

Highlands Reservoir

2019 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

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Survey and Management Summary

Fish populations in Highlands Reservoir were surveyed in 2019 using electrofishing and trap nets, and in 2020 using baited hoop nets. Data from the previous 2015-2016 survey are presented with the 2019-2020 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: Highlands Reservoir is a 1,437-acre impoundment and canal system located in Harris County east of Highlands, Texas. It lies on Goose Creek in the San Jacinto River Basin and is located approximately 1 mile upstream from McNair, Texas and two miles north of Interstate 10. The reservoir is used for water supply and was opened to public fishing in 2015. Highlands Reservoir has high turbidity. Habitat features consist of standing timber, riprap, and overhanging brush.

Management History: Highlands Reservoir was opened to the public for fishing in 2015. Prior to 2015 the San Jacinto River Authority (SJRA) managed the reservoir based on water supply needs. Important sport fish include Channel Catfish, Blue Catfish and White Crappie.

Fish Community

- **Prey species:** Prey species in Highlands Reservoir included Gizzard Shad, Bluegill, and Longear Sunfish. The Index of Vulnerability for Gizzard Shad indicated most Gizzard Shad are available to predators for consumption. Sunfish were small and available to predators, but not large or abundant enough to provide a panfish fishery.
- **Catfishes:** Blue Catfish and Channel Catfish are present in Highlands Reservoir; however, few were collected in 2020, likely due to a failure of hoop nets as a collection gear. The 2016 gill net survey exhibited good catch rates for both species.
- **Temperate basses:** There is no evidence of a temperate bass fishery in Highlands Reservoir.
- **Largemouth Bass:** Few Largemouth Bass were collected, but those that were collected were in good condition.
- **White Crappie:** White Crappie were abundant with legal-sized fish available to anglers. Most crappie reached legal size (10 inches) at age 2.

Management Strategies: Highlands Reservoir has existing fisheries for Blue Catfish, Channel Catfish, and management goals will focus on improving angling opportunities for catfishes and crappies and supporting production of sunfish as prey. Exotic vegetation is present and will be monitored annually and controlled if necessary.

Introduction

This document is a summary of fisheries data collected from Highlands Reservoir in 2019-2020. 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 2019-2020 data for comparison.

Reservoir Description

Highlands Reservoir is a 1,437-acre impoundment in Harris County, east of Highlands, Texas in Harris County controlled by the San Jacinto River Authority (SJRA). It lies on Goose Creek in the San Jacinto River Basin and is located approximately one mile upstream from McNair, Texas and two miles north of Interstate 10. The twelve-foot-high Highlands Reservoir Dam has a crest length of 37,000 feet; it was constructed by the Federal Works Agency in 1943. The reservoir is made up of 3 components: a lower major section, an upper minor section, and a canal system that runs a total of 28 miles (Figure 1). The regularly inundated portions of the major and minor sections are a combined 518 acres, which expands during highwater to 1,440 acres with a normal capacity of about 3,800 acre-feet. Only the lower major section is accessible by boat and all fisheries data presented in this report were collected there. The canal system is comprised of 3 sections: an 11-mile main canal that supplies water from Lake Houston, an 8-mile south canal, and a 9-mile east canal (Figure 1). Primary water use is municipal and industrial water supply and the reservoir experiences high exchange rates of turbid water and regular fluctuations of water level (Figure 2). The reservoir was opened to the public in 2015 for recreational use. Habitat at time of sampling consisted of riprap, standing timber, and overhanging brush. Other descriptive characteristics for Highlands Reservoir are presented in Table 1.

Angler Access

Highlands Reservoir does not have a boat ramp, but non-motorized watercraft are allowed to launch from shore. Fishing is allowed from the shoreline, and the southern half has excellent maintained shoreline access; the northern half has limited bank access

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Ragan, Best, and Webb, 2016) included:

1. Determine what, if any, fisheries exist and promote quality fisheries if present.
Action: Hoop net and trap net surveys were utilized to collect fish population data and informal interviews with active anglers indicated that the reservoir has active White Crappie, Blue Catfish, and Channel Catfish fisheries and most anglers target catfishes and crappies at Highlands Reservoir. Fisheries were promoted through social media and a "Where to Fish in Houston" brochure series.
2. Stock Florida Largemouth Bass to increase Largemouth Bass abundance and prevalence of Florida-strain genetic influence in the population.
Action: Florida Largemouth Bass fingerlings were stocked in 2016.
3. Improve structural and vegetative habitat in the lower portion of the reservoir.
Action: No structural habitat has been added to the lower portion of the reservoir. Vegetation surveys have determined that increasing native emergent aquatic vegetation would require removal of large areas of well-established shoreline vegetation composed of native and non-native species and is not practical at this time. High turbidity, grass

carp presence, and fluctuating water levels may make establishment of floating-leaved and submersed native aquatic vegetation impractical.

Harvest regulation history: There is no previous harvest regulation history. The reservoir is currently managed under statewide regulations (Table 2).

Stocking history: Grass Carp were stocked in 2008, 2011, and 2015 by SJRA to control hydrilla in the canal system. Florida Largemouth Bass and Bluegill were stocked in 2016 (Table 3).

Vegetation/habitat management history: Historically, vegetation has been managed by SJRA with herbicide. The southern shoreline, composed primarily of riprap, has been treated for alligator weed as needed. A section of shoreline along the northern half of the reservoir is inaccessible and alligator weed is abundant along that edge. Triploid Grass Carp were stocked in 2008, 2011, and 2015 by SJRA for hydrilla control in the water supply canals.

Water transfer: Highlands Reservoir is primarily used for municipal and industrial water supply within the San Jacinto River Basin. One permanent pumping station on Lake Houston supplies water to the canal system that feeds Highlands Reservoir. Control gates at the top of Highlands Reservoir control the amount of water flowing into the reservoir with another set of control gates at the bottom controlling the outflow to the rest of the canal system. The lower canals provide water for industrial customers.

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Highlands Reservoir with a focus on collecting baseline fisheries data and identifying existing fisheries (Ragan, Best, and Webb 2016). Primary components of the OBS plan for 2019-2020 are listed in Table 4. 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 hour at 12, 5-min stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing. Ages for Largemouth Bass were determined using otoliths from all collected fish sized 13.0 to 14.9 inches (n=3).

Trap netting – Crappie were collected using 10 trap nets at 10 randomly-selected stations. CPUE for trap netting was recorded as the number of fish caught per net night (fish/nn). Ages for crappie were determined using otoliths from 13 randomly selected fish (range 9.0 to 10.9 inches).

Gill netting – The 2016 OBS Plan called for gill netting, however hoop netting replaced gill netting after 2016 due to a lack of suitable depths to set gill nets.

Hoop nets – Channel Catfish were collected using tandem hoop-net series at 5 stations. Nets were baited with cheese and deployed for 2-night soak durations. CPUE for hoop netting was recorded as the number of fish caught per hoop net series (fish/series).

Genetics – Genetic analysis of Largemouth Bass was conducted according to the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

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 and creel statistics.

Habitat – A structural habitat survey was conducted in 2019. Exotic vegetation surveys were conducted in 2016, 2018, and 2019 to monitor exotic vegetation. Habitat was assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Water level – Water level data from January 2019 to present was provided by SJRA, Highlands Division. Water level data was not recorded prior to January 2019.

