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

2016 Fisheries Management Survey Report

Limestone Reservoir

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Limestone Reservoir were surveyed in 2016 using electrofishing and trap nets and in 2017 using gill nets. Historical data are presented with the 2016-2017 data for comparison. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir Description:** Limestone Reservoir is a 13,680-acre reservoir within the Navasota River system in Limestone, Robertson, and Leon Counties, Texas. Water levels were 1.5 to 2.0 feet below conservation pool (363 feet above mean sea level [MSL]) during 2016 electrofishing and trap net surveys and near conservation pool during the 2017 gill net survey. Habitat features consisted of boat docks, piers and bulk-headed shorelines, as well as a variety of emergent and submerged aquatic vegetation.

- **Management History:** Important sport fishes include catfishes, White Bass, Largemouth Bass and White Crappie. Sport fish have always been managed with statewide regulations. The management plan from 2012 recommended annual monitoring of noxious vegetation and implementing control measures if necessary. Noxious vegetation was monitored annually through 2014, and never required control measures. Other management efforts from 2012 included sharing information about the reservoir's loss of volume (through erosion and sedimentation within its watershed) with Texas Parks and Wildlife Department's (TPWD's) habitat branch and others who could take-on the issue on a watershed scale. A short document on this issue (Appendix D) is included in this report. Recent management efforts have focused on posting appropriate invasive species signage at access points, providing technical support and informational materials for the "Clean, Drain and Dry" campaign, educating marina owners about invasive species through verbal and written means so that they can in turn educate their customers, and keeping track of existing and future interbasin water transfers to facilitate potential invasive species responses. These efforts are described fully in the management history section of this report.

- **Fish Community**
  - **Prey species:** Gizzard Shad were observed in the reservoir in record numbers and 75% were available as prey to sport fish. Threadfin Shad were present in high numbers, consistent with previous surveys. Other forage species included Bluegill, Longear Sunfish and Redear Sunfish.
  - **Catfishes:** Blue Catfish catch rates were below the historical average for the species while catch rates for Channel Catfish were at a historical high. Legal-sized individuals were abundant for both species. Body condition varied for Blue Catfish, but was generally good for Channel Catfish. Flathead Catfish are present in low numbers.
  - **White Bass:** White Bass catch rates were just below average for the species. Legal-sized fish were less abundant than in previous surveys. Body condition was excellent for most size classes.
  - **Largemouth Bass:** Largemouth Bass catch rates were below average, and similar to the previous two surveys. The population was stable and body condition was very good.
  - **Crappies:** White Crappie were collected with trap nets in 2016, and with gill nets in 2017. Black Crappie were also caught in both surveys. Catch rates were similar to recent surveys and body condition was excellent for White Crappie.

- **Management Strategies:** The sport fishes in Limestone Reservoir will continue to be managed with statewide regulations. We will continue to maintain invasive species efforts. Access and vegetation surveys will be conducted in summer 2020 and trap netting and gill netting surveys will be conducted in 2020 and 2021. We will also coordinate with the Brazos River Authority on a habitat project.

INTRODUCTION

This document is a summary of fisheries data collected from Limestone Reservoir in 2016-2017. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2016-2017 data for comparison.

Reservoir Description

Limestone Reservoir is a 13,680-acre reservoir within the Navasota River system in Limestone, Robertson, and Leon Counties, Texas. The reservoir was created in 1978 and is operated by the Brazos River Authority (BRA). Water uses include power plant cooling and recreation. Primary land use surrounding Limestone's 117 miles of shoreline is agriculture. The reservoir is eutrophic with water transparencies ranging from 1 to 2 feet, and average and maximum depths of 16.5 and 43 feet respectively. Habitat at time of sampling consisted mainly of natural shoreline and bulk heading. Littoral vegetation is dominated by common buttonbush, cattail and rice cutgrass. Conservation pool elevation is 363 feet above mean sea level [MSL]. Water level dropped eight feet below conservation pool during 2013, but has been within four feet of conservation pool ever since (Figure 1a). The water level was 1.5 to 2.0 feet below conservation pool during the 2016 surveys and just above conservation pool during the 2017 survey (Figure 1b). Other descriptive characteristics for Limestone Reservoir are in Table 1.

Angler Access

Bank and boat access on Limestone Reservoir is adequate when the reservoir is near full pool. Bank fishing is limited to a few day-use areas on the reservoir, one of which has a fishing pier, and boat access consists of six ramps. All boat ramps became unusable during the 2011 - 2012 drought, highlighting access issues that occur during low water levels. No boating access is available at water levels below 355 feet MSL. With exception of a brief period during mid-2013, boat ramps have been useable since 2012. Additional boat ramp characteristics are in Table 2.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Tibbs and Baird 2012) included:

1. Monitor the reservoir for noxious vegetation (e.g. hydrilla, water hyacinth, eurasian watermilfoil, alligator weed and giant reed) annually, conduct a full vegetation survey in 2016, provide survey data upon request and work with the controlling authority to control noxious vegetation if they become problematic.

   Action: Noxious vegetation was monitored annually through 2012 however, since none posed a threat to access, and control efforts were unnecessary and unlikely, the noxious vegetation presence on Limestone Reservoir was reclassified as a tier III infestation, requiring monitoring every four years only.

2. Share information on Limestone Reservoir with the TPWD watershed coordinator, Southeast Aquatic Resource Partnership (SARP) and Reservoir Fish Habitat Partnership (RFHP); propose funding from SARP and RFHP to perform best management practice (BMP) work within the watershed.

   Action: A short document was drafted to describe the status of Limestone Reservoir and its fishery, present the information to the Habitat Branch of the Inland Fisheries Division for their review and consideration and request their expertise in retaining grant funding to accomplish the needed work. Funding from organizations such as the SARP and RFHP could then be used to promote best management practices or other work to reverse the effects of erosion and sedimentation within this watershed. The document is included in this report as Appendix D.

3. Track the loss of shoreline habitat with a full structural habitat survey prior to the next report.
   Action: A re-survey of bulkhead habitat was conducted during winter 2017 and compared to the previous structural habitat survey conducted in 2008.
4. Cooperate with the controlling authority to post invasive species signage at access points, provide technical support/informational materials for the "Clean, Drain and Dry" campaign, and educate business owners about invasive species through verbal and written means, so that they can in turn educate their customers. Keep track of existing and future interbasin water transfers to facilitate potential invasive species responses.
   Action: Invasive species signage was posted at Limestone Reservoir access points during summer 2013. District biologists have made a speaking point about invasive species, how to prevent their spread, and potential effects on Limestone Reservoir while speaking to business owners and constituent groups such as the Central Texas Flyrodders, Legacy Outfitters and Brazos River Sportsman's Club over the past several years. Interbasin transfer is a permanent section in all formal reports now, and is part of this report.

Harvest regulation history: Sportfishes in Limestone Reservoir have always been managed with statewide regulations. The current harvest regulations are listed in Table 3.

Stocking history: Limestone Reservoir was last stocked with 158,879 Florida Largemouth Bass in 2015. No other stockings have occurred since. The complete stocking history is in Table 4.

Vegetation/habitat management history: Hydrilla, (*Hydrilla verticillata*) was the only species of concern in the reservoir in 1997 (19 surface acres) however only trace amounts have been observed since. Water hyacinth (*Eichhornia crassipes*) coverage was estimated at 3.5 acres in 2001, 37.5 acres in 2002, and 35 acres in 2003 and 2004. Additional estimates were trace (2006), 12 acres (2008), 7.7 acres (2009) and <0.1 acre (2010). Water hyacinth was observed at only one of 135 shoreline points during 2016. Eurasain watermilfoil (*Myriophyllum spicatum*) was first observed in 2006 (estimated 21 acres) and maintained similar coverage through 2008. There were 18.8 acres of watermilfoil in 2009, but coverage dropped to 2.7 acres in 2010. No watermilfoil was observed in 2012 or 2016. Giant cane (*Arundo donax*) was first noted during the summer 2008 vegetation survey (<0.1 acres) and has remained stable. Alligator weed (*Alternanthera philoxeroides)* was observed during the 2012 survey at 20 of 75 random shoreline points surveyed (27%), but species occurrence dropped to (2%) in 2016. These noxious species were monitored annually through 2012. Low water precluded a noxious vegetation survey in 2011. Since none of the infestations have ever posed a threat to public access, and control efforts are unnecessary and unlikely, the noxious vegetation present on Limestone Reservoir was reclassified as a tier III infestation during 2013, only requiring monitoring every four years. Data on all vegetation species, including the summer 2016 survey, are included in Table 7 of this report.

Water transfer: No interbasin transfers are known to exist within Limestone Reservoir.

Reservoir capacity: Limestone Reservoir was impounded in 1978. Original plans calculated the reservoir's capacity at conservation pool (363 feet above mean sea level) to be 225,400 acre-feet with a surface area of 14,200 acres. Two volumetric surveys have been conducted by the Texas Water Development Board (TWDB) on Limestone since impoundment; one in 1993 and another in 2002. The 2002 survey found a volume of 215,748 acre-feet and a surface area of 13,379 acres at conservation pool elevation. According to the TWDB, there has been an estimated reduction of 9,652 acre-feet, or 4.3% less than that recorded in the original permit. The reduction is assumed to be a combination of sedimentation, and improved data and calculation methodologies.

METHODS

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Limestone Reservoir (TPWD unpublished). Primary components of the OBS plan are listed in Table 5. All survey sites were randomly selected and all surveys were conducted

according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad and Threadfin Shad were collected by electrofishing (1.3 hours at 15, 5-min stations). The 2016 survey is the first daytime electrofishing survey completed on Limestone Reservoir. Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

Gill netting – Blue Catfish, Channel Catfish, White Bass and crappies were collected by gill netting (10 net nights at 10 stations). Catch per unit effort for gill netting was recorded as the number of fish caught per net night (fish/nn).

