Lake Livingston

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

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Contents

Contents ... i

Survey and Management Summary ... 1

Introduction ... 2

- Reservoir Description ... 2
- Angler Access ... 2
- Management History ... 2

Methods ... 4

Results and Discussion ... 4

Fisheries Management Plan for Lake Livingston, Texas ... 7

Objective-Based Sampling Plan and Schedule (2021–2025) ... 9

Literature Cited ... 11

Tables and Figures ... 12

- Water Level ... 12
- Reservoir Characteristics ... 12
- Boat Ramp Characteristics ... 13
- Harvest Regulations ... 15
- Stocking History ... 16
- Objective-Based Sampling Plan for 2020-2021 ... 18
- Structural Habitat Survey ... 19
- Percent Directed Angler Effort per Species ... 19
- Total Fishing Effort and Fishing Expenditures ... 19
- Gizzard Shad ... 20
- Bluegill ... 21
- Blue Catfish ... 22
- Channel Catfish ... 23
- White Bass ... 25
- Striped Bass ... 27
- Largemouth Bass ... 28
- Crappies ... 32
- Proposed Sampling Schedule ... 33

APPENDIX A – Catch rates for all species from all gear types ... 34

APPENDIX B – Map of sampling locations ... 35

APPENDIX C – Reporting of creel ZIP code data ... 36

APPENDIX D – Fish consumption advisory issued by TDSHS ... 37

Survey and Management Summary

Fish populations in Lake Livingston were surveyed in 2020 using electrofishing and 2021 using gill netting. Anglers were surveyed from June through August 2020 with a creel survey. 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: Lake Livingston is an 83,277-acre mainstream impoundment on the Trinity River in Trinity, Polk, San Jacinto, and Walker counties. The reservoir was constructed in 1969 by the Trinity River Authority (TRA) and the City of Houston for municipal, agricultural, and industrial purposes. In cooperation with the TRA and the City of Houston, East Texas Electric Cooperative operates a hydroelectric facility at the dam (construction completed in June 2020). Private and commercial real estate development, Lake Livingston State Park, and several TRA public parks are present around the lower half of the reservoir. Primary fish habitat is standing timber, woody debris, and boat docks.

Management History: Important sport fish include catfishes, White Bass, Largemouth Bass, and crappies. All recreational fisheries have been regulated with statewide length and bag limits, except for the bag limit for Blue and Channel Catfish (50 fish/day; commercial harvest is allowed) and the 48-inch maximum length limit for Alligator Gar. The management plan from the 2016 survey report recommended continued support for the Friends of Lake Livingston (FoLL) Friends of Reservoirs chapter littoral vegetation restoration efforts. Since 2013, FoLL, in cooperation with 8 independent school districts and numerous other partners, has propagated and introduced approximately 35,000 water willow plants at 20 sites throughout the reservoir. Striped Bass are stocked annually to provide TPWD hatcheries a source of broodfish for temperate bass production. Primary management challenges include siltation and habitat loss, and control of invasive species, primarily giant salvinia and water hyacinth.

Fish Community

- **Prey species:** Gizzard Shad and Threadfin Shad were abundant and provided ample forage for sport fish**.** Bluegill were the most abundant sunfish but catch rate was low (49.0/h) and few fish > 6 inches were collected.
- **Catfishes:** Blue Catfish were abundant over the last three survey years. In 2021, catch rates increased to a historical high for the reservoir (42.7/nn) and ample numbers of fish 12 to 25 inches were available to anglers. Historically, Channel Catfish abundance has been low. Gill net catch rates from the last three surveys ranged from 1.5 to 4.1/nn, and few fish were > 12 inches. Catfishes were the second most popular sportfish during the summer of 2016 and 2020.
- **Temperate basses:** White Bass abundance has increased considerably over the last three survey years. In 2021, the catch rate was 21.5/nn, a historical high for the reservoir. Size structure and fish condition were desirable. The White Bass fishery was the most popular during the summer of 2016 and 2020, and the average angler catch rate was 4.3/h. Striped Bass abundance has been relatively low and no fish were collected from the 2021 gill net survey. No directed angling effort for Striped Bass was observed during the last three creel surveys.
- **Largemouth Bass:** Largemouth Bass abundance has been relatively low. Electrofishing catch rates did increase in 2016 and 2020, but few legal-size fish were available to anglers. No directed effort for Largemouth Bass was observed during the summer 2020 creel survey. Largemouth Bass had adequate growth rates (average age at 14 inches was 1.6 years).
- **Crappies:** Trap net catch rates of crappies have been historically low, and trap net surveys were discontinued in 2016. Few anglers target crappies.

Management Strategies: Continue to support habitat enhancement efforts by FoLL. Stock Florida Largemouth Bass every four years. Change the Channel and Blue Catfish harvest regulation to a no minimum length limit/50-fish daily bag limit, of which no more than five fish 30 inches or larger may be retained. Stock Striped Bass annually through 2023, then evaluate tailrace abundance and water temperatures. Consult with TRA regarding navigation lane boating hazards. Support TRA as needed with control of invasive aquatic vegetation.

Introduction

This document is a summary of fisheries data collected from Lake Livingston from 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

Lake Livingston is located on the Trinity River in Trinity, Polk, San Jacinto, and Walker counties, approximately 60 miles northeast of Houston. The 83,277-acre reservoir was constructed in 1969 by the Trinity River Authority (TRA) and the City of Houston to provide water for municipal, agricultural, and industrial purposes. In cooperation with the TRA and the City of Houston, East Texas Electric Cooperative (ETEC) operates a hydroelectric facility at the dam (construction completed in June 2020). Lake Livingston was eutrophic with a mean TSI chl-*a* of 61.7 (Texas Commission on Environmental Quality 2020). Lake Livingston has a drainage area of approximately 15,700 square miles and a shoreline length of approximately 350 miles. Aquatic habitat was limited and consisted of standing timber, woody debris, and boat docks. In 2015, the Texas Department of State Health Services (TDSHS) issued a fish consumption advisory for seven fish species (including Blue Catfish and White Bass) (Appendix D). In 2016, adult zebra mussels were found in Lake Livingston, and in 2017 the reservoir was officially classified as infested (established, reproducing population). However, abundance of adult zebra mussels remains low, as TRA and Texas Parks and Wildlife Department (TPWD) have not observed any adults on reservoir infrastructure or settlement samplers. There is considerable private and commercial real estate development, as well as Lake Livingston State Park and several TRA public parks, around the lower half of the reservoir. Other physical characteristics of Lake Livingston are in Table 1.

Angler Access

Lake Livingston has 29 public boat ramps and one private boat ramp. Additional boat ramp characteristics are in Table 2. Shoreline access is limited to public boat ramp areas. Fishing piers are present at Wolf Creek, Tigerville Park, and Lake Livingston State Park.

Management History

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

1. Support littoral habitat enhancement efforts by the Friends of Lake Livingston (FoLL) Friends of Reservoirs chapter.

   Action: Funding has been provided to FoLL via Reservoir Fisheries Habitat Partnership and TPWD Conservation License Plate grants. With logistical support from 8 independent school districts, 15 local partners, the Texas Department of Criminal Justice (TDCJ)-Ellis Unit, Lee College, TRA, and TPWD, FoLL has propagated and introduced approximately 35,000 water willow plants at 20 sites throughout the reservoir, including 25,000 since 2017.

2. Stock Striped Bass annually to enhance the population and support hatchery broodfish collections below the Lake Livingston dam.

   Action: Striped Bass were stocked annually from 2017-2020.

3. Continue to support efforts of TRA to control giant salvinia, water hyacinth, and water lettuce.

   Action: Annual vegetation surveys have been conducted in cooperation with TRA. Approximately $25,000 has been provided by TPWD each year for herbicides and equipment maintenance.

Harvest regulation history: Sport fishes in Lake Livingston are currently managed with statewide regulations, except for the 50-fish bag limit for Blue and Channel Catfish and the 48-inch maximum length limit for Alligator Gar. Current regulations are found in Table 3.

Stocking history: Since 1977, Striped Bass have been stocked annually, except for 1981, 1990, 1991, and 2001. Florida Largemouth Bass (FLMB) have been stocked periodically, most recently in 2017 and 2020. A complete stocking history is presented in Table 4.

Vegetation/habitat management history: Historically, water hyacinth and water lettuce have been problematic at Lake Livingston. During 2000–2010, abundance varied from 100–1,000 acres (approximately 90% of coverage was water hyacinth). Low water in 2011 reduced coverages significantly. Since then, plants have been scattered reservoir-wide, but total coverage has been < 50 acres. Giant salvinia was first discovered in 2011. The TRA has treated giant salvinia, water hyacinth, and water lettuce with herbicides annually to minimize plant coverage.

Historically, TPWD and Texas Black Bass Unlimited planted native aquatic vegetation at several sites throughout the reservoir, but no long-term plant survival occurred. Since 2013, FoLL has introduced over 35,000 water willow plants at 20 total sites, and in 2020, plants were surviving at 10 of these sites.

Water transfer: Lake Livingston was built by the TRA for municipal water supply. The TRA functions as a water wholesaler to the Houston/Galveston metropolitan complex and surrounding areas. Municipal water from Lake Livingston is also provided to Huntsville, Trinity County, and Livingston. The Luce Bayou Interbasin Project, which will transfer 500 million gallons of raw water per day from the Trinity River below Lake Livingston to Lake Houston, is scheduled for completion in 2021. This project will supplement the existing Trinity River Pump Station near Liberty, which provides up to 700 million gallons of water per day, either directly to industrial users or to water treatment plants in the Houston area.

Methods

Surveys were conducted to achieve survey and sampling objectives in accordance with the objective-based sampling (OBS) plan for Lake Livingston (Driscoll and Ashe 2017). Primary components of the OBS plan are listed in Table 5. Due to poor habitat conditions throughout a majority of the reservoir, the Largemouth Bass population is primarily confined to embayments and creek arms. In 2016 and 2020, fall electrofishing sites were randomly selected within 10 creeks and embayments that provided more desirable centrarchid habitat and were sampled during daytime (reservoir is shallow and turbid). Otherwise, 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 fall electrofishing in 2011 (2.0 hours at 24, 5-min stations), 2016 (2.2 hours at 26, 5-min stations), and 2020 (2.0 hours at 24, 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 10 randomly selected fish (range 13.5 to 14.5 inches).

Gill netting – Blue Catfish, Channel Catfish, White Bass, and Striped Bass were collected by gill netting (15 net nights at 15 stations) in 2012, 2017, and 2021. 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 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 and creel statistics.

Creel survey – An annual roving creel survey was conducted from June 2011 through May 2012, but only data from the June through August 2011 quarter are presented for appropriate trend comparisons with 2016 and 2020 data. A summer quarter roving creel survey was conducted from June through August in 2016 and 2020. Angler interviews were conducted on 5 weekend days and 4 weekdays per quarter to assess angler use and fish catch/harvest statistics in accordance with the Fishery Assessment Procedures (TPWD, Inland Fisheries Division, unpublished manual revised 2017). Total angler catch of Largemouth Bass $\geq$ 4, 7, and 10 pounds was also estimated. Anglers were asked if released fish were within weight categories. Harvested fish lengths were converted to weights for classification (19 inches = 4 pounds; 23 inches = 7 pounds; 25 inches = 10 pounds). Harvested and released fish were combined to represent total catch for weight categories.

