

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-6

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2015 Fisheries Management Survey Report

**Greenbelt Reservoir**

*Prepared by:*

Charles Munger, District Management Supervisor  
And  
John Clayton, Assistant District Management Supervisor

Inland Fisheries Division  
Amarillo District  
Canyon, Texas



Carter Smith  
Executive Director

Craig Bonds  
Director, Inland Fisheries

July 31, 2016

## TABLE OF CONTENTS

Survey and Management Summary .....	1
Introduction.....	2
Reservoir Description.....	2
Angler Access .....	2
Management History .....	2
Methods.....	3
Results and Discussion.....	4
Fisheries Management Plan .....	6
Objective-Based Sampling Plan and Schedule 2016-2020 .....	7
Literature Cited.....	9
Figures and Tables .....	10-24
Water Level (Figure 1) .....	10
Habitat Survey Summary (Table 1).....	10
Reservoir Characteristics (Table 2) .....	10
Boat Ramp Characteristics (Table 3).....	11
Harvest Regulations (Table 4) .....	11
Stocking History (Table 5).....	12
Objective-Based Sampling Plan Components 2015-2016 (Table 6) .....	13
Aquatic Vegetation Survey (Table 7) .....	14
Percent Directed Angler Effort (Table 8) .....	14
Total Fishing Effort and Expenditures (Table 9) .....	15
Gizzard Shad (Figure 2).....	16
Bluegill (Figure 3) .....	17
Channel Catfish (Figures 4-5, Table 10).....	18
Flathead Catfish (Figure 6) .....	20
White Bass (Figures 7-8, Table 11) .....	21
Smallmouth Bass (Figure 9) .....	23
Largemouth Bass (Figures 10-11, Tables 12-13) .....	24
White Crappie (Figures 12-14, Table 14) .....	27
Walleye (Figures 15-17, Table 15).....	30
Proposed Sampling Schedule 2016-2020 (Table 16) .....	33
Objective-Based Sampling Plan Components for 2016-2020 (Table 17).....	33
Appendix A	
Catch Rates for all Species from all Gear Types.....	34
Appendix B	
Map of 2015-2016 Sampling Locations .....	35

## SURVEY AND MANAGEMENT SUMMARY

Fish populations in Greenbelt Reservoir were surveyed in 2015 using electrofishing and trap nets and in 2016 using gill nets. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Greenbelt Reservoir is a 1,990-acre impoundment located on the Salt Fork of the Red River five miles north of Clarendon in Donley County, Texas. It is owned by the Greenbelt Municipal and Industrial Water Authority, is used for water supply and recreational purposes, and has a history of significant water level fluctuations. The reservoir covered 750 acres in 2015. Angler access was good but boat access is limited to one low-water ramp. At the time of sampling, the habitat was primarily silt and gravel shoreline and flooded terrestrial vegetation.
- **Management History:** Important sport fish included Largemouth Bass, Walleye, White Bass, White Crappie, and catfish. Harvest of most species has been managed with statewide limits. An experimental 18-inch minimum length limit, three-fish bag limit was implemented on Smallmouth Bass in 1994 with no documented success. The special regulation was rescinded in 2001. An attempt to establish Yellow Perch as an additional game fish and forage for the Walleye population had limited success.
- **Fish Community**
  - **Prey species:** Electrofishing catch of Gizzard Shad was high, and most were available as prey to sport fish. Electrofishing catch of Bluegills was good and most were less than 5-inches long.
  - **Catfishes:** Channel Catfish abundance was similar to previous years and they were in good condition. Flathead Catfish abundance has remained steady.
  - **White Bass:** White Bass gill net catch rates were much higher than seen in previous surveys and most fish collected were legally harvestable. Angling effort directed to White Bass is very low at 0.22 h/acre.
  - **Smallmouth Bass:** No smallmouth bass have been collected since 2011 but a low-density fishery existed prior to drought conditions.
  - **Largemouth Bass:** Largemouth Bass were relatively abundant but the population is dominated by fish <10 inches. Largemouth Bass were highly sought by anglers in 2012.
  - **Crappie:** White Crappie abundance appears to be stable with a good number of harvestable fish with fair body condition. White Crappie was the most sought species in 2012.
  - **Walleye:** Walleye abundance has declined with no evidence of young-of-the-year in the surveys. Body condition was good. Walleye were sought by 10% of anglers in 2012.

**Management Strategies:** Continue management under current statewide harvest regulations. The proposed sampling schedule is based on meeting specific sampling objectives for target species.

## INTRODUCTION

This document is a summary of fisheries data collected from Greenbelt Reservoir in 2015-2016. The purpose of this document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other species of fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data is presented with the 2015-2016 data for comparison.

### *Reservoir Description*

Greenbelt Reservoir is a 1,990-acre impoundment on the Salt Fork of the Red River five miles north of Clarendon in Donley County, Texas. It is owned by the Greenbelt Municipal and Industrial Water Authority and is used for water supply and recreational purposes. The reservoir has a history of water level fluctuations (Figure 1). The reservoir surface area was approximately 750 acres in 2015. At the time of sampling, the habitat was primarily natural and gravel shoreline with flooded terrestrial vegetation (Table 1). Other descriptive characteristics for Greenbelt Reservoir are in Table 2.

### *Angler Access*

Greenbelt Reservoir has six public boat ramps and no private boat ramps. At full pool, angler and boat access is good with five boat ramps and large shoreline access areas. At current water levels (April, 2016, 2,630 msl), angler shoreline access is good but boat access is limited to the one low-water ramp (Table 3). Only the low-water ramp was available to anglers in 2015-2016. Extension of the other ramps is not feasible. Additional boat ramp characteristics are in Table 3. Shoreline access is available to anglers over most of the reservoir.

### *Management History*

**Previous management strategies and actions:** Management strategies and actions from the previous survey report (Munger and Clayton 2012) included:

1. Reduced quality spawning habitat due to low water and potential for Eurasian watermilfoil to create access problems.  
**Action:** Monitored reproduction of target fish species through standard surveys and monitored for access impacts from Eurasian watermilfoil.
2. Evaluate the potential for habitat enhancement projects during low water conditions.  
**Action:** No practical habitat enhancement projects were identified. Low water conditions have resulted in extensive growth of woody vegetation on exposed shorelines which will provide sufficient habitat as water levels rise.
3. Potential for introduction of zebra mussels.  
**Action:** Provided zebra mussel signs and discussed potential impacts with water controlling authority.

**Harvest regulation history:** Sport fishes in Greenbelt Reservoir have been and currently are managed with statewide regulations with one exception (Table 4). The exception was from 1994 to 2002 when Smallmouth Bass were managed under a 18-inch minimum length limit and 5-fish daily bag limit.

**Stocking history:** Greenbelt Reservoir was last stocked in 2013 with Walleye. The reservoir was experimentally stocked with Northern Pike (1967) and Yellow Perch (1983-1986) with limited success. Walleye were introduced in 1974, and Smallmouth Bass in 1980. Both species were still present in the reservoir and have self-sustaining populations through natural reproduction under normal water levels. The complete stocking history is in Table 5.

**Vegetation/habitat management history:** Eurasian Watermilfoil has not caused access problems under normal water levels. No vegetation or habitat management actions have been taken.

**Water Transfers:** Greenbelt Municipal and Industrial Water Authority provides water from Greenbelt Reservoir, on the Salt Fork of the Red River, to approximately 25,000 people through a 121-mile aqueduct system. There are five cities that use water from this reservoir (Clarendon, Hedley, Childress, Quanah and Crowell). Water is not transferred out of the Red River basin.

## METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with objective-based sampling plan (Table 6). All fish survey sites were randomly selected and were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Habitat and Angler Access surveys were conducted according to TPWD procedures manuals (revised 2009 and 2004, respectively).

*Electrofishing* – Smallmouth Bass, Largemouth Bass, Walleye, sunfishes and Gizzard Shad were collected by electrofishing (1 hour at 12, 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. The objective-based goal for Largemouth Bass was not reached for size structure estimates but was reached for abundance estimates. The objectives for Gizzard Shad were reached.

*Trap netting* – Trap netting was conducted in spring of 2016 with a total effort of 15 net nights at 15 stations. CPUE for trap netting was recorded as the number of fish caught per net night (fish/nn). All sampling objectives for White Crappie were reached.

*Gill netting* – Channel Catfish, Flathead Catfish, White Bass, and Walleye were collected by gill netting (20 net nights at 20 stations). CPUE for gill netting was recorded as the number of fish caught per net night (fish/nn). Channel Catfish and White Bass sampling objectives were reached but neither of the Walleye objectives were.

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

*Genetics* – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2012 and by electrophoresis for previous years.

*Creel* – A roving spring creel survey was conducted from 1 April 2012 through 30 June 2012. 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). The 2014 creel was not conducted due to low water levels.

*Age and Growth* – An age and growth sample of 66 White Crappie was collected from trap nets. Ages were determined using otoliths.

*Habitat* - A structural habitat and vegetation surveys were conducted in 2015. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2014).

*Water level* - Source for water level data was the United States Geological Survey (USGS 2016).

## RESULTS AND DISCUSSION

**Habitat:** A habitat survey was conducted in August 2015. Primary shoreline habitat was natural shoreline (silt) followed by gravel and rock (Table 1). Offshore habitat was primarily open water with stands of flooded terrestrial vegetation and native vegetation (Table 7).

**Creel:** Directed fishing effort by anglers in 2012 was highest for White Crappie (32%), followed by anglers fishing for anything and Largemouth Bass (Table 8). Total fishing effort for all species and direct expenditures at Greenbelt Reservoir were similar across years (Table 9).

**Prey species:** Electrofishing total CPUE of Gizzard Shad in 2015 was 339.0/h (Figure 2). Index of vulnerability (IOV) for Gizzard Shad was good, indicating 93% were available to existing predators. The IOV has remained above 85 for the past three electrofishing surveys and catch rates have all been above 300/h. Total CPUE of Bluegill in 2015 (41.0/h) was much improved over the 2013 catch rate of 4.0/h (Figure 3) during the middle of the drought and closer to what was seen in 2011 (72.0/h) in the early stage of the drought. The size structure is still dominated by small individuals. There was a minimal bluegill fishery as a few anglers targeted the species in 2006 and 2012 (Table 8).

**Channel Catfish:** The gill net CPUE of Channel Catfish was 5.4/nn in 2016 (Figure 4). Catch rates were similar in 2012 and 2016 but were much lower than in 2014 (19.8/nn). Large Channel Catfish (>20 inches) were in relatively good condition with mean *W*'s of 100 or greater. Channel Catfish were sought by about 6% of all anglers in 2012, consistent with 2002 and 2006 surveys (Table 8). There has been an increase in directed effort/acre since 2002 (Table 10) due to declining surface area as directed effort has remained consistent. Fish up to 18 inches were seen during creel surveys (Figure 5).

**Flathead Catfish:** Gill net catch rates of Flathead Catfish in 2016 (2.3/nn) and was similar to 2012 (2.4/nn) and 2014 (1.0/nn) with 9% of the population over 28 inches (Figure 6). Relative weights were mainly over 100 and considered average for this reservoir. Sought by a small percent of anglers (0.5%) in 2012 but none seeking in 2002 or 2006 (Table 8).

**White Bass:** The gill net CPUE of White Bass was 20.2/nn in 2016 which was much higher than in 2012 (6.6/nn) and 2014 (2.4/nn) (Figure 7). The increase may be due to lack of angler boat access during low water conditions and that the low water did not impact the ability of the White Bass to successfully reproduce. Most of the fish collected were legally-harvestable ( $\geq 10$  inches). Relative weights for 10-inch and larger fish were mostly above 90 and considered good. White Bass were sought by only 0.8% of anglers in 2012 which is a decline from 4.0% and 3.5% in 2002 and 2006, respectively (Table 8). While there is a quality population in Greenbelt Reservoir, directed effort was very low at 0.22 h/acre (Table 11). Most of the fish harvested in 2012 were 12-14 inches long (Figure 8).