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

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Micro-satellite DNA analysis was used to determine genetic composition of individual fish.

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 X SE of the estimate/estimate) was calculated for all CPUE statistics.

Habitat – The 2008 structural habitat survey, 2016 re-survey of bulk heading habitat, and vegetation surveys from 2008 to 2012, were conducted according to Tibbs and Baird (2008). The 2012 and 2016 vegetation surveys were conducted using an adaptation of the point method (TPWD, Inland Fisheries Division, unpublished manual revised 2015). Points were randomly generated on the shoreline and averaged a minimum of one point per shoreline mile. Aquatic vegetation has always been found close to the shore in Limestone Reservoir, so stratifying the random points to exclude deep-water areas increased precision and resulted in better data.

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

RESULTS AND DISCUSSION

Habitat: Limestone Reservoir is a moderately turbid reservoir with a secchi range from two to three feet. The most recent habitat survey results can be found in Table 6. A full vegetation survey conducted during summer 2016 found dominant vegetation to be American pondweed (Potamogeton nodosus), common buttonbush (*Cephalanthus occidentalis*) and cattail (*Typha spp.*) (Table 7).

Creel: A year-long creel survey was conducted on Limestone Reservoir during 2004/2005. Directed fishing effort was highest for Largemouth Bass (41.6%), followed by crappies (29.3%) and catfishes (14.3%). The complete Limestone creel can be found in Tibbs and Baird 2005.

Prey species: Threadfin and Gizzard Shad were collected by electrofishing at 1,379.3/h and 429.8/h respectively in 2016 (Figure 2; Appendices A and B). The catch rates for both shad species were above their historical averages. The IOV for Gizzard Shad was good as 75% of the population was available to existing predators as forage. Other important forage species collected were Bluegill (73.5/h) and Longear Sunfish (16.5/h) (Figures 3 and 4; Appendices A and B).

Catfishes: Blue Catfish were collected with gill nets at a rate of 6.4/nn in 2017, which is near the historical average for the species (Figure 5; Appendices A and B). The OBS goal for this species (general monitoring to collect CPUE and size structure data) was achieved. The PSD has improved over the past three surveys, and is currently fair to good. None of the Blue Catfish in our sample approached the preferred size category of 30 inches, and body condition was highly variable.

Channel Catfish were collected with gill nets at a rate of 13.7/nn in 2017, which is nearly twice the historical average for the species (Figure 6; Appendices A and B). The OBS goal for this species (general monitoring to collect CPUE and size structure data) was achieved. The PSD was fair to good (i.e., 27) and suggests the population is somewhat balanced. The percentage of legal-sized fish (PSD-12; i.e., 12 inches) has improved from the previous survey. Body condition remains excellent.

Flathead Catfish were not targeted during the 2017 gill net survey, but were caught at a rate of 0.2/nn (Appendices A and B).

White Bass: White Bass were collected with gill nets at a rate of 4.3 fish/nn in 2017, which is near the historical average for the species (Figure 7; Appendices A and B). The OBS goal for this species (general monitoring to collect CPUE and size structure data) was achieved. The PSD and PSD-10 values have decreased over the past three surveys, but remain good. Body condition, although excellent, decreases with increasing length class.

Largemouth Bass: Largemouth Bass were collected by electrofishing at a rate of 33.8 fish/h in 2016 and this is below average for the species in the reservoir (Figure 8; Appendices A and B). The OBS goal for this species (obtaining a CPUE-stock RSE of 25 or less, and a genetic sample of 30 fish) was achieved. The current PSD (i.e., 38) for Largemouth Bass is similar to the previous survey, and is near the lower range for balanced populations. The percentage of legal-sized fish (PSD-14; i.e., 14 inches) decreased from the previous survey, but remained good. Body condition ranged from good to excellent. Largemouth Bass genetics analyzed in 2016 showed reduced Florida influence (26%) over the 2012 survey (38%) despite stockings of pure Florida Largemouth Bass in 2014 and 2015 (Table 8). An analysis of the genetic sample revealed that 10 of 30 fish came from the 2014 and 2015 year-classes, yet none of them were pure Florida Largemouth Bass. While by no means definitive, this evidence indicates our stockings were not successful.

Crappies: White Crappie were collected with trap nets at a rate of 4.5 fish/nn in 2016 and with gill nets at a rate of 4.6 fish/nn in 2017; these catch rates are below the historical average for the species (7.7 fish/nn) but similar to recent surveys (Figures 9 and 10; Appendices A and B). The OBS goal for this species (general monitoring to collect CPUE data and a minimum of 50 stock length fish for size structure data) was nearly achieved for White Crappie with trap nets (N = 45) and gill nets (N = 46).

The PSD for White Crappie differed considerably when comparing the trap netting index (41) to the gill netting index (87), the former indicating a more balanced population with fewer large fish, and the latter low recruitment and/or high mortality of smaller fish. Sampling gear and seasonal biases account for an unknown but likely significant amount of the differences observed. Both surveys found generally excellent body condition for White Crappie. Additional comparisons between trap nets and gill nets are needed.

Black Crappie were not targeted during the 2016 trap net survey, but were caught at rates of 0.6/nn and 0.9/nn in trap net and gill net surveys respectively (Appendices A and B).

Fisheries management plan for Limestone Reservoir, Texas

Prepared – July 2017

ISSUE 1: The Largemouth Bass population remains depressed, and recent stockings in 2014 and 2015 did not positively impact Florida genetics in the population which hit a historical low in 2016. Low water plagued the reservoir from 2010 through 2013.

MANAGEMENT STRATEGIES

1. Discontinue Florida Largemouth Bass stockings.
2. Collect genetics data again in fall 2020 to see if there is improvement.
3. Propose an aquatic habitat project using recently allocated BRA funds to benefit the Largemouth Bass population prior to the next report.

ISSUE 2: 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 Brazos River Authority to post and maintain appropriate signage at access points around the reservoir.
2. Ensure that marina owners are aware of the threat of invasive species and have information to provide to their customers.

Objective Based Sampling Plan and Schedule 2017 - 2021

Sport fish, forage fish and other important fishes

Survey data suggest important sport fishes in Limestone Reservoir include Blue Catfish, Channel Catfish, White Bass, Largemouth Bass and White Crappie. Important forage fishes include Gizzard Shad, Threadfin Shad, Bluegill, Redear Sunfish and Longear Sunfish. The proposed sampling schedule (Table 9) lists electrofishing, trap netting and gill netting surveys planned for the next four years.

Low-density fisheries

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

Survey objectives, fisheries metrics, and sampling objectives

Fall Electrofishing: This survey will be used to evaluate Largemouth Bass and primary forage species (Bluegill, Longear Sunfish, Redear Sunfish, Gizzard Shad and Threadfin Shad). Black Bass were the most sought species group by anglers in Limestone Reservoir during the 2004-2005 creel survey (2.0 hours/acre), and the popularity of bass fishing at this reservoir justifies sampling time and effort. A minimum of 15, random five-minute daytime electrofishing stations will be sampled in fall 2020. The goals of the Largemouth Bass survey will be general monitoring (using CPUE, size structure and relative weight as metrics) and prevalence of Northern and Florida Largemouth Bass alleles (using fin clips from 30 random individuals) to characterize the Largemouth Bass population and make comparisons with historical and future data. Catch per unit effort target precision will be an RSE ≤ 25. Target sample size will be an N ≥ 50 stock-sized fish to determine population size structure, allowing us to calculate proportions with 80% confidence. If catch rates indicate collecting our size structure target is reasonable, sampling will continue at random stations until that target is reached.

The goals of the forage species surveys will be general monitoring (using CPUE and size structure as metrics) to characterize Bluegill, Longear Sunfish, Redear Sunfish, Gizzard Shad and Threadfin Shad populations and make comparisons with historical and future data. Since trend data show large variations in catch of forage species, no catch per unit effort target precision, target sample sizes or relative weights will be assigned. Index of vulnerability (IOV) will be calculated for Gizzard Shad to assess the relative proportion of individuals in the population suitable as prey for sport fish.

Winter Trap Netting: This survey will be used to evaluate White Crappie, which is the dominant Crappie species in Limestone Reservoir. The 2004-2005 creel survey showed directed angling effort for Crappie to be 1.6 hours/acre, making it the second most sought-after species in the reservoir. A minimum of 15 random trap netting stations will be sampled in winter 2020. The goal of the White Crappie survey will be general monitoring (using CPUE, size structure and relative weight as metrics) to characterize the White Crappie population and make comparisons with historical and future data. Catch per unit effort target precision will be an RSE ≤ 25. Target sample size will be an N ≥ 50 stock-sized fish to determine population size structure, allowing us to calculate proportions with 80% confidence. If catch rates from the first fifteen nets indicate collecting our size structure target is reasonable, sampling will continue at random stations until that target is reached.

Spring Gill and Trap Netting: The gill net survey will be used to evaluate White Bass, Blue Catfish, Channel Catfish and White Crappie and the trap net survey will be used to evaluate White Crappie only. The 2004-2005 creel survey showed directed angling effort for Crappie to be 1.6 hours/acre, making it the second most sought-after species in the reservoir. White Bass and catfishes were sought at very low levels by anglers during the 2004-2005 creel survey (0.4 hour/acre for White Bass and 0.7 hour/acre for catfish as a group). White Crappie data has been collected with trap nets and gill nets, and varies substantially by gear and among years. The spring 2021 White Crappie gill net data will be compared

with the winter 2020 and spring 2021 trap net data to characterize differences among White Crappie samples obtained with two different gears at the same time and the same gear (trap netting) in two different seasons. A minimum of 15 random gill netting stations and 15 trap netting stations will be sampled in spring 2021, with the total of each gear equaling the winter trap netting effort to facilitate seasonal comparisons. The goal of the gill netting survey will be general monitoring (using CPUE, size structure and relative weight as metrics) to characterize the White Bass, catfish and White Crappie populations, make comparisons with historical and future data, and compare White Crappie samples to winter and spring trap netting White Crappie samples. The goal of the spring trap netting survey would be to compare White Crappie samples obtained during winter 2020 trap netting and with those obtained from spring 2021 gill netting. For White Crappie, catch per unit effort target precision, and target sample size, will be an RSE ≤ 25 and an N ≥ 50 stock-sized fish respectively. Target sample sizes will determine population size structure, and allow us to calculate proportions with 80% confidence. No catch per unit effort target precision or target sample sizes will be assigned for White Bass or catfishes.

