Limestone Reservoir

2020 Fisheries Management Survey Report

PERFORMANCE REPORT

As Required by

FEDERAL AID IN SPORT FISH RESTORATION ACT

TEXAS

FEDERAL AID PROJECT F-221-M-4

INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

Prepared by:

John Tibbs, District Management Supervisor
and
Michael S. Baird, Assistant District Management Supervisor

Inland Fisheries Division
Waco District, Waco, Texas

Carter Smith
Executive Director

Craig Bonds
Director, Inland Fisheries

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Survey and Management Summary

Fish populations in Limestone Reservoir were surveyed in 2020 using electrofishing and trap nets and in 2021 using trap nets and gill nets. Historical data are presented with the 2020-2021 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 12,486-acre reservoir within the Navasota River system in Limestone, Robertson, and Leon Counties, Texas. Water level was 1-2 feet below conservation pool (363 feet above mean sea level [MSL]) during the 2020 vegetation, electrofishing, and trap net surveys and near conservation pool during the 2021 trap net and gill net surveys. Habitat features consisted of boat docks, piers, bulk-headed shorelines, natural shorelines, and emergent and submerged aquatic vegetation.

Management History: Important sport fishes include catfishes, White Bass, White Crappie and Largemouth Bass. The 2012 management plan included sharing information about the reservoir's loss of volume with Texas Parks and Wildlife Department's (TPWD's) habitat branch and others who could take-on the issue on a watershed scale. Additionally, noxious vegetation was monitored annually from 2012 to 2014 but never required control measures. More recent management efforts focused on posting appropriate aquatic invasive species (AIS) signage at access points and providing technical support and informational materials for the "Clean, Drain and Dry" campaign. In 2019, the Brazos River Authority (BRA) funded a cooperative effort to build and deploy fish attracting structures near Limestone Lake Park on the lower end of the reservoir. Management efforts from 2020-2021 include aquatic vegetation, boater access, electrofishing, winter trap netting, spring trap netting and gill netting surveys.

Fish Community

- **Prey Species**: All major forage species were collected below their historical average with the exception of Gizzard Shad. Seventy-eight percent of Gizzard Shad were a suitable size for predators.
- **Catfishes:** Blue Catfish catch rates were above the historical average while Channel Catfish catch rates were below. Legal-length fish of both species maintained good to excellent mean relative weight. Flathead Catfish were collected in low numbers.
- **White Bass:** White Bass catch rates were above the historical average and numbers of legal-length fish in the population improved substantially from previous surveys. Mean relative weight remained good to excellent.
- **Largemouth Bass:** Largemouth Bass were collected in higher numbers than the previous two surveys and the catch rate and proportion of legal-length fish also improved. Mean relative weight ranged from good to excellent and Florida Largemouth Bass influence increased from 26% to 31%.
- **Crappies:** White Crappie catch rates were among the highest on record, mean relative weight was excellent, and a good proportion of legal-length fish were available to anglers. Black Crappie were collected in low numbers.

Management Strategies: The sport fishes in Limestone Reservoir will continue to be managed with statewide regulations. We will continue to maintain AIS efforts. Access, vegetation, and electrofishing surveys will be conducted in summer and fall 2024 and trap netting and gill netting surveys will be conducted in 2025. We will also coordinate with the BRA on a habitat project pending future funding and reservoir priorities.

Introduction

This document is a summary of fisheries data collected from Limestone Reservoir in 2020-2021. 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 2020-2021 data for comparison.

Reservoir Description

Limestone Reservoir is a 12,486-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 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 cattail, American pondweed, water hyacinth and common buttonbush. Conservation pool elevation is 363 feet above mean sea level [MSL]. Water level dropped to 4 feet below conservation pool on two occasions during 2018 and to 3.5 feet below conservation pool once during early 2020 (Figure 1a). Water level was below conservation pool (361.8 – 362.8) during 2020 surveys and at conservation pool during the 2021 surveys (Figure 1b). Other descriptive characteristics for Limestone Reservoir are in Table 1.

Angler Access

Bank and boat access on Limestone Reservoir are 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 several short, wheelchair accessible piers. Boat access consists of six public ramps. Three of the six boat ramps were still usable during the 2018 and 2020 low water periods according to elevation specific boat accessibility analysis done in 2012 (Tibbs and Baird 2013). No public boating access is available at water levels below 355 feet MSL. Additional boat ramp characteristics are in Table 2.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Baird and Tibbs 2017) included:

1. Discontinuing Florida Largemouth Bass stockings, monitoring Largemouth Bass genetics in fall 2020, and completing a habitat project with the BRA pending funding and reservoir prioritization - to help benefit Largemouth Bass and other sport fishes.

   Action: Florida Largemouth Bass stockings were discontinued in 2017. A 29-fish genetics sample was collected and analyzed on Largemouth Bass in fall 2020 and those data are included in this report. In 2019, the BRA funded a cooperative effort to build and deploy artificial fish attracting structures (i.e., 25 Georgia-style structures; five each in five freshwater reef locations) near Limestone Lake Park on the lower-end of the reservoir. Freshwater reef locations and coordinates were added to the TPWD website within the Limestone Reservoir link.

2. Cooperating with the BRA to maintain appropriate AIS signage at access points around the reservoir and ensure that marina owners are aware of the AIS threat and have information to provide to their customers.

   Action: Invasive species signage was posted at Limestone Reservoir access points during summer 2013 and have been maintained as needed. District staff have made a speaking point about AIS, how to prevent their spread, and potential effects on Limestone Reservoir while speaking to anglers over the past several years. Interbasin water transfers will be updated as needed.

Harvest regulation history: Sportfish in Limestone Reservoir are currently managed with statewide regulations. Current harvest regulations are in Table 3.

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

Vegetation/habitat management history: A summary of the aquatic vegetation management history through 2016 can be found in Baird and Tibbs (2017). The aquatic vegetation survey conducted in August 2020 found alligator weed at 4 of 135 random shoreline points (4.4%), water hyacinth at 12 of 135 shoreline points (8.9%) and no hydrilla. Data on all aquatic vegetation observed during summer 2020 are included in this report.

Water transfer: There are no interbasin transfers 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. Three volumetric surveys have been conducted by the Texas Water Development Board (TWDB) on Limestone since impoundment: 1993, 2002 and 2012. The 2012 survey found a volume of 203,780 acre-feet and a surface area of 12,486 acres at conservation pool elevation. According to the TWDB estimates, the reservoir has lost between 481 and 636 acre-feet of capacity annually since impoundment due to sedimentation (TWDB, 2012).

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Limestone Reservoir (Baird and Tibbs 2017). 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 2017).

Electrofishing – Largemouth Bass, sunfishes, Gizzard Shad and Threadfin Shad were collected by electrofishing (1.4 hours at 17, 5-min stations in fall). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing.

Trap netting – Crappies were collected by trap netting (15 net nights at 15 stations in winter, 11 net nights at 11 stations in spring). Catch per unit effort (CPUE) for trap netting was recorded as the number of fish caught per net night (fish/nn).

Gill netting – Catfishes, White Bass and crappies were collected by gill netting (11 net nights at 11 stations in spring). Catch per unit effort (CPUE) for gill 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 2017). Micro-satellite DNA analysis has been used to determine genetic composition of individual fish since 2005.

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, and 2016 re-survey of bulk heading habitat, were conducted according to Baird and Tibbs (2009). The 2012, 2016 and 2020 vegetation surveys were conducted using an adaptation of the point method (TPWD, Inland Fisheries Division, unpublished manual revised 2017). 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 2021).

Results and Discussion

Habitat: The 2008 structural habitat survey estimated 79.4 miles of natural shoreline, 28.5 miles of bulkheaded shoreline, 8.0 miles of boulder/rip-rap shoreline and 3.7 miles of boat docks/ramps (Table 6; Baird and Tibbs 2009). The littoral zone vegetation encountered during summer 2020 was dominated by cattail, pondweed, water hyacinth and common buttonbush. The complete summer 2020 vegetation survey is in Table 7.

Prey species: Threadfin and Gizzard Shad (Figure 2) were collected by electrofishing at 568.9/h and 343.8/h respectively in 2020 (Appendices A and B). The catch rate for Gizzard Shad was above the historical average while that of Threadfin Shad was below its historical average (Appendix B). The IOV for Gizzard Shad was good and 78% of the population was available to existing predators as forage. Other important forage species collected below their historical averages were Bluegill (26.1/h; Figure 3), Longear Sunfish (7.8/h) and Redear Sunfish (0.7/h) (Appendices A and B).

Catfishes: Blue and Channel Catfish were collected with gill nets at rates of 9.3 and 5.9/nn respectively in 2021 (Figures 4 and 5; Appendices A and B). Blue Catfish catch rates were above their historical average while Channel Catfish catch rates were below (Appendix B). The size structure objective of collecting a minimum of 50 stock-length fish was met for Blue Catfish (N = 51) but not for Channel Catfish (N = 35). The objective of achieving an RSE equal to or less than 25 for abundance estimates was met for both catfish species (Figures 4 and 5). The current Blue Catfish population exhibited stronger recruitment of young fish and a lower percentage of quality-length fish than in 2017. All legal-length fish maintained good to excellent relative weights (Figure 4). Channel Catfish exhibited the opposite trend: weaker recruitment of young fish and a higher percentage of quality-length fish than in 2017. Mean relative weight (i.e., body condition) remained excellent overall and improved with increasing length, similar to previous surveys. Flathead Catfish were collected in low numbers in 2021 and are included in Appendices A and B.

