

PERFORMANCE REPORT

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FEDERAL AID IN SPORT FISH RESTORATION ACT

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FEDERAL AID PROJECT F-221-M-2

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2011 Survey Report

Waco Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Waco Reservoir were surveyed in 2011 using an electrofisher and trap nets and in 2012 using gill nets. Anglers were surveyed from June 2011 to May 2012 with a creel. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Waco Reservoir is an 8,465-acre impoundment supplied by the North, Middle, and South Bosque Rivers within the Brazos River Basin, McLennan County. Water levels were six feet below conservation pool (462) during 2011 electrofisher and trap net surveys and full pool during 2012 gill net surveys. Fish habitat at the time of sampling was dominated by natural, rock, and gravel shorelines. Bank and boat access (10 ramps) on the reservoir is good, but there are currently no handicap-specific facilities.
- **Management history:** Important sport fish include largemouth bass, white bass, palmetto bass, white crappie, and catfish. The management plan from the 2007 survey report included annual monitoring of noxious vegetation, completing an exotic vegetation management plan, facilitating the placement and design of fishing piers with associated fish habitat structures, evaluating a trophy blue catfish slot limit regulation if implemented, and conducting a thorough habitat survey prior to the 2012 report.
- **Fish Community**
 - **Prey species:** Most major forage species were collected at rates above their historical average, with the exception of gizzard shad which were well below average. Most gizzard shad were available as prey for predators.
 - **Catfishes:** Blue and channel catfish were collected in good numbers, and both species had good to excellent condition. Only a single flathead catfish was collected. Over 20% of all anglers at Waco Reservoir fished for some species of catfish.
 - **Temperate bass:** White bass were sampled at historical high rates, and newly stocked Palmetto bass were also collected. Surprisingly, only a little over 3% of anglers at Waco Reservoir fished for white bass or hybrids. The spring spawn was disrupted by low, then high water, which had a lot to do with the reduction in anglers targeting those species.
 - **Largemouth bass:** Largemouth bass catch rate and body condition was average. Over 50% of all anglers at Waco Reservoir fished for largemouth bass.
 - **White crappie:** White crappie were collected at below average rates; black crappie were not observed. Over 12% of all anglers at Waco Reservoir fished for white crappie.
- **Management Strategies:** Continue managing Waco Reservoir with statewide regulations with the exception of the trophy blue catfish regulation. Conduct general monitoring with electrofisher and trap nets in 2015 and gill nets in 2016. Conduct supplemental monitoring with electrofisher and trap net surveys in 2013 and gill net surveys in 2014.

INTRODUCTION

This document is a summary of fisheries data collected from Waco Reservoir in 2011-2012. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other species of fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2011-2012 data for comparison.

Reservoir Description

Waco Reservoir is an 8,465-acre impoundment supplied by the North, Middle, and South Bosque Rivers within the Brazos River Basin, McLennan County. It is operated by the U.S. Army Corps of Engineers and primary water uses included flood control, municipal water supply and recreation. Mean and maximum depths are 28 and 92 feet respectively. Waco has a drainage area of 1,670 square miles, a storage capacity of 104,100 acre-feet, and a shoreline length of 60 miles. Water levels were six feet below conservation pool (462) during 2011 electrofisher and trap net surveys and at full pool during 2012 gill net surveys (Figure 1). Fish habitat at the time of sampling was dominated by natural, rock, and gravel shorelines. Hydrilla, a non-native, was first documented in the reservoir in 2003. The high water levels of 2007 reduced Hydrilla to just a few plants, but the 2011 survey showed that Hydrilla had rebounded to 9.4 acres. Bank and boat access (10 ramps) on the reservoir is good, but there are currently no handicap-specific facilities. More information about Waco Reservoir and its facilities can be obtained by visiting the Texas Parks and Wildlife Department's web site at www.tpwd.state.tx.us and navigating within the [fishing link](#).

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Tibbs and Baird 2007) included:

1. Monitoring the reservoir for noxious vegetation annually.
Action: Noxious vegetation surveys have been conducted annually to monitor for Hydrilla and other potentially noxious species. Additional information can be found in the vegetation/habitat history section of this report.
2. Completing an exotic vegetation management plan.
Action: A Hydrilla Management Plan was completed, agreed upon by all partners, and formalized into a memorandum of understanding (MOU).
3. Continuing to work with the U.S. Army Corps of Engineers to facilitate the placement and design of one or two fishing piers and adjacent fish habitat structures.
Action: A reconnoitering survey was performed in 2005 to identify optimal locations for the construction of fishing piers which handicap and bank anglers could access. These locations were discussed with the U.S. Army Corps of Engineers, and construction began on two of the three identified sites in 2006. The piers were only partially constructed when reservoir levels reached 25 feet above conservation pool in 2007, and damage from the high water left the piers structurally unsafe. These structures were removed, and to date, the construction of additional piers has not been initiated by the U.S. Army Corps of Engineers.
4. Presenting a trophy blue catfish length limit regulation at the 2008 staff meeting, and pending the outcome of that meeting, initiating and evaluating the new regulation.
Action: The trophy blue catfish length limit regulation was approved and initiated on September 1, 2009. The regulation is currently being evaluated on three reservoirs: Lewisville, Richland Chambers, and Waco.
5. Conducting and mapping a thorough habitat/vegetation survey for the 2011 report.
Action: A habitat and vegetation survey was conducted on Lake Waco during summer

2011; results of these surveys are included in this report.

Harvest regulation history: Sportfishes in Waco Reservoir are currently managed with statewide regulations with the exception of blue catfish. Blue catfish are currently managed with a 30- to 45-inch slot limit, where blue catfish less than 30 inches or greater than 45 inches can be retained; only one blue catfish greater than 45 inches may be retained each day, and the daily bag limit is 25 blue and channel catfish in any combination (Table 2).

Stocking history: Waco Reservoir was stocked with 131,621 blue catfish and 143,249 Florida largemouth bass in 2004. Palmetto bass have been reintroduced and stocked annually at a rate of 5 fish per acre since 2009. The complete stocking history is in Table 3.

Vegetation/habitat history: Efforts from the aquatic habitat enhancement initiative begun in 1998 had produced nearly 75 acres of native species by 2003, however Hydrilla (*Hydrilla verticillata*) was also observed late that season. The new conservation pool achieved in October 2003 (i.e., 462) reduced native and noxious vegetation alike to remnant populations of water willow, several native floating-leaved species, and wild celery. While native species struggled to regain a foothold, Hydrilla expanded to 73 acres by 2006, with the main areas of infestation being Twin Bridges Park, Speegleville Park, Airport Park, and Reynolds Creek. The Speegleville and Twin Bridges Park areas were treated with the aquatic herbicide *Nautique* during summer 2006, however high densities of Hydrilla remained throughout the year. Prolonged high water levels in 2007 knocked-back most of the Hydrilla once again, yet a few sprigs were observed in 2008, and 1.72 acres were visible around the Speegleville Marina by mid-summer 2009. The 2010 noxious vegetation survey showed an increase in Hydrilla coverage to 4.53 acres, and another exotic species, Giant Reed (*Arundo spp.*), was first observed during this survey. The 2011 vegetation survey showed some improvement in native vegetation, with 13.3 acres each of arrowhead, cattail, and rice cutgrass, and 0.1 acres each of bulrush and water willow. Bulrush and water willow were planted as part of cooperative effort between TPWD and the City of Waco. However, non-native Hydrilla and giant reed also expanded to 9.4 and 0.1 acres respectively.

Water Transfer: Waco Reservoir, a U.S. Army Corps of Engineers reservoir, is primarily used for flood control, municipal water supply, and recreation. There is one raw water intake station on the reservoir which transfers water offsite to the City of Waco Water Utilities Services Department treatment plant adjacent to the dam. From that Dissolved Air Flotation plant, partially treated water is pumped to two filtration plants, and then to nearly 200,000 customers in Central Texas.

Reservoir capacity: Waco Reservoir was impounded in 1965. Original plans calculated the reservoir's capacity at conservation pool (455 feet above mean sea level) to be 152,500 acre-feet with a surface area of 7,270 acres. Two volumetric surveys have been conducted since impoundment: one in 1970 by the US Army Corps of Engineers, and one in 1995 by the Texas Water Development Board. The 1970 survey found a volume of 149,189 acre-feet and a surface area of 7,237 acres at conservation pool elevation, whereas the 1995 survey found a volume of 144,830 acre-feet at normal elevation pool, indicating a loss of approximately 2.9% in surface acreage (i.e., 174.8 acre-feet per year during the 25 year period between surveys). A permanent pool rise occurred in October 2003, which raised the conservation pool level to 462 feet above mean sea level, yet additional surveys by the Texas Water Development Board have not yet been conducted. Additional information on this survey and its findings can be found at the following web link: http://www.twdb.state.tx.us/hydro_survey/waco/WacoRPT.pdf

METHODS

Fishes were collected by electrofishing (1.5 hours at 18 5-min stations), gill netting (10 net nights at 10 stations), and trap netting (10 net nights at 10 stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing and, for gill and trap nets, as the number of fish per net night (fish/nn). All survey sites were randomly selected and all surveys

were conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2011).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD)], as defined by Guy et al. (2007), and condition indices [relative weights (Wr)] were calculated for target fishes according to Anderson and Neumann (1996). Index of vulnerability (IOV) was calculated for gizzard shad (DiCenzo et al. 1996). Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE statistics and SE was calculated for structural indices and IOV. No age and growth was conducted in 2011-2012. Source for water level data was the United States Geological Survey (USGS) website.

RESULTS AND DISCUSSION

Habitat: Littoral zone habitat consisted primarily of natural and rocky shoreline with standing timber and inundated stumps. An aquatic vegetation survey was conducted in summer, 2011. A physical habitat survey was conducted in winter, 2012 (Table 4).

Creel Directed fishing effort by anglers was highest for black bass spp. (51.2%), followed by anglers fishing for catfish spp. (20.3%), anything (12.6%), and lastly crappie spp. (12.3%; Table 5). Total fishing effort for all species at Waco Reservoir was 244,635 hours from June 2011 to May 2012, which is higher than the previous creel survey from June 2007 to May 2008, during which the total fishing effort was 172,294 hours. Bank anglers comprised 17% of the total fishing effort in '11-'12. Anglers spent an estimated \$1,514,864 on direct expenditures in '11-'12, compared to \$789,984 in '07-'08.