Results and Discussion

Habitat: Littoral zone structural habitat consisted primarily of riprap and a mix of overhanging brush (Table 5). One and a half acres of native emergent vegetation was observed in 2019. Non-native vegetation, including alligator weed, covered less than 1% of the regularly inundated portion of the reservoir (Table 6). Historically, hydrilla has been present in the reservoir and connected canals, but none was observed in the reservoir in 2019. Triploid Grass Carp were stocked in 2015 and can move freely between the reservoir and canals.

Prey species: Electrofishing catch rates of Gizzard Shad, Bluegill, and Longear Sunfish were 19.0/h, 28.0/h, and 57.0/h, respectively (Figures 3-5). Index of vulnerability (IOV) for Gizzard Shad was excellent, indicating that 100% of Gizzard Shad were available to existing predators. Few quality sized Longear Sunfish or Bluegill were present for anglers to target but provide additional forage for sport fish.

Catfish: Highlands Reservoir is shallow and has a high exchange rate, resulting in large sandy flats through much of the reservoir. Sufficient depths to set gill nets (the standard sampling method for catfishes) were not available, so hoop nets were utilized as an experimental substitute. Gill net and hoop net data cannot be directly compared but both are presented in Figures 6–9. Gillnet catch rates in 2016 of Blue Catfish were 13.2/nn and Channel Catfish were 4.8/nn. 2020 hoop net catch rate was exceedingly low (0.8/s) for both species likely due to a failure of hoop nets as a collection method. Too few fish were collected to determine PSD or general body condition of either species in 2020.

Temperate Bass: Yellow Bass were the only temperate bass observed in 2019-2020 (Appendix A). One White Bass was observed during electrofishing in 2016 but none were collected during this report period. Highlands reservoir does not appear to support a temperate bass fishery.

Largemouth Bass: The electrofishing total catch rate of Largemouth Bass was 6.0/h in 2019, an increase from 3.0/h in 2015 (Figure 10). Body condition of observed fish was good ($W_r > 85$). The only legally sized Largemouth Bass that was collected was 2 years old.

White Crappie: The trap net catch rate of White Crappie was 22.1/nn, with a PSD of 37 (Figure 11). Mean relative weight was over 90 for most size classes. Most White Crappie reached 10 inches (legal size) by age 2 (Figure 12). Black Crappie were observed but were not abundant (Appendix A).

Fisheries Management Plan for Highlands Reservoir, Texas

Prepared – July 2020

ISSUE 1: Highlands Reservoir hosts a promising crappie fishery, is one of the few crappie fisheries in the Greater Houston Area, and does not require a watercraft to fish for crappie.

MANAGEMENT STRATEGY

1. Continue to promote crappie fishing opportunities Highlands Reservoir through traditional and social media outlets.

ISSUE 2: Highlands reservoir is habitat limited, likely reducing angler success and fish recruitment. Habitat improvements may help concentrate fish, resulting in more consistent angler catch rates. Littoral habitat improvements may help promote more consistent fish recruitment

MANAGEMENT STRATEGY

1. Increase structural habitat in the lower portion of the lake both within casting distance of shore to concentrate fish for anglers to target and offshore to provide refuge habitats for fish that may increase residence time in a reservoir with high water exchange rates.
2. Deposit gravel in 2-6ft of water to improve sunfish spawning substrate, subsequently increasing the abundance of small sunfish available for forage in the reservoir.
3. Apply to for Conservation License Plate funding to support habitat improvement efforts.

ISSUE 3: Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels 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 these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.
2. Educate the public about invasive species through the use of media and the internet.
3. Make a speaking point about invasive species when presenting to constituent and user groups.
4. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.

Objective-Based Sampling Plan and Schedule (2020–2024)

Sport fish, forage fish, and other important fishes

Sport fishes in Highlands Reservoir include Blue Catfish, Channel Catfish, and White Crappie. Forage species include Gizzard Shad, Bluegill, and Longear Sunfish.

Negligible fisheries

Largemouth Bass: Largemouth Bass are present in low abundance in Highlands Reservoir. The CPUE-Total for Largemouth Bass was 3.0/h in 2015 and 6.0/h in 2019. In 2016 a bass-only survey was conducted to determine Florida-strain influence in the Largemouth Bass population at Highlands Reservoir: the CPUE-Total was 8.0/h at biologist selected stations. Anecdotal information from anglers indicated few anglers target Largemouth Bass. Bootstrap analysis of 2016 and 2020 data estimated that 65-100, 5-minute stations would be needed to achieve an RSE of less than 25 and that a minimum of 100, 5-minute biologist-chosen stations would be required to collect 50 stock-sized fish. Therefore, Largemouth Bass will be recorded as presence/absence if collected during gillnet or trap net surveys as outlined below. Any Largemouth Bass that are collected will be aged (maximum n=20) and their genetics analyzed for Florida-strain influence (maximum n=30).

Temperate Bass: A single White Bass was collected in 2016 and Yellow Bass are present but no other temperate bass species have been observed in Highlands Reservoir and there are no reports of anglers targeting temperate basses. Temperate bass species will be recorded as presence/absence should they be collected with catfishes, crappies, or prey species as outlined below.

Survey objectives, fisheries metrics, and sampling objectives

Catfishes: Catfish are regularly cited as a target species during informal interviews of anglers at Highlands Reservoirs. Hoop net surveys of Blue Catfish and Channel Catfish in 2020 were not successful; gill nets will be used to survey catfishes when suitable depths are available. Bootstrap analysis of 2016 gill net data predict the required effort to collect 50 stock sized Blue Catfish and with an RSE of less than 25 will be five net nights at five randomly selected gillnet. To achieve similar metrics for Channel Catfish, 12 net nights would be required; however, there is not enough area of adequate depth to set 12 nets and Blue Catfish are the dominant catfish species in Highlands Reservoir. Therefore, the survey objective will be to determine relative abundance (CPUE) and size structure (PSD) of Blue Catfish over five gill net stations. Channel catfish population metrics will also be recorded but no more than five gill nets will be set.

Crappies: White Crappie are common at Highlands reservoir and are regularly cited as a target species by anglers. Bootstrap analysis of 2016 and 2020 trap net data indicate that 5 net nights at randomly selected stations will collect 50 stock-size White Crappie with 80% confidence which will be sufficient to

determine the survey objectives of population size structure and growth rate. No additional stations will be sampled if 50 stock-sized fish are not collected in the first 5 stations. Age at 10 inches (the minimum length limit) will be determined from 13 fish between 9 and 10.9 inches. Trap net surveying of crappies at Highlands is justified by a dearth of other available fisheries, abundance of White Crappie, and relatively low sampling effort needed meet objectives.

Prey Species: Gizzard Shad, Bluegill, and Longear Sunfish are the primary forage fish at Highlands Reservoir and were surveyed in 2015 and 2019 by electrofishing. During both surveys catch rates were low and RSEs were high. Bootstrap analysis of 2015 and 2019 prey species data estimate that 80% of the time, a minimum of 57 stations would be needed to obtain an $RSE < 25$ for all three species. An electrofishing survey of 12, 5-minute stations will be conducted only if sunfish spawning habitat is added to Highlands Reservoir, as outlined in the Fisheries Management Plan section above. Otherwise, no effort will be expended to survey the prey species in 2023; instead, body condition of Blue Catfish, Channel Catfish, and White Crappie will be used to infer prey availability.

