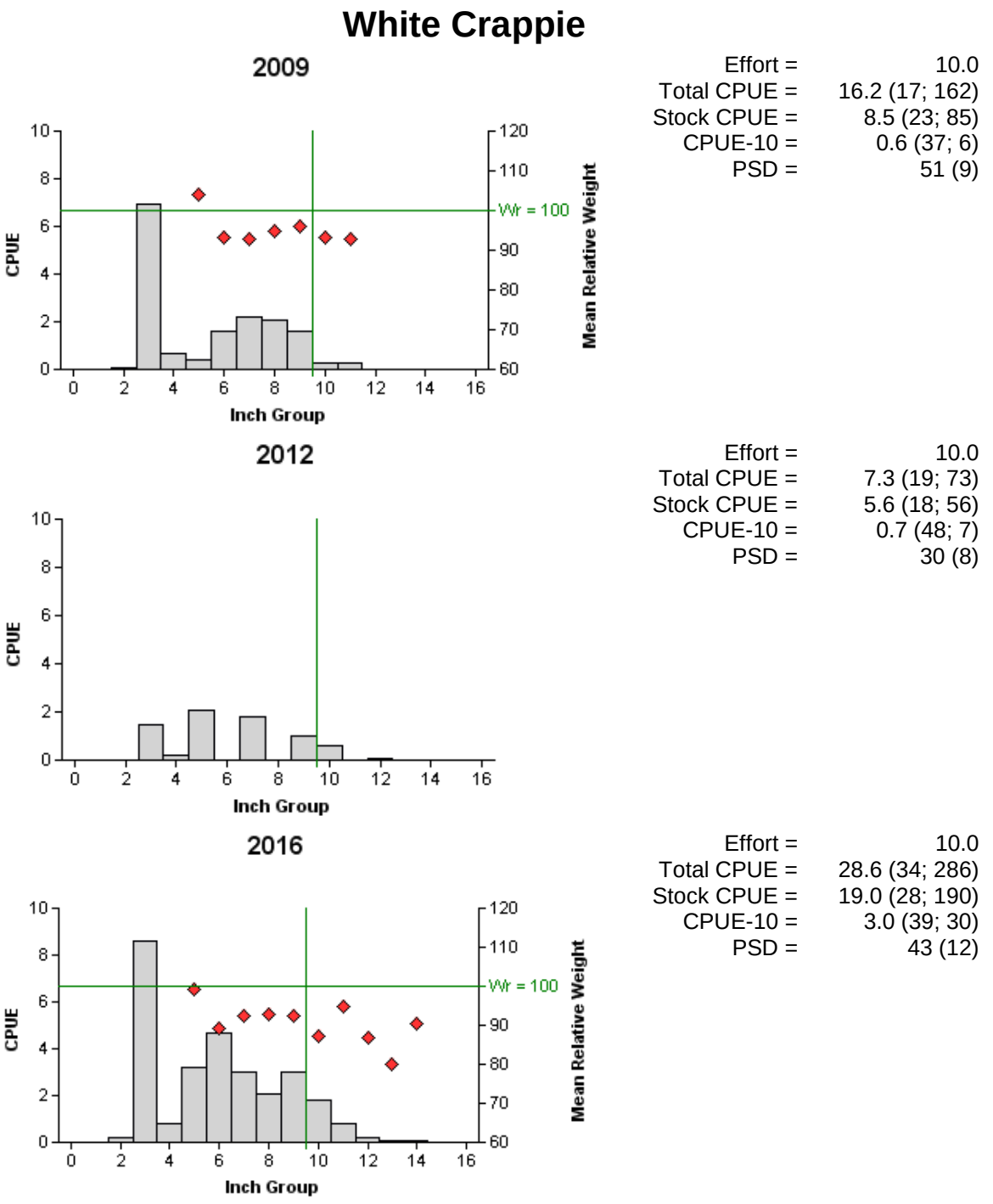


Figure 10. Number of White Crappie caught per net night (CPUE, bars), mean relative weights by inch group (red diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap net surveys, Brownwood Reservoir, Texas, 2009, 2012, and 2016. The vertical green line indicates the 10-inch minimum length limit. The horizontal green line represents a mean relative weight threshold of 100 for 2012 and 2016 samples.

