

Lake Brazos

2020 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-4

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

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Survey and Management Summary

Fish populations in Lake Brazos were surveyed in 2020 using electrofishing and trap nets and in 2021 using gill nets. Historical data are presented with the 2020-2021 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: Lake Brazos is a 523-acre impoundment of the Brazos River located in downtown Waco, McLennan County, Texas. There is no water gaging station on Lake Brazos, therefore water elevation data are not available. Bank and boat access on the reservoir are good, and include handicap-accessible facilities such as walkways, picnic shelters and fishing piers. Habitat features consisted mainly of natural shoreline, limited bulkheading, piers, bridge pilings and emergent aquatic vegetation.

Management history: Important sport fish include Largemouth Bass, catfishes, temperate basses and White Crappie. The management plan from 2008 recommended annual monitoring of giant reed and working with the City of Waco on control efforts if necessary. Giant reed was monitored annually through 2014, at which time it was determined that it was not increasing in coverage and there was little probability that it would require treatment. Management plans from 2008 and 2012 included addition of new fish habitat, and to date, over 50 bamboo crappie condos have been placed into the reservoir. More recent management efforts focused on posting appropriate aquatic invasive species (AIS) signage at access points and providing technical support and informational materials for the Texas Parks and Wildlife Department's (TPWD) "Clean, Drain and Dry" campaign. A roving creel survey was conducted from June 1, 2018 through May 31, 2019 to determine the extent of game fishes sought and harvested. Management efforts from 2020-2021 include aquatic vegetation, boater access, electrofishing, trap netting, and gill netting surveys.

Fish Community:

- **Prey species:** Gizzard Shad were collected well above their historical average catch rate while the Threadfin Shad catch rate was average. Bluegill and Longear Sunfish numbers were low. Other minor prey species like Redear Sunfish, Redbreast Sunfish and Green Sunfish were collected in numbers similar to historical averages.
- **Catfishes:** Blue and Channel Catfish were collected below their historical average catch rates. Mean relative weight for both species was variable. Flathead Catfish were not observed.
- **Temperate Bass:** The White Bass catch rate was well below the historical average while Palmetto and Striped Bass catch rates were both higher than historical averages. Mean relative weight for most temperate basses was fair to low.
- **Largemouth Basses:** The Largemouth Bass total catch rate was similar to the historical average and the same as the previous survey. Mean relative weight was generally fair but variable across length classes. The proportion of legal-length fish improved from previous surveys.
- **White Crappie:** White Crappie were collected at 2.0 fish/nn which was below their historical average catch rate. Mean relative weight was generally fair. Black Crappie have not been observed since 2011.

Management Strategies: The sport fishes in Lake Brazos will continue to be managed with statewide regulations. We will continue to maintain AIS efforts. Access, vegetation, and electrofishing surveys will be conducted in summer and fall 2024 and trap netting and gill netting surveys will be conducted in spring 2025. Promoting the fishery and the unique opportunities it provides to urban anglers will also be a priority.

Introduction

This document is a summary of fisheries data collected from Lake Brazos in 2018-2021. 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 fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2018-2021 data for comparison.

Reservoir Description

Lake Brazos is a 523-acre impoundment of the Brazos River located in downtown Waco, McLennan County, Texas. The reservoir was constructed by the City of Waco in 1965 to serve as a municipal water source and to stimulate economic development in the downtown area. Other water uses include recreation. The reservoir is eutrophic with an average reservoir depth of 12.3 feet, and water transparencies typically ranging from 1 to 3 feet. Habitat at time of sampling consisted mainly of natural shoreline, limited bulkheading, piers, bridge pilings and emergent aquatic vegetation. Littoral vegetation is dominated by water willow, giant reed and cattail. Lake Brazos is at a constant level during normal conditions and was near full pool during the 2020 and 2021 surveys. Other descriptive characteristics for Lake Brazos are in Table 1.

Angler Access

Bank and boat access on Lake Brazos is good. Boat access consists of two, two-lane ramps (Brazos Park East I and II) and two paddle craft launches (Brazos Park East III, Bosque Park), and a single lane ramp at the McLennan Community College (MCC) campus. All four ramps were useable during recent surveys, and there are currently no access issues. Shoreline access is excellent throughout the lower two-thirds of the reservoir. Additional boat ramp characteristics are in Table 2.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Baird and Tibbs 2017) included:

1. Gill netting in January 2019 and 2021 to minimize the impacts of spring flooding and obtaining better information on catfish and temperate bass populations; increasing gill netting effort to 10 nets to improve sampling precision.

Action: Gill netting effort was increased to 10 net nights for the 2021 season. Flooding during January and February 2019 prevented a gill net survey from being performed at that time however, a 10-net night survey was completed in January 2021 and these data are included in this report.

2. Conduct an angler creel survey from June 1, 2019 through May 31, 2020.

Action: An angler creel survey was conducted one year earlier than planned, from June 1, 2018 through May 31, 2019. These creel data are included in this report.

3. Work with partners to build new fish habitat structures and deploy into Lake Brazos, update fish attractor map and coordinates on the TPWD website and utilize side scan sonar to monitor artificial fish habitat structure condition as needed. Explore new concepts for fish attractors, such as fishing lights on piers, and implement if feasible.

Action: Because Lake Brazos is riverine and prone to flooding, artificial habitats would not stay in place which posed problems for boaters. Therefore, fish attractors were not deployed into the reservoir. The Waco District still plans to investigate the use of fishing lights as fish attractors to try to improve angler access and utilization of the fishery.

4. Cooperate with the City of Waco to post appropriate AIS signage at access points throughout the reservoir. Educate the public about AIS and make a speaking point about AIS when presenting to constituent and user groups. Keep track of (i.e., map) all existing and future interbasin water transfer routes to facilitate potential invasive species responses.

Action: Aquatic invasive species signage was posted at Lake Brazos access points during summer 2013 and have been maintained as needed. District staff have made a speaking point about AIS, how to prevent their spread, and potential effects on Lake Brazos while speaking to anglers over the past several years. Interbasin water transfers are updated as needed.

Harvest regulation history: Sport fishes in Lake Brazos have always been managed with statewide regulations. The current harvest regulations are listed in Table 3.

Stocking history: Lake Brazos was stocked with 7,386 advanced fingerling Channel Catfish in 2018 and 52,958 Florida Largemouth Bass in 2020. The complete stocking history is in Table 4.

Vegetation/habitat management history: Vegetation/habitat management actions have been limited to the addition of fish habitat (crappie condos) near fishing piers, and past, annual monitoring of giant reed shoreline coverage. No new aquatic vegetation issues exist.

Water Transfer: No interbasin transfers are known to exist within Lake Brazos.

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Lake Brazos (Baird and Tibbs 2017). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected, and all surveys were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad and Threadfin Shad were collected by daytime electrofishing (1.0 hour at 12, 5-min stations in fall). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

Trap netting – White Crappie were collected by trap netting (10 net nights at 10 stations in winter). Catch per unit effort (CPUE) for trap netting was recorded as the number of fish caught per net night (fish/nn).

Gill netting – Catfishes, White Crappie and temperate basses were collected by gill netting (10 net nights at 10 stations in spring). Catch per unit effort (CPUE) for gill netting was recorded as the number of fish caught per net night (fish/nn).

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017). Micro-satellite DNA analysis has been used to determine genetic composition of individual fish since 2005.

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). Hybrid Striped Bass PSD was calculated according to Dumont and Neely (2011). Index of vulnerability (IOV) was calculated for Gizzard Shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error ($RSE = 100 \times SE$ of the estimate/estimate) was calculated for all CPUE statistics.

Creel survey – A roving creel survey was conducted from June 1, 2018 through May 31, 2019. Angler interviews were conducted on 5 weekend days and 4 weekdays during each quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Habitat – The 2008 structural habitat survey was conducted according to Tibbs and Baird (2009). The 2016 and 2020 vegetation surveys were conducted using an adaptation of the point method (TPWD, Inland Fisheries Division, unpublished manual revised 2017). Vegetation points were randomly generated on the shoreline and averaged a minimum of one point per shoreline mile. Aquatic vegetation has always been found close to the shore in Lake Brazos, so stratifying the random points to exclude deep-water areas increased precision and resulted in better data.

Water level – There is no source for water level data for Lake Brazos. Water is released regularly from Lake Whitney for power production during the summer, so water levels in Lake Brazos remain constant almost all of the time due to the design of the dam.

Results and Discussion

Habitat: The 2009 structural habitat survey estimated 26.7 miles of natural shoreline, 4.1 miles of bulkheaded shoreline, 3.5 miles of boulder/rip-rap shoreline and 1.0 mile of rock bluff shoreline (Table 6; Baird and Tibbs 2009). The littoral zone vegetation encountered during summer 2020 was dominated by water willow, giant reed and cattail and all three were more widespread as compared to 2016. The complete summer 2020 vegetation survey is in Table 7.

Creel: The 2018-2019 creel is the first angler creel survey to be conducted on Lake Brazos. Directed fishing effort was highest for catfishes (44.0%), anglers seeking anything (27.1%), black basses (20.3%)

and crappies (6.0%; Table 8). Bank anglers outnumbered boat anglers nearly two to one. Total angler effort was 45,580 hours for the whole creel and total directed expenditures were \$192,846 (Table 9). When standardized by area, effort was 87.2 hours per acre and economic impact was \$364 per acre. These estimates show high utilization and economic impact when compared to two other recent creel surveys on adjacent larger reservoirs. In 2014-15, Lake Belton estimates were 18.3 hours/acre and \$133/acre and in 2011-12, Lake Waco estimates were 28.9 hours/acre and \$179/acre. High bank utilization and economic value coupled with reasonable catch rates make Lake Brazos a unique fishery that provides a lot of opportunity for urban anglers.

Prey species: The fall 2020 electrofishing catch rates of Threadfin and Gizzard Shad (Figure 1) were 34.0/h and 515.0/h respectively (Appendices A and B). The Index of vulnerability (IOV) for Gizzard Shad was excellent, with 94% of the population available to predators as forage. Other important forage species collected were Bluegill (Figure 2; 48.0/h), Longear Sunfish (23.0/h), Redear Sunfish (8.0/h), Green Sunfish (2.0/h) and Redbreast Sunfishes (1.0/h; Appendices A and B). Of all the forage species, only Gizzard Shad and Redbreast Sunfish were collected above their historical average catch rate; other species totals were lower than average (Figures 1 and 2; Appendix B).

Catfishes: Blue and Channel Catfish were collected with gill nets at rates of 4.8 and 2.1/n respectively in 2021 and these catch rates were below average for both species (Figures 3 and 5; Appendices A and B). Despite doubling gill netting effort from 5 to 10 net nights, the size structure objective of collecting a minimum of 50 stock-length fish was not met for blues (N = 45) or channels (N = 17). The abundance objective of achieving an RSE equal to or less than 25 was only met for blues (Figures 3 and 5). All PSD indices for Blue Catfish decreased in 2021, illustrating a much lower proportion of quality and preferred-length fish in the population compared to the 2017 sample (Figure 3). Channel Catfish had a much larger proportion of preferred-length individuals in the sample (Figure 5). Mean relative weight for both species was variable ranging from fair to excellent. Flathead Catfish were not collected in 2021, but historical catch rates are included in Appendix B.