Habitat – A structural habitat survey was conducted in 2016. Aquatic vegetation surveys were conducted from 2017 - 2020 to monitor giant salvinia and water hyacinth, and coverages were assessed with the digital shapefile method (TPWD, Inland Fisheries Division, unpublished manual revised 2017).

Water level – Source for water level data was the United States Geological Survey (USGS 2021).

Results and Discussion

Habitat: A habitat survey was last conducted in 2016 (Driscoll and Ashe 2017). Littoral zone structural habitat consisted primarily of natural shoreline, bulkhead, and boat docks (Table 6). An area of approximately 5,800 acres of standing timber occupies the middle portion of the reservoir. Aquatic vegetation was limited to detrimental plants (e.g., giant salvinia, water hyacinth, and water lettuce), but coverages were limited. Water hyacinth and water lettuce were scattered throughout the reservoir and comprised < 10 acres. Giant salvinia is primarily confined to White Rock Creek, Brushy Creek, and the Fingers backwater area of the reservoir. Current coverage is < 30 acres.

Sedimentation due to turbid inflows has occurred at high rates in the upper third of the reservoir and at the mouths of all creeks where flow rates slow and suspended sediments settle. Deposition of sediment has degraded considerable amounts of littoral habitat and isolated productive backwater areas from the reservoir.

Creel: The popularity of the White Bass fishery has increased considerably over the last three creel survey periods, from 12% of directed angling effort in 2011 to 58% in 2020 (Table 7). The proportion of directed angling effort for catfishes has declined over the same survey periods from 45% in 2011 to 19% in 2020. Angling effort for Largemouth Bass has also declined. Approximately 25% of anglers targeted Largemouth Bass in 2011, compared to 14% in 2016 and 0% in in 2020. Although total angling effort has been relatively low, effort did increase over the last three creel survey periods from 23,178 hours (2011) to 55,070 hours (2020) (Table 8). Similarly, total angler expenditures also increased across periods and was $338,482 in 2020.

Prey species: In 2020, Gizzard Shad and Threadfin Shad abundance was high, with electrofishing catch rates of 290.0 and 3,787.5/h, respectively (Figure 2 and Appendix A). Most Gizzard Shad were available as prey (IOV = 94). Other prey species included sunfishes [Bluegill (Figure 3), Longear Sunfish, and Redear Sunfish], but abundance was low (combined catch rate of 64.0h; Appendix A).

Catfishes: Blue Catfish gill net catch rates were relatively high and stable in 2012 (34.8/nn) and 2017 (28.7/nn) (Figure 4). In 2021, catch rates increased to a historical high for the reservoir (42.7/nn). Size structure also improved over the last three surveys as reflected by increasing PSD values (14 in 2012; 25 in 2021). Fish condition was moderate as W*r* for most fish ranged from 80 to 120, indicating adequate prey availability.

Historically, Channel Catfish abundance has been low. Gill net catch rates from the last three surveys ranged from 1.5 to 4.1/nn, and few fish were > 12 inches (Figure 5).

Catfish anglers (rod and reel only) accounted for 18.9% of the total angling effort during the summer of 2020 (Table 7). Angler catch rates declined from 1.5/h in 2011 to 0.6/h in 2020 (Table 9). In 2020, total estimated harvest was 2,260 fish; 2,019 were Blue Catfish (89%; Figure 6) and 241 were Channel Catfish (11%; Figure 7). Anecdotal information indicates that passive gear angling is popular and likely accounts for most of the annual catfish harvest, and these anglers were not included during creel surveys.

Temperate basses: Gill net surveys indicate increasing recruitment and abundance of White Bass. Since 2015, Trinity River inflows were relatively high during the winter and spring seasons of most years which likely resulted in favorable spawning conditions and strong year classes. Gill net catch rates were 3.1, 11.3, and 21.5/nn (a historic high for the reservoir) in 2012, 2017, and 2021, respectively (Figure 8). Fish were in adequate condition, as W*r* for most inch groups exceeded 90. The White Bass fishery was the most popular during 2016 (39.2% of angling effort) and 2020 (58.3% of angling effort) (Table 7). Angler catch rate in 2020 was relatively high (4.3/h) and increased from previous years (Table 10). Total angler harvest also increased over the last three survey periods and was 35,916 fish in 2020 (Table 10 and Figure 9).

Striped Bass have been stocked annually to maintain a broodfish source for hatchery production of Striped Bass, Palmetto Bass, and Sunshine Bass. However, survival of stocked fry and fingerlings has been relatively low, as evidenced by gill net surveys in the reservoir. Gill net catch rates in 2012 (1.5/nn) and 2017 (0.9/nn) were low, and no fish were collected in 2020 (Figure 10). In addition, during the last several years few adult fish have been collected for hatchery production from the tailrace below the dam. Few anglers target Striped Bass. During the last three creel survey periods, no directed effort was documented (Table 7) and only two fish were observed as harvested (Figure 11).

Largemouth Bass: Limited littoral habitat has inhibited Largemouth Bass recruitment and abundance. Historically, fall electrofishing catch rates of Largemouth Bass from random, reservoir-wide surveys have been low (< 20/h) and in 2011, the catch rate was 7.5/h (Figure 12). Beginning in 2016, surveys were restricted to random sampling within 10 creeks and embayments with more desirable habitat. Although catch rates were higher and similar among years (2016 = 39.2/h; 2020 = 37.5/h), catch was relatively low and few fish > 14 inches were observed (Figure 13). Growth of Largemouth Bass was desirable; average

age at 14 inches (13.5 to 14.5 inches) was 1.6 years (N = 10; range = 1 – 2 years). Body condition from the past three surveys was adequate, as relative weight was > 90 for most size classes of fish. In 2020, FLMB genetic influence was relatively low and similar to that from 2011 (Table 14).

Popularity of the Largemouth Bass fishery has declined. During the summer quarter in 2011, 25% of the angling effort was directed at Largemouth Bass (Table 7). In 2016, directed angler effort declined to 14%, and in 2020, no directed effort was observed. Although some smaller local tournaments are conducted on the reservoir each year, none were observed during the last three creel survey periods (Table 11).

Crappies: White and Black Crappie were present, but population abundance has been low. Trap netting for crappies was discontinued in 2016 due to historically poor catch rates (typically < 2.0/nn). Few anglers target crappies (< 4% of the total angling effort) (Table 7).

Fisheries Management Plan for Lake Livingston, Texas

Prepared – July 2021

ISSUE 1: Littoral habitat degradation and siltation limit centrarchid recruitment and abundance. Since 2013, FoLL, in cooperation with 8 independent school districts and numerous other partners, has propagated and introduced approximately 35,000 water willow plants at 20 sites throughout the reservoir. Since 2017, TPWD, FoLL, and the TDCJ-Ellis Unit have collaborated to construct and introduce approximately 200 plastic fish attractors at 17 sites.

MANAGEMENT STRATEGIES

1. Continue to support habitat enhancement efforts by FoLL and assist with grant applications to maintain funding.
2. Monitor water willow planting sites to document progress. When appropriate, recommend changes that may improve project efficiency and success.
3. Stock FLMB fingerlings every four years (1,000 fish/km of shoreline with suitable habitat; 100,000 fish total) to increase fishing quality. Continue to monitor angler catch of Largemouth Bass $\geq$ 8 pounds and FLMB genetics to document stocking efficacy.

ISSUE 2: Channel and Blue Catfish harvest at Lake Livingston has been regulated with a 12-inch minimum length limit and 50-fish daily bag limit since 1995. Beginning in 2017, a statewide effort was initiated to reduce complexity of existing catfish harvest regulations. Public input was requested to ensure that regulations were consistent with the desires of catfish anglers. The Blue Catfish population at Lake Livingston is abundant, anglers are harvest-oriented, and there is little concern for overharvest.

MANAGEMENT STRATEGY

1. Effective September 1, 2021, Channel and Blue Catfish harvest will be regulated with no minimum length limit and a 50-fish daily bag limit, of which no more than five fish 30 inches or larger may be retained.

ISSUE 3: Since 1977, Striped Bass have been stocked annually, excluding four years. Historically, Striped Bass broodfish were collected from the Lake Livingston tailrace for statewide hatchery production of Striped Bass, Palmetto Bass, and Sunshine Bass, and the tailrace supported a productive Striped Bass fishery. However, Striped Bass abundance in the tailrace has been relatively low the past few years and no broodfish have been collected since 2019. Operation of the ETEC hydroelectric facility (completed in June 2020) could result in increased temperatures of reservoir discharges, further reducing Striped Bass abundance. As part of the post-startup monitoring plan, ETEC is required to monitor tailrace water temperatures and take mitigative steps once water temperatures and dissolved oxygen levels reach 30.5ºC and 3.5mg/L, respectively. Striped Bass abundance in the reservoir has also been low, and no directed angling effort has been observed during the last three creel surveys.

MANAGEMENT STRATEGIES

1. Continue to stock Striped Bass fry or fingerlings annually through 2023 in the reservoir and tailrace. Stocking rates will be based on production and availability from hatcheries.

2. During 2022 and 2023, evaluate Striped Bass abundance in the tailrace during the spring and water temperatures during the summer. If no Striped Bass are observed and summer water temperatures routinely exceed 31ºC, explore other viable options to mitigate for the loss of available broodfish that have historically been collected in the tailrace.

ISSUE 4: The historical Trinity River (above U.S. Highway 190) and White Rock Creek channels are delineated with red and green navigation markers and serve as boat lanes. However, due to high siltation rates, a 1-km section of the Trinity River navigation lane is < 3 feet deep and woody debris is abundant. A 0.5-km section of the White Rock Creek lane is < 1 foot deep and not navigable. Both locations are safety hazards for boaters.

MANAGEMENT STRATEGY

1. Consult with TRA regarding appropriate strategies to address navigation hazards.

ISSUE 5: Although White Bass and Blue Catfish populations are abundant and provide the most popular fisheries, the TDSHS issued a fish consumption advisory in 2015.

MANAGEMENT STRATEGY

1. Promote these fisheries when appropriate, but ensure anglers are aware of the consumption advisory.

ISSUE 6: Historically, water hyacinth and water lettuce coverages have impeded access. Giant salvinia was discovered in 2011. Although coverages of these invasive plants have been minimal in recent years, the potential exists for these plants to expand.

MANAGEMENT STRATEGIES

1. Monitor invasive aquatic plants annually.
2. Continue to support annual control efforts by TRA.

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

Sport fish, forage fish, and other important fishes

Sport fishes in Lake Livingston include Blue Catfish, Channel Catfish, Flathead Catfish, White Bass, Striped Bass, Largemouth Bass, and crappies. Important forage species include Bluegill, Gizzard Shad, and Threadfin Shad.

Low-density fisheries

Although Striped Bass are stocked annually to maintain a broodfish population for hatchery production of Striped Bass, Palmetto Bass, and Sunshine Bass, no directed angling effort for Striped Bass has been observed during the last four creel survey periods (2007-2008, 2011-2012, 2016, and 2020). Catch rates from the last three gill net surveys (2008, 2012, and 2016) have also been low (< 2.0/nn). Although no future directed sampling is planned, Striped Bass catch will be recorded from gill net surveys directed at catfishes and White Bass (see below).