White Bass: The gill net catch rate for White Bass was 8.4/nn in 2021 and is one of the highest catch rates recorded for the species in the reservoir (Figure 6; Appendices A and B). This catch rate equates to 92 stock-length fish with a sample RSE of 32, so the size structure objective was met but not the RSE objective for abundance estimates. The proportion of legal-length (PSD-10 = 82) and quality-length (PSD-12 = 55) fish in the population increased substantially over the previous two surveys while recruitment remained relatively stable. Mean relative weight remained good to excellent (Figure 6).

Largemouth Bass: Largemouth Bass were collected by electrofishing at a rate of 39.5/h in 2020 and this is below average for the species but an improvement over the previous two surveys (Figure 7; Appendices A and B). The objectives of collecting a minimum of 50 stock-length fish with an RSE equal to or less than 25, and a robust genetic sample, were not achieved because only 17 stock-length individuals were collected. The current PSD of 47 is much improved from the previous survey (38) and demonstrates a balanced population. The percentage of legal (PSD-14) and preferred-length (PSD-15) fish also improved minimally from the previous survey. Mean relative weight ranged from good to excellent (Figure 7). Largemouth Bass genetics analyzed in 2020 showed increased Florida influence (31%) from the 2016 survey (26%), yet no pure Florida Largemouth Bass were collected (Table 8).

White Crappie: White Crappie were collected with winter trap netting (11.0/nn), spring trap netting (18.5/nn) and spring gill netting (10.5/nn; Figures 8 and 9; Appendices A and B). The OBS size structure goal of collecting a minimum of 50 stock-length fish and abundance goal of achieving an RSE equal to or less than 25 was achieved with 152 stock-length individuals and an RSE of 25 (Figure 8). The winter 2020 trap netting survey catch rates were among the highest on record (Appendix B). The non-standard, spring trap net and gill net surveys also achieved the OBS goals, with 201 stock-length individuals and an RSE of 23 for spring trap nets and 116 stock-length individuals and an RSE of 25 for spring gill nets (Figure 9).

Trap netting reflected White Crappie recruitment better than gill netting and spring surveys showed higher percentages of legal-length fish than the winter trap netting survey. For example, the PSD-10 from winter

trap netting was 39 compared to 71 and 63 for spring trap netting and spring gill netting respectively. Recruitment was less evident in the spring gill netting sample. Spring trap netting collected more individuals than the other two surveys, showed a high percentage of legal-length fish, and evidence of recent recruitment. This is of interest because the same trend was observed on Granbury Reservoir during 2017-2018 comparisons and on Fort Parker State Park Reservoir during 2018-2019 comparisons (Baird and Tibbs 2018, 2019). Based on population structure indices and length-frequency histograms, spring trap netting seems to be the best option for future sampling of White Crappie on Limestone Reservoir.

Fisheries Management Plan for Limestone Reservoir, Texas

Prepared – July 2021

ISSUE 1: White Crappie were collected by trap netting in winter 2020, and by trap netting and gill netting in spring 2021 to determine seasonal differences in catch rates and to evaluate which gear or gear/season combination produces the best sampling results in the reservoir. Spring trap netting collected more individuals than the other two surveys, showed a high percentage of legal-length fish, and demonstrated evidence of recent recruitment. The same trend was observed on Granbury (2017- 2018) and Fort Parker (2018-2019) (Baird and Tibbs 2018, 2019). Based on population structure indices and length-frequency histograms, spring trap netting seems to be the best option for future sampling of White Crappie on Limestone Reservoir.

MANAGEMENT STRATEGIES

1. Discontinue winter trap netting for crappies on Limestone Reservoir.
2. Begin spring trap netting for crappies on Limestone in spring 2025.
3. Continue collecting data on crappies during gill netting efforts.

ISSUE 2: Although recently flooded timber can provide good fisheries habitat, its usefulness declines as a reservoir ages. Artificial fish structures deployed into Limestone Reservoir in 2019 with BRA funding and cooperative manpower from other partners received a lot of good publicity and created new areas for anglers to fish. The fishery at Limestone Reservoir could benefit from many more projects like this.

MANAGEMENT STRATEGIES

1. Work with the BRA to use dedicated habitat funding to install new artificial fish reefs throughout the reservoir.
2. Take advantage of other funding sources to purchase materials for artificial habitat when available.

ISSUE 3: Water hyacinth is currently hampering access for homeowners and anglers in some areas of the reservoir. The Waco team identified problematic areas during summer 2020 and the Aquatic Habitat and Enhancement (AHE) staff confirmed these areas in late spring 2021. The AHE crew plans to treat impacted areas in July 2021.

MANAGEMENT STRATEGIES

1. Communicate with AHE staff throughout 2021 and 2022 to ensure that water hyacinth stands are treated effectively.
2. Keep BRA staff informed of treatment schedules and details.

ISSUE 4: Many AIS threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels 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 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 AIS are significant. Additionally, the potential for AIS 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 maintain AIS signage at access points.
2. Contact and educate marina owners about AIS, and provide them with posters, literature, etc… so that they can in turn educate their customers.
3. Educate the public about AIS through the use of media and the internet.
4. Make a speaking point about AIS when presenting to constituent and user groups.
5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential AIS responses.

Objective-Based Sampling Plan and Schedule (2021–2025)

Sport fish, forage fish, and other important fishes

Sport fishes in Limestone Reservoir include Blue Catfish, Channel Catfish, White Bass, White Crappie and Largemouth Bass. Important forage fish species include Gizzard Shad, Threadfin Shad, Bluegill, Redear Sunfish and Longear Sunfish.

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 monitor Largemouth Bass and primary forage species (Bluegill, Longear Sunfish, Redear Sunfish, Gizzard Shad and Threadfin Shad). A minimum of 15, random five-minute daytime electrofishing stations will be sampled in fall 2024. The objectives of the electrofishing survey will be general monitoring (i.e., CPUE, size structure and mean relative weight) and prevalence of Northern and Florida Largemouth Bass alleles (i.e., fin clips from 30 random individuals) to characterize the Largemouth Bass population and make comparisons with historical and future data. Abundance target precision will be a RSE ≤ 25 for CPUE $_{Total}$ and CPUE $_{Stock}$, and target sample size for size structure will be N ≥ 50 stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group ≥ stock-length. If objectives are not met in 15 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met. Since the primary forage species objectives are exploratory, no target precision or target sampling sizes will be sought for these species; additional sampling will not be necessary beyond that which is done for Largemouth Bass.

Spring Trap Netting: This survey will be used to monitor White Crappie. Recent catch rate comparisons observed on Granbury (2017-2018), Fort Parker (2018-2019) and Limestone (2020-2021) suggest spring trap netting collects superior CPUE, population structure and mean relative weight data (on these reservoirs) for monitoring purposes (Baird and Tibbs 2018, 2019, 2021). Therefore, a minimum of 11 randomly selected trap net stations will be sampled in spring 2025. The objectives of the spring trap netting survey will be general monitoring (i.e., CPUE, size structure, and mean relative weight) to characterize the population and make comparisons with historical and future data. Abundance target precision will be a RSE ≤ 25 for CPUE $_{Total}$ and CPUE $_{Stock}$, and target sample size for size structure will be N ≥ 50 stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group ≥ stock-length. If objectives are not met in 11 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met.

Spring Gill Netting: This survey will be used to monitor Blue Catfish, Channel Catfish, White Bass, and White Crappie. A minimum of 11 randomly selected gill net stations will be sampled in spring 2025. The objectives of the spring gill netting survey will be general monitoring (i.e., CPUE, size structure, and mean relative weight) to characterize populations and make comparisons with historical and future data. Abundance target precision will be a RSE ≤ 25 for CPUE $_{Total}$ and CPUE $_{Stock}$, and target sample size for size structure will be N ≥ 50 stock, allowing us to calculate PSDs with 80% confidence. Mean relative weight will be determined by measuring and weighing at least 5 fish per represented inch group ≥ stock-length. If objectives are not met in 10 stations, but catch rates indicate they're attainable, sampling will continue at random stations until the objectives are met.