**Smallmouth bass:** The electrofishing CPUE of Smallmouth Bass was 0.0/h in 2016 and 2014 indicating the population may not have survived the low water level. Smallmouth Bass were last collected in electrofishing surveys in 2011 (Figure 9) and the majority of those fish were less than 6 inches in length.

No anglers seeking but one 18-inch fish was observed in the 2002 creel (Table 8). An effort will be made to re-establish the species in Greenbelt Reservoir. If it is unsuccessful, the species will be removed from future reports.

**Largemouth Bass:** The electrofishing CPUE of Largemouth Bass was 332.0/h in 2015, but the sample was dominated by fish <10 inches in length (Figure 10). The CPUE of stock-size fish was similar to previous years, but the size structure was less than desired with a PSD of only 18. Body condition in 2016 was above average for all size classes of fish which is an improvement compared to previous years. Largemouth Bass is a highly sought species at 23.2%. This is very similar to rates seen in 2002 (21.8%) and 2006 (23.5%) (Table 8). There was 6.29 h/acre directed effort for Largemouth Bass in 2012 with a harvest rate of 2.57 fish/acre (Table 12). Most of the fish harvested in 2012 were 14 inches (Figure 11). Genetics surveys indicated no Florida Largemouth Bass genotypes but there was 33% of Florida Largemouth Bass alleles detected in 2012 (Table 13).

**White Crappie:** The trap net CPUE of White Crappie was 6.3/nn in 2016; similar to the 2013 (8.0/nn) but lower than in 2011 (15.9/nn; Figure 12). Mean relative weight was over 85 for each of the surveys. White Crappie were the most sought species in 2012 at 31.6%. This is much higher than the seeking rates in 2002 (9.3%) and 2006 (0.8%) (Table 8). Directed effort toward White Crappie was 8.59 h/acre in 2012 which was much higher than in 2002 or 2006 (Table 14). The harvest mode in 2012 was at 12 inches (Figure 13). All aged fish were legal size (10 inches) by age 3 (Figure 14).

**Walleye:** The electrofishing CPUE for Walleye was only 1.0/h in fall 2015, lower than the 4.0/h in 2011 (Figure 15). Generally, young-of-the-year fish (<10 inches) can be collected by electrofishing but none have been collected since 2011. This may indicate that the low water level limited natural reproduction. The gill net CPUE in 2016 was 1.1/nn, similar to 2014 (1.4/nn) but about a third of the rate in 2012 (3.2/nn; Figure 16). Most of the fish collected in 2016 were longer than 16 inches and most relative weights were between 90 and 100. Walleye were sought by 10% of anglers in 2012 which was higher than that seen in 2002 (6.9%) and 2006 (2.9%) (Table 8). There were 1,894 hours of directed effort for Walleye on Greenbelt Reservoir which equates to 2.71 h/acre (Table 15). Most of the fish harvested in 2012 were 18 inches long (Figure 17).

## Fisheries management plan for Greenbelt Reservoir, Texas

Prepared – July 2016.

**ISSUE 1:** Both Walleye and Smallmouth Bass have had self-sustaining populations prior to the drought. The prolonged low water level has reduced the amount and quality of spawning areas for these species and reduced the density of aquatic vegetation nursery cover in the reservoir. Water levels in the reservoir had declined to the point where most of the spawning areas consisted of silt substrates instead of sand or gravel, but water levels have since begun to increase.

### MANAGEMENT STRATEGY

1. Conduct supplemental stocking of Smallmouth Bass to re-establish the population and natural reproduction.
2. Conduct supplemental stocking of Walleye to boost the reproductive population by increasing the spawning stock.
3. Monitor future reproduction to determine if regular stocking is warranted to maintain the populations. If the Smallmouth Bass population does not show indications of recovery by 2020 it will be removed as a management objective.

**ISSUE 2:** Boating access was impeded by low water levels from 2011-2016. None of the boat ramps can be extended because the lake bottom levels out with no access to deeper water. No ramp extension is feasible at the low-water ramp but there is the potential to improve parking at the site.

### MANAGEMENT STRATEGIES

1. Discuss the possibility of improving parking at the low-water ramp with the water controlling authority.

**ISSUE 3:** 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. 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. Current low water conditions have reduced the risk of zebra mussel infestation, but inflows could return the reservoir to high risk. Two Tier III invasive plant species have been identified within the reservoir during the last vegetation survey.

### MANAGEMENT STRATEGIES

1. Monitor the extent of the Tier III species Eurasian watermilfoil and Torpedograss to determine if angler access is being impeded. If either species shows indication of becoming a problem, work with the controlling authority to develop a control program.
2. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.
3. Contact and educate marina owners about invasive species, and provide them with posters, literature, etc... so that they can in turn educate their customers.
4. Educate the public about invasive species through the use of media and the internet.
5. Make a speaking point about invasive species when presenting to constituent and user groups.



## Objective-Based Sampling Plan and Schedule

### Greenbelt Reservoir 2016-2020

#### Sport fish, forage fish, and other important fishes

Sport fishes in Greenbelt Reservoir include **Channel Catfish, Flathead Catfish, White Bass, Smallmouth Bass, Largemouth Bass, White Crappie** and **Walleye**. The primary forage species is **Gizzard Shad**.

#### Low-density fisheries

**Smallmouth Bass:** Smallmouth Bass were collected by electrofishing at a rate of 11/h in 2011, but none were collected in 2013 or 2015. A consistently low relative abundance in surveys and limited directed angler effort in past angler surveys indicate this is a minimal fishery.

**Flathead catfish:** While Flathead Catfish are typically collected in gill nets at a rate of 1-2/nn, past angler surveys have indicated limited directed effort toward this species.

#### Survey objectives, fisheries metrics, and sampling objectives

**Reservoir Status/Disclaimer:** Current water levels directly impact our ability to sample fisheries within Greenbelt Reservoir. At current water levels (4/30/16) the total area of Greenbelt Reservoir is approximately 750 acres. Large portions of the Salt Fork and Kelly Creek arms of the reservoir are too shallow to sample which reduces the area that can be sampled to approximately 500 acres. The estimates of projected effort are based on the ability to sample the entire reservoir basin and will be adjusted based on the area that can be effectively sampled.

**Walleye:** Walleye were sampled with gill nets in 2012, 2014 and 2016 with catch rates of 3.2/nn, 1.4/nn and 1.1/nn, respectively. Continuation of gill net sampling will allow for monitoring of any large-scale changes in relative abundance and size structure. Continuation of electrofishing sampling will determine reproductive success by presence or absence of YOY fish in years when stocking does not occur. At current population levels, estimated gill net sampling effort based on achieving sampling objectives for size structure estimation (PSD; 50 fish minimum with 80% confidence) is 55 net nights while sampling for a desired RSE-25 will require 30 net nights. Gill net sampling effort for spring 2018 and 2020 will be 20 random stations or until either the 50 fish sample or an RSE-25 is reached. Electrofishing sampling effort to evaluate young-of-the-year will be based on achieving sampling objectives for largemouth bass. Fall 2017 and 2019 electrofishing will be 12 random stations.

**Channel Catfish:** Channel Catfish were collected by gill nets in 2012 at 6.0/nn, 19.8/nn in 2014 and 5.4/nn in 2016. Continuation of sampling by gill nets will allow for monitoring of large-scale changes in relative abundance and size structure. Estimated gill net sampling effort needed to achieve sampling objectives for relative abundance (CPUE-T; RSE-25 with 80% confidence) is 15 random stations and effort for size structure estimation (PSD; 50 fish minimum with 80% confidence) is 20 random gill net stations. Sampling effort will be based on that required to meet objectives for walleye and will be 20 random gill nets in spring 2018 and 2020.

**White Bass:** The gill net CPUE for White Bass in 2012 was 6.6/nn, 2.4/nn in 2014 and 20.2/nn in 2016. Continuation of gill net sampling will allow for monitoring of any large-scale changes in relative

abundance and size structure. Estimated sampling effort to achieve sampling objectives for relative abundance (CPUE-T; RSE-25 with 80% confidence) is 10 random gill nets and size structure estimation (PSD; 50 fish minimum with 80% confidence) is 5 random gill net stations. As White Bass can be managed with minimal regulation and the risk of a population crash is very low, the gill sampling effort will be based on the effort needed to evaluate the walleye population and will be 20 random gill nets in spring 2018 and 2020.

**Largemouth Bass:** Largemouth Bass were collected by electrofishing at a rate of 127/h in 2011, 15/h in 2013 and 332/h in 2015. Catch rate in 2013 was likely impacted by record low water levels during that year. Continuation of electrofishing sampling will allow for monitoring of large-scale changes in relative abundance and size structure. Estimated sampling effort based on achieving sampling objectives for relative abundance (CPUE-T; RSE-25 with 80% confidence) is more than 40 random 5-minute electrofishing stations. Estimated sampling effort based on achieving sampling objectives for size structure estimation (PSD; 50 fish minimum with over 90% confidence) is 31 random 5-minute electrofishing stations. If the reservoir remains around 750 acres, the electrofishing sampling effort for fall 2017 and fall 2019 will be 24 random 5-minute electrofishing stations or until either the 50 fish sample or RSE-25 is reached. A 30 fish sample will be collected for genetics.

**White crappie:** White Crappie collected in trap net surveys in 2011 and 2013 had catch rates of 15.9/nn and 8.0/nn, respectively and the spring 2016 catch rate was 6.3/nn. Continuation of trap net sampling will allow for monitoring of large-scale changes in relative abundance and size structure. Estimated sampling effort based on achieving sampling objectives for relative abundance (CPUE-T; RSE-25 with 80% confidence) is 20 random trap net stations. Sampling effort based on achieving sampling objectives for size structure estimation (PSD; 50 fish minimum with over 90% confidence) is 20 random trap net stations. Sampling effort for fall 2017 and 2019 will be 20 random trap net stations.

**Gizzard shad:** Gizzard Shad are the primary forage at Greenbelt Reservoir. Electrofishing catch rates in 2011 and 2013 were 333/h and 382/h, respectively and 339.0/h in 2015. Continuation of sampling will allow for monitoring of large-scale changes in relative abundance and size structure. Estimated sampling effort based on achieving sampling objectives for relative abundance (CPUE-T; RSE-25 with over 80% confidence) would be 13 random 5-minute electrofishing stations and size structure estimation (PSD and IOV; 50 fish minimum with over 80% confidence) would be achieved by 18 5-minute electrofishing stations. Sampling effort in fall 2017 and 2019 will be based on the effort for largemouth bass.

The proposed sampling schedule is presented in Table 16 and the objective-based sampling plan components for Greenbelt Reservoir, Texas 2016 – 2020 are presented in Table 17.

## LITERATURE CITED

- Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 *in* B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2<sup>nd</sup> edition. American Fisheries Society, Bethesda, Maryland.
- DiCenzo, V. J., M. J. Maceina, and M. R. Stimpert. 1996. Relations between reservoir trophic state and gizzard shad population characteristics in Alabama reservoirs. *North American Journal of Fisheries Management* 16:888-895.
- Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution (PSD): a further refinement of population size structure index terminology. *Fisheries* 32(7): 348.
- Munger, C., and J. Clayton. 2012. Inland fisheries division monitoring and management program survey report, Greenbelt Reservoir 2011. Texas Parks and Wildlife Department, Federal Aid in Sport Fish Restoration Act, Federal Aid Grant F-221-M, Performance Report, Austin.
- United States Geological Society (USGS). 2016. National water information system: Web interface. Available: <http://waterdata.usgs.gov/tx> (Accessed 11 May 2016).