Survey objectives, fisheries metrics, and sampling objectives

Catfishes: Historically, the catfish fishery has been the most popular at Lake Livingston, accounting for 35-60% of the annual angling effort. Blue Catfish is the most abundant species, accounting for over 85% of the annual harvest. Channel Catfish comprise the remaining catfish harvest. Flathead Catfish are present in the reservoir but are rarely sampled, and no fish have been observed during creel surveys.

Gill netting surveys conducted every four years have indicated relatively stable Blue and Channel Catfish recruitment and abundance and should provide adequate population-level insight relative to large-scale changes that would dictate further investigation. A minimum of 15 randomly selected gill netting sites will be sampled in 2025, but sampling will continue at random sites until 50 stock-sized Blue Catfish are collected and the RSE of CPUE-S is < 25 (the anticipated effort to meet both sampling objectives is 6-12 stations with 80% confidence). A maximum of 10 additional gill nets will be deployed if objectives are not attained. At the effort needed to achieve sampling objectives for Blue Catfish, the expected RSE for CPUE-S is 45-55 for Channel Catfish. No additional effort will be expended to achieve an RSE ≤ 25.

White Bass: Popularity of the White Bass fishery has been variable, accounting for 12-58% of the annual angling effort. Gill net catch rates have also been variable, ranging from 3.1 to 21.5/nn over the last three survey years. Gill net surveys every four years, per catfish sampling above, should provide sufficient population-level insight. At 15 nn of effort, the expected RSE for CPUE-S is 28-45. A maximum of 10 additional gill nets will be deployed in an attempt to achieve an RSE ≤ 25 and collect 50 stock-size fish.

Largemouth Bass: During the last three creel surveys, the proportion of angling effort directed at Largemouth Bass has varied from 0-25%. Historically, random, fall nighttime electrofishing reservoir-wide has resulted in catch rates of < 20 fish/h. Due to poor habitat conditions throughout a majority of the reservoir, the Largemouth Bass population is primarily confined to embayments and creek arms. Daytime fall electrofishing (reservoir is shallow and turbid), randomized only within areas of better habitat off the main body of the reservoir, increased catch rates in 2016 (39.2/h) and 2020 (37.5/h). These daytime surveys will continue in 2024 and every four years thereafter. A minimum of 24, 5-min electrofishing sites will be sampled, but sampling will continue until 50 stock-sized fish are collected and the RSE of CPUE-S is < 25. If failure to achieve either objective has occurred after one day of sampling and objectives can be attained with up to 12 additional random stations, another day of effort will be expended.

In addition, average age of Largemouth Bass between 13.0 and 14.9 inches (N = 13) will be estimated in 2024.

Crappies: The crappie fishery accounts for < 10% of the annual angling effort. Historically, trap netting has resulted in low catch rates (typically < 2 fish/nn). Trap netting was discontinued in 2016. Creel surveys (as described below) will be used to monitor the crappie fishery and make inferences about the population.

Prey species: Bluegill, Gizzard Shad, and Threadfin Shad are the primary forage at Lake Livingston. Daytime fall electrofishing, as per Largemouth Bass above, will allow for monitoring of large-scale changes in Bluegill and Gizzard Shad relative abundance and size structure. Effort based on achieving sampling objectives for Largemouth Bass should result in sufficient numbers of Bluegill (PSD; 50 fish minimum) and Gizzard Shad size structure (IOV; 50 fish minimum). No additional effort will be expended to achieve an RSE $\leq$ 25 for forage species, but Largemouth Bass body condition (fish > 8" TL) will be used to provide additional information on forage abundance and vulnerability.

Creel survey frequency and objectives

The overall fishery at Lake Livingston (i.e., directed angling effort, catch rates, and harvest) will be monitored with a summer quarter, roving creel survey in 2024 (5 weekend and 4 weekdays/quarter).

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Tables and Figures

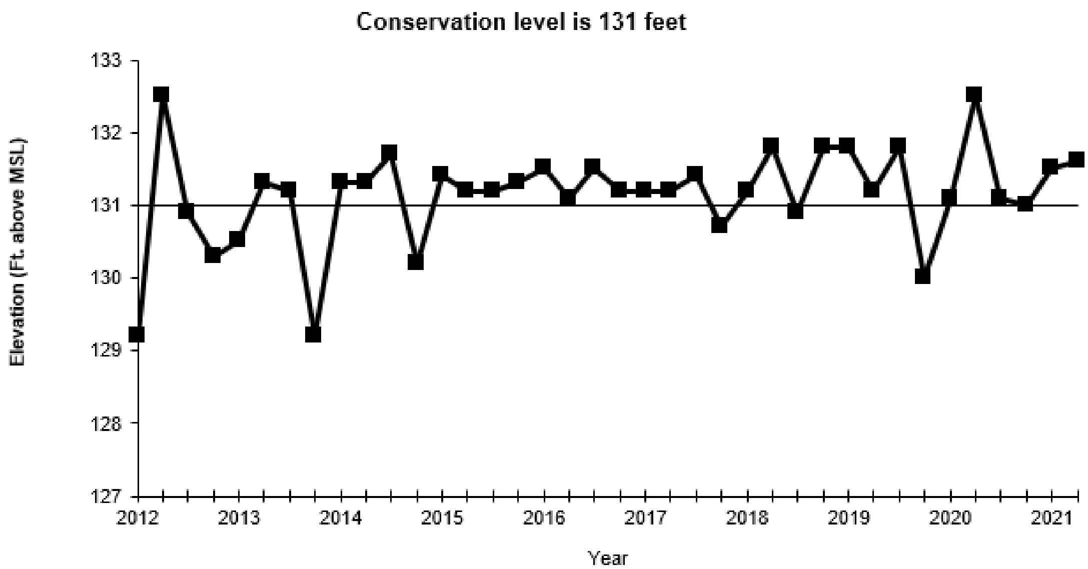


Figure 1. Quarterly water level elevations in feet above mean sea level (MSL) recorded for Lake Livingston, Texas

Table 1. Characteristics of Lake Livingston, Texas.

Characteristic	Description
Year constructed	1969
Controlling authority	Trinity River Authority
Counties	Polk, Trinity, San Jacinto, Walker
Reservoir type	Mainstem
Shoreline Development Index	10.7
Conductivity	200-450 µS/cm

Table 2. Boat ramp characteristics for Lake Livingston, Texas, January 2021. Reservoir elevation at time of survey was 131 feet above mean sea level.

Boat ramp	Latitude Longitude (dd)	Public	Parking capacity (N)	Elevation at end of boat ramp (ft)	Condition
3278 Marina	30.61514; -95.04683	Y	10	124	Adequate
Wolf Creek	30.66198; -95.14763	Y	20	125	Excellent
Point Blank	30.74622; -95.20692	Y	10	127	Adequate
Patrick’s Ferry	30.79775; -95.15983	Y	15	128	Adequate
Waterwood	30.82968; -95.24328	Y	45	126	Excellent
Cove Marina	30.85554; -95.34311	Y	5	128	Adequate
Bethy Creek Resort	30.84801; -95.38249	Y	5	126	Adequate
Highway 19	30.85829; -95.39874	Y	20	123	Adequate
White Rock City	30.95933; -95.33519	Y	10	123	Adequate
Cauthan	30.96803; -95.33293	Y	12	126	Adequate
Outback Marina	30.90502; -95.30331	Y	15	125	Adequate
Gallaway’s	30.91249; -95.27454	Y	5	125	Adequate
Gilmore’s Marina	30.91220; -95.26294	Y	20	127	Severe erosion in front of boat ramp
Harbor’s Point	30.92358; -95.25762	N			
Nick’s Pit Stop	30.83309; -95.15414	Y	8	127	Access road and parking area rough and eroded
Lakeside Resort	30.81121; -95.12912	Y	20	123	Excellent
Fair Four Seasons	30.79606; -95.10657	Y	15	126	Adequate
Hilton K	30.81145; -95.09682	Y	15	127	Adequate
Playcation Station	30.81300; -95.09441	Y	4	125	Adequate
Broken Arrow Marina	30.83992; -95.08195	Y	20	127	Adequate

Walker's Waterpoint	30.83271; -95.08348	Y	20	127	Access road and parking area rough and eroded
Kickapoo Marina	30.81272; -95.08143	Y	10	124	Adequate
Sandy Creek Marina	30.80994; -95.07560	Y	3	128	Adequate
Penwaugh Marina	30.74011; -95.05815	Y	10	124	Adequate
Blanchard	30.73642; -95.08828	Y	32	124	Excellent
Tigerville Park	30.71518; -95.05353	Y	12	123	Adequate
Beacon Bay Marina	30.68744; -95.03510	Y	15	122	Adequate
State Park #1	30.66050; -95.00699	Y	19	126	Adequate
State Park #2	30.65898; -95.00649	Y	36	125	Excellent
State Park #3	30.65219; -95.00570	Y	29	124	Excellent

Table 3. Harvest regulations for Lake Livingston, Texas.

Species	Bag limit	Length limit
Gar, Alligator	1[a, b]	48-inch maximum [c]
Catfish: Channel and Blue Catfish, their hybrids and subspecies	50 (in any combination)	12-inch minimum
Catfish, Flathead	5	18-inch minimum
Bass, White	25	10-inch minimum
Bass, Striped	5	18-inch minimum
Bass, Largemouth	5	14-inch minimum
Crappie: White and Black Crappie, their hybrids and subspecies	25 (in any combination)	10-inch minimum

[a] Mandatory harvest reporting required for all harvested Alligator Gar (reporting available through the My Texas Hunt Harvest app or at https://apps.tpwd.state.tx.us/huntharvest/home.faces).

[b] Between one half-hour after sunset and one half-hour before sunrise, no person may take or possess an Alligator Gar with archery equipment or crossbow unless they possess a harvest authorization.

[c] Anglers holding a harvest authorization can harvest one Alligator Gar exceeding 48 inches in length per year.

Table 4. Stocking history of Lake Livingston, Texas. FGL = fingerling; AFGL = advanced fingerling; ADL = adults; FRY = fry; UNK = unknown.

