

PERFORMANCE REPORT

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FEDERAL AID PROJECT F-221-M-4

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2013 Fisheries Management Survey Report

Benbrook Reservoir

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July 31, 2014

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Benbrook Reservoir were surveyed in 2013 with electrofishing and trap netting, and in 2014 using gill netting. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Benbrook Reservoir is a 3,635-acre impoundment located on the Clear Fork of the Trinity River approximately 10 miles southwest of Fort Worth. Water level fluctuates widely in the reservoir. Benbrook Reservoir has consistently been hypereutrophic. Habitat consisted of standing timber and rocks.
- **Management history:** Important sport fishes included White Bass, Palmetto Bass, Largemouth Bass, White Crappie, and catfishes. The management plan from the 2009 survey report included stocking Palmetto Bass at 10 fingerlings/acre, annually. Largemouth Bass have been managed with state-wide minimum length limit of 14 inches. Florida Largemouth Bass were introduced in the mid-to-late 1970s and stocked again in 2007. Blue Catfish were stocked in 1990 and 1991 to capitalize on the abundant prey base. Recent efforts to improve the fish habitat and angler success have included planting aquatic vegetation.
- **Fish Community**
 - **Prey species:** Threadfin Shad continued to be abundant. Electrofishing catch of Gizzard Shad was high. Electrofishing catch of Bluegill and Longear Sunfish was much higher than the previous survey.
 - **Catfishes:** Blue Catfish numbers in Benbrook Reservoir declined from the previous sample. The Channel Catfish catch rate dropped from the 2010 sample.
 - **Temperate basses:** White Bass, Yellow Bass, and Palmetto Bass were present. White Bass were collected at a higher rate than in previous years. Yellow Bass, which may have been introduced through a pipeline connecting Cedar Creek Reservoir and Richland-Chambers Reservoir to Benbrook Reservoir, were collected in gill nets for the first time in 2006 and reached historic highs in 2014. Palmetto Bass abundance remained average over the past two surveys, despite sporadic stocking.
 - **Largemouth Bass:** Largemouth Bass were captured in moderate abundance. Abundance of fish over 14 inches was high. Largemouth Bass body condition was average. Florida influence remains high despite the last stocking being in 2007.
 - **Crappies:** Size and body condition of White Crappie continued to be good, and abundance was much higher the two previous samples. Black Crappie were sampled for the past two surveys, but in low numbers.
- **Management Strategies:** Stock Palmetto Bass at alternating rates of 50 and 100 fry per acre annually. Conduct standard sport fish monitoring in 2017-2018 with an additional gill netting survey in 2016. Continue habitat improvements through shoreline emergent vegetation plantings, concentrating on the areas of Rocky Creek Park and the northwestern shore near Dutch Branch. Conduct year-long creel survey in 2017-2018.

INTRODUCTION

This document is a summary of fisheries data collected from Benbrook Reservoir in 2013-2014. 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 2013-2014 data for comparison.

Reservoir Description

Benbrook Reservoir is a 3,635-acre impoundment constructed in 1952 on the Clear Fork of the Trinity River. It is located in Tarrant County approximately 10 miles southwest of Fort Worth and is operated and controlled by the United States Army Corps of Engineers (USACE). Benbrook Reservoir has a drainage area of 429 square miles in Tarrant and Parker Counties. Primary water uses included municipal water supply (controlled by Tarrant Regional Water District [TRWD]) and recreation. Benbrook Reservoir was listed as hypereutrophic with a mean TSI chl-a reading of 58.28, which was slightly higher than the two previous samples (Texas Commission on Environmental Quality 2011). The primary habitat at time of sampling consisted of rocks and standing timber. No aquatic vegetation was observed during the habitat survey. Water level has been highly variable since 1995, and in subsequent years the water level has reached 10 or more feet below conservation pool (Figure 1). Tarrant Regional Water District began drawing more water from Benbrook Reservoir (Clear Fork) for municipal uses in 2005 to reduce the demand on the West Fork of the Trinity River Reservoirs (e.g., Bridgeport, Eagle Mountain, and Worth). Other descriptive characteristics for Benbrook Reservoir are in Table 1.

Angler Access

Benbrook Reservoir has 16 public boat ramps within six public parks, but when water levels drop to approximately 10 feet low, none are useable. Bank fishing access was available at Holiday Park, Mustang Park, Rocky Creek Park, and Longhorn Park. Additional boat ramp characteristics are in Table 2.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Hungerford and Brock 2010) included:

1. Maintain a quality Palmetto Bass fishery through annual stocking.
Action: Palmetto Bass were stocked in 2008, 2009, 2011 (all fingerlings), and 2013 (fry).
2. Request American water-willow from new TPWD aquatic plant nursery site in Athens for test planting in several shoreline areas. If test plots are successful, the strategy will be expanded to other portions of the reservoir.
Action: Planted American water-willow for in several shoreline areas in summer of 2013. If test plots are successful, the strategy will be expanded to other portions of the reservoir. We also planted some cattail, bulrush, and pickerel weed.
3. Communicated with the USACE and TRWD regarding posting of signs educating the public about the spread of aquatic nuisance species. Contacted marina operators and emphasized the importance of cleaning, draining, and drying vessels when leaving all reservoirs to reduce risk of spreading zebra mussels.
Action: Signs were distributed to USACE for distribution at public access points. We made a speaking point when talking to the public the importance of cleaning, draining, and drying vessels prior to launching at other reservoirs. Since Benbrook does receive water from a pipeline connected to two other reservoirs, TRWD was informed of the risk of zebra mussel movement as well.

Harvest regulation history: Sport fishes in Benbrook Reservoir are currently managed with statewide harvest regulations (Table 3).

Stocking history: Benbrook Reservoir has been stocked periodically with Palmetto Bass since the early 1990s and annually since 2002. Threadfin Shad were stocked in 1984, Blue Catfish in 1990, and Florida Largemouth Bass in 2007. The complete stocking history is in Table 4.

Vegetation/habitat history: Negligible amounts of American water-willow were observed during the summer of 2013. No aquatic vegetation was observed in Benbrook Reservoir during the 2009 habitat survey. Historically, native emergent aquatic vegetation (cattail and American water-willow) was observed (Brock 2002). Drastic water level fluctuations since 1995 are likely the cause for their disappearance.

Water Transfer: Benbrook Reservoir is primarily used for municipal water supply, recreation, and to a lesser extent, flood control. There is currently one permanent pumping station on the reservoir which connects to a raw water treatment plant for municipal use. There is also an outfall from a pipeline operated by TRWD that transfers water to Benbrook Reservoir from Richland Chambers and Cedar Creek Reservoirs in East Texas. According to TRWD staff, the water is mixed with approximately 66.7% Richland Chambers water and 33.3% from Cedar Creek.

METHODS

Fishes were collected by electrofishing (1 hour at 12, 5-min stations), gill netting (5 net nights at 5 stations), and trap netting (5 net nights at 5 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), terminology modified by Guy et al. 2007], and condition indices [relative weight (W_r)] were calculated for target fishes according to Anderson and Neumann (1996). Palmetto Bass PSD was calculated according to Dumont and Neely (2011). Index of vulnerability (IOV) was calculated for gizzard shad (DiCenzo et al. 1996). Standard error (SE) was calculated for structural indices and IOV. Relative standard error ($RSE = 100 \times SE \text{ of the estimate/estimate}$) was calculated for all CPUE and creel statistics. Ages were determined using otoliths from 5 to 10 fish per inch group.