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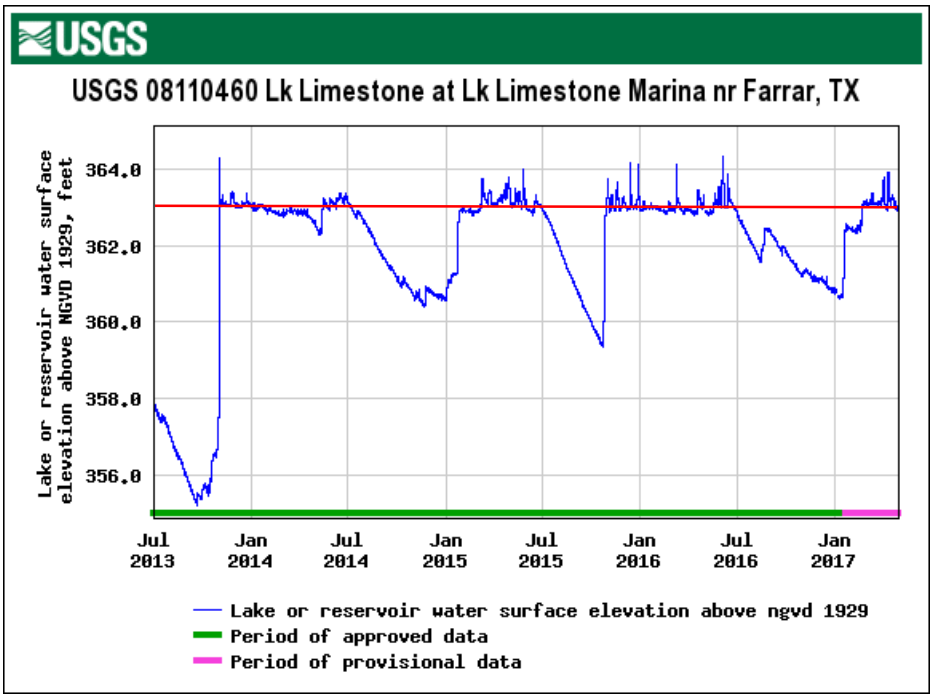


Figure 1a. Daily mean water levels for Limestone Reservoir from July 1, 2013 through July 1, 2017. Conservation pool level (red line) is 363 feet above MSL. Figure from the USGS website.

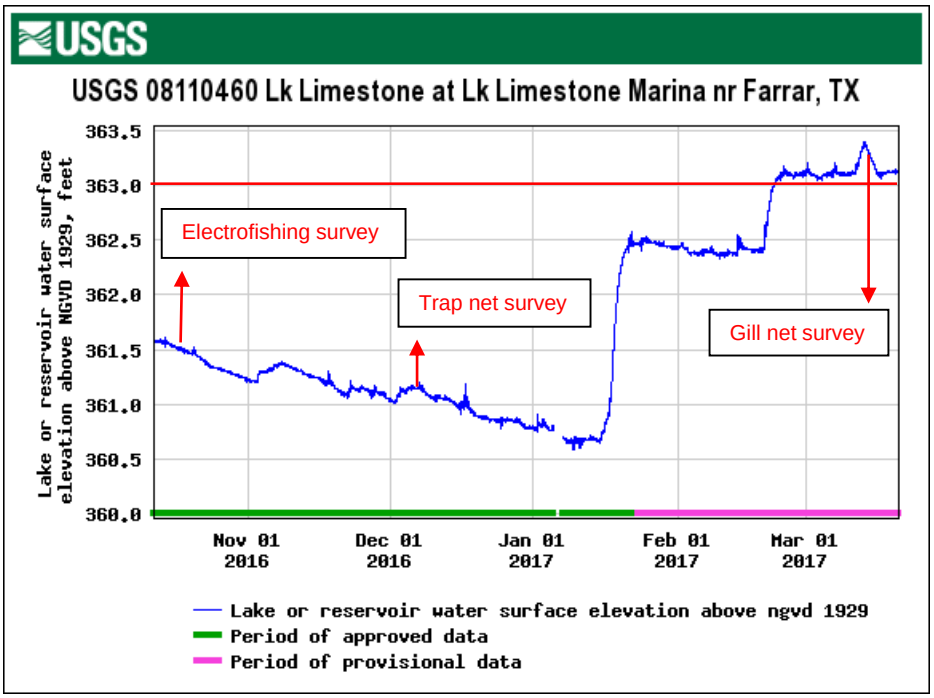


Figure 1b. Daily mean water levels for Limestone Reservoir for the 2016/2017 sampling season. Red arrows designate approximate days for electrofishing (October 12, 2016), trap net (December 6, 2016) and gill net (March 20, 2017) surveys. Conservation pool level (red line; no arrows) is 363 feet above MSL. Figure from the USGS website.

Table 1. Characteristics of Limestone Reservoir, Texas 2016 - 2017.

Characteristic	Description
Year Constructed	1978
Controlling authority	Brazos River Authority
Counties	Limestone, Robertson, and Leon
Reservoir type	Tributary
Shoreline Development Index (SDI)	7.9
Conductivity (um)	209 (average from the past three surveys)

Table 2. Boat ramp characteristics for Limestone Reservoir, Texas, 2016 - 2017. Reservoir elevation at time of survey was 361.9 feet above MSL (1.1 feet below conservation pool).

Boat ramp	Latitude Longitude (dd)	Trailer Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
BRA Park #1	31.32845; -96.33179	16	359	Good, needs extended
Leon County Park	31.33895; -9631066	12	357	Good, needs extended
Limestone County #2	31.43429; -96.37516	10	355	Poor ramp and parking
Limestone County #3	31.44755; -96.37821	10	357	Poor ramp and parking
Running Branch Marina	31.34379; -96.36858	8	NA	Usable only at full pool
Limestone Marina	31.38628; -9631771	10	NA	Good, gravel parking

Table 3. Harvest regulations for Limestone Reservoir, 2016 - 2017.

Species	Bag Limit	Length limit (inches)
Catfish: Channel, Blue, their hybrids and subspecies	25 (in any combination)	12 - No Limit
Catfish, Flathead	5	18 - No Limit
Bass, White	25	10 - No Limit
Bass, Largemouth	5 [a]	14 – No limit
Bass, Spotted	5 [a]	No Limit
Crappie: White, Black, their hybrids and subspecies	25 (in any combination)	10 - No Limit

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

Table 4. Stocking history for Limestone Reservoir, Texas. Life stages are fry (FRY), fingerlings (FGL), advanced fingerlings (AFGL) and adults (ADL). 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	1986	135,425	FGL	2.0
	1996	306,470	FGL	1.8
	1998	1,500	AFGL	9.8
	1998	78,575	FGL	2.3
	Total	521,970		
Channel Catfish	1979	338,237	AFGL	7.9
	Total	338,237		
Florida Largemouth Bass	1979	78,758	FGL	2.0
	1979	122,040	FRY	1.0
	1995	127	ADL	12.0
	1995	69,878	FGL	1.0
	1996	43,426	FGL	1.6
	1996	185,281	FRY	1.0
	2014	290,220	FGL	1.5
	2015	158,879	FGL	1.6
	Total	948,609		
Largemouth Bass	1994	151	ADL	11.8
	1996	45	ADL	12.0
	Total	196		
Palmetto Bass (Striped X White Bass Hybrid)	1984	274,175	FGL	2.0
	Total	274,175		

Table 5. Objective-based sampling plan components for Limestone Reservoir, Texas 2016 – 2017.

Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	General monitoring	CPUE, Size structure, Wr	RSE-Stock< 25, N ≥ 50 stock
	Genetics	% FLMB	N = 30, any age
Bluegill	General monitoring	CPUE, Size structure	none
Redear Sunfish	General monitoring	CPUE, Size structure	none
Longear Sunfish	General monitoring	CPUE, Size structure	none
Gizzard Shad	General monitoring	CPUE, Size structure	none
Trap netting			
White Crappie	General monitoring	CPUE, Size structure, Wr	N ≥ 50 stock
Gill netting			
Blue Catfish	General monitoring	CPUE, Size structure, Wr	none
Channel Catfish	General monitoring	CPUE, Size structure, Wr	none
White Bass	General monitoring	CPUE, Size structure, Wr	none
Crappie spp.	General monitoring	CPUE, Size structure, Wr	none

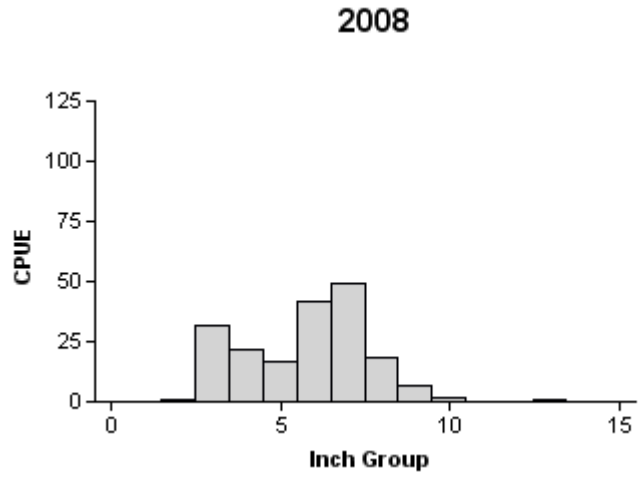
Table 6. Survey of structural habitat types, Limestone Reservoir, Texas, 2008 and 2017. In 2017, only bulk heading was estimated. Shoreline habitat type units are in miles.