Habitat and Vegetation: Highlands Reservoir has a history of excess hydrilla growth impeding water supply. Phragmites and alligator weed are also present. Exotic vegetation will be surveyed annually to monitor growth and determine if control efforts are needed. Structural habitat is stringently maintained by SJRA and will be surveyed if major changes are made.

Literature Cited

- Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.
- DiCenzo, V. J., M. J. Maceina, and M. R. Stimpert. 1996. Relations between reservoir trophic state and Gizzard Shad population characteristics in Alabama reservoirs. North American Journal of Fisheries Management 16:888-895.
- Guy, C. S., R. M. Neumann, D. W. Willis, and R. O. Anderson. 2007. Proportional size distribution (PSD): a further refinement of population size structure index terminology. Fisheries 32(7): 348.
- Ragan, N., A. Best, and M. Webb. 2016. Highlands Reservoir 2015 fisheries management survey report. Texas Parks and Wildlife Department, Federal Aid Report F-221-M-6, Austin.

Tables and Figures

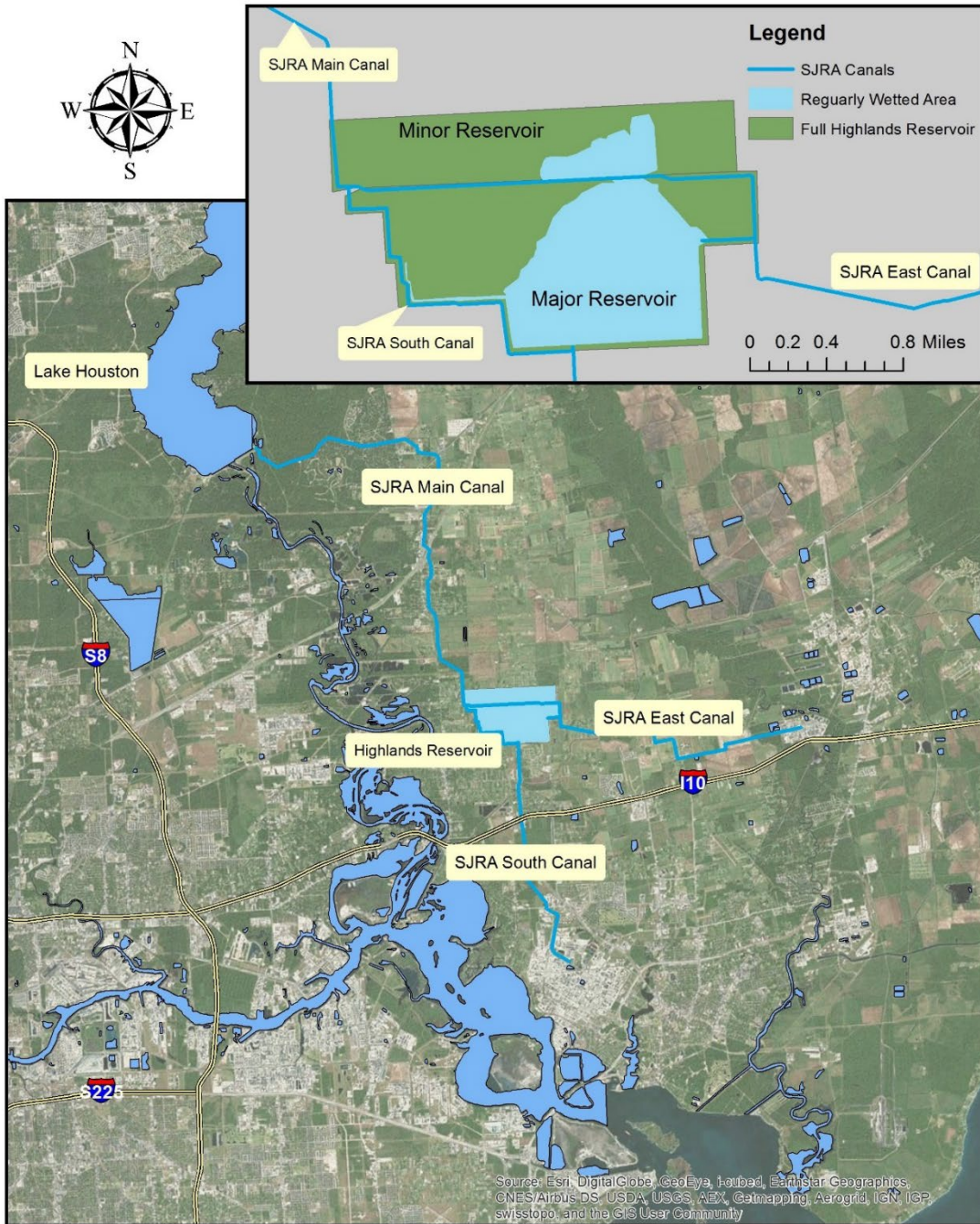


Figure 1. Map of Highlands Reservoir, Texas with associated San Jacinto River Authority canals. The lower major reservoir is the only sections accessible by boat for fisheries surveys.