Species	Year	Number	Size
Blue Catfish	1969	159,800	UNK
	2012	21	ADL
	Total	159,821	
Channel Catfish	1969	634,905	AFGL
	1970	254,000	AFGL
	Total	888,905	
Florida Largemouth Bass	1975	26,000	FRY
	1976	22,000	FRY
	1977	250,330	FRY
	1978	301,350	FGL
	1978	451,936	FRY
	1996	814,762	FGL
	1996	84,252	FRY
	2000	501,639	FGL
	2001	500,018	FGL
	2006	201,694	FGL
	2007	200,586	FGL
	2017	108,695	FGL
	2020	51,970	FGL
	Total	3,515,232	
Largemouth Bass	1969	1,018,400	FRY
Paddlefish	1990	63,232	FRY
	1991	34,132	FRY
	1992	20,370	FRY
	Total	117,734	
ShareLunker Largemouth Bass	2010	2,069	FGL
Striped Bass	1977	884,726	UNK
	1978	117,091	UNK
	1979	224,000	UNK
	1980	283,584	UNK
	1982	341,357	UNK
	1983	189,265	UNK
	1984	1,424,455	FGL
	1985	896,996	FGL
	1986	108,780	FGL
	1986	339,705	FRY
	1987	97,416	FGL

1987	801,169	FRY
1988	59,800	FGL
1988	839,815	FRY
1989	766,205	FGL
1989	139,482	FRY
1992	351,750	FGL
1993	405,370	FGL
1994	1,114,221	FGL
1994	674,449	FRY
1995	900,833	FGL
1996	207,158	FGL
1996	233,921	FRY
1997	740,024	FGL
1997	245,407	FRY
1998	689,849	FGL
1999	913,952	FGL
2000	900,264	FGL
2002	1,392,893	FGL
2003	1,032,104	FGL
2004	437,508	FGL
2005	526,148	FGL
2006	746,278	FGL
2007	796,122	FGL
2008	206,090	FGL
2009	814,606	FGL
2010	767,253	FGL
2010	1,938,340	FRY
2011	50,687	FGL
2012	252,640	FGL
2013	1,029,903	FGL
2014	795,073	FGL
2015	1,067,557	FGL
2016	497,249	FGL
2017	873,861	FGL
2018	1,117,519	FGL
2019	170,361	AFGL
2019	621,253	FGL
2020	229,718	FGL
2020	3,146,243	FRY
2021	764,403	FGL
2021	957,319	FRY
Total	35,122,172	

Table 5. Objective-based sampling plan components for Lake Livingston, 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
	Age-and-growth	Age at 14 inches	N = 13, 13.0 – 14.9 inches
	Condition	W_r	10 fish/inch group (max)
Bluegill [a]	Abundance	CPUE – Total	
	Size structure	PSD, length frequency	
Threadfin Shad [a]	Abundance	CPUE – Total	
Gizzard Shad [a]	Abundance	CPUE – Total	
	Size structure	Length frequency	
	Prey availability	IOV	
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[a]	Abundance	CPUE– stock	
	Size structure	PSD, length frequency	
	Condition	W_r	
White Bass	Abundance	CPUE– stock	RSE-stock ≤ 25
	Size structure	PSD, length frequency	N ≥ 50 stock
	Condition	W_r	10 fish/inch group (max)
Creel survey			
All sport fish	Trend information on angler utilization	Angler effort, CPUE, total harvest and size composition	

[a] No additional effort will be expended to achieve an RSE ≤ 25 for CPUE of Bluegill, Threadfin Shad, Gizzard Shad, or Channel Catfish if not reached from designated Largemouth Bass or Blue Catfish sampling effort.

Table 6. Survey of structural habitat types, Lake Livingston, Texas, 2016.

Habitat type	Estimate	% of total
Bulkhead	32.2 miles	9.6
Bulkhead with boat docks	126.0 miles	37.7
Natural	163.5 miles	49.0
Natural with boat docks	3.4 miles	0.1
Rocky	7.6 miles	2.3
Rocky with boat docks	0.1 miles	<0.1
Rock bluff	1.3 miles	<0.1
Standing timber	5,778 acres	6.9

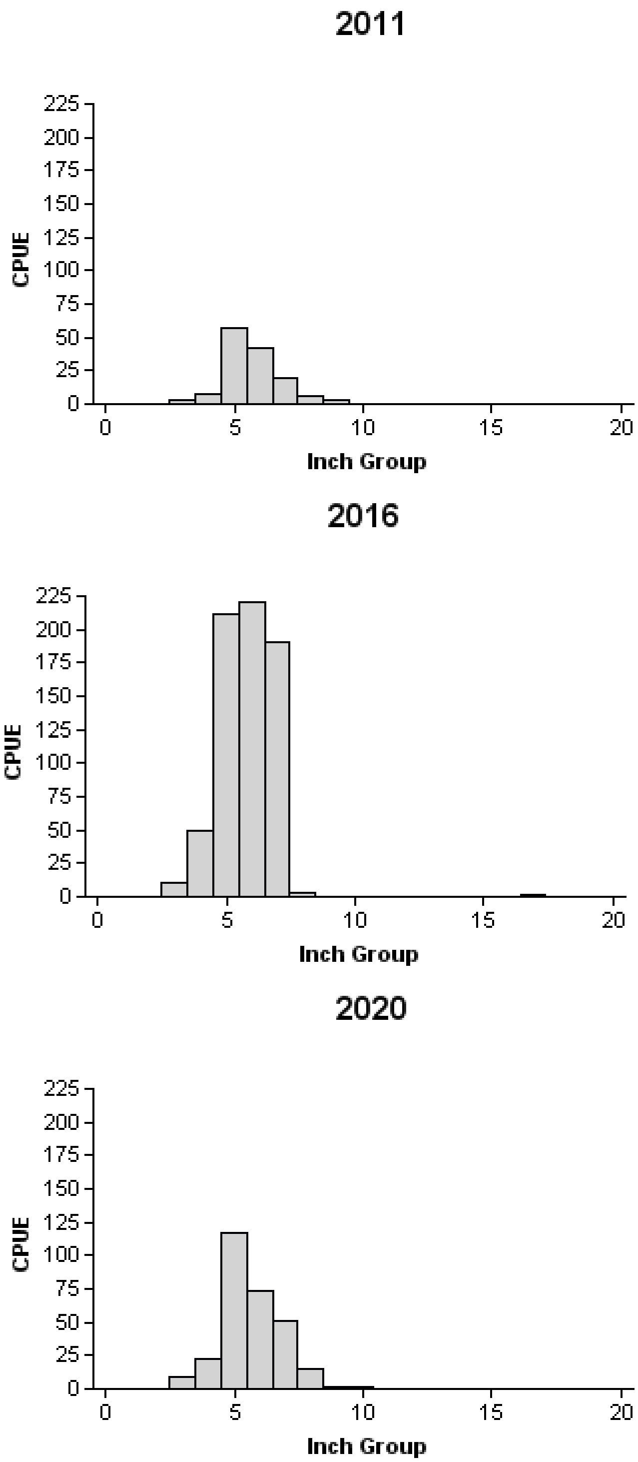
Table 7. Percent directed angler effort by species for Lake Livingston, Texas, 2011, 2016, and 2020. Survey periods were from 1 June through 31 August.

Species	2011	2016	2020
Catfishes	45.0	34.7	18.9
White Bass	12.0	39.2	58.3
Largemouth Bass	25.2	13.7	0.0
Crappies	0.0	2.4	3.1
Anything	17.8	10.0	19.7

Table 8. Total fishing effort (h) for all species and total directed expenditures at Lake Livingston, Texas, 2011, 2016, and 2020. Survey periods were from 1 June through 31 August. Relative standard error is in parentheses.

Creel statistic	2011	2016	2020
Total fishing effort	23,178 (32)	30,950 (40)	55,070 (62)
Total directed expenditures	$133,527 (100)	$313,913 (93)	$338,482 (64)

Gizzard Shad



2011
Effort = 2.0
Total CPUE = 137.5 (24; 275)
IOV = 93 (2)

2016
Effort = 2.2
Total CPUE = 688.6 (66; 1492)
IOV = 99 (1)

2020
Effort = 2.0
Total CPUE = 290.0 (22; 580)
IOV = 94 (2)

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, Lake Livingston, Texas, 2011, 2016, and 2020.

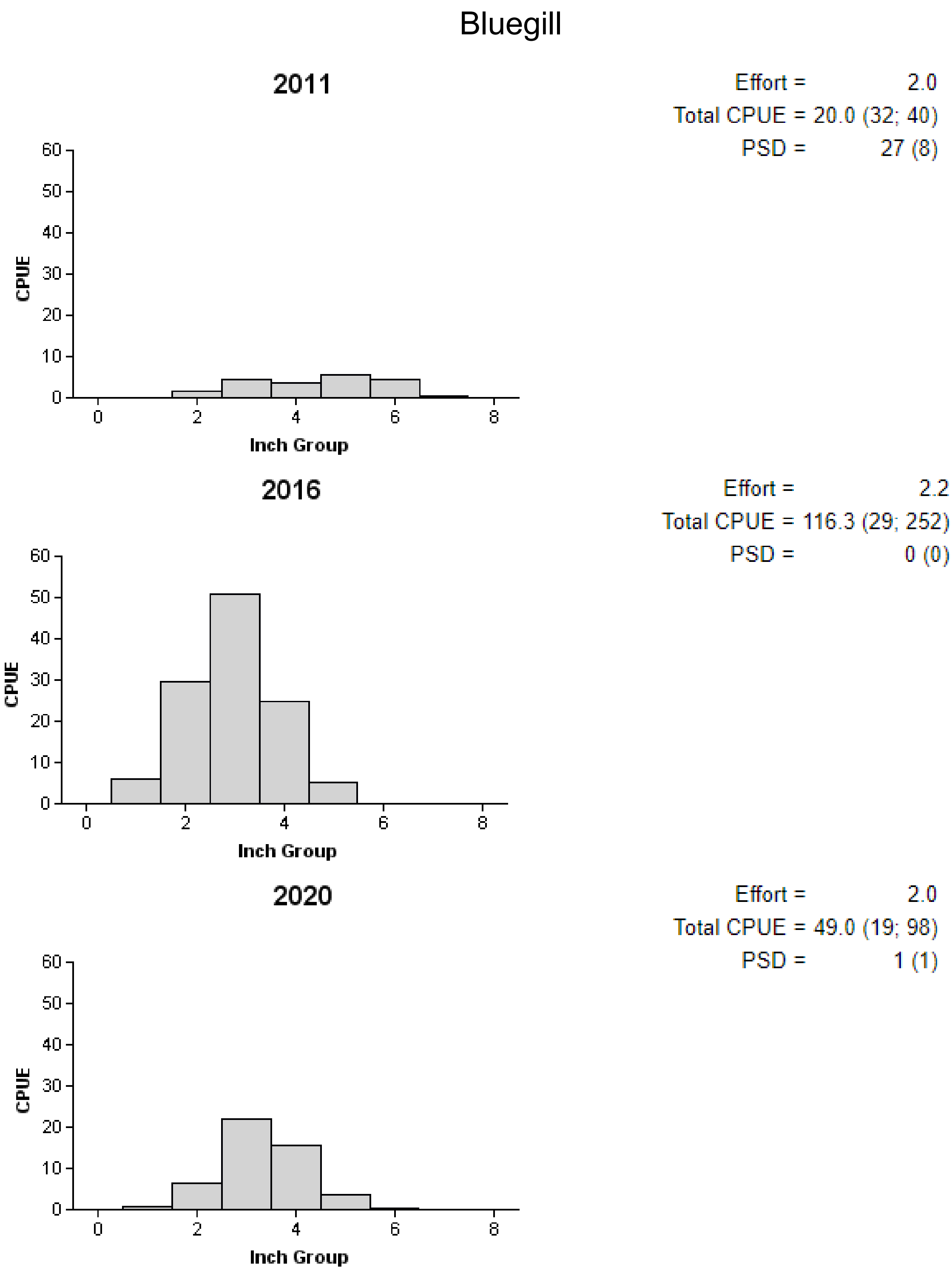
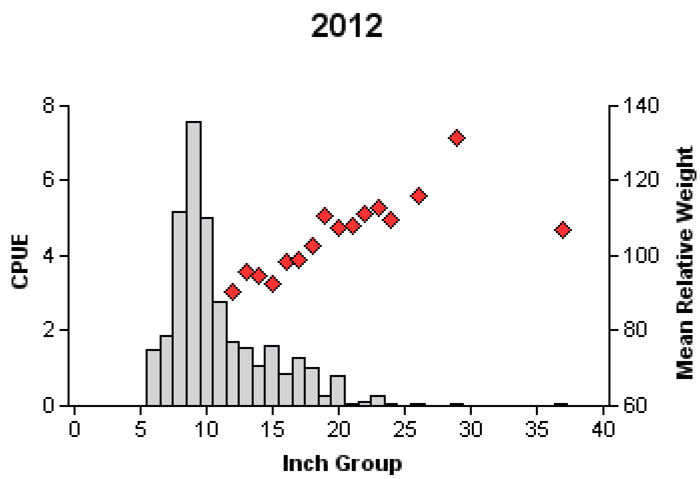
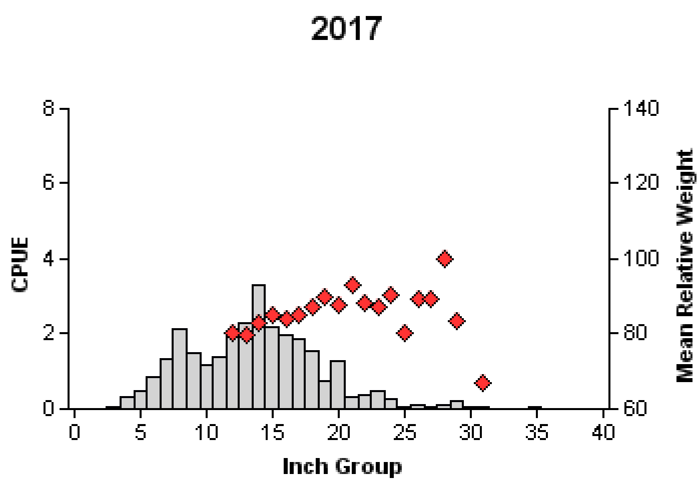