Catfishes were the most sought-after sport fish group in the reservoir with a combined directed fishing effort for Channels, Blues and Flatheads of 19,583 hours (Tables 10 and 11). The total estimated harvest for Blue Catfish and Channel Catfish was 430 and 589 respectively for the creel survey period (Tables 10 and 11; Figures 4 and 6). Nearly one-fourth of all legal-length Blue Catfish caught by anglers were released while only 8.4% of legal-length Channel Catfish were released (Tables 10 and 11).

Temperate Basses: The OBS plan for Lake Brazos's three species of temperate basses included collecting a minimum of 50 stock length fish of each species, with a sample RSE equal to or less than 25, to allow comparison of trend data, population structure indices and length-frequency histograms among years (Table 5). The OBS objectives were not met for any of these species despite doubling the gill netting effort.

The gill net catch rate for White Bass was 0.6/n in 2021 compared to 1.8/n and 0.2/n in 2013 and 2011 respectively (Figure 7; Appendices A and B). This catch rate equated to 6 stock-length fish with an RSE of 83. All collected White Bass were of legal length and mean relative weight was fair to good (Figure 7).

Hybrid Striped Bass (HSB) were first stocked in Lake Waco in 2009, through a cooperative effort between TPWD and the City of Waco. Lake Brazos Reservoir's HSB fishery is completely dependent on HSB immigration through the Lake Waco dam, which is just upstream in the Bosque arm of Lake Brazos. Therefore, this fishery is a low-density one. Hybrid Striped Bass were collected with gill nets at a rate of 0.4/n in 2021 which translated to only 4 individuals with an RSE of 55 (Figure 9; Appendices A and B). Mean relative weight was fair to good.

Like HSB, the Striped Bass fishery in Lake Brazos is dependent on immigration from Whitney Reservoir, a mainstem reservoir on the Brazos river upstream of Lake Brazos. The gill net catch rate for Striped Bass was 2.8/n in 2021 compared to 0.6 and 1.6/n in 2013 and 2011 respectively (Figure 11; Appendices A and B). This is the highest Striped Bass catch rate on record for Lake Brazos. Nearly one-

half of the collected Stripers were legal length ($PSD_{18} = 44$) and mean relative weight ranged from fair to good.

Only one percent of anglers targeted temperate basses and surprisingly, no harvest of this species group was observed during the 2018-2019 creel (Tables 8, 12, 13 and 14; Figures 8, 10 and 12).

Largemouth Bass: Largemouth Bass were collected by electrofishing at a rate of 40.0/h in 2020 which was near the historical average for the species (Figure 13; Appendices A and B). The objectives of collecting a minimum of 50 stock-length fish with an RSE equal to or less than 25 was not achieved because only 22 stock-length individuals were collected. The proportion of legal-length bass collected has increased over the last three surveys as illustrated by PSD_{14} values: 21 in 2012, 24 in 2016 and 45 in 2020 (Figure 13). Mean relative weight remained similar to previous surveys and was fair to good. Florida Largemouth Bass influence ($n = 30$ individuals analyzed) was 39% in the 2016 survey (Table 16). Observed harvest during the creel survey showed good angler compliance (Figure 14). Largemouth Bass anglers were not harvest oriented as 82% of all legal-length fish caught were released (Figure 15). All but one unreleased bass were due to a single tournament in mid-June. It was a catch-and-release tournament so likely most of those were ultimately released as well.

Crappie: White Crappie were collected with winter trap nets (2020) and spring gill nets (2021) both at 2.0 /nn, which was below the historical average for the species (Figures 15 and 16; Appendices A and B). The objective for this species was presence/absence with practical effort so that objective was met (Table 5; Figures 15 and 16). The PSD for both samples was high but low catch rates limited interpretation. Mean relative weight was generally good in the trap net sample and generally excellent in the gill net sample. Neither gear type/season combination has provided reliable and repeatable sampling statistics (Appendix B). Although White Crappie were only sought by 6.0% of anglers, they were the most harvested species according to creel survey data (Table 17; Figure 17). Black Crappie were not collected in 2021, but historical catch rates are included in Appendix B.

Fisheries Management Plan for Lake Brazos, Texas

Prepared – July 2021

ISSUE 1: Trap netting for crappies was already an optional survey in 2009 when TPWD's management of Lake Brazos first began. Although catch rates have been fair since that time, spring trap netting surveys might improve trend data. Recent sampling evaluations on Granbury, Fort Parker and Limestone Reservoirs found very good results in spring trap netting surveys for crappies. Spring trap netting collected more individuals than winter trap netting or spring gill netting, showed a high percentage of legal-length fish and evidence of recent recruitment on all three reservoirs. Based on population structure indices and length-frequency histograms from these evaluations, spring trap netting might provide better data for crappies on Lake Brazos as well.

MANAGEMENT STRATEGIES

1. Begin spring trap netting for crappies on Lake Brazos in spring 2025.
2. Continue collecting data on crappies during gill netting efforts.

ISSUE 2: High utilization and a large proportion of bank anglers coupled with a diversity of species to fish for make Lake Brazos a unique fishery. For example, three popular species of Temperate Bass can be found in Lake Brazos yet directed angler effort observed during the 2018-2019 angler creel was only 1% for the entire group. Blue Catfish over 10 lbs have been collected in the three most recent surveys, yet few larger catfish of any species were documented in the creel.

MANAGEMENT STRATEGIES

1. Highlight this unique fishery through presentations and social media when applicable.
2. Work with partners to post new signage at access points and popular bank fishing sites around the reservoir showcasing sportfish opportunities for anglers.

ISSUE 3: Many AIS threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels 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 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 AIS are significant. Additionally, the potential for AIS to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to maintain AIS signage at access points.
2. Educate the public about AIS through the use of media and the internet.
3. Make a speaking point about AIS when presenting to constituent and user groups.
4. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential AIS responses.

Objective-Based Sampling Plan and Schedule (2021–2025)

Sport fish, forage fish, and other important fishes

Sport fishes in Lake Brazos include Largemouth Bass, Channel Catfish, Blue Catfish, and White Crappie. Important forage fish species include Gizzard Shad, Threadfin Shad, Bluegill, Redear and Longear Sunfish.

Low-density fisheries

Spotted Bass, Flathead Catfish and Black Crappie occur in low abundance in Lake Brazos and are generally caught incidentally to other targeted species. We will continue collecting and reporting data for these species and upgrade their status if appropriate.

Survey objectives, fisheries metrics, and sampling objectives

Fall Electrofishing: This survey will be used to monitor Largemouth Bass and primary forage species (Bluegill, Longear Sunfish, Redear Sunfish, Gizzard Shad and Threadfin Shad). A minimum of 12, random five-minute daytime electrofishing stations will be sampled in fall 2024. The objectives of the Largemouth Bass survey will be general monitoring (i.e., CPUE, size structure and mean relative weight) and prevalence of Northern and Florida Largemouth Bass alleles (i.e., fin clips from 30 random individuals) to characterize the Largemouth Bass population and make comparisons with historical and future data. Abundance target precision will be a $RSE \leq 25$ for $CPUE_{Total}$ and $CPUE_{Stock}$, and target sample size for size structure will be $N \geq 50$ stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group \geq stock-length. If objectives are not met in 12 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met. Since the primary forage species objectives are exploratory, no target precision or target sampling sizes will be sought for these species; additional sampling will not be necessary beyond that which is done for Largemouth Bass.

Spring Trap Netting: This survey will be used to monitor White Crappie. Recent comparisons between winter and spring trap netting and spring gill netting for crappie on Granbury (2017-2018), Fort Parker (2018-2019) and Limestone (2020-2021) suggest spring trap netting collects more data and more precise data for monitoring purposes (Baird and Tibbs 2018, 2019, 2021). Therefore, a minimum of 10 randomly selected trap net stations will be sampled in spring 2025. The objectives of the White Crappie survey will be general monitoring (i.e., CPUE, size structure and mean relative weight) to characterize the population and make comparisons with historical and future data. Abundance target precision will be a $RSE \leq 25$ for $CPUE_{Total}$ and $CPUE_{Stock}$, and target sample size for size structure will be $N \geq 50$ stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group \geq stock-length. If objectives are not met in 10 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met.

Spring Gill Netting: This survey will be used to monitor Blue Catfish, Channel Catfish, White Bass, Hybrid Striped Bass, Striped Bass, and White Crappie. A minimum of 10 randomly selected gill net stations will be sampled in spring 2025. The objectives of these surveys will be general monitoring (i.e., CPUE, size structure and mean relative weight) to characterize populations and make comparisons with historical and future data. Abundance target precision will be a $RSE \leq 25$ for $CPUE_{Total}$ and $CPUE_{Stock}$, and target sample size for size structure will be $N \geq 50$ stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group \geq stock-length. If objectives are not met in 10 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met.

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Tables and Figures

Table 1. Characteristics of Lake Brazos, Texas.

| Characteristic | Description |
|-----------------------------------|-----------------------------|
| Year Constructed | 1965 |
| Controlling authority | City of Waco |
| County | McLennan |
| Reservoir type | Main stem Brazos River |
| Shoreline Development Index (SDI) | N/A |
| Conductivity | 811 $\mu\text{S}/\text{cm}$ |

Table 2. Boat ramp characteristics for Lake Brazos, Texas, September 2020. There is currently no source for water level data for Lake Brazos. Latitude and longitude are in decimal degrees.

| Boat ramp | Latitude/Longitude (dd) | Parking capacity (N) | Condition |
|--------------------------------------|-------------------------|----------------------|-----------|
| Brazos Park East I | 31.5897/-97.1543 | 53 | Good |
| Brazos Park East II | 31.5829/-97.1511 | 15 | Poor |
| Brazos Park East III Paddle craft | 31.5886/-97.1546 | 7 | Good |
| Bosque Park Paddle craft | 31.5850/-97.1932 | 40 | Excellent |
| McClennan Community College | 31.5940/-97.1701 | 5 | Good |

Table 3. Harvest regulations for Lake Brazos, Texas.

| Species | Bag Limit | Length limit (inches) |
|--|------------------------|-----------------------|
| Catfish: Channel, Blue and hybrids | 25 (any combination) | 12-inch minimum |
| Catfish, Flathead | 5 | 18-inch minimum |
| Bass, White | 25 | 10-inch minimum |
| Bass, Striped and Hybrid Striped | 5 (in any combination) | 18-inch minimum |
| Bass, Largemouth, Smallmouth and hybrids | 5 ^a | 14-inch minimum |
| Bass, Spotted | 5 ^a | None |
| Crappie: White, Black and hybrids | 25 (any combination) | 10-inch minimum |

^a Daily bag for Largemouth Bass, Smallmouth Bass and Spotted Bass, = 5 fish in any combination.

