Nasworthy Reservoir

2018 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-3

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

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Survey and Management Summary

Fish populations in Nasworthy Reservoir were surveyed in 2018 using electrofishing, trap netting and in 2019 using gill netting and tandem hoop netting. Anglers were surveyed from June 2018 through May 2019 with a creel survey. Historical data are presented with the 2018-2019 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: Nasworthy Reservoir is a 1,380-acre impoundment located on the southwestern edge of San Angelo, Texas in Tom Green County. It is a shallow turbid reservoir with stable water levels and extensive emergent vegetation. Access is good with numerous public boat ramps and parks.

Management History: Important sport fish include Largemouth Bass, White Crappie, and Channel Catfish. Red Drum were once an important game species, but the discontinued operation of the power plant on Nasworthy Reservoir in 2003 eliminated this fishery that was dependent on the plant's heated water effluent. Palmetto Bass (Striped Bass x White Bass hybrid) were stocked from 1974 to 2007. In 2018 Palmetto Bass stockings resumed at a higher stocking density in an attempt to restructure the Gizzard Shad population.

Fish Community

- **Prey species:** Threadfin Shad were present in the reservoir. Electrofishing catch of Gizzard Shad was adequate, however Gizzard Shad IOV was poor. Electrofishing catch of Bluegill was slightly lower than previous years with most from 2 to 6 inches long.
- **Catfishes:** The Channel Catfish population had good size structure with fish up to 26 inches observed during sampling. Channel Catfish was the most sought after species in Nasworthy Reservoir. Blue Catfish were present in the reservoir in low abundance.
- **Temperate basses:** White Bass were present in the reservoir in low abundance. Palmetto Bass were abundant due to high density stocking in spring 2018.
- **Largemouth Bass:** The Largemouth Bass population continued to be characterized by poor size structure and slow growth. Largemouth Bass below the slot limit tended to be in poor condition while bass above the slot were in good condition. Nearly 16% of all anglers at Nasworthy Reservoir fished for Largemouth Bass.
- **White Crappie:** White Crappie were abundant and continued to have slow growth and poor condition. Most crappie reached legal size in 3.4 years.

Management Strategies: Stock Palmetto Bass fingerlings at 75 fish/acre in 2020 to restructure the Gizzard Shad population. Recommend dropping the 10-inch minimum length limit on crappie to allow harvest of smaller crappie. Continue to evaluate the special slot regulation on Largemouth Bass with annual fall electrofishing surveys in 2020 and 2022 and a creel survey in 2022-2023.

Introduction

This document is a summary of fisheries data collected from Nasworthy Reservoir in 2018-2019. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2018-2019 data for comparison.

Reservoir Description

Nasworthy Reservoir is a 1,380-acre impoundment constructed in 1930 on the South Concho River. It is located in Tom Green County on the southwestern edge of San Angelo and is operated and controlled by the City of San Angelo. Primary water uses included municipal water supply, irrigation and recreation. Water level remains fairly constant (Figure 1) due to supplemental flows from upstream Twin Buttes Reservoir. The reservoir was used for power plant cooling until 2003, when the plant ceased operation. Nasworthy Reservoir was eutrophic with a mean trophic state index (TSI) chl-a of 55.46, and has not changed in the past decade (Texas Commission on Environmental Quality 2018). The reservoir experienced a mild golden alga fish kill in spring 2014, but the impacts were minimal. Habitat consisted mainly of bulkhead, riprap, boat docks, and native emergent vegetation (bulrushes and water willow). Other descriptive characteristics for Nasworthy Reservoir are in Table 1.

Angler Access

Nasworthy Reservoir has 13 public boat ramps and numerous private boat ramps (Table 2). Under normal conditions, all ramps are in the water and useable due to water supplementation from the Twin Buttes Reservoir dam just upstream. In the extreme drought of spring 2014 Twin Buttes Reservoir was too low for supplementation, so about half of the ramps at Nasworthy Reservoir became unusable due to low water. The situation was corrected by early summer 2014 as water levels rose to near conservation pool. Shoreline access is abundant at seven city-maintained parks around the lake which offers a combined 5.3 miles of bank access.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Scott 2015) included:

1. Post signage, inform the media, and communicate with local fishing clubs, Lake Nasworthy HOA, and the City of San Angelo about the new 14-18 inch slot limit on Nasworthy Reservoir. Monitor Changes in Largemouth Bass population with additional sampling.

   Action: Signage was posted and communication was made with media, and other interested parties. Additional sampling has taken place, including fish growth evaluations and a year-long creel survey.

2. Cooperate with the City of San Angelo to post signage, educate the public about invasive species, and track existing and future inter-basin water transfers to facilitate potential invasive species responses.

   Action: The San Angelo District continued to work with the City of San Angelo to post signage and to educate the public on invasive species threats through media outlets.

Harvest regulation history: In 2005, the minimum length limit and bag limit on Red Drum were removed to allow harvest of any remaining Red Drum after the closure of the reservoir's power plant. The discontinuation of hot-water discharge from the power plant made the reservoir unsuitable for this species. On September 1, 2015, the length limit for Largemouth Bass changed to a 14- to 18-inch slot limit. All other species are managed with statewide regulations. Current regulations are found in Table 3.

Stocking history: Species stocked have included Channel Catfish, Largemouth Bass, Palmetto Bass and Red Drum. Palmetto Bass were stocked from 1974 to 2007, but were discontinued due to poor growth and lack of a fishery. However, Palmetto Bass stockings resumed in 2018 and stocked at a higher

rate in an attempt to restructure the Gizzard Shad population. Red Drum stockings were discontinued after 2002 because the power plant on the reservoir stopped operation, eliminating the heated water effluent that enabled overwinter survival of Red Drum. The complete stocking history is in Table 4.

Vegetation/habitat management history: The City of San Angelo completed a dredging project in 2002 to remove excess sediment. The dredging project removed 3.8 million cubic yards of sediment and added 2,500 acre feet of reservoir capacity. The city also periodically controls spread of bulrushes with chemical methods.

Water transfer: Nasworthy Reservoir is primarily used for municipal water supply, irrigation, and recreation. When the Twin Buttes dam gates are opened by the City of San Angelo, the water feeds directly into downstream Nasworthy Reservoir. Water from Nasworthy Reservoir is fed downstream directly into the South Concho River which flows through south San Angelo to a pumping station near Ave L, supplying municipal water for San Angelo. An irrigation canal is sometimes used to provide water to Concho River watershed farmers. No interbasin transfers are known to exist.

Methods

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

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad, and Threadfin Shad were collected by electrofishing (1.2 hours at 14, 5-min stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Ages for Largemouth Bass were determined using otoliths from 13 randomly-selected fish (range 13.0 to 14.9 inches) and 33 randomly-selected fish (range 17.0 to 18.9 inches) during spring daytime electrofishing in 2017 and 2019.

Trap netting – Crappie were collected using trap nets (10 net nights at 10 stations). CPUE for trap netting was recorded as the number of fish caught per net night (fish/nn). Ages for crappie were determined using otoliths from 13 randomly-selected fish (range 9.0 to 10.9 inches).

Gill netting – Catfish species, White Bass, and Palmetto Bass were collected by gill netting (10 net nights at 10 stations). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn).

Tandem hoop nets – Channel Catfish were collected using 9 tandem hoop-net series at 9 stations. Nets were baited with soap and deployed for 2-night soak durations. CPUE for tandem hoop netting was recorded as the number of fish caught per tandem hoop net series (fish/series).

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). Palmetto 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 X SE of the estimate/estimate) was calculated for all CPUE and creel statistics. For White Crappie, total annual mortality was estimated using a recruitment adjusted catch curve described by Miranda and Bettoli (2007). Growth was estimated using a Von Bertalanffy growth curve (Isely and Grabowski 2007).

Creel survey – A roving creel survey was conducted from 2018 through 2019. The creel period was June through May. Angler interviews were conducted on 5 weekend days and 4 weekdays per quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Habitat – A structural habitat survey was last conducted in 2003. A vegetation survey was conducted in 2018. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Water level – Source for water level data was the Texas Water Development Board (TWDB 2019).

Results and Discussion

Habitat: The most recent structural habitat survey results can be found in Van Zee (2003) and has remained relatively unchanged. In 2018 there were 115 acres of native emergent plants and 11 acres of floating-leaved plants (Table 6). Due to very turbid waters, no submerged vegetation was present. Vegetation levels were very similar to past surveys and there is little variation from year to year. The City of San Angelo conducts limited herbicide applications for the purposes of maintaining boating and bank access.

Creel: Directed fishing effort by anglers was highest for Catfishes (53.6%), followed by anglers fishing for anything (19.7%), Largemouth Bass (16.2%), and White Crappie (9.1%) (Table 7). Total fishing effort at Nasworthy Reservoir was 81,662 hours (59 hours/acre) which was slightly lower than previous surveys. Total direct expenditures was $473,729 (Table 8). Eighty percent of angling effort was from bank anglers

(Table 8) owing in part to the seven city maintained parks along the reservoir with abundant bank access. ZIP code data showed that most anglers were local with 70% of all anglers traveling less than 25 miles to fish Nasworthy Reservoir. Twenty-one percent of anglers traveled over 100 miles to fish Nasworthy Reservoir. Nasworthy drew significant number of anglers from Midland/Odessa and other towns in West Texas (Appendix D).

Prey species: The electrofishing catch rate of Gizzard Shad was 238.3/h in 2018, which was lower than 426.0/h in 2016, but similar to 230.0/h in 2014 (Figure 2). Size structure continued to be poor with IOV of 35 in 2018 and 40 in 2016. IOV was high in 2014 due to a combination of high reservoir inflows that improved productivity and a mild golden alga fish kill that reduced shad population density and produced a strong year-class. Historically, IOV has been poor in Lake Nasworthy. Threadfin Shad continued to be present in the reservoir in low abundance. Bluegill catch rates were 157.7/h in 2018, which was lower than 375.0/h in 2016 and 246.0/h in 2014. Most fish ranged from two to six inches and size structure has remained consistent for the past 3 surveys (Figure 3). Less than 1% of all angling effort was for sunfish and anglers harvested an estimated 2,064 Bluegill.

Catfishes: Blue Catfish continued to be present in Lake Nasworthy in low abundance. Total gill net catch rate was 0.8/nn in 2019, slightly lower than 2.4/nn in 2013 (Figure 4). Blue Catfish up to 28 inches were collected and large fish were in excellent condition.