Figure 3. Number of Bluegill caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Livingston, Texas, 2011, 2016, and 2020.

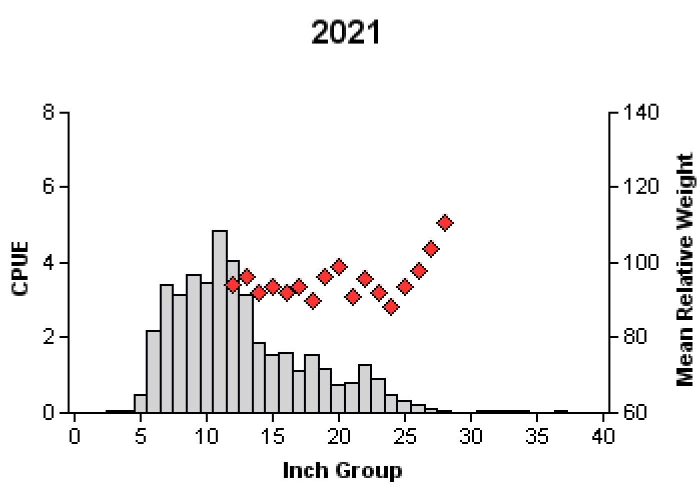
Blue Catfish



Effort = 15.0
Total CPUE = 34.8 (13; 522)
Stock CPUE = 10.9 (11; 163)
PSD = 14 (4)



Effort = 15.0
Total CPUE = 28.7 (16; 431)
Stock CPUE = 19.5 (15; 292)
PSD = 18 (3)



Effort = 15.0
Total CPUE = 42.7 (13; 640)
Stock CPUE = 21.3 (11; 320)
PSD = 25 (3)

Figure 4. 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, Lake Livingston, Texas, 2012, 2017, and 2021.

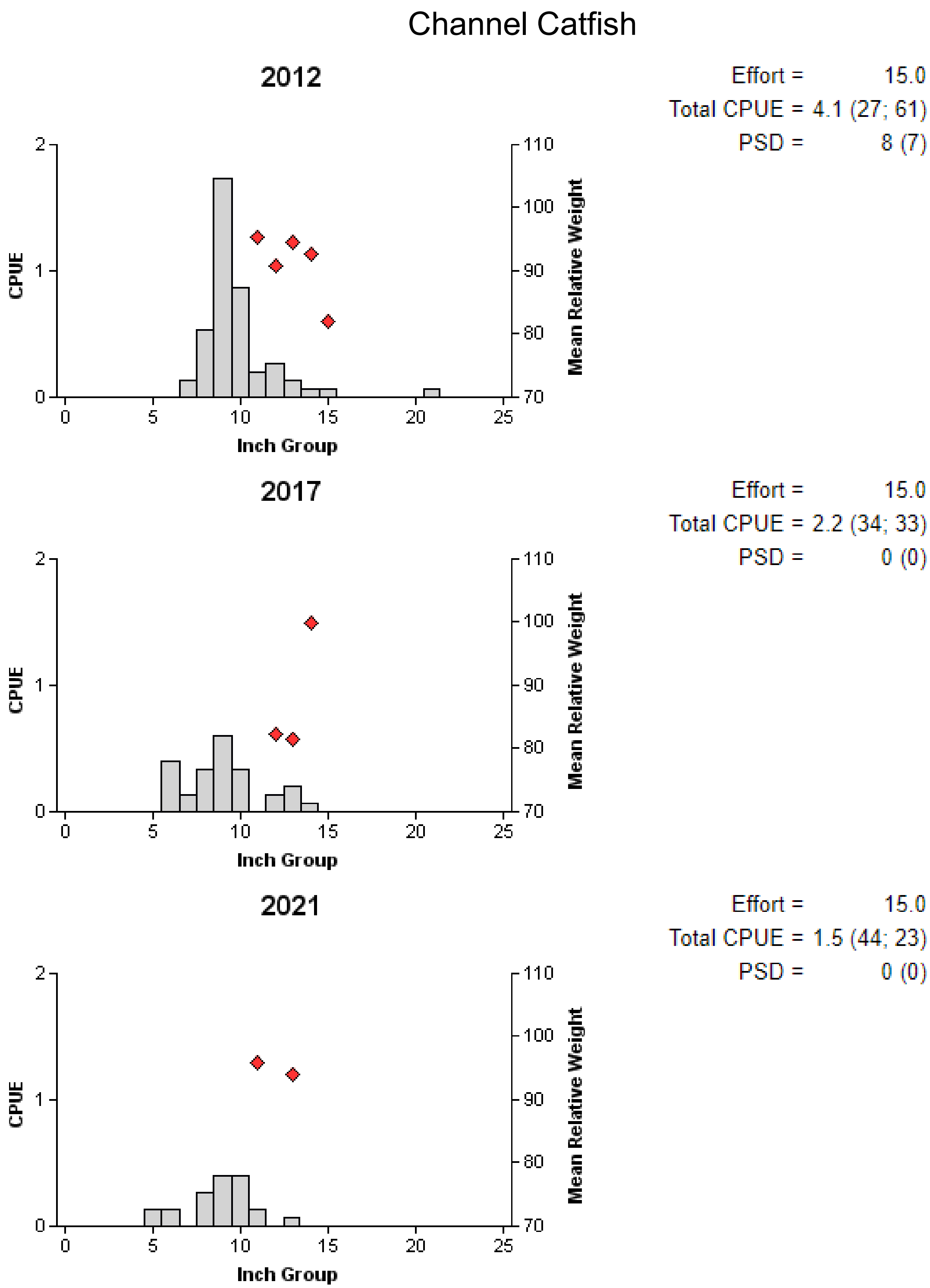


Figure 5. Number of Channel Catfish caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2012, 2017, and 2021.

Catfishes

Table 9. Creel survey statistics for catfishes at Lake Livingston, Texas, from June through August 2011, June through August 2016, and June through August 2020. Total catch per hour is for anglers targeting catfishes, and total harvest is the estimated number of catfishes harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2011	2016	2020
Surface area (acres)	73,887	83,277	83,277
Directed effort (h)	10,420.05 (32)	10,749.49 (37)	10,381.84 (67)
Directed effort/acre	0.14 (32)	0.13 (37)	0.12 (67)
Total catch per hour	1.51 (101)	0.84 (53)	0.59 (47)
Total harvest	1,118.00 (220)	3,465.00 (103)	2,260.00 (141)
Harvest/acre	0.02 (220)	0.04 (103)	0.03 (141)
Percent legal released	20.7	0.0	24.0

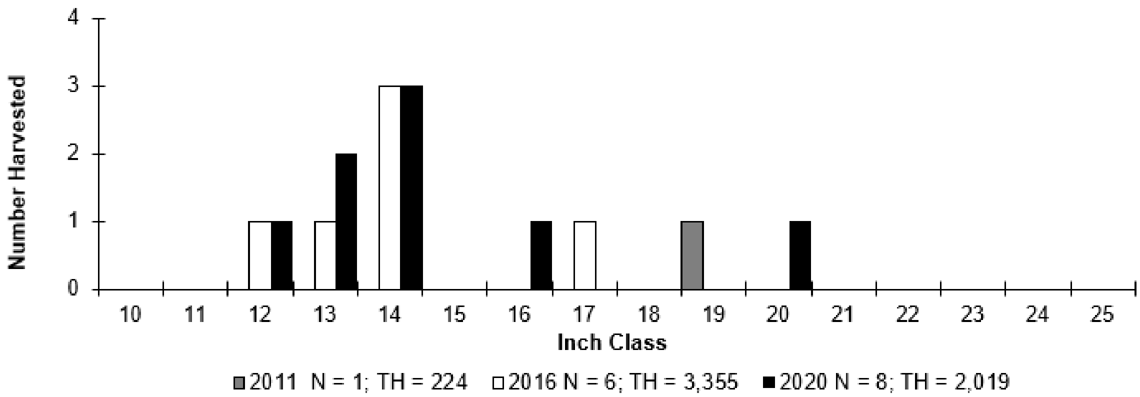


Figure 6. Length frequency of harvested Blue Catfish observed during creel surveys at Lake Livingston, Texas, June 2011 through August 2020, all anglers combined. N is the number of harvested Blue Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period

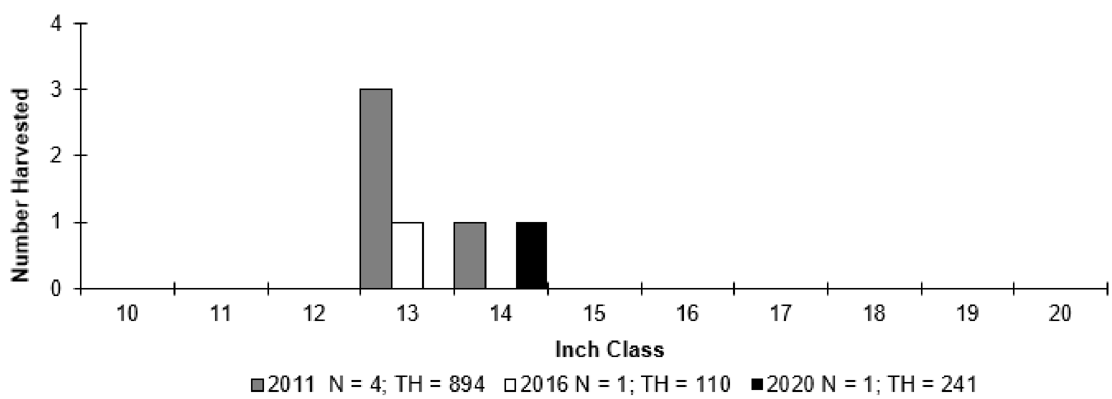


Figure 7. Length frequency of harvested Channel Catfish observed during creel surveys at Lake Livingston, Texas, June 2011 through August 2020, all anglers combined. N is the number of harvested Channel Catfish observed during creel surveys, and TH is the total estimated harvest for the creel period.

