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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2016 Fisheries Management Survey Report

Austin Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Austin Reservoir were surveyed in 2016 by using electrofishing. This report summarizes the results of the survey and contains a fisheries management plan for the reservoir based on those findings. Historical data are presented with the 2016 data for comparison.

- **Reservoir Description:** Austin Reservoir is a stable-level 1,589-acre riverine-type impoundment of the Colorado River located in the heart of the City of Austin (COA). It was constructed in 1893 for hydro-electric power, municipal water supply, water conservation and recreation. The reservoir is used to pass water from Travis Reservoir downstream. The reservoir is operated by COA and the Lower Colorado River Authority (LCRA). The reservoir lies within the Edwards Plateau and has a catchment area of approximately 38,240 square miles. Land surrounding the reservoir is highly developed with commercial and residential property bordering most of the shoreline. Natural habitat features consisted of boulders and emergent aquatic plants.

- **Management History:** Important sport fish include Largemouth Bass. The 2012 management plan included stocking Florida Largemouth Bass to maintain high genetic influence, and managing invasive levels of hydrilla. Largemouth Bass have been managed under statewide regulations. Other species of interest are Common Carp and Smallmouth Buffalo; the reservoir has been promoted as a prime destination for bank anglers pursuing these species. The triploid Grass Carp permit was lifted in 2016 to allow for harvest and help restore aquatic vegetation in the reservoir.

- **Fish Community**
  - **Prey species:** Gizzard Shad, Threadfin Shad, Redbreast Sunfish, and Bluegill were the predominant sources of forage.

  - **Catfishes:** Blue Catfish, Channel Catfish, and Flathead Catfish have historically been present in low densities.

  - **Temperate basses:** White Bass have historically been present in low densities. Striped Bass have been present in very low densities due to emigration from Travis Reservoir during flood events.

  - **Black basses:** Largemouth Bass were moderately abundant. Almost all angling effort is directed towards Largemouth Bass. Austin Reservoir was considered one of Texas' best trophy Largemouth Bass fisheries. Since 1994, anglers have submitted 20 Largemouth Bass weighing 13 pounds or greater to the Texas Parks and Wildlife Department (TPWD) ShareLunker Program. The most recent entry was in February 2014. Since 2014, the depletion of aquatic vegetation habitat has impacted catch of trophy-size bass. Guadalupe Bass have been present in low densities.

  - **Crappie:** Black Crappie and White Crappie have been historically present in low densities.

  - **Rough fishes:** Common Carp, Smallmouth Buffalo, and Freshwater Drum are present in moderate densities and provide recreational angling opportunities for bank anglers. Austin Reservoir is known to consistently produce trophy-size specimens of these species, which attracts bank anglers who direct their efforts towards a catch-and-release experience.

Management Strategies

The reservoir should continue to be managed with existing harvest regulations. Efforts to restore quality bass fishing by restoring aquatic habitat should be pursued. Encourage the removal of triploid Grass Carp. Continue to conduct annual electrofishing surveys to measure Largemouth Bass abundance as it relates to aquatic vegetation coverage. When habitat is restored, continue Florida Largemouth Bass stockings to maintain optimal genetic influence and trophy potential for this population. Educate angler

groups about lake vegetation management and encourage them to support a “balanced” management approach. Continue efforts to create awareness and educate people about invasive species.

INTRODUCTION

This document is a summary of fisheries data collected from Austin Reservoir in 2016. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other species of fishes was collected (Appendix A), this report deals primarily with major sport species and important prey species. Fisheries management strategies are included to address existing problems or opportunities. Historical data are presented with the 2016 data for comparison.

Reservoir Description

Austin Reservoir is a stable-level 1,589-acre riverine-type impoundment of the Colorado River located in the City of Austin (COA). It was constructed in 1893 for purposes of hydro-electric power, municipal water supply, water conservation, and recreation. The reservoir is used to pass water from Travis Reservoir downstream. The reservoir is operated by COA and the Lower Colorado River Authority (LCRA). The reservoir lies within the Edwards Plateau and has a catchment area above the dam of 38,240 square miles, of which 11,900 is probably noncontributing. The flow into Lake Austin is basically controlled/regulated by reservoirs in the upstream. Austin Reservoir was classified mesotrophic, with a mean TSI chl-*a* value of 42.92 (Texas Commission on Environmental Quality 2011). A calculation of median trophic classification values since 2014, after most of the aquatic vegetation was eradicated, suggests that the reservoir has remained mesotrophic (LCRA 2017). Land surrounding the reservoir is highly developed with commercial and residential property bordering most of the shoreline. Shoreline habitat at time of sampling consisted of bulkhead, natural shoreline, rocky bluffs, boulders, and caged native submerged/emergent vegetation. The most common shoreline habitat feature was bulkhead (50%). Exotic hydrilla (*Hydrilla verticillata*) and Eurasian watermilfoil (*Myriophyllum spicatum*), non-natives, previously accounted for the vast majority of the aquatic vegetation in the reservoir. High numbers of stocked triploid Grass Carp in 2013 lead to decimation of the aquatic vegetation habitat. Other descriptive characteristics for Austin Reservoir are listed in Table 1.

Angler Access

Austin Reservoir has four public boat ramps. All ramps remained open under stable water level conditions maintained at this reservoir. Additional boat ramp characteristics are in Table 2. Public shoreline access was available in seven public parks.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (De Jesus and Farooqi, 2013) included:

1. Continue annual aquatic vegetation and fall electrofishing surveys and continue to use hydrilla coverage, as documented by TPWD aquatic vegetation surveys, to determine the need for additional triploid Grass Carp stockings.

   Action: Multiple aquatic vegetation surveys were conducted annually to monitor hydrilla and other aquatic vegetation. Annual fall electrofishing surveys were conducted to monitor the Largemouth Bass population. Data from aquatic vegetation surveys were used to determine triploid Grass Carp stocking rates in Austin Reservoir. The stockings were coordinated by a user-group committee formed to manage aquatic vegetation in the reservoir.

2. Continue Florida Largemouth Bass stockings when applicable.

   Action: Florida Largemouth Bass were stocked in 2013 and 2014 into Austin Reservoir.

3. Promote Smallmouth Buffalo fishing opportunities.

   Action: The trophy Smallmouth Buffalo fishing opportunities at Austin Reservoir were promoted at organized carp angler events and via social media.

4. Cooperate with management authorities and educate the public on the prevention of the spread of aquatic invasive species

   Action: Invasive species awareness signs were posted at all the public boat ramps. Austin Reservoir hosted a couple of invasive species media events, used to promote awareness. Zebra mussel boater surveys were conducted at several ramps on Austin Reservoir.

Harvest Regulation History: Sport fish in Austin Reservoir have been managed with statewide regulations. Current regulations are found in Table 3.

Stocking History: Since 1996 Austin Reservoir has been stocked regularly with Florida Largemouth Bass. After historic ShareLunker entries from this reservoir, ShareLunker offspring were stocked since 2008. Triploid Grass Carp were stocked to control expanding hydrilla since 2003, but have not been stocked since 2013. The complete stocking history is in Table 4.

Vegetation/habitat management history: Aquatic vegetation management has been a part of the Austin Reservoir overall management scheme for over 50 years. A history of aquatic vegetation management efforts through 2000 are found in Tennant and Magnelia (2001). Since 2003, 56,767 triploid Grass Carp have been stocked by the COA, TPWD, LCRA and Friends of Lake Austin (FOLA) to control the aquatic plant hydrilla. A history of those efforts and effects on the Largemouth Bass population through 2006 is found in Chilton and Magnelia (2009). In addition to triploid Grass Carp stockings the reservoir has been periodically drawn down 12 feet during the winter months in an attempt to manage aquatic vegetation. Waterfront homeowners have also used bottom barriers and harvesters to control aquatic vegetation along their shoreline. Angler attitudes and opinions concerning aquatic vegetation management practices on the reservoir are found in Smith et al. (2002).

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

METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Austin Reservoir (TPWD unpublished). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (1.5 hours at 18, 5-min stations; Appendix B). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Ages for Largemouth Bass were determined by a category-2 evaluation (using otoliths from 13 randomly-

selected fish ranging 13.0 to 14.9 inches; TPWD, Inland Fisheries Division, unpublished manual revised 2015).

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.

Statistics – Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), terminology modified by Guy et al. 2007], and condition indices [relative weight (W_r)] were calculated for target fishes according to Anderson and Neumann (1996). Index of vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for CPUE.

Habitat – A structural habitat and vegetation survey was conducted in 2016. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

RESULTS AND DISCUSSION

Habitat: Littoral zone structural habitat consisted primarily of bulkhead and natural shoreline (Table 6). Aquatic vegetation coverage peaked at over 600 acres, 39.5% of the reservoir's surface area in 2012 (De Jesus and Farooqi 2013). At that time, hydrilla accounted for 554 acres and Eurasian watermilfoil for 78 acres. By fall 2013, hydrilla was, for practical purposes, eradicated, allowing Eurasian watermilfoil to expand to 202 acres, 13% of the reservoir's surface area (Table 7). A prolonged, cold winter in 2013/14 along with excessive grazing by wintering coots and Grass Carp decimated the remaining milfoil by the following spring. The reservoir has been void of free-growing submersed aquatic vegetation ever since (Table 7).

