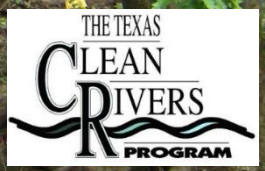
2018 Cypress Creek Basin Highlights Report

A Summary of Water Quality in the Cypress Creek Basin in 2017



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Lake O' the Pines National Water Quality Initiative Phase I Update

- Laura-Ashley Overdyke — Executive Director, Caddo Lake Institute

  2018 Updates on the Paddlefish Project: Caddo Lake Institute

- Tim Bister — Texas Parks and Wildlife Department

  Invasive Species Control Activities in 2017

- Adam Whisenant and Greg Conley — Texas Parks and Wildlife Department

  Dewatering Below Lake O' the Pines Ferrell's Bridge Dam

PREPARED IN COOPERATION WITH THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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List of Acronyms and Abbreviations

AEP SWEPCO	American Electric Power - Southwestern Electric Power Company
cfs	Cubic feet per second (measurement of stream flow)
CBA	Caddo Biocontrol Alliance
CLI	Caddo Lake Institute
CRP	Clean Rivers Program
FM	Farm-to-Market Road
FY	Fiscal Year
HQI	Habitat Quality Index
IBI	Index of biotic
IR	Integrated Report
I-Plan	Implementation Plan
MPN/100 mL	Most Probable Number per 100 milliliters (bacteria measurement units)
NWQI	National Water Quality Initiative
NCPC	National Center for Pharmaceutical Crops
NETMWD	Northeast Texas Municipal Water District
PCB	Polychlorinated biphenyls
QAPP	Quality Assurance Project Plan
RBA	Rapid Bioassessment
RUAA	Recreational Use Attainability Analysis
SH	State Highway
TCEQ	Texas Commission on Environmental Quality
TCFWSD	Titus County Fresh Water Supply District
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TPLA	Total Phosphorus Load Agreement
TPWD	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
TWRI	Texas Water Resources Institute
UAA	Use Attainability Analysis
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WWTP	Wastewater Treatment Plant
§303(d) List	Impaired water bodies in Section §303(d) of the Federal Clean Water Act

Introduction

The Texas Clean Rivers Program (CRP) is a statewide water quality monitoring and assessment program that provides funding and resources for regional watershed protection efforts. The program is administered by the Texas Commission on Environmental Quality (TCEQ) in partnership with river authorities and other regional governments with the goal of maintaining and improving water quality in each river basin in the state.

As the coordinating agency in the Cypress Creek basin, the Northeast Texas Municipal Water District (NETMWD) works with federal and state agencies, municipalities, water suppliers, and private companies to accomplish water quality monitoring and watershed protection objectives set forth by CRP.

Water quality monitoring is the heart of the program. NETMWD, TCEQ, and the Caddo Lake Institute (CLI) routinely collect water quality data from 53 sites in the Cypress Creek basin. TCEQ assesses the data to determine if Texas Surface Water Quality Standards (TSWQS) are being met. During the most recent assessment in 2014, TCEQ evaluated 31 water bodies in the Cypress Creek basin. The results reported in the Texas Integrated Report (IR) indicate that 15 of the water bodies did not meet surface water quality standards. Low levels of dissolved oxygen and pH and elevated levels of bacteria and heavy metals were the primary causes of the impairments. These impairments are discussed within each Segment section of this report.

CRP Objectives:

- Provide Quality-Assured Data to the Commission for Use in Water Quality Decision-Making
- Identify and evaluate water quality concerns
- Promote cooperative watershed planning
- Inform and engage stakeholders
- Maintain efficient use of public funds
- Adapt program to emerging water quality issues

The Cypress Creek watershed encompasses approximately 6,000 square miles. Its major tributaries – Big Cypress Creek, Little Cypress Creek, James' Bayou, Harrison Bayou, and Black Cypress Bayou – drain into Caddo Lake on the Texas/Louisiana border. The watershed has a diverse ecology. The flow of Big Cypress Creek, above Lake O' the Pines, is intermittent in its headwaters. The stream runs through flat to rolling terrain surfaced by sandy and clay loams that support water-tolerant hardwoods, conifers, and grasses. Below Lake O' the Pines, Big Cypress Creek flows into Caddo Lake through bottomland thick with hardwood and cypress trees.