Prey species: Threadfin and gizzard shad were collected by electrofisher at 108.0/h and 110.7/h respectively in 2011. The Index of vulnerability (IOV) for gizzard shad was good, and 85% of gizzard shad were available to existing predators as forage. Other important forage species collected were bluegill (388.7/h), longear sunfish (112.0/h), redear sunfish (32.7/h), green sunfish (6.0/h), and warmouth (2.0/h). Panfish seldom reach preferred size classes in Waco, and few anglers actively seek them. (Figures 2 and 3; Appendices A and B).

Catfishes: Blue catfish were collected with gill nets at 2.8/n in 2012; this catch rate equated to 28 collected individuals, and was below the historical average. Proportional size distribution values have remained similar over the past two surveys indicating acceptable recruitment, growth, and mortality. Many sampled individuals were in the quality size category of 20 inches or more. Body condition, expressed as relative weight (Wr), was good to excellent across all size classes (Figure 4; Appendices A and B). Additional jugline catch size distribution and growth data are presented in Appendices D and E. A total of 12,501 blue catfish were harvested and 8,939 released from June 2011 through May 2012. Observed harvest showed good angler compliance, and harvested fish ranged in length from 12 to 21 inches (Figure 5).

Channel catfish were collected with gill nets at 7/n in 2012; this catch rate equates to 70 collected individuals, and was the second highest catch rate on record. Proportional size distribution values have fluctuated moderately over the past three surveys indicating variable recruitment, growth, and mortality. Sampled channel catfish did not reach the preferred size category of 24 inches. Body condition was fair, varying greatly across size classes (Figure 6; Appendices A and B). A total of 19,710 channel catfish were harvested and 26,913 released from June 2011 through May 2012. Observed harvest showed good angler compliance. Harvested fish ranged in length from 11 to 28 inches (Figure 7) with only one below the 12" minimum.

Flathead catfish are present in the reservoir. A total of 236 flathead catfish were harvested and 849 released from June 2011 through May 2012.

Temperate bass: White bass were collected with gill nets at 4.3/nn in 2012; this catch rate equated to 43 collected individuals, and was well above the historical average for the species. The PSD for white bass has remained similar over the past three surveys, indicating stable recruitment, growth, and mortality. Body condition was good in smaller size classes (i.e., 90), yet poor in larger size classes (i.e., 70), possibly due to recent spawning activity of older brood fish (Figure 8; Appendices A and B). A total of 7,864 white bass were harvested and 19,393 released from June 2011 through May 2012. Observed harvest showed good angler compliance. Harvested fish ranged in length from 10 to 14 inches (Figure 9).

Palmetto bass stockings began in 2009 through a cooperative effort between TPWD and the City of Waco. Palmettos were collected with gill nets at 1.4/nn in 2012; this catch rate equated to 14 collected individuals, and represents good recruitment to the fishery given the low stocking rate of 5 fish/acre. The PSD for palmetto bass was 93. Many sampled individuals were approaching the memorable size category of 20 inches or more. Body condition was good across all size classes (Figure 10; Appendices A and B). A total of 226 palmetto bass were harvested and 1,305 released from June 2011 through May 2012. Observed harvest showed good angler compliance. The two harvested fish were 19 inches (Figure 11).

Largemouth bass: Largemouth bass were collected by electrofisher at 189/h in 2011; this catch rate equates to 284 collected individuals, and was higher than the historical average. Proportional size distribution was good (38), and reflects improvement to the population structure since the 2007 survey. The proportion of individuals 14-inches and larger was 12, indicating fair numbers of harvestable bass for anglers including several individuals at or near 20 inches. Body condition was good with relative weights (W_r) averaging above 90 for most size classes. Florida largemouth bass influence has remained relatively constant as Florida alleles were estimated at 48% in 2011 (Figure 12; Table 9; Appendices A and B). A total of 17,759 largemouth bass were harvested and 84,899 released from June 2011 through May 2012. Fish in possession of a tournament angler were considered "harvested" even if the tournament was a catch and release format. Observed harvest showed good angler compliance. Harvested fish ranged from 14 to 21 inches (Figure 13).

White crappie: White crappie were collected from trap nets at 2.1/nn in 2011; this catch rate is below average for white crappie in the reservoir. The proportional size distribution (PSD) has remained excellent over the past three surveys, and over 70% of stock-sized fish (5 inches) and longer were also longer than the quality size of 8-inches. Few sampled crappie approached the memorable size category of 12 inches. Body condition, expressed as relative weight (W_r), typically remained above 90. A total of 74,643 white crappie were harvested and 87,569 released from June 2011 through May 2012. Observed harvest showed good angler compliance. Harvested fish ranged from 10 to 16 inches (Figure 15).

Fisheries management plan for Waco Reservoir, Texas

Prepared – July 2012.

ISSUE 1: Prolonged high water levels in 2007 eliminated most of the Hydrilla in Waco Reservoir, however it is still present and expanding once again. Nearly 10 acres were observed during the 2011 survey.

MANAGEMENT STRATEGIES

1. Continue monitoring the reservoir for noxious vegetation annually through 2015.
2. Continue following the Hydrilla Management Plan and agreed upon MOU to work with the U.S. Army Corps of Engineers, City of Waco, and private marinas to monitor and evaluate management options for Hydrilla on an annual basis.

ISSUE 2: Efforts from the aquatic habitat enhancement initiative of 1998 were very successful on Waco Reservoir, producing nearly 75 acres of native species by 2003. This initiative was then hampered by the permanent seven-foot conservation pool rise of 2003 as well as prolonged high water caused by localized flooding during summer 2007. Although the 2011 vegetation survey showed some improvement in native vegetation expansion aquatic habitat enhancement is still needed to create important fish habitat future fisheries will rely on once the lakes' standing timber ages and disappears. Additionally, planting and encouraging the enhancement of native vegetation should aid in slowing the expansion of exotic species such as Hydrilla.

MANAGEMENT STRATEGIES

1. Utilize appropriate species of native vegetation being grown at the City of Waco Wetlands facility for plantings on Waco Reservoir.
2. Request appropriate species of native vegetation from the Texas Freshwater Fisheries Center (TFFC) aquatic plant nursery, and plant vegetation as needed.
3. Monitor the spread/growth of native vegetation plantings on an annual basis. Then based on results, review the program during the next report year and make recommendations.
4. Investigate alternative funding sources to promote aquatic habitat enhancement on the lake.

ISSUE 3: Recruitment of palmetto bass from initial stockings has been very good, despite the low stocking rate. Creel data show both targeted and incidental catch by anglers. The majority of anglers are supportive of the new fishery but some remain concerned about effects on other species.

MANAGEMENT STRATEGIES

1. Gill net in spring, 2014 and 2016 to monitor the development of the palmetto bass fishery.
2. Collect Tier II age sample of palmetto bass in 2016 to obtain baseline information.
3. Conduct extra electrofishing and trap netting in 2013 to document important sportfish (e.g. largemouth bass, white crappie) and prey (e.g. gizzard shad) populations to document possible changes in sportfish and preyfish populations.
4. Work with local media and game wardens to ensure education and compliance by anglers.

ISSUE 4: Waco Reservoir has the potential to produce trophy largemouth bass with improved habitat conditions since the permanent pool rise of seven feet in October 2003, good forage base, and on-going habitat improvement projects, yet the percentage of pure Florida largemouth bass genotypes remains at zero.

MANAGEMENT STRATEGIES

1. Request stockings of Florida largemouth bass fingerlings during 2013 and 2015.
2. Determine genetic composition of multiple year classes in 2015 following established protocol.

ISSUE 5: The current blue catfish regulation was implemented on September 1, 2009. A research project evaluating the effect of the regulation is ongoing and data collection is scheduled to be complete in 2016.

MANAGEMENT STRATEGIES

1. Continue collecting data required to evaluate the regulation.
2. Present relevant information to interested angler groups and at professional meetings.

ISSUE 6: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (*Dreissena polymorpha*) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches and plugging engine cooling systems. Giant Salvinia (*Salvinia molesta*) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority 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.

SAMPLING SCHEDULE JUSTIFICATION:

The proposed sampling schedule includes standard electrofisher sampling in 2013 and 2015, trap netting in 2013 and 2015, and gill net sampling in 2014 and 2016 (Table 17).

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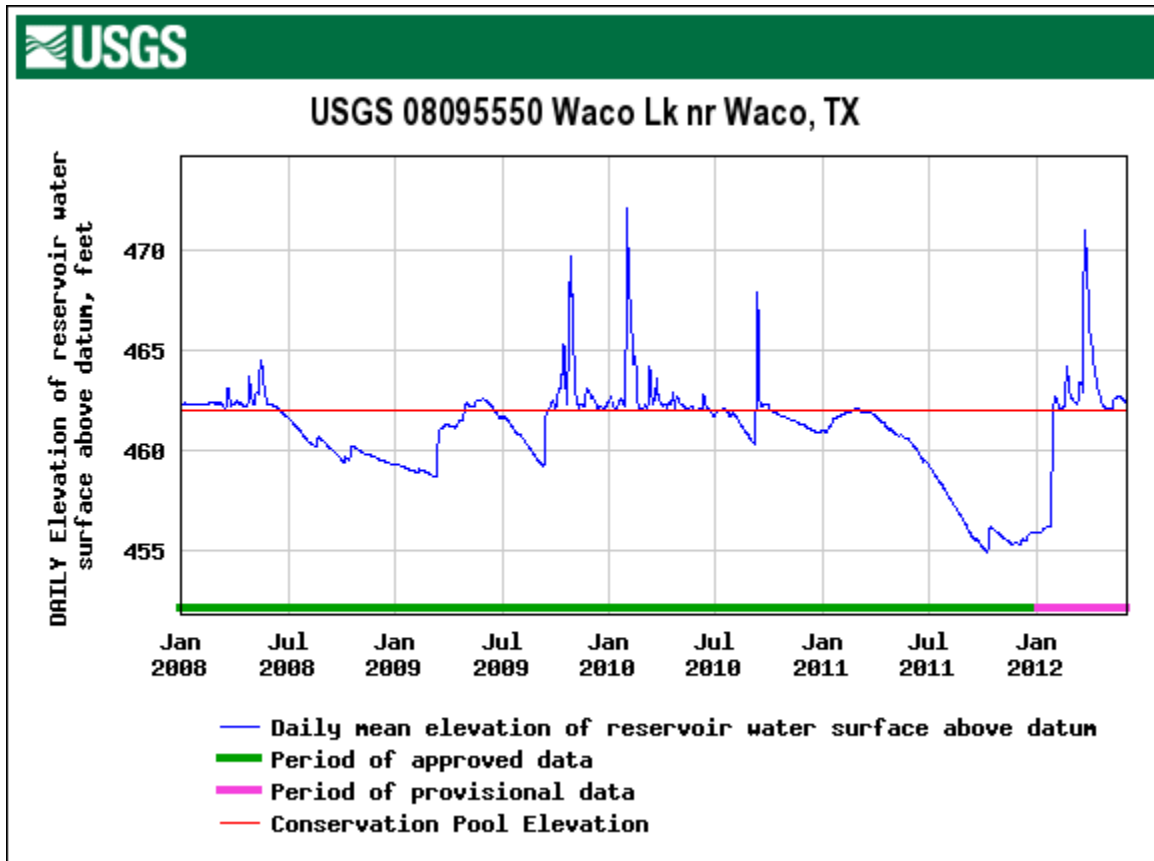


Figure 1. Daily mean water levels for Waco Reservoir from January 1, 2008 through June 1, 2012. Conservation pool level is 462 feet above mean sea level. Figure from USGS website.