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Tables and Figures

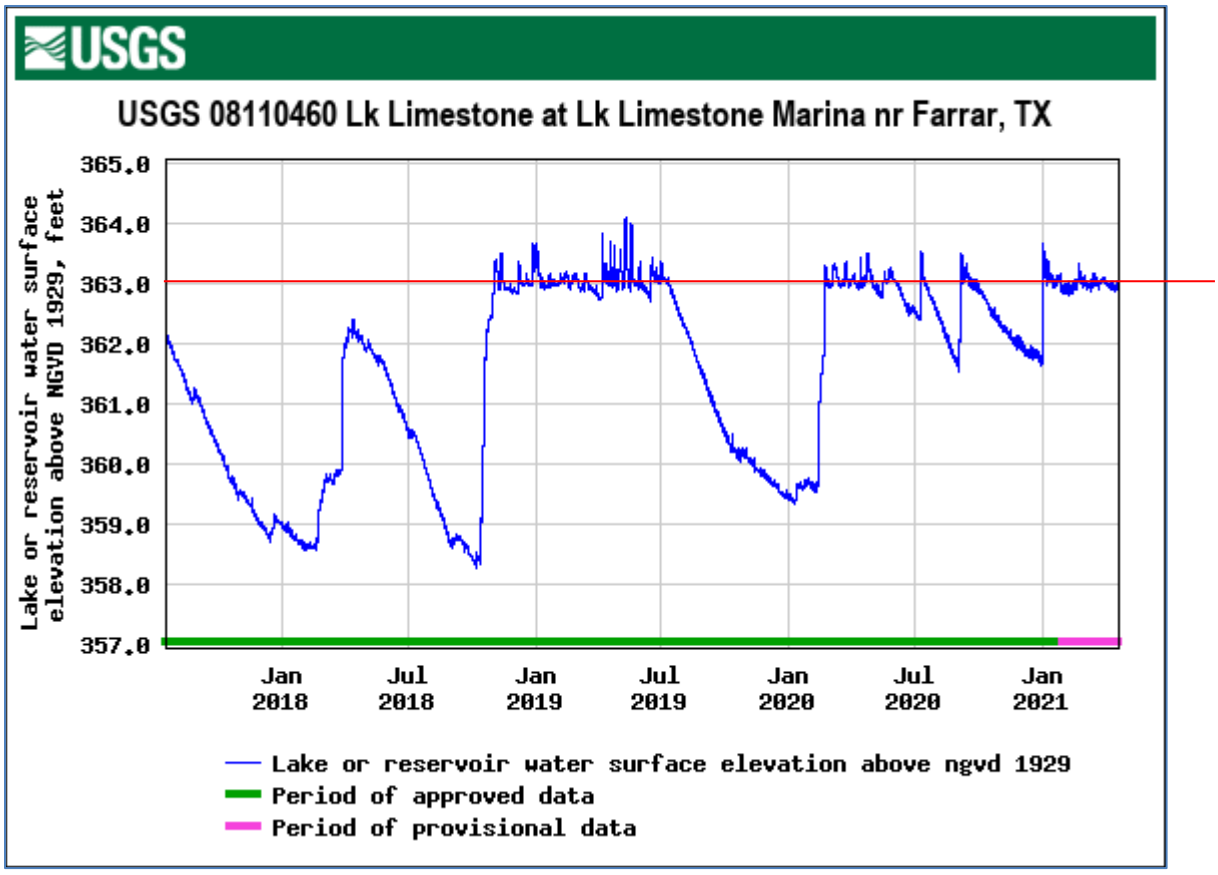

Figure 1a. Daily mean water levels for Limestone Reservoir from July 2017 through April 2021. NAVD 1988 refers to the National Geodetic Vertical Datum of 1929. The red line indicates Conservation pool (363.0). Figure from the USGS website

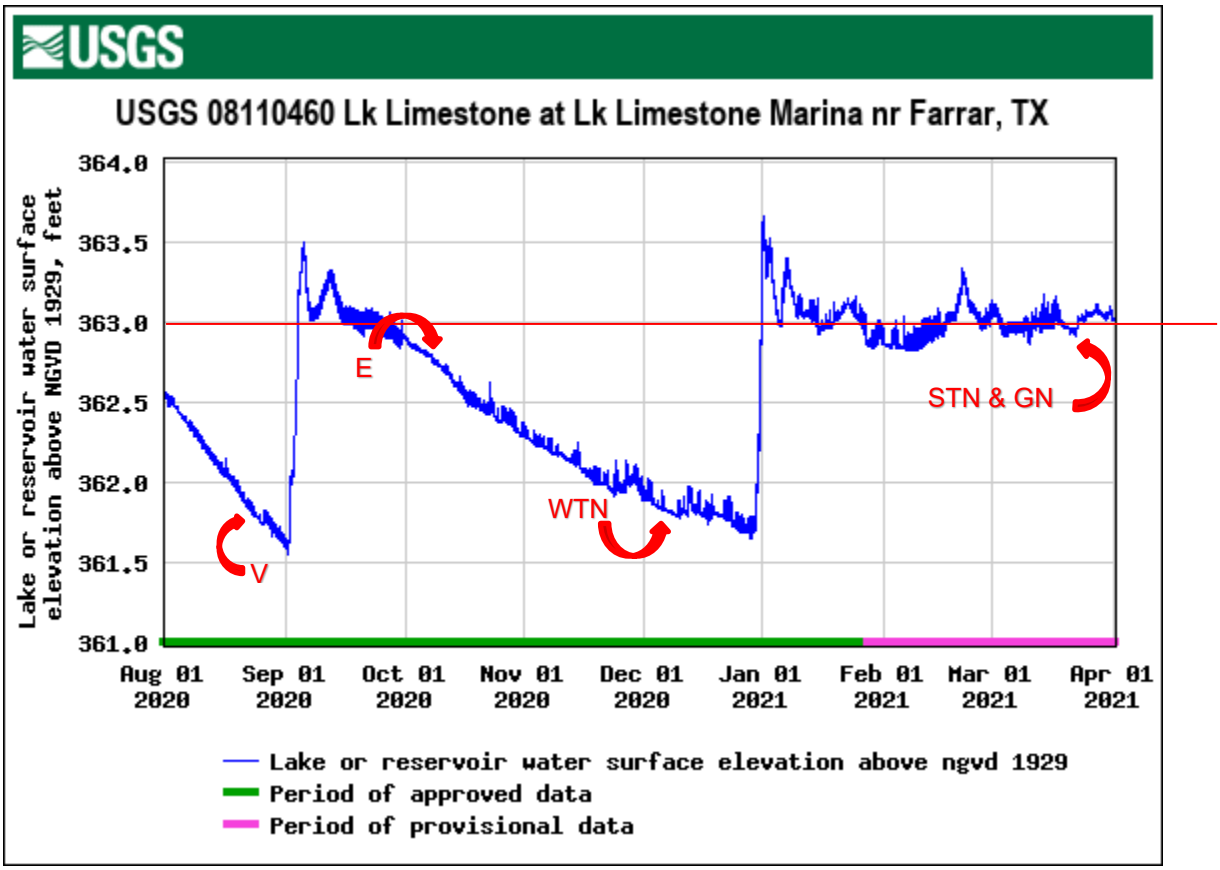

Figure 1b. Daily mean water levels for Limestone Reservoir from August 2020 through April 2021. NAVD 1988 refers to the National Geodetic Vertical Datum of 1929. The red line indicates Conservation pool (363.0). Surveys are indicated by V (vegetation), EF (electrofishing), WTN (winter trap netting), STN (spring trap netting) and GN (gill netting). Figure from the USGS website

Table 1. Characteristics of Limestone Reservoir, Texas.

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	209 µS/cm

Table 2 Boat ramp characteristics for Limestone Reservoir, Texas, August 2020. Reservoir elevation at time of survey was 361.8 feet below MSL (1.2 feet below conservation pool). Latitude and longitude are in decimal degrees.

Boat ramp	Latitude Longitude (dd)	Parking capacity (N)	Condition
BRA Park #1	31.32845; -96.33179	16	Usable at full pool
Leon County Park	31.33895; -9631066	12	Usable at full pool
Limestone County #2	31.43429; -96.37516	10	Poor ramp
Limestone County #3	31.44755; -96.37821	10	Poor ramp
Running Branch Marina	31.34379; -96.36858	8	Usable at full pool
Limestone Marina	31.38628; -9631771	10	Good

Table 3. Harvest regulations for Limestone Reservoir, Texas.

Species	Bag Limit	Length limit
Catfish: Channel, Blue and hybrids	25 (any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Largemouth	5[a]	14-inch minimum
Bass, Spotted	5[a]	None
Crappie: White, Black and hybrids	25 (any combination)	10-inch minimum

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

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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 2020 – 2021.

Gear/target species	Survey objective	Metrics	Sampling objective
Electrofishing			
Largemouth Bass	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)
	Genetics	% FLMB	N = 30, any age
Bluegill	Abundance	CPUE $_{Stock}$	General monitoring
	Size structure	PSD, length frequency	General monitoring
Redear Sunfish	Abundance	CPUE $_{Stock}$	General monitoring
	Size structure	PSD, length frequency	General monitoring
Longear Sunfish	Abundance	CPUE $_{Stock}$	General monitoring
	Size structure	Length frequency	General monitoring
Gizzard Shad	Abundance	CPUE $_{Stock}$	General monitoring
	Size structure	Length frequency	General monitoring
	Prey availability	IOV	N ≥ 50
Trap netting			
White Crappie	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)
Gill netting			
Blue Catfish	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)
Channel Catfish	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)
White Bass	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)
White Crappie	Abundance	CPUE $_{Stock}$	RSE $_{Stock}$ ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W*r*	10 fish/inch group (max)

Table 6. Survey of structural habitat types, Limestone Reservoir, Texas, 2008 and 2016. In 2016, only bulk heading was estimated. Shoreline habitat type units are in miles.