Genetic analysis of largemouth bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2011). Micro-satellite DNA analysis was used to determine genetic composition of individual fish from 2005 through 2012 and by electrophoresis for previous years.

Source for water level data was the United States Geological Survey (USGS 2014) and from the Tarrant Regional Water District.

RESULTS AND DISCUSSION

Habitat: The last structural habitat survey was conducted in 2009. Littoral zone habitat consisted primarily of natural shoreline and standing timber (Table 5). Large water level fluctuations beginning in 1995 have been detrimental to the littoral habitat in Benbrook Reservoir. Native emergent vegetation (cattail and American water-willow) was present prior to drastic water level fluctuations (Brock 2002).

Creel: The last creel survey conducted at Benbrook Reservoir was in 2000-2001.

Prey species: Electrofishing catch rates of Gizzard Shad were 207.0/h in 2009, 165.0/h in 2010 and 345.0/h in 2013. Index of vulnerability (IOV) for Gizzard Shad was good, indicating that 73% of Gizzard Shad were available to existing predators; this was lower than IOV estimates in previous years (Figure 2). The electrofishing catch rate of Threadfin Shad was 495.0/h in 2013. Total CPUE of Bluegill in 2013 was 259.0/h, which is lower than the 2010 survey (365.0/h; Figure 3). Longear Sunfish total CPUE was 90.0/h in 2013 which is lower than the previous survey (193.0/h; Appendix C). Benbrook Reservoir continued to support an excellent forage base.

Catfishes: The gill net catch rate of Blue Catfish was 5.4/nn in 2012, the highest catch rate on record, but declined to 2.6/nn in 2014 (Figure 4). Mean relative weights of Blue Catfish were good the past two surveys with values mostly between 90 and 100 indicating robust individuals. Total CPUE of Channel Catfish was 4.6/nn in 2014, which is higher than the 2012 survey (2.2/nn; Figure 5). Mean relative weights of stock-size (≥ 11 inches) Channel Catfish were generally above 90. Flathead Catfish were present in the reservoir as one individual was collected in 2010 (Appendix C).

Temperate Basses: The gill net catch rate of White Bass was 10.0/nn in 2014, which was much higher than the previous two surveys (Figure 6). No white bass were collected in 2012, perhaps the survey was conducted after the fish traveled up the creeks. All fish collected were legal for harvest and mean relative weights were around 90. Yellow Bass have been sampled in Benbrook since 2006 (Appendix C), and the 2014 survey produced the highest catch rate on record (24.0/nn). The gill net catch rate of Palmetto Bass was 2.8/nn in 2014, but higher than the catch rate of 1.0/nn in 2012. Mean relative weights were generally between 90 and 100 (Figure 7). Growth of Palmetto Bass was good with fish reaching 18 inches in approximately 3 years (Figure 8). Palmetto Bass fry were stocked in 2013 and 2014. One fish from the 2013 fry stocking was collected in the 2014 gill net survey. Stocking success of fry will be evaluated with gill netting every other year.

Largemouth Bass: The electrofishing catch rate of Largemouth Bass was 94.0/h in 2010 and 74.0/h in 2013 (Figure 9). The reservoir was significantly lower at the time of the 2013 survey than during the 2010 survey (Figure 1) which made sampling conditions less than ideal as very little shoreline habitat was available. Catch rate of Largemouth Bass ≥ 14 inches was good in the past two surveys (14.0/h in 2013 and 8.0/h in 2010). The mean relative weights of Largemouth Bass in 2013 varied widely, ranging from around 80 up to nearly 110. It appears the varying water level is, at the very least, affecting our ability to collect adequate and consistent electrofishing data, and could potentially be influencing the abundance of the Largemouth Bass population. Florida Largemouth Bass influence has remained relatively constant as Florida alleles have ranged from 48.3% (1999) to 63.0% (2009), holding strong at 60.0% in 2013 (Table 6).

Crappies: The trap net catch rate of White Crappie was 17.2/nn in 2013, higher than in 2009 (11.0/nn) and much higher than in 2005 (2.0/nn). The PSD of 94 which was higher than the PSD in 2005 and lower than the PSD in 2009 (Figure 10). Mean relative weight was between 90 and 100 for all size classes in 2013. Four Black Crappie were collected during the 2009 trap net survey and 5 were collected in 2013 (Appendix C).

Fisheries management plan for Benbrook Reservoir, Texas

Prepared – July 2014.

ISSUE 1: Palmetto Bass continue to provide a quality fishery in Benbrook Reservoir. However, the fishery has to be maintained through stocking. Since Benbrook typically ranks low on the statewide stocking request, and the limited availability of fingerlings, we decided to request fry annually going forward.

MANAGEMENT STRATEGIES

1. Stock Palmetto Bass fry annually based upon actual surface area. We will request a rate of 100/acre and 50/acre in alternating years.
2. Conduct gill net surveys every other year to monitor growth, relative abundance, and condition of Palmetto Bass.

ISSUE 2: Recently, the Tarrant Regional Water District has modified their policy of water distribution resulting in drastic water level fluctuations at Benbrook Reservoir. In addition, drought conditions have amplified the effects of the water level. In the fall of 2011, the water level reached a historic low of more than 16 feet below conservation pool. The potential detrimental impact on habitat with these water level fluctuations is great. Collaboration among TRWD, USACE, and TPWD to enhance aquatic habitat (brush-pile construction) during low water levels was successful; however effectiveness was short-lived due to the rapid deterioration of the material used.

MANAGEMENT STRATEGIES

1. Continue to transplant American water-willow and other emergent aquatic vegetation from TPWD aquatic plant nursery site in Athens for planting in shoreline areas of Rocky Creek Park and along the Baja Beach area on the northwest side of the reservoir. If plantings are successful, the strategy will be expanded to other portions of the reservoir.
2. Work with USACE and TRWD at Benbrook Reservoir to help support habitat improvement projects.

ISSUE 3: The last creel survey at Benbrook Reservoir was conducted in 2000-2001. Creel data are outdated.

MANAGEMENT STRATEGY

1. Conduct a year-long creel survey from June 2017 through May 2018.

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

MANAGEMENT STRATEGIES

1. Cooperate with the USACE 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 additional gill netting in 2016, and standard monitoring in 2017-2018 (Table 7). Gill net surveys will be conducted every other year to monitor the Palmetto Bass fishery. A year-long creel survey will be conducted in 2017-2018.

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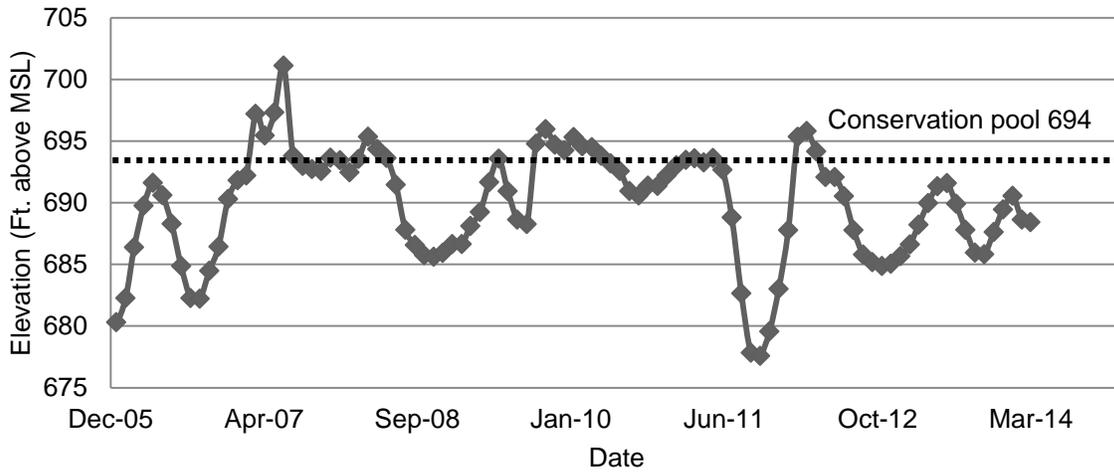


Figure 1. Mean monthly water level elevations in feet above mean sea level (MSL) recorded for Benbrook Reservoir, Texas.