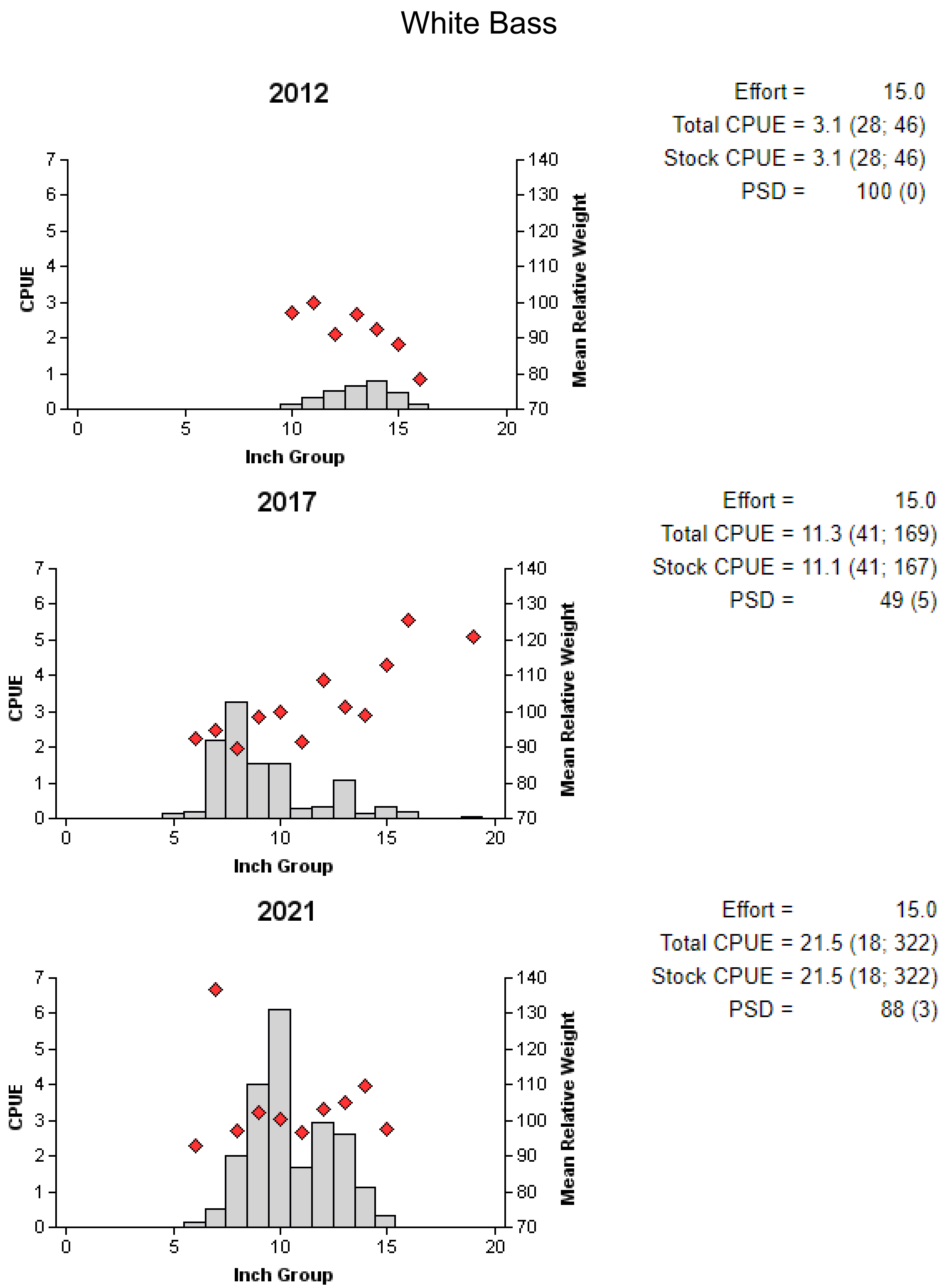


Figure 8. Number of White Bass caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2012, 2017, and 2021.

Table 10. Creel survey statistics for White Bass at Lake Livingston, Texas, from June through August 2011, June through August 2016, and June through August 2020. Total catch per hour is for anglers targeting White Bass and total harvest is the estimated number of White Bass harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2011	2016	2020
Surface area (acres)	73,887	83,277	83,277
Directed effort (h)	2,780.49 (64)	11,792.20 (50)	32,116.40 (63)
Directed effort/acre	0.04 (64)	0.14 (50)	0.39 (63)
Total catch per hour	2.77 (100)	2.41 (62)	4.34 (25)
Total harvest	9,389.00 (67)	25,162.00 (82)	35,916.00 (70)
Harvest/acre	0.13 (67)	0.30 (82)	0.43 (70)
Percent legal released	0.0	0.0	2.3

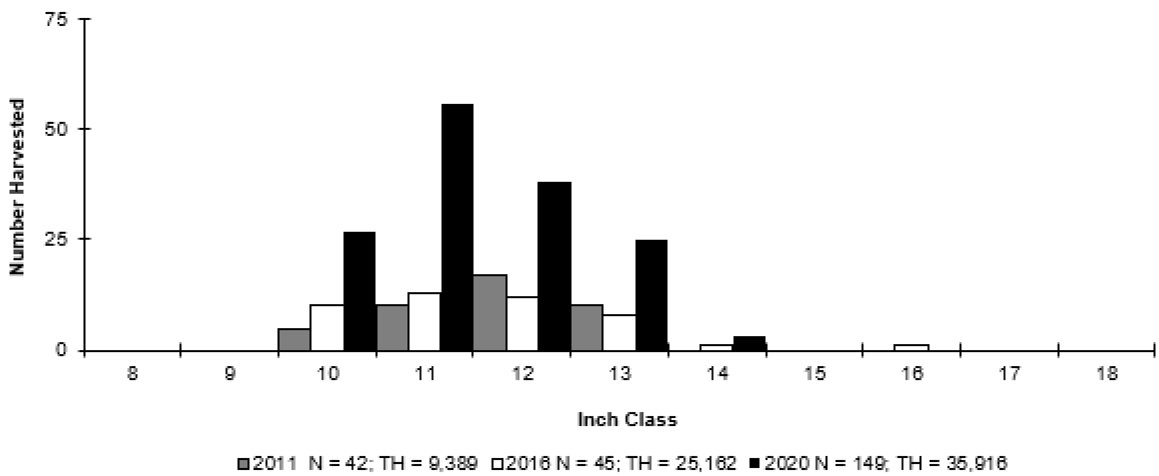


Figure 9. Length frequency of harvested White Bass observed during creel surveys at Lake Livingston, Texas, June 2011 through August 2020, all anglers combined. N is the number of harvested White Bass observed during creel surveys, and TH is the total estimated harvest for the creel period.

Striped Bass

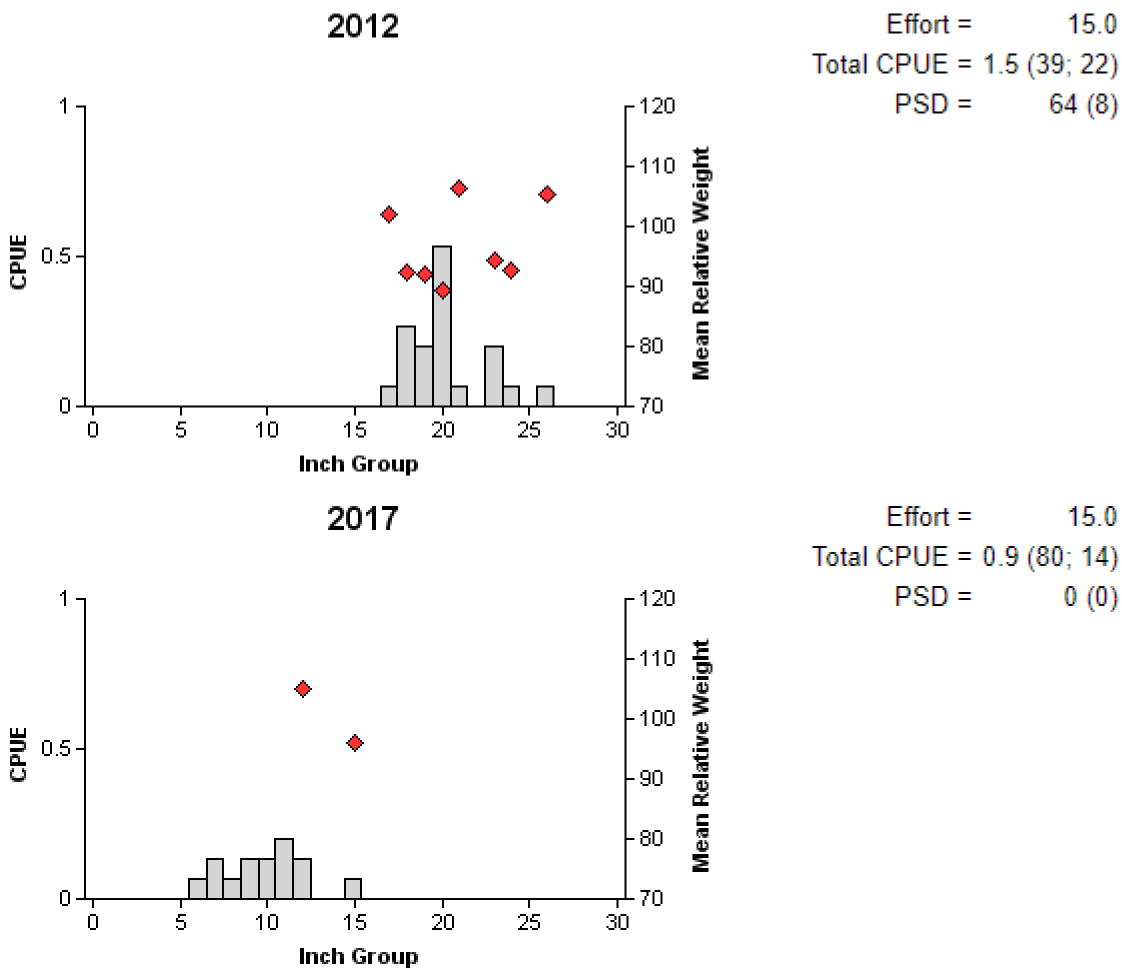


Figure 10. Number of Striped Bass caught per net night (CPUE), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2012 and 2017. No Striped Bass were collected in 2021.