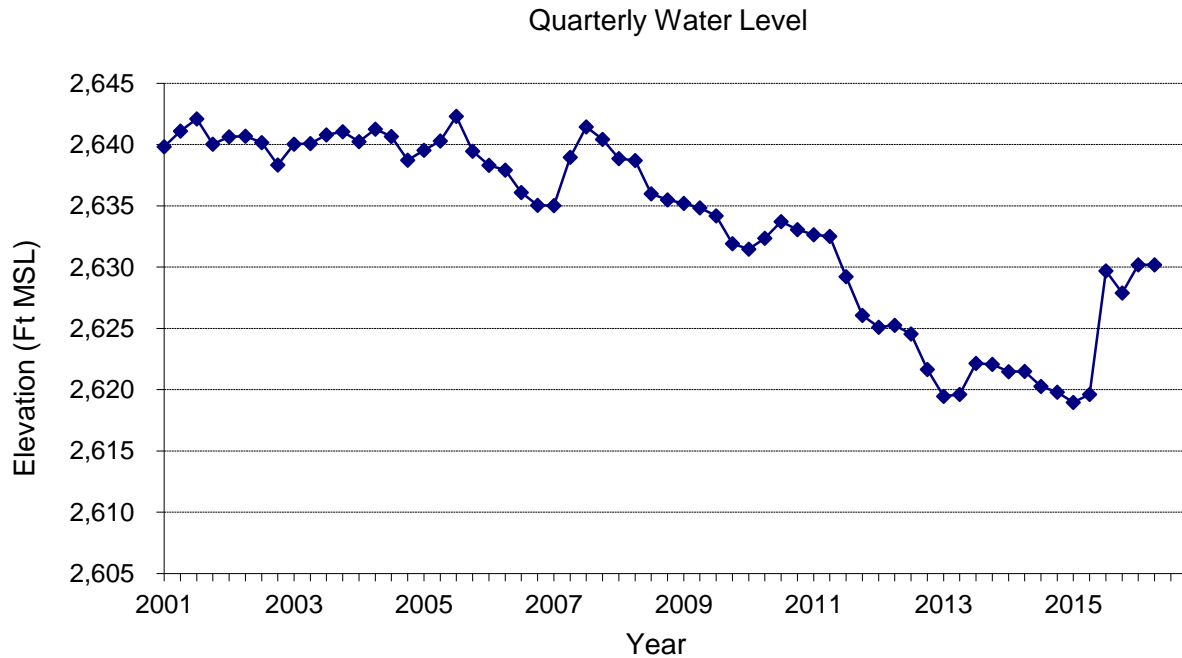


Figure 1. Quarterly water level elevations in feet above mean sea level (ft MSL) recorded for Greenbelt Reservoir, Texas. Conservation pool elevation is 2,663 feet above mean sea level.

Table 1. Survey of structural habitat types, Greenbelt Reservoir, Texas, 2015. Shoreline habitat type units are in miles and standing timber is acres. Surface area at the time of sampling was approximately 750 acres.

Habitat	Miles	Percent (miles)
Natural shore	9.67	61.0
Gravel shore	3.05	19.3
Rock shore	1.77	11.2
Natural shore with docks	1.35	8.5
<b>Total</b>	<b>15.84</b>	<b>100</b>

Table 2. Characteristics of Greenbelt Reservoir, Texas.

Characteristic	Description
Year constructed	1967
Controlling authority	Greenbelt Municipal and Industrial Water Authority
County	Donley
Reservoir type	Mainstream
Shoreline Development Index (SDI)	2.87
Conductivity	1,032 $\mu$ mhos/cm

Table 3. Boat ramp characteristics for Paradise Reservoir, Texas, August, 2015. Reservoir elevation at time of survey was 2,629 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
Lakeside Marina	34.99668 -100.89582	Y	20	2,647	Out of water. Extension is not feasible
Kinkaid Park	34.99331 -100.90499	Y	15	2,643	Out of water. Extension is not feasible
Kelly Creek North	34.99392 -100.91020	Y	15	2,645	Out of water. Extension is not feasible
North Ramp	35.01086 -100.89725	Y	30	2,646	Out of water. Extension is not feasible
Salt Fork	35.01721 -100.92597	Y	15	2,646	Out of water. Extension is not feasible
Low water	34.99886 -100.89896	Y	10	2,626	Adequate, rough launch and unpaved parking

Table 4. Harvest regulations for Greenbelt Reservoir, Texas.

Species	Bag Limit	Length Limit
Catfish: Channel and Blue, their hybrids and subspecies	25 (in any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass: Smallmouth and Largemouth	5 (in any combination)	14-inch minimum
Crappie: White and Black, their hybrids and subspecies	25 (in any combination)	10-inch minimum
Walleye	5	No more than 2 under 16

Table 5. Stocking history of Greenbelt Reservoir, Texas. Size categories are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), adults (ADL) and unknown (UNK). Average total length (TL; mm) of each species stocked is given by size category and year.

Species	Year	Number	Life Stage	Length (mm)
Blue Catfish	1967	9,600	UNK	UNK
	1971	8,000	UNK	UNK
	1982	20,000	UNK	UNK
	1987	6,240	FGL	25 - 102
	Total	43,840		
Channel Catfish	1967	30,000	AFGL	102 - 279
	1968	45,000	AFGL	102 - 279
	1969	51,000	AFGL	102 - 279
	1971	8,000	AFGL	102 - 279
	1995	131,455	FGL	25 - 102
	2000	50,000	AFGL	102 - 279
	Total	315,455		
Flathead Catfish	1977	39	UNK	UNK
	Total	39		
Florida Largemouth Bass	1982	75,333	FGL	25 - 102
	1982	4,000	FRY	1 - 25
	2000	201,025	FGL	25 - 102
	Total	280,358		
Green Sunfish x Redear Sunfish	1967	201,000	UNK	UNK
	Total	201,000		
Largemouth Bass	1967	240,000	UNK	UNK
	1980	14,523	UNK	UNK
	1981	20,000	UNK	UNK
	Total	274,523		
Northern Pike	1967	150,000	UNK	UNK
	Total	150,000		
Rainbow Trout	1991	3,339	ADL	>=229
	Total	3,339		
Smallmouth Bass	1980	5,000	UNK	UNK
	1981	72,400	UNK	UNK
	1982	100,500	UNK	UNK
	1987	30	ADL	>=178
	Total	177,930		

Continued on next page

Table 5. Continued from previous page

Walleye	1974	100,000	FRY	1 - 25
	1976	100,000	FRY	1 - 25
	1977	4,600	FRY	1 - 25
	2001	99,000	FGL	25 - 127
	2006	41,200	FGL	25 - 127
	2013	815,000	FRY	1 - 25
	Total	1,159,800		
White Crappie	1967	97	UNK	UNK
	1968	96	UNK	UNK
	Total	193		
Yellow Perch	1983	7,500	FGL	UNK
	1985	1,145	FGL	UNK
	1986	330	FGL	UNK
	Total	8,975		

Table 6. Objective-based sampling plan components for Greenbelt Reservoir, Texas 2015 – 2016.

Gear/target species	Survey objective	Metrics	Sampling objective
<i>Electrofishing</i>			
Largemouth Bass	Abundance	CPUE – stock	RSE-Stock $\leq$ 25
	Size structure	PSD, length frequency	N $\geq$ 50 stock
Gizzard Shad	Abundance	CPUE – Total	RSE $\leq$ 25
	Size structure	PSD, length frequency	N $\geq$ 50
	Prey availability	IOV	N $\geq$ 50
<i>Gill netting</i>			
Channel Catfish	Abundance	CPUE – stock	RSE-Stock $\leq$ 25
	Size structure	PSD, length frequency	N $\geq$ 50 stock
White Bass	Abundance	CPUE – stock	RSE-Stock $\leq$ 25
	Size structure	PSD, length frequency	N $\geq$ 50 stock
Walleye	Abundance	CPUE – stock	RSE-Stock $\leq$ 25
	Size structure	PSD, length frequency	N $\geq$ 50 stock
<i>Trap netting</i>			
White Crappie	Size structure	PSD, length frequency	N $\geq$ 50 stock
	Abundance	CPUE - stock	RSE-Stock $\leq$ 25

Table 7. Survey of aquatic vegetation, Greenbelt Reservoir, Texas, 2011 and 2015. Surface area (acres) is listed with percent of total reservoir surface area in parentheses. Surface area at the time of sampling in 2015 was approximately 750 acres.

Vegetation	2011	2015
Flooded terrestrial		32.75 (4.4)
Native floating-leaved		0.10 (0.0)
Native emergent		29.02 (3.9)
Non-native		
Eurasian watermilfoil (Tier III)*	112.7 (16.0)	0.01 (0.0)
Torpedograss (Tier III)*		0.01 (0.0)

\*Tier III is Watch Status

Table 8. Percent directed angler effort by species for Greenbelt Reservoir, Texas, 2002 – 2012. Survey periods were from 1 April through 30 June.

Species	2002	2006	2012
Channel Catfish	5.4	7.3	5.9
Flathead Catfish	0.0	0.0	0.5
White Bass	4.0	3.5	0.8
Bluegill	0.0	0.6	1.0
Largemouth Bass	21.8	23.5	23.2
White Crappie	9.3	0.8	31.6
Walleye	6.9	2.9	10.0
Black Bass	7.2	18.2	0.1
Catfish	1.6	4.5	0.0
Common Carp	0.4	0.0	2.2
Anything	43.6	38.7	24.7
Acres	1,990	1,085	700

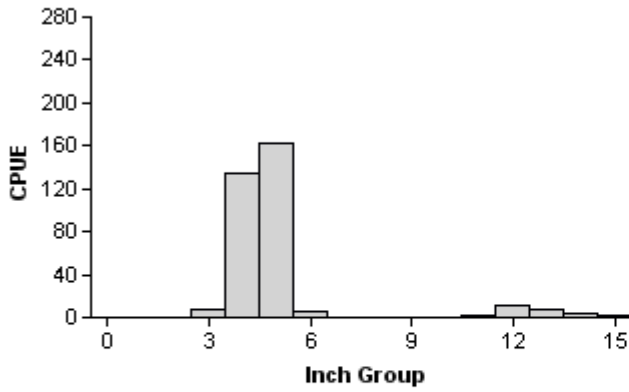


Table 9. Total fishing effort (h) for all species and total directed expenditures at Paradise Reservoir, Texas, 2009- 2012. Survey periods were from 1 April through 30 June. Relative standard error is in parentheses.

Creel statistic	2002	2006	2012
Total fishing effort	24,849 (17)	22,184 (20)	19,014 (17)
Total directed expenditures	\$92,943 (51)	\$144,277 (56)	\$128,498 (47)

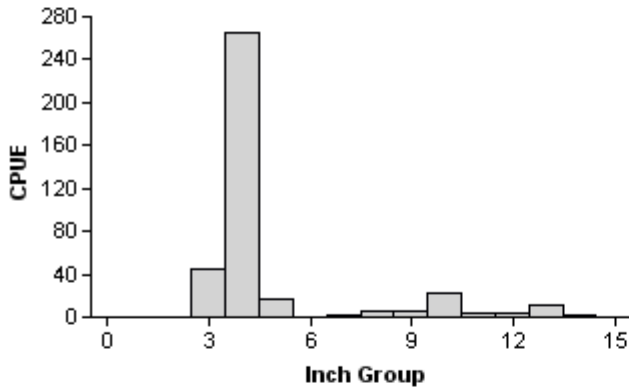
**Gizzard Shad**

**2011**



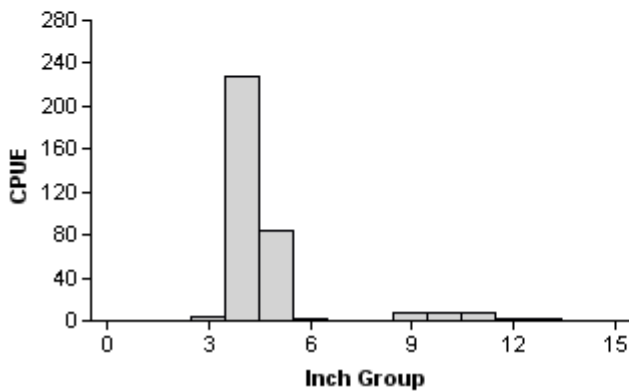
Effort = 1.0  
 Total CPUE = 333.0 (38; 333)  
 Stock CPUE = 24.0 (54; 24)  
 IOV = 93 (3)

**2013**



Effort = 1.0  
 Total CPUE = 382.0 (27; 382)  
 Stock CPUE = 55.0 (15; 55)  
 IOV = 86 (5)

**2015**



Effort = 1.0  
 Total CPUE = 339.0 (40; 339)  
 Stock CPUE = 24.0 (32; 24)  
 IOV = 93 (4)

Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE or SE and N are in parentheses) for fall electrofishing surveys, Greenbelt Reservoir, Texas, 2011, 2013, and 2015. RSE is used for CPUE values and SE is used for PSD and IOV values.