Table 1. Characteristics of Benbrook Reservoir, Texas.

Characteristic	Description
Year constructed	1952
Controlling authority	U.S. Army Corps of Engineers
Counties	Tarrant
Reservoir type	Mainstream
Shoreline Development Index (SDI)	4.48
Conductivity	277 $\mu\text{S}/\text{cm}$

Table 2. Boat ramp characteristics for Benbrook Reservoir, Texas, Fall 2013. Reservoir elevation at time of survey was 689.1 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
Benbrook Marina	32.65592 -97.47547	Y	75	688.0	Good.
North Holiday Park (Hobie Point)	32.65239 -97.47014	Y	25	685.0	Good.
North Holiday Park (Swimming Beach)	32.64272 -97.47086	Y	25	691.0	Poor slope.

Table 2, Continued.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
North Holiday Park (Mercer Day Use)	32.63153 -97.47772	Y	25	685.0	Poor slope.
Holiday Park (Mercer Camping)	32.62928 -97.48100	Y	15	688.0	Poor slope. Only open to campers.
Holiday Park (Holiday Camping)	32.62364 -97.48497	Y	15	691.0	Good. Only open to campers.
Holiday Park (Double Ramp)	32.61644 -97.49547	Y	20	687.0	Good.
Bear Creek Campground (Bear Creek Ramp)	32.60347 -97.49881	Y	10	688.0	Poor slope. Only open to campers.
Bear Creek Campground (Double Ramp)	32.61167 -97.48847	Y	10	689.0	Good. Only open to campers.
Mustang Park (Mustang Creek)	32.60728 -97.47253	Y	10	690.0	Poor slope.
Mustang Park (Mustang Point)	32.61039 -97.47056	Y	40	682.0	Good.
Longhorn Park	32.64711 -97.44630	Y	11	689.0	Good.
Rocky Creek Park (Double Ramp)	32.60233 -97.45958	Y	25	689.0	Poor slope.
Rocky Creek Park (South Creek)	32.59458 -97.45347	Y	15	690.0	Poor slope.

Table 3. Harvest regulations for Benbrook Reservoir, Texas.

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

Table 4. Stocking history of Benbrook, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL), 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	1990	38,246	FGL	1.9
	1991	<u>37,446</u>	FGL	2.1
	Total	75,692		
Channel Catfish	1970	15,000	AFGL	7.9
	1972	<u>9,374</u>	AFGL	7.9
	Total	24,374		
Florida Largemouth Bass	1974	50,800	FGL	2.0
	1974	48,000	FRY	1.0
	1976	180,000	FRY	1.0
	1992	38,271	FGL	1.2
	1992	151,318	FRY	0.9
	1997	190,546	FGL	1.6
	2002	181,438	FGL	1.6
	2007	<u>182,472</u>	FGL	1.6
Total	1,022,845			
Largemouth Bass	1968	115,000	UNK	UNK
	1969	<u>98,000</u>	UNK	UNK
	Total	213,000		

Table 4, continued

Species	Year	Number	Life Stage	Mean TL (in)
Palmetto Bass (Striped X White Bass hybrid)	1978	19,980	UNK	UNK
	1979	38,190	UNK	UNK
	1982	30,000	UNK	UNK
	1991	59,600	FRY	1.0
	1992	30,126	FGL	1.3
	1994	57,133	FGL	1.3
	1995	97,887	FGL	1.3
	1996	59,212	FGL	1.3
	1997	57,000	FGL	1.7
	1998	57,423	FGL	1.1
	1999	32,244	FGL	1.5
	2002	18,954	FGL	1.5
	2003	33,760	FGL	1.5
	2004	38,050	FGL	1.4
	2005	54,628	FGL	1.7
	2006	36,336	FGL	1.6
	2008	26,209	FGL	1.4
	2009	27,847	FGL	1.4
	2011	44,990	FGL	1.3
	2013	363,501	FRY	0.2
Total		1,183,070		
Threadfin Shad	1984	1,000	AFGL	2.0
	Total	1,000		

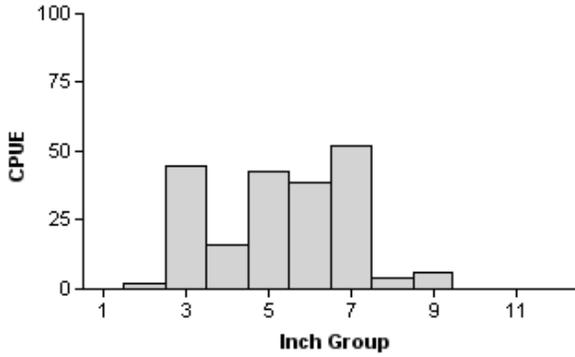
Table 5. Survey of structural zone and physical habitat types, Benbrook Reservoir, Texas, 2009. A linear shoreline distance (miles) was recorded for each habitat type found. Surface area (acres) and percent of reservoir surface area was determined for each type of habitat found.

Shoreline habitat type	Shoreline Distance		Surface Area	
	Miles	Percent of total	Acres	Percent of reservoir surface area
Rocky shoreline	1.8	4.7	1081	29.7
Standing timber				
Natural	29.1	76.1		
Riprap	1.0	2.6		
Rock bluff	1.9	5.0		
Gravel	4.4	11.6		

Gizzard Shad

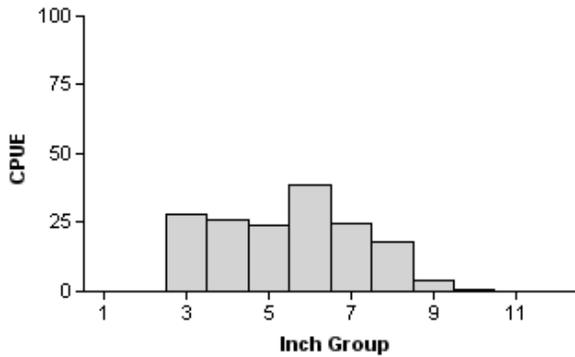
2009

Effort = 1.0
 Total CPUE = 207.0 (31; 207)
 IOV = 95 (2.8)



2010

Effort = 1.0
 Total CPUE = 165.0 (27; 165)
 IOV = 86 (6.8)



2013

Effort = 1.0
 Total CPUE = 345.0 (16; 345)
 IOV = 73 (6.6)

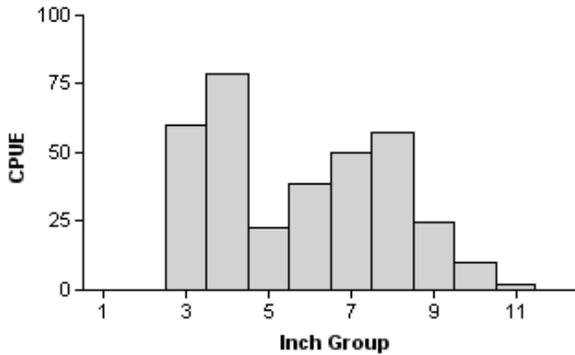
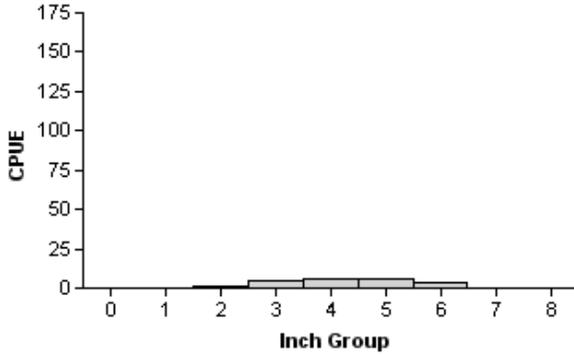


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Benbrook Reservoir, Texas.