Habitat type	2008 Estimate	% of total	2016 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, 2012, 2016 and 2020. The percent of randomly selected points where species occurred is listed for each survey year. Water level was approximately 2.0, 1.1 and 1.2 feet below conservation pool respectively at the time of the surveys.

Vegetation	2012	2016	2020
American pondweed		22% (29 of 135)	12% (16 of 135)
American lotus		7% (10 of 135)	<1% (1 of 135)
Rice cutgrass		4% (5 of 135)	0% (0 of 135)
Bulrush		2% (3 of 135)	<1% (1 of 135)
Common buttonbush		33% (44 of 135)	7% (9 of 135)
Cattail		12% (16 of 135)	14% (19 of 135)
Square-stemmed spike rush		3% (4 of 135)	0% (0 of 135)
Calla Lilly			<1% (1 of 135)
Water willow			<1% (1 of 135)
Giant reed		1% (1 of 135)	1.5% (2 of 135)
Eurasian watermilfoil		0% (0 of 135)	0% (0 of 135)
Alligator weed	27% (20 of 75)	2% (3 of 135)	4% (4 of 135)
Hydrilla	0% (0 of 75)	0% (0 of 135)	0% (0 of 135)
Water Hyacinth	0% (0 of 75)	<1% (1 of 135)	9% (12 of 135)

Gizzard Shad

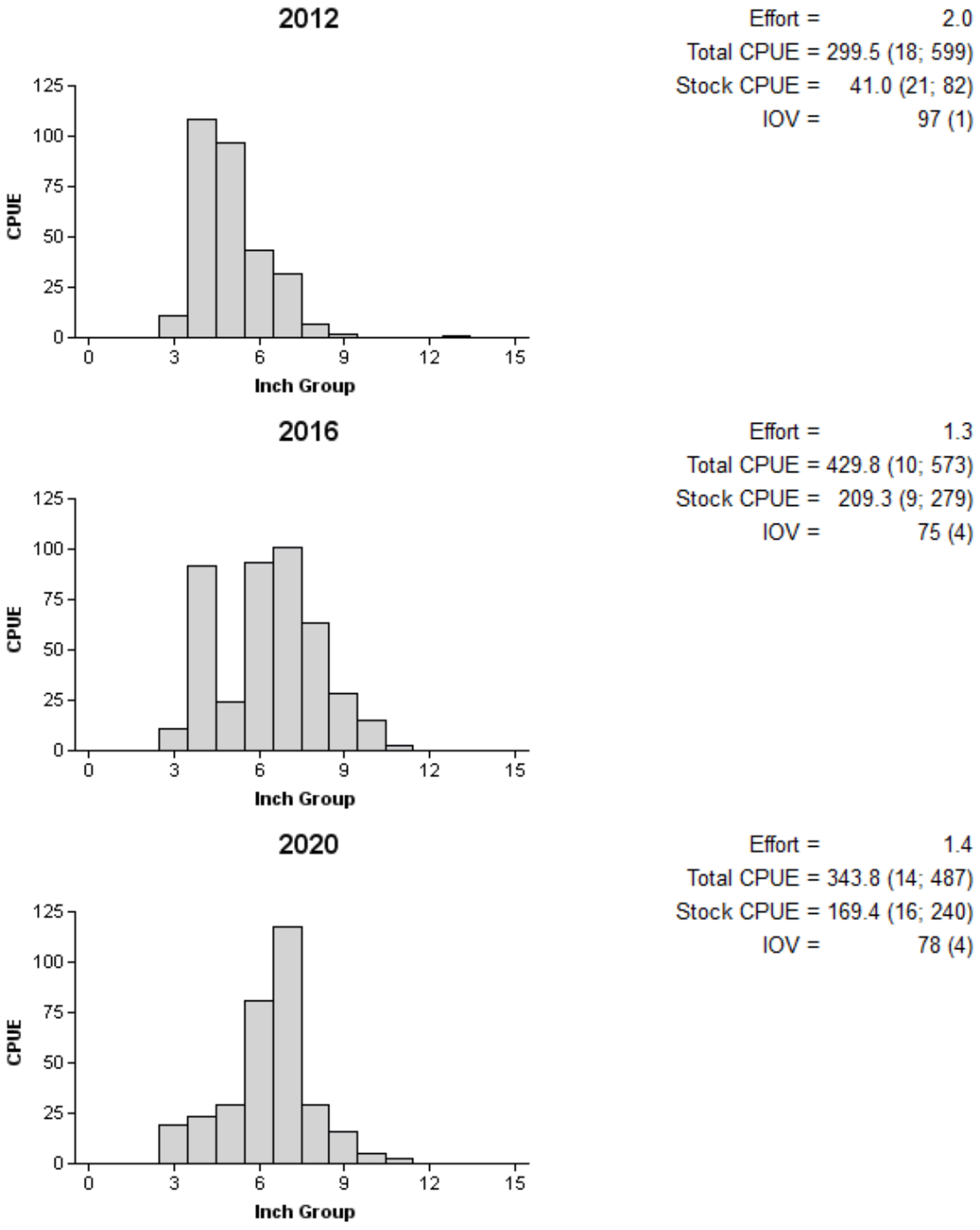


Figure 2. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Limestone Reservoir, Texas, 2012, 2016 and 2020.

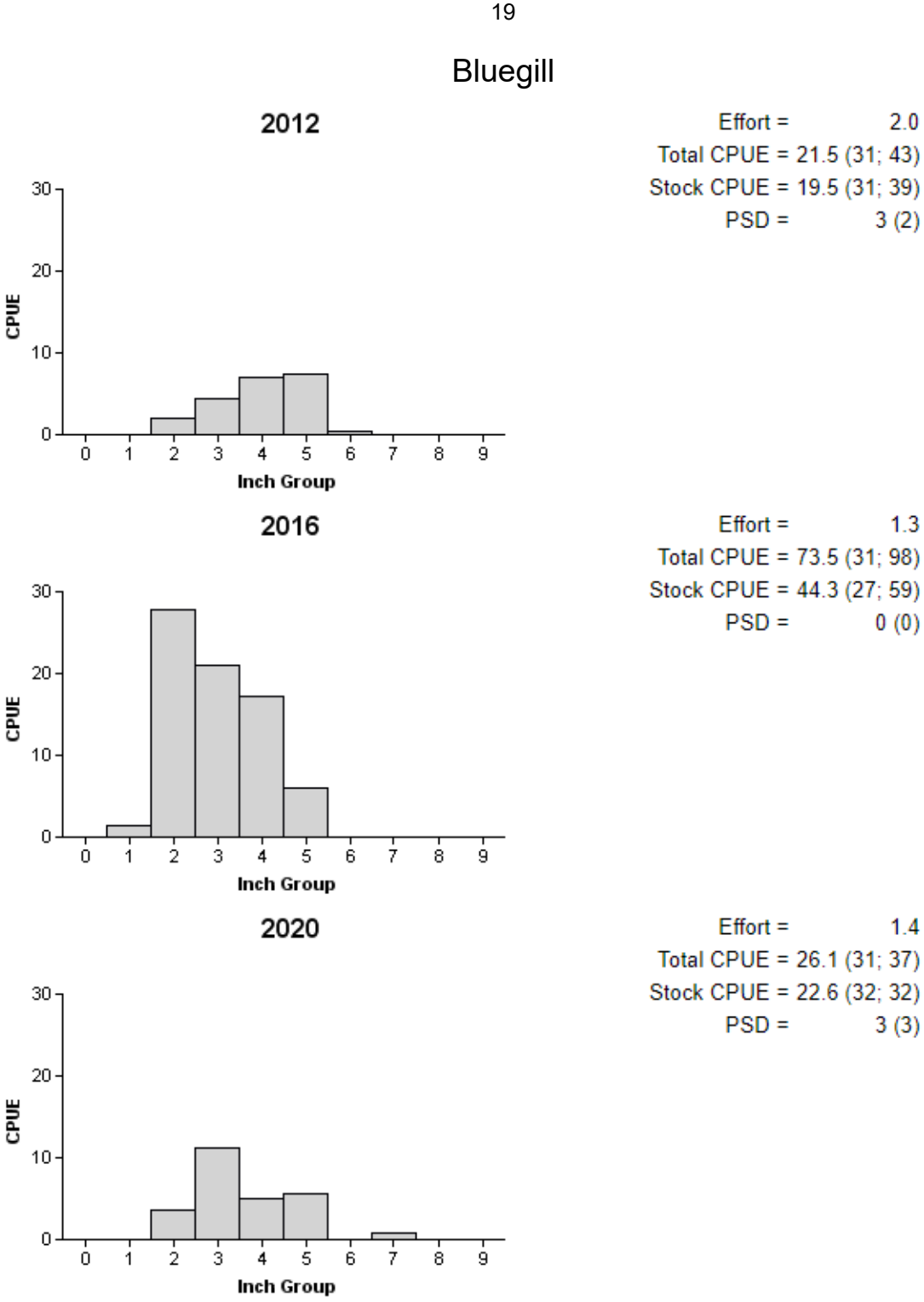


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Limestone Reservoir, Texas, 2012, 2016 and 2020.