Hydrilla was first documented in the reservoir in July 1999. Winter (January and February) reservoir drawdowns have been a strategy used by the controlling authorities in an attempt to control this potentially invasive aquatic plant. In February 2003, the first triploid Grass Carp stocking was initiated by the COA. Ever since, triploid Grass Carp were stocked as needed to help control expanding hydrilla. Stocking rates were based on the results of TPWD aquatic vegetation surveys, and triploid Grass Carp were conservatively stocked in an incremental fashion. The premise of incrementally stocking was to rely upon the fact that hydrilla would be a preferred food item (Fowler and Robson 1978). The strategy was to increase the number of Grass Carp slowly until there were just enough in the reservoir to control hydrilla, but not so many as to eliminate less preferred species (Chilton and Magnelia 2009). The decision to incrementally stock, rather than using high initial stocking rates, was made with the understanding that aquatic vegetation was good for erosion control, fish habitat, and water clarity (Carpenter and Lodge 1986). The documented number of triploid Grass Carp in the reservoir per acre of hydrilla, taking into account monthly mortality, ranged from 11.8 to 3,482.4 since 2003; however a high of approximately 30,000 fish per acre of hydrilla must have occurred slightly before complete eradication of hydrilla in 2013. Historic trends show responses in hydrilla coverage since the introduction of triploid Grass Carp in 2003 without affecting the Eurasian watermilfoil, not preferred by the triploid Grass Carp (Magnelia and De Jesus 2009). Since 2008, hydrilla mixed with other aquatic plants remained concentrated in the very upper end of the reservoir, above Emma Long Park (Appendix C). Eurasian watermilfoil competes with hydrilla and coverage for these species has fluctuated in past years, possibly related to ecological conditions alternately favoring both species. The milfoil species typically grew at a depth of 15 feet or less and is adapted to grow at cooler temperatures (Smith and Barko 1990), while hydrilla can grow to over 20 feet of depth in the reservoir's clear water, and require warmer temperatures to flourish. Extreme drought conditions in central Texas between 2011 and 2015 led to the reduction of hypolimnetic discharges from Travis Reservoir upstream, which created a water temperature gradient in Austin Reservoir. Cooler water reached approximately mid reservoir under regular releases from Travis Reservoir, warming further downstream. Low discharge flows and reduced cool water stretches created favorable conditions for

hydrilla in the upper stretches of Austin Reservoir. Bellinger et al. (In press) also revealed that during the drought period, cyanobacterial blooms initiation and peak changed, abundances increased, and the probability of a growing season day experiencing a bloom approximately tripled as physicochemical conditions were altered by low flows; exacerbated by heavy hydrilla infestations. Before the drought, over 17,000 triploid Grass Carp were stocked into Austin Reservoir by COA, TPWD, LCRA, and FOLA over 9 years. Between 2011 and 2013, over 39,000 triploid Grass Carp were stocked incrementally to combat the aggressively-spreading hydrilla and its obtrusive density. The final stocking in 2013 put the estimated stocking rate at approximately 55 fish per acre of hydrilla, which was enough to eradicate the plant as well as most other non-target aquatic vegetation species in following years. This rate was significantly higher than the threshold presented by Hanlon et al. 2000. The study suggested that if the management goal for a lake is to control some of the problem aquatic plants while maintaining a small population of predominately unpalatable aquatic plants, triploid Grass Carp can be stocked at approximately 10 to 12 fish per acre of vegetation. At Austin Reservoir, historic monitoring suggested that noticeable impacts to hydrilla area coverage by triploid Grass Carp were accomplished at rates around 45 fish per vegetated acre. While this value could be set as a target in future management, it presents risks during high-level plant infestations; leaving the need for refinement in the impact assessment process.

The aquatic plant coverage in the upper third of the reservoir provided good habitat for Largemouth Bass, but excessive densities of the macrophytes likely presented negative impacts to the fishery and water quality. Before 2012, overall lake coverage has remained within the ideal percentages (20 – 40%) optimal for fish production (Durocher et al. 1984, Dibble et al. 1996). Unfavorable conditions for anglers, boaters and swimmers were presented when hydrilla topped out, matting on the reservoir surface, through most of its coverage area. Evidence suggests that the impacts of aquatic vegetation to the fishery, lake operations, water quality, and recreational safety are more related to vegetation density than area coverage. Refining our management approach to aquatic vegetation control using triploid Grass Carp is necessary to look at preserving beneficial aquatic vegetation biomass and establish a balance for all purposes.

Prey species: Electrofishing catch rates of Gizzard Shad increased to 102.7/h in 2016 from 47.3/h, in 2012. Index of vulnerability for Gizzard Shad was poor, indicating that only 23% of Gizzard Shad were available to existing predators; improved since the previous survey (Figure 1). Total CPUE for Threadfin Shad was 12.0/h. Total CPUE of Redbreast Sunfish, Bluegill, and Redear Sunfish in 2016 were 127.3/h, 85.3/h, and 11.3/h, respectively. Redbreast Sunfish relative abundance noticeably declined after the loss of aquatic vegetation, opposite of the significant increase observed in 2012, when aquatic vegetation coverage was its highest (Figure 2). Surprisingly, Bluegill relative abundance remained similar to previous surveys, with a slight increase since 2012 (73.3/h; Figure 3). Size structure continued to be dominated by small individuals for all sunfish species; however large Bluegill, Redbreast Sunfish and Redear Sunfish individuals were present and provided quality sunfish fishing opportunities (Figures 2 - 4). Other available prey species captured included Threadfin Shad and Blacktail Shiners (Appendix A). Inland Silversides were also observed in the 2016 survey; however, they were hard to capture with our dip nets. Opposite of what was reported in De Jesus and Farooqi (2013), the shift towards a dominant pelagic-based forage community was visible after the loss of aquatic vegetation at Austin Reservoir. Nutrient consumption by microalgae, in the absence of macrophytes, has provided a boost in the shad community overall, while centrarchids, which require vegetation habitat to thrive, experienced an overall reduction.

Largemouth Bass: The electrofishing catch rate of stock-length Largemouth Bass in 2016 was 41.3/h, lower than the 69.3/h in 2012 (Figure 5), and below the average (64.0/h) since 2000. Size structure was adequate as PSD varied from 44 to 63 since 2011; with memorable-size individuals present (Figure 5). Growth of Largemouth Bass in Austin Reservoir was poor for the Edwards Plateau eco-region (Prentice 1987); as, on average, fish reached legal harvest size of 14 inches by age 5 (N = 13; range = 2 – 5 years; Figure 6). Body condition in 2016 was sub-optimal (relative weight ≤ 100) for nearly all size classes of fish, with more size groups below 85 than in previous surveys (Figure 5). Florida Largemouth Bass influence has remained relatively constant as Florida alleles have ranged from 76 to 84% and Florida genotype has ranged from 13 to 20% (Table 8).

Austin Reservoir hosts a moderate-density Largemouth Bass population. Historic creel surveys revealed

almost all angling effort (91%) on the reservoir was directed towards Largemouth Bass (Smith et al. 2002). Many large bass have been caught in this reservoir since the early 1990's, including 20 bass over 13 pounds, entered into the TPWD ShareLunker Program. Based on those catches, it was regarded as one of the state's best trophy Largemouth Bass fisheries. Anecdotal fishing reports seem to coincide with electrofishing catch rates; they are at their best when vegetation coverage is not excessive, allowing open patches and defined edges for Largemouth Bass to thrive. The best electrofishing catch rates were obtained when vegetation coverage hovered between 300 and 400 acres or 19 to 25% of lake surface area (Appendix F). The triploid Grass Carp stocking strategy was adequate to maintain these desirable conditions from 2003 through 2011, when extreme drought conditions began to alter the ecosystem and impact the successful strategy. Hydrilla began to expand aggressively in 2011, which it likely led to strong year classes (combined with stockings) and poor foraging conditions that are related to poor growth. The reactive increased triploid Grass Carp stocking rates led to an immediate decimation of aquatic vegetation, also linked to poor foraging and growth. This is evident in the poor growth exhibited in Figure 6, where 38% of the 14- to 15-inch sample were from the 2011 and 2012 year classes (4- and 5-year-old fish).

This was the first time since triploid Grass Carp have been stocked in Austin Reservoir that complete eradication of aquatic vegetation was the outcome. Understanding the importance of maintaining a healthy "balanced" aquatic plant community should drive future management efforts to restore the excellent trophy Largemouth Bass fishery this lake is capable of maintaining. TPWD and their partners have taken this experience as an opportunity to learn and make adjustments to future fisheries management. Some immediate actions taken were to reduce the grazing pressure in the lake to help accelerate the reestablishment of aquatic vegetation and aid angling success: 1) Hundreds of native aquatic plant species propagules were planted by COA along littoral areas (protected by cages); 2) The triploid Grass Carp permit was lifted by TPWD, allowing for angler harvest of the triploid Grass Carp; 3) A network of 13 fish brush habitat attractors were installed by TPWD and the Texas Tournament Zone (TTZ) Friends of Reservoirs chapter along the lake to maintain angler success (Appendix D and E); 4) A triploid Grass Carp removal effort by TPWD, the Austin Carp Anglers, and COA led to the removal of 167 fish, totaling almost 2,700 pounds. The removal effort also allowed for the collection of scientific data to learn about feeding habits, mortality rates, and longevity of these fish in Austin Reservoir. Further investigations will allow us to "fine tune" our management approaches in the future, restore the quality of this fishery, and get anglers back on this water.

Fisheries management plan for Austin Reservoir, Texas

Prepared - July 2017.

ISSUE 1: A balanced healthy aquatic plant community has been the driving force of the quality bass fishing history on Austin Reservoir. A less-conservative and reactive stocking scheme of triploid Grass Carp, attributed to the aggressively expanding hydrilla during drought conditions led to the eradication of most of the aquatic vegetation in the lake. Much to the dismay of anglers and TPWD, the quality fishing component at Austin Reservoir has been lost. Restoration of habitat to improve fishing quality is necessary.

MANAGEMENT STRATEGIES

1. Encourage and participate in triploid Grass Carp removal efforts.
2. Continue to approve native aquatic vegetation plantings by the City of Austin.
3. Partner with local fishing outfits to install natural and artificial fish habitat structures.
4. Continue annual aquatic vegetation and fall electrofishing surveys to document vegetation coverage and Largemouth Bass population trends.
5. Develop new methodology to help monitor the effects of Grass Carp on aquatic vegetation density to refine traditional aerial surveys, currently used.
6. Educate angler groups about aquatic vegetation management at Austin Reservoir and encourage them to advocate for a balanced approach.

ISSUE 2: Twenty Largemouth Bass over 13 pounds (i.e., ShareLunker trophy bass) have been documented caught from this reservoir since the early 1990's. Many 8- to 12-pound fish were regularly reported caught in tournaments and by recreational anglers as well. Based on these catches the reservoir has proven its potential for producing trophy Largemouth Bass. Maintaining genetic influence from the Florida Largemouth Bass will increase the potential for future trophy bass catches.

MANAGEMENT STRATEGY

1. Continue requesting annual Florida Largemouth Bass stockings at 100/acre when vegetation habitat recovers.

ISSUE 3: In recent years there has been increasing interest in trophy Smallmouth Buffalo fishing in Texas, especially Austin-area reservoirs. The species is attracting anglers from other states and overseas, where Smallmouth Buffalo rarely reach large sizes or are not available. The rod and reel record for Austin Reservoir is 70.5 pounds. The anglers employ European-style bank fishing techniques and are limited to those reservoirs offering good bank access. Historically, the species has not been recognized as a sport fish.

MANAGEMENT STRATEGIES

1 Promote the availability of the Smallmouth Buffalo fishery in Austin Reservoir to recruit more anglers.

2 Investigate opportunities to increase bank access for these angler types.

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 authorities 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.
5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.
6. Make boaters aware of zebra mussel infestation in Travis and that Lake Austin will likely have them soon.