Table 1. Characteristics of Waco Reservoir, Texas.

Characteristic	Description
Year Constructed	1965
Controlling authority	U.S. Army Corps of Engineers
County	McLennan
Reservoir type	Tributary
Shoreline Development Index (SDI)	5.0
Conductivity	325 umhos/cm

Table 2. Harvest regulations for Waco Reservoir.

Species	Bag Limit	Minimum-Maximum Length (inches)
Catfish, Blue ¹	25 (in any combination)	See caption below
Catfish, Channel	25 (in any combination)	12 - No Limit
Catfish, Flathead	5	18 - No Limit
Bass, White	25	10 - No Limit
Bass: largemouth	5	14 - No Limit
Bass: Spotted	5 (in any combination)	No Limit - No Limit
Crappie: white and black crappie, their hybrids and subspecies	25 (in any combination)	10 - No Limit

¹Blue catfish are currently managed with a 30- to 45-inch slot limit, where blue catfish less than 30 inches or greater than 45 inches can be retained; only one blue catfish greater than 45 inches may be retained each day; the daily bag limit is 25 for blue catfish, channel catfish, their hybrids and subspecies.

Table 3. Stocking history for Waco Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), adults (ADL) and unknown (UNK). Life stages for each species are defined as having a mean length that falls within the given length range. For each year and life stage the species mean total length (Mean TL; in) is given. For years where there were multiple stocking events for a particular species and life stage the mean TL is an average for all stocking events combined.

Species	Year	Number	Life Stage	Mean TL (in)
Blue catfish	1988	15	ADL	15.8
	1989	72,800	FGL	2.7
	2000	91,499	FGL	2.1
	2004	6,610	AFGL	6.0
	2004	125,011	FGL	2.1
	Total	295,935		
Channel catfish	1972	90,000	AFGL	7.9
	1990	60,768	FGL	3.9
	Total	150,768		
Florida Largemouth bass	1981	19,875	FRY	1.0
	1982	19,980	FRY	1.0
	1983	4,500	AFGL	5.0
	1983	20,350	FRY	1.0
	1994	300,466	FGL	1.3
	1996	35,076	FGL	1.3
	2004	143,249	FGL	1.6
	Total	543,496		
Largemouth bass	1971	400,000	FRY	0.7
	Total	400,000		
Palmetto Bass (striped X white bass hybrid)	1975	72,233	UNK	UNK
	1977	73,121	UNK	UNK
	1979	65,700	UNK	UNK
	2009	42,776	FGL	1.4
	2010	37,555	FGL	1.8
	2011	42,727	FGL	1.6
	Total	334,112		
ShareLunker Largemouth Bass	2008	2,884	FGL	1.5
	Total	2,884		
Striped bass	1983	72,300	UNK	UNK
	1995	116,260	FGL	1.3
	1996	80,768	FGL	1.3
	Total	269,328		
Threadfin shad	1984	500	AFGL	3.0
	Total	500		

Species	Year	Number	Life Stage	Mean TL (in)
Walleye	1974	138,000	FRY	0.2
	1975	70,000	FRY	0.2
	1976	78,500	FRY	0.2
	1978	1,357,000	FRY	0.2
	Total	1,643,500		

Table 4. Survey of littoral zone and physical habitat types, Waco Reservoir, Texas, 2011-2012. Linear shoreline distance (miles) and percent of linear shoreline distance was recorded for each habitat type greater than one percent; otherwise noted as trace. Percent of total shoreline distance is blank for boat docks/piers because they were dually coded with adjacent habitat; counts are given instead. Survey was conducted using 2010 NAIP, 1-meter resolution satellite imagery.

Shoreline habitat type	Shoreline Distance	
	Miles	Percent of total
Natural shoreline	55.9	87.6
Rock shoreline	4.8	7.5
Gravel shoreline	2.1	3.2
Bulkhead	1.1	1.7
Boat docks/piers		N=67

Table 5. Percent directed angler effort, for all anglers by species group for Waco Reservoir, Texas, 2011-2012.

Species group	% directed effort 2011-2012
Black bass spp.	51.2
Crappie spp.	12.3
Catfish spp.	20.3
Temperate bass spp.	3.3
Panfish spp.	0.2
Anything	12.6

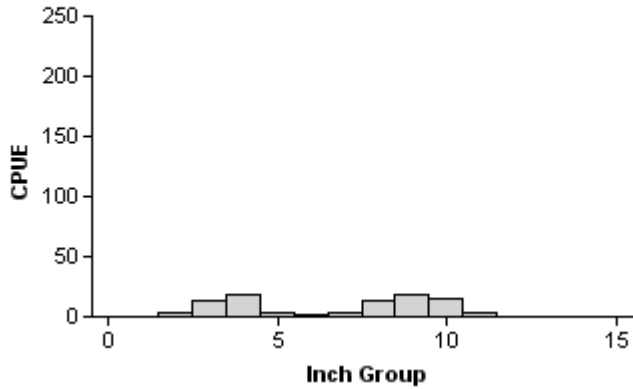
Table 6. Total fishing effort (h) for all species and total directed expenditures at Waco Reservoir, Texas, 2001-2002, 2007-2008 and 2011-2012. Relative standard errors (RSE) are in parentheses.

Creel Statistic	Year		
	2011-2012	2007-2008	2001-2002
Total fishing effort (hours)	244,635	172,294	70,847
Total directed expenditures	\$1,514,864	\$789,984	\$66,091

Gizzard Shad

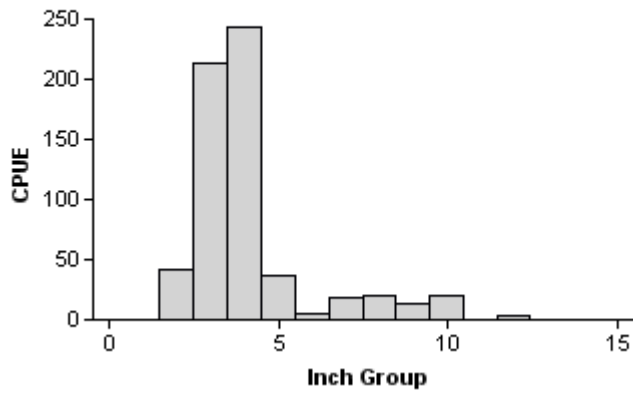
2003

Effort = 1.5
 Total CPUE = 91.3 (26; 137)
 Stock CPUE = 53.3 (25; 80)
 IOV = 45 (10.2)



2007

Effort = 1.5
 Total CPUE = 614.0 (28; 921)
 Stock CPUE = 74.0 (14; 111)
 IOV = 91 (2.7)



2011

Effort = 1.5
 Total CPUE = 110.7 (25; 166)
 Stock CPUE = 24.7 (24; 37)
 IOV = 85 (4.6)

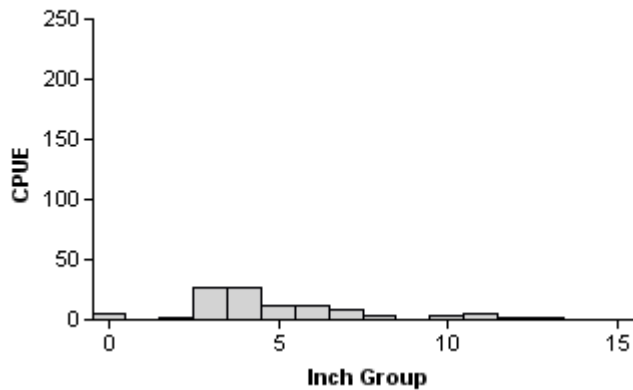
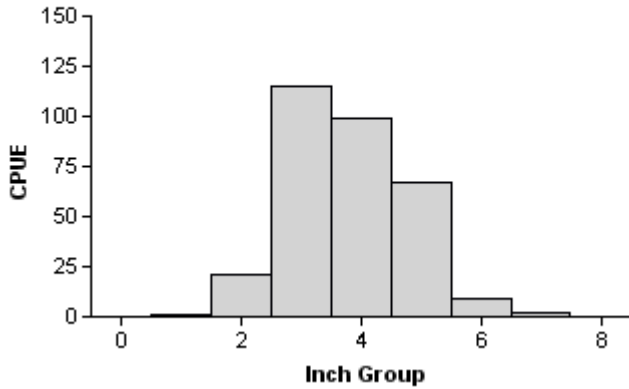


Figure 2. Number of gizzard shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Waco Reservoir, Texas, 2003, 2007, and 2011.