Gill net catch rate of stock size Channel Catfish was 4.8/nn in 2019, slightly lower than 6.8/nn in 2013, but higher than 2.2/nn in 2011. Size structure was excellent in 2018 with a PSD of 52 and PSD-P of 8 (Figure 5). Channel Catfish up to 26 inches were collected. Condition of Channel Catfish generally increased with increasing fish length and fish over 20 inches had relative weights over 100.

Tandem hoop nets were used on Lake Naswothy for the first time in spring 2019. Catch rate of stock size Channel Catfish was 3.2/series. Sizes of fish ranged from 7 to 16 inches. The tandem hoop nets failed to collect larger Channel Catfish. Although this was only one sample, it appears gill nets provide a better representation of Channel Catfish in Lake Nasworthy.

Flathead Catfish were present in the reservoir. Eleven Flathead Catfish were sampled during spring gill netting in 2019 with fish ranging from 16 to 30 inches long. Flathead Catfish were in adequate condition with most fish with relative weights ranging from 90 to 100.

Catfishes were the most sought after species by anglers in Nasworthy Reservoir with 43,730 hours of directed effort (32 hours/acre), of which nearly all was for Channel Catfish (Table 9). Anglers harvested an estimated 4,502 Channel Catfish and observed fish ranged from 11 to 27 inches in length (Figure 6), while only 39 Blue Catfish were estimated to be harvested. An estimated 136 Flathead Catfish were harvested. Overall effort and harvest levels were similar to previous creel surveys.

White Bass: White Bass continue to be present in Lake Nasworthy in low abundance. Gill net catch rate was 1.0/nn in 2019 and was similarly low to past surveys (Figure 7). Fish up to 14 inches were observed in the survey. Less than 1% of all angling effort was for White Bass and 169 were estimated to be harvested with fish ranging from 10-11 inches in length.

Palmetto Bass: Total gill net catch rate in 2019 was 9.2/nn, of which nearly all were from a stocking in spring 2018 (Figure 8). Most fish ranged from 7 to 10 inches, while one fish at 23 inches was collected. Prior to 2018, Palmetto Bass had not been stocked since 2007, indicating the 23 inch Palmetto Bass was at least 12 years old.

Largemouth Bass: The electrofishing catch rate of stock-length Largemouth Bass was 42.9/h in 2018, lower than the 88.0/h in 2016, but similar to 37.0/h in 2014. Size structure was poor as PSD was 26 each of the past three surveys, while PSD-P ranged from 12 to 22 (Figure 9). Growth of Largemouth Bass in Nasworthy Reservoir was below average; average age at 14 inches (13.0 to 14.9 inches) was 4.1 years (N = 34; range = 4 – 6 years) in spring 2017 and 4.4 years (N = 21; range 4 – 5 years) in spring 2019. Average age at 18 inches (17.0 to 18.9 inches) was 5.7 years (N = 35; range = 4 – 12 years) in spring 2017 and 5.4 years (N = 9; range 5 – 7 years) in spring 2019. Condition was poor for smaller Largemouth Bass, but improved with increasing fish length. In 2018, bass below the slot limit (< 14 inches) had mean

relative weights ranging from 77 to 87. However, most bass above the slot (≥ 18 inches) had relative weights greater than 100. While the poor Gizzard Shad IOV limits the food availability for smaller bass, it appears that bass over 18 inches are taking advantage of the abundant Gizzard Shad from 8-10 inches.

Largemouth Bass were the second most sought after species in Nasworthy Reservoir, and the most popular for boat anglers. 13,324 hours of angling effort was directed at Largemouth Bass, of which 1101 hours were tournament effort (Table 10). An estimated 556 Largemouth Bass were harvested by non-tournament anglers and ranged from 12 to 19 inches (Figure 10). Since the implementation of the slot length limit in 2015, bass harvest has increased. Total bass harvest was nearly double previous surveys, but overall harvest was still low at 0.4 bass per acre. Tournament anglers caught an estimated 532 Largemouth Bass, which were later released.

White Crappie: Trap net catch rates of stock size White Crappie were 16.0/nn in 2018, similar to 18.9/nn in 2017 and 17.6/nn in 2016. Size structure has been consistent over the past 3 surveys with PSD ranging from 56 to 66 and PSD-P from 12 to 19 (Figure 11). Condition of White Crappie continued to be poor with relative weights below 90 for most legal size fish (Figure 11). Growth of White Crappie was slow in 2018, mean age at length at 10 inches was 3.5 years (N = 13, range 2-4 years). This was slower than 2.0 years in 2016 (N = 33, all 2 years) and 2.3 years in 2012 (N = 26, range 1-5), but identical to 3.5 years in 2010 (N = 10, range 2-7) and 2008 (N = 10, range 2-5).

Anglers spent an estimated 7,443 hours fishing for White Crappie during the 2018/2019 creel survey (Table 11). This was much higher than previous surveys. Anglers harvested an estimated 1,105 crappie and most were 10-11 inches in length (Figure 12). Fifty-nine percent of all legal size White Crappie were released, which is fairly high for crappie. It is suspected that anglers were releasing legal-size crappie due to their inability to catch enough crappie to make it worth their time to keep and clean. The ratio of sub-legal to legal size White Crappie in the creel survey was 7.1 to 1, thus 12% of all angler caught White Crappie were legal size.

A category 4 growth survey was conducted in 2017 to obtain growth and mortality estimates. A total of 568 stock size fish were collected and 10 White Crappie per 10 mm length group were retained for aging. A total of 214 crappie were aged and an age-length key was used to assign ages to un-aged crappie. Fish collected ranged from 0-5 years and age structure was dominated by age-3 crappie produced in 2014. Because of this large year-class, the assumption of equal recruitment was violated and a standard catch curve was not suitable. To estimate total annual mortality, estimates of year-class strength from past surveys were used to adjust for unequal recruitment (Miranda and Bettolli 2007). However, this limited the catch curve to using only three data points (Appendix C). The recruitment adjusted catch curve estimated total annual mortality to be 68% (Z = -1.1407, R^2 = 0.98) (Appendix C). The Von Bertalanffy growth curve provided a good fit for the length-at-age data (Appendix C). The Von Bertalnaffy growth equation predicted that White Crappie would reach legal size (10 inches) in 3.4 years.

Fisheries Management Plan for Nasworthy Reservoir, Texas

Prepared – July 2019

ISSUE 1: The White Crappie population in Lake Nasworthy has long been characterized by high abundance, slow growth, poor condition, high natural mortality, and limited numbers of legal size fish. Due to high natural mortality and slow growth, most crappie die before reaching 10 inches. Anglers have expressed dissatisfaction with the crappie fishing on Lake Nasworthy. Removal of the 10-inch minimum length limit could improve angler satisfaction as well as reduce intraspecific competition within the White Crappie population.

MANAGEMENT STRATEGY

1. Recommend removal of the 10-inch minimum length limit, but maintain the 25 fish daily bag.
2. Evaluate White Crappie harvest with a roving creel survey from June 2022 to May 2023.

ISSUE 2: The Gizzard Shad population has a history of poor size structure and low IOV. As a result White Crappie and Largemouth Bass have had poor relative weights. Hybrid Striped Bass have been used to restructure Gizzard Shad populations in other Texas Reservoirs and we will attempt to do so on Nasworthy Reservoir. Palmetto Bass were stocked at 75 fish/acre in spring 2018 and 40 fish/acre in 2019.

MANAGEMENT STRATEGIES

1. Request Palmetto Bass fingerlings at 75 fish/acre in 2020.
2. Evaluate stocking success with gill netting in spring 2021 and 2023.
3. Monitor Changes in the Largemouth Bass, White Crappie, and Gizzard Shad populations with fall electrofishing and trap netting from 2020 and 2022.

ISSUE 3: Overall, Largemouth Bass are the second most sought after species at Lake Nasworthy and most popular among boat anglers. Currently, Largemouth Bass are managed with a 14 to 18 inch slot limit. Additional sampling is needed to assess the special regulation.

MANAGEMENT STRATEGY

1. Monitor the Largemouth Bass population with fall electrofishing from 2020 and 2022.
2. Evaluate Largemouth Bass harvest with a roving creel survey from June 2022 to May 2023.

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

MANAGEMENT STRATEGIES

1. Cooperate with the City of San Angelo 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.

Objective-Based Sampling Plan and Schedule (2019–2023)

Sport fish, forage fish, and other important fishes

Sport fishes in Nasworthy Reservoir include catfish species, White Bass, Palmetto Bass, Largemouth Bass, and White Crappie. Known important forage species include Bluegill and Gizzard Shad.

Low-density fisheries

Blue and Flathead Catfish: While both are present in the reservoir, gill net catch rates are low. Although, anglers fishing for "any catfish" is high, we did not document any directed effort for Flathead Catfish and very little for Blue Catfish (< 0.5%) in the 2018-2019 creel survey. Sampling these populations is unnecessary in FY 2019-2023.

White Bass: White Bass are present in low numbers (0.2-1.4/nn in past four surveys) and received less than 1% of all angling effort. Sampling these populations is unnecessary in FY 2019-2023.

Survey objectives, fisheries metrics, and sampling objectives

Channel Catfish: Channel Catfish are the most sought after species in Nasworthy Reservoir with 53.6% of all directed effort for catfish. Gill net catch rates of Channel Catfish have ranged from 3.5/nn to 9.5/nn for the past 21 years. Survey objectives will be abundance, size structure, and condition. Data from gill netting from 2009-2019 indicates an RSE ≤ 25 would be achieved with 6-10 gill nets, while 50 stock size fish would be collected in 8 to 16 gill nets (calculated with 80% confidence). As per the Palmetto Bass sampling effort, we will sample with 10 randomly selected gill net sets in 2021 and 2023 (Table 12). No additional sampling will be conducted beyond the original 10 random stations.

Palmetto Bass: Palmetto Bass have been stocked in Nasworthy Reservoir for the purpose of restructuring the Gizzard Shad population. Palmetto Bass were stocked in spring 2018 and 2019 at 75 and 40 fish/acre, respectively. Palmetto Bass will be requested at 75 fish/acre in 2020. Survey objectives will be to monitor stocking success, condition, and length frequency. We will sample with 10 randomly selected gill net sets in spring 2021 and 2023 to monitor the Palmetto Bass population (Table 12).