Objective-Based Sampling Plan for Austin Reservoir

2017 - 2021

Sport fish, forage fish, and other important fishes

The main sport fish in Austin Reservoir is Largemouth Bass. Known important forage species include Bluegill, Redear Sunfish, Redbreast Sunfish, Gizzard Shad, and Threadfin Shad. Other sport fishes occur in the reservoir; however provide insignificant fishing opportunities.

Low-density fisheries

Blue Catfish: Blue Catfish are present in the Colorado River Basin, but have never been stocked into Austin Reservoir. Occasional bycatch is reported by anglers, not targeting this species. This species is present in very low density and does not provide a viable fishery. Sampling this population is unnecessary in FYs 2017-2021.

Channel Catfish: The 2001 creel survey indicated Channel Catfish angling comprised 5.0% of total angling effort (third to Largemouth Bass and anglers fishing for anything). Directed total effort for this species was 2,455 hours at 1.5 hours/acre. Gill netting total CPUE ranged from 0.2/nn to 2.8/nn (1.4/nn average) from 1997 to 2013. The only stocking effort of Channel Catfish at Austin Reservoir was a supplemental stocking of 204 adult fish averaging 14 inches in length. This species is present in very low abundance and does not provide a viable fishery. Sampling this population is unnecessary in FYs 2017-2021.

Flathead Catfish: Flathead Catfish are present in low abundance, based on gill netting surveys conducted between 2005 and 2013. During this time, CPUE total averaged 0.7 fish/nn, and ranged between 0 and 1.6 fish/nn. A creel survey in 2001 did not capture directed effort for this species, revealing little interest by anglers to pursue this species at Austin Reservoir. Sampling this population is unnecessary in FYs 2017-2021.

White Bass: White Bass are present in low abundance, based on gill netting surveys conducted between 2005 and 2013. During this time, CPUE total averaged 0.6/nn, and ranged between 0.4/nn and 0.8/nn. A creel survey in 2001 did not capture directed effort for this species, revealing little interest by

anglers to pursue this species at Austin Reservoir. Sampling this population is unnecessary in FYs 2017-2021.

Crappie: Crappie are present in low abundance. Optional trap netting was deemed unnecessary over a decade ago due to poor catches. A creel survey in 2001 did not capture directed effort for this species, revealing little interest by anglers to pursue this species at Austin Reservoir. Sampling this population is unnecessary in FYs 2017-2021.

Survey objectives, fisheries metrics, and sampling objectives

Largemouth Bass: Largemouth Bass have been the most popular sport fish in Austin Reservoir. The popularity and reputation for quality/trophy Largemouth Bass fishing at this reservoir warrant sampling time and effort. Results from a 2001 creel survey showed directed angling effort for Largemouth Bass to be 24.5 hours/acre, and accounted for 91% of the total directed effort. Largemouth Bass are managed with a 14-inch minimum statewide regulation. This lake is known for quality fish and good catch rates, tied in historically with a healthy aquatic vegetation community. Trend data on CPUE, size structure, and body condition have been collected annually since 2000 with fall nighttime electrofishing. The population appears to be in good shape, and anglers were anecdotally satisfied with the fishing until 2014. The stocking of triploid Grass Carp, at increased rates, to control aggressively-expanding hydrilla caused a crash in the aquatic vegetation community in 2014, leading to a significant reduction of catch rates and numbers of large specimens caught ever since. Continuation of annual trend data in this reservoir with night electrofishing (bass-only in 2017 – 2019) in the fall will allow for determination of any large-scale changes in the Largemouth Bass population in relation to changes in the aquatic habitat (Table 9). A minimum of 18 randomly selected 5-min electrofishing sites will be sampled in 2017, but sampling will continue at random sites until 50 stock-size fish are collected and the RSE of CPUE-S is ≤ 25 (the anticipated effort to meet both sampling objectives is 18 stations with 75% confidence). Exclusive of the original 18 random stations, six additional random stations will be pre-determined in the event some 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 6 additional random stations, another night of effort will be expended.

Sunfish and Shad: Bluegill, Redear Sunfish, Redbreast Sunfish, Gizzard Shad, and Threadfin Shad are the primary forage at Austin Reservoir. Trend data on CPUE and size structure of these sunfish have been collected every four since 2000. Abundance of Threadfin Shad was also measured as a function of CPUE during those surveys and will remain the main sampling objective to measure Threadfin Shad abundance. Continuation of sampling will allow for monitoring of large-scale changes in sunfish relative abundance and size structure. Sampling effort based on achieving sampling objectives for Largemouth Bass will result in sufficient numbers of sunfish 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 sunfish species combined. No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of sunfish. Instead, Largemouth Bass body condition can provide information on forage abundance, vulnerability, or both relative to predator density. Relative weight of Largemouth Bass ≥ 8” TL will be determined from their length/weight data (maximum of 10 fish weighed and measured per inch class).

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Texas Commission on Environmental Quality. 2011. Trophic classification of Texas reservoirs. 2010 Texas Water Quality Inventory and 303 (d) List, Austin. 18 pp.

Table 1. Characteristics of Austin Reservoir, Texas

Characteristic	Description
Year constructed	1893
Controlling authority	City of Austin and LCRA
County	Travis
Reservoir type	Mainstem river system: Colorado
Shoreline development index (SDI)	8.5
Conductivity	378.0 µS/cm

Table 2. Boat ramp characteristics for Austin Reservoir, Texas, September, 2016. Reservoir elevation at time of survey was 492 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft.)	Condition
Walsh	30.29721 -97.78380	Y	13	480	Good/being renovated
Loop 360 Bridge	30.34975 -97.79940	Y	20	482	Good.
Emma Long Park	30.32930 -97.84285	Y	20	482	Fair
Mary Quinlan Park	30.32624 -97.92852	Y	10	485	Good

Table 3. Harvest regulations for Austin Reservoir, Texas.

Species	Bag limit	Length limit (inches)
Catfish: Channel and Blue Catfish	25 (in any combination)	12-minimum
Flathead Catfish	5	18-minimum
White Bass	25	10-minimum
Bass: Largemouth	5*	14-minimum
Bass: Guadalupe	5*	No minimum limit
White and Black Crappie	25 (in any combination)	10-minimum

*Five Largemouth and Guadalupe Bass in any combination.

Table 4. Stocking history for Austin Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), adults (ADL) and unknown (UNK). Life stages for each species are defined as having a mean length that falls within the given length range. For each year and life stage the species mean total length (Mean TL; in) is given. For years where there were multiple stocking events for a particular species and life stage the mean TL is an average for all stocking events combined.

Species	Year	Number	Life Stage	Mean TL (in)
Channel Catfish	2007	204	ADL	14.6
	Total	204		
Florida Largemouth Bass	1996	1,103,215	FRY	0.6
	1997	196,074	FRY	0.7
	1998	184,554	FGL	1.4
	1998	685,311	FRY	0.7
	1999	4,980	AFGL	5.4
	1999	184,016	FGL	1.7
	2003	262,750	FGL	1.7
	2003	881,925	FRY	0.6
	2004	318	ADL	10.2
	2004	162,149	FGL	1.6
	2004	431,007	FRY	0.4
	2005	12,000	FGL	1.9
	2007	171,291	FGL	2.1
	2007	89,897	FRY	0.3
	2009	174,246	FRY	0.3
	2010	182,277	FGL	1.7
	2011	436,843	FRY	0.3
	2013	164,679	FGL	1.5
	2014	160,109	FGL	1.6
	Total	5,487,641		
Triploid Grass Carp	2003	13	ADL	24.1
	Total	13		
Northern Pike	1980	88,500	UNK	0.0
	1981	34,514	UNK	0.0
	Total	123,014		
Palmetto Bass (Striped X White Bass hybrid)	1975	20,000	UNK	0.0
	1977	20,035	UNK	0.0
	1981	5,000	UNK	0.0
	1983	10,089	UNK	0.0
	Total	55,124		
Rainbow Trout	2001	3,008	ADL	9.3
	Total	3,008		

Table 4. Stocking history for Austin Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), adults (ADL) and unknown (UNK). Life stages for each species are defined as having a mean length that falls within the given length range. For each year and life stage the species mean total length (Mean TL; in) is given. For years where there were multiple stocking events for a particular species and life stage the mean TL is an average for all stocking events combined.

Species	Year	Number	Life Stage	Mean TL (in)
ShareLunker				
Largemouth Bass	2008	12,612	AFGL	6.2
	2010	2,220	FGL	2.5
	2011	3,913	FGL	2.4
	2012	11,025	FGL	2.0
	2013	6,380	FGL	2.0
	2014	11,230	FGL	2.0
	Total	47,380	AFGL	
Triploid Grass Carp	2003	3,825	AFGL	10.0
	2004	4,300	AFGL	10.0
	2006	1,600	AFGL	10.0
	2007	3,075	AFGL	10.0
	2009	4,400	AFGL	12.0
	2011	13,200	AFGL	10.0
	2012	17,369	AFGL	12.0
	2013	8,998	AFGL	12.0
	Total	56,767		
Walleye	1976	20,200	FRY	0.2
	Total	20,200		

Table 5. Objective-based sampling plan components for Austin Reservoir, Texas 2016 – 2017.

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

[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, Austin Reservoir, Texas, 2016. Shoreline habitat distances are in miles.

Habitat type	Distance	% of total
Natural shoreline	19.8	34.0
Bulkhead w/ piers	23.0	40.0
Rocky bluff	1.4	2.0
Bulkhead	5.7	10.0
Natural shoreline w/ piers	7.4	13.0
Rocky shoreline w/ piers	0.2	< 1.0
Rocky bluff w/ piers	0.1	< 1.0

Table 7. Survey of aquatic vegetation, Austin Reservoir, Texas, 2013 – 2016. Surface area (acres) is listed with percent of total reservoir surface area in parentheses. Surveys were conducted in the fall.

Vegetation	2013	2014	2015	2016
Native submersed	1.0 (<1.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Native floating-leaved	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Native emergent*	-	-	<1.0 (<1.0)	<1.0 (<1.0)
Non-native				
Hydrilla (Tier I)**	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Eurasian watermilfoil (Tier III)**	202 (13.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)

*Coverage not calculated in historical surveys; however several acres of bulrush were noted eaten by triploid grass carp beginning in 2014, leaving the lake with less than an acre of emergent native vegetation, mostly American waterwillow (*Justicia americana*).
**Tier I is immediate Response, Tier III is Watch Status.