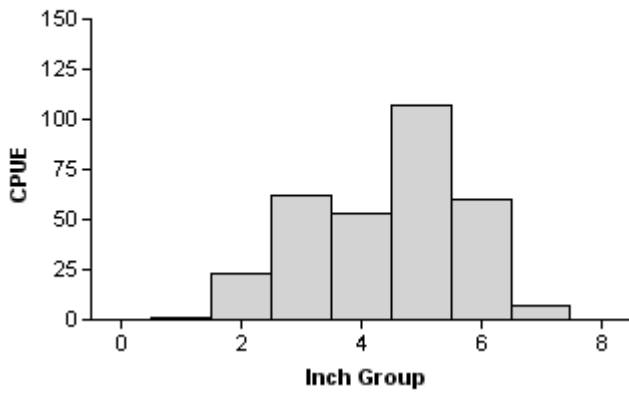
Bluegill

2003



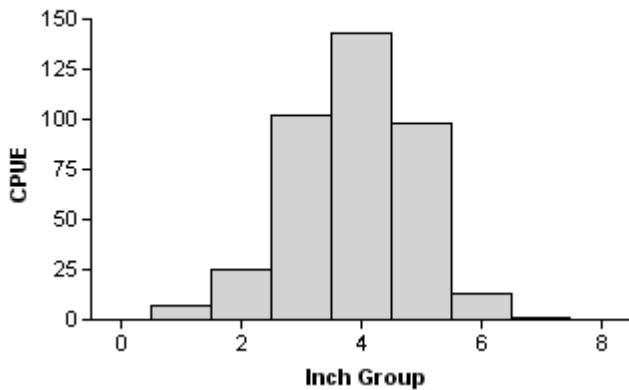
Effort = 1.5
 Total CPUE = 314.7 (16; 472)
 Stock CPUE = 292.7 (16; 439)
 PSD = 4 (2.1)

2007



Effort = 1.5
 Total CPUE = 314.0 (32; 471)
 Stock CPUE = 290.0 (35; 435)
 PSD = 23 (7.3)

2011



Effort = 1.5
 Total CPUE = 388.7 (27; 583)
 Stock CPUE = 356.7 (29; 535)
 PSD = 4 (1.4)

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, Waco Reservoir, Texas, 2003, 2007, and 2011.

Blue Catfish

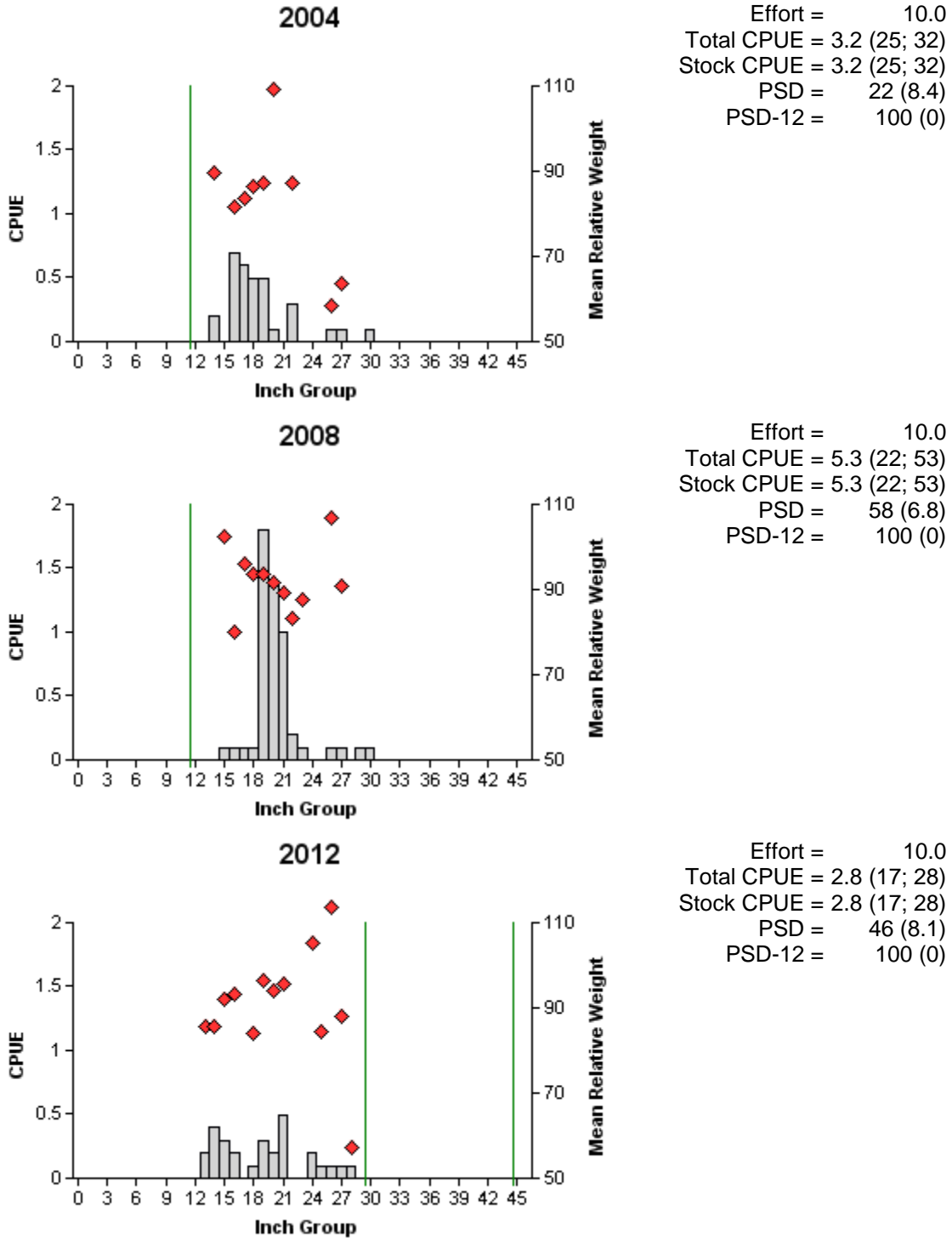


Figure 4. Number of blue catfish caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Waco Reservoir, Texas, 2004, 2008, and 2012. Vertical lines represent the 12-inch minimum length limit, and 30 to 40-inch slot limit.

Blue Catfish

Table 7. Creel survey statistics for blue catfish at Waco Reservoir from June 2011 through May 2012. Directed effort and total catch is for anglers targeting catfish spp. and harvest is the estimated number of blue catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	49,679 (14)
Directed effort/acre	5.87
Total catch per hour	1.03 (42)
Total harvest	12,501 (44)
Harvest/acre	1.48

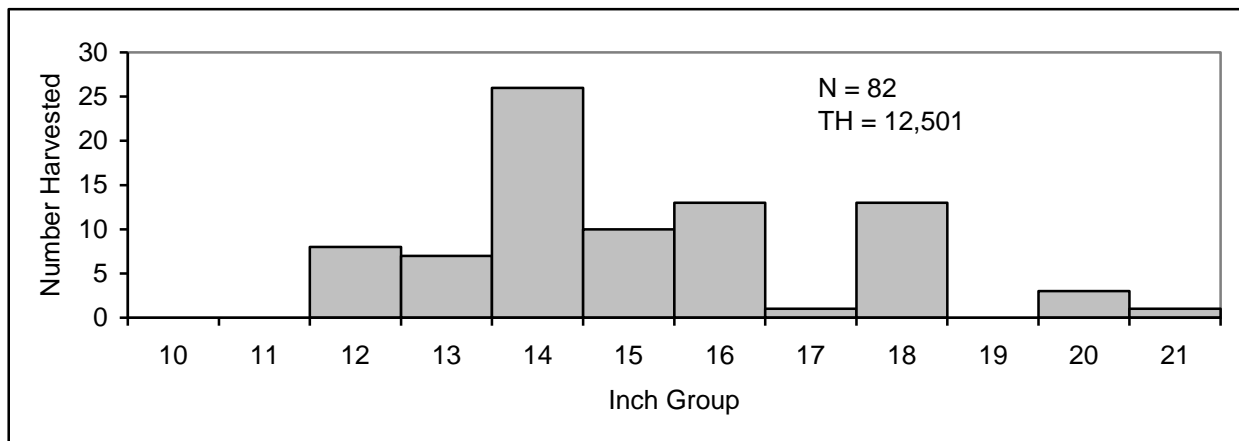
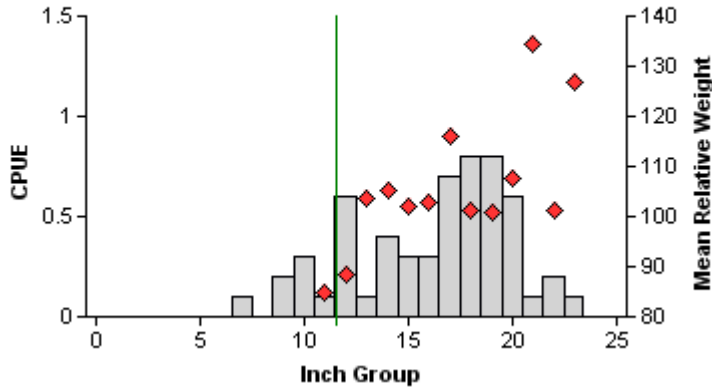


Figure 5. Length frequency of harvested blue catfish observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested blue catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

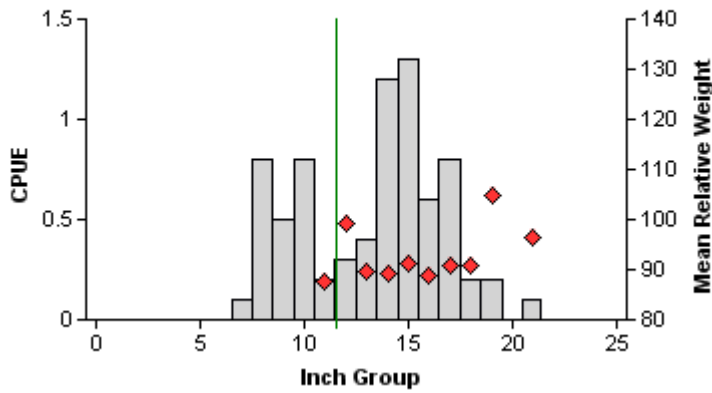
Channel Catfish

2004



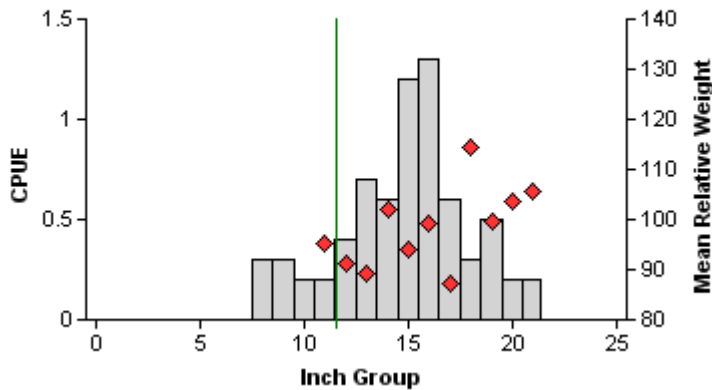
Effort = 10.0
 Total CPUE = 5.7 (21; 57)
 Stock CPUE = 5.1 (23; 51)
 PSD = 71 (5.2)
 PSD-12 = 98 (1.6)

2008



Effort = 10.0
 Total CPUE = 7.5 (31; 75)
 Stock CPUE = 5.3 (30; 53)
 PSD = 36 (11.8)
 PSD-12 = 96 (3.3)

2012



Effort = 10.0
 Total CPUE = 7.0 (17; 70)
 Stock CPUE = 6.2 (21; 62)
 PSD = 50 (8.1)
 PSD-12 = 97 (2.3)

Figure 6. 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, Waco Reservoir, Texas, 2004, 2008, and 2012. Vertical line represents the 12-inch minimum length limit.