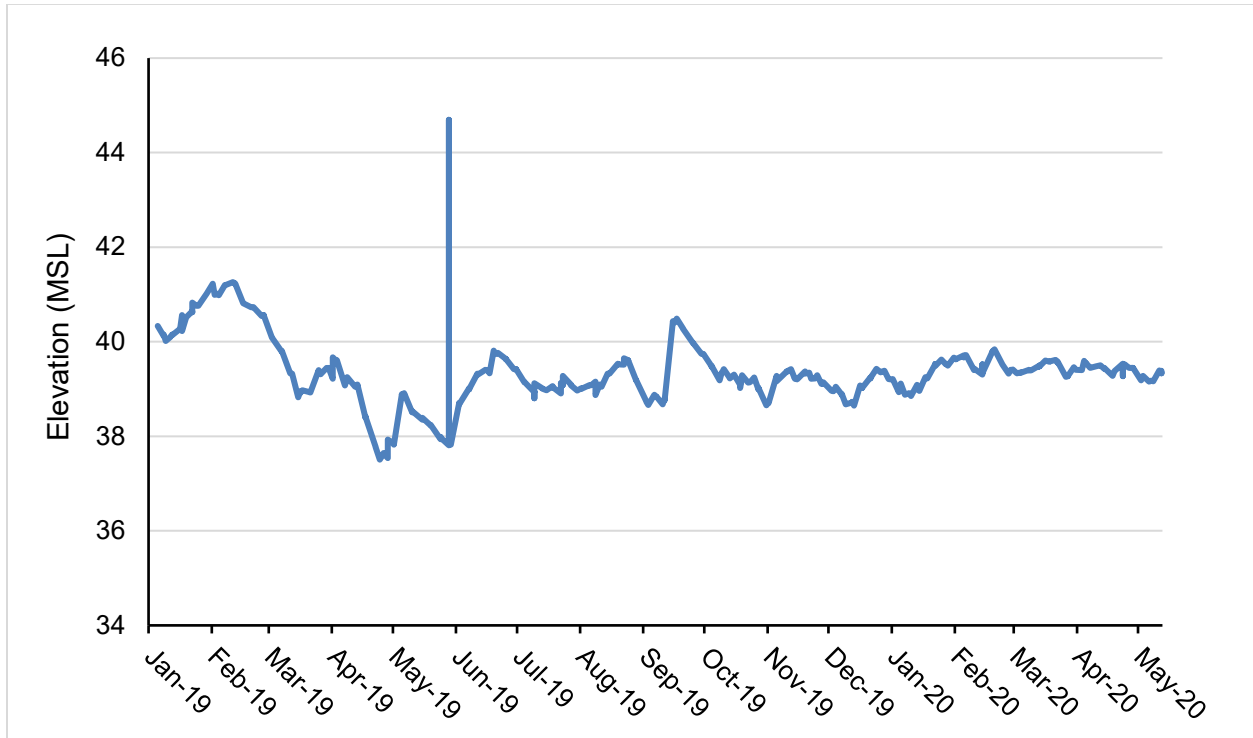


Figure 2. Daily water level elevations in feet above mean sea level (MSL) recorded for Highlands Reservoir, Texas from January 2019-May 2020. Data is not available prior to January 2019.

Table 1. Characteristics of Highlands Reservoir, Texas.

Characteristic	Description
Year constructed	1943
Controlling authority	San Jacinto River Authority
County	Harris
Reservoir type	Water Supply
Conductivity	83 μ S/cm
Major section area	931 acres
Minor section area	509 acres
Total reservoir area	1437 acres
Regularly inundated area	518 acres
Main canal length ^a	11 miles
South canal length ^a	8 miles
East canal length ^a	9 miles
Total canal length ^a	28 miles

^a Average canal width is 20 feet

Table 2. Harvest regulations for Highlands Reservoir, Texas.

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

Table 3. Stocking history of Highlands Reservoir, Texas. FGL = fingerling, ADL = adults.

Species	Year	Number	Size
Grass Carp	2008	9,000	ADL
	2011	4,000	ADL
	2015	4,000	ADL
	Total	17,000	
Bluegill	2016	109,429	FGL
Florida Largemouth Bass	2016	136,478	FGL

Table 4. Objective-based sampling plan components for Highlands Reservoir, Texas 2019–2020. The survey objective was to collect baseline data to determine fishery presence or absence. Sampling objectives were consistent with historical TPWD sampling procedure for reservoirs of similar size in order to estimate effort required in the future to gather quality data.

Gear/target species	Survey objective	Metrics	Sampling objective
<i>Electrofishing</i>			
Largemouth Bass	Abundance	CPUE–Stock	12, 5-minute electrofishing stations
	Size structure	PSD, length frequency	
	Age-and-growth	Age at 14 inches	
	Condition	W_r	
	Genetics	% FLMB	
Bluegill and other Sunfish species	Abundance	CPUE–Total	12, 5-minute electrofishing stations
	Size structure	PSD, length frequency	
Gizzard Shad	Abundance	CPUE–Total	12, 5-minute electrofishing stations
	Size structure	PSD, length frequency	
	Prey availability	IOV	
<i>Trap netting</i>			
Crappie	Size structure	PSD, length frequency	10 net nights
	Age-and-growth	Age at 10 inches	
<i>Tandem hoop netting</i>			
Channel Catfish	Abundance	CPUE–stock	5 tandem net series
	Size structure	Length frequency	

Table 5. Survey of structural habitat types, Highlands Reservoir, Texas, 2019.

Habitat type	Estimate	% of total
Natural	0.34 miles	9
Rip rap	1.87 miles	52
Overhanging brush	0.39 miles	11
Rip rap / standing timber	0.31 miles	9
Overhanging brush / standing timber	0.69 miles	19

Table 6. Survey of aquatic vegetation, Highlands Reservoir, Texas, 2016, 2018, and 2019. Vegetation surveys were not conducted in 2017 due to hurricane activity. Surface area (acres) is listed with percent of the regularly inundated areas of the reservoir in parentheses.

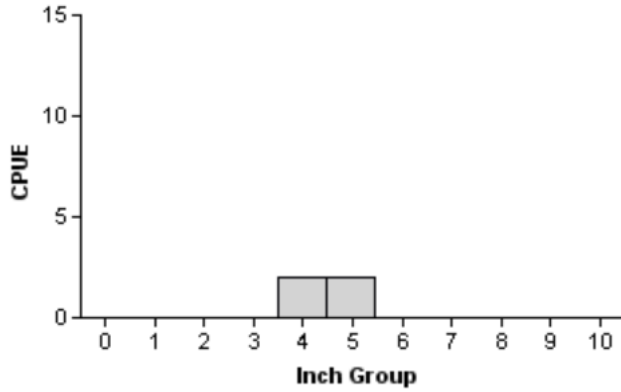
Vegetation	2016	2018	2019
Native submersed			
Native floating-leaved			
Native emergent			1.48 (<0.01)
Non-native			
Alligator weed (Tier III)*	Trace (<1)	Trace (<1)	2.84 (<0.01)
Phragmites spp. Tier III)		Trace (<1)	0.05 (<0.01)

*Tier I is Immediate Response, Tier II is Maintenance, Tier III is Watch Status

Gizzard Shad

2015

Effort = 1.0
 Total CPUE = 4.0 (43; 4)
 IOV = 100 (0)



2019

Effort = 1.0
 Total CPUE = 19.0 (31; 19)
 IOV = 100 (0)

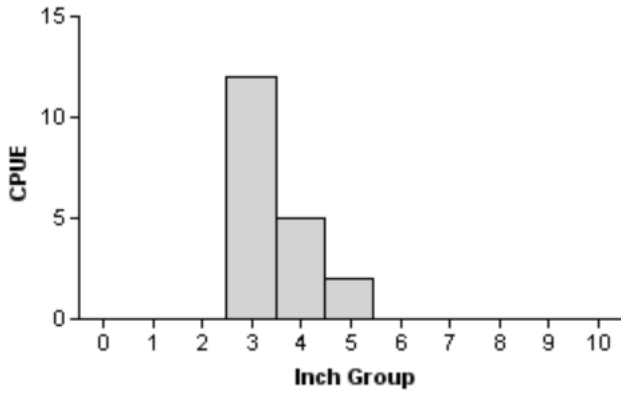
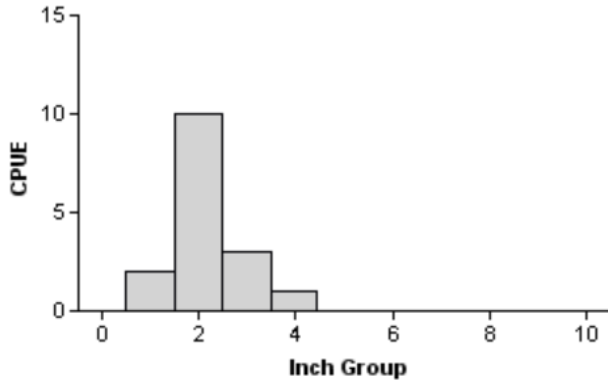


Figure 3. Number of Gizzard Shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for IOV are in parentheses) for fall electrofishing surveys, Highlands Reservoir, Texas, 2015 and 2019.