Gizzard Shad

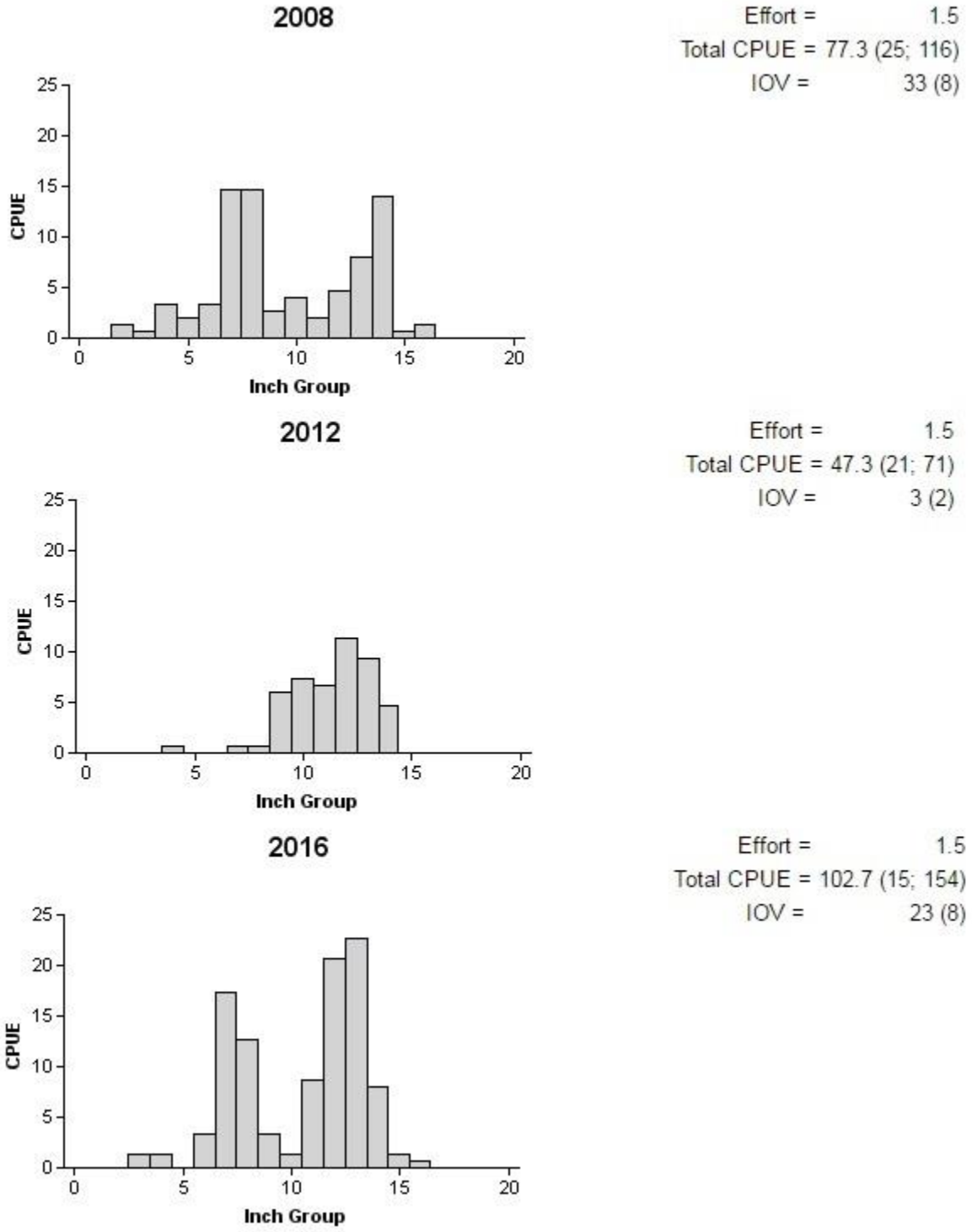


Figure 1. Number of Gizzard Shad caught per hour (CPUE) population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Austin Reservoir, Texas, 2008, 2012, and 2016.

Redbreast Sunfish

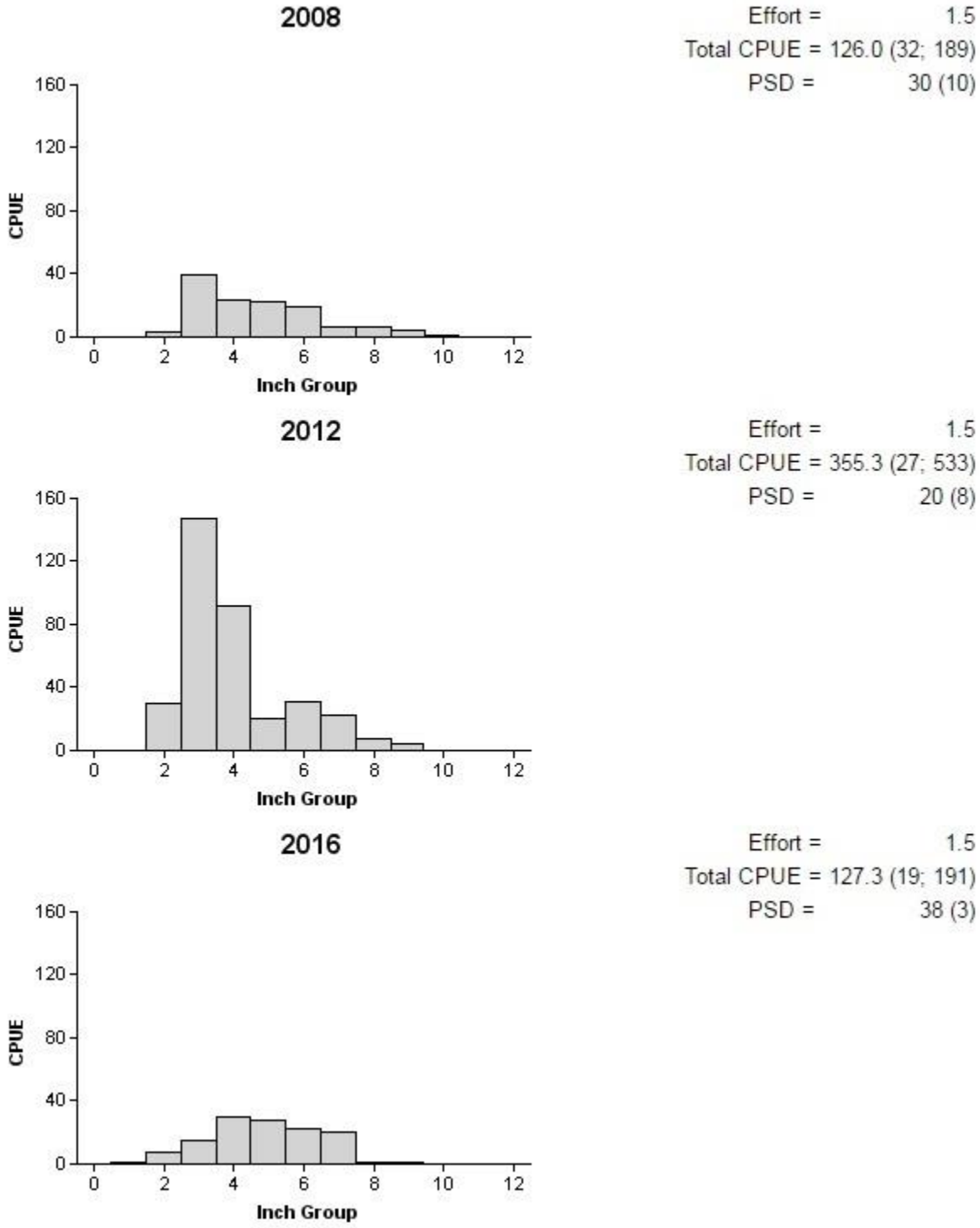


Figure 2. Number of Redbreast Sunfish caught per hour (CPUE) population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Austin Reservoir, Texas, 2008, 2012 and, 2016.

Bluegill

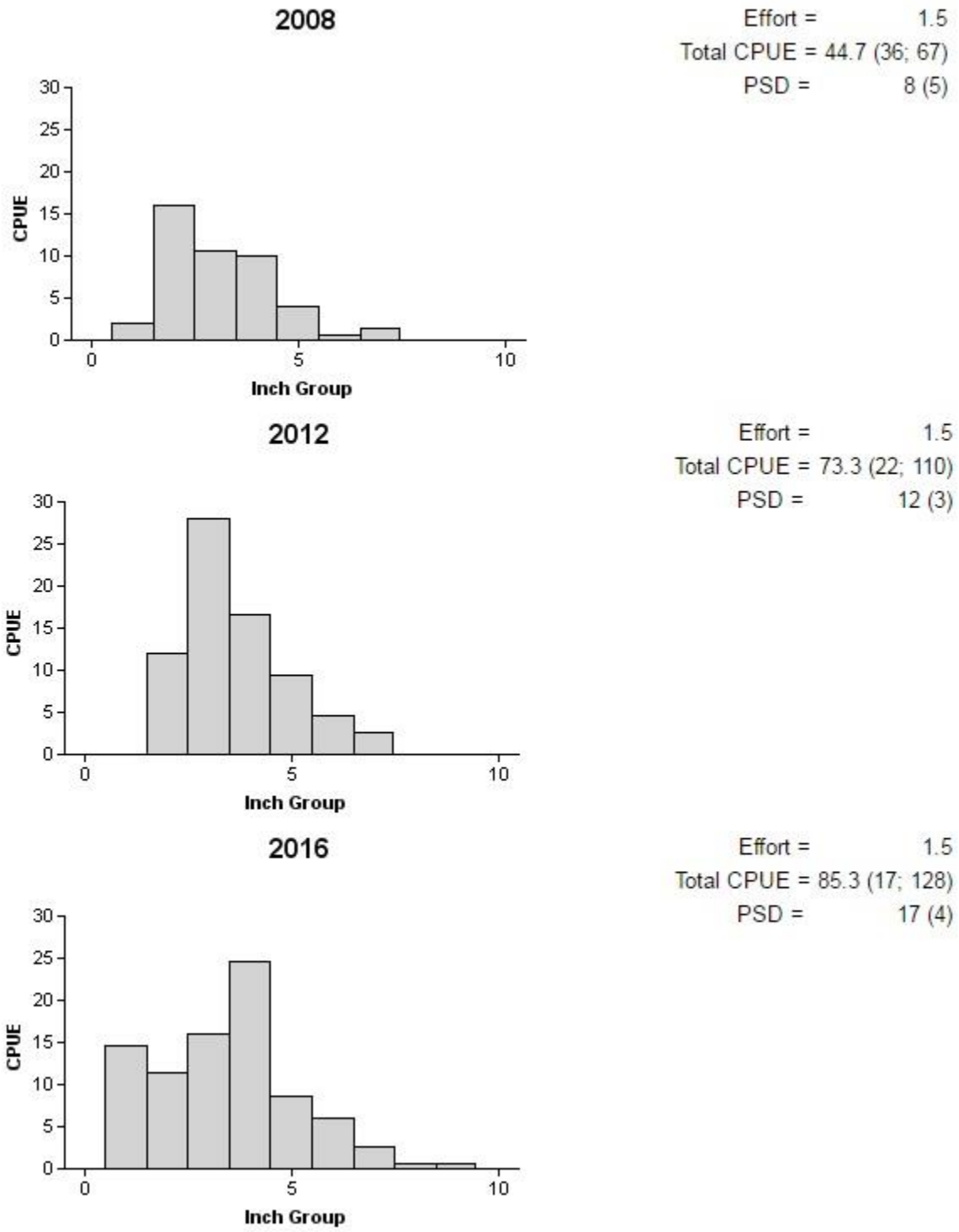


Figure 3. Number of Bluegill caught per hour (CPUE) population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Austin Reservoir, Texas, 2008, 2012, and 2016.