Channel Catfish

Table 8. Creel survey statistics for blue catfish at Waco Reservoir from June 2011 through May 2012. Directed effort and total catch is for anglers targeting catfish spp. and harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	49,679 (14)
Directed effort/acre	5.87
Total catch per hour	1.03 (42)
Total harvest	19,710 (34)
Harvest/acre	2.33

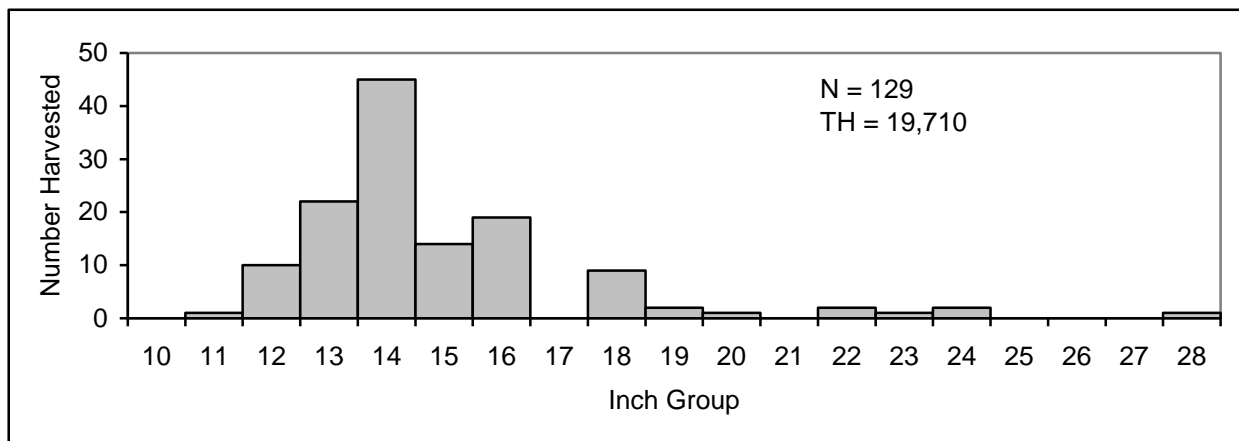


Figure 7. Length frequency of harvested channel catfish observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested channel catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

White Bass

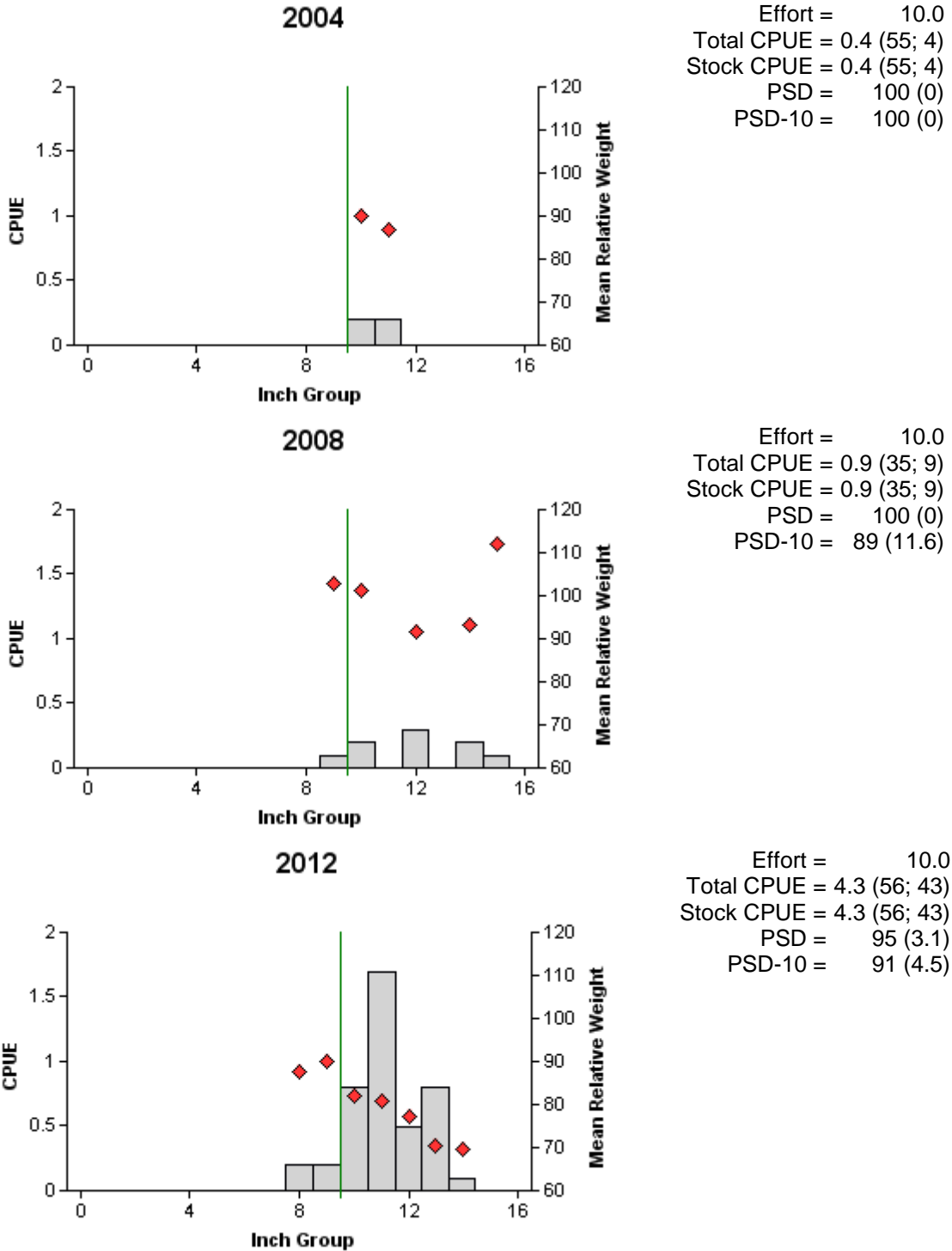


Figure 8. Number of white bass caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Waco Reservoir, Texas, 2004, 2008, and 2012. Vertical line represents the 10-inch minimum length limit.

White Bass

Table 9. Creel survey statistics for white bass at Waco Reservoir from June 2011 through May 2012. Directed effort is for anglers targeting temperate bass spp. 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.

Directed effort (h)	8,121 (27)
Directed effort/acre	0.96
Total catch per hour	4.43 (44)
Total harvest	7,864 (54)
Harvest/acre	0.93

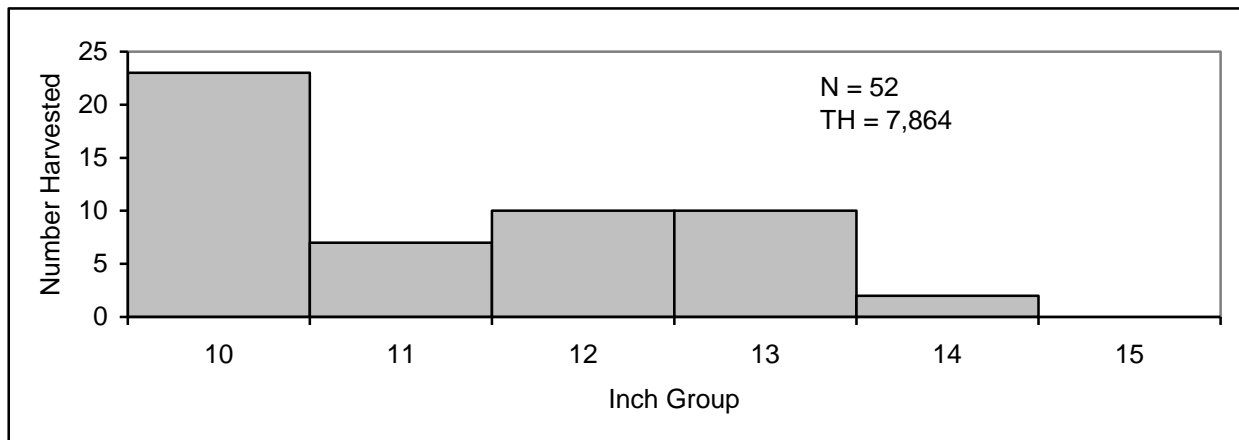
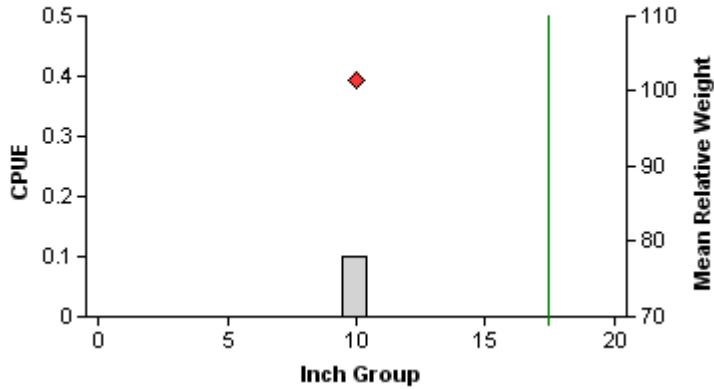


Figure 9. Length frequency of harvested white bass observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

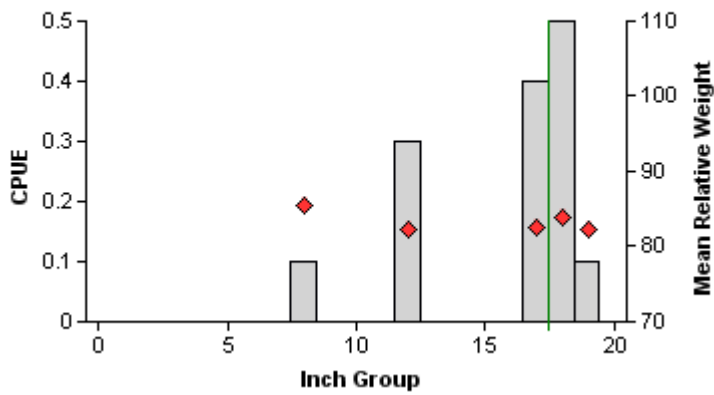
Palmetto Bass

2010



Effort = 10.0
 Total CPUE = 0.1 (100; 1)
 Stock CPUE = 0.1 (100; 1)
 PSD = 0 (105.4)
 PSD-18 = 0 (0)

2012



Effort = 10.0
 Total CPUE = 1.4 (85; 14)
 Stock CPUE = 1.4 (85; 14)
 PSD = 93 (1.6)
 PSD-18 = 43 (12.3)

Figure 10. 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, Waco Reservoir, Texas, 2008 and 2012. Vertical line represents the 18-inch minimum length limit.