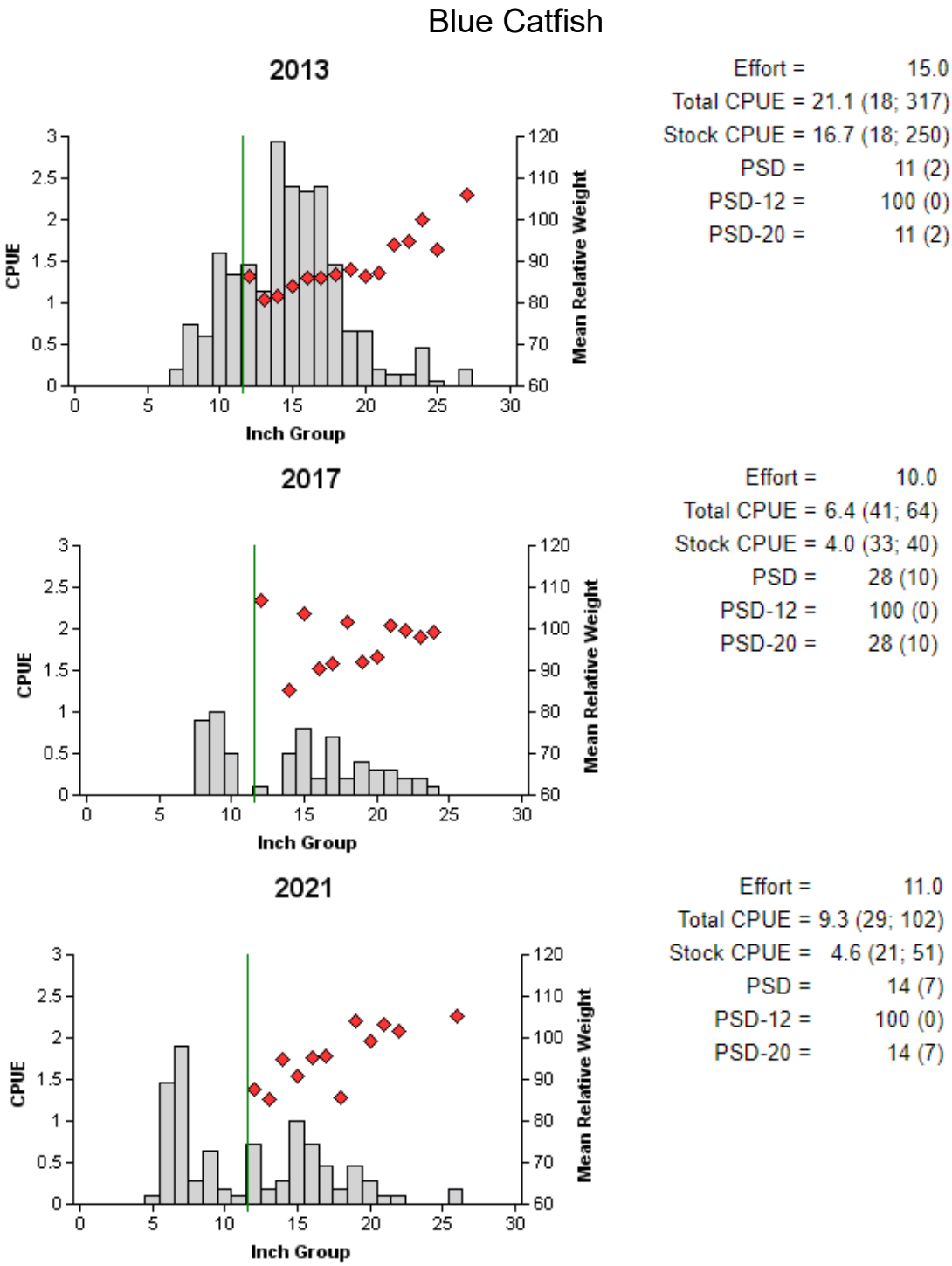


Figure 4. Number of Blue Catfish caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2013, 2017 and 2021. Vertical line represents 12-inch minimum length limit.

Channel Catfish

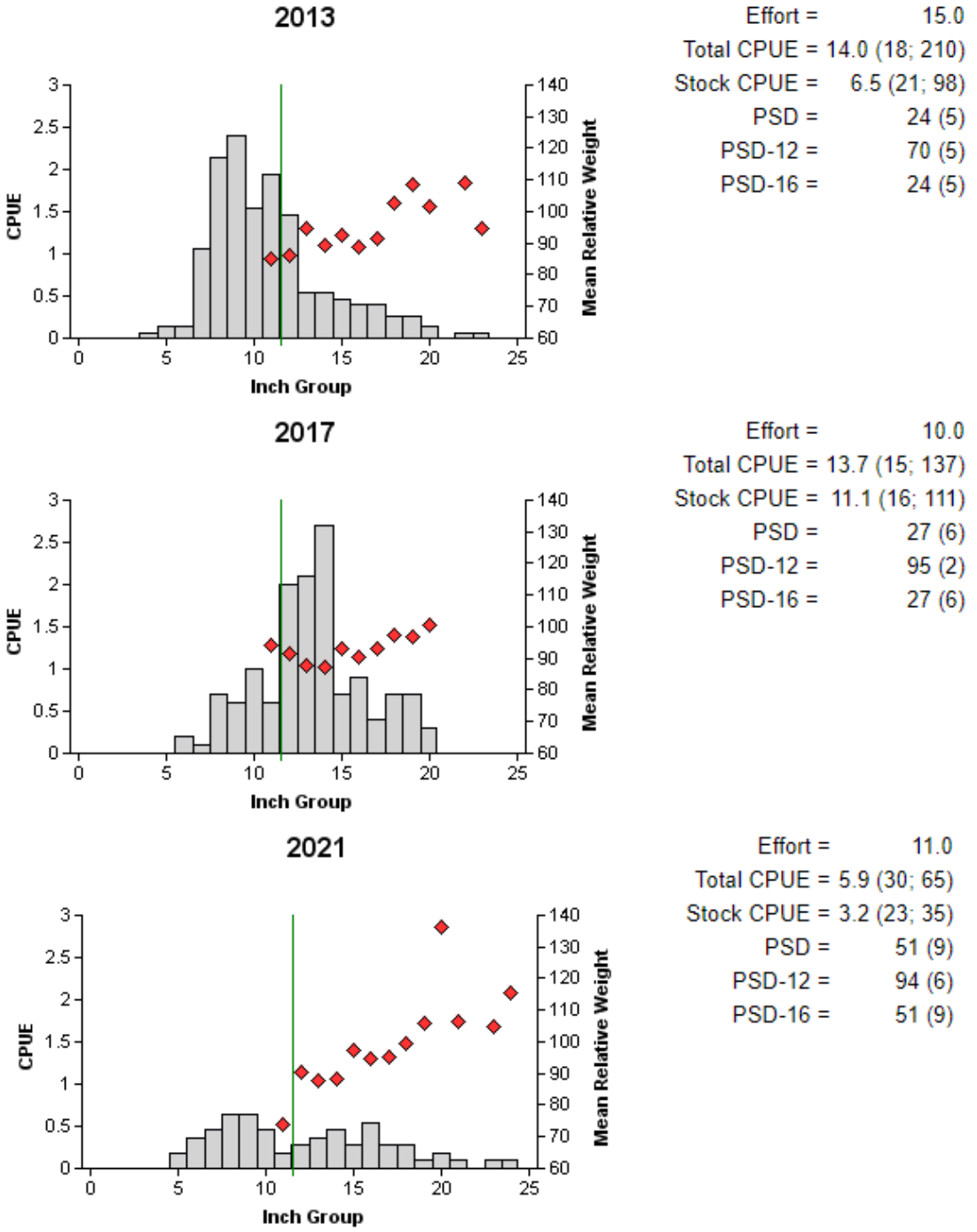


Figure 5. Number of Channel Catfish caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2013, 2017 and 2021. Vertical line represents 12-inch minimum length limit.