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

| Species | Year | Number | Life Stage | Mean TL (in) |
|-------------------------|-------|---------|------------|--------------|
| Blue Catfish | 2008 | 47,400 | FGL | 2.0 |
| | 2009 | 47,491 | FGL | 2.0 |
| | Total | 94,891 | | |
| Bluegill | 2007 | 10,203 | AFGL | 2.0 |
| | 2008 | 47,890 | AFGL | 2.1 |
| | Total | 58,093 | | |
| Channel Catfish | 1989 | 2,700 | FGL | 3.9 |
| | 1990 | 5,456 | FGL | 2.4 |
| | 2006 | 19,609 | AFGL | 8.5 |
| | 2007 | 99,090 | FGL | 2.4 |
| | 2018 | 7,386 | AFGL | 10.1 |
| | Total | 134,241 | | |
| Florida Largemouth Bass | 2007 | 35,640 | FRY | 0.3 |
| | 2008 | 49,860 | FGL | 1.7 |
| | 2010 | 47,025 | FGL | 1.8 |
| | 2020 | 52,958 | FGL | 1.7 |
| | Total | 185,483 | | |
| Largemouth Bass | 2007 | 12,712 | FGL | 1.1 |
| | Total | 12,712 | | |

Table 5. Objective-based sampling plan components for Lake Brazos, Texas 2020 – 2021.

| Gear/target species | Survey objective | Metrics | Sampling objective |
|-----------------------|-------------------|-----------------------|---------------------------|
| <u>Electrofishing</u> | | | |
| Largemouth Bass | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |
| | Condition | Wr | 10 fish/inch group (max) |
| Bluegill | Abundance | CPUE _{Stock} | General monitoring |
| | Size structure | PSD, length frequency | General monitoring |
| Redear Sunfish | Abundance | CPUE _{Stock} | General monitoring |
| | Size structure | PSD, length frequency | General monitoring |
| Longear Sunfish | Abundance | CPUE _{Stock} | General monitoring |
| | Size structure | Length frequency | General monitoring |
| Gizzard Shad | Abundance | CPUE _{Stock} | General monitoring |
| | Size structure | PSD, length frequency | General monitoring |
| | Prey availability | IOV | N ≥ 50 |
| <u>Trap netting</u> | | | |
| White Crappie | Abundance | CPUE _{Stock} | Practical effort |
| | Size structure | PSD, length frequency | Practical effort |
| | Condition | Wr | 10 fish/inch group (max) |
| <u>Gill netting</u> | | | |
| Blue Catfish | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |
| | Condition | Wr | 10 fish/inch group (max) |
| Channel Catfish | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |
| | Condition | Wr | 10 fish/inch group (max) |
| White Bass | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |
| | Condition | Wr | 10 fish/inch group (max) |
| Hybrid Striped Bass | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |

Table 6 con't. Objective-based sampling plan components for Lake Brazos, Texas 2020 – 2021.

| | | | |
|--------------|----------------|-----------------------|---------------------------|
| Striped Bass | Condition | <i>Wr</i> | 10 fish/inch group (max) |
| | Abundance | CPUE _{Stock} | RSE _{Stock} ≤ 25 |
| | Size structure | PSD, length frequency | N ≥ 50 stock |
| | Condition | <i>Wr</i> | 10 fish/inch group (max) |

Table 7. Survey of structural habitat types, Lake Brazos, Texas, 2009. Shoreline habitat type units are in miles.

| Habitat type | Estimate | % of total |
|-------------------------------|----------|------------|
| Bulkhead | 4.1 | 11.2 |
| Gravel shoreline (rocks < 4") | 0.1 | Trace |
| Gravel shoreline (rocks > 4") | 3.5 | 9.5 |
| Rock bluff | 1.0 | 2.7 |
| Natural | 26.7 | 72.6 |
| Giant Reed | 0.9 | 2.4 |
| Boat docks and Ramps | 0.5 | 1.4 |

Table 8. Survey of aquatic vegetation, Lake Brazos, Texas, 2009-2020. Percent of total reservoir area is listed for 2009 through 2013, while percent of randomly selected points where species occurred is listed for 2016 and 2020. Although no gauging station exists near Lake Brazos, water level was near full pool during the surveys.

| Vegetation | 2009 | 2010 | 2011 | 2012 | 2013 | 2016 | 2020 |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------------|------------------|
| <u>Native emergent</u> | | | | | | | |
| Cattail | | | | | | 8.3% (3 of 36) | 19.4% (7 of 36) |
| Common buttonbush | | | | | | 2.8% (1 of 36) | |
| Water willow | | | | | | 31% (11 of 36) | 38.9% (14 of 36) |
| <u>Non-native</u> | | | | | | | |
| Giant reed | 3.6 (0.7) | 6.6 (1.3) | 6.2 (1.2) | 7.5 (1.4) | 7.5 (1.4) | 19.4% (7 of 36) | 27.8% (10 of 36) |

Table 9. Percent directed angler effort by species for Lake Brazos, Texas, 2018-19. Survey periods were from 1 June through 31 May.

| Species | 2018/2019 |
|----------------------------|-----------|
| Common Carp | 0.9 |
| Flathead Catfish | 1.0 |
| Catfishes (Blues/Channels) | 44.0 |
| Temperate basses | 1.0 |
| Sunfishes | 0.7 |
| Black basses | 20.3 |
| Crappies | 6.0 |
| Anything | 27.1 |

Table 10. Total fishing effort (h) for all species and total directed expenditures at Lake Brazos, Texas, 2018-19. Survey periods were from 1 June through 31 May. Relative standard error is in parentheses.

| Creel statistic | 2018/2019 |
|-----------------------------|----------------|
| Total fishing effort | 45,580 (21) |
| Total directed expenditures | \$192,846 (25) |

Gizzard Shad

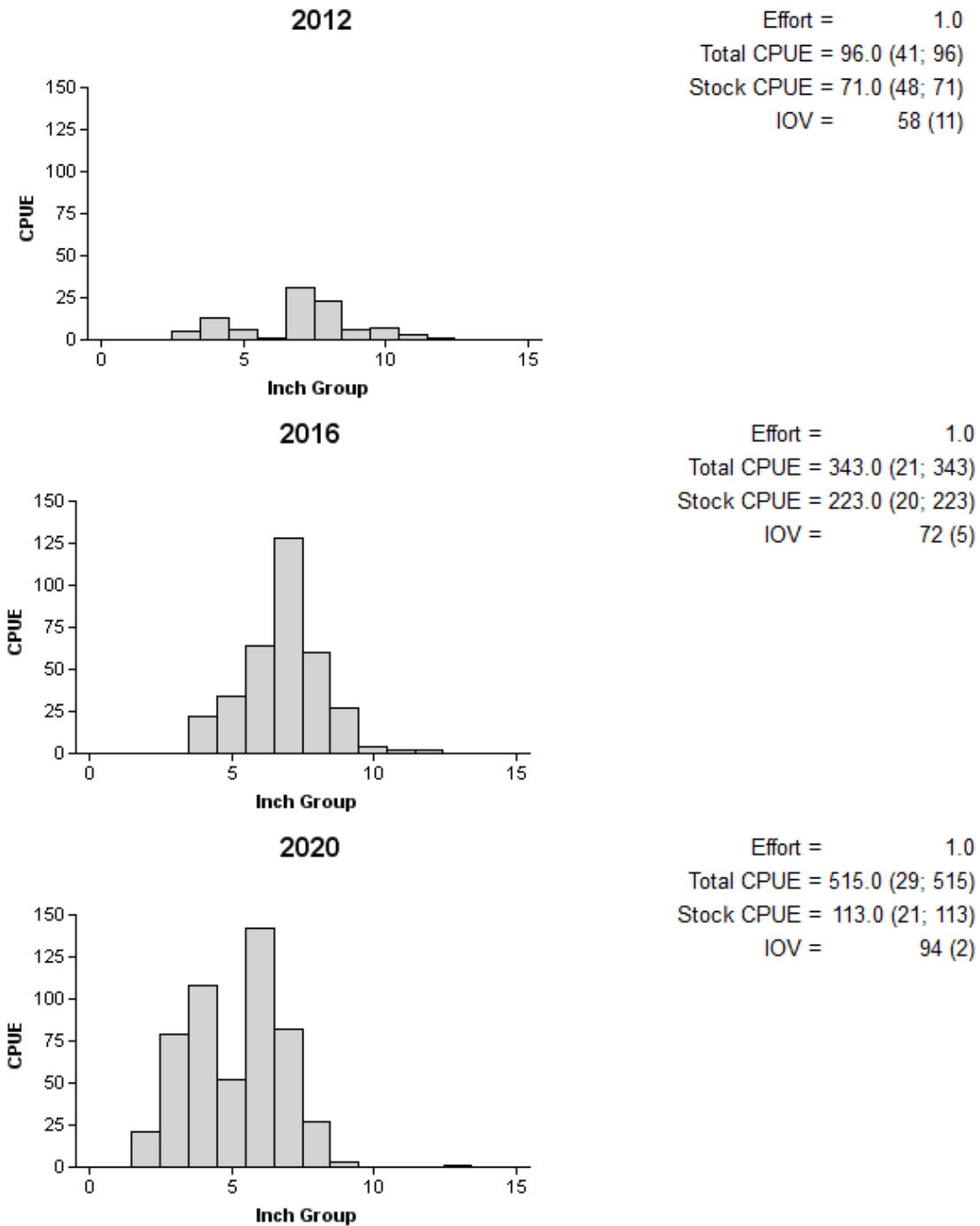
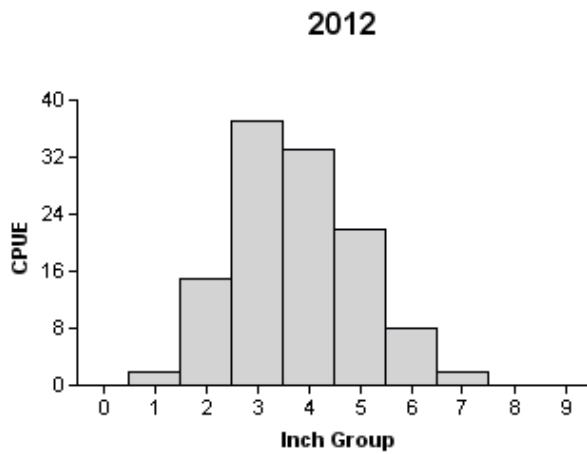
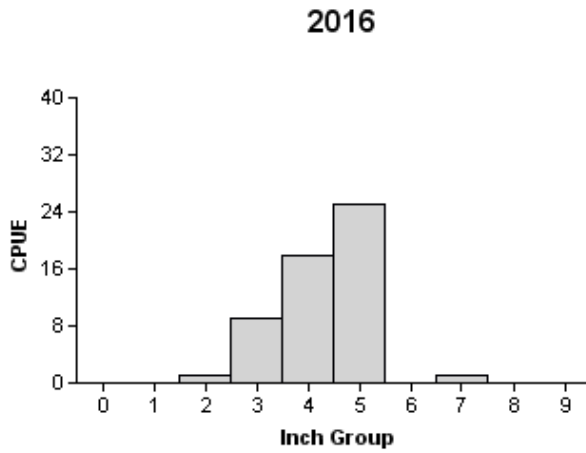


Figure 1. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Lake Brazos, Texas, 2012, 2016 and 2020.