### Bluegill

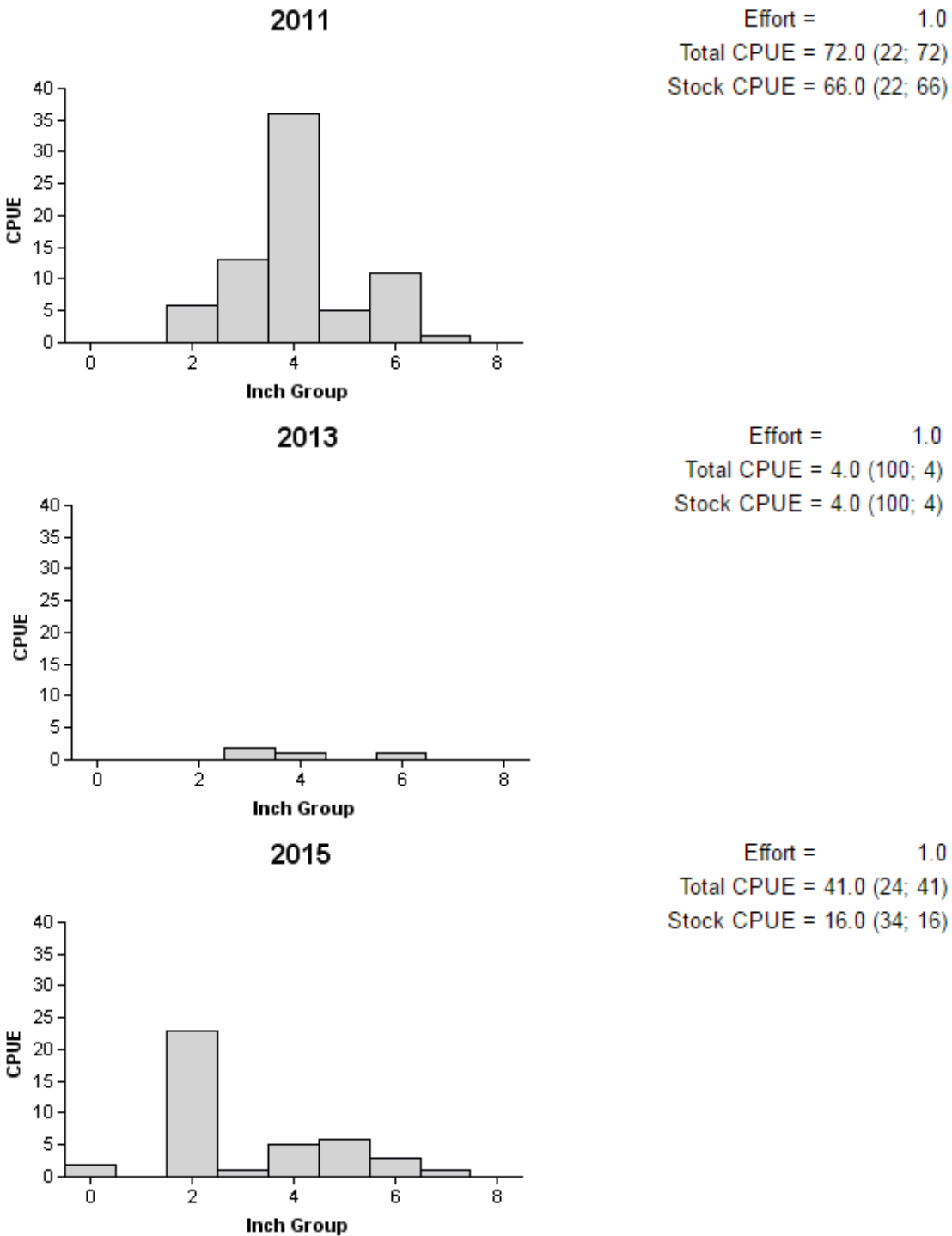


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE or SE and N are in parentheses) for fall electrofishing surveys, Greenbelt Reservoir, Texas, 2011, 2013, and 2015. RSE is used for CPUE values and SE is used for PSD values.

### Channel Catfish

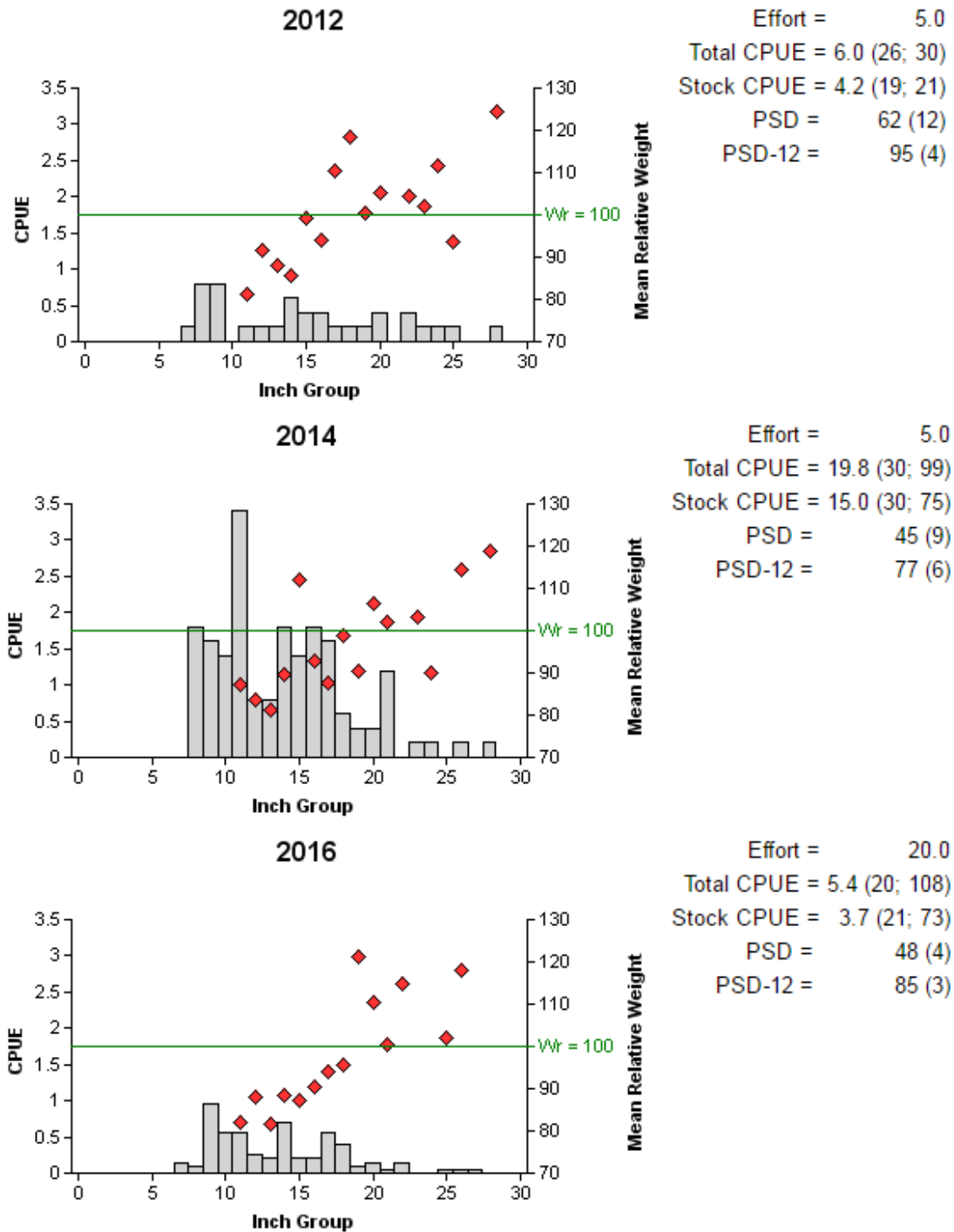


Figure 4. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for spring gill net surveys, Greenbelt Reservoir, Texas, 2012, 2014, and 2016. RSE is used for CPUE values and SE is used for PSD values.

## Channel Catfish

Table 10. Creel survey statistics for Channel Catfish at Greenbelt Reservoir, Texas, from 1 April through 30 June each year. 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		
	2002	2006	2012
Surface area (acres)	1,990	1,085	700
Directed effort (h)	1,332.9 (41)	1,610.0 (47)	1,125.2 (51)
Directed effort/acre	0.67 (41)	1.48 (47)	1.61 (51)
Total catch per hour	0.11 (84)	0.06 (109)	0.08 (71)
Total harvest	719 (81)	172 (116)	265 (202)
Harvest/acre	0.36 (81)	0.16 (116)	0.38 (202)
Percent legal released	0.0	0.0	3.9

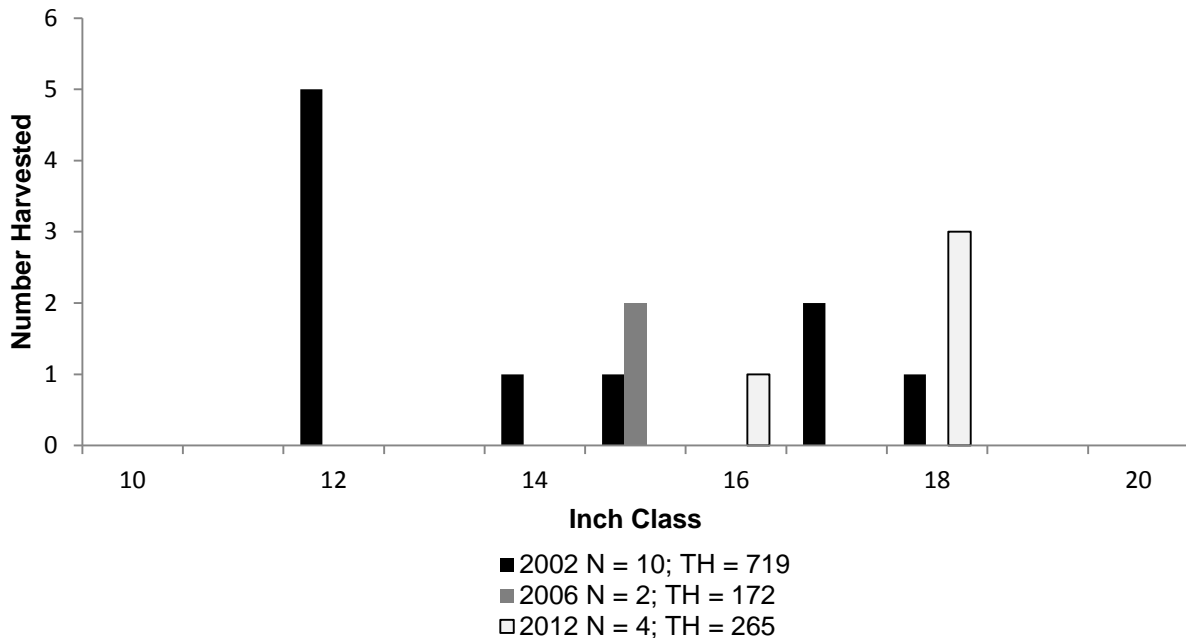


Figure 5. Length frequency of harvested Channel Catfish observed during creel surveys at Greenbelt Reservoir, Texas, from 1 April through 30 June each year, all anglers combined. N is the number of harvested Channel Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