Bluegill

2015

Effort = 1.0
Total CPUE = 16.0 (34; 16)
PSD = 0 (0)



2019

Effort = 1.0
Total CPUE = 28.0 (49; 28)
PSD = 8 (6)

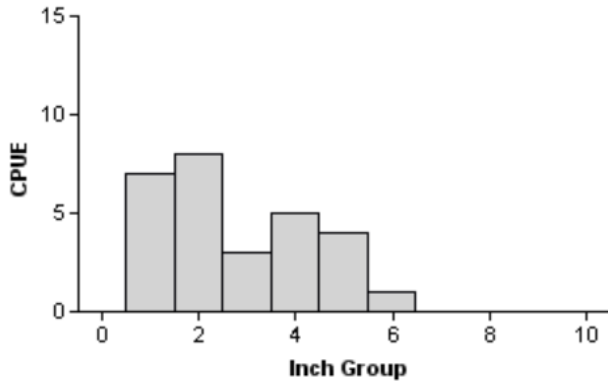


Figure 4. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Highlands Reservoir, Texas, 2015 and 2019.

Longear Sunfish

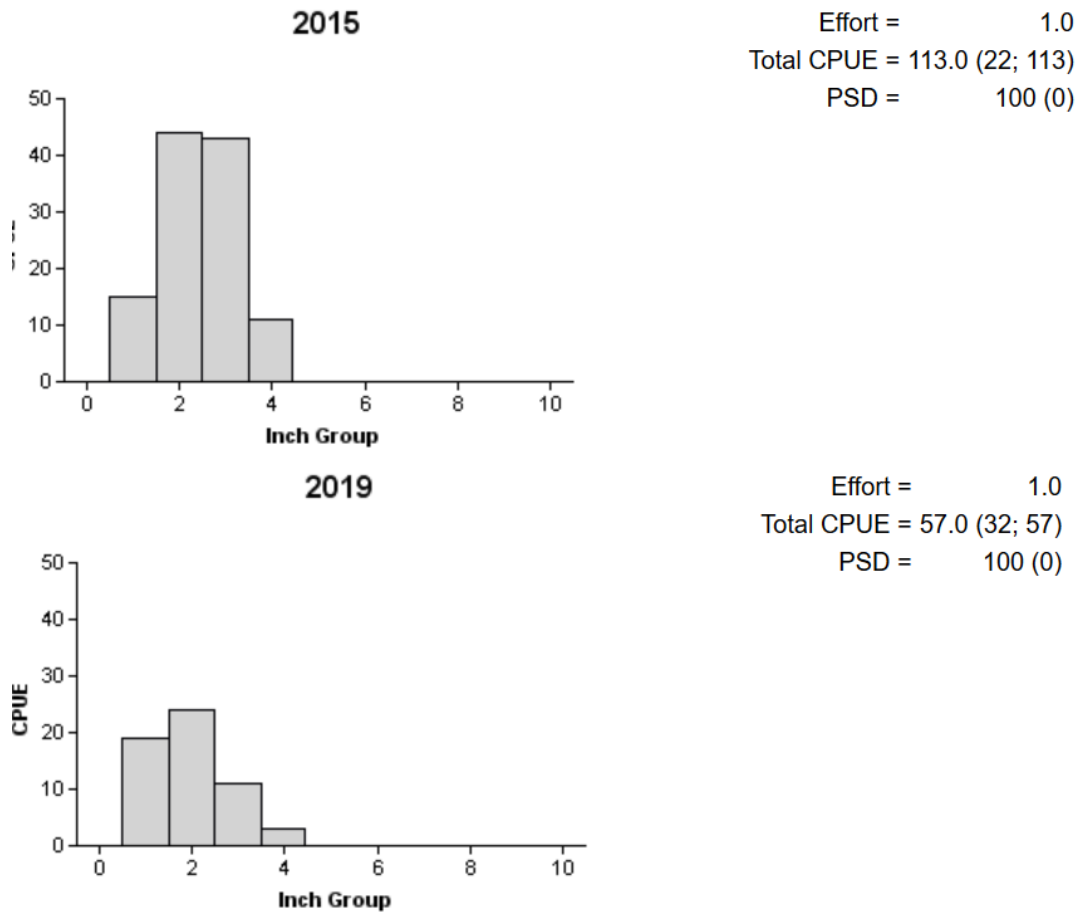


Figure 5. Number of Longear Sunfish caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Highlands Reservoir, Texas, 2015 and 2019.

Blue Catfish

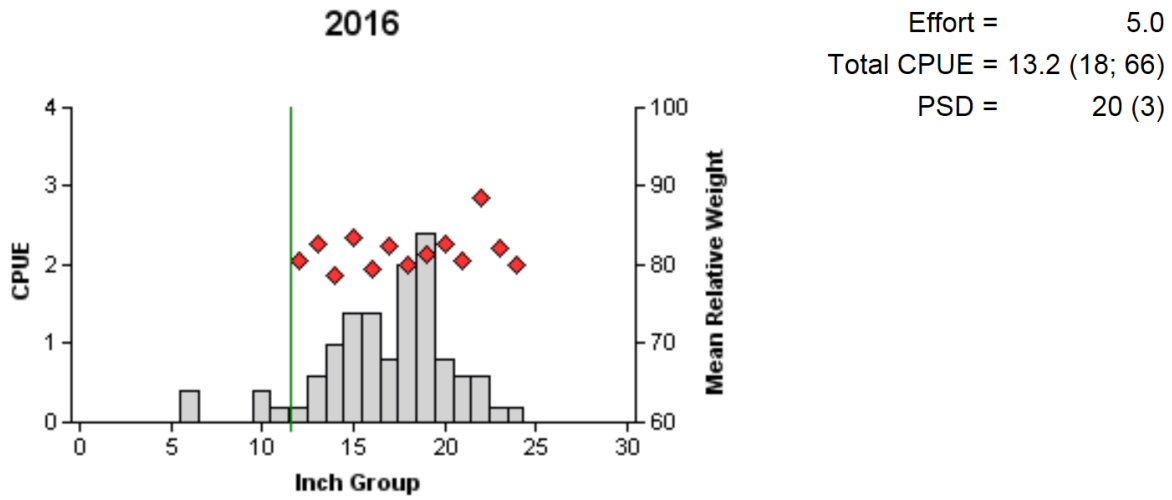


Figure 6. Number of Blue Catfish caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for the spring gill net survey, Highlands Reservoir, Texas, 2016. Vertical line indicates minimum length limit.