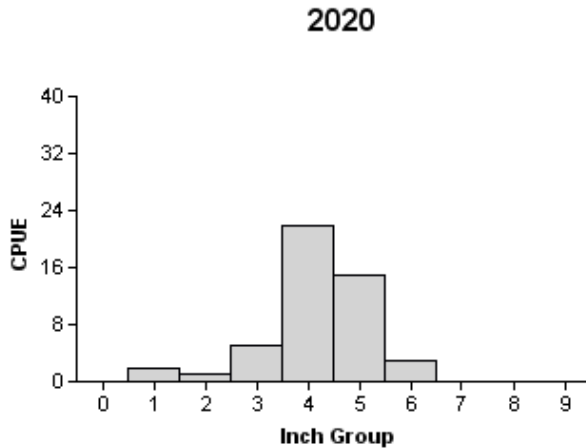
Bluegill



Effort = 1.0
 Total CPUE = 119.0 (27; 119)
 Stock CPUE = 102.0 (28; 102)
 PSD = 10 (3)



Effort = 1.0
 Total CPUE = 54.0 (24; 54)
 Stock CPUE = 53.0 (25; 53)
 PSD = 2 (2)



Effort = 1.0
 Total CPUE = 48.0 (16; 48)
 Stock CPUE = 45.0 (17; 45)
 PSD = 7 (4)

Figure 2. 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, Lake Brazos, Texas, 2012, 2016 and 2020.

Blue Catfish

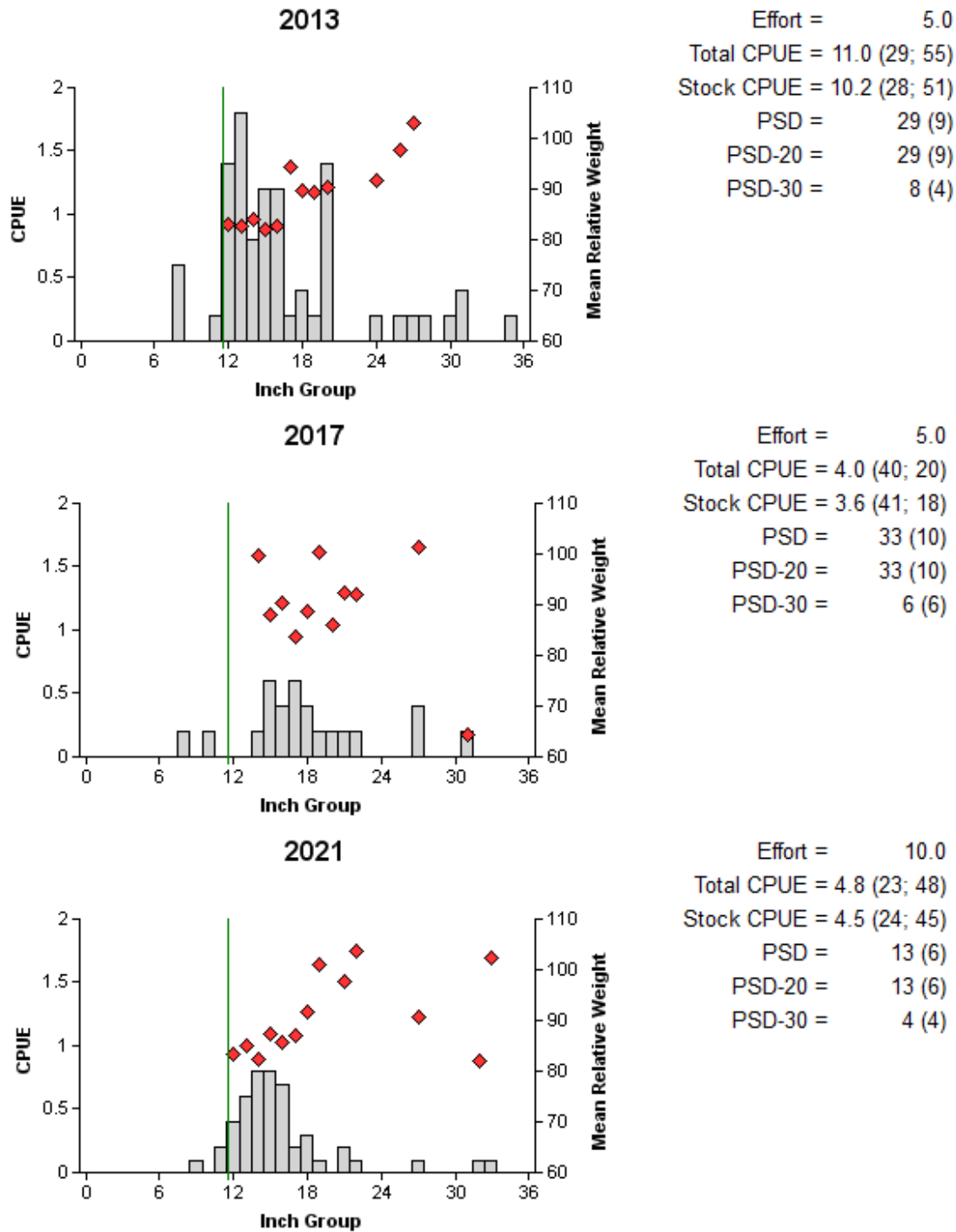


Figure 3. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2013, 2017 and 2021. Vertical line represents 12-inch minimum length limit.

Table 11. Creel survey statistics for catfishes at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting Blue and Channel Catfishes combined, while total harvest is the estimated number of Blue Catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|-------------|
| Surface area (acres) | 523 |
| Directed effort (h) | 19,583 (24) |
| Directed effort/acre | 37.4 (24) |
| Total catch/hour | 0.4 (29) |
| Total harvest | 430 (56) |
| Harvest/acre | 0.8 (56) |
| Percent legal released | 24.0 |

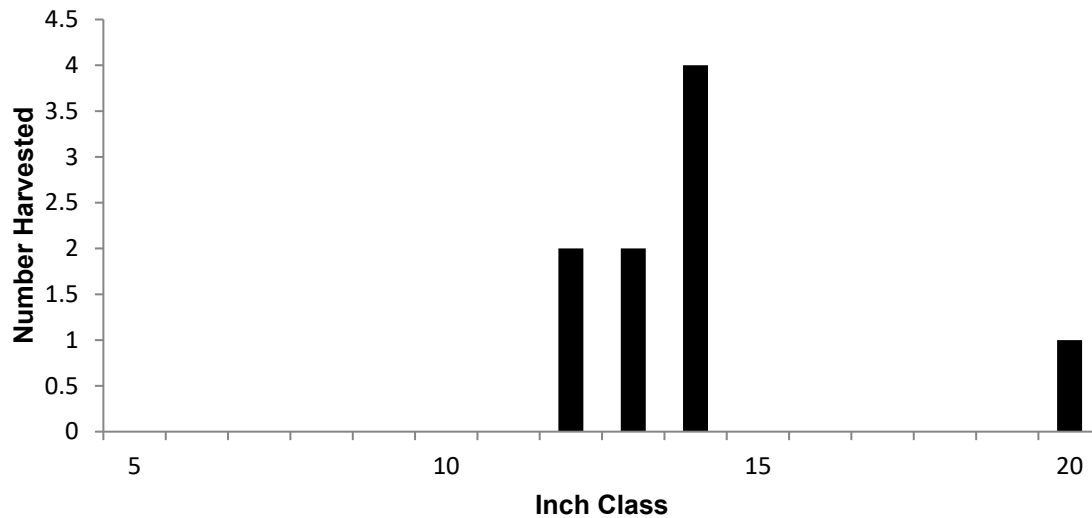


Figure 4. Length frequency of harvested Blue Catfish observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested Blue Catfish observed during creel surveys was 9 fish, and the total estimated harvest for the creel survey period was 430 fish. The minimum length limit for Blue and Channel Catfish at the time of the survey was 12 inches.

Channel Catfish

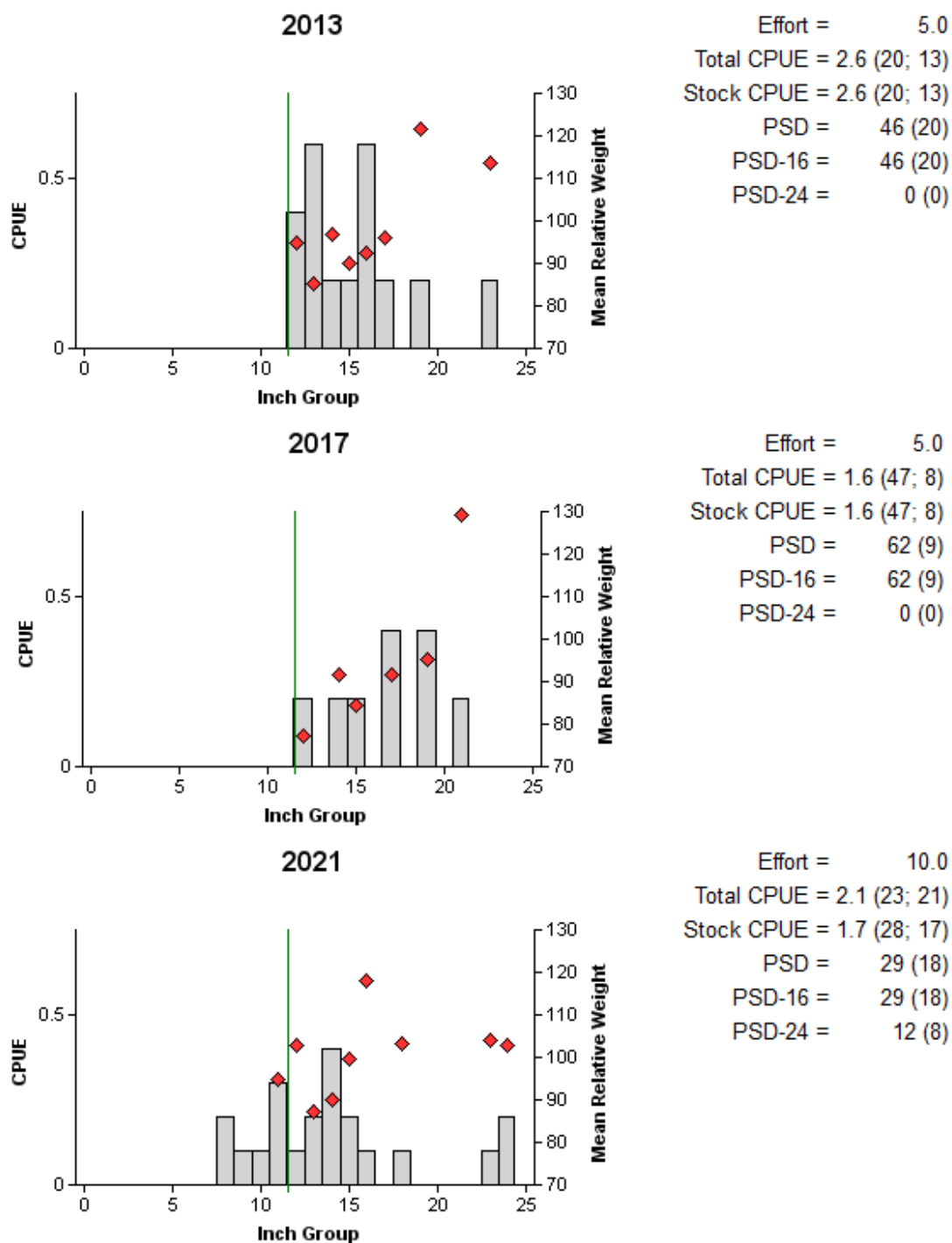


Figure 5. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2013, 2017 and 2021. Vertical line represents 12-inch minimum length limit.