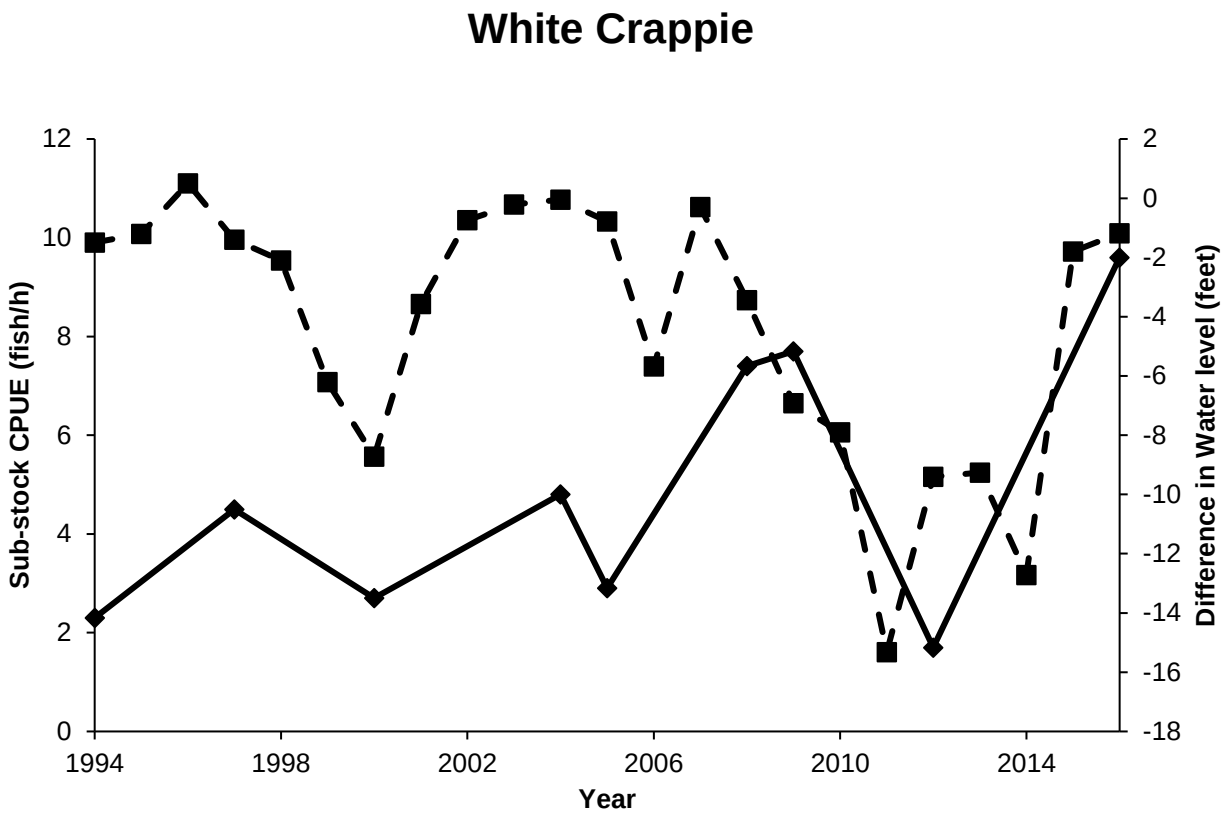