Palmetto Bass

Table 10. Creel survey statistics for palmetto bass at Waco Reservoir from June 2011 through May 2012. Directed effort and total catch per hour is for anglers targeting temperate bass spp. Total harvest is the estimated number of white bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	8,121 (27.4)
Directed effort/acre	0.96
Total catch per hour	1.09 (145)
Total harvest	226 (328)
Harvest/acre	0.03

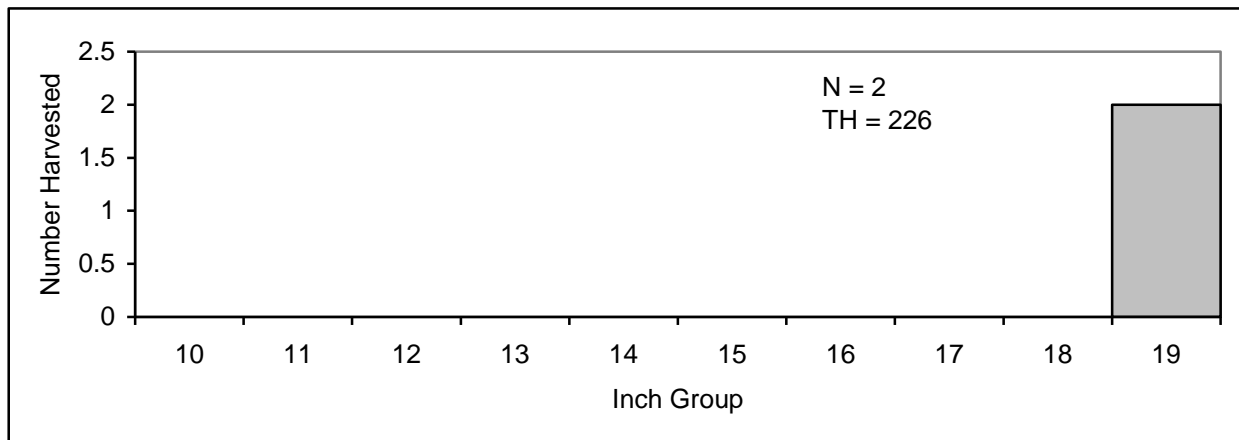


Figure 11. Length frequency of harvested Palmetto bass observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested white bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

Largemouth Bass

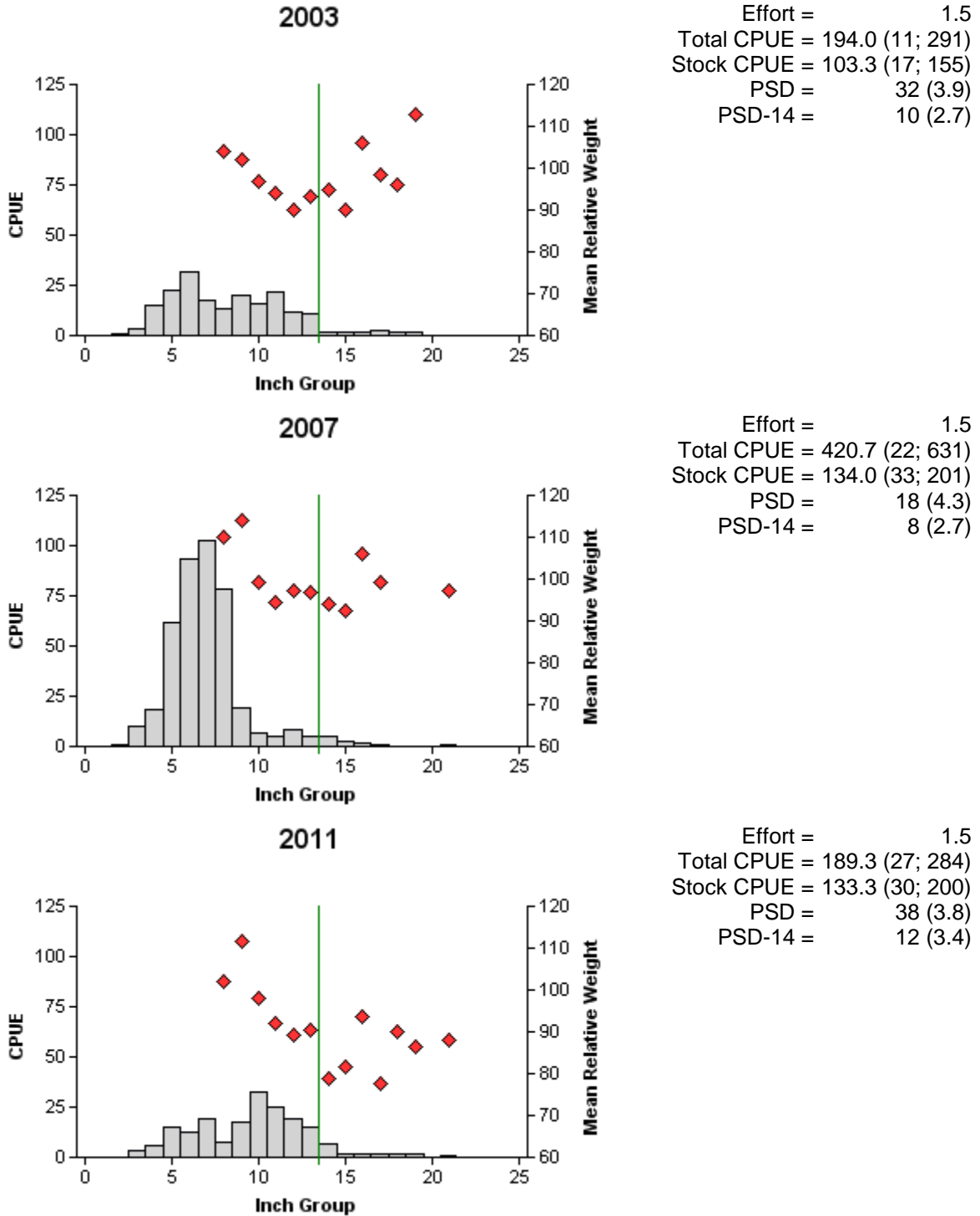


Figure 12. Number of largemouth bass caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Waco Reservoir, Texas, 2003, 2007, and 2011.

Largemouth Bass

Table 11. Creel survey statistics for largemouth bass at Waco Reservoir from June 2011 through May 2012. Directed effort and total catch per hour is for anglers targeting black bass spp. Total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Directed effort (h)	125,369 (14)
Directed effort/acre	14.81
Total catch per hour	1.16 (17)
Total harvest	17,759 (30)
Harvest/acre	2.10

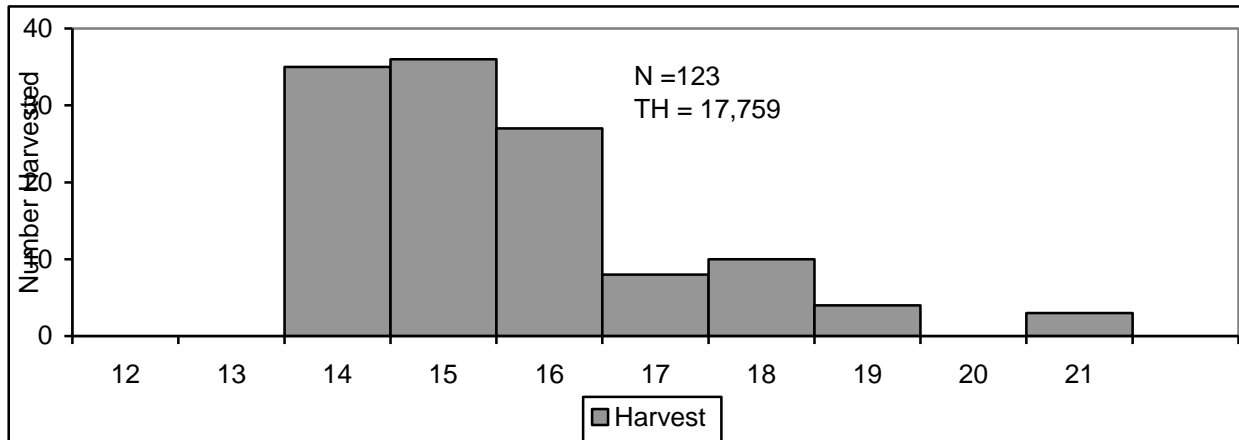


Figure 13. Length frequency of harvested largemouth bass observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

Table 12. Results of genetic analysis of largemouth bass collected by fall electrofishing, Waco Reservoir, Texas, 2003, 2005, and 2011. Analysis conducted in 2004 or earlier are based on allozyme testing, while later analyses are based on microsatellite DNA testing. Genetic information was not collected during the 2010 electrofishing season. FLMB = Florida largemouth bass, NLMB = Northern largemouth bass, Hybrid = bass with both FLMB and NLMB alleles.