Habitat type	2008 Estimate	% of total	2017 Estimate
Bulkhead	28.5	24.4	30.7
Gravel shoreline	1.3	<1.0	
Boulder/riprap shoreline	8.0	<1.0	
Natural shoreline	79.4	67.8	
Boat Docks/Ramps	3.7	<1.0	
Giant reed	<0.1	<1.0	
Native emergents	1.0	<1.0	

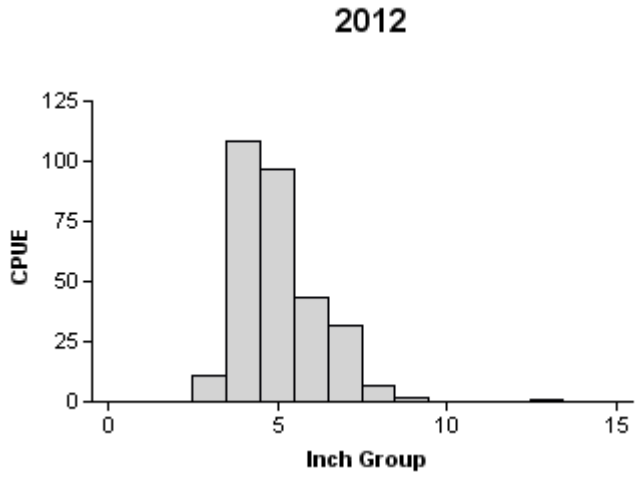
Table 7. Survey of aquatic vegetation, Limestone Reservoir, Texas, 2009 through 2016. Percent of total reservoir surface area is listed for 2009, 2010 and 2012, while percent of randomly-selected points where species occurred, is listed for 2016. Reservoir elevation at time of survey was 361.9 feet above MSL (1.1 feet below conservation pool). Tier III is watch status.

Vegetation	2009	2010	2012	2016
Native submersed				
American pondweed (Potamogeton nodosus)				22% (29 of 135)
Native floating-leaved				
American lotus (*Nelumbo lutea*)				7% (10 of 135)
Native emergent				
Rice cutgrass (*Leersia oryzoides*)				4% (5 of 135)
Bulrush (*Scirpus spp.*)				2% (3 of 135)
Common buttonbush (Cephalanthus occidentalis)				33% (44 of 135)
Cattail (*Typha spp.*)				12% (16 of 135)
Square-stemmed spike rush (*Eleocharis quadrangulata*)				3% (4 of 135)
Non-native				
Giant reed (*Arundo donax)* (Tier III)				1% (1 of 135)
Eurasian watermilfoil (*Myriophyllum spp.*) (Tier III)	18.8 (0.1)	2.7 (trace)		0% (0 of 135)
Alligator weed (*Alternanthera philoxeroides*) (Tier III)			27% (20 of 75)	2% (3 of 135)
Hydrilla (*Hydrilla verticillata*) (Tier III)		0.1 (trace)		0% (0 of 135)
Water hyacinth (*Eichornia crassipes*) (Tier III)	7.7 (0.1)	.04 (trace)	N/A	<1% (1 of 135)

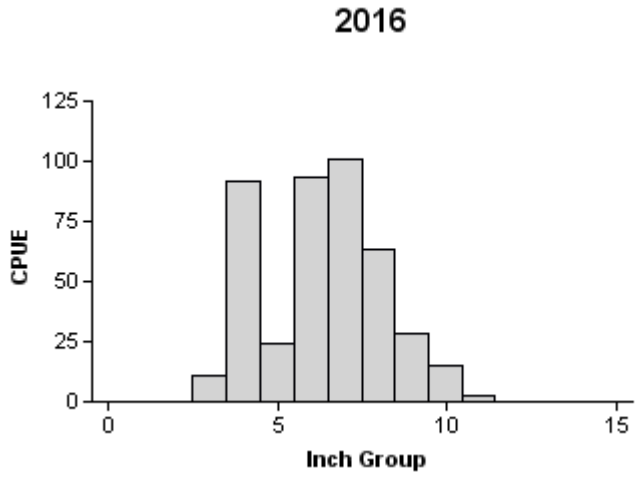
Gizzard Shad



Effort = 1.5
Total CPUE = 190.0(12;285)
Stock CPUE= 77.3 (21; 116)
IOV = 85 (3)



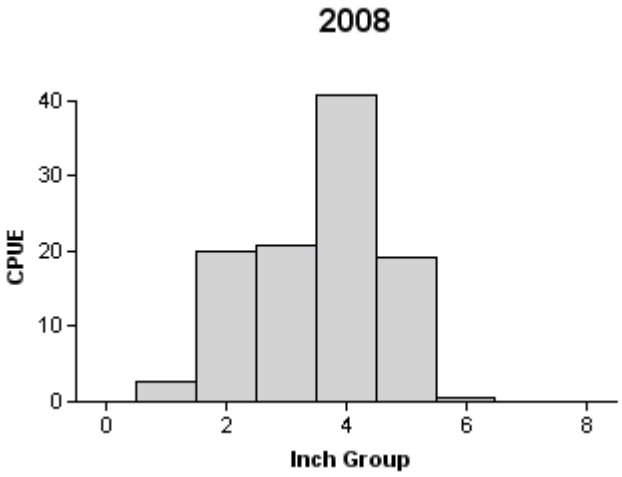
Effort = 2.0
Total CPUE= 299.5(18;599)
Stock CPUE= 41.0 (21; 82)
IOV = 97 (1)



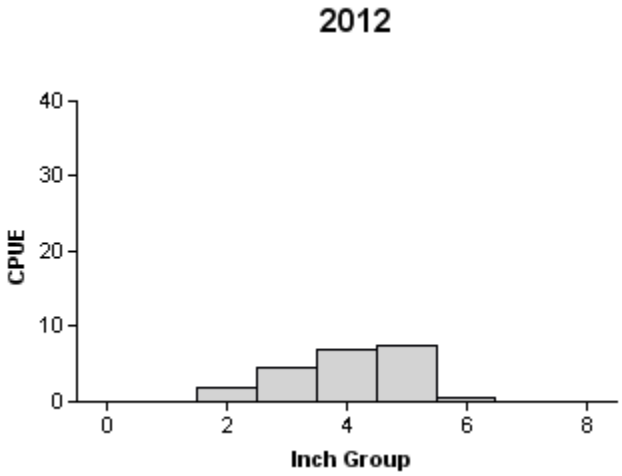
Effort = 1.3
Total CPUE= 429.8(10;573)
Stock CPUE= 209.3 (9; 279)
IOV = 75 (4)

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, Limestone Reservoir, Texas, 2008, 2012 and 2016 (daytime).

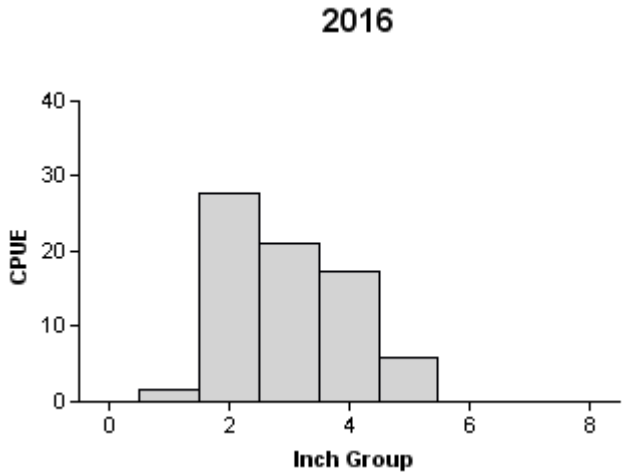
Bluegill



Effort = 1.5
Total CPUE= 104.0(24;156)
Stock CPUE= 81.3 (26; 122)
PSD = 1 (1)



Effort = 2.0
Total CPUE = 21.5 (31;43)
Stock CPUE = 19.5 (31;39)
PSD = 3 (2)



Effort = 1.3
Total CPUE = 73.5 (31;98)
Stock CPUE = 44.3 (27;59)
PSD = 0 (0)

Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parenthesis) for fall electrofishing surveys, Limestone Reservoir, Texas, 2008, 2012 and 2016 (daytime).