Table 11. Creel survey statistics for catfishes at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting Blue and Channel catfishes combined, while total harvest is the estimated number of Channel Catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|-------------|
| Surface area (acres) | 523 |
| Directed effort (h) | 19,583 (24) |
| Directed effort/acre | 37.4 (24) |
| Total catch/hour | 0.4 (29) |
| Total harvest | 589 (68) |
| Harvest/acre | 1.1 (68) |
| Percent legal released | 8.4 |

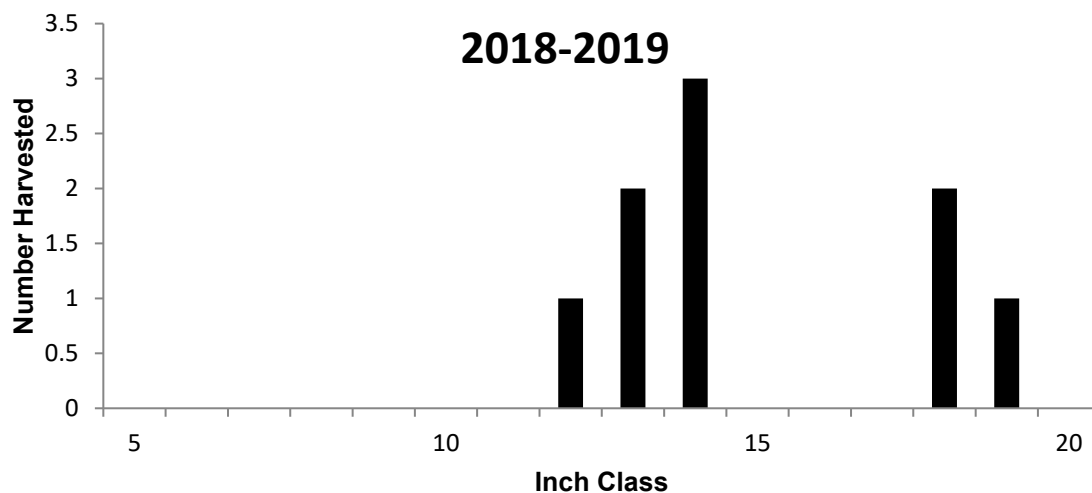


Figure 6. Length frequency of harvested Channel Catfish observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested Channel Catfish observed during creel surveys was 9 fish, and the total estimated harvest for the creel survey period was 589 fish. The minimum length limit for Blue and Channel Catfish at the time of the survey was 12 inches.

White Bass

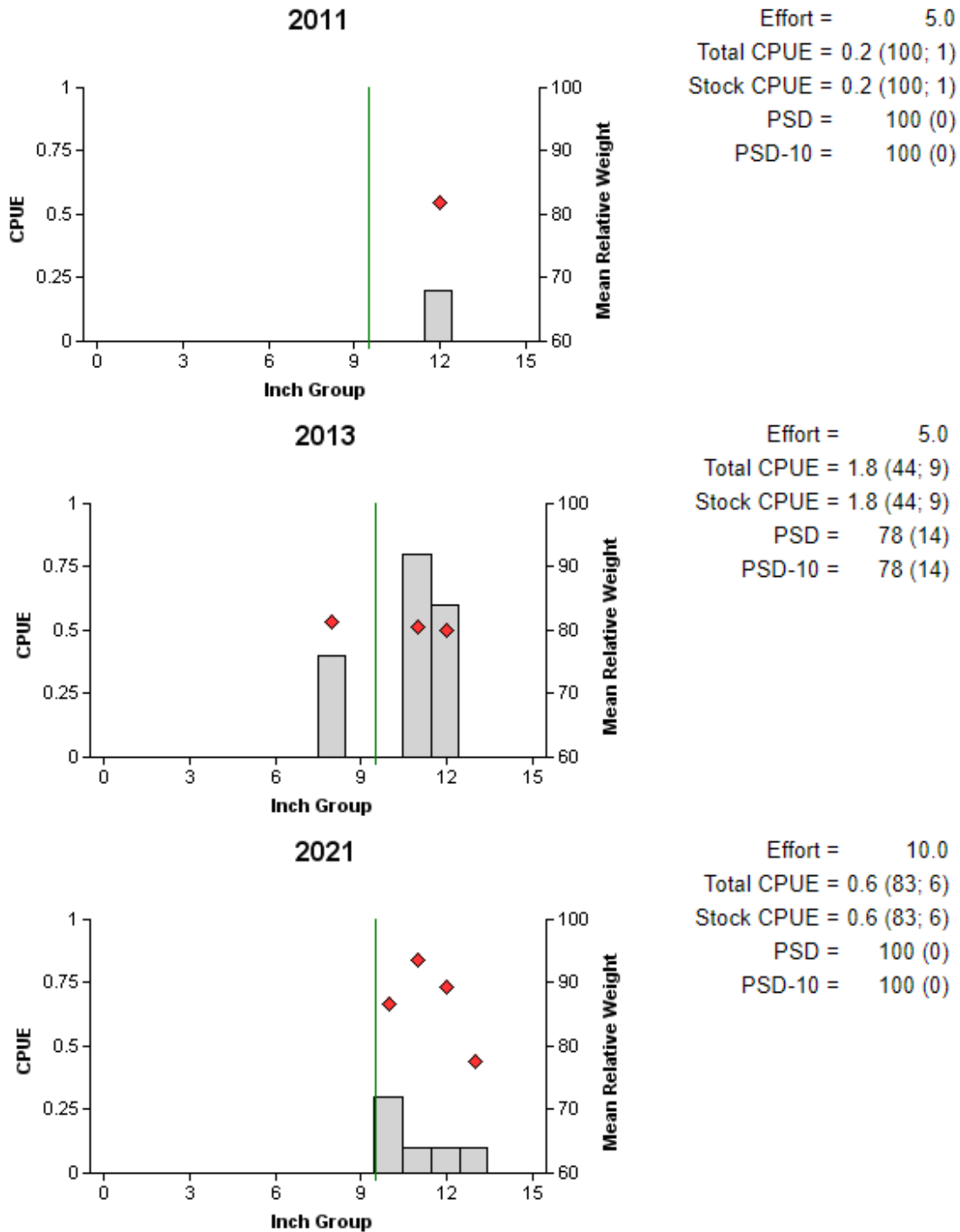


Figure 7. Number of White Bass caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2011, 2013 and 2021; none were collected in 2017. Vertical line represents 10-inch minimum length limit.

Table 12. Creel survey statistics for temperate basses at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting all temperate basses combined, while total harvest is the estimated number of White Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|-----------|
| Surface area (acres) | 523 |
| Directed effort (h) | 475 (84) |
| Directed effort/acre | 0.9 (84) |
| Total catch/hour | 14.0 (--) |
| Total harvest | 0.0 (0) |
| Harvest/acre | 0.0 (0) |
| Percent legal released | 100.0 |

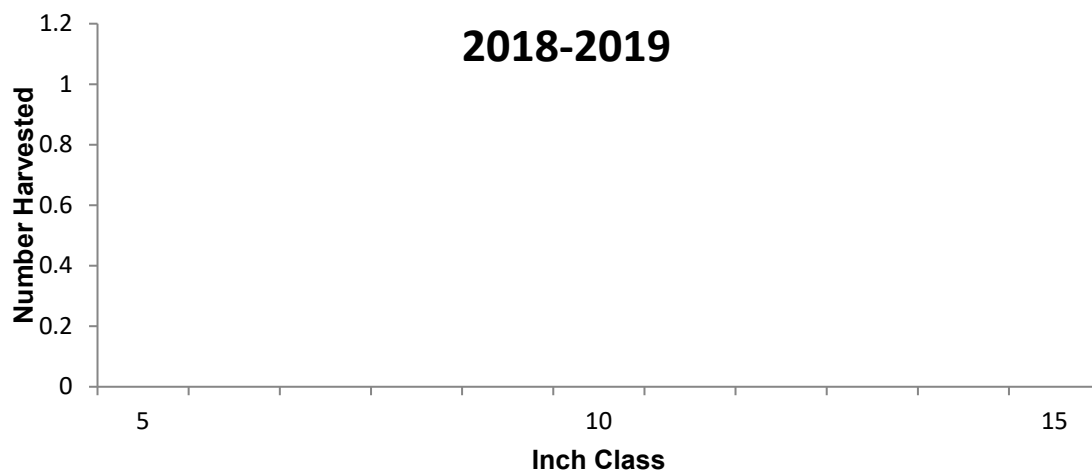


Figure 8. Length frequency of harvested White Bass observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested White Bass observed during creel surveys was 0 fish, and the total estimated harvest for the creel survey period was 0 fish. The minimum length limit for White Bass at the time of the survey was 10 inches.

Hybrid Striped Bass

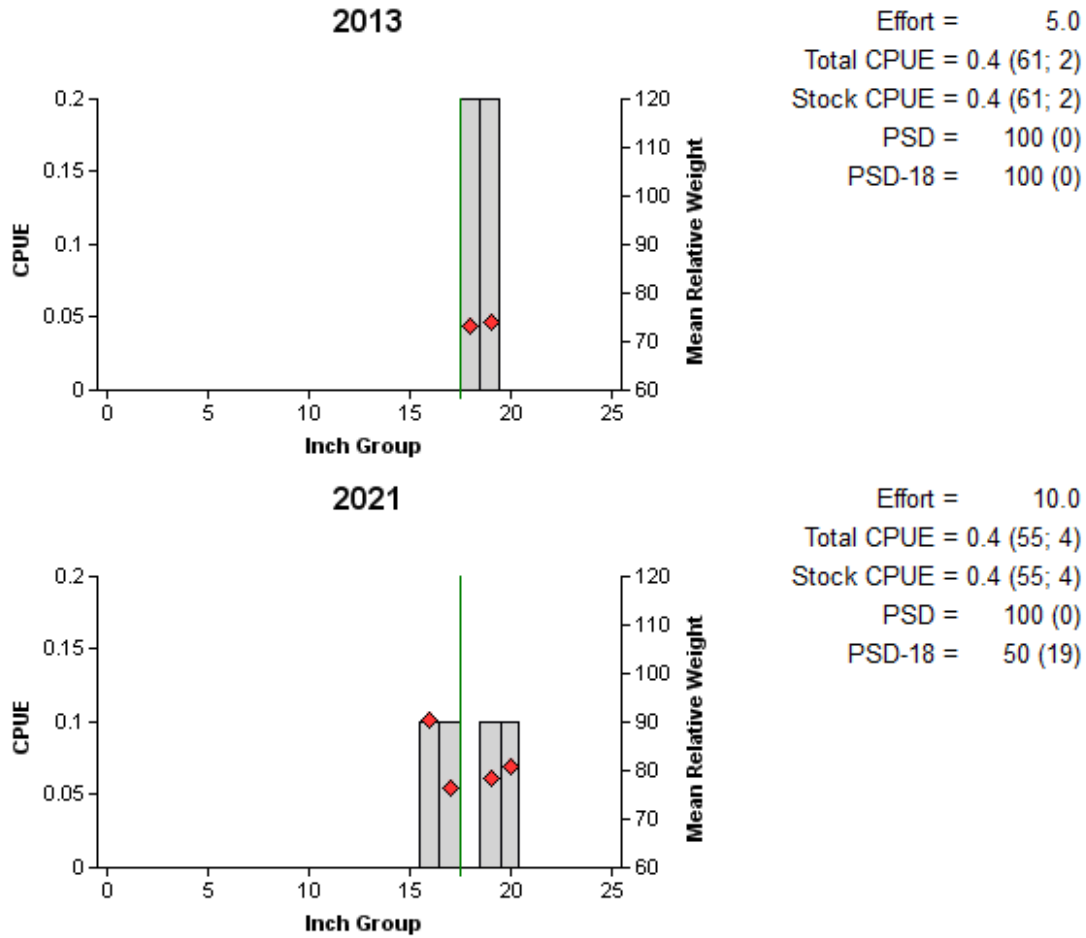


Figure 9. Number of Hybrid Striped Bass caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2013 and 2021; none were collected in 2017. Vertical line represents 18-inch minimum length limit.