The watershed originates in southern portions of Hopkins and Franklin Counties. Headwaters flow south eastwardly into Camp, Titus, Morris, Cass, Marion, and Harrison Counties. Reservoirs in the basin include: Monticello Reservoir, Lake Cypress Springs, Lake Bob Sandlin, Ellison Creek Reservoir, Lake O' the Pines, and Caddo Lake.

THE CYPRESS CREEK BASIN WATERSHEDS

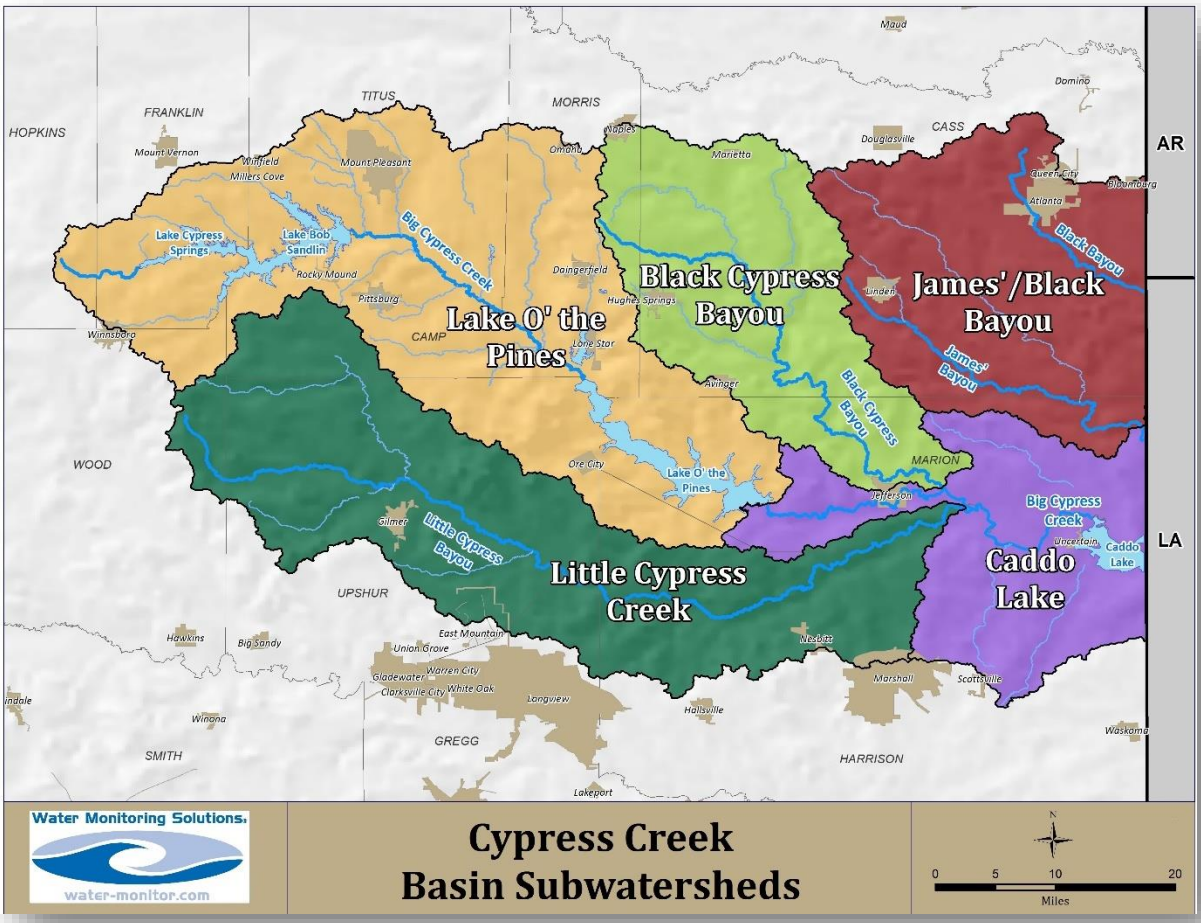

Figure 1: *Map of the Cypress Creek Basin*

Water Quality Monitoring

Water quality monitoring typically includes physical and chemical measurements such as levels of dissolved oxygen, suspended sediments, nutrients, temperature, or heavy metals. It can also include the collection of fish, aquatic insects, and habitat data to measure aquatic life and assess the health of streams and reservoirs. Clean Rivers Program partners collect monitoring data following a TCEQ-approved Quality Assurance Project Plan (QAPP) to ensure that the data collected are consistent with regulatory requirements. NETMWD, TCEQ (Region 5: Tyler), and the CLI collected water quality data from 53 sites in the Cypress Creek basin during Fiscal Year (FY) 2017. Figure 2 shows sites being monitored by NETMWD and CLI during FY 2018.