Largemouth Bass: Largemouth Bass are second most sought after species and most popular among boat anglers during the 2018-2019 creel survey. Largemouth Bass are managed with a 14 to 18 inch slot limit. Annual monitoring with fall electrofishing is necessary to monitor large-scale changes in the population due the special harvest regulation and recent Palmetto Bass stockings. Survey objectives are to monitor abundance, size structure, condition, and growth. A minimum of 12 randomly selected 5-min electrofishing sites will be sampled in fall 2020 and 2022 (Table 12), but sampling will continue at random sites until 50 stock-size fish are collected and the RSE of CPUE-Stock is < 25 (the anticipated effort to meet both sampling objectives is 12-15 stations with 80% confidence). Exclusive of the original 12

random stations, 6 additional random stations will be pre-determined in the event extra sampling is necessary. A maximum of 18 stations will be sampled. Otoliths from 13 fish between 13.0 and 14.9 inches will be collected to determine mean age at 14 inches.

White Crappie: White Crappie in Nasworthy Reservoir are the third most sought after species in the 2018-2019 creel survey. The White Crappie population is characterized by high abundance, poor size structure, condition, and growth. Annual surveys are needed to assess the effects of recent management actions (Palmetto Bass stocking and possible regulation change) on the White Crappie population. Our objectives are to monitor trends in abundance, size structure, condition, and growth. Analysis of historical trap net data from 1998-2018 indicates that a CPUE-Stock with an RSE ≤ 25 and collection of 50 stock size crappie would be achieved most years with 10 net nights. Ten randomly selected trap net sites will be sampled in 2020 and 2022 (Table 12). Otoliths from 13 fish between 9.0 and 10.9 inches will be collected to determine mean age at 10 inches each year. No additional sampling will be conducted beyond the original 10 random stations.

Bluegill and Gizzard Shad: Sunfish, Gizzard Shad, and Threadfin Shad are important forage fish in Nasworthy Reservoir. Over the past three surveys, total catch rates of Bluegill have ranged from 157.7 fish/h to 374.0 fish/h while Gizzard Shad have ranged from 230.0 fish/h to 426.0 fish/h. Threadfin Shad are present in lower abundance. Continuation of sampling, as per Largemouth Bass above, will allow for monitoring of large-scale changes in Bluegill and Gizzard Shad relative abundance and size structure. Sampling effort based on achieving sampling objectives for Largemouth Bass should result in sufficient numbers of Bluegill and Gizzard Shad for size structure estimation (PSD and IOV; 50 fish minimum with 80% confidence) and relative abundance estimates (RSE < 25 of CPUE-Total). If the target for Bluegill and Gizzard Shad sampling is not attained, no additional effort will be expended to achieve an RSE≤25 for CPUE.

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Tables and Figures

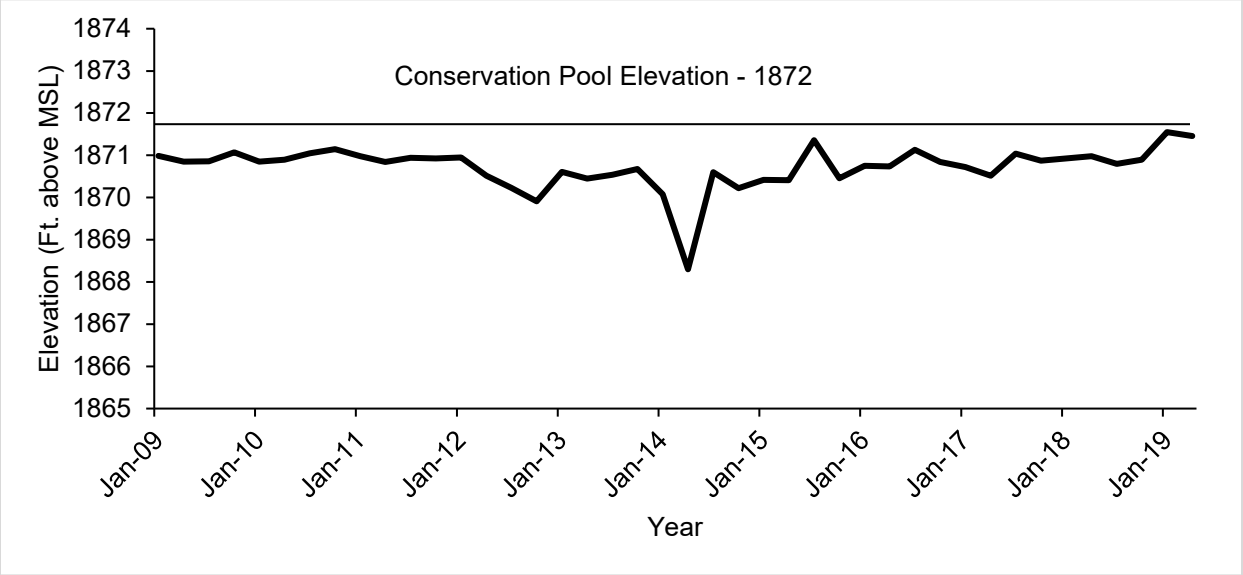


Figure 1. Quarterly water level elevations in feet above mean sea level (MSL) recorded for Nasworthy Reservoir, Texas.

Table 1. Characteristics of Nasworthy Reservoir, Texas.

Characteristic	Description
Year constructed	1930
Controlling authority	City of San Angelo
County	Tom Green
Drainage basin	Colorado River Basin
Reservoir type	Tributary
Shoreline Development Index	7.01
Conductivity	1,250 µmhos/cm

Table 2. Boat ramp characteristics for Nasworthy Reservoir, Texas, August, 2018. Reservoir elevation at time of survey was 1,870.5 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
Red Bluff Road	31.38603 -100.5045	Y	2	unknown	Poor (closed, needs repair)
Spring Creek Marina W	31.3771 -100.5129	Y	5	1865	Excellent, no access issues
Spring Creek Marina E	31.3786 -100.5068	Y	5	1867	Excellent, no access issues
Middle Concho Park W	31.37856 -100.5208	Y	3	1867	Excellent, no access issues
Middle Concho Park E	31.37803 -100 5121	Y	5	1865	Excellent, no access issues
Fisherman's Road	31.37283 -100.4968	Y	10	1867	Excellent, no access issues
Bass Club Lagoon	31.37558 -100.4912	Y	3	1867	Excellent, no access issues
Nasworthy Marina	31.37731 -100.4899	Y	3	1867	Excellent, no access issues
Goodfellow AFB	31.37817 -100.4859	Y	3	1867	Excellent, no access issues
Pecan Creek North	31.36772 -100.4812	Y	20	1867	Excellent, no access issues
Pecan Creek South	31.36281 -100.4762	Y	5	1868	Excellent, no access issues
Knickerbocker North	31.39763 -100.4841	Y	20	1867	Excellent, no access issues
Power Plant	31.39201 -100.4895	Y	25	1866	Excellent, no access issues

Table 3. Harvest regulations for Nasworthy Reservoir, Texas.

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

Table 4. Stocking history of Nasworthy Reservoir, Texas. FRY =<1 inch; FGL = fingerling; ADL = adult, and UNK = unknown.

Species	Year(s) Stocked	Number of Years	Number Stocked	Size
Threadfin Shad	1984	1	8,800	UNK
Channel Catfish	1966–1974	8	148,425	UNK
	1975-2012	4	37,650	FGL
	2011	1	157	ADL
Palmetto Bass	1974-1982	6	90,373	UNK
	1994-2007	12	212,545	FGL
	2018	1	101,800	FGL
	2019	1	41,544	FGL
Bluegill	2010	1	360	ADL
Redear Sunfish	1970	1	4,900	UNK
Largemouth Bass	1968-1972	4	364,140	UNK
	1993	1	145	ADL
	1997	1	52,600	FGL
Florida Largemouth Bass	1990	1	159,799	FRY
	1980-1995	4	529,394	FGL
	1995	2	2,331	ADL
White Crappie	1972	1	16,000	UNK
Green x Redear Sunfish	1966	1	14,700	UNK
Red Drum	1984-2002	11	1,912,854	FGL

Table 5. Objective-based sampling plan components for Nasworthy Reservoir, Texas 2018–2019.

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
	Age-and-growth	Age at 18 inches	N = 33, 17.0 – 18.9 inches
	Condition	W_r	10 fish/inch group
Bluegill [a]	Abundance	CPUE–Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
Gizzard Shad [a]	Abundance	CPUE–Total	RSE ≤ 25
	Size structure	PSD, length frequency	N ≥ 50
	Prey availability	IOV	N ≥ 50
Trap netting			
Crappie	Abundance	CPUE–Stock	RSE-Stock ≤ 25
	Size structure	PSD, length frequency	N = 50
	Age-and-growth	Age at 10 inches	N = 13, 9.0 – 10.9 inches
Tandem hoop netting			
Channel Catfish	Abundance	CPUE–stock	RSE-Stock ≤ 25
	Size structure		N ≥ 50 stock

[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of 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 aquatic vegetation, Nasworthy Reservoir, Texas, 2006–2018. Surface area (acres) is listed with percent of total reservoir surface area in parentheses.

Vegetation	2006	2014	2018
Native submersed	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Native floating-leaved	Unknown	8.0 (0.6)	11.0 (0.8)
Native emergent	92.0 (6.7)	115.0 (8.3)	115.0 (8.3)

Table 7. Percent directed angler effort by species for Nasworthy Reservoir, Texas, 2003-2004, 2015, and 2018–2019. Survey periods were from, 1 September 2003 through 31 August 2004, 1 March 2015 through 31 August 205, and 1 June 2018 through 31 May 2019.

Species	2003/2004	2015	2018/2019
Catfishes	44.8	43.6	53.6
White Bass	1.0	< 0.1	0.6
Palmetto Bass	0.4	0.0	0.0
Sunfishes	1.3	< 0.1	0.5
Largemouth Bass	12.0	13.7	14.9
White Crappie	4.8	1.9	9.1
Common Carp	< 0.1	< 0.1	0.4
Anything	35.8	33.5	19.7
Tournament	0.0	6.1	1.3

Table 8. Total fishing effort (h) for all species and total directed expenditures at Nasworthy Reservoir, Texas, 2003-2004, 2015, and 2018-2019. Survey periods were from, 1 September 2003 through 31 August 2004, 1 March 2015 through 31 August 205, and 1 June 2018 through 31 May 2019. Relative standard error is in parentheses.