### Flathead Catfish

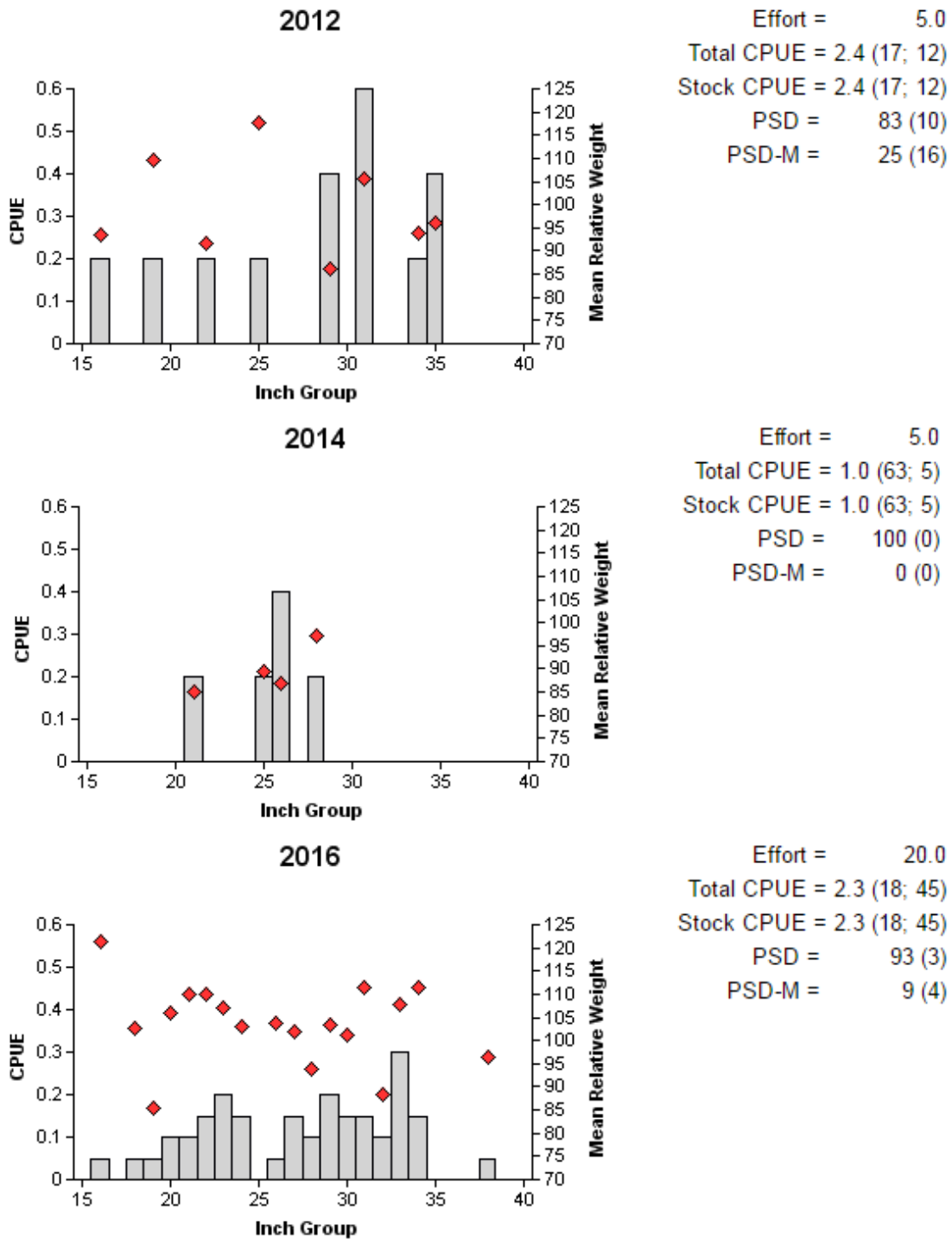


Figure 6. Number of Flathead Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for spring gill net surveys, Greenbelt Reservoir, Texas, 2012, 2014, and 2016. RSE is used for CPUE values and SE is used for PSD values.

## White Bass

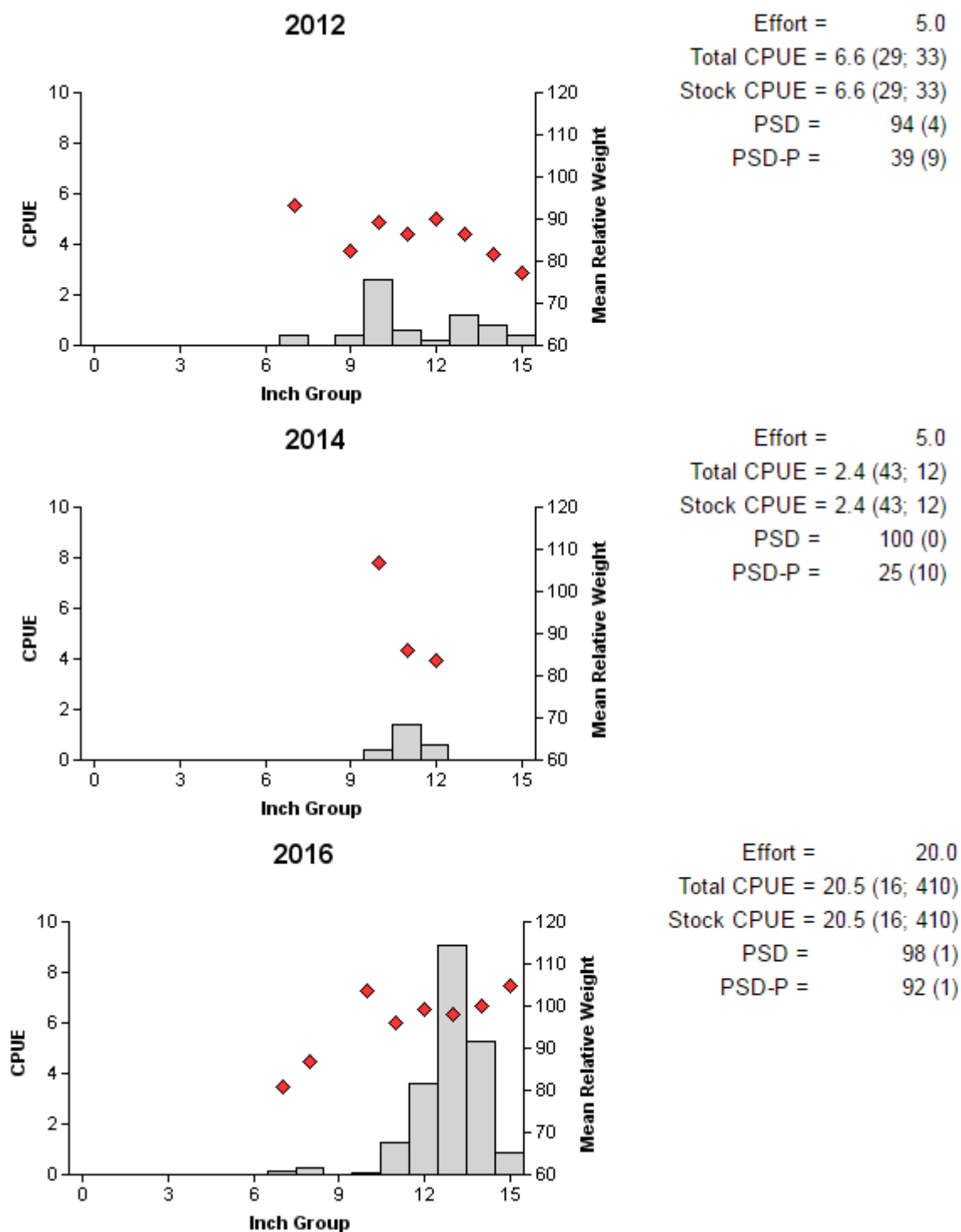


Figure 7. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for spring gill net surveys, Greenbelt Reservoir, Texas, 2012, 2014, and 2016. RSE is used for CPUE values and SE is used for PSD values.

## White Bass

Table 11. Creel survey statistics for White Bass at Greenbelt Reservoir, Texas, from 1 April through 30 June each year. Total catch per hour is for anglers targeting White Bass and total harvest is the estimated number of White Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2002	2006	2012
Surface area (acres)	1,990	1,085	700
Directed effort (h)	982.9 (49)	769.1 (64)	156.7 (106)
Directed effort/acre	0.49 (49)	0.71 (64)	0.22 (106)
Total catch per hour	0.03 (111)	0.84 (164)	0.00 (--)
Total harvest	1,107 (59)	86 (162)	1,007 (73)
Harvest/acre	0.56 (59)	0.08 (162)	1.44 (73)
Percent legal released	17.0	12.6	28.5

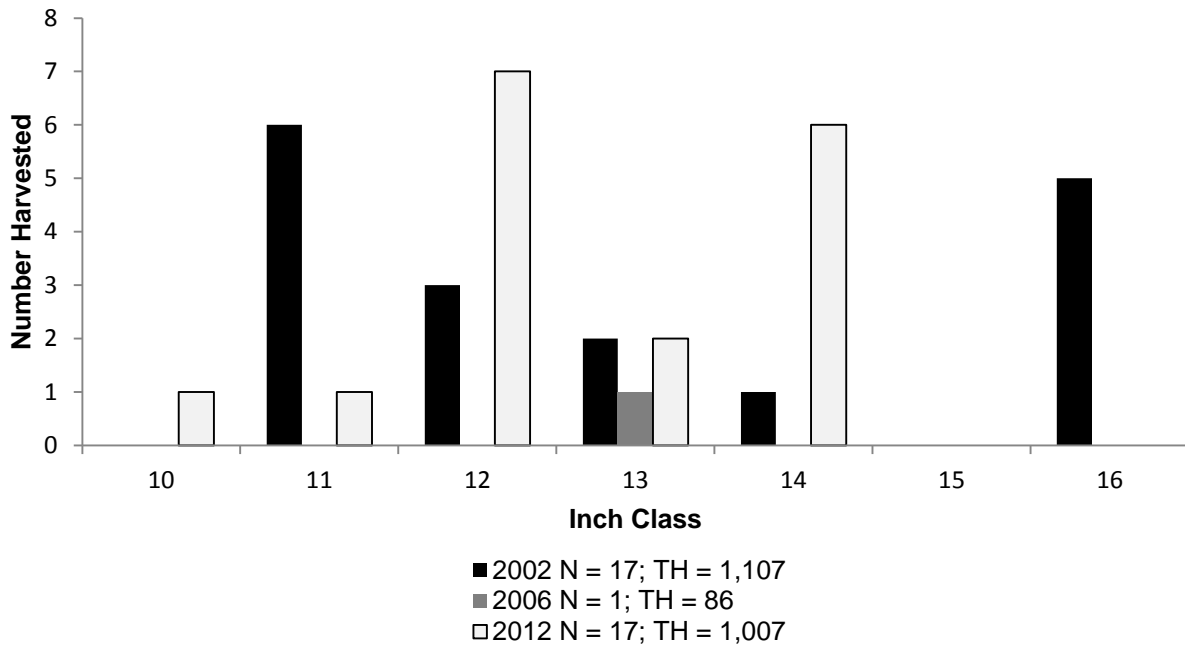


Figure 8. Length frequency of harvested White Bass observed during creel surveys at Greenbelt Reservoir, Texas, from 1 April through 30 June each year, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.