Year	Sample size	Genotype			% FLMB alleles	% Northern alleles
		%FLMB	%Hybrid	%NLMB		
2003	30	10	80	10	49	51
2005	30	0	100	0	43	57
2011	30	0	93	7	48	52

White Crappie

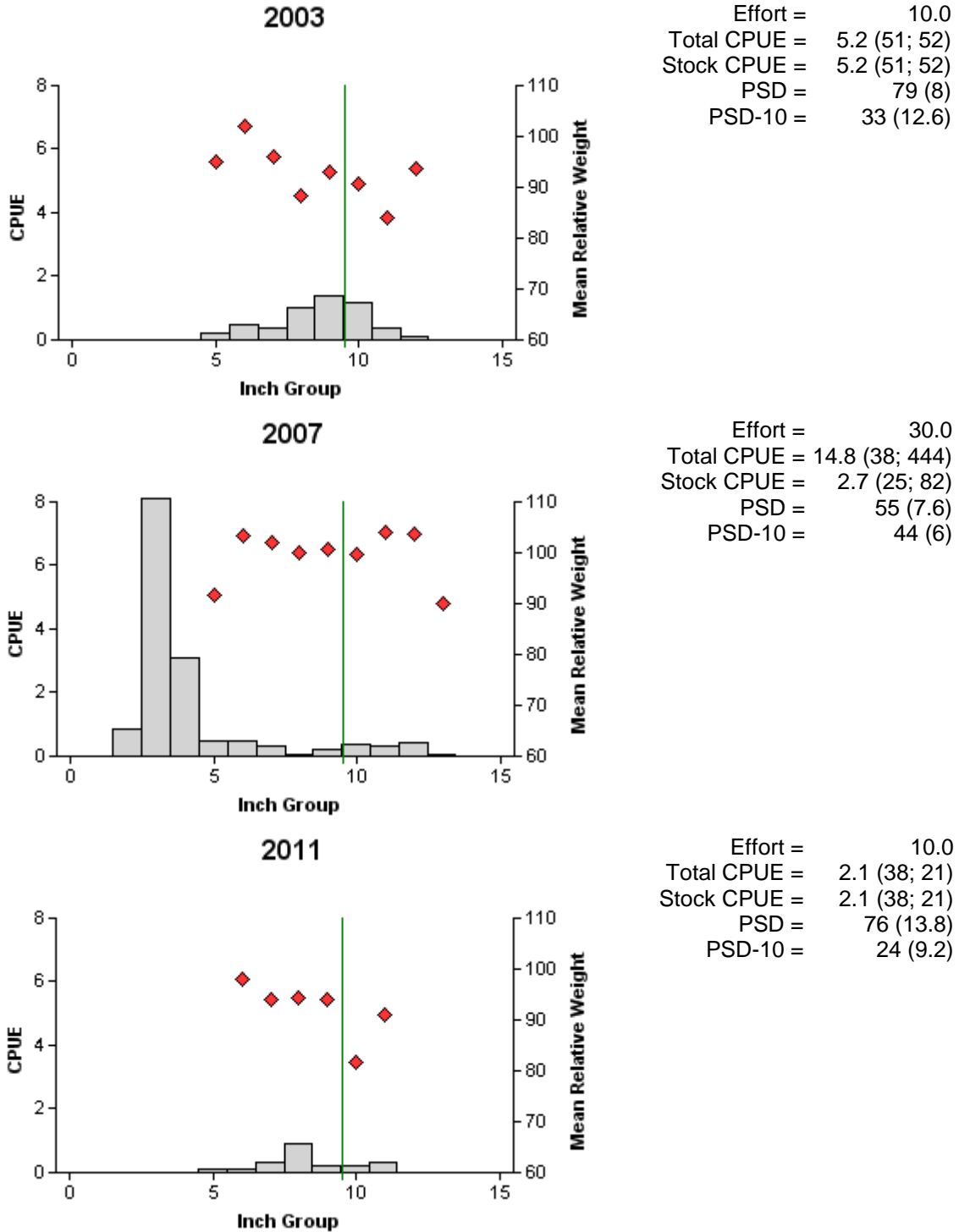


Figure 14. Number of white crappie caught per net night (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap net surveys, Waco Reservoir, Texas, 2003, 2007, and 2011. The increased effort in 2007 was due to a tier IV crappie sample conducted in winter of 2007.

White Crappie

Table 13. Creel survey statistics for white crappie at Waco Reservoir from June 2011 through May 2012, where 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.

Directed effort (h)	30,208 (17)
Directed effort/acre	3.57
Total catch per hour	2.99 (25)
Total harvest	74,643 (28)
Harvest/acre	8.82

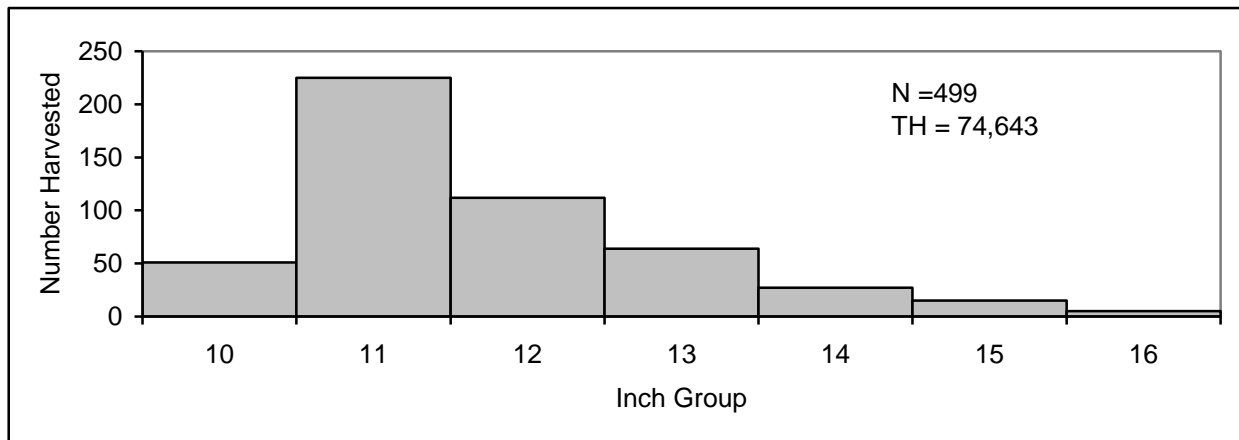


Figure 15. Length frequency of harvested white crappie observed during creel surveys at Waco Reservoir, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested white crappie observed during creel surveys, and TH is the total estimated harvest for the creel period.

Table 14. Proposed sampling schedule for Whitney Reservoir, Texas. Gill net surveys are conducted in the spring, vegetation and access surveys are conducted in the summer, and electrofisher and trap net surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

Survey Year	Electrofisher	Trap Net	Gill Net	Vegetation Survey	Access Survey	Creel Survey	Report
Fall 2012-Spring 2013							
Fall 2013-Spring 2014	A	A	A				
Fall 2014-Spring 2015							
Fall 2015-Spring 2016	S	S	S	S	S		S

APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Waco Reservoir, Texas, 2011-2012.

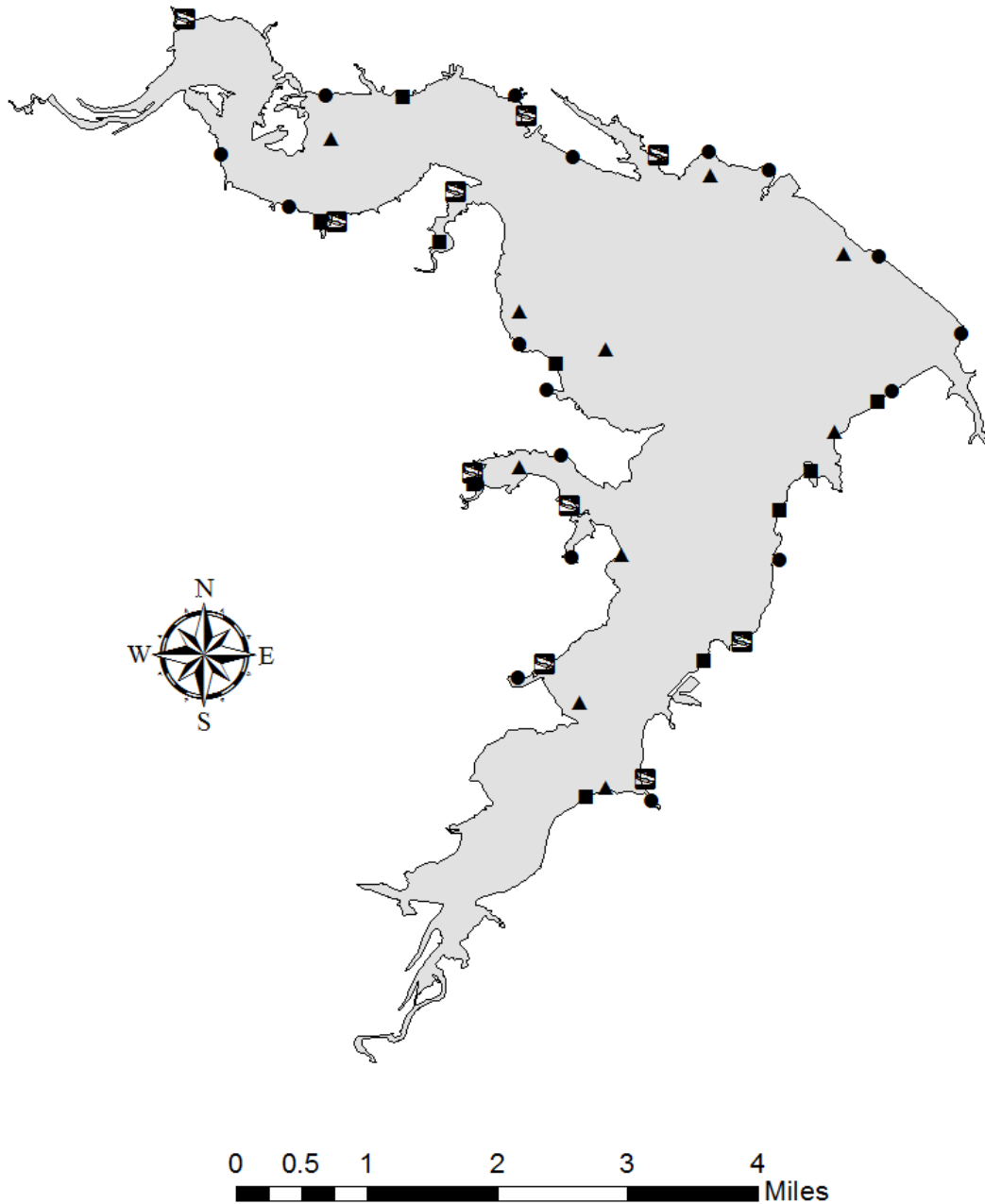
Species	Gill Netting		Trap Netting		Electrofishing	
	N	CPUE	N	CPUE	N	CPUE
Gizzard shad					166	110.7
Threadfin shad					162	108.0
Blue catfish	28	2.8				
Channel catfish	70	7.0				
Flathead catfish	1.0	0.1				
White bass	43	4.3				
Palmetto bass	14	1.4				
Green sunfish					9	6.0
Warmouth					3	2.0
Bluegill					583	388.7
Longear sunfish					171	112.0
Redear sunfish					49	32.7
Spotted bass					26	17.3
Largemouth bass					284	189.3
White crappie			21	2.1		

APPENDIX B

Historical catch rates (CPUE) of targeted species by gear type for standard surveys on Waco Reservoir, Texas, 1996 to present. All stations were randomly selected. Electrofishing stations were shocked with a 5.0 Smith-Root GPP (Gas Powered Pulsator) until 2010, when a 7.5 Smith-Root GPP began being used. Species averages are in bold.