Creel statistic	2003/2004	2015	2018/2019
Total fishing effort	103,424 (NA)	89,185 (16)	81,662 (12)
Boat	16,133 (NA)	23,273 (23)	16,531 (18)
Bank	87,921 (NA)	65,912 (19)	65,131 (14)
Total directed expenditures	$323,121 (NA)	$503,045 (33)	$473,729 (35)

Gizzard Shad

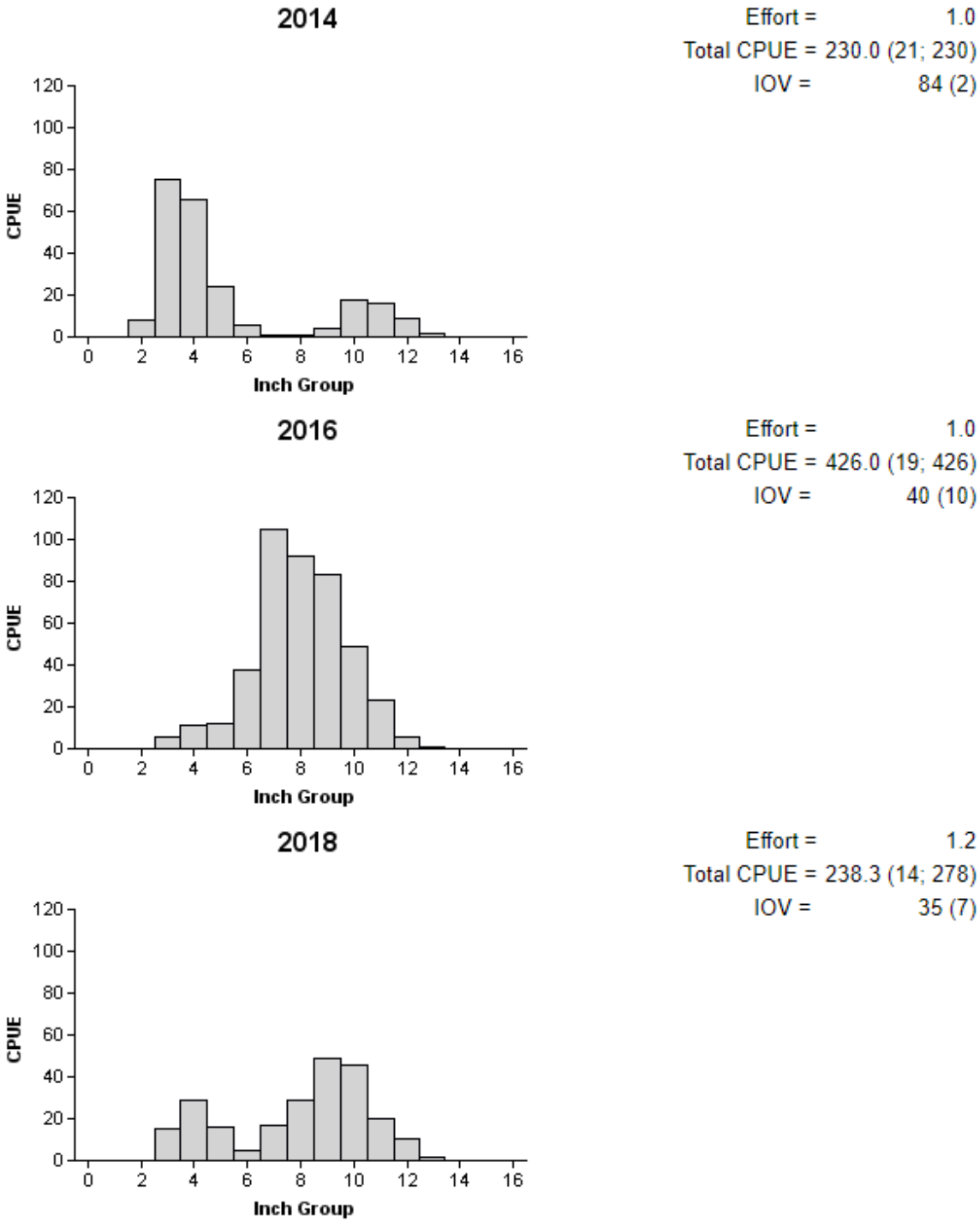


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Nasworthy Reservoir, Texas, 2014, 2016, and 2018.

Bluegill

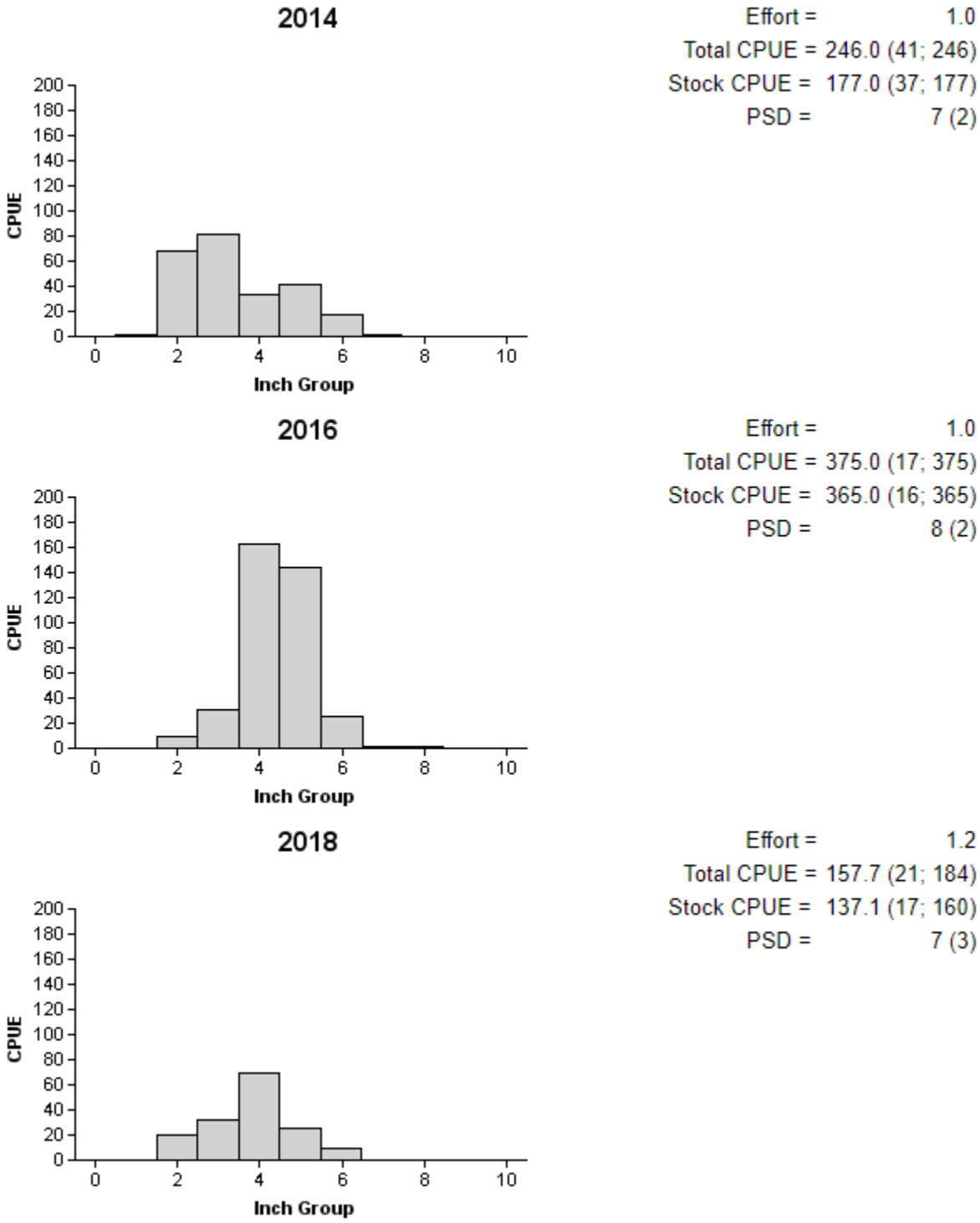


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Nasworthy Reservoir, Texas, 2014, 2016, and 2018.

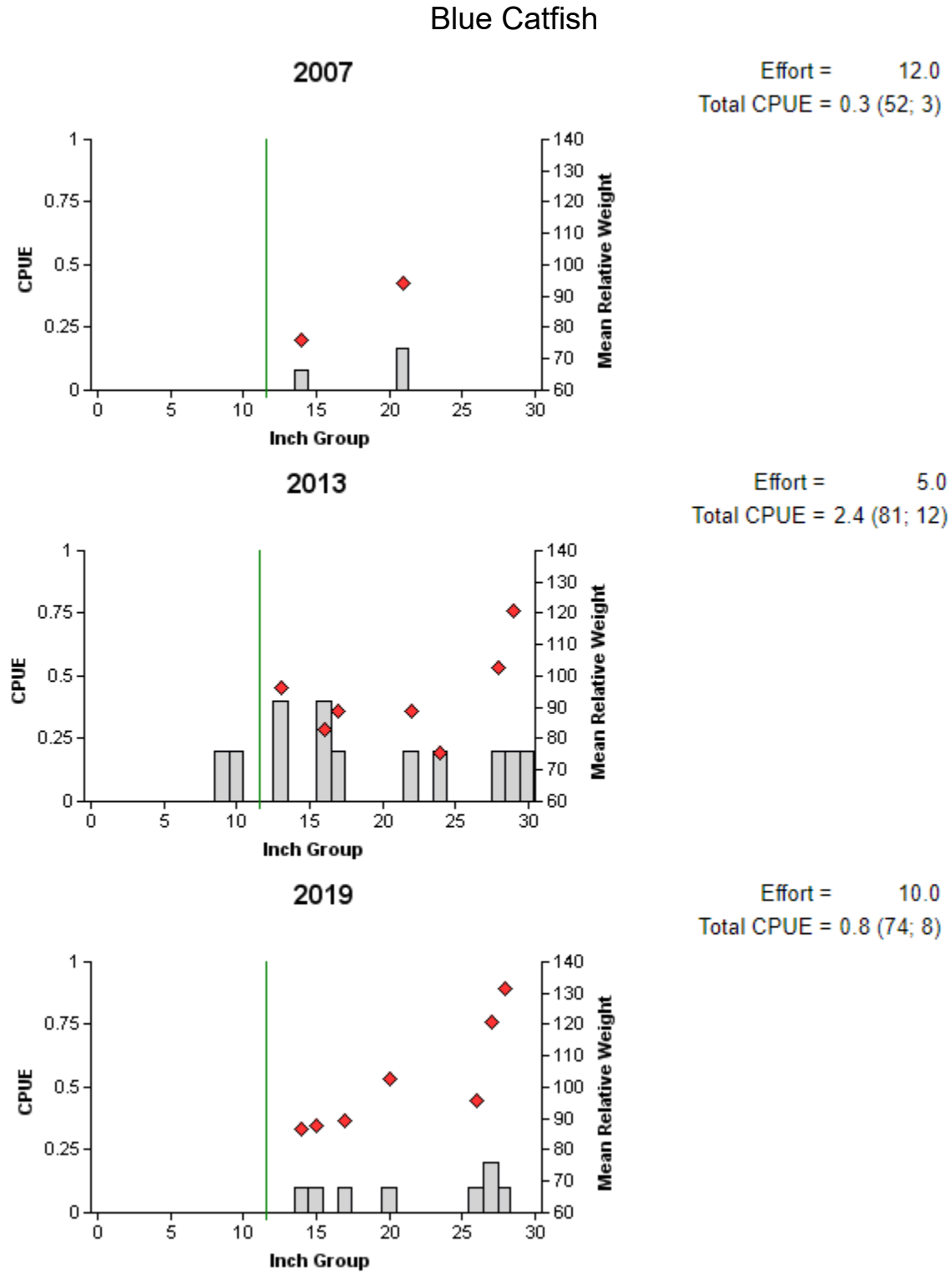


Figure 4. Number of Blue Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Nasworthy Reservoir, Texas 2007, 2013, and 2019. Vertical line indicates the minimum length limit.