## Smallmouth Bass 2011

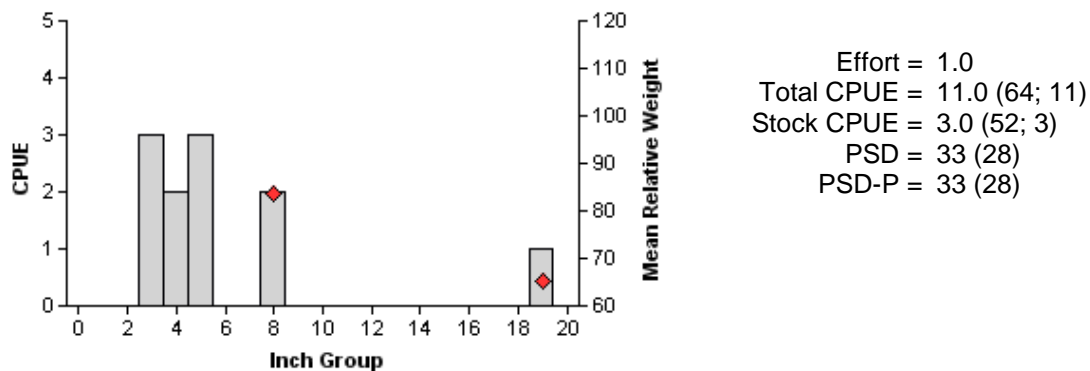


Figure 9. Number of Smallmouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for fall electrofishing surveys, Greenbelt Reservoir, Texas, 2011. No Smallmouth Bass were collected in fall electrofishing surveys in 2013 or 2015. RSE is used for CPUE values and SE is used for PSD values.

### Largemouth Bass

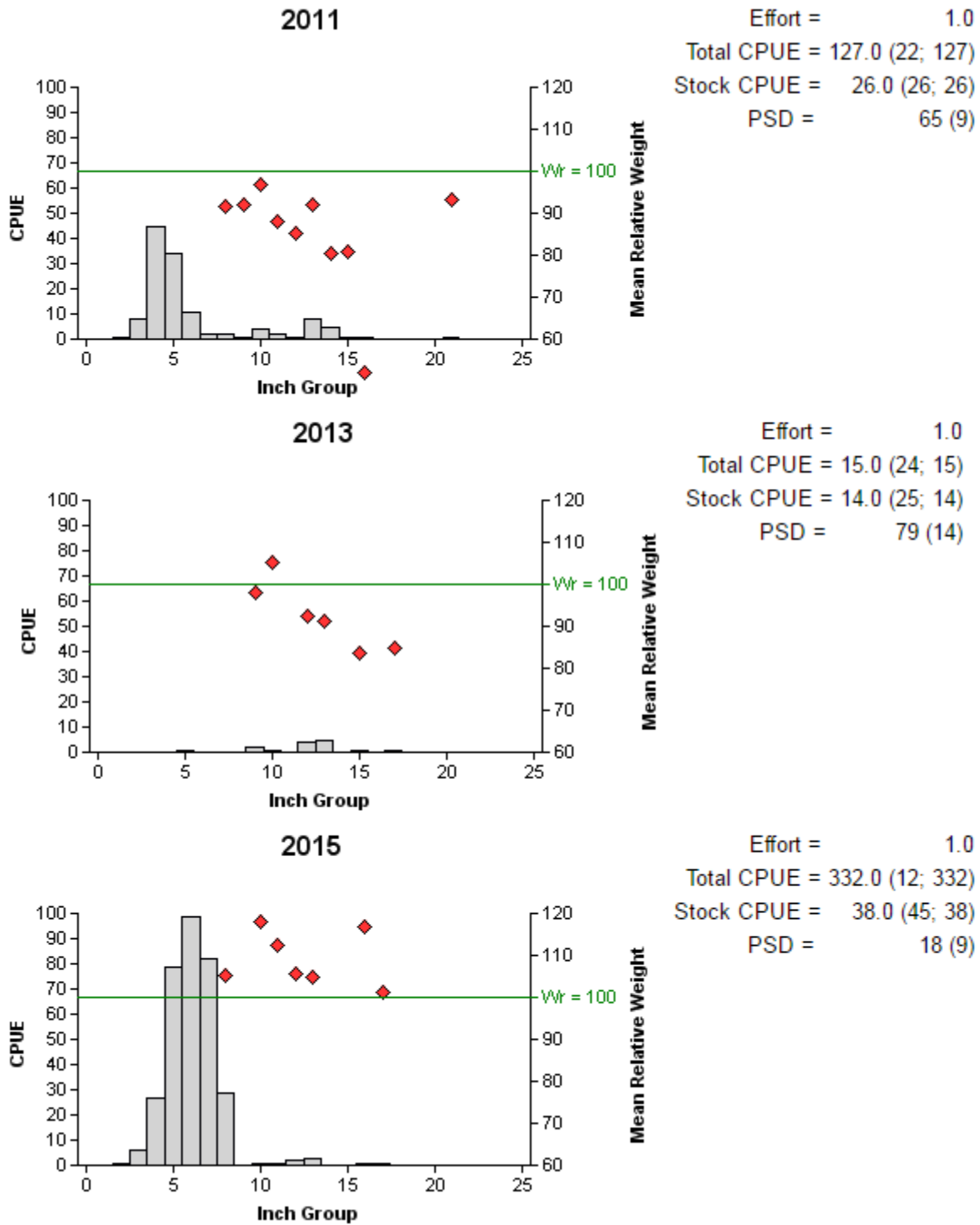


Figure 10. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for fall electrofishing surveys, Greenbelt Reservoir, Texas, 2011, 2013, and 2015. RSE is used for CPUE values and SE is used for PSD values.

### Largemouth Bass

Table 12. Creel survey statistics for Largemouth Bass at Greenbelt Reservoir, Texas, from 1 April through 30 June each year. Total catch per hour is for anglers targeting Largemouth Bass and total harvest is the estimated number of Largemouth Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2002	2006	2012
Surface area (acres)	1,990	1,085	700
Directed effort (h)	5,411.7 (22)	5,207.0 (29)	4,401.9 (26)
Directed effort/acre	2.72 (22)	4.80 (29)	6.29 (26)
Total catch per hour	0.24 (58)	0.98 (23)	0.44 (41)
Total harvest	825 (51)	557 (43)	1,801 (46)
Harvest/acre	0.41 (51)	0.51 (43)	2.57 (46)
Percent legal released	36.2	21.5	28.0

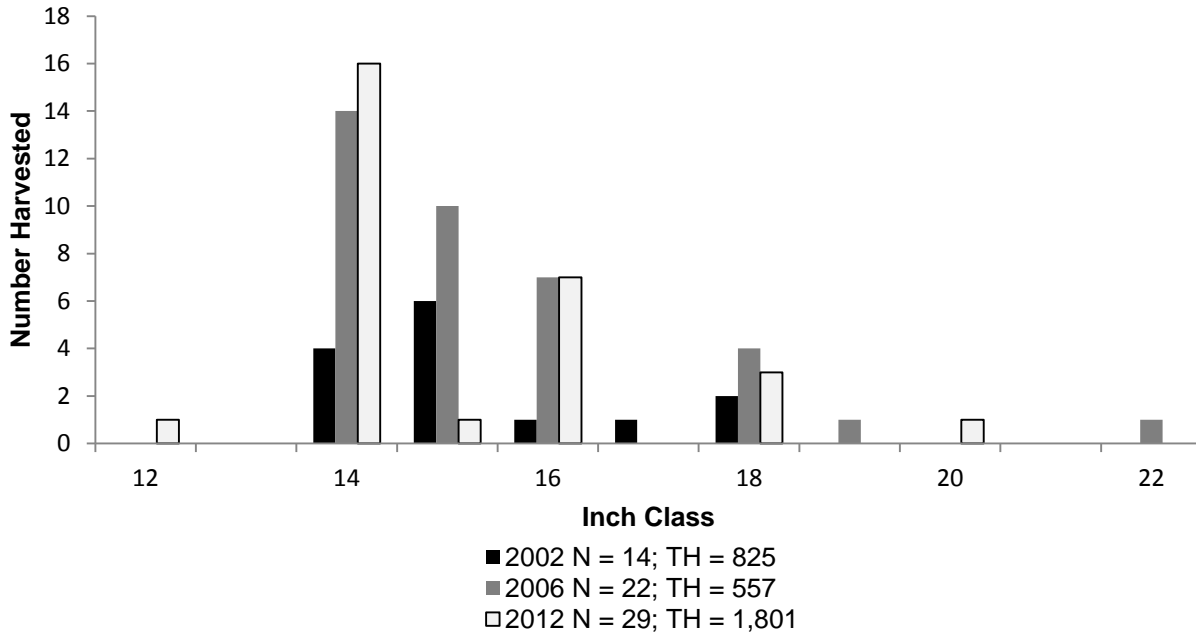


Figure 11. Length frequency of harvested Largemouth Bass observed during creel surveys at Greenbelt Reservoir, Texas, from 1 April through 30 June each year, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

### Largemouth Bass

Table 13. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Greenbelt Reservoir, Texas. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, F1 = first generation hybrid between a FLMB and a NLMB, Fx = second or higher generation hybrid between a FLMB and a NLMB. Genetic composition was determined with micro-satellite DNA analysis.

Year	Sample size	Number of fish				% FLMB alleles	% pure FLMB
		FLMB	F1	Fx	NLMB		
2005	31	0	0	16	15	15	0
2011	30	0	1	22	7	14	0
2015	30	0	0	11	13	33	0

### White Crappie

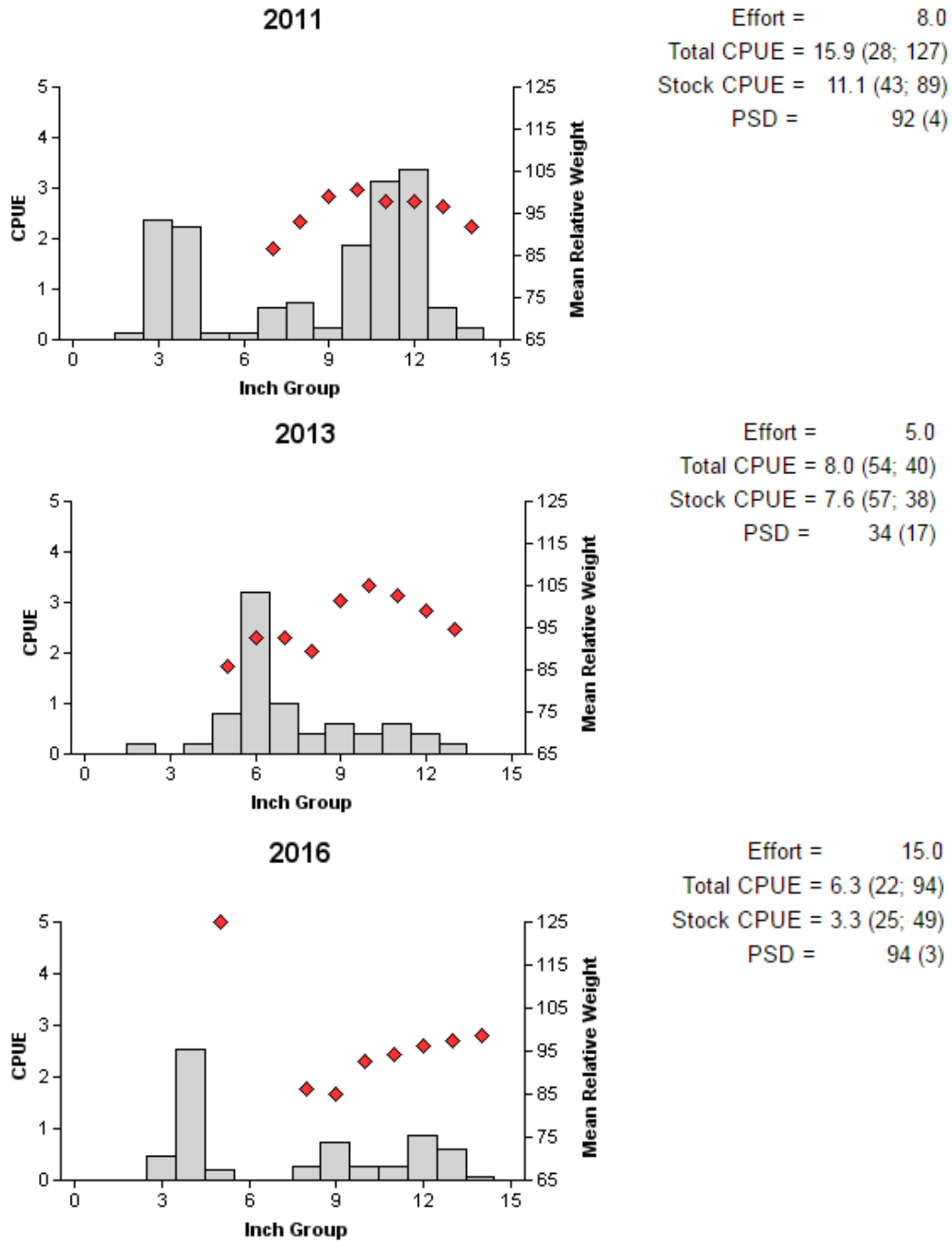


Figure 12. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for fall trap net surveys, Greenbelt Reservoir, Texas, 2011 and 2013 and spring trap netting in 2016. RSE is used for CPUE values and SE is used for PSD values.