White Bass

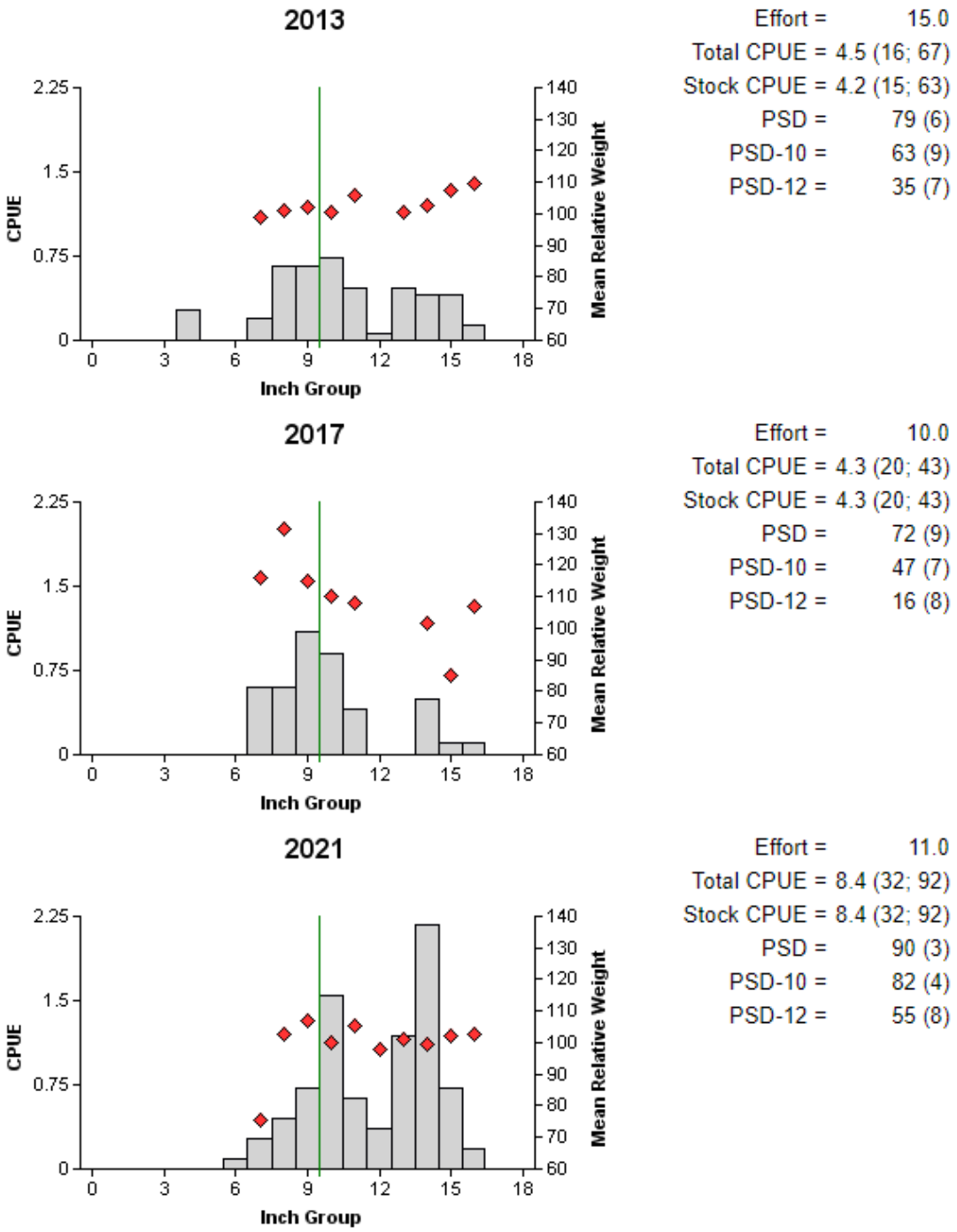


Figure 6. Number of White Bass caught per net night (CPUE, bars), mean relative weights (diamonds) and population indices (RSE and N for CPUE and SE for size structure in parentheses) for spring gill net surveys, Limestone Reservoir, Texas, 2013, 2017 and 2021. Vertical line represents 10-inch minimum length limit.

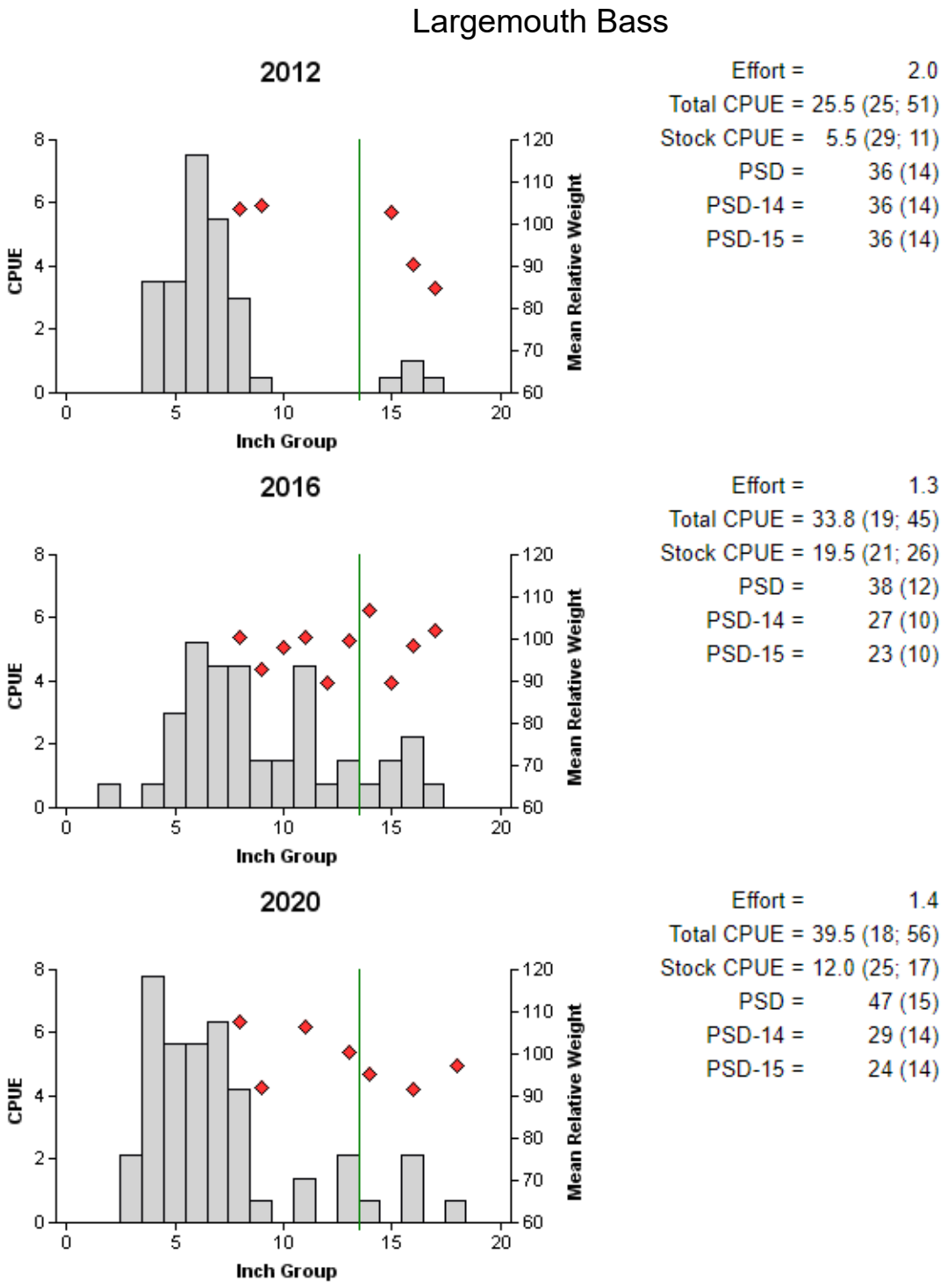


Figure 7. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Limestone Reservoir, Texas, 2012, 2016, and 2020. Vertical line represents 14-inch minimum length limit.

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.

	Number of fish					
Year	Sample size	FLMB	Hybrid	NLMB	% FLMB alleles	% FLMB
2012	28	0	26	2	38	0
2016	30	0	29	1	26	0
2020	29	0	28	1	31	0