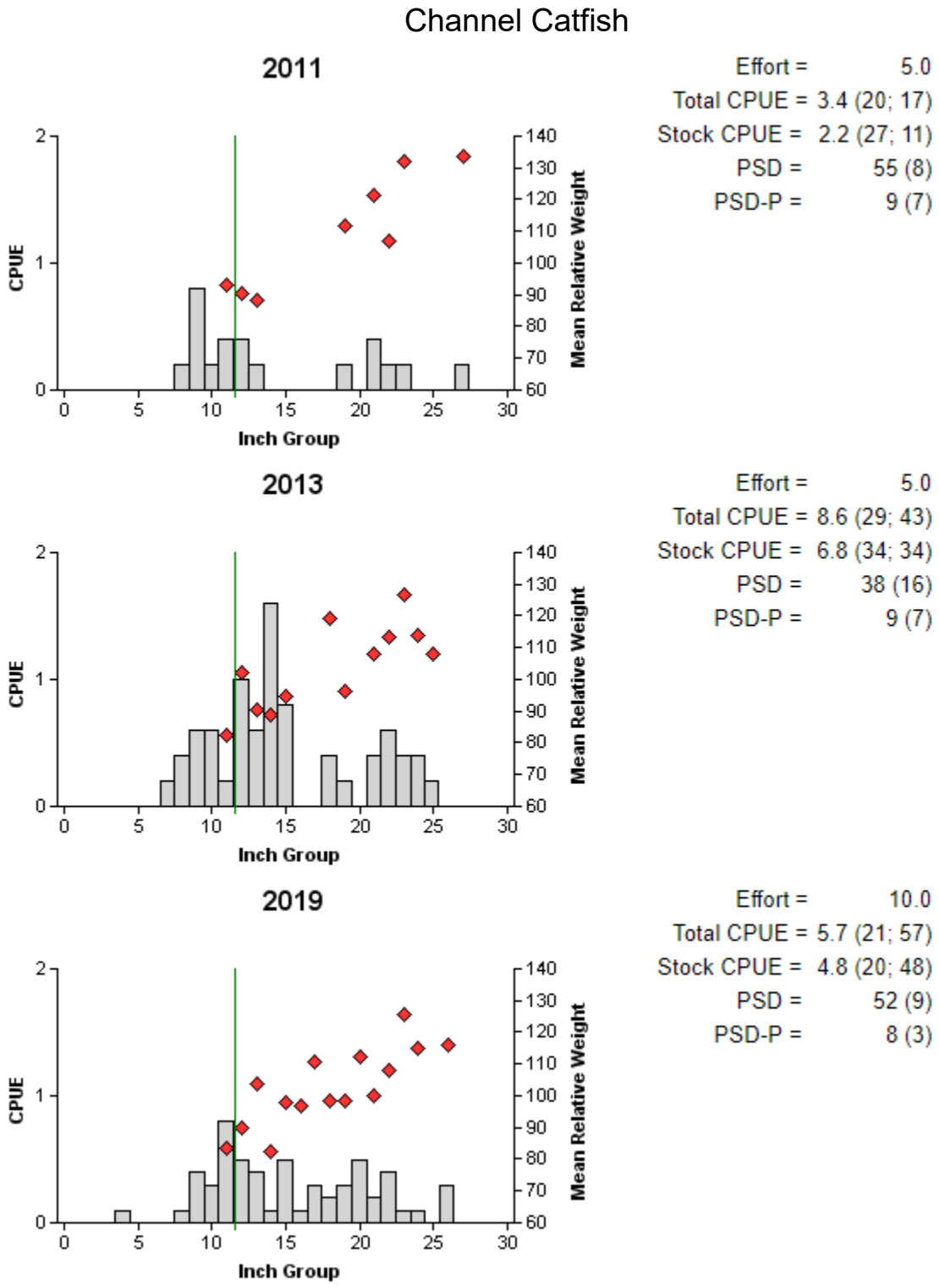


Figure 5. Number of Channel Catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Nasworthy Reservoir, Texas, 2011, 2013, and 2019. Vertical line indicates the minimum length limit.

Table 9. Creel survey statistics for Catfishes at Nasworthy Reservoir, Texas, from September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019. Total catch per hour is for anglers targeting Channel Catfish and total harvest is the estimated number of Channel Catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2003/2004	2015	2018/2019
Surface area (acres)	1,380	1,380	1,380
Directed effort (h)	44,580.10 (13)	38,874.14 (20)	43,730.06 (14)
Directed effort/acre	32.30 (13)	28.17 (20)	31.69 (14)
Total catch per hour	0.22 (36)	0.41 (38)	0.19 (45)
Total harvest	3,241.00 (45)	4278.36 (49)	4,677.77 (44)
Blue Catfish	0.00	51.58 (317)	39.49 (183)
Channel Catfish	3,241.00 (45)	4,105.25 (38)	4,502.35 (36)
Flathead Catfish	0.00	121.53 (315)	135.93 (270)
Harvest/acre	2.35 (45)	3.10 (49)	3.39 (44)
Percent legal released	9	13	41
Blue Catfish	NA	0	86
Channel Catfish	9	14	39
Flathead Catfish	NA	0	52

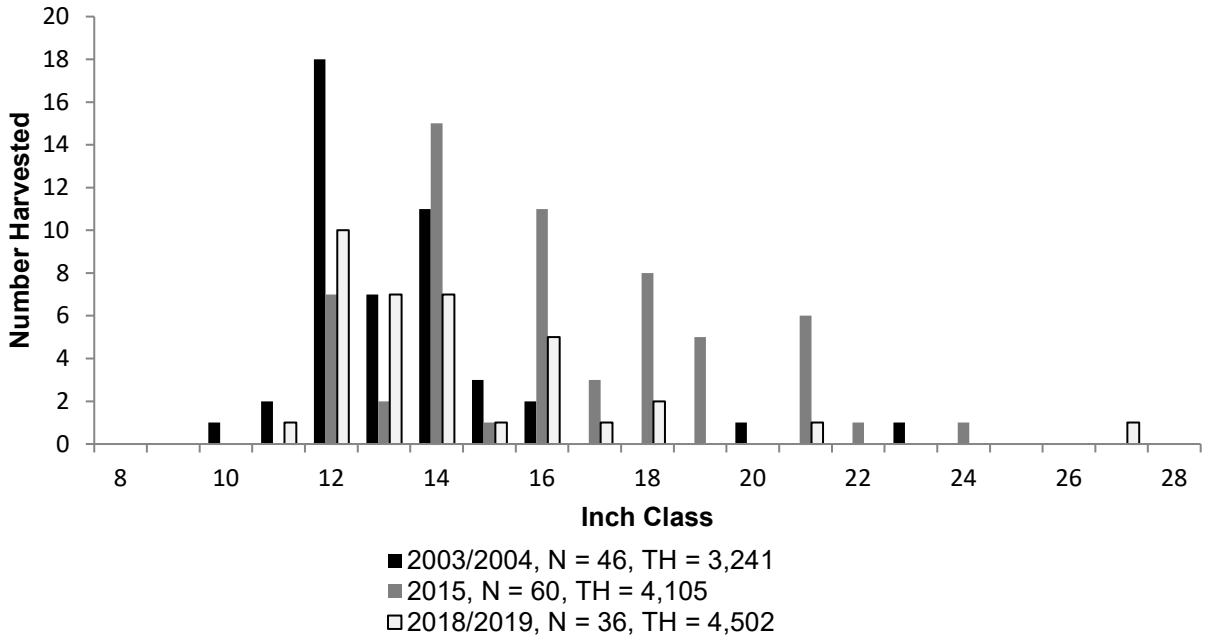


Figure 6. Length frequency of harvested Channel Catfish observed during creel surveys at Nasworthy Reservoir, Texas, September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019, all anglers combined. N is the number of harvested Channel Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