Redear Sunfish

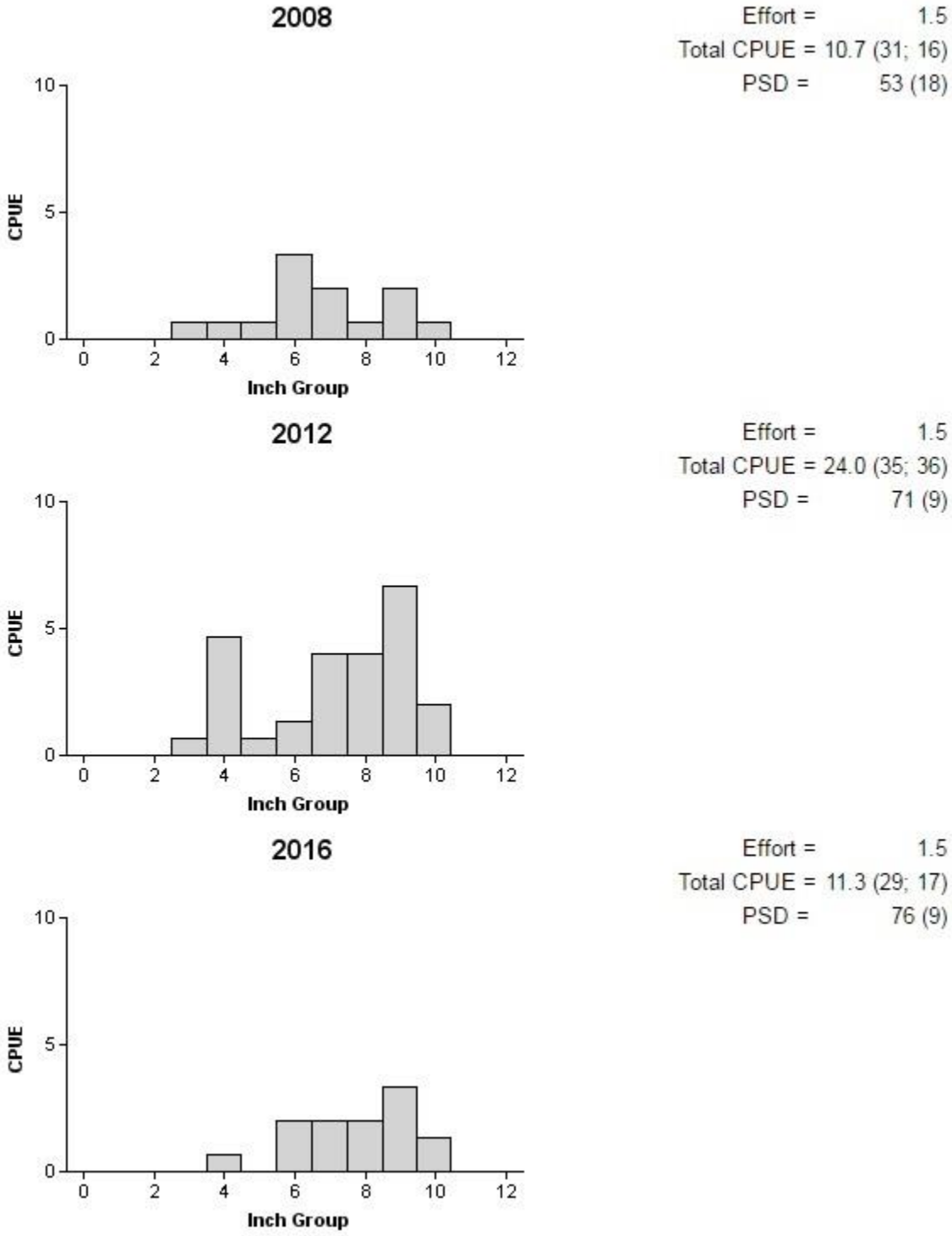
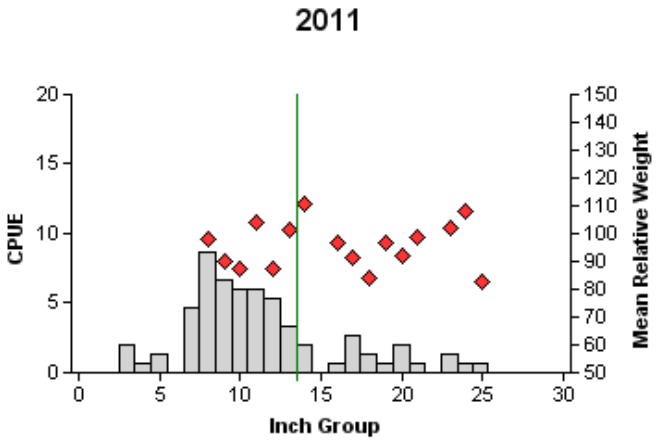
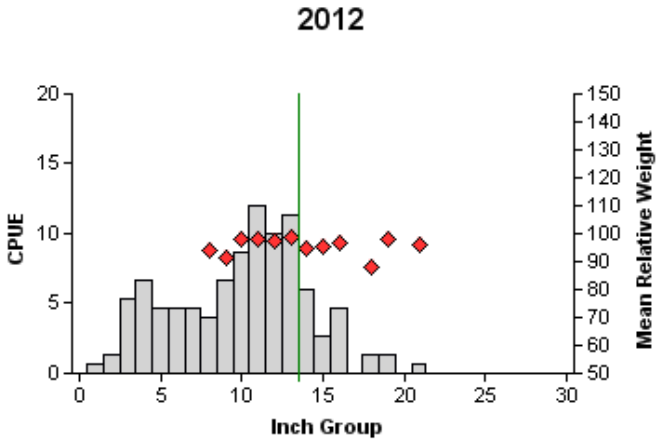


Figure 4. Number of Redear Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Austin Reservoir, Texas, 2008, 2012, and 2016.

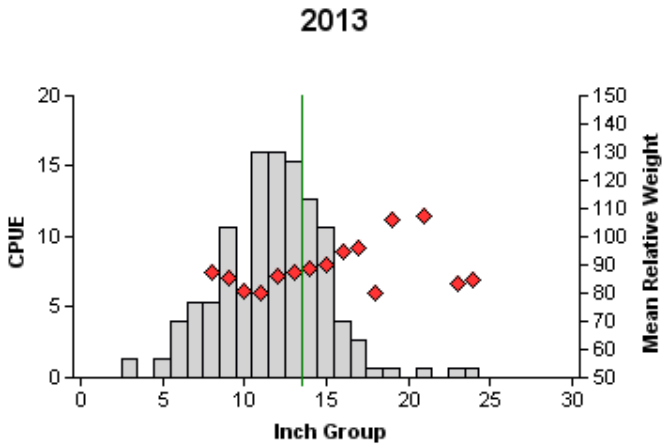
Largemouth Bass



Effort =	1.5
Total CPUE =	57.3 (16; 86)
Stock CPUE =	48.7 (18; 73)
CPUE-14 =	12.7 (25; 19)
CPUE-18 =	7.3 (33; 11)
CPUE-21 =	4.0 (42; 6)
PSD =	44 (6)



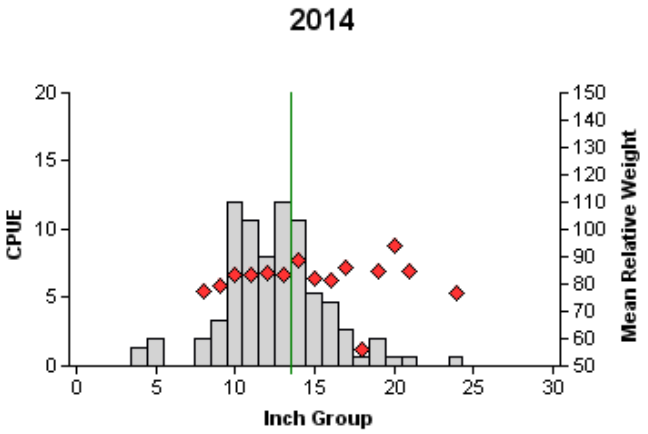
Effort =	1.5
Total CPUE =	97.3 (15; 146)
Stock CPUE =	69.3 (16; 104)
CPUE-14 =	16.7 (21; 25)
CPUE-18 =	3.3 (49; 5)
CPUE-21 =	0.7 (100; 1)
PSD =	55 (8)



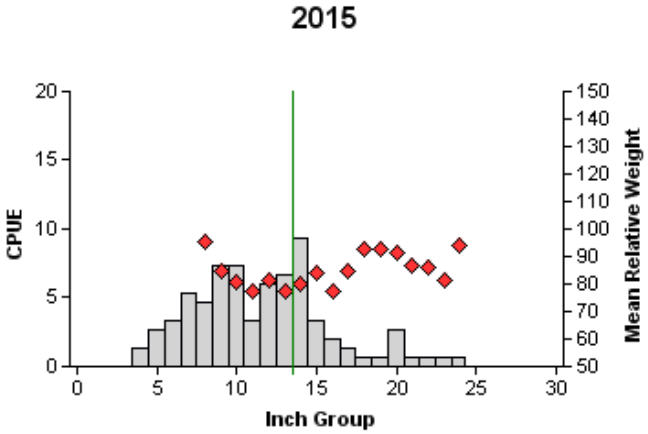
Effort =	1.5
Total CPUE =	114.7 (22; 172)
Stock CPUE =	102.7 (23; 154)
CPUE-14 =	33.3 (29; 50)
CPUE-18 =	3.3 (39; 5)
CPUE-21 =	2.0 (54; 3)
PSD =	63 (7)

Figure 5. 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, Austin Reservoir, Texas, 2011 through 2016. Minimum length limit indicated by vertical line.