White Crappie

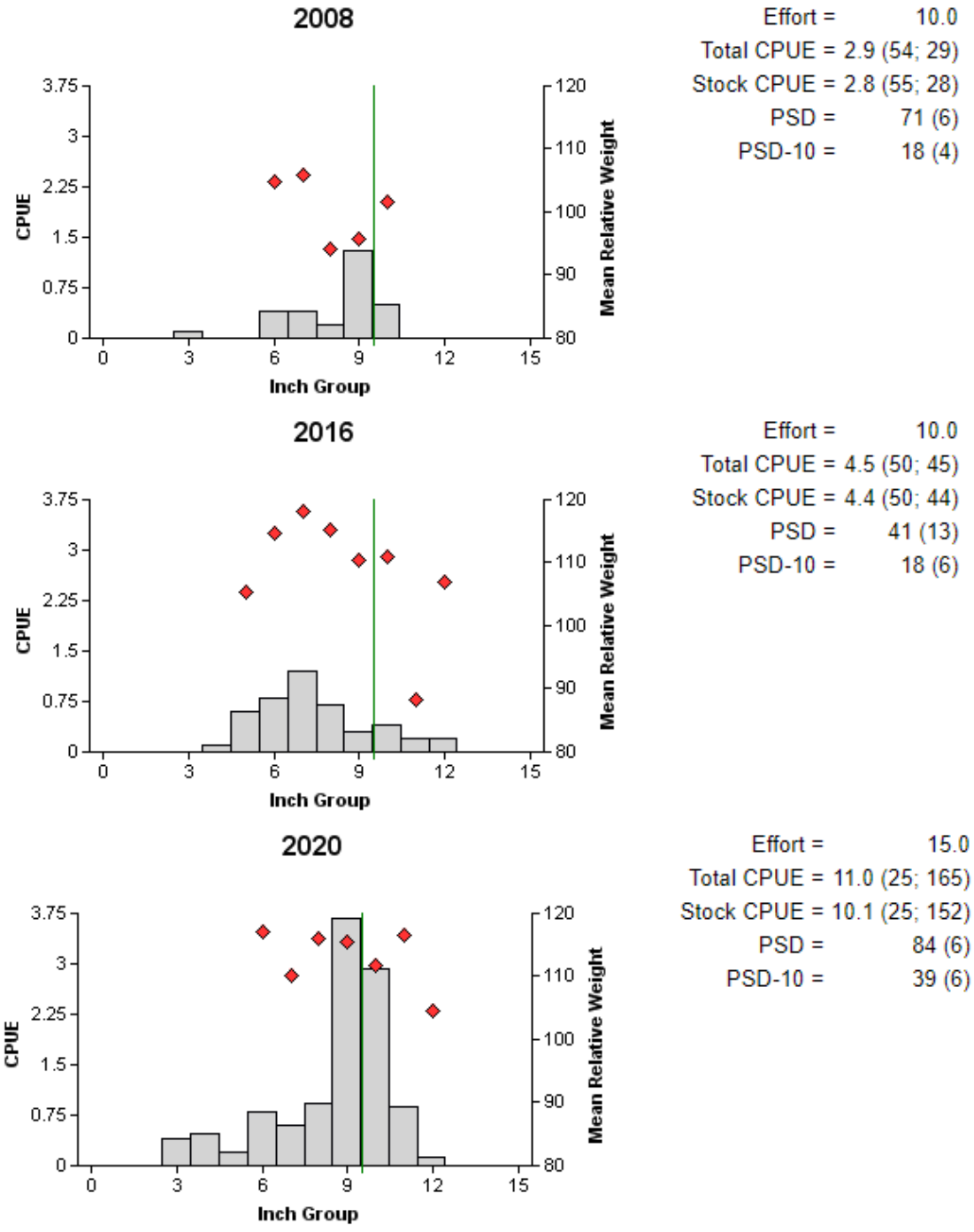


Figure 8. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for winter trap netting surveys, Limestone Reservoir, Texas, 2008, 2016, and 2020. Vertical line indicates 10-inch minimum length limit.

White Crappie

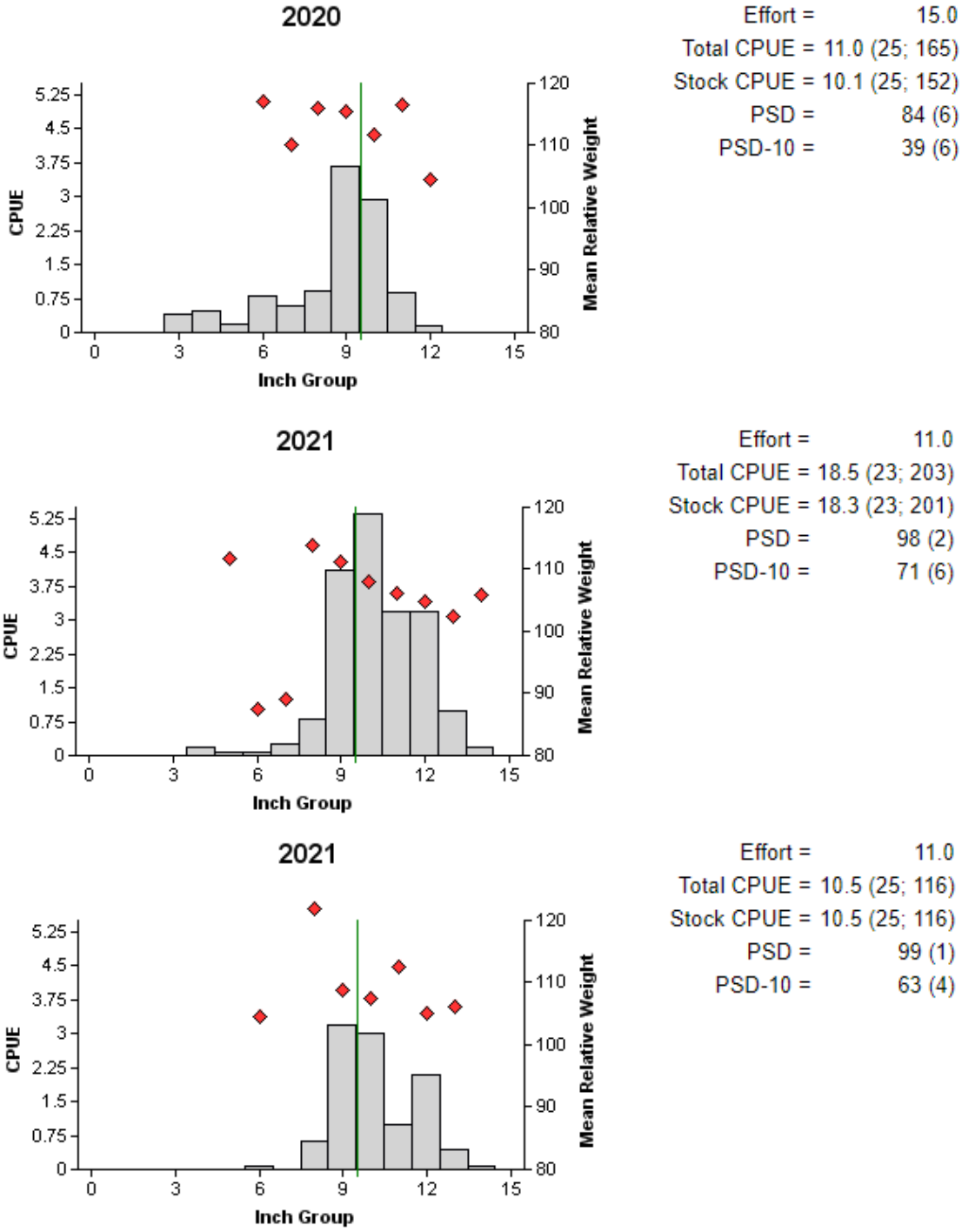


Figure 9. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for 2020 winter trap netting (top figure), 2021 spring trap netting (middle figure) and 2021 spring gill netting (bottom figure), Limestone Reservoir, Texas. Vertical line indicates minimum length limit.

Proposed Sampling Schedule

Table 9. Proposed sampling schedule for Limestone Reservoir, Texas. Survey period is June through May. Vegetation, access, and electrofishing surveys are conducted in late summer and fall while gill net and all future trap net surveys are conducted in the spring. Standard survey denoted by S.

	Survey Year			
	2021-2022	2022-2023	2023-2024	2024-2025
Vegetation				X
Angler Access				X
Electrofishing - Fall				X
Trap Netting - Spring				X
Gill Netting - Spring				X
Report				X

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

Number (N), relative standard error (RSE), and catch rate (CPUE) of all target species collected from all gear types from Limestone Reservoir, Texas, 2020-2021.