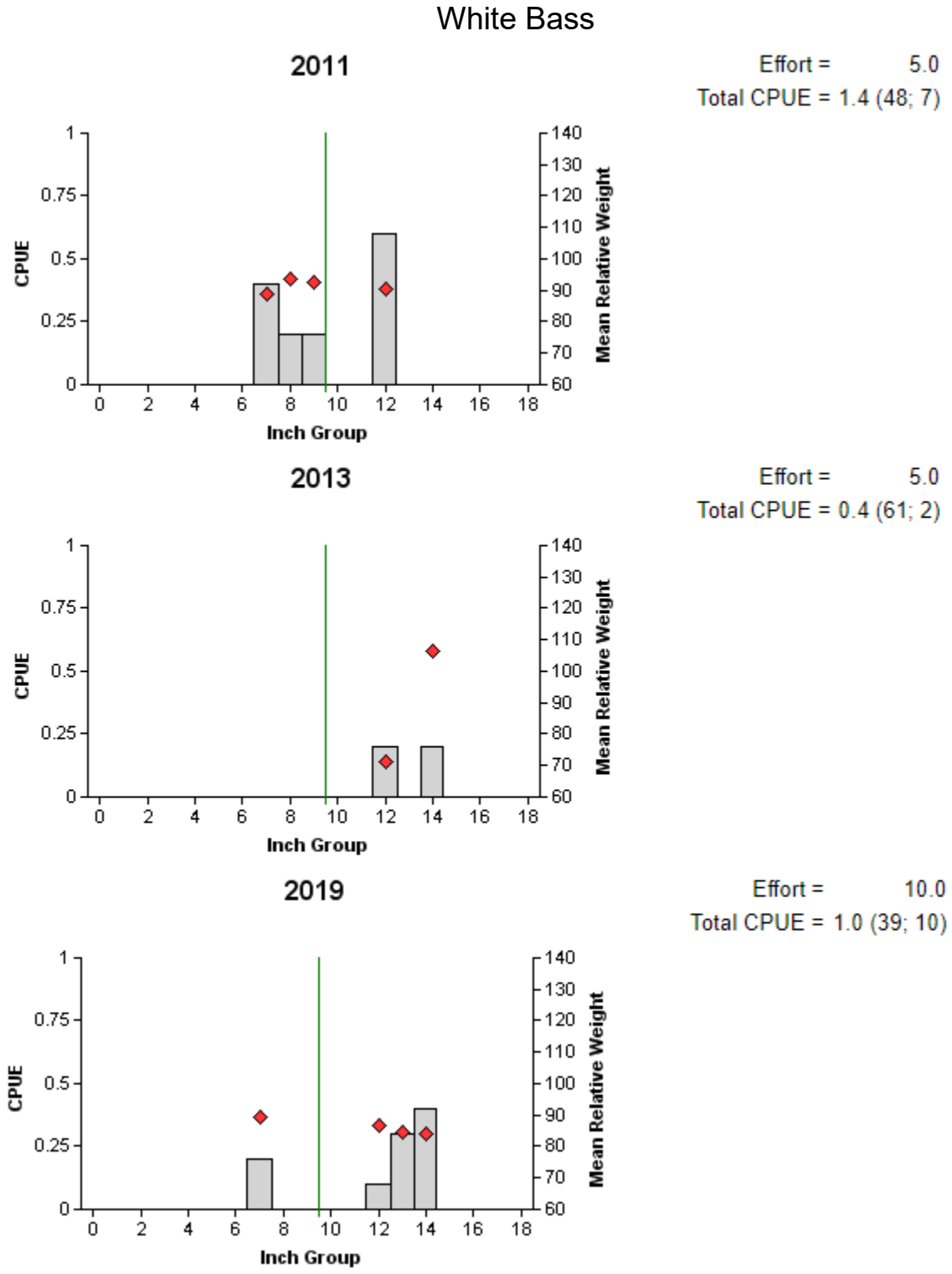


Figure 7. Number of White Bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Nasworthy Reservoir, Texas, 2011, 2013, and 2019. Vertical line indicates the minimum length limit.

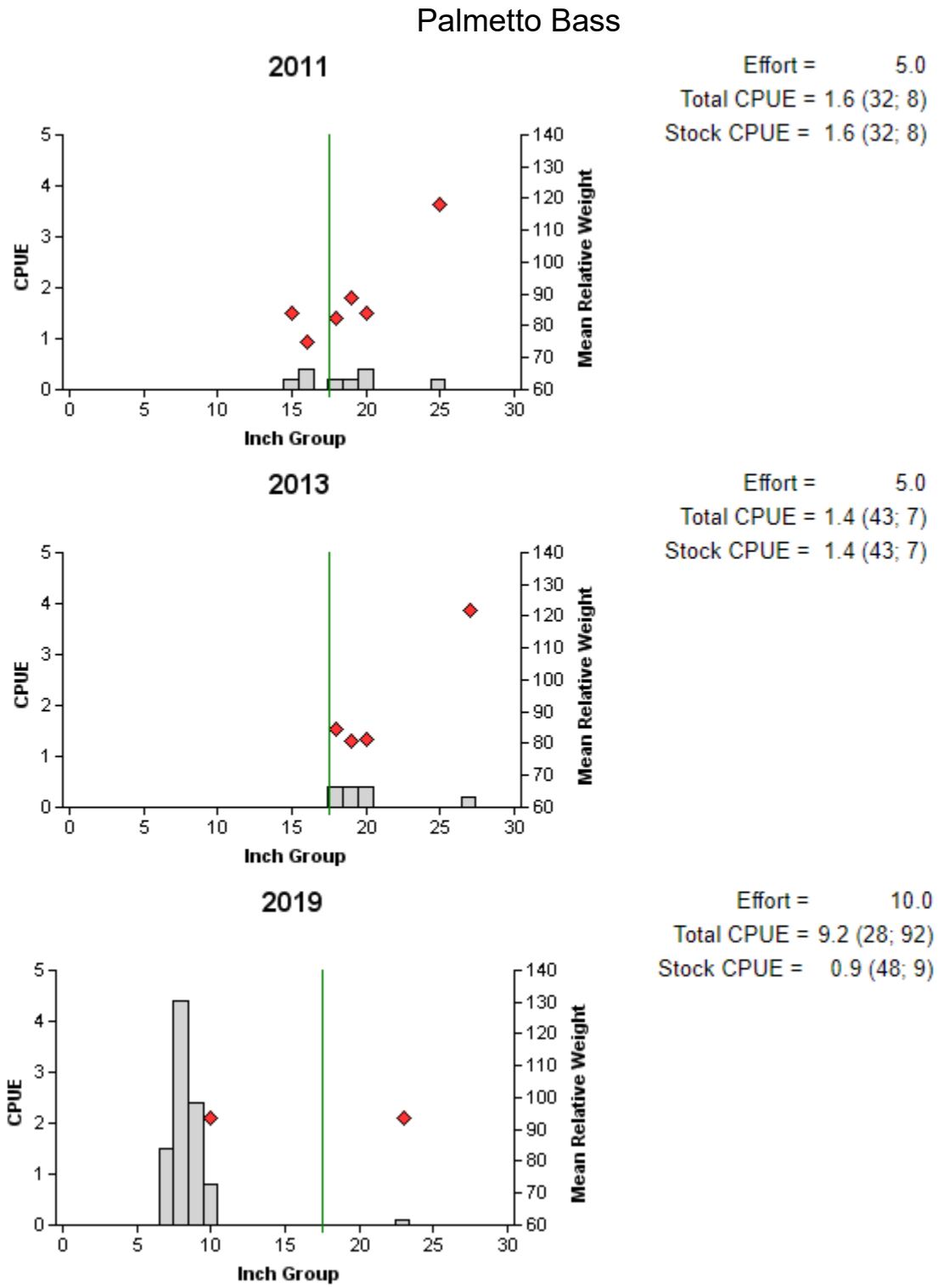


Figure 8. Number of Palmetto Bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Nasworthy Reservoir, Texas, 2011, 2013, and 2019. Vertical line indicates the minimum length limit.

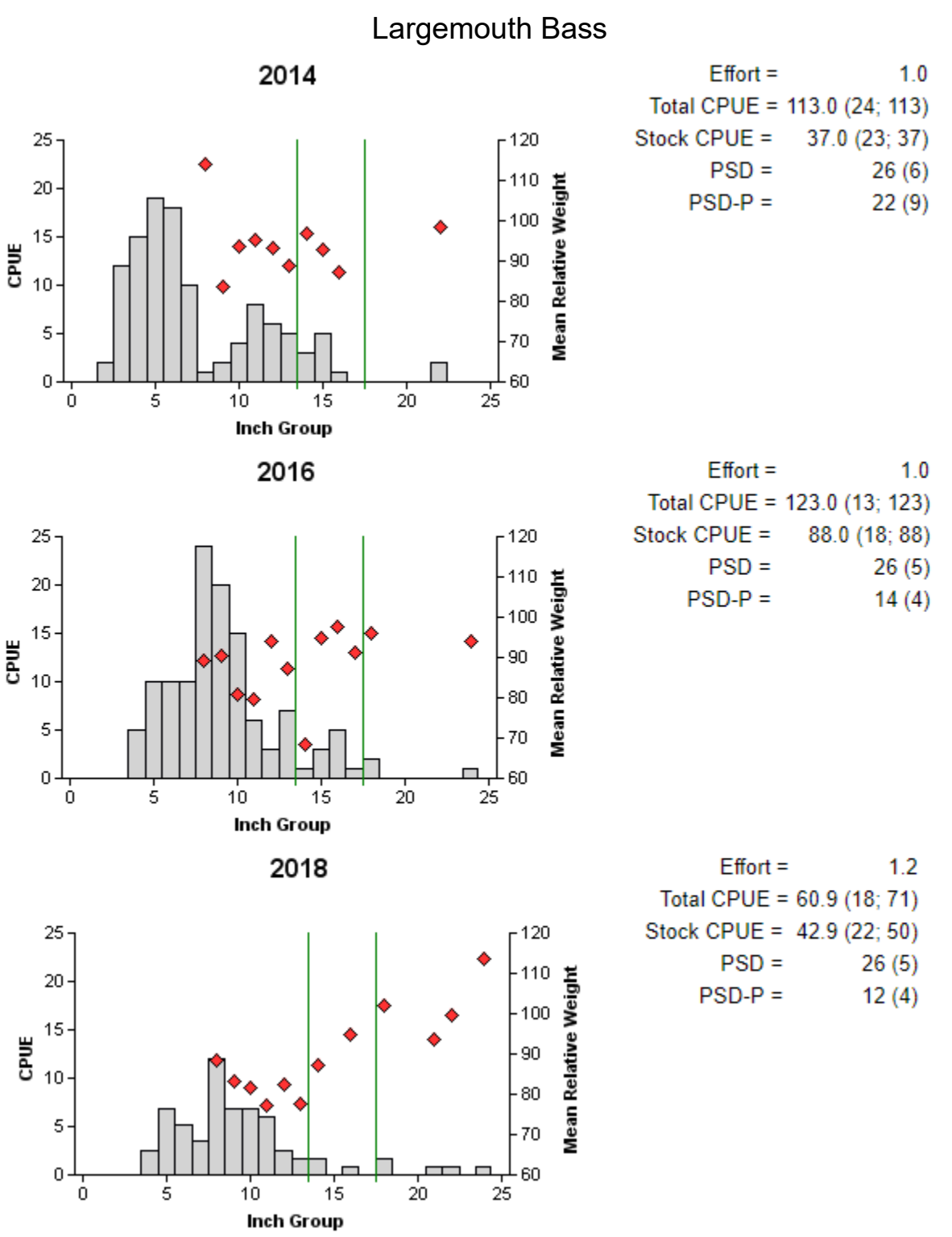


Figure 9. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Nasworthy Reservoir, Texas, 2014, 2016, and 2018. Vertical line indicates upper and lower slot length limits.

Table 10. Creel survey statistics for Largemouth Bass at Nasworthy Reservoir, Texas, from September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019. Catch rate is for all anglers targeting Largemouth Bass. Harvest is partitioned by the estimated number of fish harvested by non-tournament anglers and the number of fish retained by tournament anglers for weigh-in and release. The estimated number of fish released by weight category is for anglers targeting Largemouth Bass. Relative standard errors (RSE) are in parentheses.