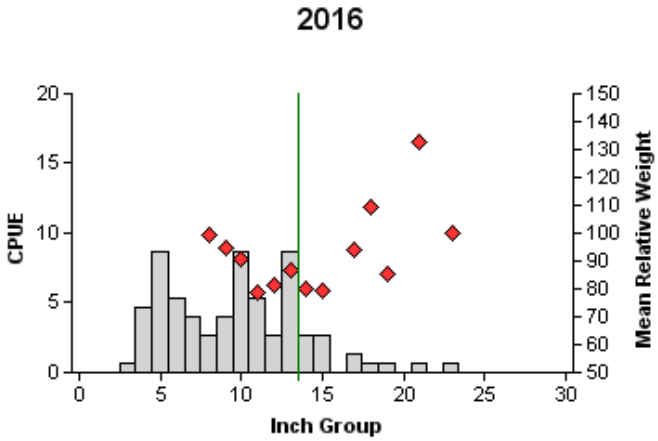
Largemouth Bass



Effort = 1.5
Total CPUE = 79.3 (14; 119)
Stock CPUE = 76.0 (15; 114)
CPUE-14 = 28.0 (23; 42)
CPUE-18 = 4.7 (52; 7)
CPUE-21 = 2.0 (73; 3)
PSD = 63 (5)

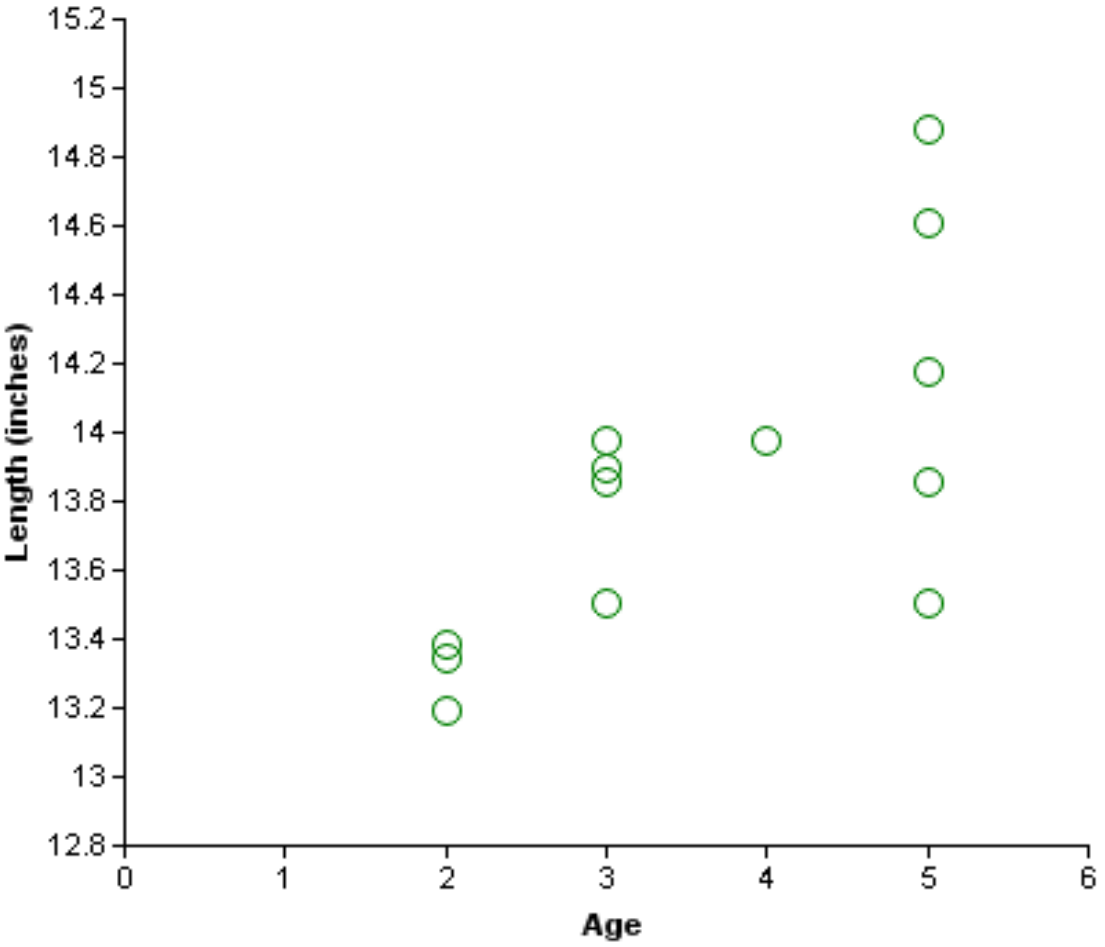


Effort = 1.5
Total CPUE = 70.7 (13; 106)
Stock CPUE = 58.0 (14; 87)
CPUE-14 = 22.7 (22; 34)
CPUE-18 = 6.7 (30; 10)
CPUE-21 = 2.7 (45; 4)
PSD = 61 (6)



Effort = 1.5
Total CPUE = 64.7 (15; 97)
Stock CPUE = 41.3 (15; 62)
CPUE-14 = 9.3 (29; 14)
CPUE-18 = 2.7 (45; 4)
CPUE-21 = 1.3 (69; 2)
PSD = 50 (6)

Figure 5 (cont.). 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, Austin Reservoir, Texas, 2011 through 2016. Minimum length limit indicated by vertical line.



Mean Length	Survey Year	Age	Number of Fish
13.31	2016	2	3
13.81	2016	3	4
13.98	2016	4	1
14.20	2016	5	5

Figure 6. Length at age for Largemouth Bass collected during electrofishing at Austin Reservoir, Texas, fall 2016 (N = 13). Mean length at age by survey year displayed in the table below graph.

Largemouth Bass

Table 8. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Austin Reservoir, Texas, 2008, 2012, and 2016. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined by micro-satellite DNA analysis.

		Number of fish				
Year	Sample size	FLMB	Intergrade	NLMB	% FLMB alleles	% FLMB
2008	30	4	26	0	76	13
2012	30	5	25	0	80	17
2016	30	6	24	0	84	20

Table 9. Proposed sampling schedule for Austin Reservoir, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

Survey year	Electrofish Fall(Spring)	Trap net	Gill net	Habitat		Access	Creel survey	Report
				Structural	Vegetation			
2017-2018	A*				A			
2018-2019	A*				A			
2019-2020	A*				A			
2020-2021	S			S	S	S		S

*****Bass-only electrofishing

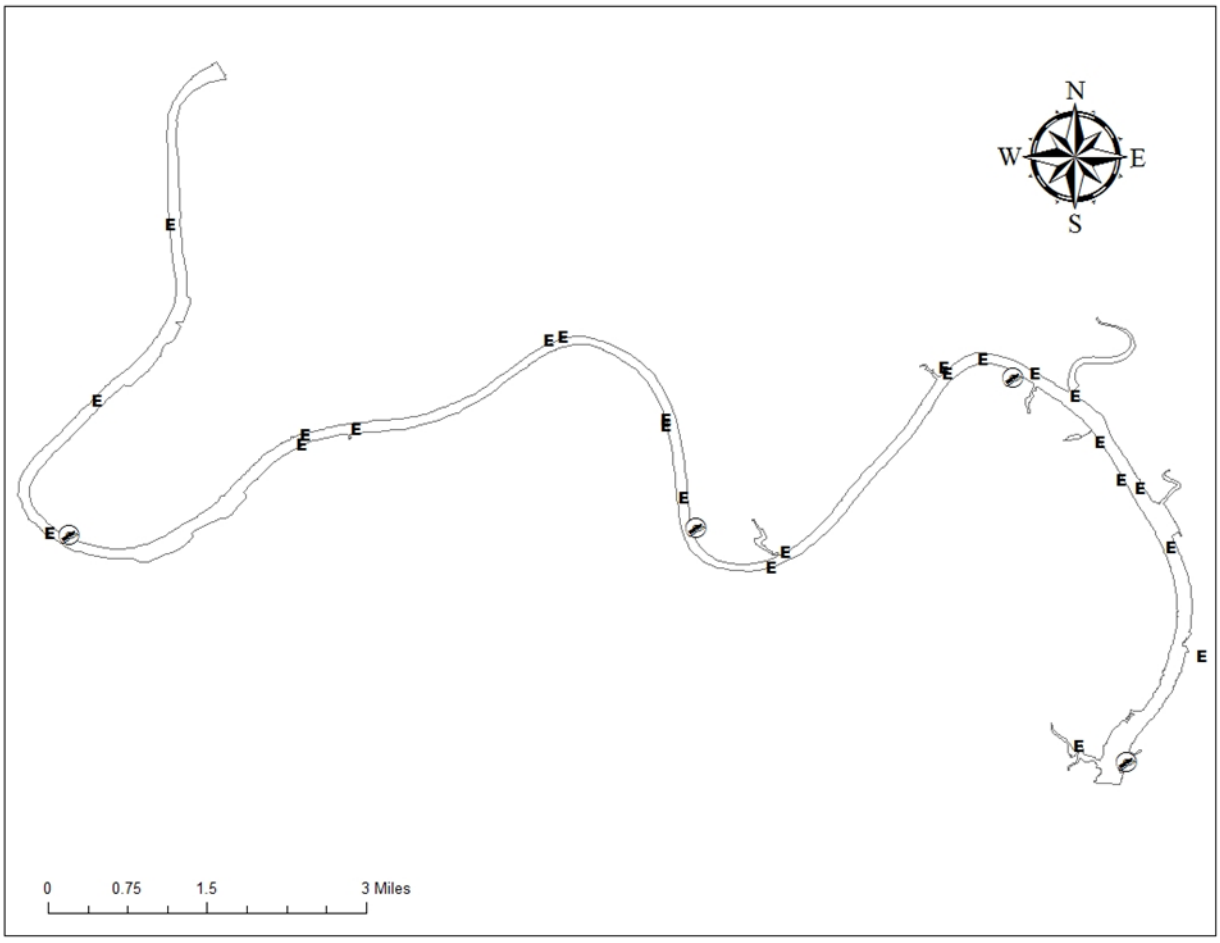
APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected by electrofishing in November 2016 from Austin Reservoir, Texas. Sampling effort was 1.5 hours for electrofishing.