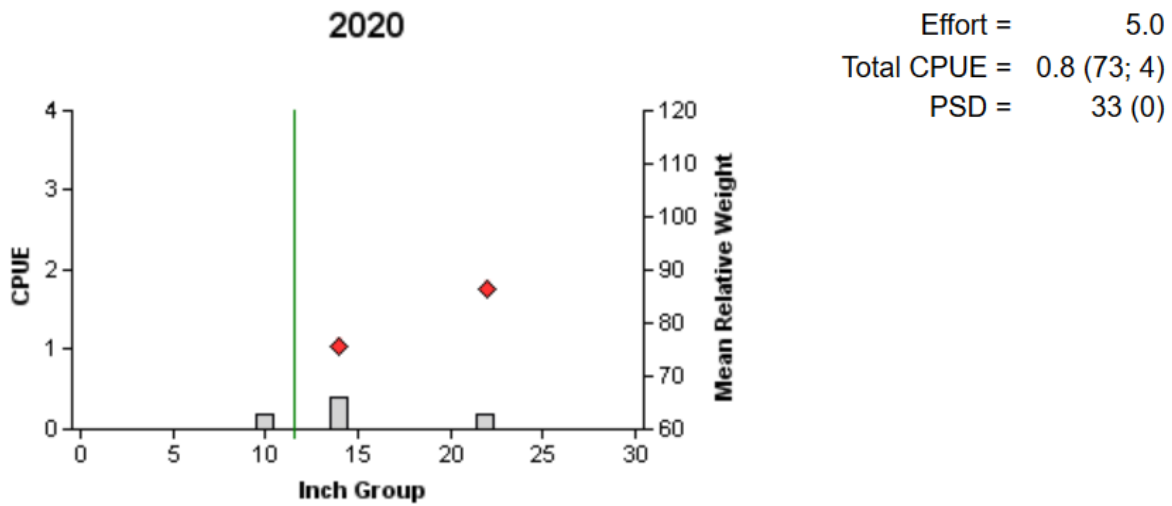


Figure 7. Number of Blue Catfish caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for the hoop net survey, Highlands Reservoir, Texas, 2020. Vertical line indicates minimum length limit.

Channel Catfish

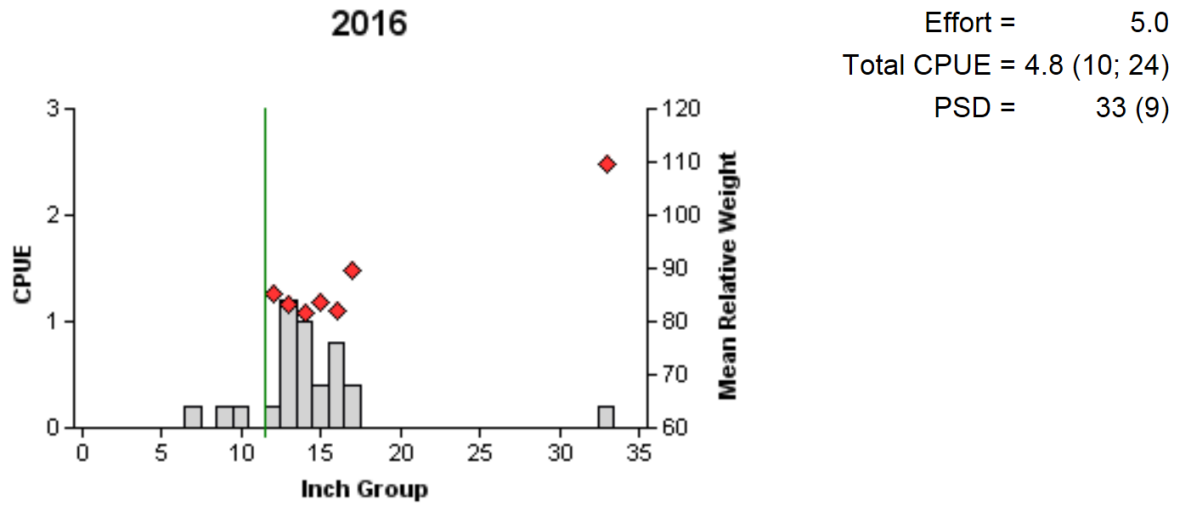


Figure 8. Number of Channel Catfish caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for the spring gill net survey, Highlands Reservoir, Texas, 2016. Vertical line indicates minimum length limit.

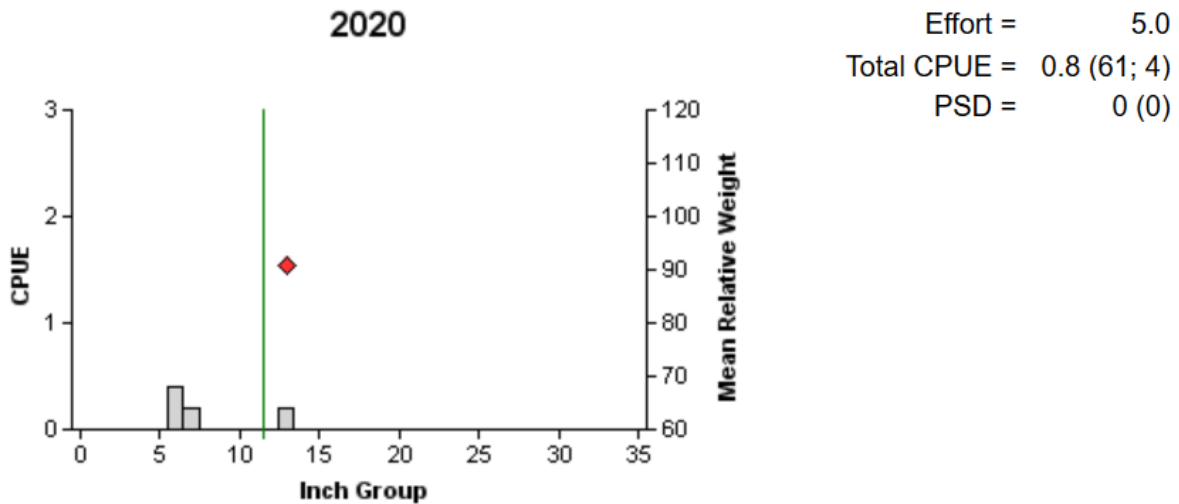


Figure 9. Number of Channel Catfish caught per net series (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for the spring hoop net survey, Highlands Reservoir, Texas, 2020. Vertical line indicates minimum length limit.