## White Crappie

Table 14. Creel survey statistics for White Crappie at Greenbelt Reservoir, Texas, from 1 April through 30 June in each year. 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		
	2002	2006	2012
Surface area (acres)	1,990	1,085	700
Directed effort (h)	2,302.0 (34)	180.8 (104)	6,013.5 (23)
Directed effort/acre	1.16 (34)	0.17 (104)	8.59 (23)
Total catch per hour	0.10 (89)	0.00 (--)	1.13 (27)
Total harvest	1,234 (63)	39 (113)	6,260 (40)
Harvest/acre	0.62 (63)	0.04 (113)	8.94 (40)
Percent legal released	5.9	2.2	6.4

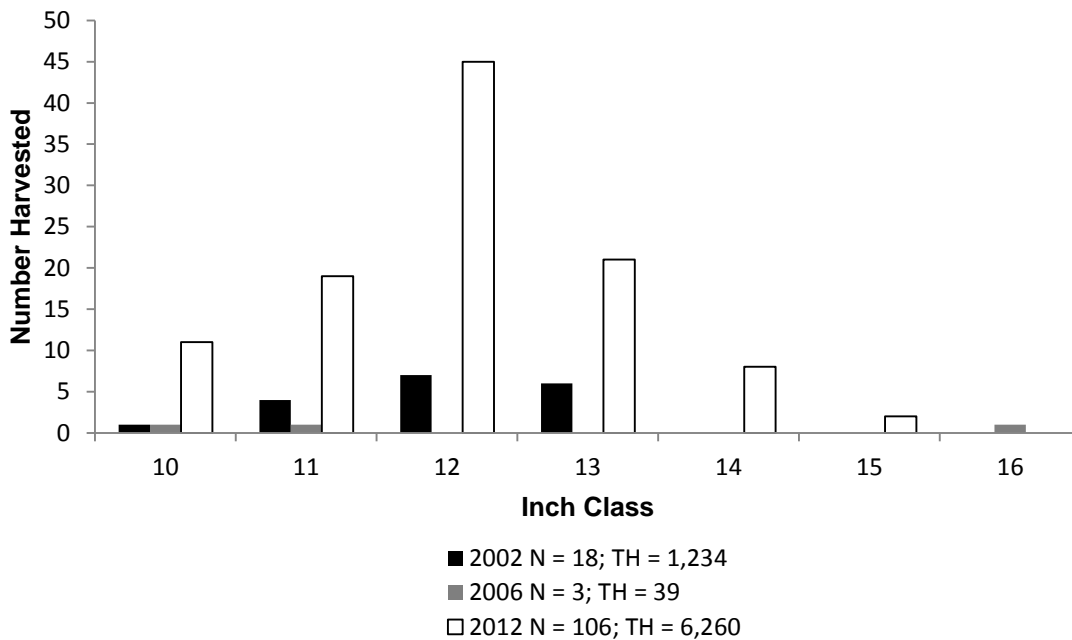


Figure 13. Length frequency of harvested White Crappie observed during creel surveys at Greenbelt Reservoir, Texas, from 1 April through 30 June in each year, all anglers combined. N is the number of harvested White Crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

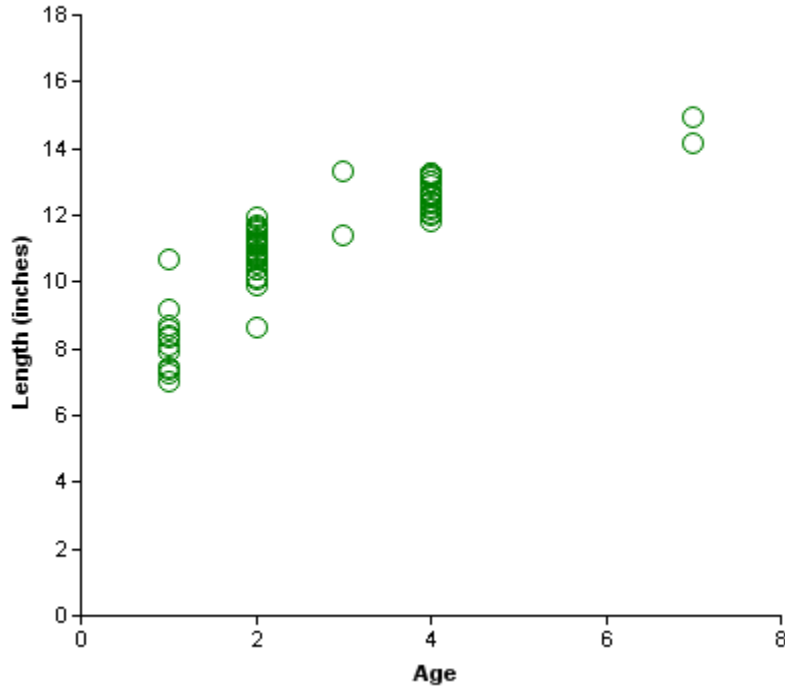
**White Crappie**

Figure 14. Length at age for 66 White Crappie collected from trap nets at Greenbelt Reservoir, Texas, November, 2011.

**Walleye**

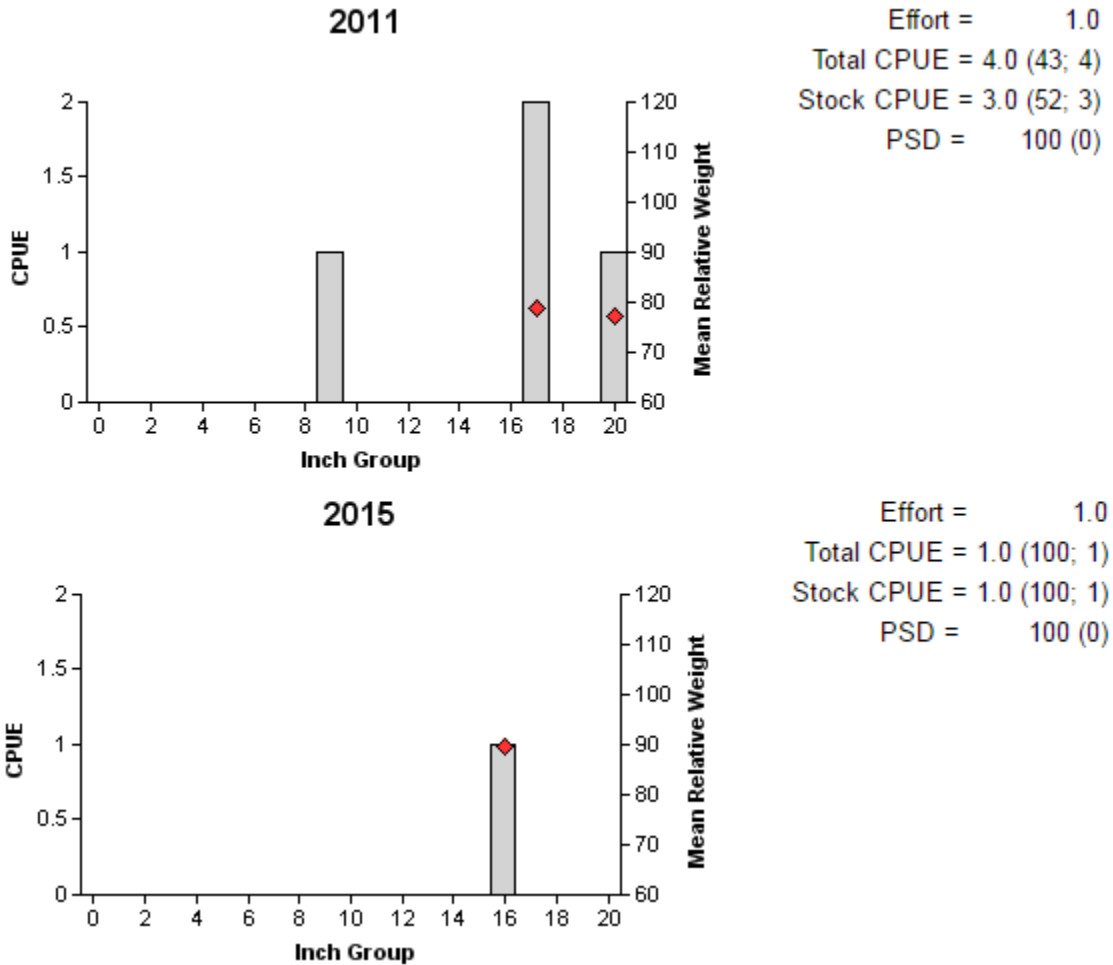


Figure 15. Number of Walleye caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for fall electrofishing surveys, Greenbelt Reservoir, Texas, 2011 and 2015. No Walleye were collected during fall electrofishing in 2013. RSE is used for CPUE values and SE is used for PSD values.