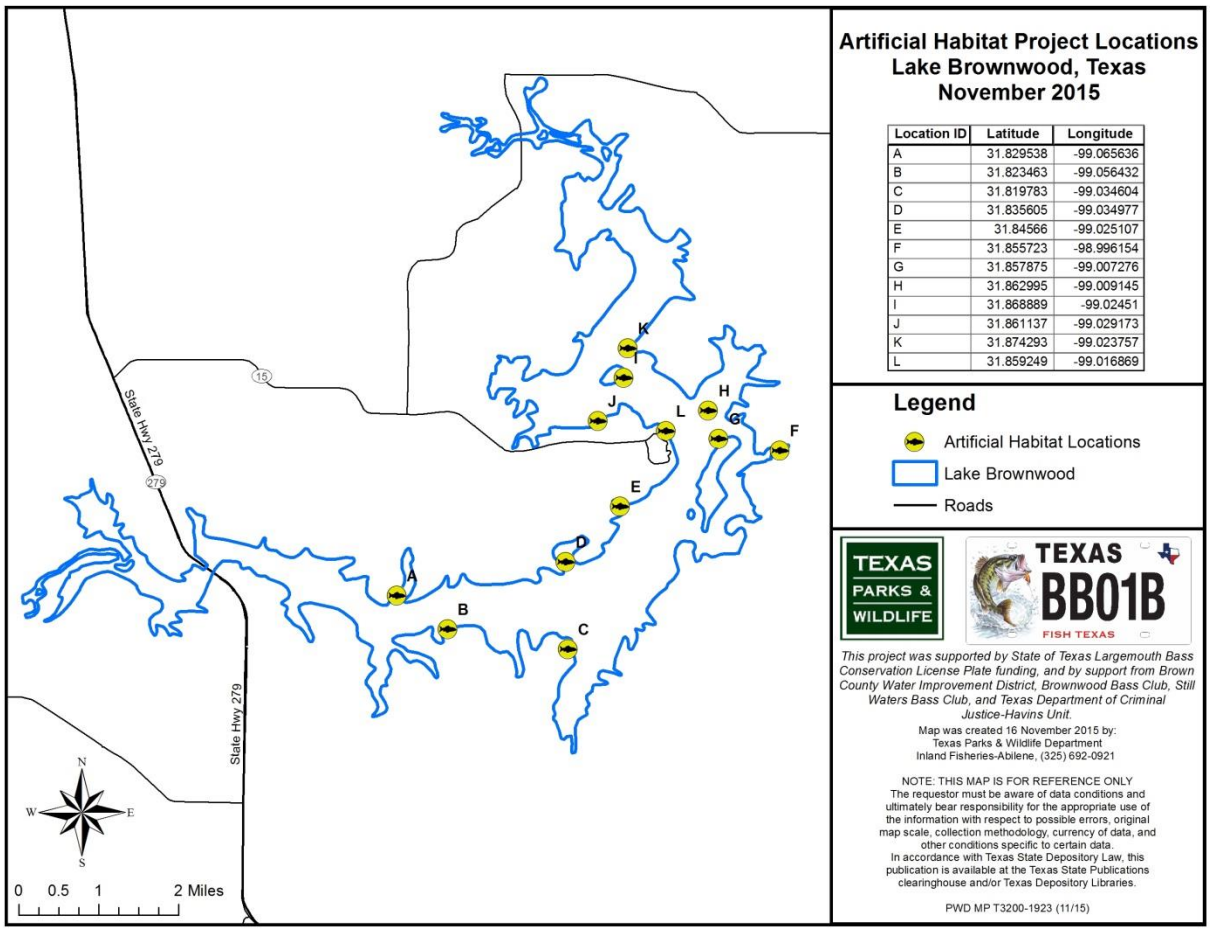