Statistic	2003/2004	2015	2018/2019
Surface area (acres)	1,380	1,380	1,380
Directed angling effort (h)			
Tournament	NA	5,436.74 (29)	1,101.41 (51)
Non-tournament	NA	12,235.56 (21)	12,137.27 (17)
All black bass anglers combined	12,390.90 (15)	17,672.30 (23)	13,323.67 (18)
Angling effort/acre	9.0 (15)	12.8 (23)	9.7 (18)
Catch rate (number/h)	0.35 (52)	0.58 (25)	0.33 (41)
Tournament	NA	1.06 (22)	0.39 (44)
Non-tournament	NA	0.42 (37)	0.33 (45)
Harvest			
Non-tournament harvest	286 (53)	133 (114)	556 (73)
Harvest/acre	0.2 (53)	0.1 (114)	0.4 (73)
Tournament weigh-in and release	322 (53)	1904 (46)	532 (67)
Release by weight			
<4.0 lbs	NA	7,967 (44)	13,363 (53)
4.0-6.9 lbs	NA	54 (74)	847 (65)
7.0-9.9 lbs	NA	0	0
≥10.0 lbs	NA	0	0
Percent legal released (non-tournament)	64	88	96

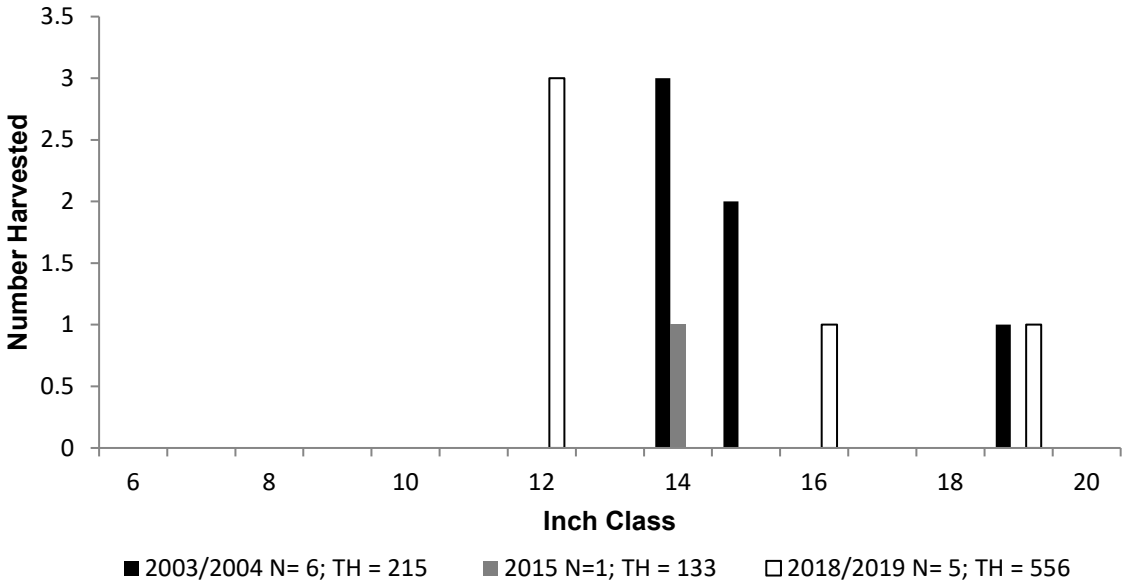


Figure 10. Length frequency of non-tournament harvested Largemouth Bass observed during creel surveys at Nasworthy Reservoir, Texas, September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and NTH is the estimated non-tournament harvest for the creel period.

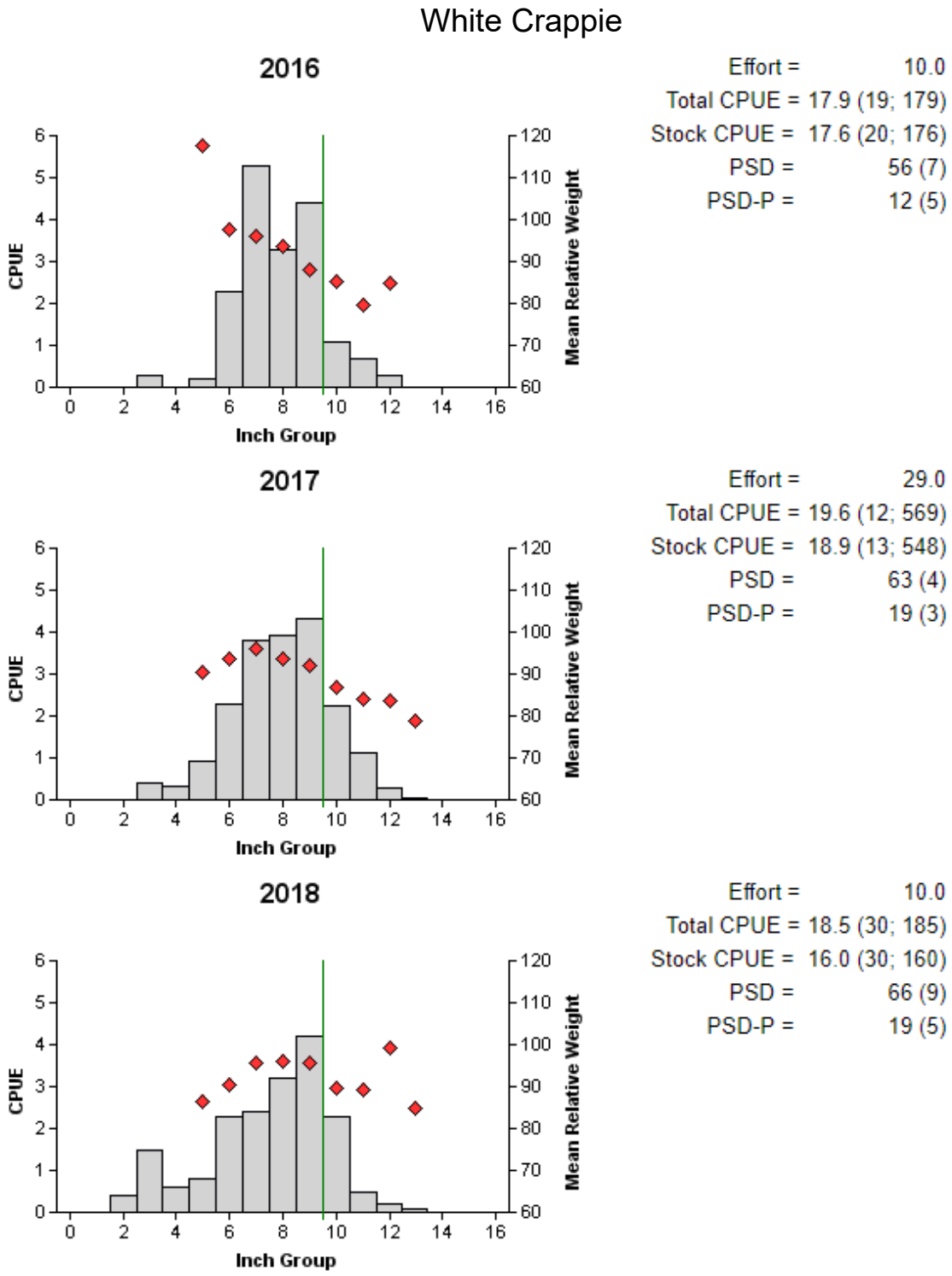


Figure 11. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Nasworthy Reservoir, Texas, 2016, 2017, and 2018. Vertical line indicates minimum length limit.

Table 11. Creel survey statistics for White Crappie at Nasworthy Reservoir, Texas, from September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019. Total catch per hour is for anglers targeting White Crappie and total harvest is the estimated number of White Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year		
	2003/2004	2015	2018/2019
Surface area (acres)	1,380	1,380	1,380
Directed effort (h)	4,937.60 (23)	1,715.80 (39)	7,443.22 (22)
Directed effort/acre	3.58 (23)	1.24 (39)	5.39 (22)
Total catch per hour	0.80 (64)	0.55 (95)	1.43 (56)
Total harvest	1,912.00 (51)	132.53 (244)	1,104.90 (56)
Harvest/acre	1.39 (51)	0.10 (244)	0.80 (56)
Percent legal released	0	71	59

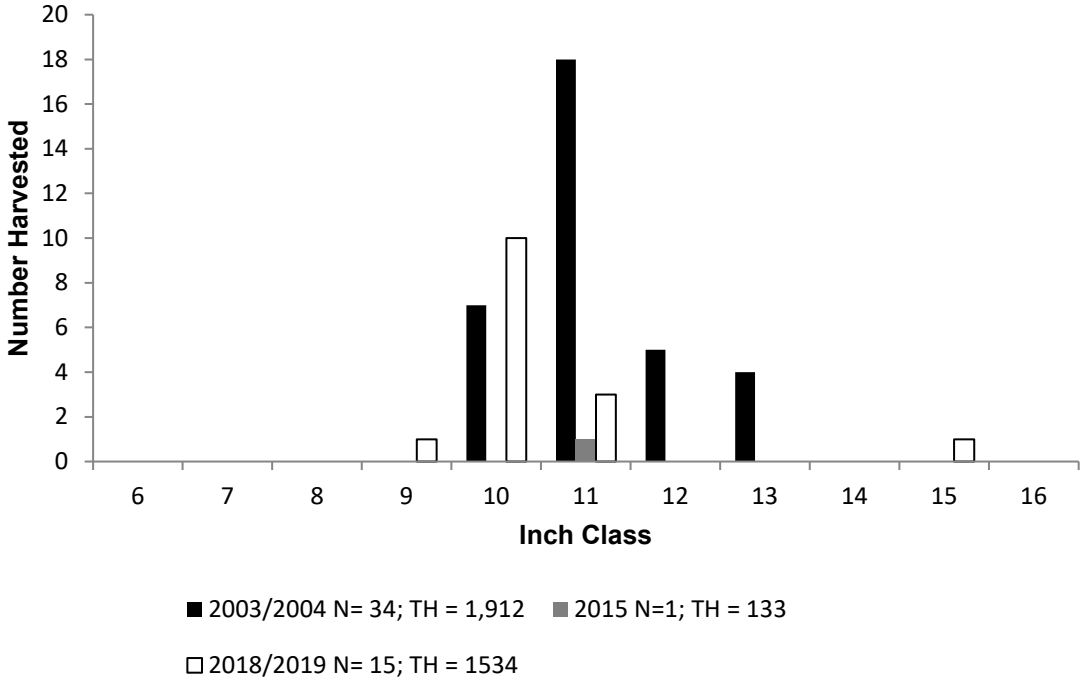


Figure 12. Length frequency of harvested White Crappie observed during creel surveys at Nasworthy Reservoir, Texas, September 2003 through August 2004, March 2015 through August 2015, and June 2018 through May 2019, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Proposed Sampling Schedule