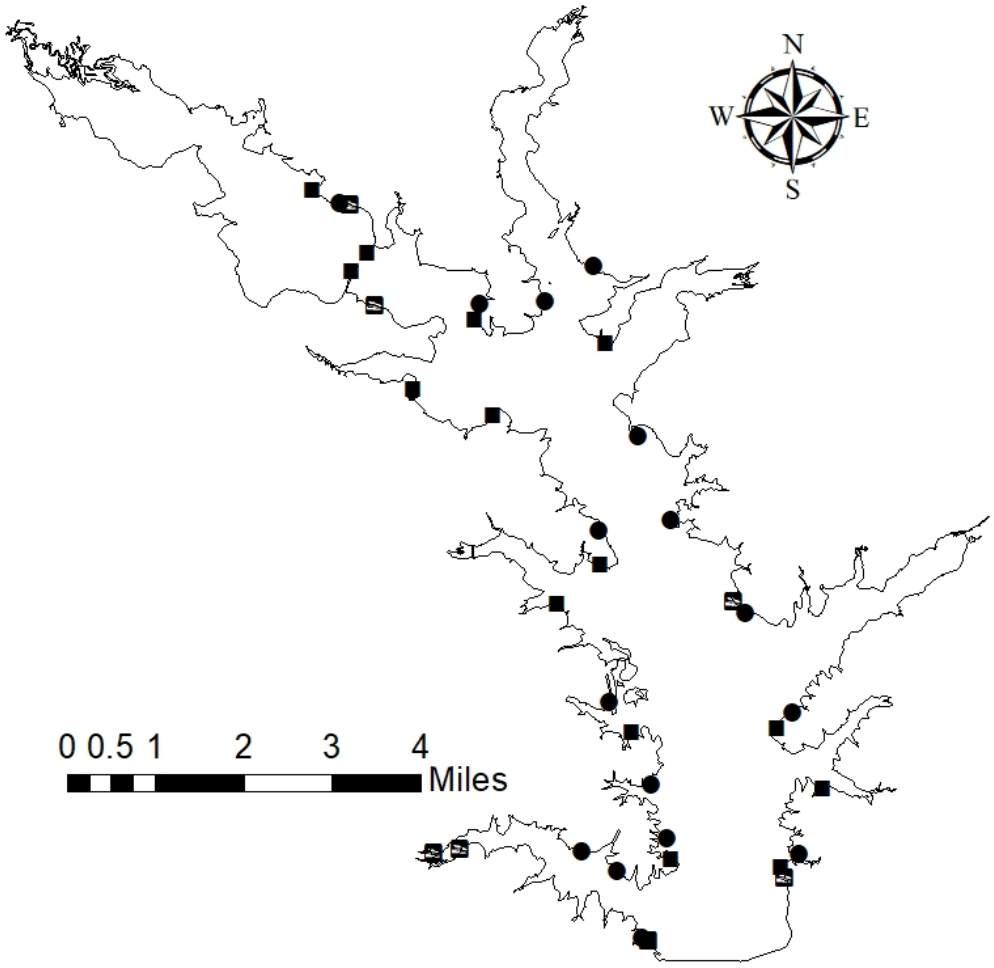
Species	Gill Netting		Trap Netting		Electrofishing	
	N/RSE	CPUE	N/RSE	CPUE	N/RSE	CPUE
Gizzard Shad					487/15	343.8
Threadfin Shad					806/33	568.9
Blue Catfish	102/29	9.3				
Channel Catfish	65/30	5.9				
Flathead Catfish	2/67	0.2				
White Bass	92/32	8.4				
Bluegill					37/31	26.1
Longear Sunfish					11/55	7.8
Redear Sunfish					1/100	0.7
Largemouth Bass					56/18	39.5
White Crappie	116/25	10.6	165/25	11.0		
Black Crappie	9/36	0.8	2/100	0.1		

APPENDIX B – Historical catch rates for target species by gear type

Historical catch rates (CPUE) of targeted species by gear type for management surveys on Limestone Reservoir, Texas, 1997 to present. All stations were randomly selected. Electrofishing stations utilized a 5.0 Smith-Root GPP (Gas Powered Pulsator) through 2010, after which a 7.5 Smith-Root GPP was used. Objective based sampling began in 2015. Species averages are in bold. Dashes represent no data. Asterisks indicate a catch rate from a non-standard gear or season.

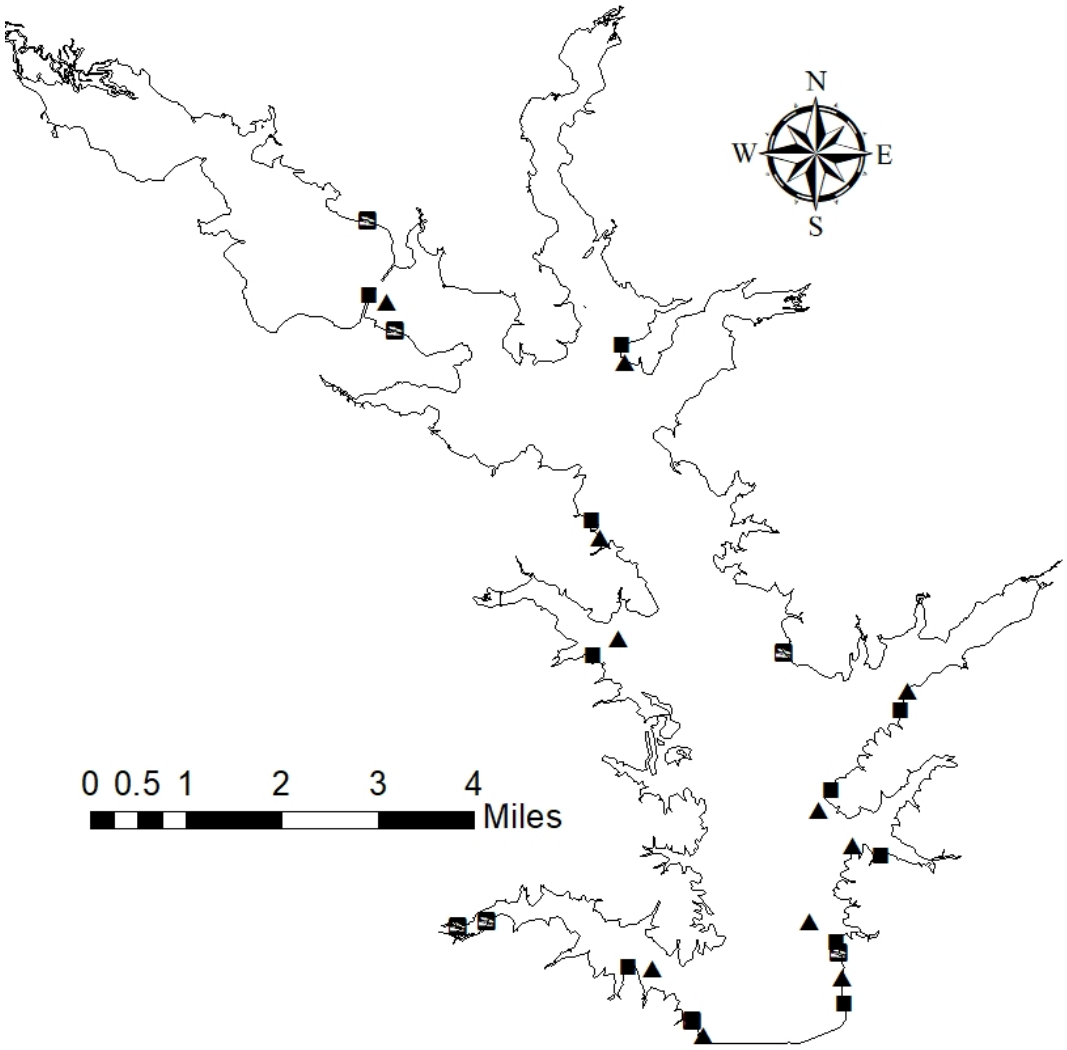
Gear	Species	97	00/01	02	04/05	08/09	12/13	16/17	20/21	**Avg.**
Electrofishing	Largemouth Bass	86.0	60.0	115.0	52.0	32.0	26.0	34.0	39.5	**55.6**
	Gizzard Shad	265.0	94.0	387.0	216.0	190.0	300.0	430.0	343.8	**278.2**
	Threadfin Shad	701.0	181.0	1184.0	1609.0	1302.0	1282.0	1379.0	568.9	**1025.9**
	Bluegill Sunfish	22.0	55.0	215.0	56.0	104.0	22.0	74.0	26.1	**71.8**
	Redear Sunfish	0.0	2.0	13.0	3.0	13.0	2.0	2.0	0.7	**4.5**
	Longear Sunfish	23.0	25.0	126.0	20.0	45.0	9.0	17.0	7.8	**34.1**
	Green Sunfish	2.0	9.0	1.0	0.0	0.0	0.0	4.0	0.0	**2.0**
	Warmouth	3.0	2.0	7.0	2.0	1.0	0.0	2.0	0.0	**2.1**
Gill nets	Blue Catfish	0.5	2.3	-	2.1	12.6	21.1	6.4	9.3	**7.8**
	Channel Catfish	4.1	3.6	-	3.3	6.2	14.0	13.7	5.9	**7.3**
	White Bass	9.9	4.3	-	6.2	5.2	4.4	4.3	8.4	**6.1**
	Flathead Catfish	0.5	0.2	-	0.0	0.0	0.1	0.2	0.2	**0.2**
	White Crappie	-					*2.6	*4.6	*10.6	**5.9**
	Black Crappie	-					*0.8	*0.9	*0.8	**0.8**
Trap nets	White Crappie	16.0	9.9	-	5.1	2.9	-	4.5	11.0	**8.2**
	Black Crappie	0.1	0.4	-	0.1	0.0	-	0.6	0.1	**0.2**

APPENDIX C – Map of sampling locations



Location of sampling sites, Limestone Reservoir, Texas, 2020. Electrofishing and winter trap netting stations are indicated by solid circles and squares respectively. Boat ramps are indicated by larger squares with boat/ramp symbols on them. Water level was below conservation pool (361.8 – 362.8) during 2020 surveys.

APPENDIX C – Map of sampling locations cont.



Location of sampling sites, Limestone Reservoir, Texas, 2021. Spring trap netting and gill netting stations are indicated by solid squares and triangles respectively. Boat ramps are indicated by larger squares with boat/ramp symbols on them. Water level was at conservation pool (363.0) during 2021 surveys.

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