Longear Sunfish

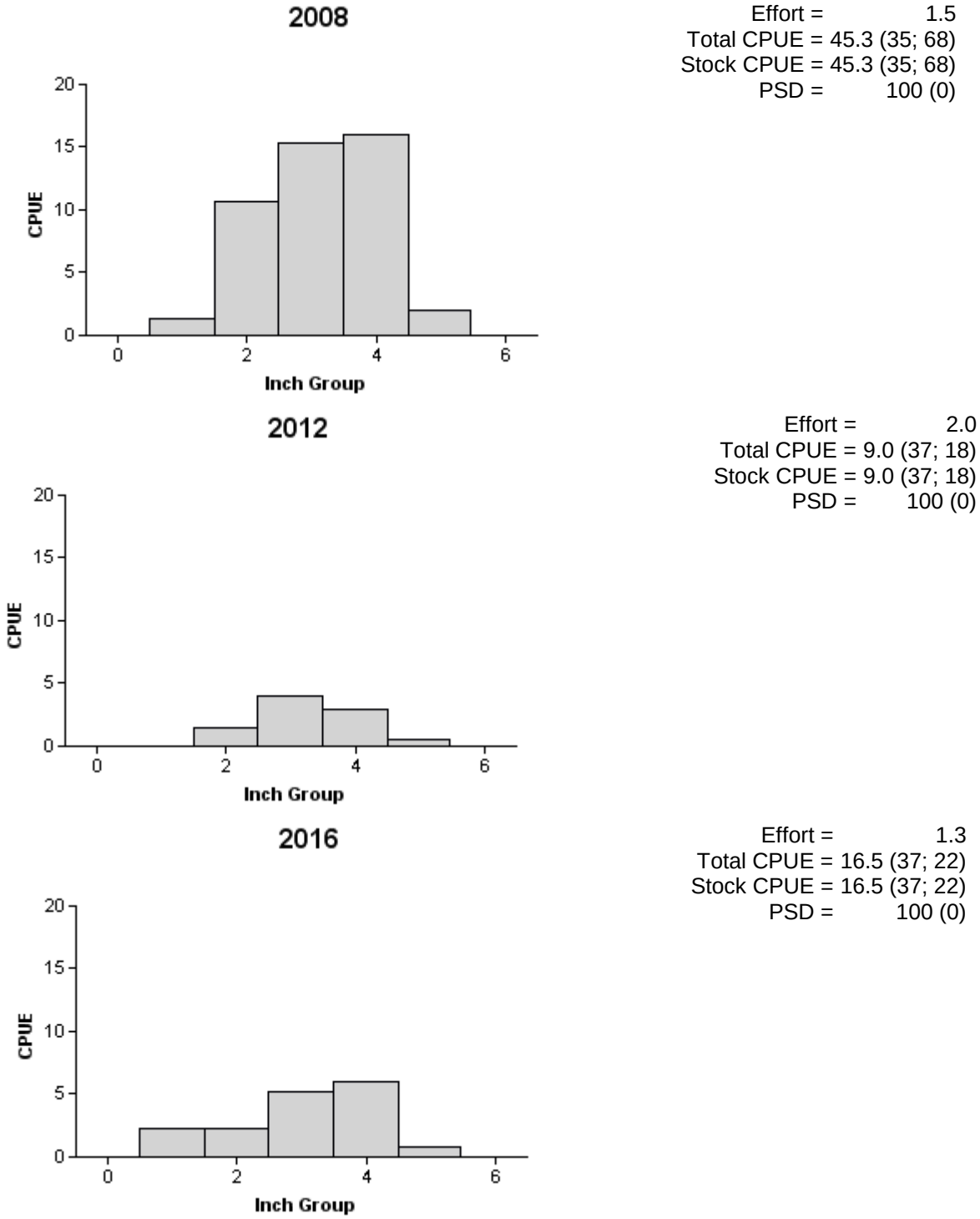


Figure 4. Number of Longear Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parenthesis) for fall electrofishing surveys, Limestone Reservoir, Texas, 2008, 2012 and 2016 (daytime).

Blue Catfish

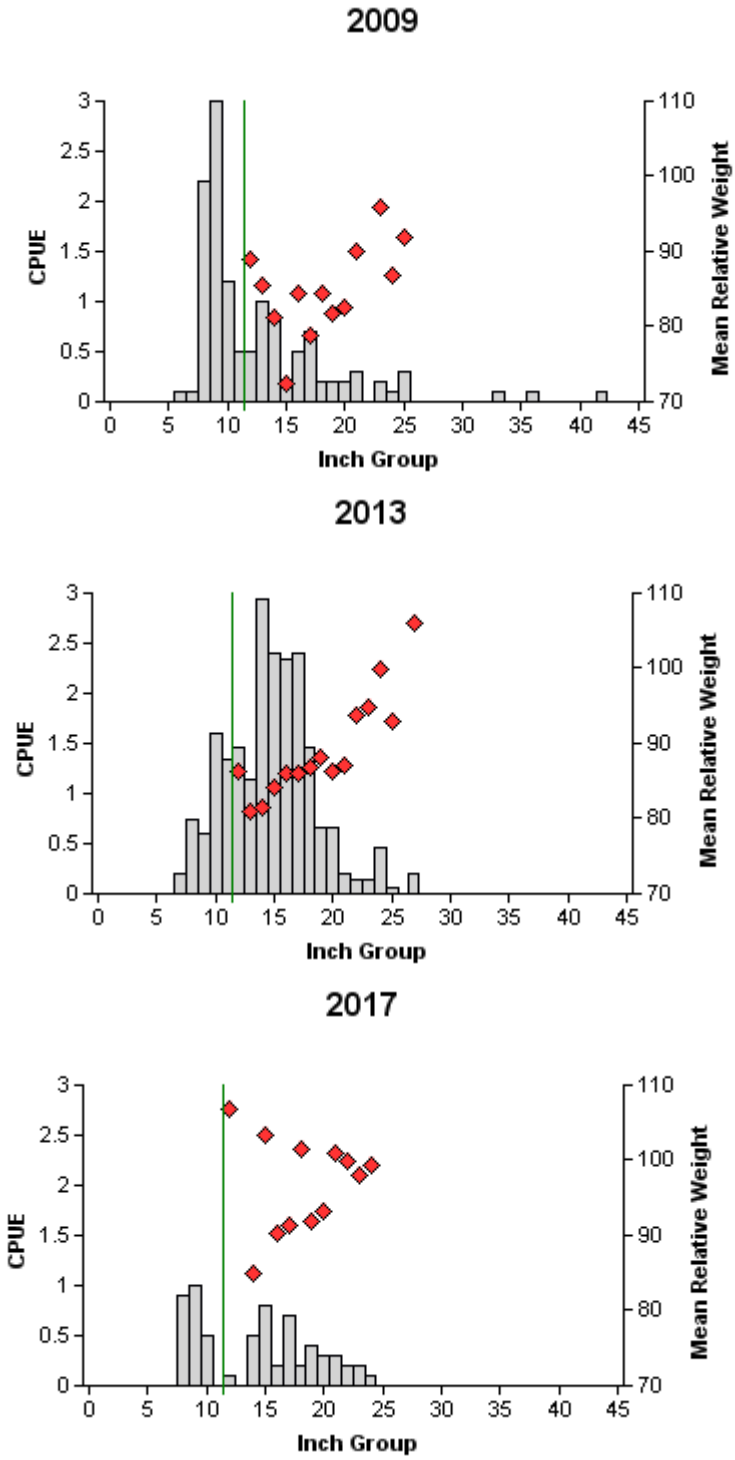
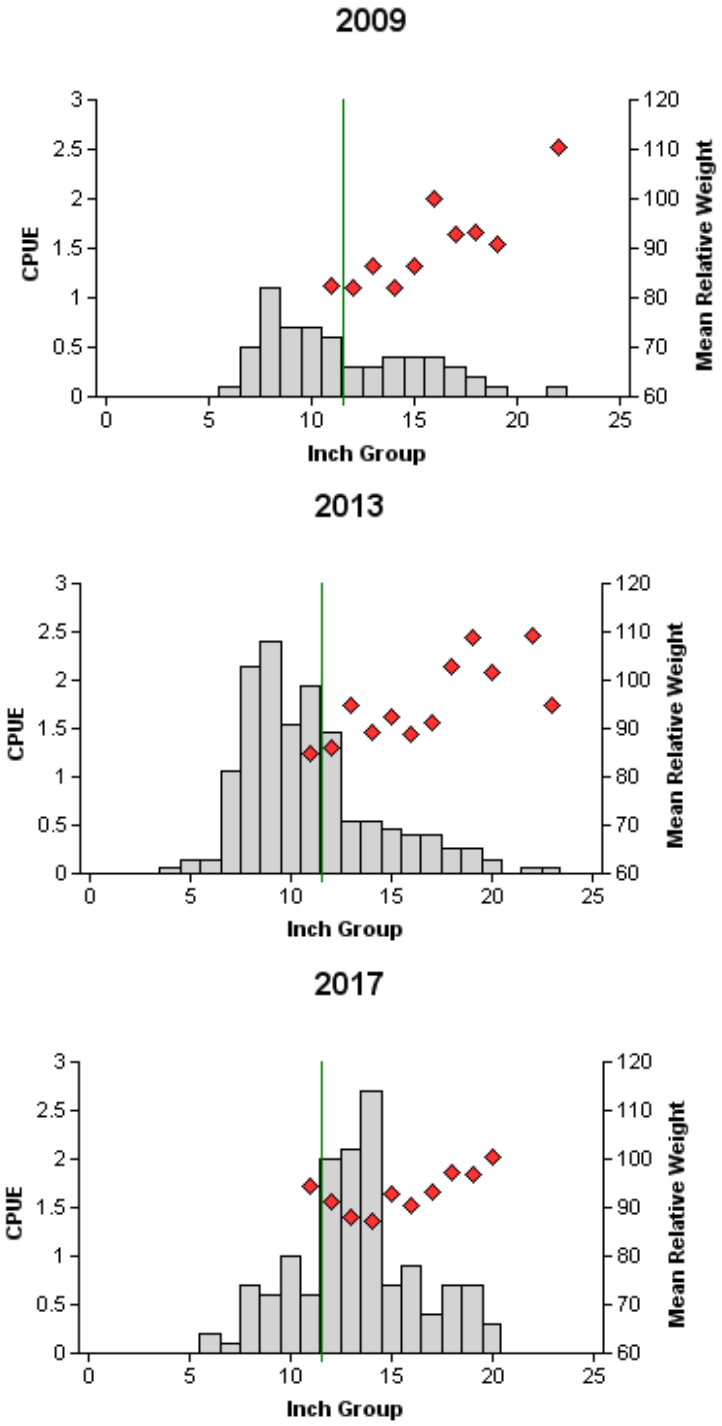


Figure 5. Number of Blue Catfish caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2009, 2013 and 2017. Minimum length limit represented by vertical line.