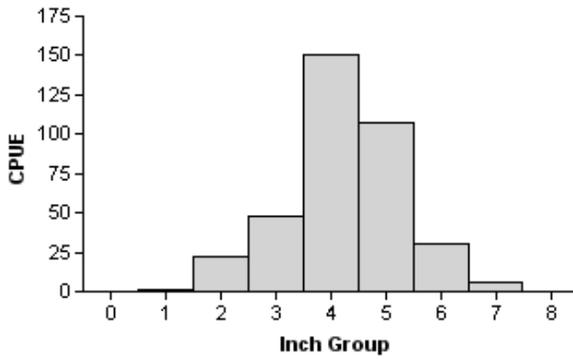
Bluegill

2009



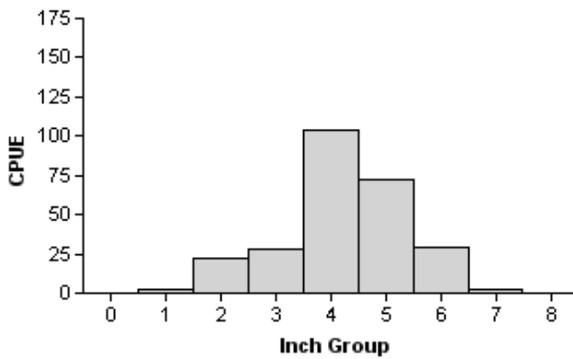
Effort = 1.0
 Total CPUE = 21.0 (40; 21)
 Stock CPUE = 20.0 (38; 20)
 CPUE-6 = 3.0 (52; 3)
 PSD = 15 (5.3)

2010



Effort = 1.0
 Total CPUE = 365.0 (31; 365)
 Stock CPUE = 342.0 (31; 342)
 CPUE-6 = 36.0 (44; 36)
 PSD = 11 (1.8)

2013

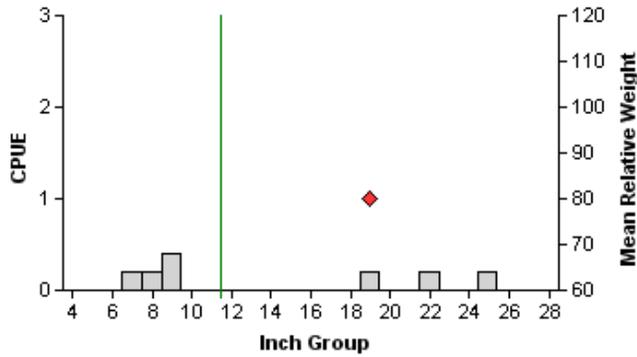


Effort = 1.0
 Total CPUE = 259.0 (36; 259)
 Stock CPUE = 235.0 (37; 235)
 CPUE-6 = 31.0 (55; 31)
 PSD = 13 (3.9)

Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE in parentheses) for fall electrofishing surveys, Benbrook Reservoir, Texas.

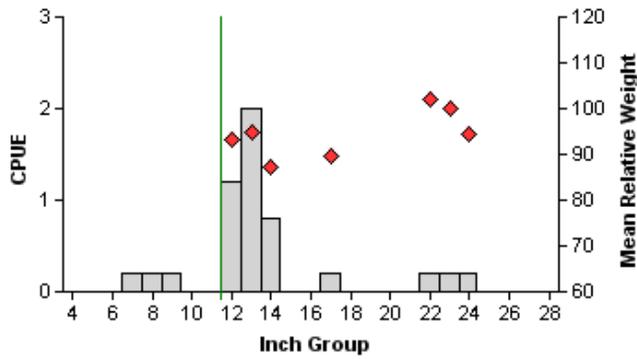
Blue Catfish

2010



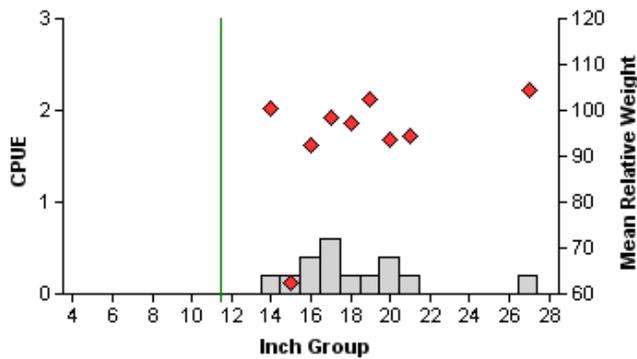
Effort = 5.0
 Total CPUE = 1.4 (48; 7)
 Stock CPUE = 0.6 (67; 3)
 PSD = 67 (17.7)

2012



Effort = 5.0
 Total CPUE = 5.4 (34; 27)
 Stock CPUE = 4.8 (36; 24)
 PSD = 12 (9.8)

2014



Effort = 5.0
 Total CPUE = 2.6 (40; 13)
 Stock CPUE = 2.6 (40; 13)
 PSD = 31 (15.5)

Figure 4. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill netting surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