	Electrofishing	
Species	N	CPUE
Gizzard Shad	154	102.7
Threadfin Shad	18	12.0
Blacktail Shiner	3	2.0
Redbreast Sunfish	191	127.3
Green Sunfish	1	0.7
Warmouth	1	0.7
Bluegill	128	85.3
Longear Sunfish	6	4
Redear Sunfish	17	11.3
Largemouth Bass	97	64.7
Guadalupe Bass	1	0.7
Logperch	3	2.0

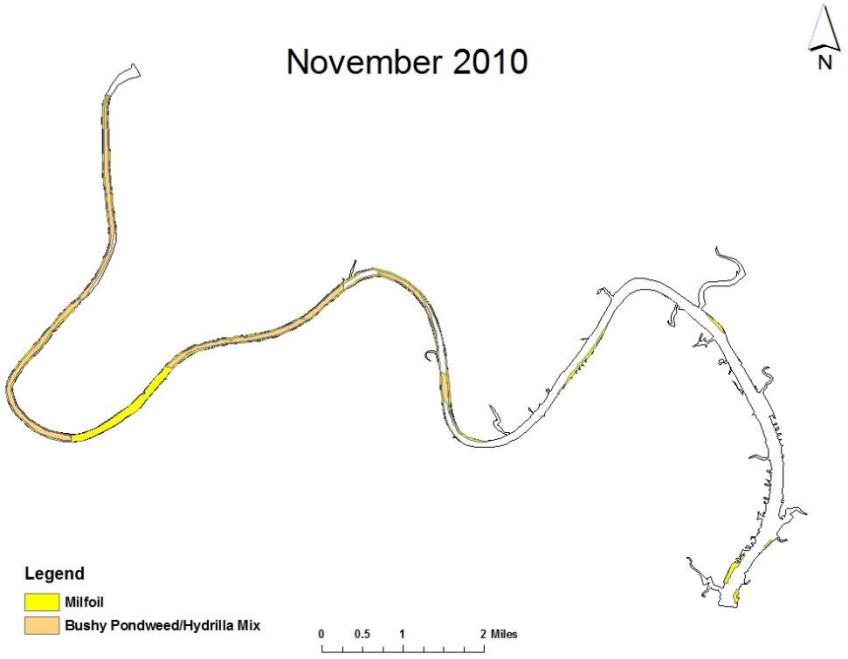
APPENDIX B

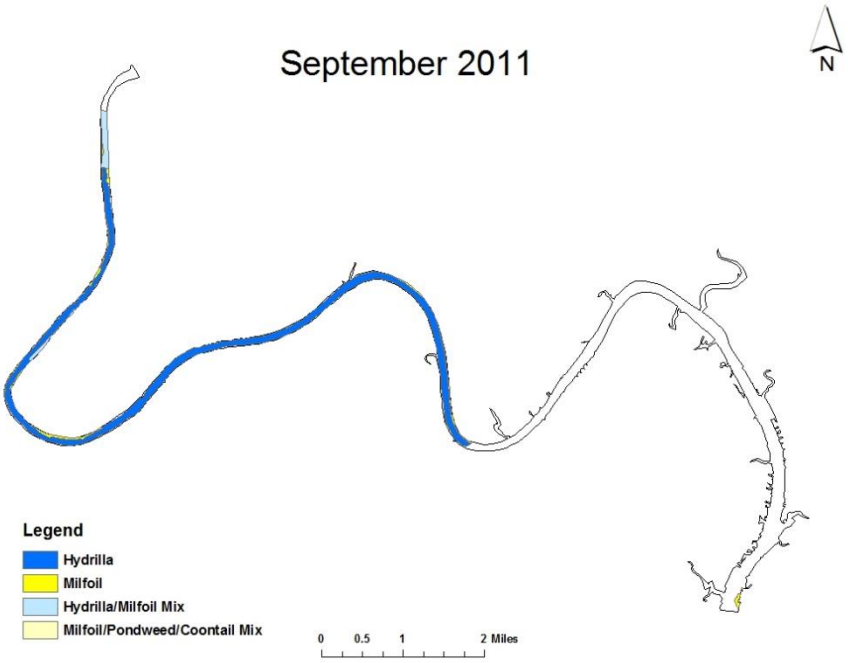
Location of sampling sites, Austin Reservoir, Texas, 2016. Electrofishing stations indicated by E. Boat ramps marked by encircled boat symbols.



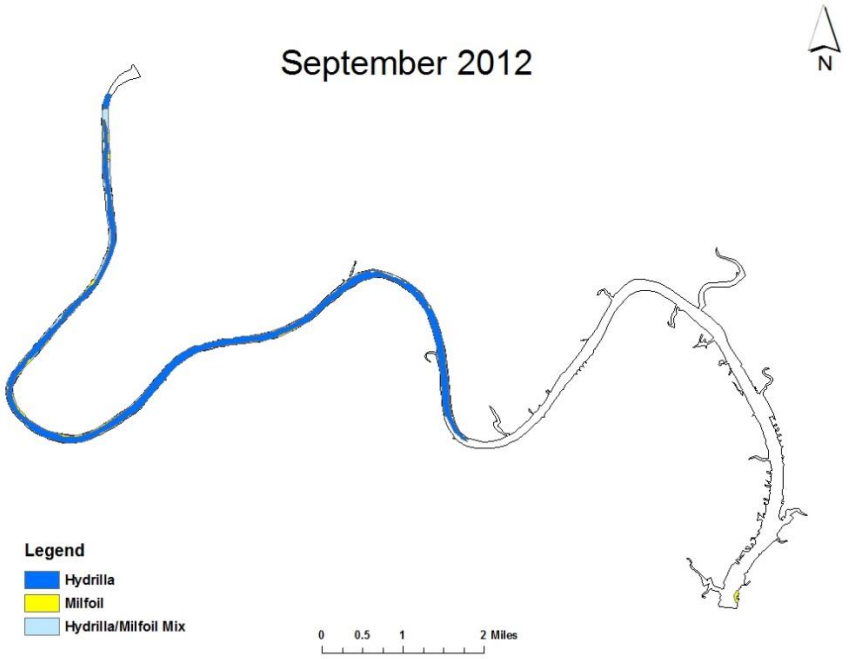
APPENDIX C

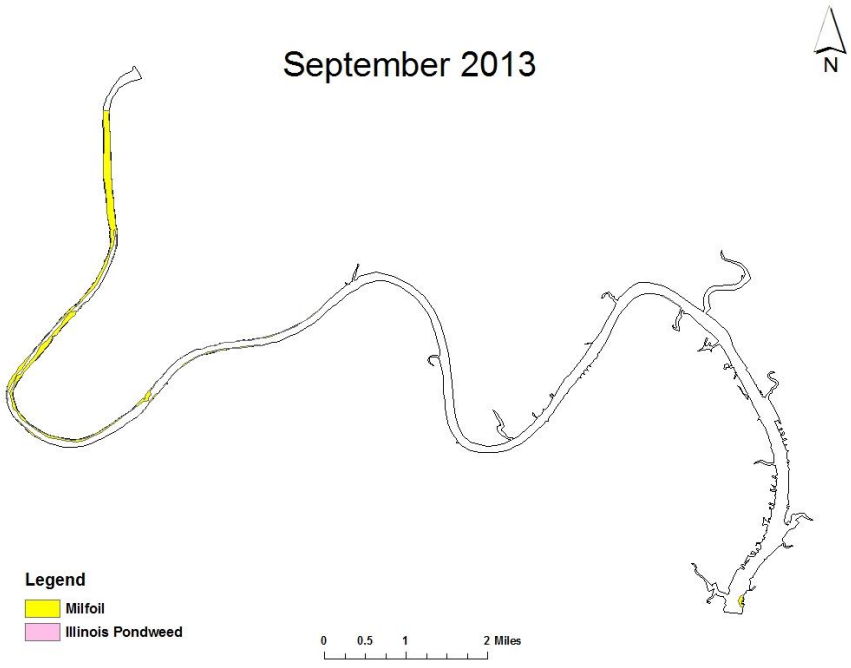
Aquatic vegetation coverage maps from standardized aquatic vegetation surveys at Austin Reservoir, Texas from 2010 to 2016. Maps represent surveys conducted in fall. The sequence demonstrates the shift from a balanced multi-species aquatic vegetation community before the 2011 – 2015 drought to a hydrilla monoculture during the drought to the aquatic vegetation eradication caused by overgrazing. No aquatic vegetation has reestablished as of fall 2016.