Table 13. Creel survey statistics for temperate basses at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting all temperate basses combined, while total harvest is the estimated number of Hybrid Striped Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|-----------|
| Surface area (acres) | 523 |
| Directed effort (h) | 475 (84) |
| Directed effort/acre | 0.9 (84) |
| Total catch/hour | 14.0 (--) |
| Total harvest | 0.0 (0) |
| Harvest/acre | 0.0 (0) |
| Percent legal released | NA |

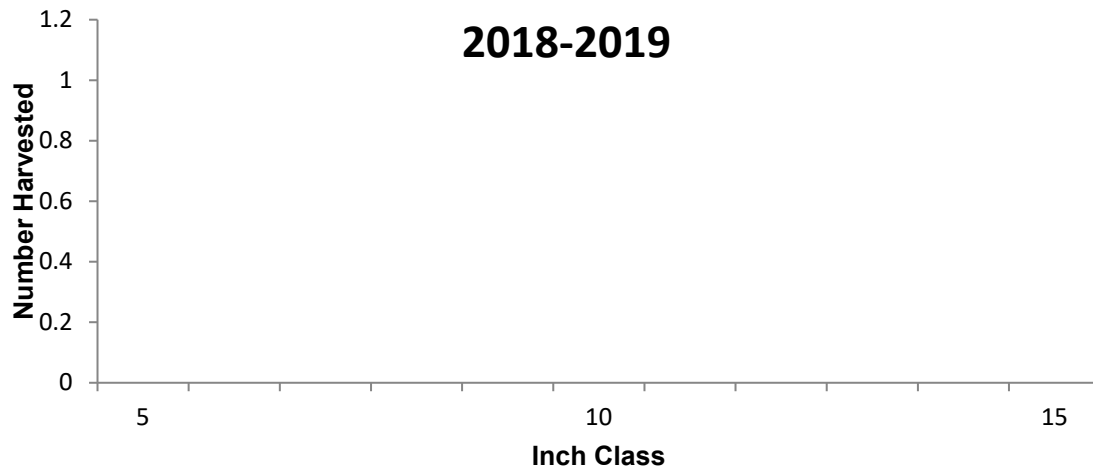


Figure 10. Length frequency of harvested Hybrid Striped Bass observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested Hybrid Striped Bass observed during creel surveys was 0 fish, and the total estimated harvest for the creel survey period was 0 fish. The minimum length limit for hybrid striped bass at the time of the survey was 18 inches.

Striped Bass

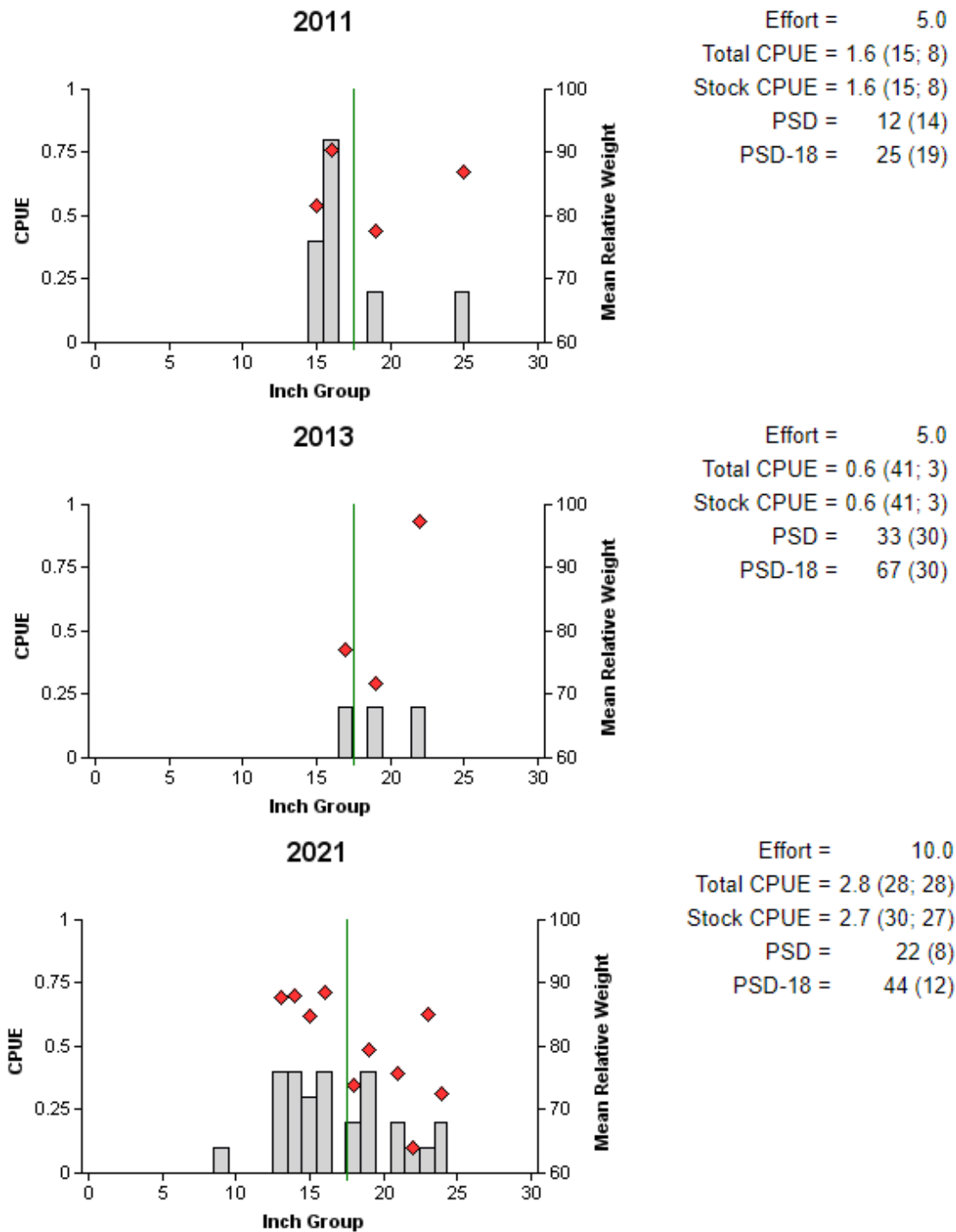


Figure 11. Number of Striped Bass caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2011, 2013 and 2021; none were collected in 2017. Vertical line represents 18-inch minimum length limit.

Table 14. Creel survey statistics for temperate basses at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting all temperate basses combined, while total harvest is the estimated number of Striped Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|-----------|
| Surface area (acres) | 523 |
| Directed effort (h) | 475 (84) |
| Directed effort/acre | 0.9 (84) |
| Total catch/hour | 14.0 (--) |
| Total harvest | 0.0 (0) |
| Harvest/acre | 0.0 (0) |
| Percent legal released | NA |

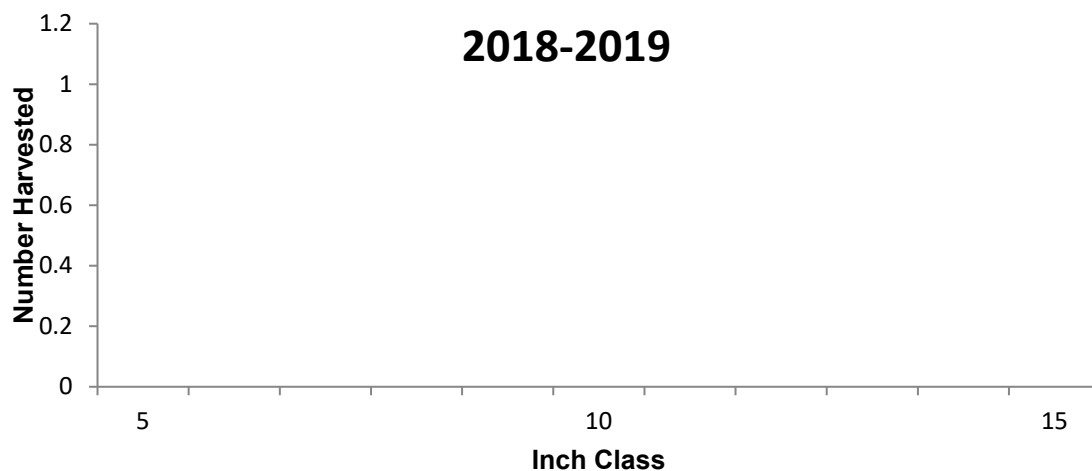


Figure 12. Length frequency of harvested Striped Bass observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested Striped Bass observed during creel surveys was 0 fish, and the total estimated harvest for the creel survey period was 0 fish. The minimum length limit for Striped Bass at the time of the survey was 18 inches.