Channel Catfish

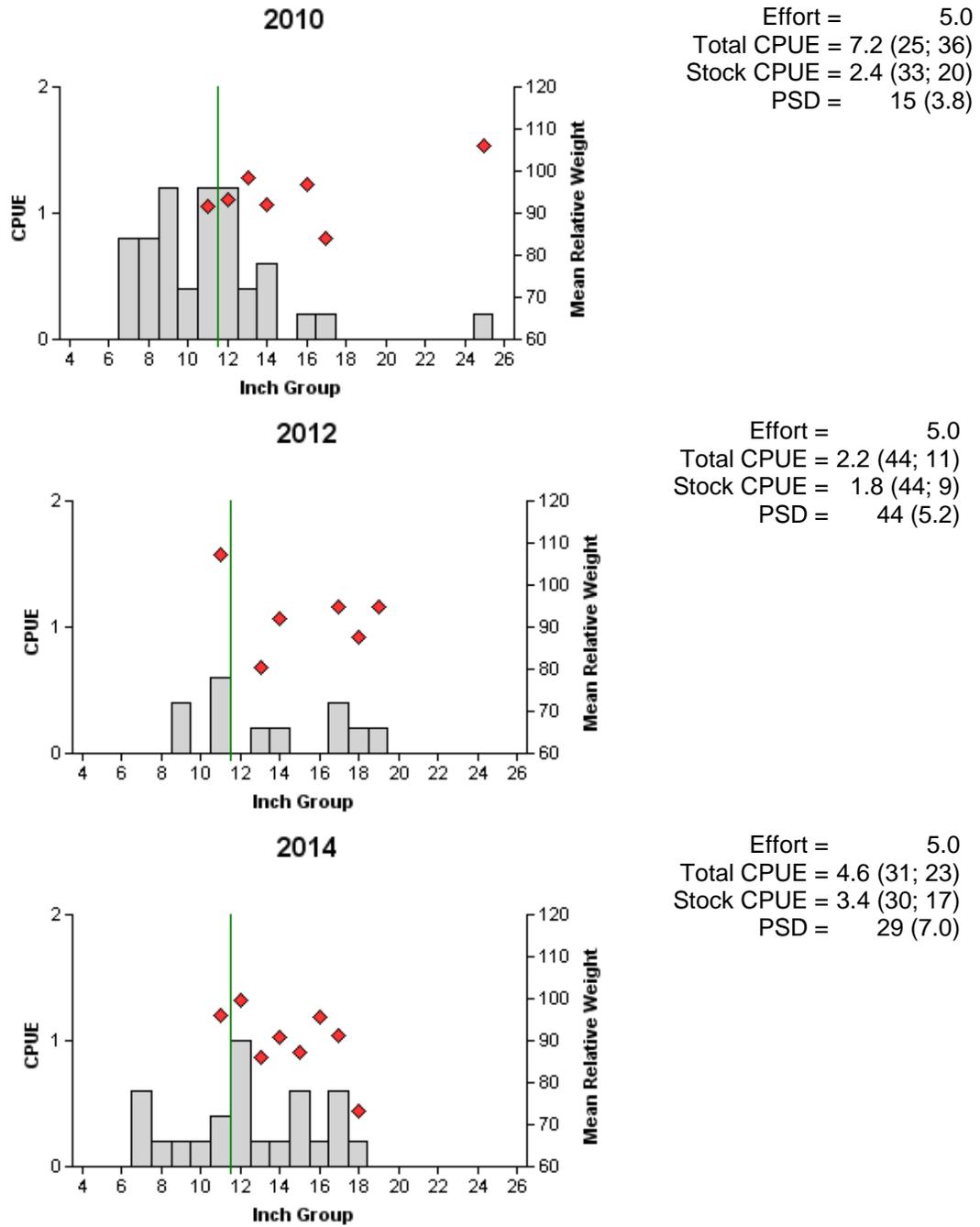


Figure 5. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill netting surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

White Bass

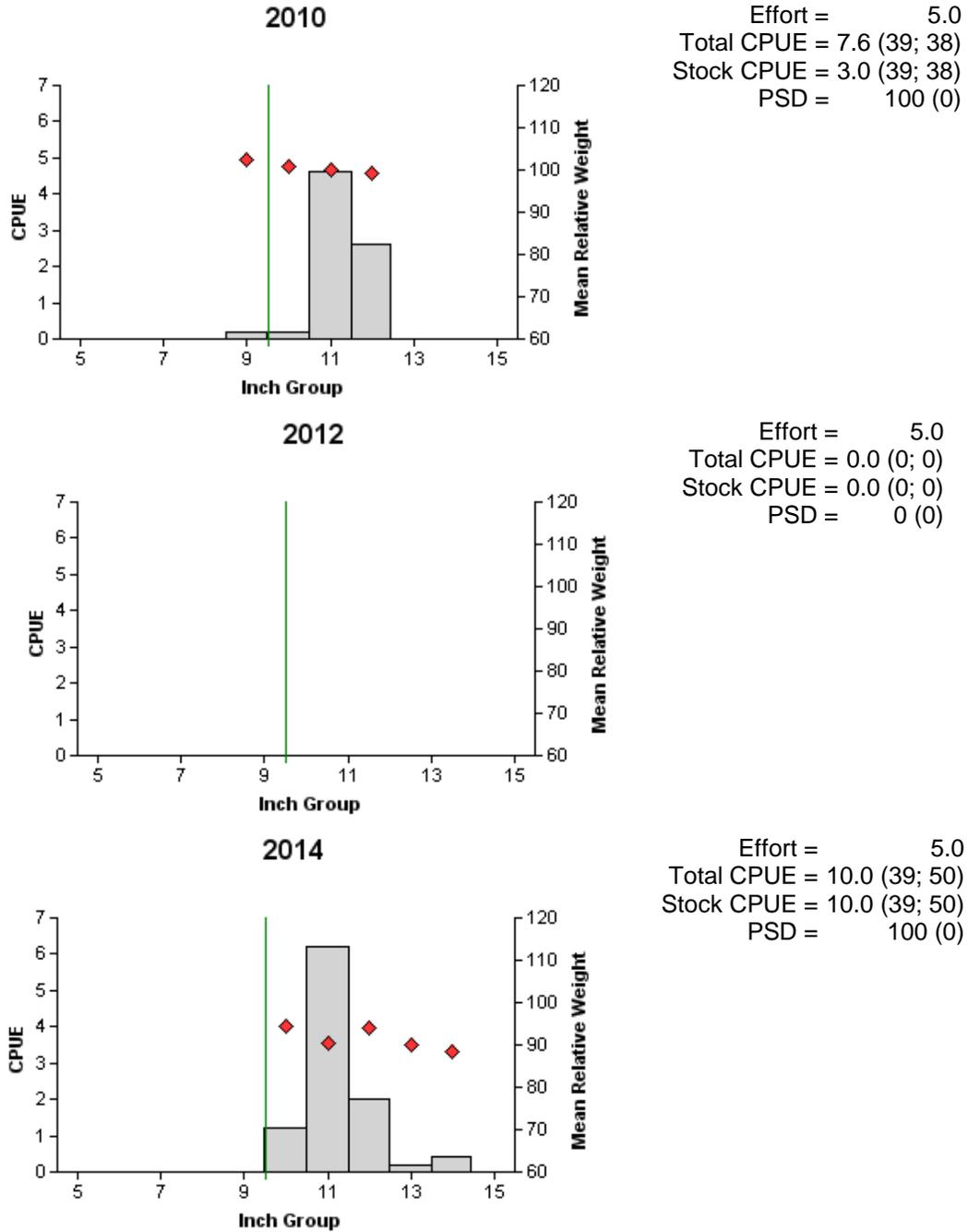


Figure 6. Number of White Bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill netting surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