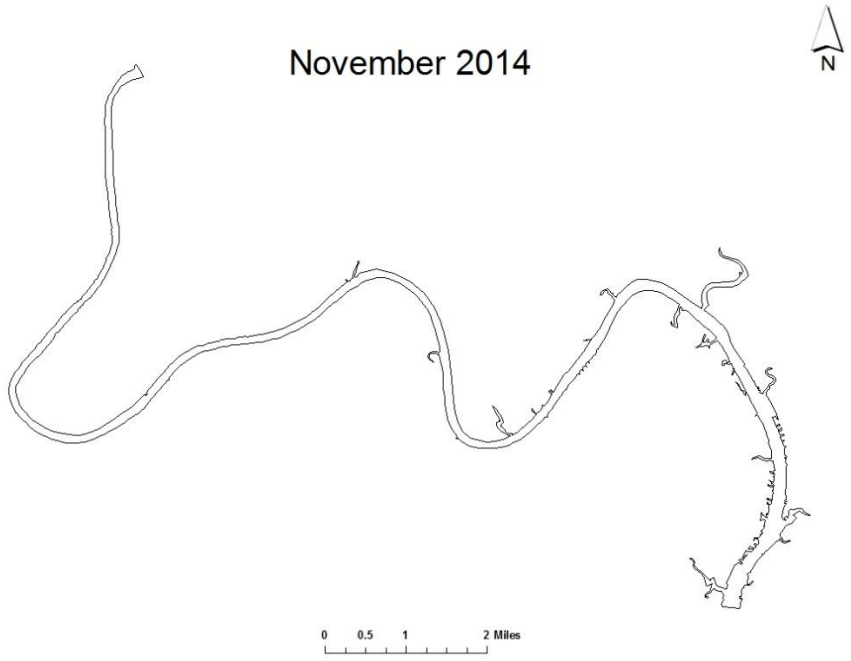


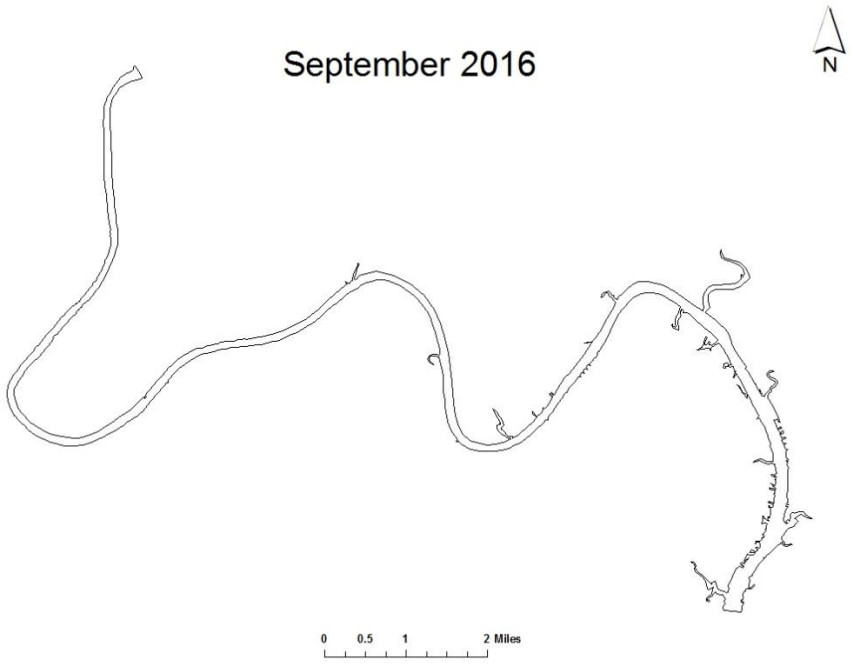
APPENDIX C (Continued)





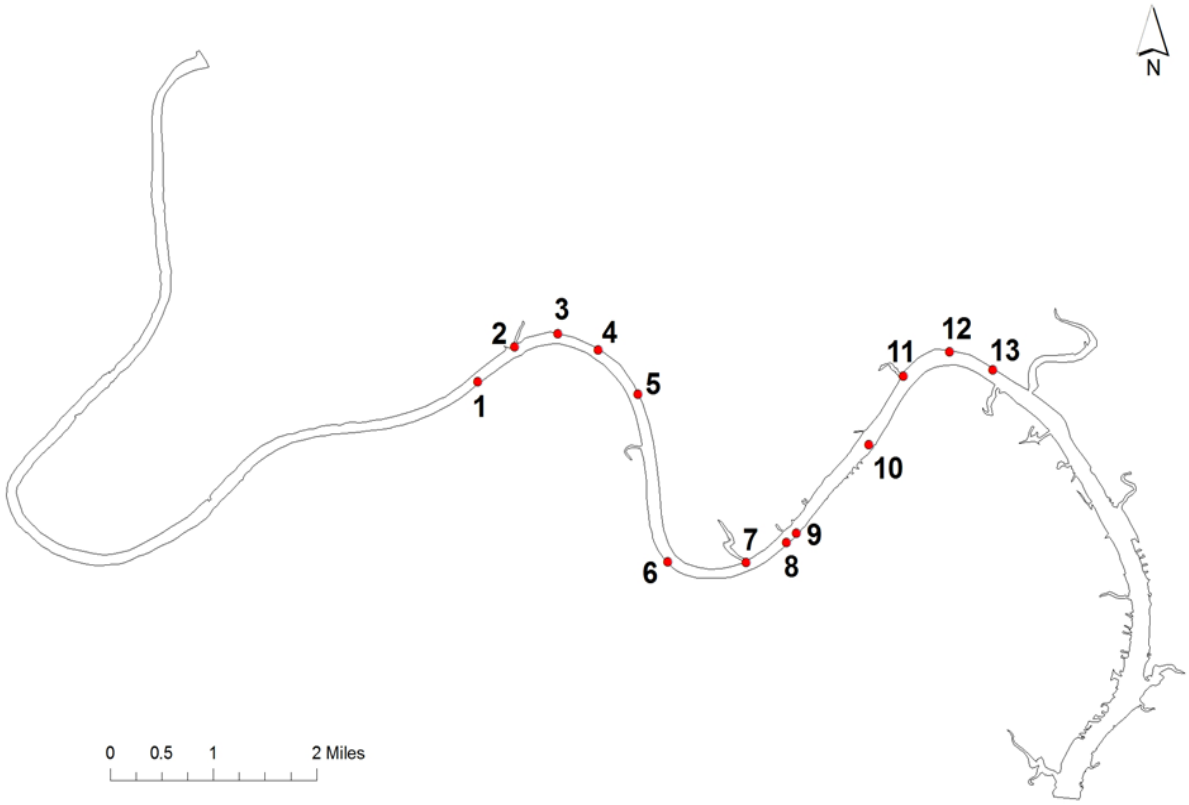
APPENDIX C (Continued)





APPENDIX D

Map of Austin Reservoir, Texas with fish attractor locations (2015). Thirteen fish habitat structures were installed in 2015. Sunken ash juniper (*Juniperus ashei*) brush piles were used at the sites.



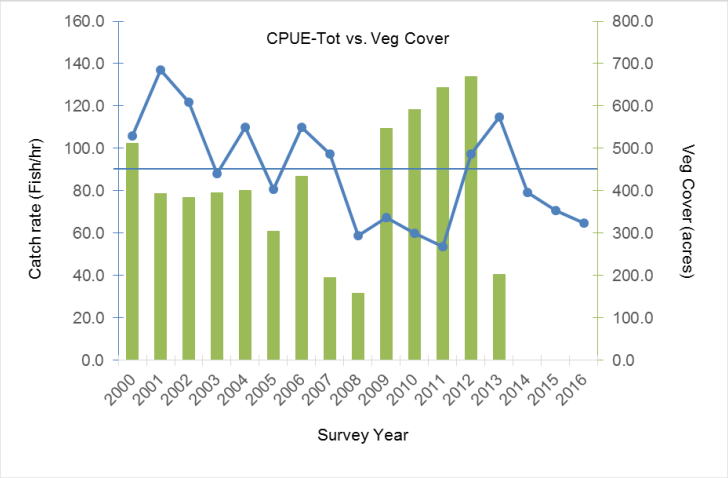
APPENDIX E

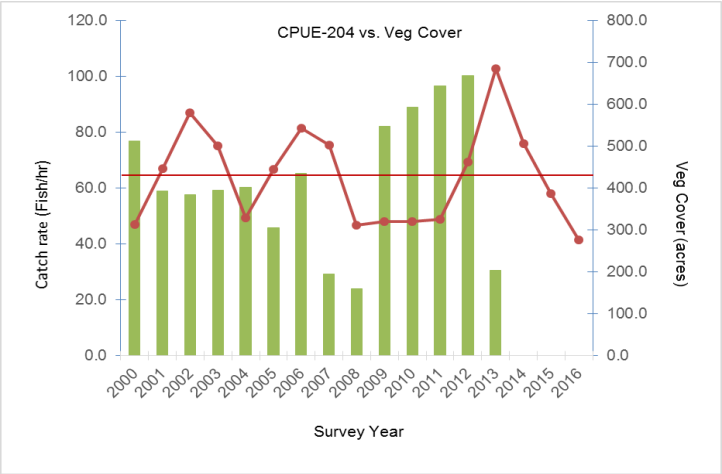
GPS coordinates for Austin Reservoir, Texas fish attractor locations. GPS coordinates are in degree decimal minutes. Attractors were installed in 2015. Ash juniper (*Juniperus ashei*) brush piles, a.k.a. cedar trees, sunken with cinder blocks, were used to build the attractors.

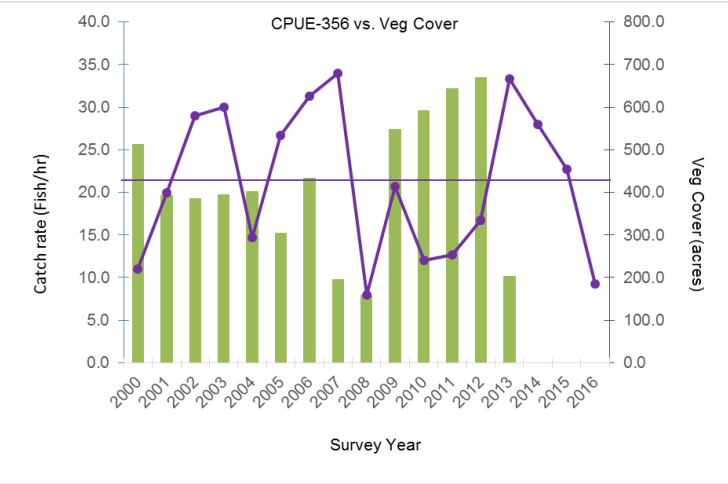
#	Latitude	Longitude	Description
1	30° 20.943'	97° 52.159'	Boulder ledge
2	30° 21.216'	97° 51.851'	Creek mouth point
3	30° 21.321'	97° 51.487'	Boulder ledge
4	30° 21.193'	97° 51.148'	Boulder ledge
5	30° 20.842'	97° 50.812'	Boulder ledge
6	30° 19.519'	97° 50.560'	Creek mouth point
7	30° 19.510'	97° 49.898'	Creek mouth point
8	30° 19.670'	97° 49.556'	Boulder ledge
9	30° 19.744'	97° 49.475'	Creek mouth gravel bar
10	30° 20.445'	97° 48.861'	Hump
11	30° 20.984'	97° 48.570'	Creek mouth point
12	30° 21.181'	97° 48.180'	Boulder ledge
13	30° 21.035'	97° 47.816'	Ledge under 360 bridge

APPENDIX F

Historic Largemouth Bass fall electrofishing catch rates (CPUE; dots) in relation to total aquatic vegetation coverage (bars) from Austin Reservoir, Texas, from 2000 to 2016. Catch rates represent total fish (all sizes), 8-inches (204 mm) stock-size fish, and 14-inches (356 mm) harvest-size fish caught per hour of electrofishing. Mean catch rate during the time frame is represented by the horizontal line.







APPENDIX G

Scaled historic Largemouth Bass fall electrofishing catch rates (CPUE) from Austin Reservoir, Texas, from 2000 to 2016. Catch rates represent total fish (all sizes), 8-inches (204 mm) stock-size fish, 14-inches (356 mm) harvest-size fish, and 18-inches (534 mm) memorable-size fish caught per hour of electrofishing.