Largemouth Bass

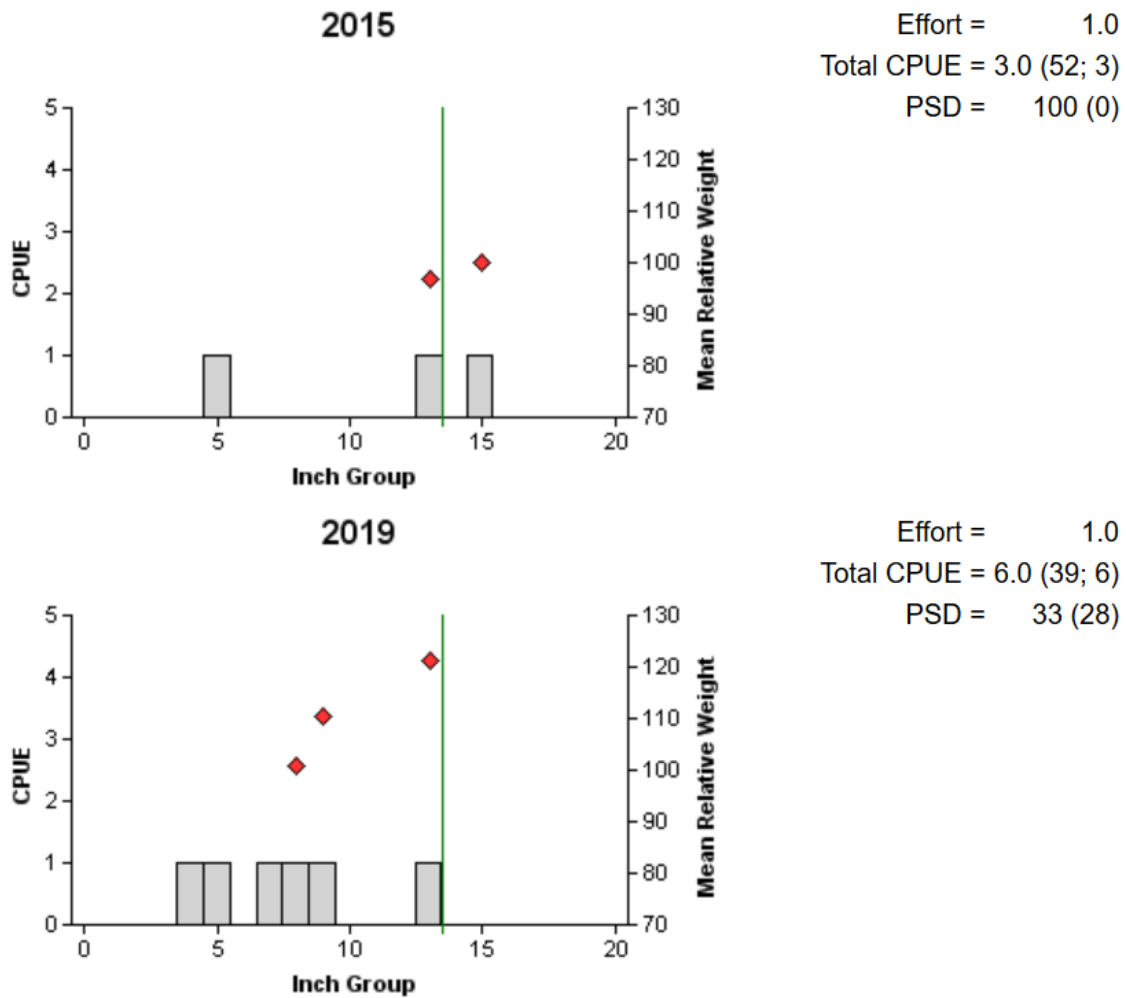


Figure 10. Number of Largemouth Bass caught per hour (CPUE, bars), mean relative weight (diamonds), population indices (RSE and N for CPUE and SE for size structure are in parentheses), and minimum length limit (green vertical line) for fall electrofishing surveys, Highlands Reservoir, Texas, 2015 and 2019.

White Crappie

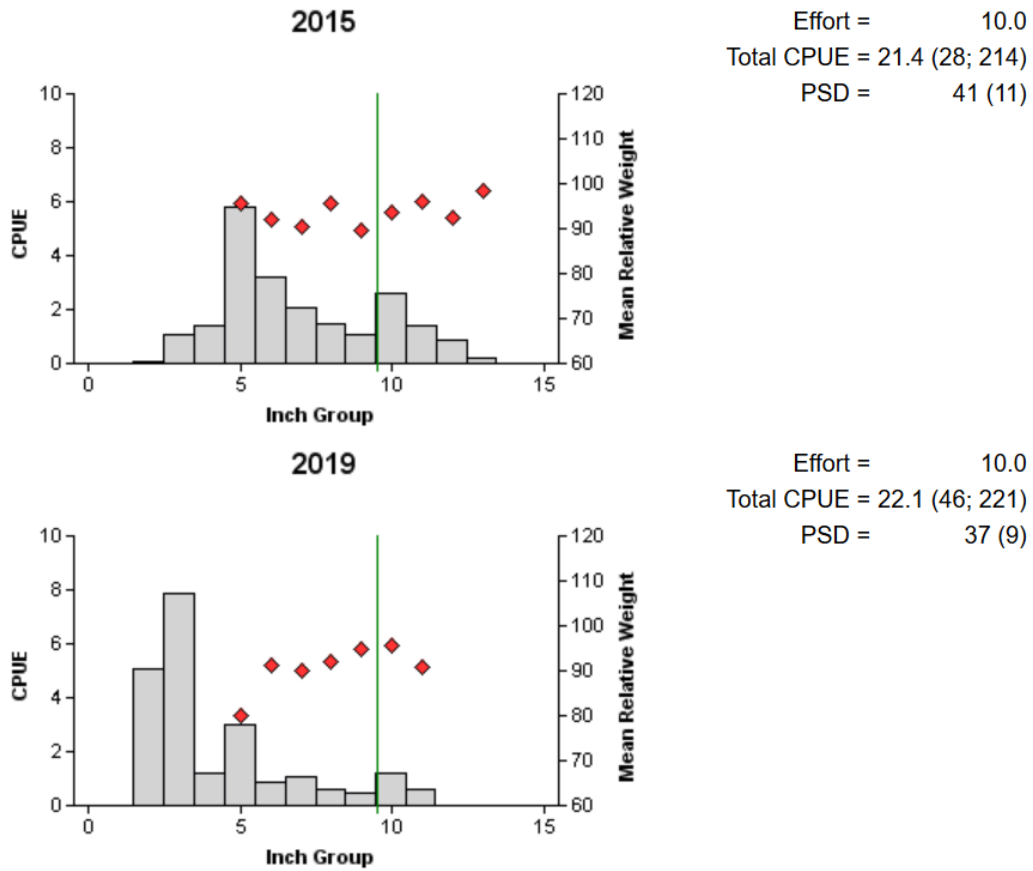


Figure 11. Number of White Crappie caught per net night (CPUE, bars), mean relative weight (diamonds), population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall trap netting surveys, Highlands Reservoir, Texas, 2015 and 2019. Vertical line indicates minimum length limit.