Palmetto Bass

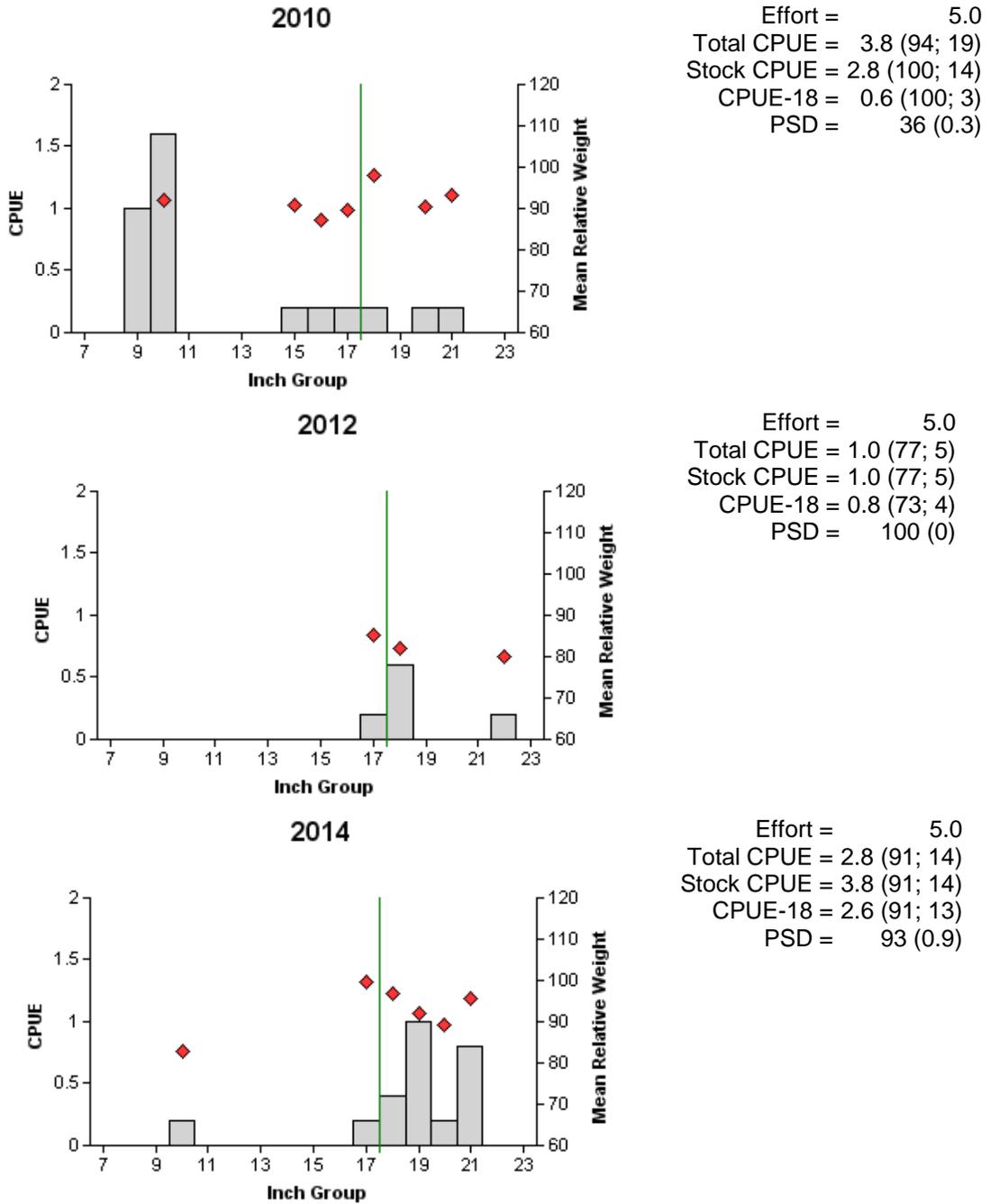


Figure 7. Number of palmetto bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill netting surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

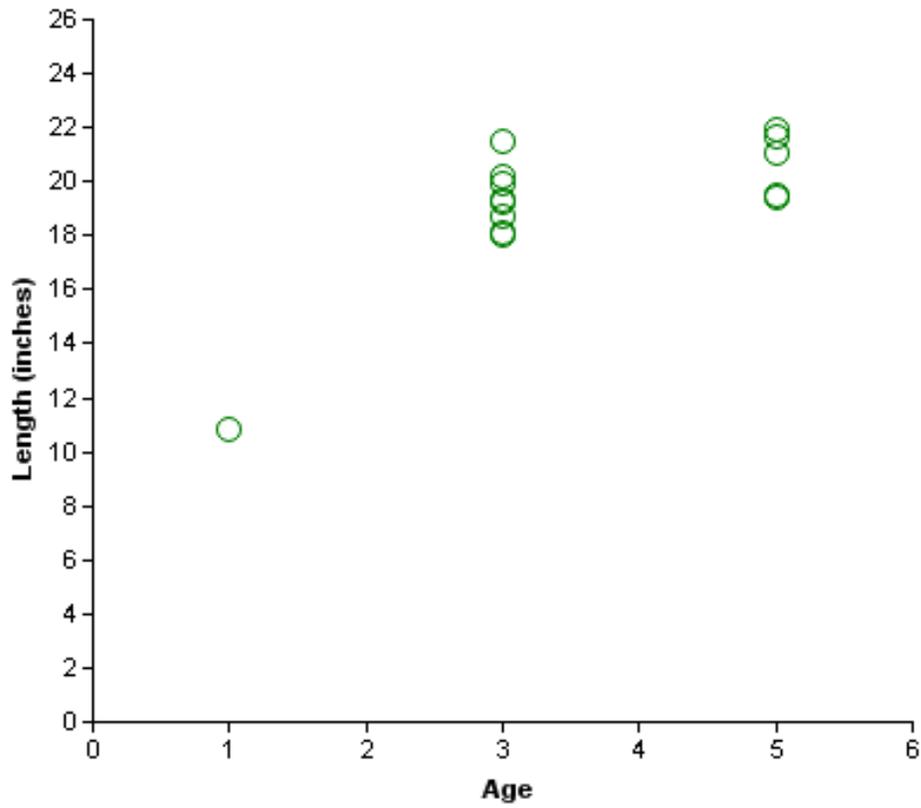


Figure 8. Length at age for Palmetto Bass (sexes combined) collected from gill nets at Benbrook Reservoir, Texas, March 2014 (N=14).