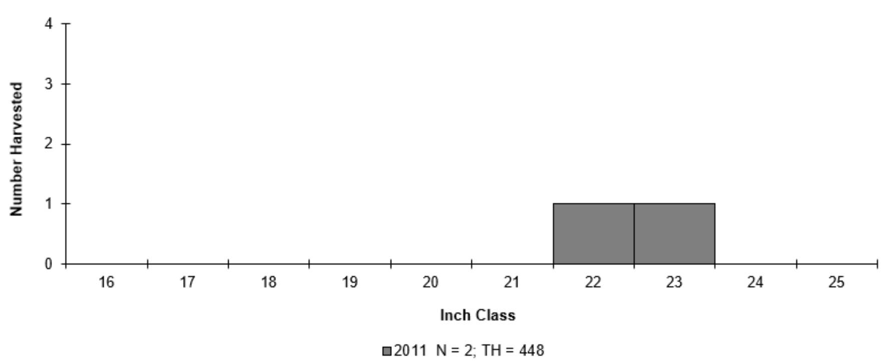
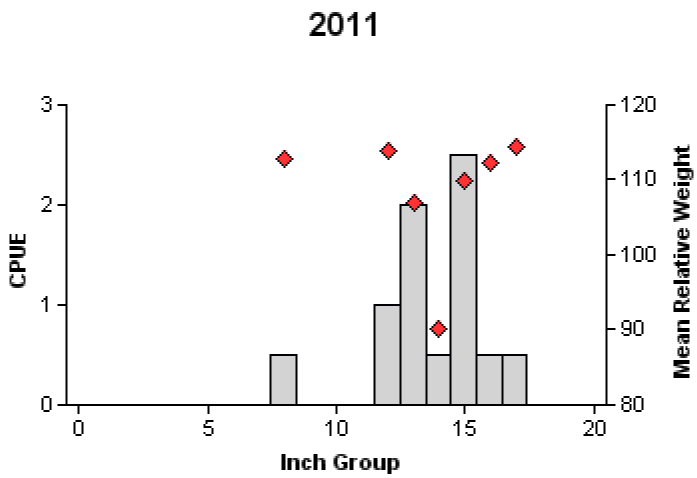


Figure 11. Length frequency of harvested Striped Bass observed during creel surveys at Lake Livingston, Texas, June through August 2011, all anglers combined. N is the number of harvested Striped Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. No Striped Bass were observed as harvested in 2016 or 2020.

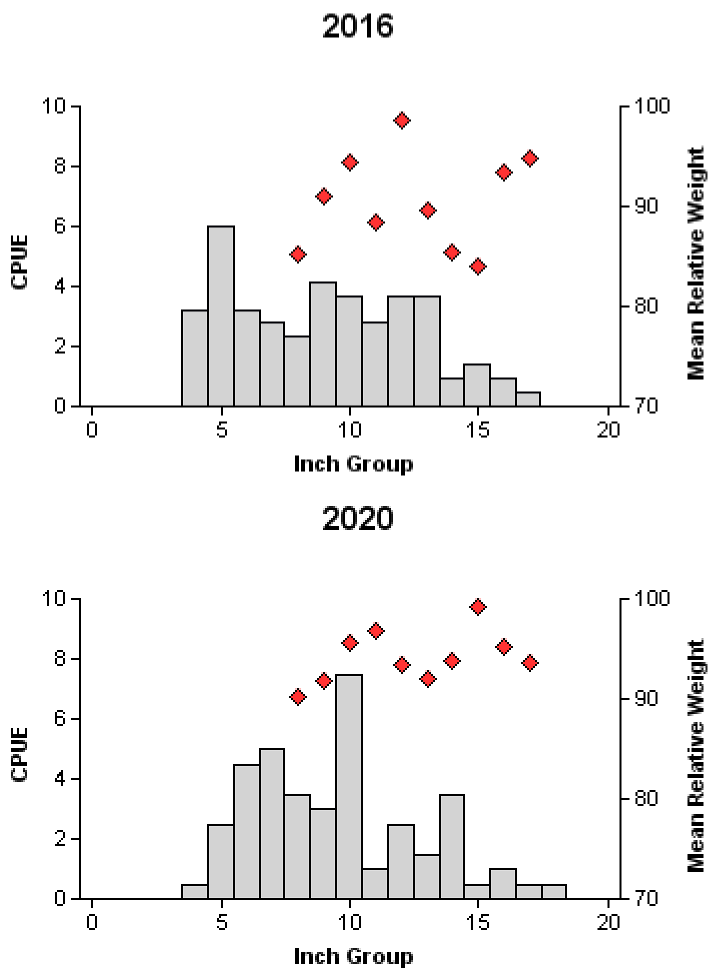
Largemouth Bass



Effort = 2.0
Total CPUE = 7.5 (30; 15)
Stock CPUE = 7.5 (30; 15)
PSD = 93 (6)

Figure 12. 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 the fall electrofishing survey, Lake Livingston, Texas, 2011.

Largemouth Bass



Effort = 2.2
Total CPUE = 39.2 (20; 85)
Stock CPUE = 24.0 (22; 52)
PSD = 46 (6)

Effort = 2.0
Total CPUE = 37.5 (20; 75)
Stock CPUE = 25.0 (27; 50)
PSD = 40 (6)

Figure 13. 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, Lake Livingston, Texas, 2016 and 2020. These surveys were conducted during the day, and survey sites were randomly selected within 10 creeks and embayments with more desirable habitat.

Table 11. Creel survey statistics for Largemouth Bass at Lake Livingston, Texas, from June through August 2011, June through August 2016, and June through August 2020. Catch rate is for all anglers targeting Largemouth Bass. Harvest is partitioned by the estimated number of fish harvested by non-tournament anglers and the number of fish retained by tournament anglers for weigh-in and release. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	2011	2016	2020
Surface area (acres)	73,887	83,277	83,277
Directed angling effort (h)			
Tournament	0.00	0.00	0.00
Non-tournament	5,841.36 (50)	4,226.08 (55)	0.00
All black bass anglers combined	5,841.36 (50)	4,226.08 (55)	0.00
Angling effort/acre	0.08 (50)	0.05 (55)	0.00
Catch rate (number/h)	1.13 (27)	0.48 (36)	
Total catch	5,989.00 (71)	4,040.00 (155)	0.00
< 4.0 lbs	5,989 – 100%	3,487 – 86%	0
≥ 4-6.9 lbs	0	553 – 14%	0
≥ 7-9.9 lbs	0	0	0
≥ 10 lbs	0	0	0
Harvest			
Non-tournament harvest	1,341.00 (105)	1,677.00 (171)	0.00
Harvest/acre	0.02 (93)	0.02 (171)	0.00
Tournament weigh-in and release	0.00	0.00	0.00
Percent legal released (non-tournament)	40.0	0.0	NA

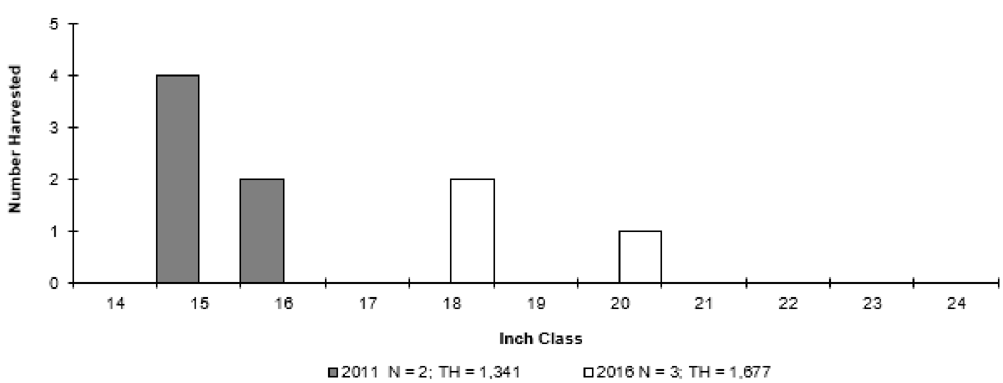


Figure 14. Length frequency of harvested Largemouth Bass observed during creel surveys at Lake Livingston, Texas, June 2011 through August 2016, all anglers combined. N is the number of harvested Largemouth Bass observed during creel surveys, and TH is the total estimated harvest for the creel period. No Largemouth Bass were observed as harvested in 2020.

Table 12. Results of genetic analysis of Largemouth Bass collected by fall electrofishing, Lake Livingston, Texas. FLMB = Florida Largemouth Bass, NLMB = Northern Largemouth Bass, F1 = first generation hybrid between a FLMB and a NLMB, Fx = second or higher generation hybrid between a FLMB and a NLMB. Genetic composition was determined with micro-satellite DNA analysis.

		Number of fish					
Year	Sample size	FLMB	F1	Fx	NLMB	% FLMB alleles	% pure FLMB
2011	29	0	0	23	6	26.0	0.0
2020	29	0	0	24	5	25.0	0.0

Crappies

Table 13. Creel survey statistics for crappies at Lake Livingston, Texas, from June through August 2011, June through August 2016, and June through August 2020. Total catch per hour is for anglers targeting White Crappie and total harvest is the estimated number of White Crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel survey statistic	Year		
	2011	2016	2020
Surface area (acres)	73,887	83,277	83,277
Directed effort (h)	0.00	735.17 (122)	1,708.73 (90)
Directed effort/acre	0.00	0.01 (122)	0.02 (90)
Total catch per hour		0.00	3.38 (19)
Total harvest	0.00	0.00	4,098.00 (113)
Harvest/acre	0.00	0.00	0.05 (113)
Percent legal released			0.0

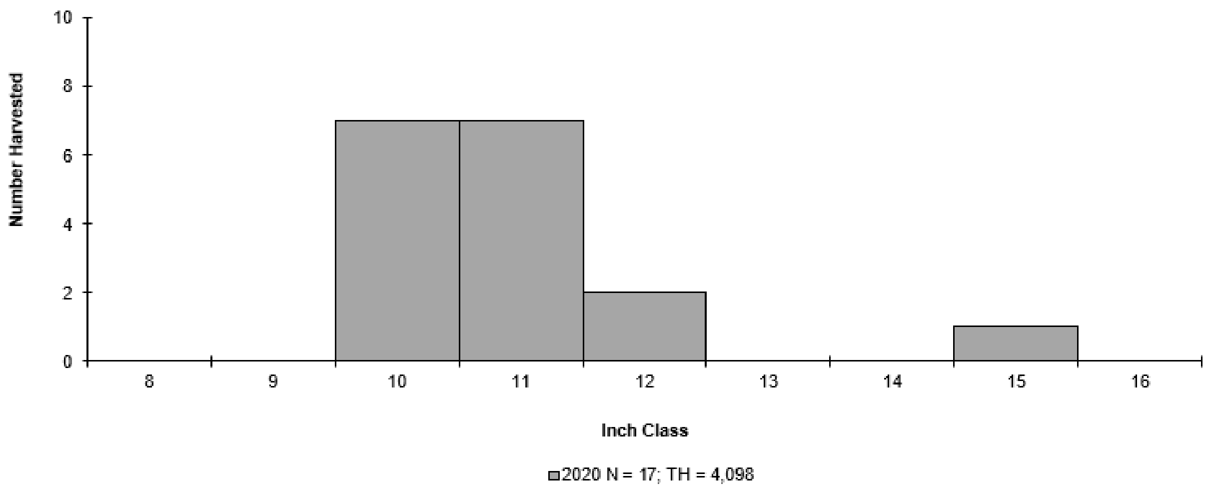


Figure 15. Length frequency of harvested crappies observed during creel surveys at Lake Livingston, Texas, June through August 2020, all anglers combined. N is the number of harvested crappies observed during creel surveys, and TH is the total estimated harvest for the creel period. No crappies were observed as harvested in 2011 or 2016.