Channel Catfish



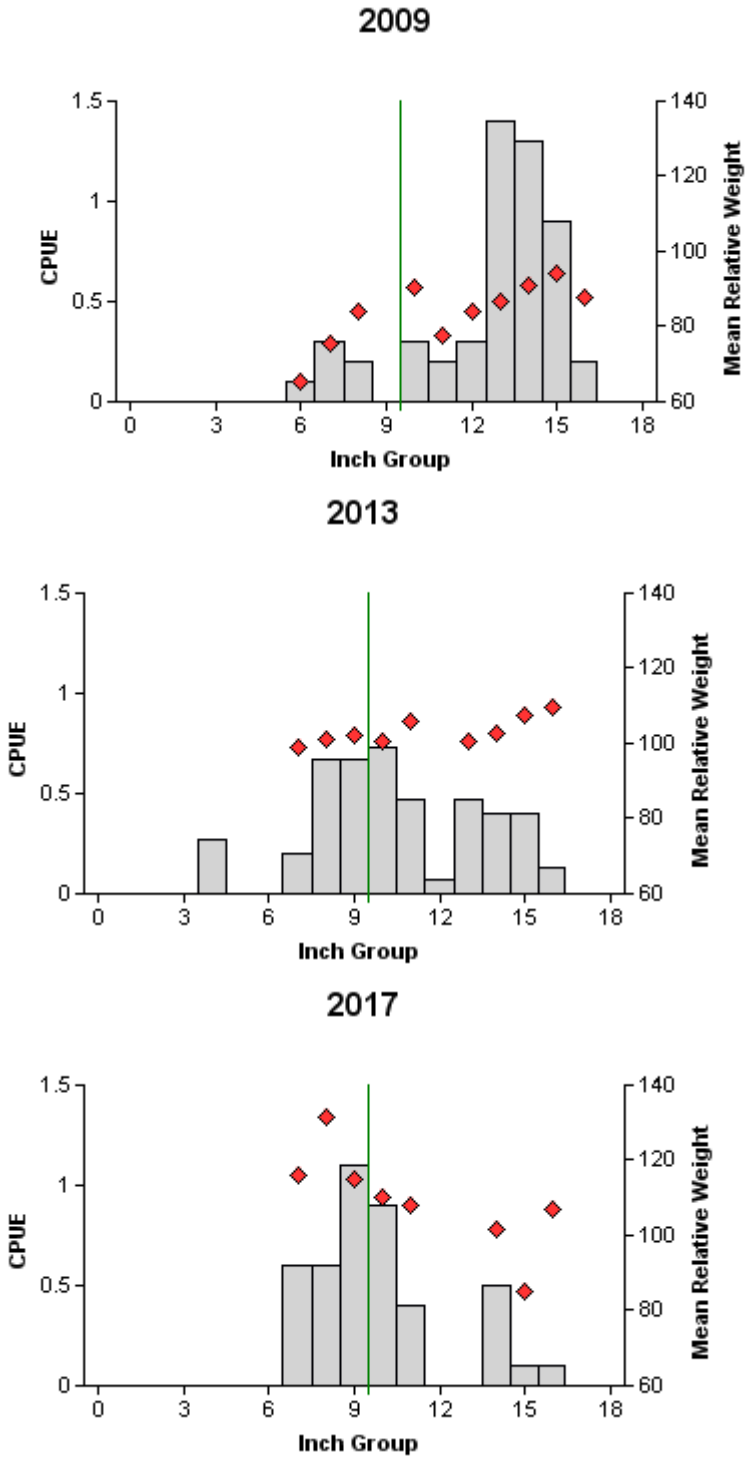
Effort =	10.0
Total CPUE =	6.2 (27; 62)
Stock CPUE =	3.1 (26; 31)
PSD =	35 (10)
PSD-12 =	81 (8)

Effort =	15.0
Total CPUE =	14.0(18;210)
Stock CPUE =	6.5 (21; 98)
PSD =	24 (5)
PSD-12 =	70 (5)

Effort =	10.0
Total CPUE =	13.7(15;137)
Stock CPUE =	11.1(16;111)
PSD =	27 (6)
PSD-12 =	95 (2)

Figure 6. Number of Channel Catfish caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2009, 2013 and 2017. Minimum length limit represented by vertical line.

White Bass



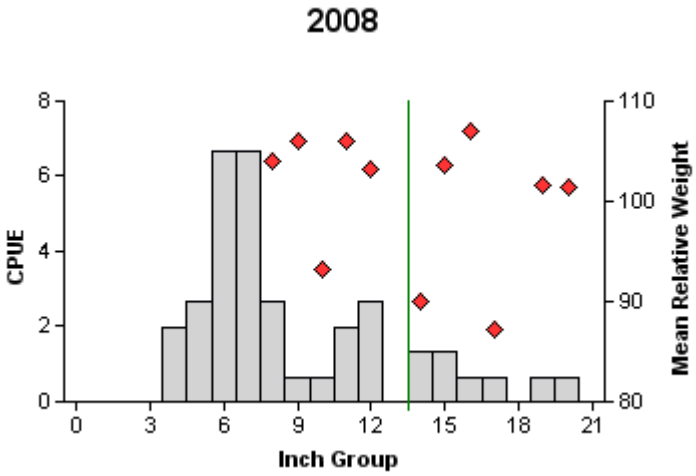
2009
Effort = 10.0
Total CPUE = 5.2 (39; 52)
Stock CPUE = 5.2 (39; 52)
PSD = 88 (8)
PSD-10 = 88 (8)

2013
Effort = 15.0
Total CPUE = 4.5 (16; 67)
Stock CPUE = 4.2 (15; 63)
PSD = 79 (6)
PSD-10 = 63 (9)

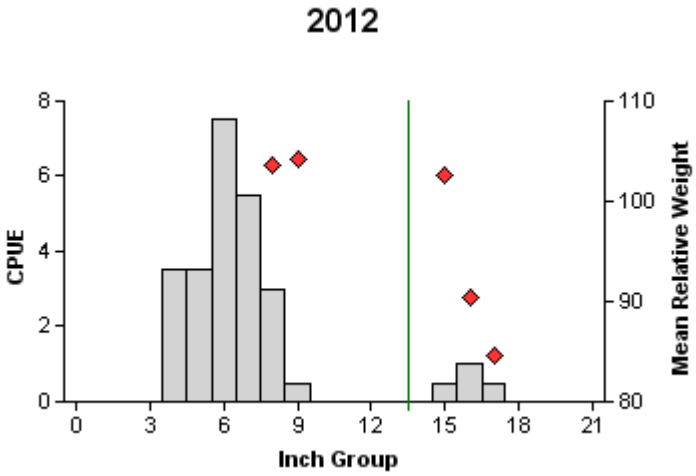
2017
Effort = 10.0
Total CPUE = 4.3 (20; 43)
Stock CPUE = 4.3 (20; 43)
PSD = 72 (9)
PSD-10 = 47 (7)

Figure 7. Number of White Bass caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2009, 2013 and 2017. Minimum length limit represented by vertical line.

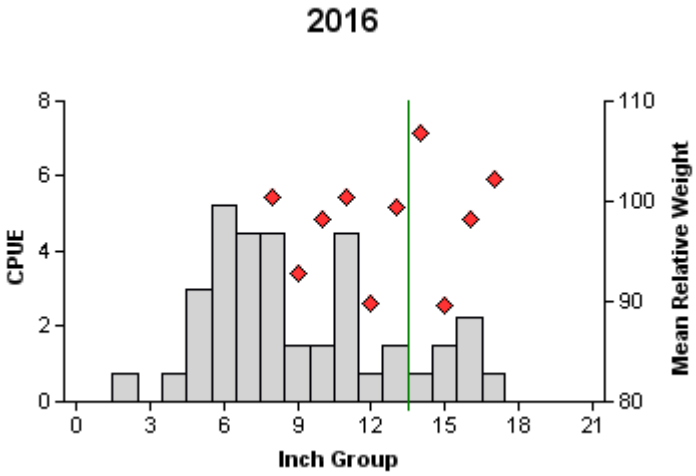
Largemouth Bass



Effort = 1.5
Total CPUE = 32.0 (24; 48)
Stock CPUE = 14.0 (29; 21)
PSD = 57 (12)
PSD-14 = 38 (10)



Effort = 2.0
Total CPUE = 25.5 (25; 51)
Stock CPUE = 5.5 (29; 11)
PSD = 36 (14)
PSD-14 = 36 (14)



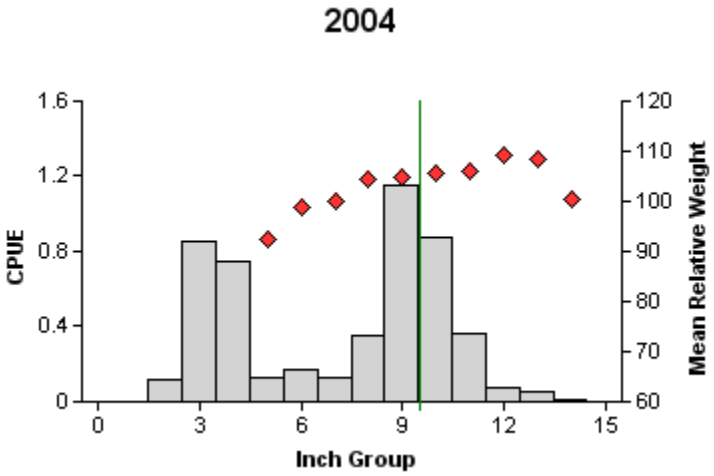
Effort = 1.3
Total CPUE = 33.8 (19; 45)
Stock CPUE = 19.5 (21; 26)
PSD = 38 (12)
PSD-14 = 27 (10)

Figure 8. Number of Largemouth Bass caught per hour (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Limestone Reservoir, Texas, 2008, 2012 and 2016 (daytime). Minimum length limit represented by vertical line.