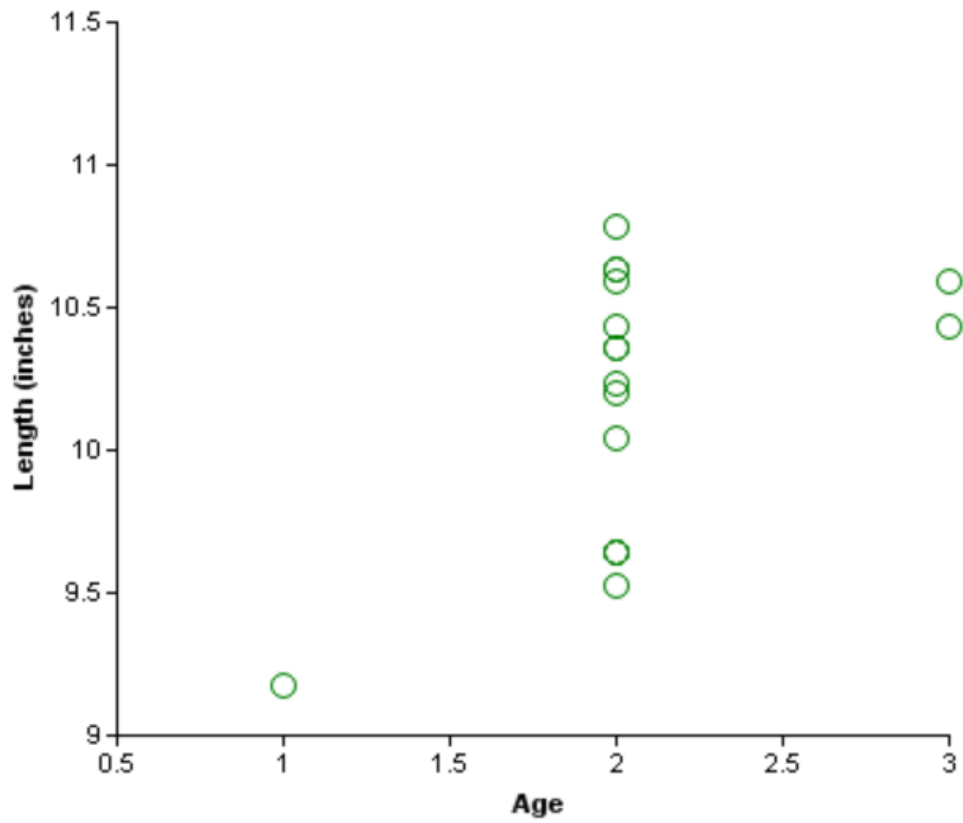


Figure 12. Length at age for 13 White Crappie sized 9-10.9 inches collected from trap nets at Highlands Reservoir, Texas, December 2019.

Proposed Sampling Schedule

Table 7. Proposed sampling schedule for Highlands Reservoir, Texas. Survey period is June through May. Hoop netting surveys are conducted in the late spring, while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

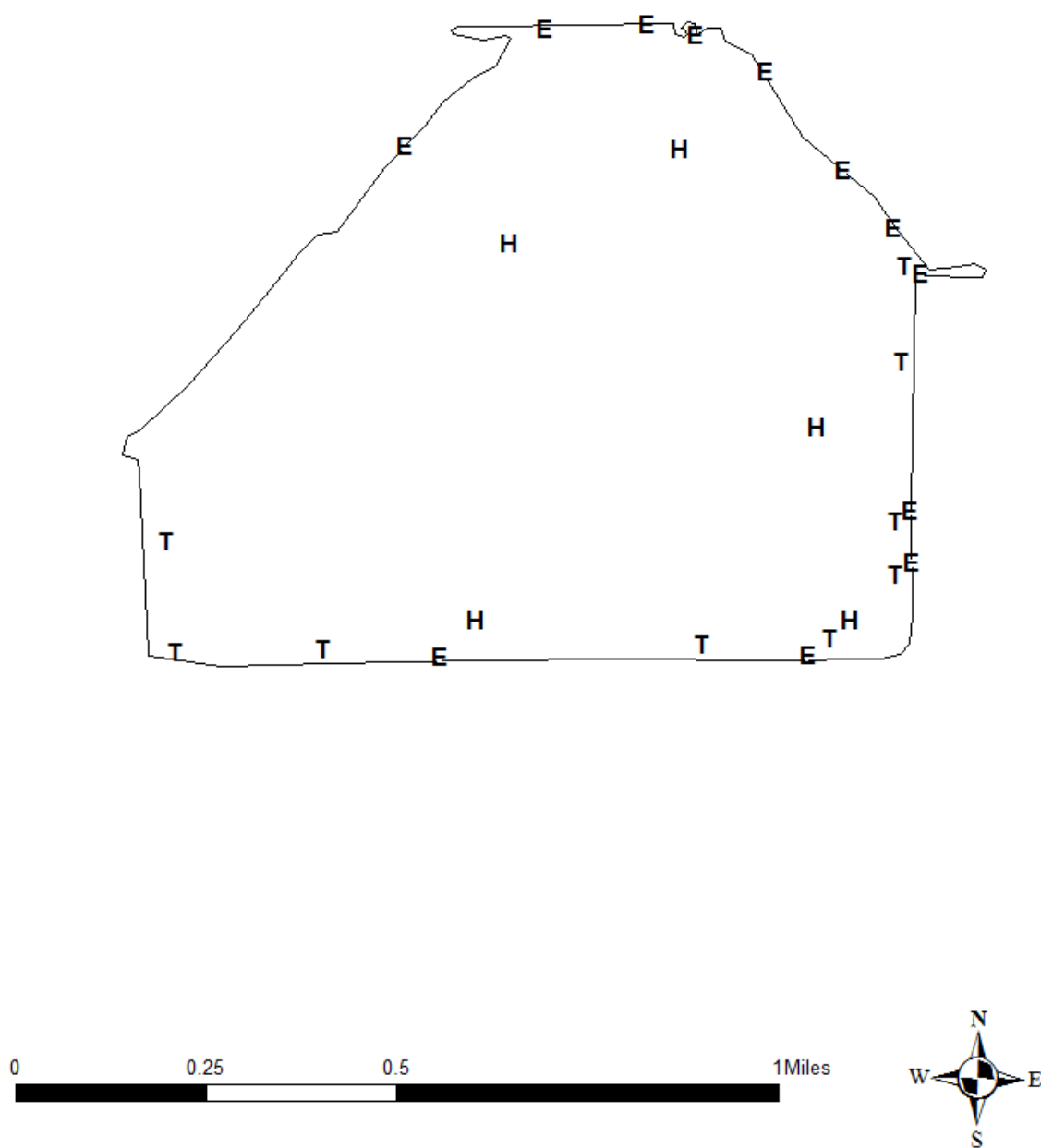
	Survey year			
	2020-2021	2021-2022	2022-2023	2023-2024
Angler Access				S
Structural Habitat				S
Vegetation	A	A	A	S
Electrofishing – Fall				S
Trap netting				S
Gill Net				S
Report				S

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

Number (N) and catch rate (CPUE with RSE in parentheses) of all target species collected from all gear types from Highlands Reservoir, Texas, 2019-2020. Sampling effort was 5 net series for hoop netting, 10 net nights for trap netting, and 1 hour for electrofishing.

Species	Electrofishing		Trap Netting		Hoop Netting	
	N	CPUE	N	CPUE	N	CPUE
Spotted gar	7	7.00 (33)				
Gizzard shad	19	19.00 (31)				
Threadfin shad	1	1.00 (100)				
Common carp	1	1.00 (100)				
Red shiner	1	1.00 (100)				
Bullhead minnow	8	8.00 (53)				
Inland silverside	2	2.00 (100)				
Blue catfish	1	1.00 (100)			4	0.80 (73)
Channel Catfish					4	0.80 (61)
Yellow bass	6	6.00 (46)				
Warmouth	2	2.00 (67)				
Orangespotted sunfish	1	1.00 (100)				
Bluegill	28	28.00 (49)			2	0.40 (100)
Longear sunfish	57	57.00 (32)				
Largemouth bass	6	6.00 (39)				
White crappie	6	6.00 (46)	221	22.10 (46)	31	6.20 (63)
Black crappie			5	0.50 (68)		
Grass carp	1	1.00 (100)				
Freshwater Drum					1	0.20 (100)

APPENDIX B – Map of sampling locations



Location of sampling sites, Highlands Reservoir, Texas, 2019-2020. Trap net, hoop net, and electrofishing stations are indicated by T, H, and E, respectively. Water level was near full pool at time of sampling.



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