Proposed Sampling Schedule

Table 14. Proposed sampling schedule for Lake Livingston, Texas. Survey period is June through May. Gill netting surveys are conducted in the spring, while electrofishing surveys are conducted in the fall.

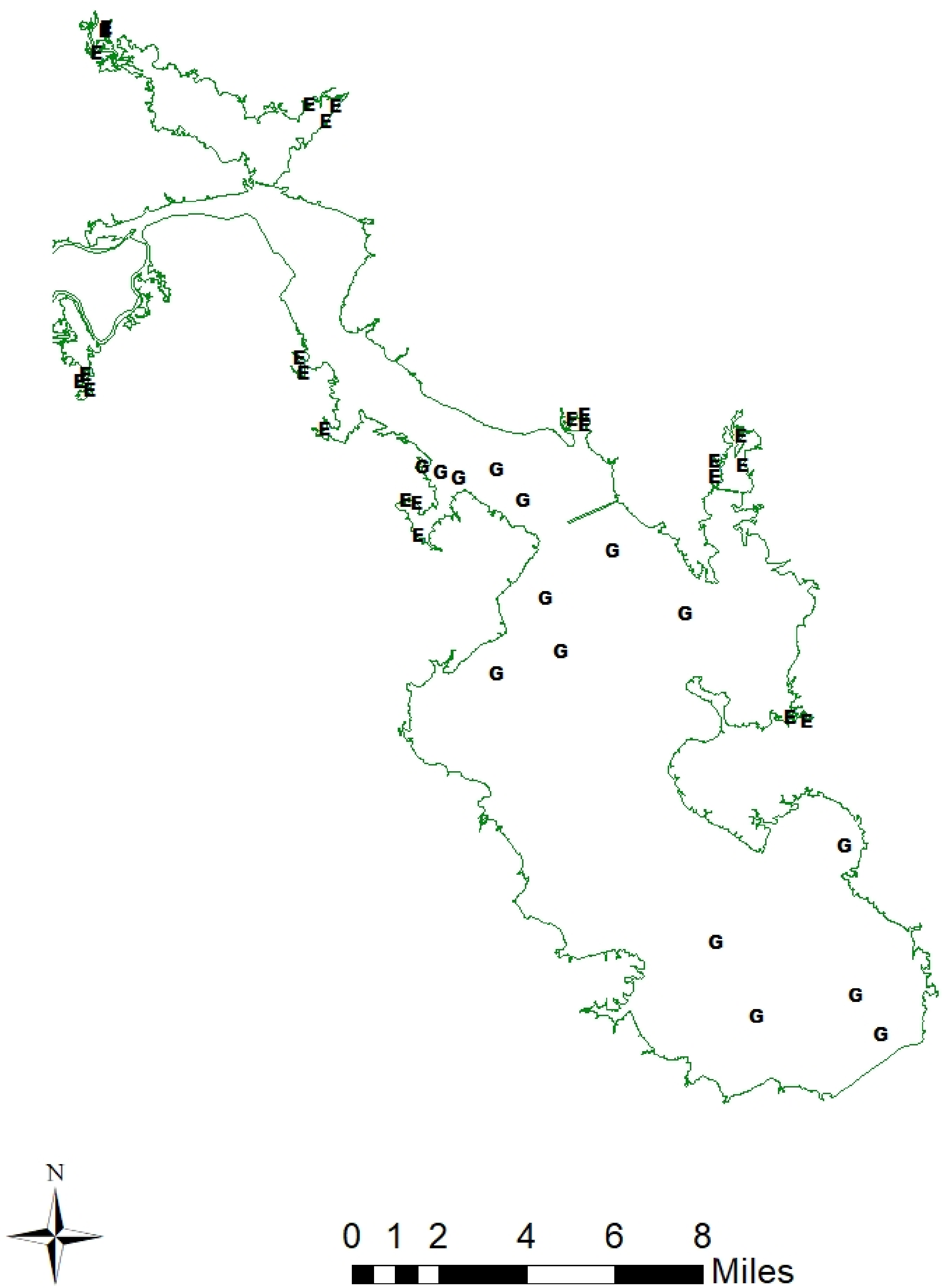
	Survey year			
	2021-2022	2022-2023	2023-2024	2024-2025
Angler Access				X
Structural Habitat				X
Vegetation	X	X	X	X
Electrofishing – Fall				X
Gill netting				X
Creel survey				X
Report				X

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

Number (N) and catch rate (CPUE) (RSE in parentheses) of all target species collected from all gear types from Lake Livingston, Texas, 2020-2021. Sampling effort was 15 net nights for gill netting and 2 hours for electrofishing.

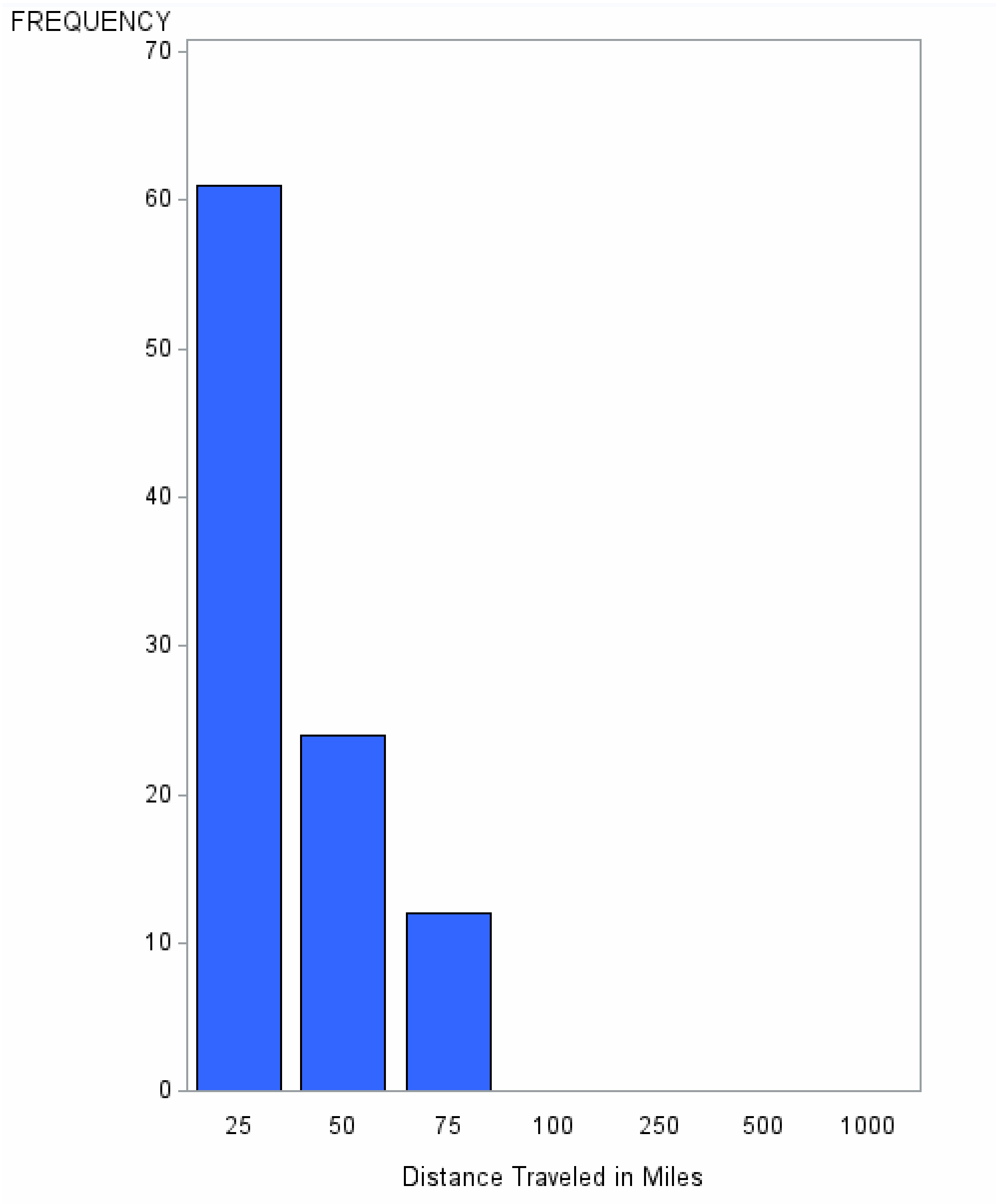
Species	Gill Netting		Electrofishing	
	N	CPUE	N	CPUE
Spotted Gar	1	0.1		
Gizzard Shad	3	0.2	580	290.0
Threadfin Shad			7,575	3,787.5
Common Carp	34	2.3		
Blue Catfish	640	42.7		
Channel Catfish	23	1.5		
White Bass	322	21.5		
Yellow Bass	75	5.0		
Bluegill			98	49.0
Longear Sunfish			26	13.0
Redear Sunfish			4	2.0
Largemouth Bass			75	37.5
White Crappie	4	0.3		

APPENDIX B – Map of sampling locations



Location of sampling sites, Lake Livingston, Texas, 2020-2021. Gill net and electrofishing stations are indicated by G and E, respectively. Water level was near full pool at time of sampling.

APPENDIX C – Reporting of creel ZIP code data



Frequency of anglers that traveled various distances (miles) to Lake Livingston, Texas, as determined from the June through August 2020 creel survey.

APPENDIX D – Fish consumption advisory issued by TDSHS

Fish consumption advisory issued by the Texas Department of State Health Services for Lake Livingston and the Trinity River (U.S. Highway 287 downstream to U.S. Highway 90) due to elevated levels of dioxins and polychlorinated biphenyls, December 2015. Recommended serving size is eight ounces.

Species	Women of childbearing age & children under 12	Women past childbearing age and persons 12 and older
Blue Catfish	DO NOT EAT	1 serving/month
Flathead Catfish	DO NOT EAT	1 serving/month
Freshwater Drum	DO NOT EAT	2 servings/month
Gar (all species)	DO NOT EAT	DO NOT EAT
Smallmouth Buffalo	DO NOT EAT	1 serving/month
Striped Bass	1 serving/month	3 servings/month
White Bass	1 serving/month	3 servings/month