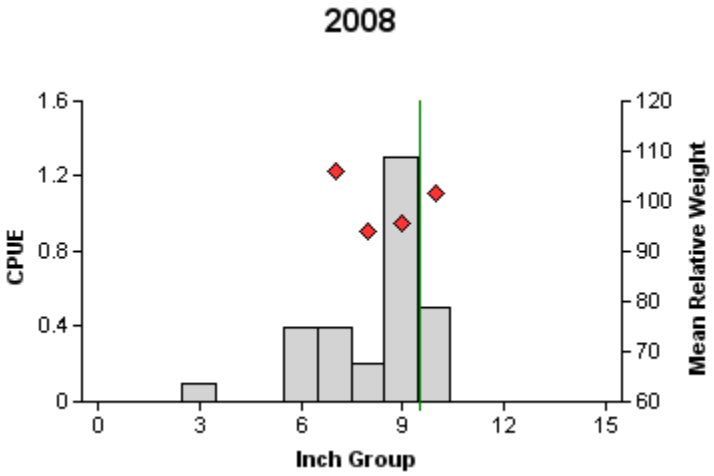
Table 8. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Limestone Reservoir, Texas, 2012 and 2016. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, Intergrade = hybrid between a FLMB and a NLMB. Genetic composition was determined with micro-satellite DNA analysis.

Year	Sample size	Number of fish			% FLMB alleles	% FLMB
		FLMB	Hybrid	NLMB		
2012	28	0	26	2	38	0
2016	30	0	29	1	26	0

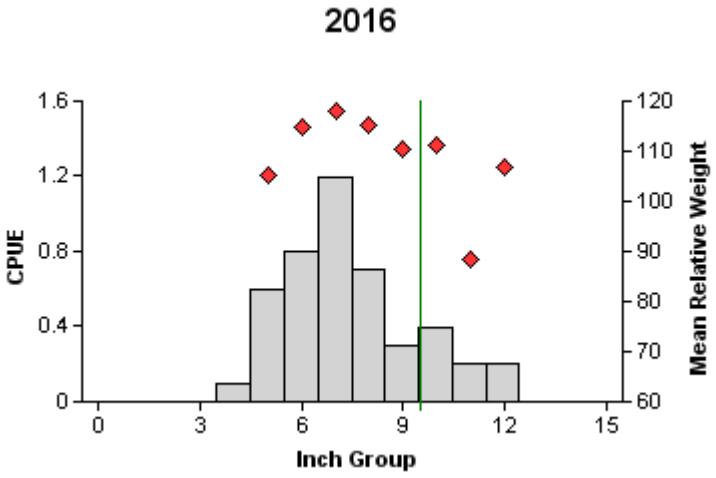
White Crappie



Effort =	75.0
Total CPUE =	5.0 (15; 378)
Stock CPUE =	3.3 (13; 249)
PSD =	87 (2)
PSD-10 =	42 (4)



Effort =	10.0
Total CPUE =	2.9 (54; 29)
Stock CPUE =	2.8 (55; 28)
PSD =	71 (6)
PSD-10 =	18 (4)



Effort =	10.0
Total CPUE =	4.5 (50; 45)
Stock CPUE =	4.4 (50; 44)
PSD =	41 (13)
PSD-10 =	18 (6)

Figure 9. Number of White Crappie caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap net surveys, Limestone Reservoir, Texas, 2004, 2008 and 2016. Minimum length limit represented by vertical line.

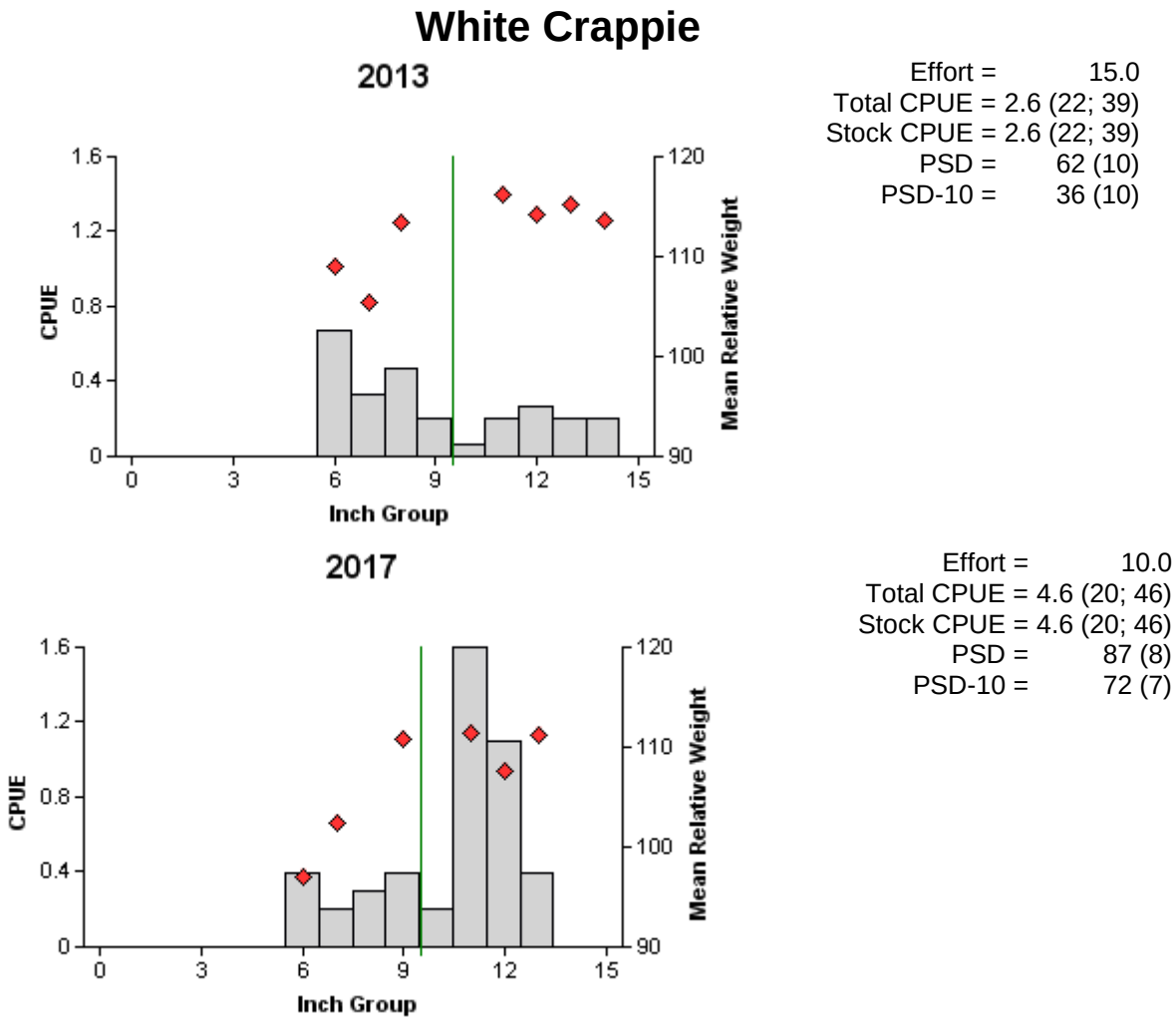


Figure 10. Number of White Crappie caught per net night (CPUE), mean relative weight (diamonds) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2013 and 2017. Minimum length limit represented by vertical line.

Table 9. Proposed sampling schedule for Limestone 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 and winter. Standard survey denoted by S and additional survey denoted by A.

Survey year	Electrofish Fall	Trap net	Gill net	Habitat		Access	Creel survey	Report
				Structural	Vegetation			
2017-2018								
2018-2019								
2019-2020								
2020-2021	S	S,A	S	S	S	S		S

APPENDIX A

Number (N), relative standard error (RSE) and catch rate (CPUE) of all target species collected from all gear types from Limestone Reservoir, Texas, 2016-2017.