Largemouth Bass

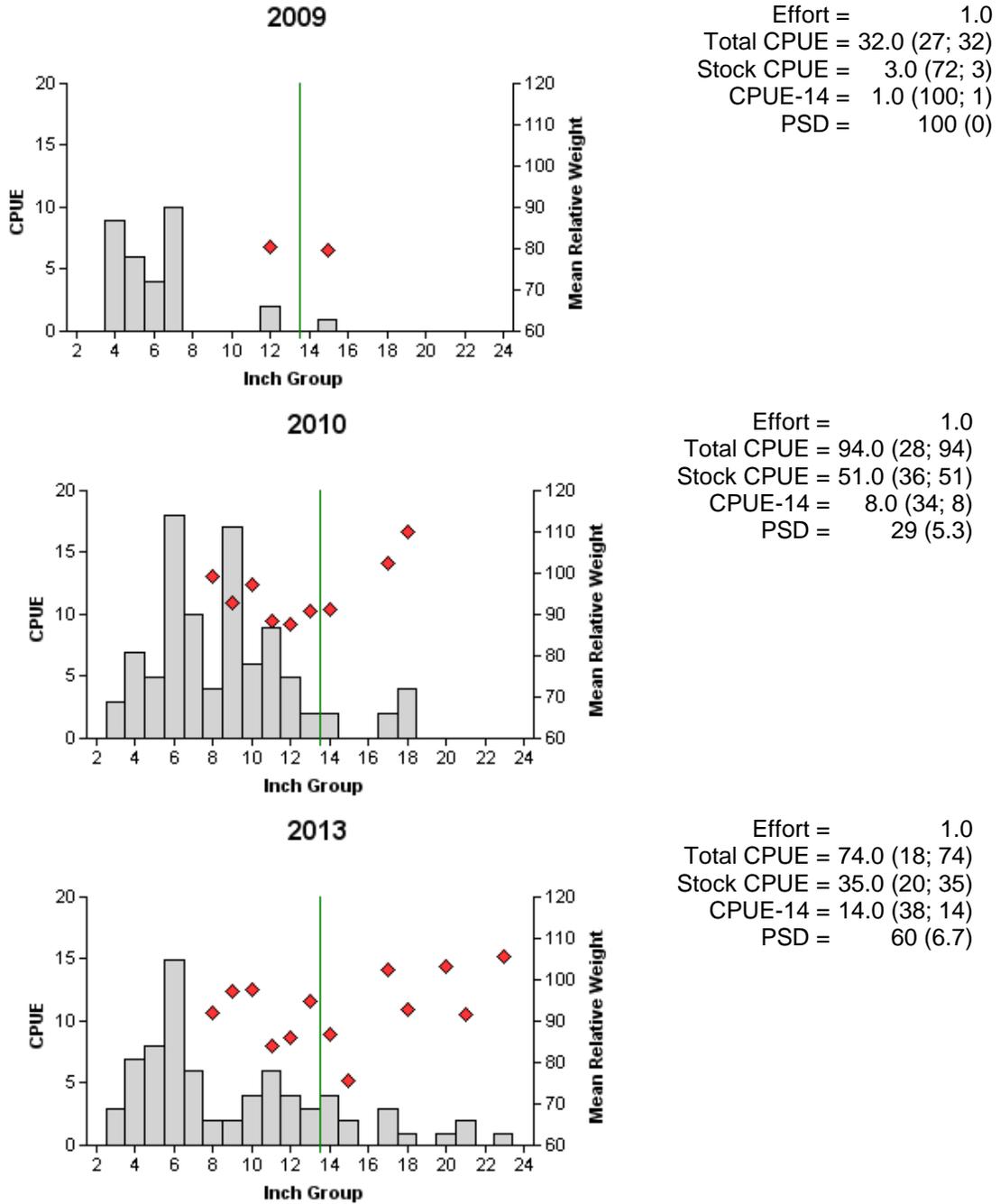


Figure 9. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

Table 6. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Benbrook Reservoir, Texas. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined by electrophoresis prior to 2005 and with micro-satellite DNA analysis since 2005.

Year	Sample size	Number of Fish			% FLMB alleles	% pure FLMB
		FLMB	Intergrade	NLMB		
1996	26	5	16	5	50.1	19.2
1999	30	3	21	6	48.3	10.0
2001	29	5	20	4	52.6	17.2
2009	25	0	25	0	63.0	0.0
2013	30	0	30	0	60.0	0.0

White Crappie

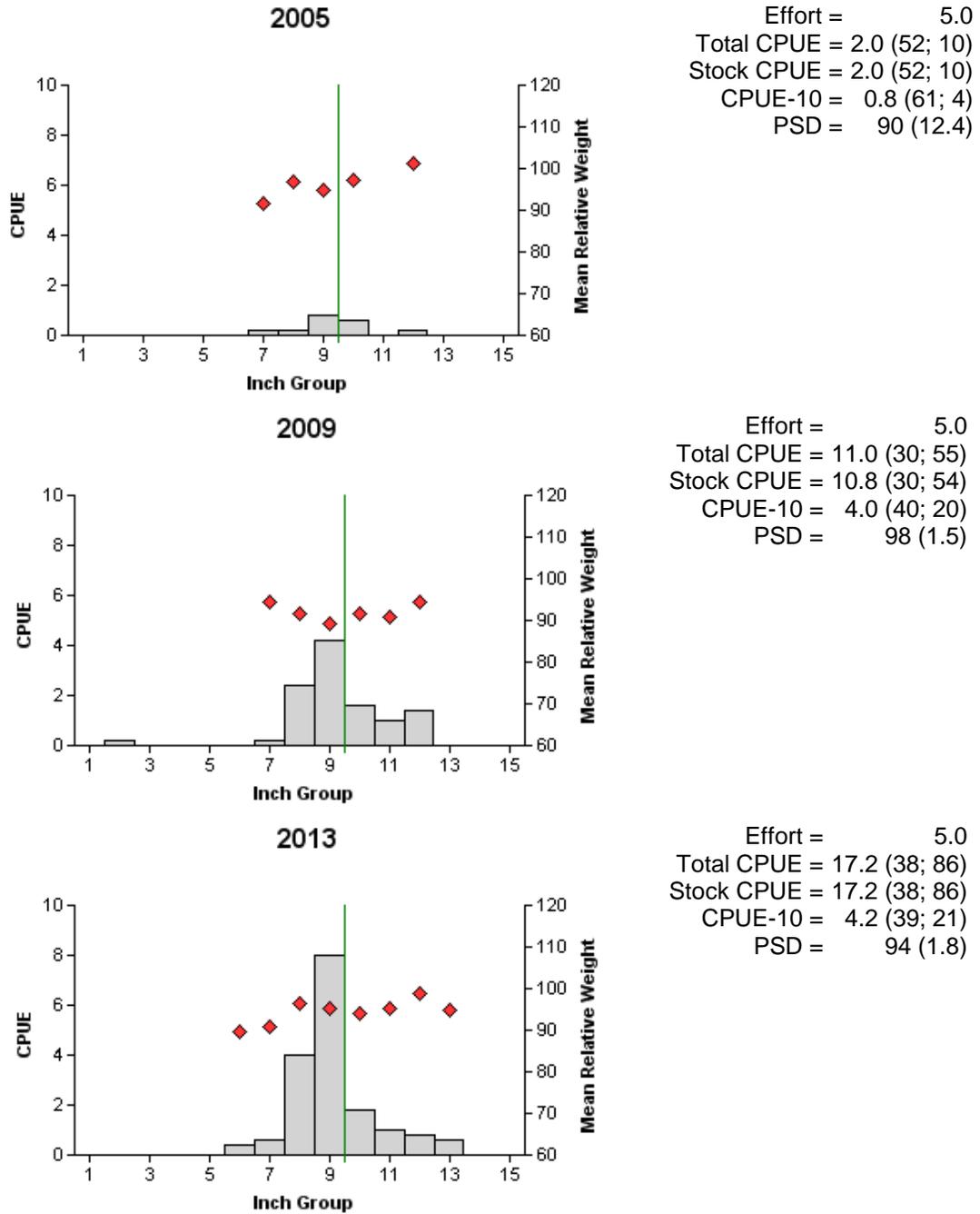


Figure 10. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Benbrook Reservoir, Texas. Solid vertical lines indicate minimum length limit at time of sampling.

Table 7. Proposed sampling schedule for Benbrook Reservoir, Texas. 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.