Walleye

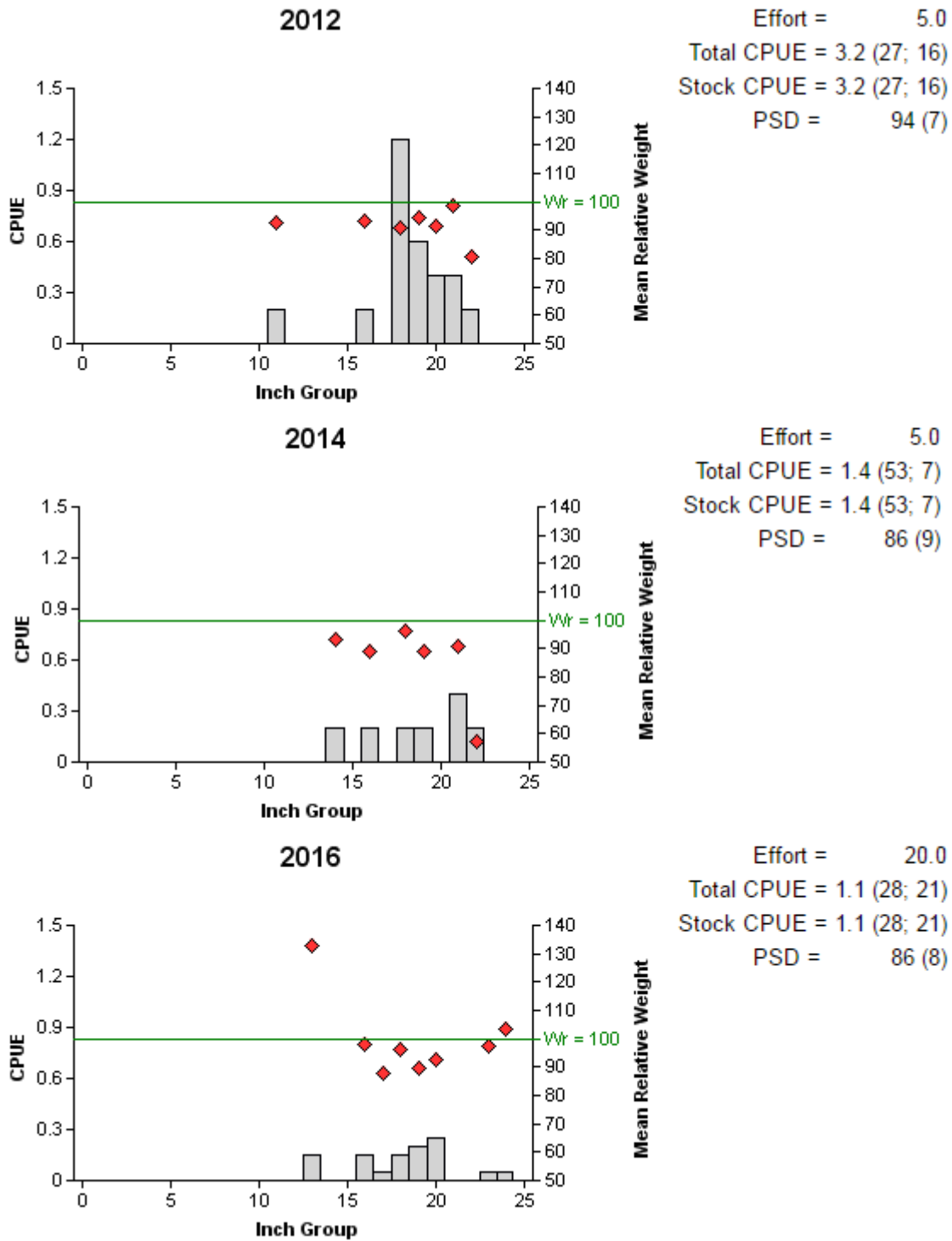


Figure 16. Number of Walleye caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE or SE and N are in parentheses) for spring gill net surveys, Greenbelt Reservoir, Texas, 2012, 2014, and 2016. RSE is used for CPUE values and SE is used for PSD values.

## Walleye

Table 15. Creel survey statistics for Walleye at Greenbelt Reservoir, Texas, from 1 April through 30 June each year. Total catch per hour is for anglers targeting Walleye and total harvest is the estimated number of Walleye harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year		
	2002	2006	2012
Surface area (acres)	1,990	1,085	700
Directed effort (h)	1,704.1 (37)	638.8 (73)	1,893.7 (36)
Directed effort/acre	0.86 (37)	0.59 (73)	2.71 (36)
Total catch per hour	0.00 (--)	0.12 (--)	0.13 (84)
Total harvest	154 (242)	99 (240)	370 (213)
Harvest/acre	0.08 (242)	0.09 (240)	0.53 (213)
Percent legal released*	0.0	0.0	1.3

\*Regulation is 5 fish/day with no more than 2 under 16 inches. Percent legal released is only calculated for the percent above 16 inches.

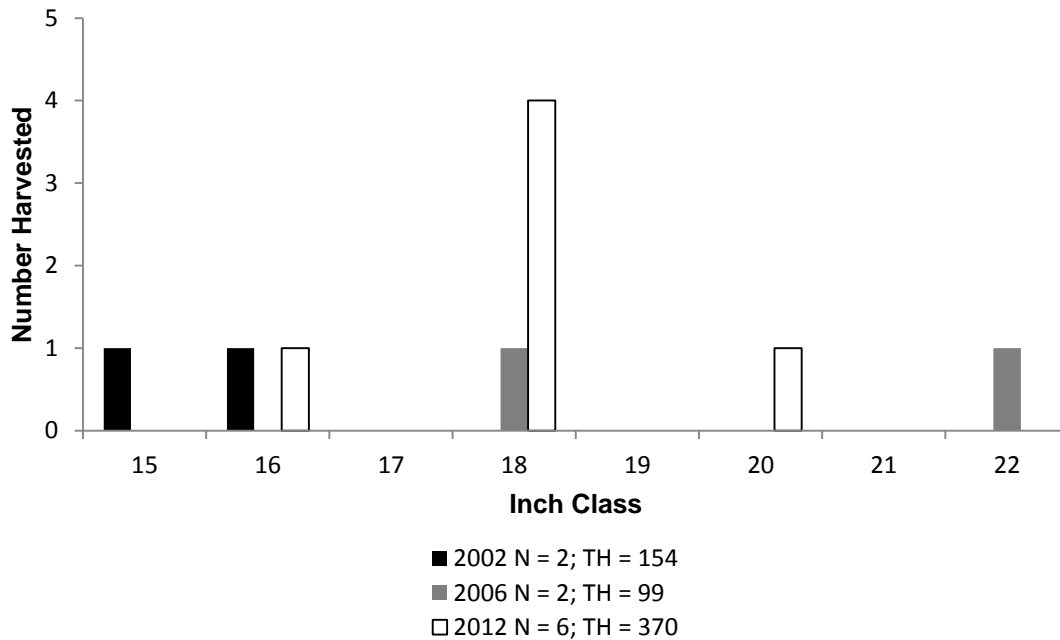


Figure 17. Length frequency of harvested Walleye observed during creel surveys at Greenbelt Reservoir, Texas, from 1 April through 30 June in each year, all anglers combined. N is the number of harvested Walleye observed during creel surveys, and TH is the total estimated harvest for the creel period.

Table 16. Proposed sampling schedule for Greenbelt 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	Electrofishing Fall	Trap net	Gill net	Habitat			Creel survey	Report
				Structural	Vegetation	Access		
2016-2017								
2017-2018	A	A	A					
2018-2019								
2019-2020	S	S	S		S	S		S

Table 17. Objective-based sampling plan components for Greenbelt Reservoir, Texas 2016 – 2020.

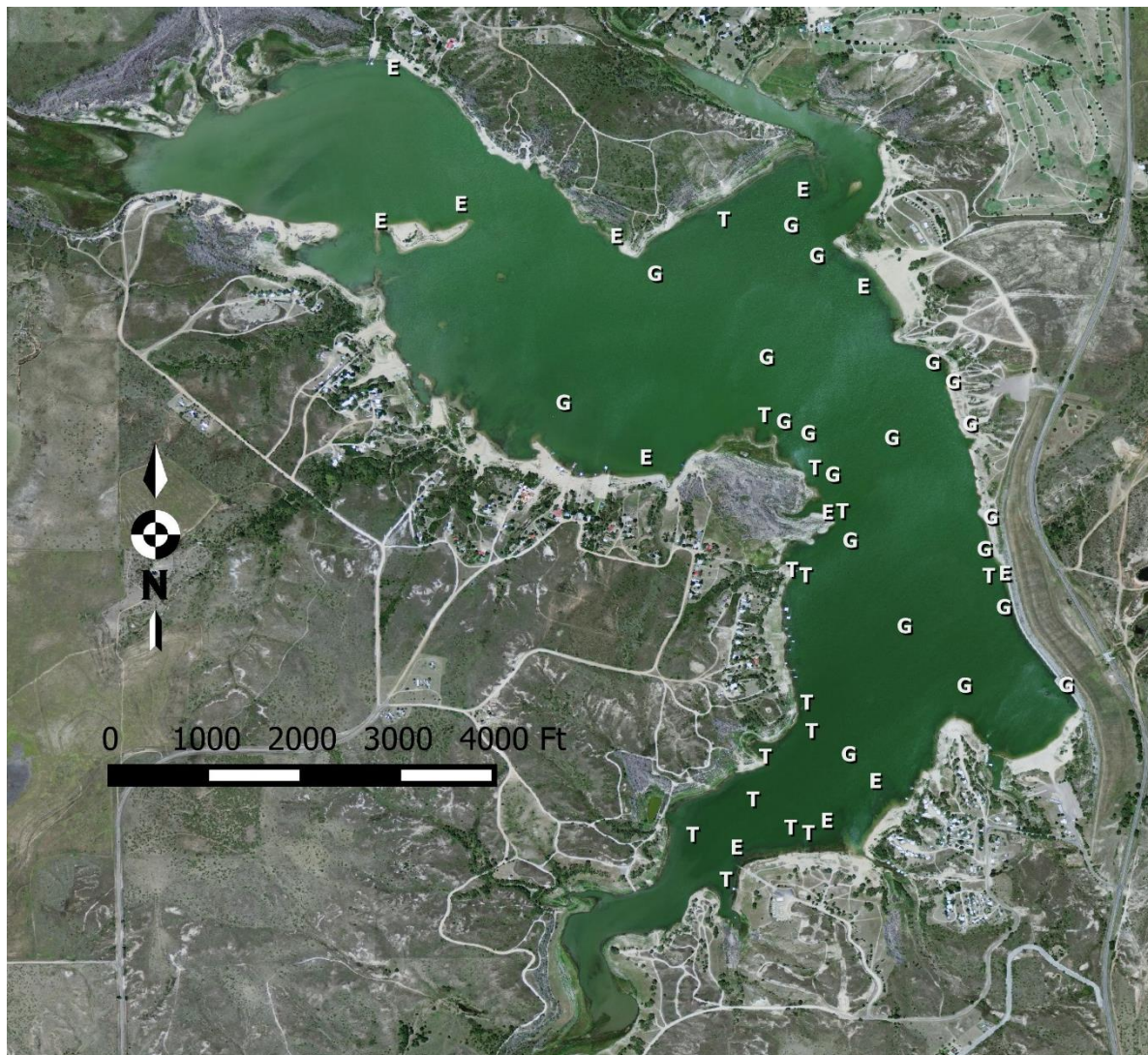
Gear/target species	Survey objective	Metrics	Sampling objective
<i>Electrofishing</i>			
Largemouth Bass	Abundance	CPUE – stock	RSE-Stock $\leq 25$
	Size structure	PSD, length frequency	$N \geq 50$ stock
	Genetics	% FLMB	$N = 30$ , any age
Gizzard Shad	Abundance	CPUE – Total	RSE $\leq 25$
	Size structure	PSD, length frequency	$N \geq 50$
	Prey availability	IOV	$N \geq 50$
<i>Trap netting</i>			
White Crappie	Abundance	CPUE-stock	RSE-stock $\leq 25$
	Size structure	PSD, length frequency	$N = 50$
<i>Gill netting</i>			
Channel Catfish	Abundance	CPUE– stock	RSE-Stock $\leq 25$
	Size structure	PSD, length frequency	$N \geq 50$ stock
White Bass	Abundance	CPUE– stock	RSE-Stock $\leq 25$
	Size structure	PSD, length frequency	$N \geq 50$ stock
Walleye	Abundance	CPUE– stock	RSE-Stock $\leq 25$
	Size structure	PSD, length frequency	$N \geq 50$ stock

**APPENDIX A**

Number (N) and catch rate (CPUE) of all species collected from all gear types from Greenbelt Reservoir, Texas, 2015-2016. Sampling effort was 1 hour for electrofishing, 20 net-nights for gill netting and 15 net-nights for trap netting.

Species	Electrofishing	N/RSE - (Electro)	Gill Netting	N/RSE - (Gill)	Trap Netting	N/RSE - (Trap)
Gizzard Shad	339.00	339/40	18.35	367/15		
Common Carp	296.00	296/18	8.80	176/14	0.20	3/100
River Carpsucker			0.20	4/78		
Black Bullhead	2.00	2/67			0.20	3/100
Channel Catfish	1.00	1/100	5.40	108/20		
Flathead Catfish			2.25	45/18		
White Bass	8.00	8/46	20.50	410/16		
Bluegill	41.00	41/24	0.35	7/48	3.07	46/34
Longear Sunfish	17.00	17/24	0.05	1/100	0.87	13/92
Largemouth Bass	332.00	332/12	3.80	76/27		
White Crappie	57.00	57/37	1.75	35/27	6.27	94/22
Yellow Perch	2.00	2/100	0.10	2/100		
Logperch	2.00	2/100				
Walleye	1.00	1/100	1.05	21/28	0.07	1/100

## APPENDIX B



Location of sampling sites, Greenbelt Reservoir, Texas, 2015-2016. Trap net, gill net, and electrofishing stations are indicated by T, G, and E, respectively.