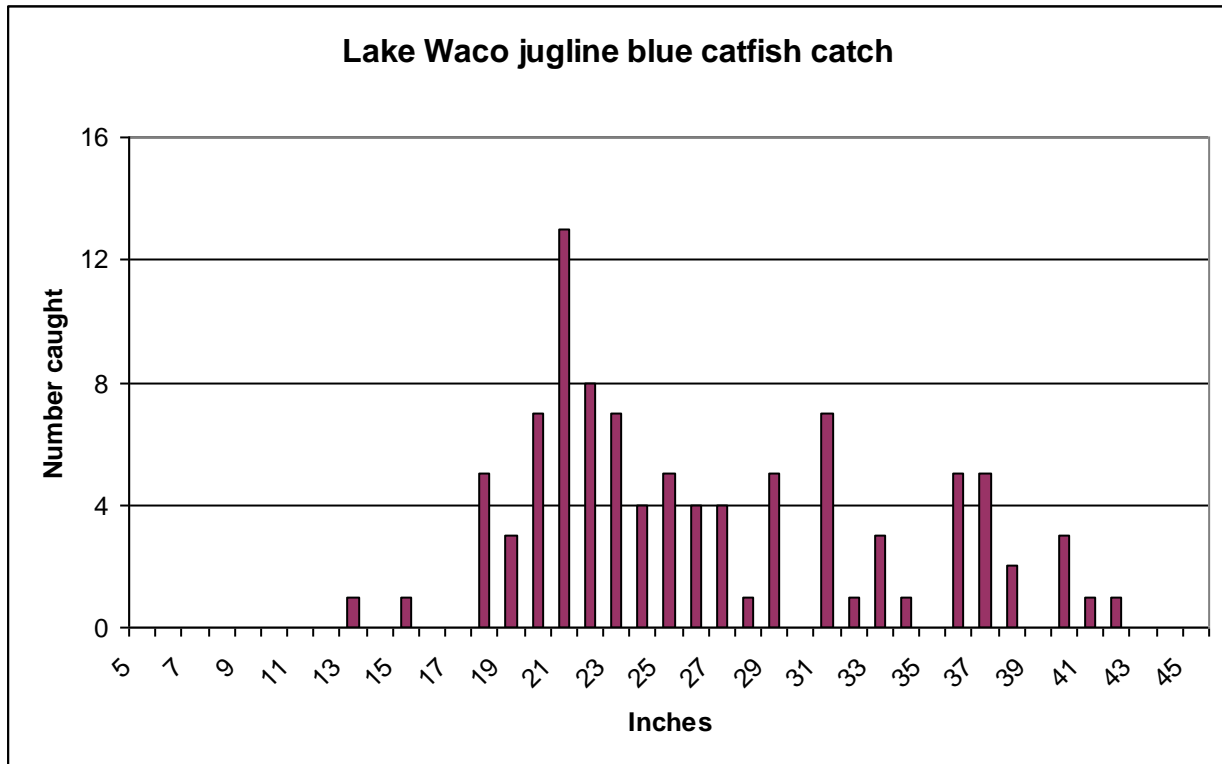
Gear	Species	1996	1999	2000	2001	2003	2004	2005	2006	2007	2008	2011	2012	Avg.
Electrofisher	Largemouth bass	74.0	177.0	71.3	194.0	194.0		155.0		421.0		189.3		184.5
	Spotted bass		11.3	26.7		2.7		2.7		8.7		17.3		11.6
	Gizzard shad	307.0	34.7	71.3	317.0	91.3		110.0		614.0		110.7		207.0
	Threadfin shad		0.7	1.3		3.3		169.0		174.0		108.0		76.1
	Bluegill sunfish	120.0	92.7	157.0	343.0	315.0		239.0		314.0		388.7		246.2
	Redear sunfish	2.7	5.3	12.0	19.3	22.7		25.3		22.7		32.7		17.8
	Longear sunfish		12.0	68.7		131.0		40.0		99.3		112.0		77.2
	Green sunfish		0.7	1.3		6.0				2.0		6.0		3.2
	Warmouth		2.7	2.0		7.3		3.3		2.7		2.0		3.3
Gill nets	Blue catfish						3.2		3.7		5.3		2.8	3.9
	Channel catfish	5.7	6.7				5.7		2.1		7.5		7.0	5.8
	White bass	1.3	1.7				0.4		2.8		0.9		4.3	1.9
	Palmetto bass												1.4	1.4
	Flathead catfish		0.6				0.1		0.2		0.1		0.1	0.2
Trap nets	White crappie	2.0	6.3			5.2		3.0		14.8		2.1		5.6
	Black crappie									0.4				0.4

APPENDIX C



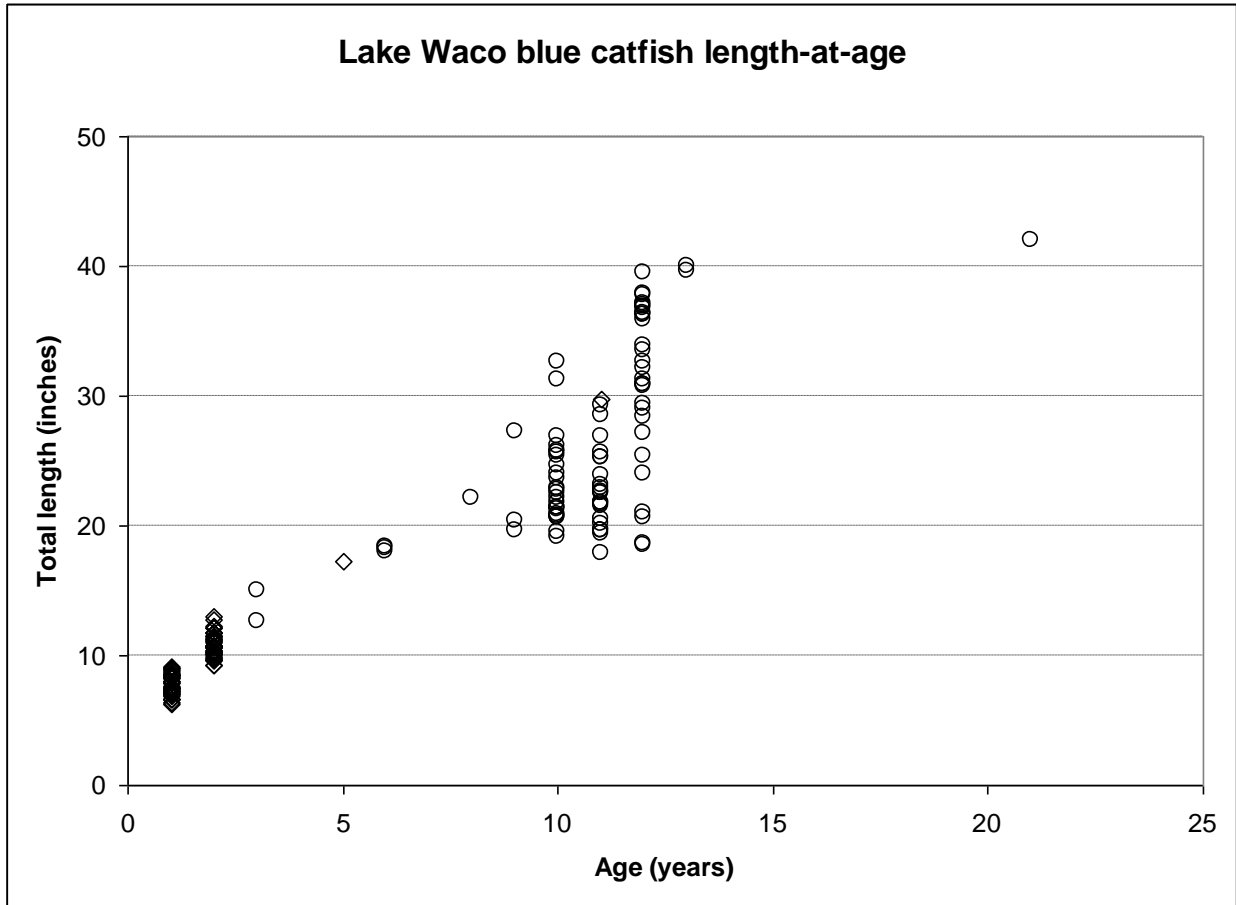
Location of sampling sites, Waco Reservoir, Texas, 2011-2012. Trap net, gill net, and electrofisher stations are indicated by squares, triangles, and circles, respectively. Water levels were six feet below conservation pool (462) during 2011 electrofisher and trap net surveys and at full pool during 2012 gill net surveys.

APPENDIX D



Size distribution of blue catfish collected using juglines in Waco Reservoir, Texas, between November 24, 2009 and March 23, 2010. A total of 97 blue catfish were collected in 225 jugline-nights. Each jugline had three hooks attached.

APPENDIX E



Length-at-age for blue catfish collected using low-pulse electrofishing (diamonds) and juglining (circles) in Waco Reservoir, Texas, between August 1, 2009 and March 29, 2010.