Table 12. Proposed sampling schedule for Nasworthy 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			
	2019-2020	2020-2021	2021-2022	2022-2023
Angler Access				S
Structural Habitat				
Vegetation				S
Electrofishing – Fall		A		S
Trap netting		A		S
Gill netting		A		S
Creel survey				S
Report				S

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

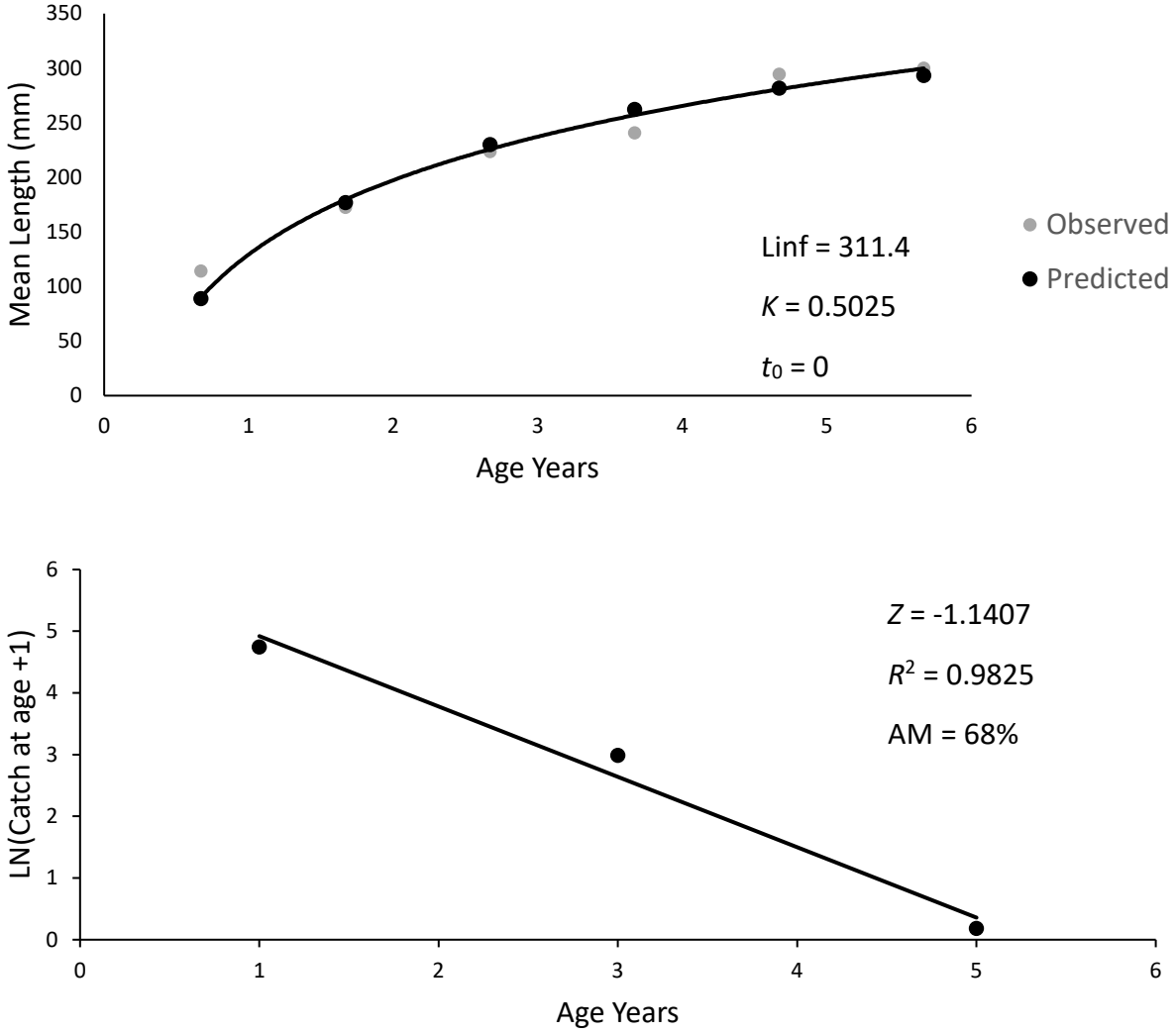
Number (N) and catch rate (CPUE) (RSE in parentheses) of all target species collected from all gear types from Nasworthy Reservoir, Texas, 2018-2019. Sampling effort was 10 net nights for gill netting, 10 net nights for trap netting, 1.2 hour for electrofishing, and 9 net series for hoop netting.

Species	Gill Netting		Trap Netting		Electrofishing		Hoop Netting	
	N	CPUE	N	CPUE	N	CPUE	N	CPUE
Gizzard Shad					278	238.3 (14)		
Threadfin Shad					19	16.3 (32)		
Blue Catfish	8	0.8 (74)						
Channel Catfish	57	5.7 (21)					54	6.0 (34)
Flathead Catfish	11	1.1 (39)						
White Bass	10	1.0 (39)						
Palmetto Bass	92	9.2 (28)						
Redbreast Sunfish					2	1.7 (68)		
Green Sunfish					3	2.6 (100)		
Warmouth					16	13.7 (26)		
Bluegill					184	157.7 (21)		
Longear Sunfish					60	51.4 (29)		
Redear Sunfish					6	5.1 (40)		
Largemouth Bass					71	60.9 (18)		
White Crappie			185	18.5 (30)				

APPENDIX B – Map of sampling locations

Location of sampling sites, Nasworthy Reservoir, Texas, 2018-2019. Trap net, gill net, hoop net, and electrofishing stations are indicated by T, G, H, and E, respectively. Water level was near full pool at time of sampling.

APPENDIX C – White Crappie growth and mortality

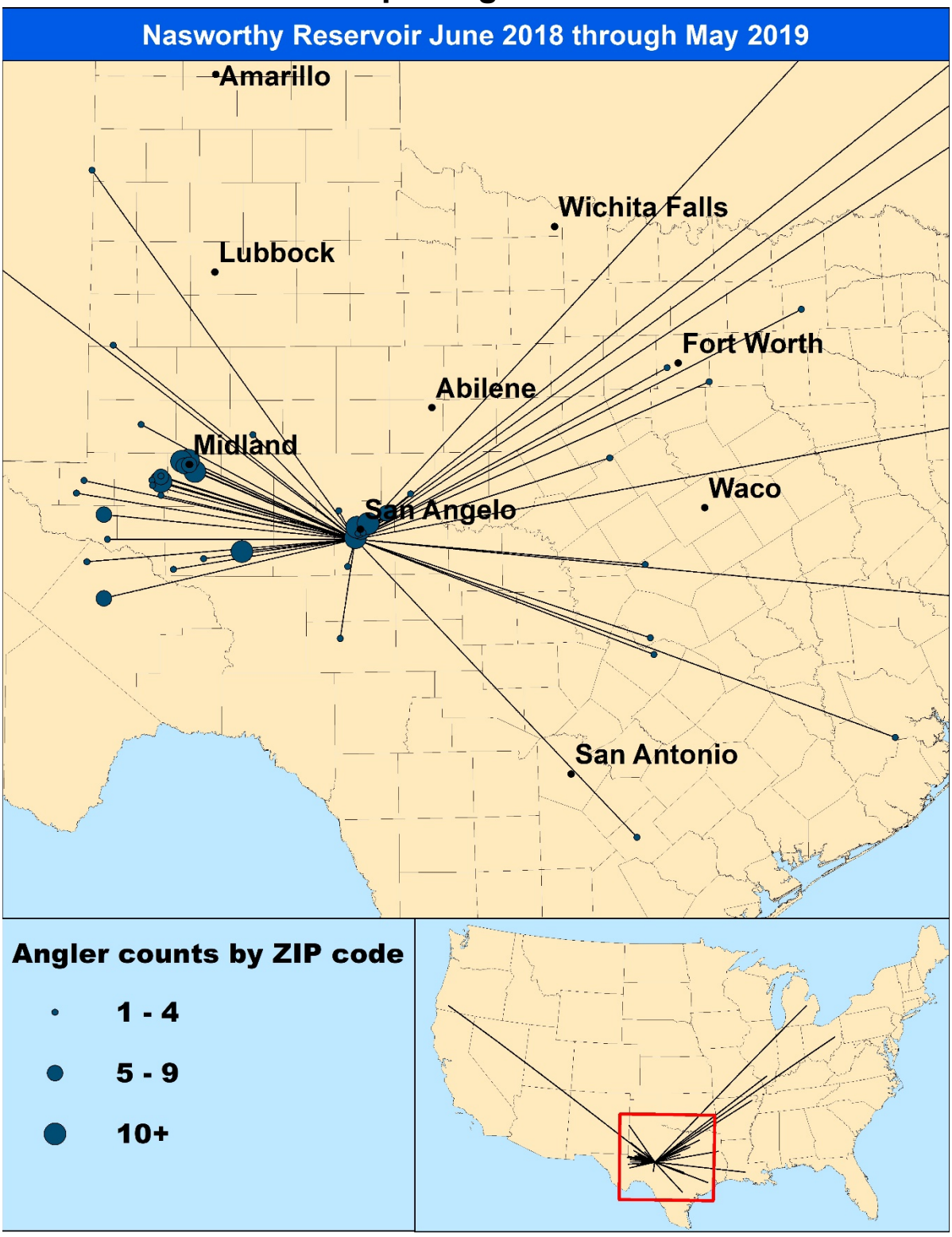


Von Bertalanffy growth model (top) and recruitment adjusted catch curve (bottom) for White Crappie collected from trap nets at Nasworthy Reservoir, Texas, December 2017.

Population parameters estimated from the White Crappie population from Nasworthy Reservoir, December 2017. White Crappie CPUE < 100 mm is used as an index of year-class strength.

Year-class	Age	Total Catch	Mean Length	White Crappie CPUE < 100 mm	Index of year class strength	Adjusted Catch	LN(adjusted catch+1)
2017	0	34	114.1				
2016	1	114	172.5	0.3	1	114	4.74
2015	2	140	223.6				
2014	3	278	240.8	4.4	14.7	18.9	2.99
2013	4	2	294.5				
2012	5	1	300.0	1.6	5.3	0.2	0.18

APPENDIX D – Reporting of creel ZIP code data



Location, by ZIP code, and frequency of anglers that were interviewed at Nasworthy Reservoir, Texas, during the June 2018 through May 2019 creel survey.

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