Largemouth Bass

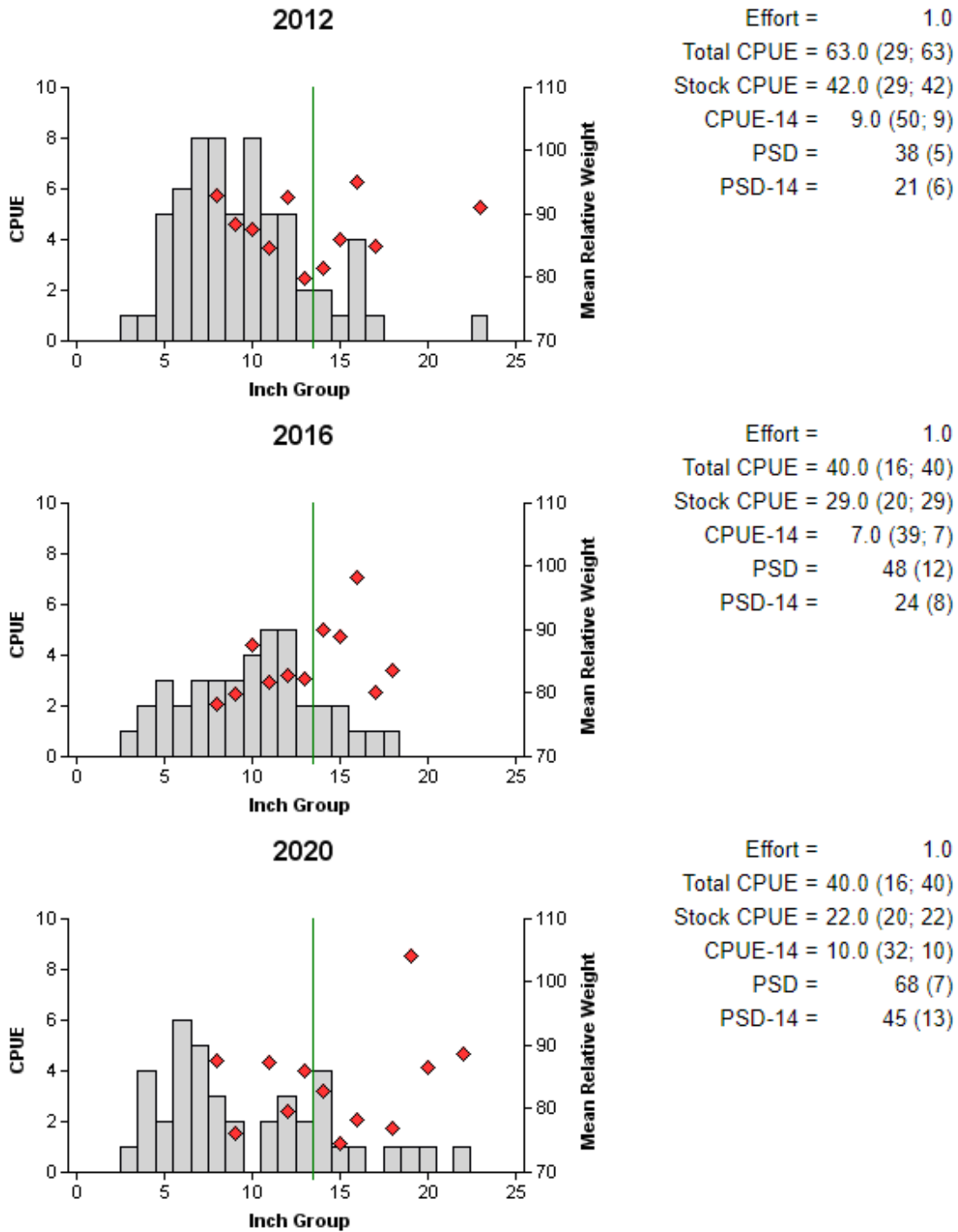


Figure 13. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for fall electrofishing surveys, Lake Brazos, Texas, 2012, 2016 and 2020. Vertical line represents 14-inch minimum length limit.

Table 15. Creel survey statistics for black basses at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting black basses combined, while total harvest is the estimated number of Largemouth Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|------------|
| Surface area (acres) | 523 |
| Directed effort (h) | 9,249 (30) |
| Directed effort/acre | 17.7 (30) |
| Total catch/hour | 1.0 (26) |
| Total harvest | 262 (94) |
| Harvest/acre | 0.5 (94) |
| Percent legal released | 82.0 |

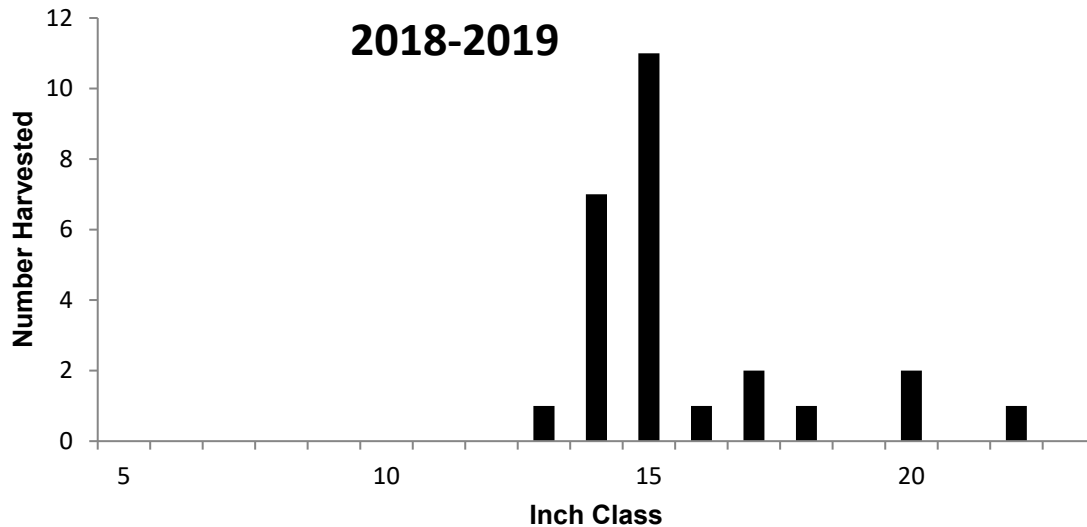


Figure 14. Length frequency of harvested Largemouth Bass observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested Largemouth Bass observed during creel surveys was 26 fish, and the total estimated harvest for the creel survey period was 262 fish. The minimum length limit for Largemouth Bass at the time of the survey was 14 inches.

Table 16 Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Lake Brazos, Texas, 2008 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.

| Year | Sample size | Number of fish | | | % FLMB alleles | % FLMB |
|------|-------------|----------------|------------|------|----------------|--------|
| | | FLMB | Intergrade | NLMB | | |
| 2008 | 15 | 0 | 13 | 2 | 33 | 0 |
| 2016 | 30 | 0 | 29 | 1 | 39 | 0 |

White Crappie

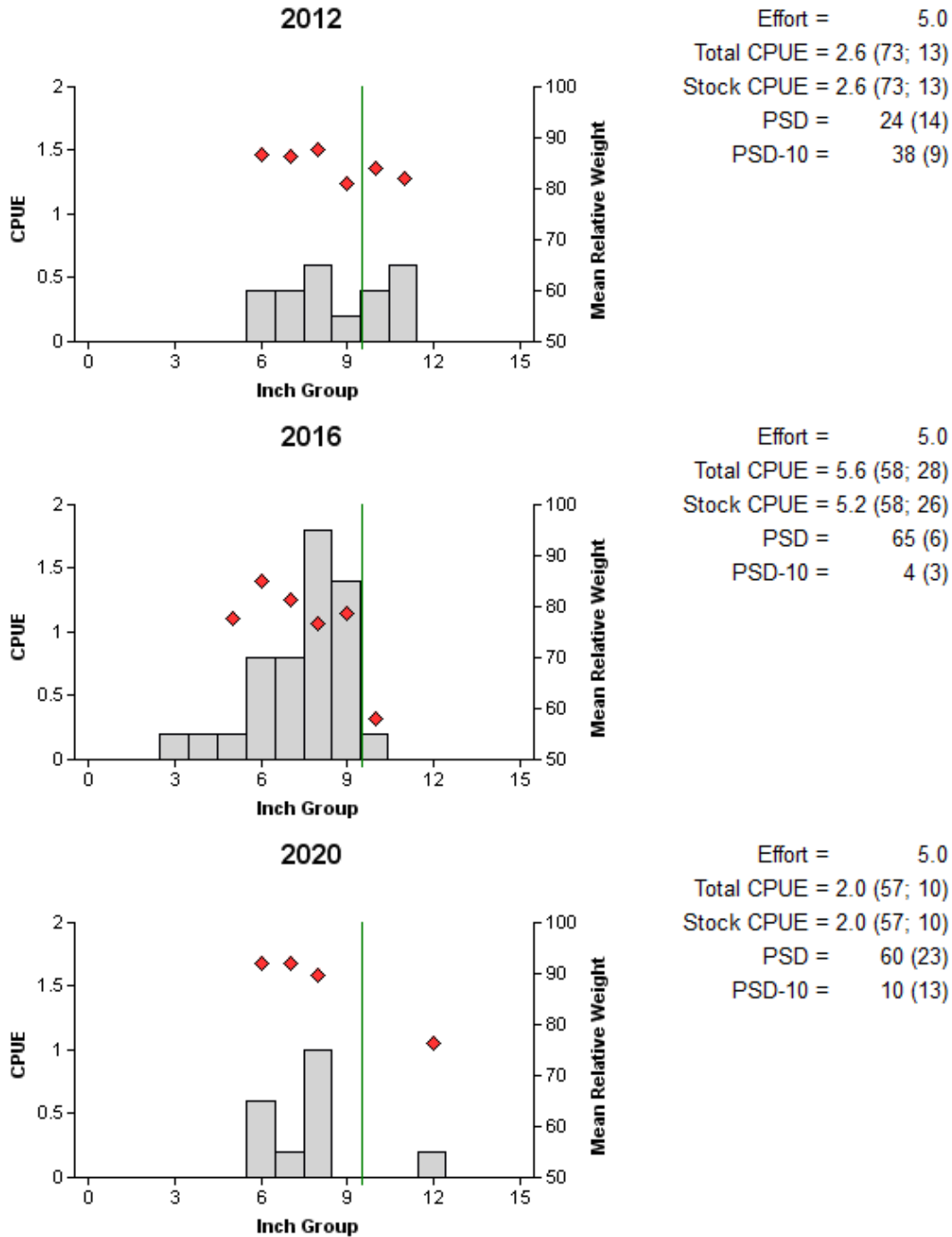


Figure 15. Number of White Crappie caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for winter trap net surveys, Lake Brazos, Texas, 2012, 2016 and 2020. Vertical line represents 10-inch minimum length limit.

White Crappie

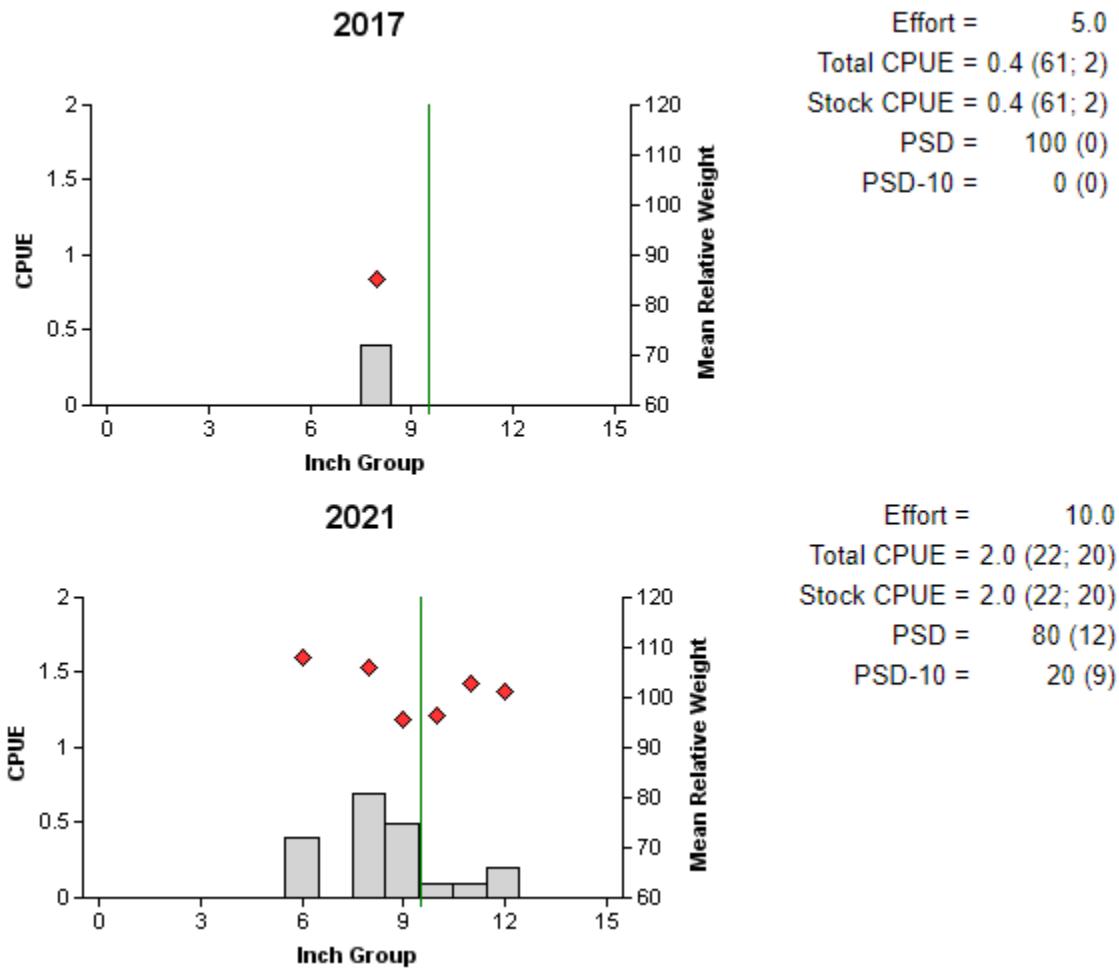


Figure 16. Number of White Crappie caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Lake Brazos, Texas, 2017 and 2021. Vertical line represents 10-inch minimum length limit.