Figure 11. Sub-stock CPUE of White Crappie (fish/h; solid line) caught during fall trap netting surveys and difference between beginning October water level elevation and conservation pool elevation (feet; dashed line), Brownwood Reservoir, Texas, 1994-2016.

Table 8. Proposed sampling schedule for Brownwood Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while low-frequency electrofishing (LFE) is conducted in the summer, and electrofishing and trap netting surveys are conducted in the fall. Additional surveys are denoted by A, whereas standard sampling and reports to be completed are labeled as S.

Survey year	Electrofishing	Trap netting	Gill netting	LFE	Habitat/ Vegetation	Access	Creel	Report
2017-2018								
2018-2019	A							
2019-2020								
2020-2021	S	S	S	A	S	S	S	S

Appendix A



Location Identification Symbol	Latitude (decimal degrees)	Longitude (Decimal degrees)
A	31.82954	-99.0656
B	31.82346	-99.0564
C	31.81978	-99.0346
D	31.83561	-99.0350
E	31.84566	-99.0251
F	31.85572	-98.9962
G	31.85787	-99.0073
H	31.86300	-99.0091
I	31.86889	-99.0245
J	31.86114	-99.0292
K	31.87429	-99.0238
L	31.85925	-99.0169

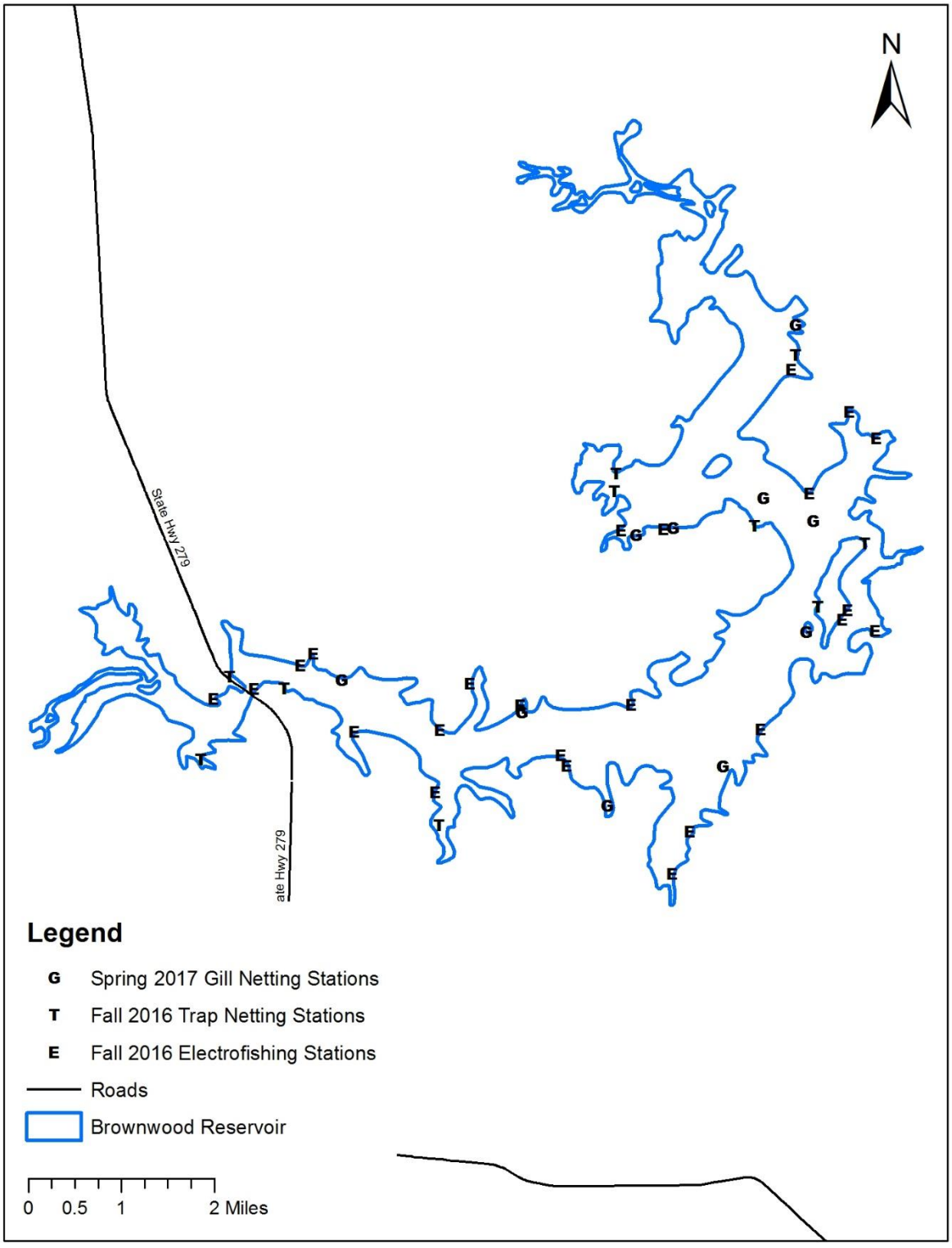
Map and coordinates of the fall 2015 artificial fish habitat project locations at Brownwood Reservoir. The project was conducted in collaboration with Brown County Water Improvement District (BCWID), Brownwood Bass Club, Still Waters Bass Club, and Texas Department of Criminal Justice – Havens Unit, Brownwood Reservoir, Texas. This project was supported by State of Texas Largemouth Bass Conservation License Plate funding as well as by additional funding support from BCWID and Brownwood Bass Club.

Appendix B

Number (N) and catch rate (CPUE) and associated relative standard error (RSE) of all species enumerated from all gear types from Brownwood Reservoir, Texas, 2016-2017. Sampling effort was, 2 hours for electrofishing, 10 net nights for trap netting, and 10 net nights for gill netting.

Species	Electrofishing		Gill Netting		Trap Netting	
	CPUE	N/RSE	CPUE	N/RSE	CPUE	N/RSE
Gizzard Shad	267.0	534/18				
Threadfin Shad	5.0	10/52				
Inland Silverside	3.5	7/60				
Blacktail Shiner	1.0	2/69				
Blue Catfish	0.5	1/100	2.2	22/32		
Channel Catfish			2.0	20/20		
Flathead Catfish			0.9	9/45		
White Bass	4.0	8/43	3.9	39/39		
Hybrid Striped Bass			0.2	2/67		
Green Sunfish	41.0	82/33				
Warmouth	6.5	13/31				
Bluegill	330.5	661/17				
Longear Sunfish	66.0	132/20				
Redear Sunfish	10.0	20/33				
Largemouth Bass	94.0	188/16				
White Crappie	0.5	1/100			28.6	286/34
Logperch	1.0	2/100				
Hybrid Sunfish	0.5	1/100				

Appendix C



Map of fisheries sampling stations, Brownwood Reservoir, Texas, 2016-2017. Water level elevation at the time of the surveys were within about ±1-ft. of conservation pool elevation.