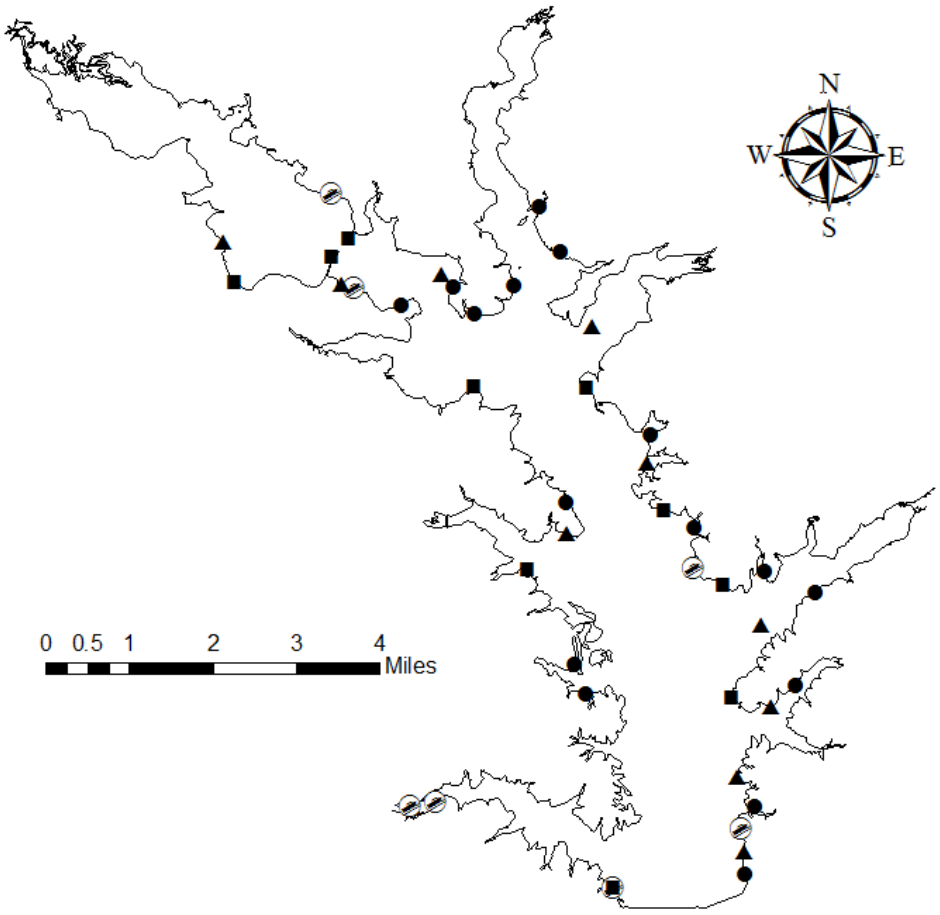
Species	Gill Netting		Trap Netting		Electrofishing	
	N/RSE	CPUE	N/RSE	CPUE	N/RSE	CPUE
Gizzard Shad					573/10	429.8
Threadfin Shad					1839/42	1,379.3
Blue Catfish	64/41	6.4				
Channel Catfish	137/15	13.7				
Flathead Catfish	2/67	0.2				
White Bass	43/20	4.3				
Green Sunfish					5/70	3.8
Warmouth					2/68	1.5
Bluegill					98/31	73.5
Longear Sunfish					22/37	16.5
Redear Sunfish					2/100	1.5
Largemouth Bass					45/19	33.8
White Crappie	*46/20	*4.6	45/50	4.5		
Black Crappie	*9/26	*0.9	6/100	0.6		

APPENDIX B

Catch rates (CPUE) of targeted species by gear type for standard surveys on Limestone Reservoir, Texas, 1997 to present. Electrofishing stations were shocked with a 5.0 Smith-Root GPP (Gas Powered Pulsator) until 2010, then a 7.5 Smith-Root GPP was used. Objective based sampling began in 2015. Species averages are in bold. Dashes represent no data collection; asterisks represent data collection with a non-typical gear, or a survey performed outside the normal time period for a gear.

Gear	Species	1997	2000	2001	2002	2004	2005	2008	2009	2012	2013	2016	2017	Avg.
Electrofisher														
	Largemouth Bass	86.0	60.0	-	115.0	52.0	-	32.0	-	26.0	-	34.0	-	**58.0**
	Gizzard Shad	265.0	94.0	-	387.0	216.0	-	190.0	-	300.0	-	430.0	-	**269.0**
	Threadfin Shad	701.0	181.0	-	1184.0	1609.0	-	1302.0	-	1282.0	-	1379.0	-	**1091.0**
	Bluegill Sunfish	22.0	55.0	-	215.0	56.0	-	104.0	-	22.0	-	74.0	-	**78.0**
	Redear Sunfish	0.0	2.0	-	13.0	3.0	-	13.0	-	2.0	-	2.0	-	**5.0**
	Longear Sunfish	23.0	25.0	-	126.0	20.0	-	45.0	-	9.0	-	17.0	-	**38.0**
	Green Sunfish	2.0	9.0	-	1.0	0.0	-	0.0	-	0.0	-	4.0	-	**2.3**
	Warmouth	3.0	2.0	-	7.0	2.0	-	1.0	-	0.0	-	2.0	-	**2.4**
Gill nets														
	Blue Catfish	0.5	-	2.3	-	-	2.1	-	12.6	-	21.1	-	6.4	**7.5**
	Channel Catfish	4.1	-	3.6	-	-	3.3	-	6.2	-	14.0	-	13.7	**7.5**
	Flathead Catfish	0.5	-	0.2	-	-	0.0	-	0.0	-	0.1	-	0.2	**0.2**
	White Bass	9.9	-	4.3	-	-	6.2	-	5.2	-	4.4	-	4.3	**5.7**
	White Crappie	-	-	-	-	-	-	-	-	-	*2.6	-	*4.6	***3.6**
	Black Crappie	-	-	-	-	-	-	-	-	-	*0.8	-	*0.9	***0.9**
Trap nets														
	White Crappie	16.0	9.9	-	-	5.1	-	2.9	-	-	-	4.5	-	**7.7**
	Black Crappie	0.1	0.4	-	-	0.1	-	0.0	-	-	-	0.6	-	**0.2**

APPENDIX C



Location of electrofishing (circles), trap net (squares) and gill net (triangles) sites, Limestone Reservoir, Texas, 2016 and 2017. Boat ramps are also marked.

APPENDIX D

Introduction

The Waco Inland Fisheries Management District encompasses a 12-county area of north central Texas. The district is responsible for fourteen major reservoirs, thirty small impoundments, and at least eight important, navigable rivers – all flowing into the Brazos River, whose drainage bisects the district from north-west to south-east. The district also contains two major ecoregions: Cross Timbers and Blackland Prarie. The Cross Timbers ecoregion dominates the western two-thirds of the district, while Blackland Prarie covers an eastern-most sliver of district including the eastern portions of Hill, McLennan, and Bell Counties, the western portion of Limestone County and most of Falls County. Due to changes in native ground cover from agricultural and farming practices, these Blackland Prarie areas are highly susceptible to erosion by wind and especially water. As such, Mexia, Aquilla, Fort Parker, and Limestone reservoirs have lost substantial amounts of volume since impoundment from erosion and sedimentation within their watersheds. The objective of this appendix is to describe the status of Limestone Reservoir and its fisheries, and to provide the information to the Habitat Branch of the Inland Fisheries Division for their review and consideration of this regional problem – and for their expertise in securing grant funding opportunities with any future statewide watershed proposals.

Geographical Area

The Texas Blackland Prarie ecoregion is a 50,501 km^2 area which runs in a southwest to northeast direction, from San Antonio to the Oklahoma border. Historically, land cover within this ecoregion was dominated by rolling topography and tallgrass prairie species such as big bluestem, indiangrass, and switchgrass, with occasional forest and wetland areas near riparian bottomlands. Early settlers were drawn to the region by its black, fertile soils, and most of the land was soon converted to farmland. A recent estimate suggests as few as 5,000 acres remain in their natural condition in terms of land cover, plant species, etc. Today, land use is dominated by pastureland, supporting livestock such as beef cattle, and cropland, including hay, corn, wheat, sorghum, cotton, milo, soybeans and pecans. Clear cutting of the native trees and grasses, along with repeated plowing from heavy farming and agricultural practices, has led to severe soil loss by wind erosion and surface runoff. The development of agricultural best management practices (BMPs) have helped farmers and other landowners reduce soil loss in recent decades, however BMPs have not been implemented in many important areas of watershed, some existing BMPs are outdated, and much of the damage to streams and reservoirs has already occurred.

Reservoir Specifics

Limestone is a 13,680-acre reservoir located in Limestone, Robertson and Leon Counties, approximately 18 miles west of Buffalo, Texas. Land use throughout its 675 square miles is primarily agriculture, and more recently oil/gas exploration. The reservoir was constructed in 1978 by the Brazos River Authority (BRA) for flood control, power plant cooling and recreation. The reservoir is eutrophic, has mean and maximum depths of 16.5 and 43 feet, respectively, and water transparencies ranging from 1 to 2 feet. Structural habitat consists primarily of natural shoreline, bulk heading, extensive standing timber, and boat docks. Aquatic vegetation is plentiful, including shoreline species like Cattail, Bulrush, Cutgrass, Buttonbush, Black willow, Water willow, Lotus and Pondweed, as well as noxious species like Hydrilla, Water hyacinth, Eurasian watermilfoil and Alligator weed.

Loss of Volume and Impacts to the Fishery

Original plans calculated Limestone's volume to be 225,400 acre-feet at conservation pool (363 feet above mean sea level) upon impoundment in 1978. The Texas Water Development Board (TWDB) conducted volumetric surveys during 1993 and 2002. The 2002 survey found Limestone's capacity to be 215,748 acre-feet, and an estimated reduction of 9,652 acre-feet, or 4.3% less than that recorded in the original permit. Studies of the other three reservoirs have also shown significant losses in volume since impoundment. For example, according to recent TWDB surveys, Aquilla loses 84 to 218 acre-feet of reservoir volume each year while Mexia loses 22 acre-feet annually. Although the loss of Fort Parker Reservoir capacity is unknown at this time, dredging operations initiated by the town of Groesbeck in 1994 were begun to remove 930 acre-feet of deposited silt in and adjacent to the Navasota River channel within the reservoir; those efforts were abandoned in 2002 with little success. As stated above, the volumetric loss within Limestone Reservoir has been estimated at 9,652 acre-feet since impoundment. This relatively rapid loss of habitat is the single most important issue facing these reservoirs. Currently, the upper one-fifth of Limestone Reservoir is shallow and difficult to navigate by boat, and fisheries management activities have been, more or less, restricted to other portions of reservoir for nearly a decade. Without action in the next couple of decades, it is likely that impacts to the fishery due to sedimentation in these four reservoirs will only become more severe.

Summary

Although Inland Fisheries Management staff can identify symptoms of larger, watershed-wide issues with the limnological, habitat and fisheries data we collect, we are not equipped logistically or financially to remedy problems on this scale. The objective of this appendix is to describe the status of Limestone Reservoir and its fisheries, to provide the information to the Habitat Branch of the Inland Fisheries Division for their review and consideration, and to request their expertise in securing grant funding from organizations such as the SARP and RFHP to promote BMPs or other work to reduce or reverse the effects of erosion and sedimentation within this watershed.