Table 17. Creel survey statistics for crappies at Lake Brazos, Texas, June 1, 2018 through May 31, 2019. Directed effort, directed effort/acre and total catch per hour are for anglers targeting crappies combined, while total harvest is the estimated number of White Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

| Creel survey statistic | 2018/2019 |
|------------------------|------------|
| Surface area (acres) | 523 |
| Directed effort (h) | 2,721 (45) |
| Directed effort/acre | 5.2 (45) |
| Total catch/hour | 1.6 (81) |
| Total harvest | 852 (58) |
| Harvest/acre | 1.6 (58) |
| Percent legal released | 11.3 |

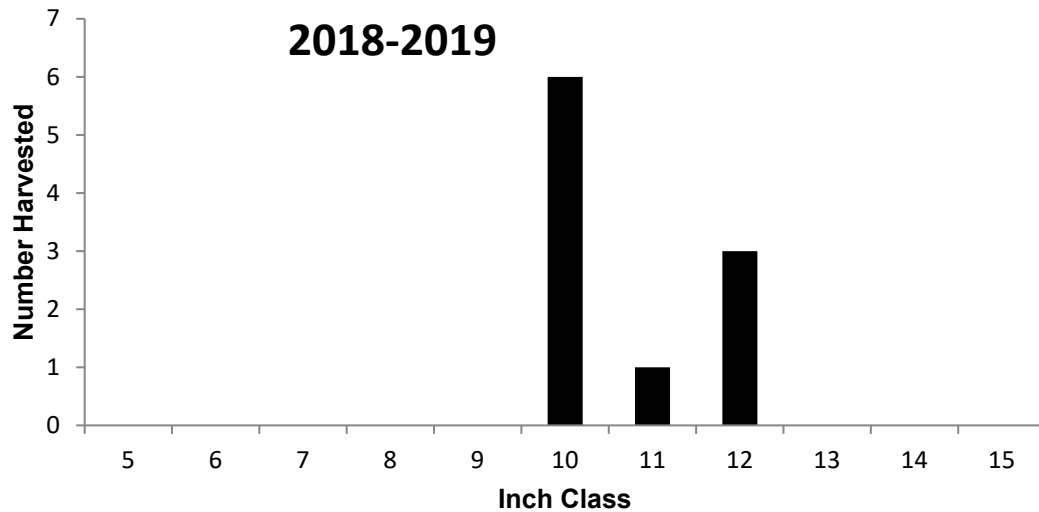


Figure 17. Length frequency of harvested White Crappie observed during creel surveys at Lake Brazos, Texas, June 1, 2018 through May 31, 2019, all anglers combined. The number of harvested White Crappie observed during creel surveys was 10 fish, and the total estimated harvest for the creel survey period was 852 fish. The minimum length limit for White Crappie at the time of the survey was 14 inches.

Proposed Sampling Schedule

Table 18. Proposed sampling schedule for Lake Brazos, Texas. Survey period is June through May. Gill net surveys are conducted in the spring while electrofishing and trap net surveys are conducted in the fall and winter respectively.

| | Survey Year | | | |
|-----------------------|-------------|-----------|-----------|-----------|
| | 2021-2022 | 2022-2023 | 2023-2024 | 2024-2025 |
| Vegetation | | | | X |
| Angler Access | | | | X |
| Electrofishing - Fall | | | | X |
| Trap Netting - Spring | | | | X |
| Gill Netting - Spring | | | | X |
| Report | | | | X |

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

Number (N), relative standard error (RSE), and catch rate (CPUE) of all target species collected from all gear types from Lake Brazos, Texas, 2020-2021. Sampling effort was 10 net nights for trap netting and gill netting, and 1 hour for electrofishing.

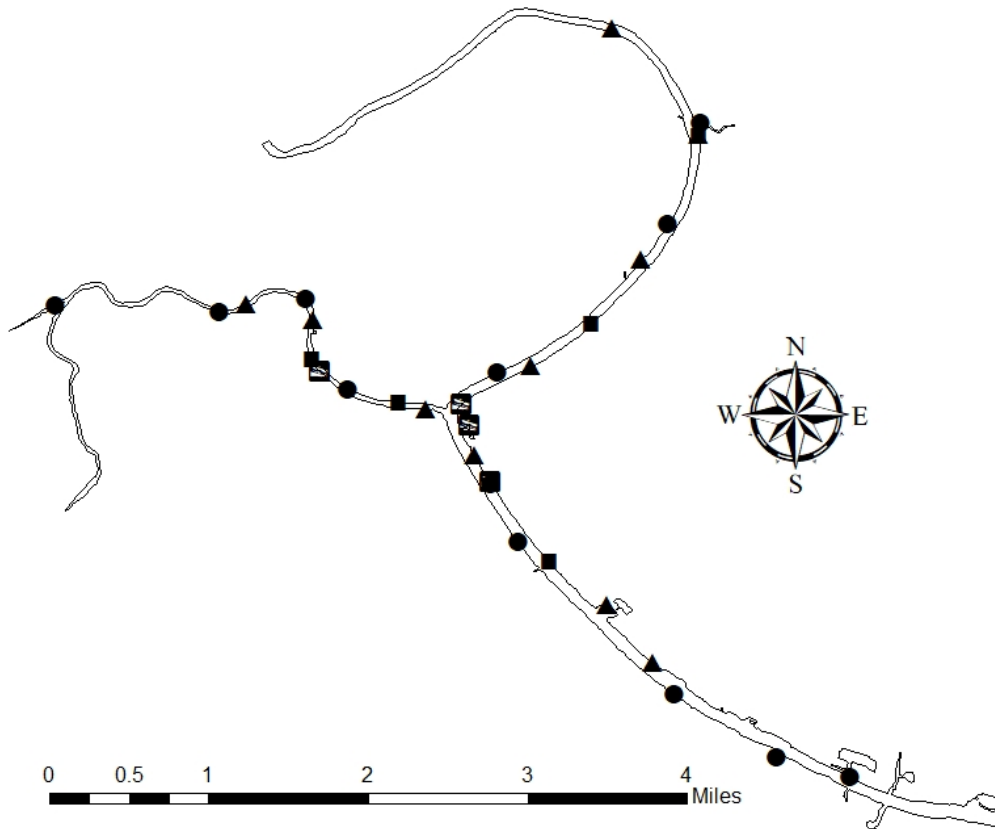
| Species | Gill Netting | | Trap Netting | | Electrofishing | |
|-------------------|--------------|------|--------------|------|----------------|-------|
| | N/RSE | CPUE | N/RSE | CPUE | N/RSE | CPUE |
| Gizzard Shad | | | | | 515/29 | 515.0 |
| Threadfin Shad | | | | | 34/57 | 34.0 |
| Blue Catfish | 48/23 | 4.80 | | | | |
| Channel Catfish | 21/23 | 2.10 | | | | |
| White Bass | 6/83 | 0.60 | | | | |
| Palmetto Bass | 4/55 | 0.40 | | | | |
| Striped Bass | 28/28 | 2.80 | | | | |
| Green Sunfish | | | | | 2/100 | 2.0 |
| Redbreast Sunfish | | | | | 1/100 | 1.0 |
| Bluegill | | | | | 48/16 | 48.0 |
| Longear Sunfish | | | | | 23/29 | 23.0 |
| Redear Sunfish | | | | | 8/38 | 8.0 |
| Largemouth Bass | | | | | 40/16 | 40.0 |
| White Crappie | 20/22 | 2.0 | 10/57 | 2.0 | | |

APPENDIX B – Historical catch rates for target species by gear type

Historical catch rates (CPUE) of targeted species by gear type for management surveys on Lake Brazos, Texas, 2000 to present. All stations were randomly selected. Electrofishing stations utilized a 5.0 Smith-Root GPP (Gas Powered Pulsator) through 2010, after which a 7.5 Smith-Root GPP was used. Objective based sampling began in 2015. Species averages are in bold. Dashes represent no data.

| Gear | Species | 08/09 | 10/11 | 12/13 | 16/17 | 20/21 | Avg. |
|---------------|-------------------|-------|-------|-------|-------|-------|--------------|
| Electrofisher | | | | | | | |
| | Largemouth Bass | 20.0 | 52.0 | 63.0 | 40.0 | 40.0 | 43.0 |
| | Smallmouth Bass | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.4 |
| | Spotted Bass | 13.0 | 7.0 | 13.0 | 0.0 | 0.0 | 6.6 |
| | Gizzard Shad | 155.0 | 162.0 | 96.0 | 343.0 | 515.0 | 254.2 |
| | Threadfin Shad | 21.0 | 12.0 | 17.0 | 116.0 | 34.0 | 40.0 |
| | Bluegill Sunfish | 50.0 | 95.0 | 119.0 | 54.0 | 48.0 | 73.2 |
| | Redear Sunfish | 12.0 | 2.0 | 5.0 | 14.0 | 8.0 | 8.2 |
| | Longear Sunfish | 41.0 | 119.0 | 133.0 | 35.0 | 23.0 | 70.2 |
| | Redbreast Sunfish | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.2 |
| | Green Sunfish | 5.0 | 2.0 | 0.0 | 1.0 | 2.0 | 2.0 |
| | Warmouth | 0.0 | 4.0 | 2.0 | 0.0 | 0.0 | 1.2 |
| Gill nets | | | | | | | |
| | Blue Catfish | 5.2 | 9.6 | 11.0 | 4.0 | 4.8 | 6.9 |
| | Channel Catfish | 7.4 | 2.0 | 2.6 | 1.6 | 2.1 | 3.1 |
| | White Bass | 1.4 | 0.2 | 1.8 | 0.0 | 0.6 | 0.8 |
| | Palmetto Bass | 0.0 | 0.0 | 0.4 | 0.0 | 0.4 | 0.2 |
| | Striped Bass | 0.6 | 1.6 | 0.6 | 0.0 | 2.8 | 1.1 |
| | Flathead Catfish | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.1 |
| Trap nets | | | | | | | |
| | White Crappie | 4.2 | 1.6 | 2.6 | 5.6 | 2.0 | 3.2 |
| | Black Crappie | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |

APPENDIX C – Map of sampling locations



Location of sampling sites, Lake Brazos, Texas, 2020-2021. Electrofishing and gill netting stations are indicated by solid circles and squares, respectively. Water level was near conservation pool at time of sampling.



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