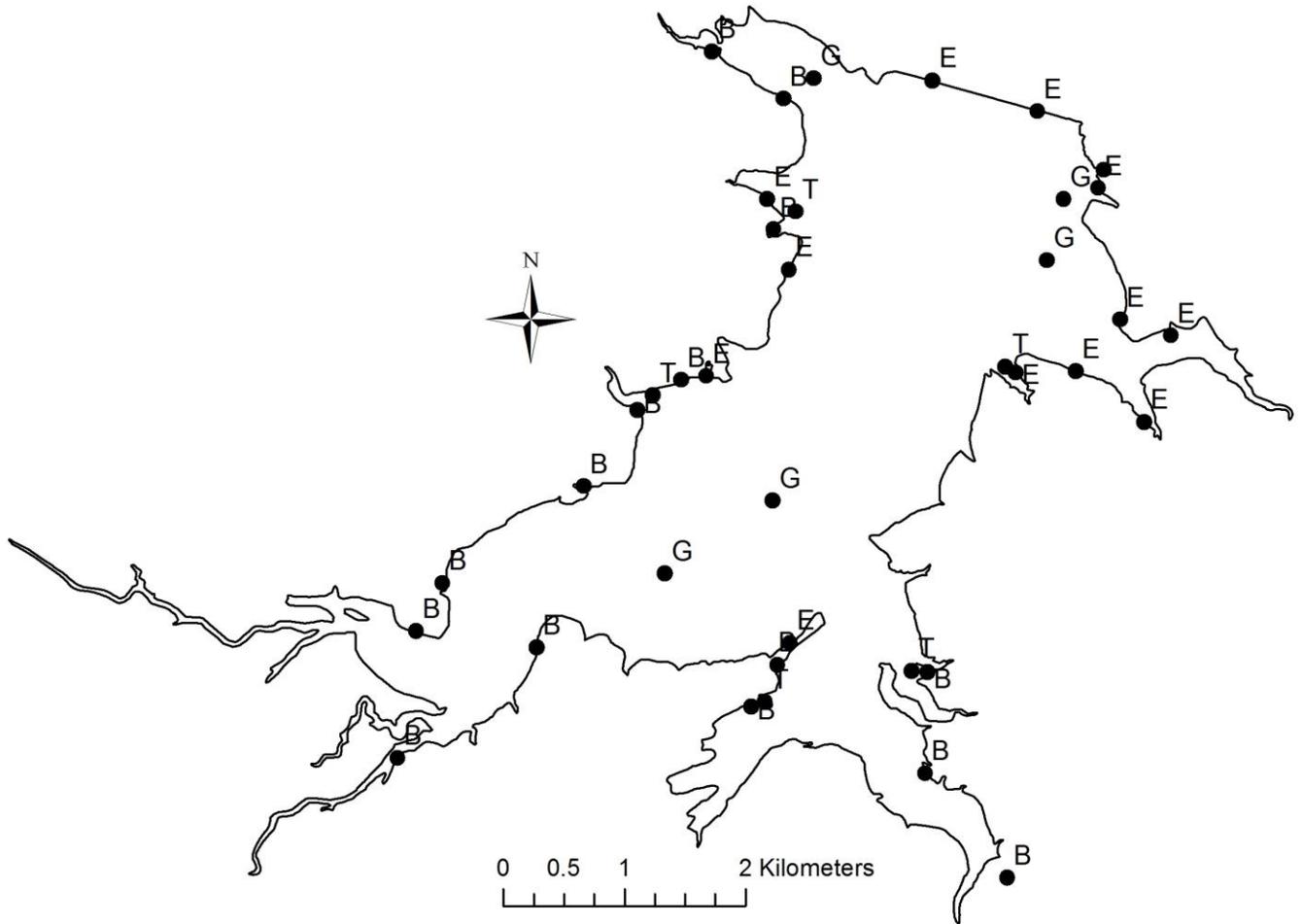
Survey year	Electrofishing	Trap net	Gill net	Habitat			Creel survey	Report
				Structural	Vegetation	Access		
2014-2015								
2015-2016			A					
2016-2017								
2017-2018	S	S	S			S	A	S

APPENDIX A

Number (N) and catch rate (CPUE) of all species collected from all gear types from Benbrook Reservoir, Texas, 2013-2014. Sampling effort was 5 net nights for gill netting, 5 net nights for trap netting, and 1 hour for electrofishing.

Species	Gill Netting		Trap Netting		Electrofishing	
	N	CPUE	N	CPUE	N	CPUE
Gizzard Shad	44	8.8			345	345.0
Threadfin Shad					495	495.0
Common Carp	40	8.0				
River Carpsucker	3	0.6				
Blue Catfish	13	2.6				
Channel Catfish	23	4.6				
White Bass	50	10.0				
Yellow Bass	120	24.0				
Palmetto Bass	14	2.8				
Bluegill	2	0.4			259	259.0
Longear Sunfish					90	90.0
Largemouth Bass	5	1.0			74	74.0
White Crappie	8	1.6	86	17.2		
Black Crappie	2	0.4	5	1.0		
Freshwater Drum	4	0.8				

APPENDIX B



Location of sampling sites, Benbrook Reservoir, Texas, 2013-2014. Trap net, gill net, and electrofishing stations are indicated by T, G, and E, respectively. Boat ramps are indicated with a B. Water level was 6.8 feet below conservation pool at time of trap netting, 5.5 below conservation pool at time of gill netting, and 7.9 feet below conservation pool at the time of electrofishing.

Appendix C

Historical catch rates of targeted species by gear type for Benbrook Reservoir, Texas.

Gear	Species	Year											
		1987	1989	1991	1993	1996	1999	2001	2002	2003	2004	2005	2006
Gill Netting (fish/net night)	Blue Catfish	0.1	0.1	0.0	0.0	0.6	1.0		0.6		0.8		3.8
	Channel Catfish	7.0	12.0	4.0	3.8	3.5	3.0		1.6		6.8		3.4
	Flathead Catfish	0.0	0.0	0.0	0.0	0.1	0.0		0.0		0.0		0.0
	White Bass	28.0	11.0	18.0	23.8	13.8	14.4		8.6		11.5		3.0
	Yellow Bass	0.0	0.0	0.0	0.0	0.0	0.0		0.0		0.0		4.4
	Palmetto Bass	0.0	1.0	0.0	1.4	6.0	9.4		2.4		1.8		8.4
Electrofishing (fish/hour)	Gizzard Shad	311.0	139.0	177.0	394.0	131.0	272.0	256.0		192.0			288.0
	Threadfin Shad	518.0	243.3	523.0	298.0	29.0	224.0	232.0		464.0			1089.0
	Bluegill	277.0	346.0	165.0	104.0	27.0	41.0	194.0		253.0			276.0
	Longear Sunfish	191.0	207.3	277.0	0.0	19.0	28.0	97.0		151.0			145.0
	Redear Sunfish	30.0	80.0	15.0	5.3	2.0	0.0	0.0		3.0			0.0
	Largemouth Bass	145.0	314.0	159.0	127.3	72.0	125.0	72.0		66.0			120.0
Trap Netting (fish/net night)	White Crappie	3.0	3.0	2.8	5.0	2.6	2.6	8.6					2.0
	Black Crappie	0.0	0.0	1.0	0.4	0.6	0.2	0.2					0.0

Appendix C, continued.

Historical catch rates of targeted species by gear type for Benbrook Reservoir, Texas.

Gear	Species	Year					
		2008	2009	2010	2012	2013	2014
Gill Netting (fish/net night)	Blue Catfish	3.0		1.4	5.4		2.6
	Channel Catfish	3.0		7.2	2.2		4.6
	Flathead Catfish	0.0		0.2	0.0		0.0
	White Bass	1.4		7.6	0.0		10.0
	Yellow Bass	13.2		11.8	3.8		24.0
	Palmetto Bass	4.4		3.8	1.0		2.8
Electrofishing (fish/hour)	Gizzard Shad		207.0	165.0		345.0	
	Threadfin Shad		787.0	586.0		495.0	
	Bluegill		21.0	365.0		259.0	
	Longear Sunfish		12.0	193.0		90.0	
	Redear Sunfish		0.0	3.0		0.0	
	Largemouth Bass		32.0	94.0		74.0	
Trap Netting (fish/net night)	White Crappie		11.0			17.2	
	Black Crappie		0.8			1.0	