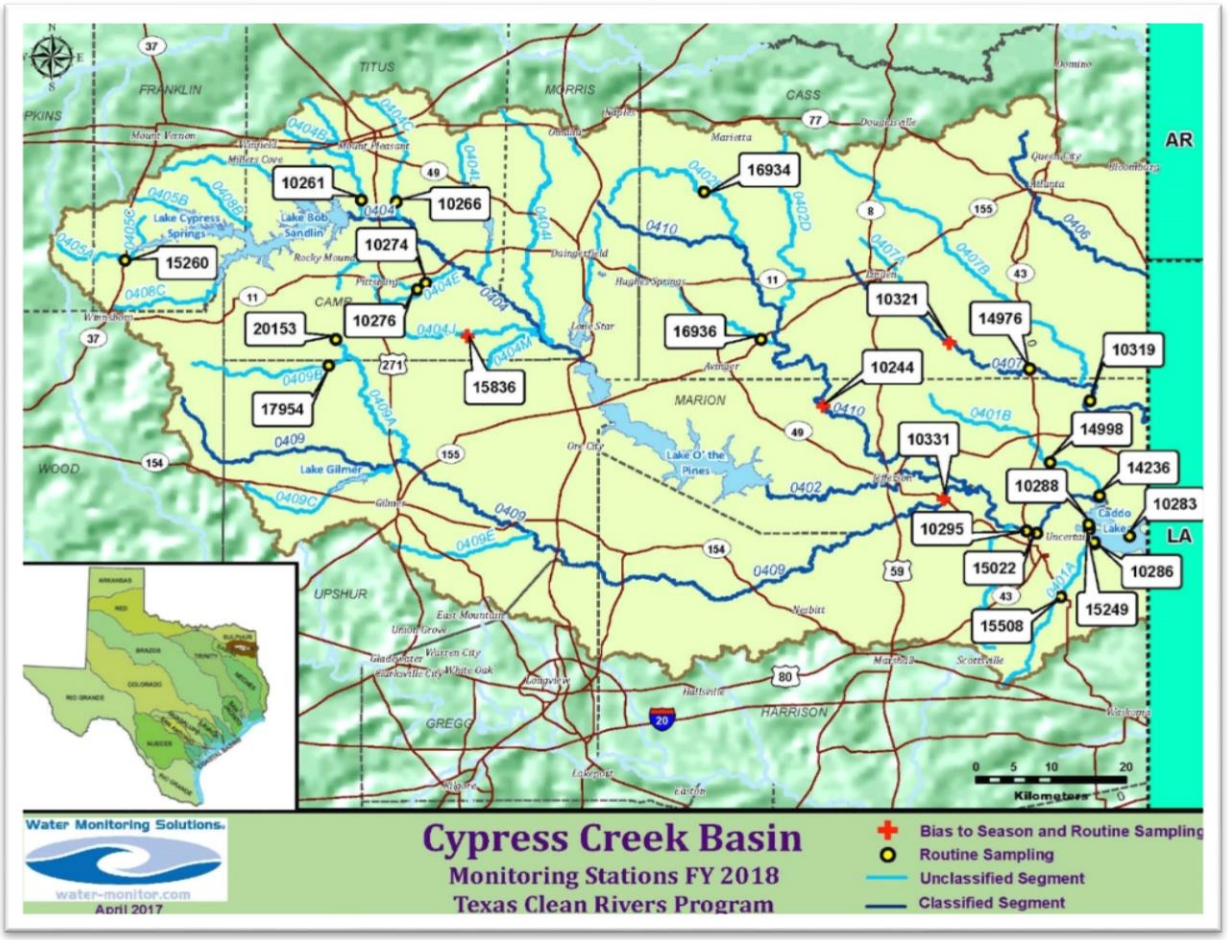

***Figure 2: FY** 2018 CRP Monitoring Stations*

Water Quality Assessment

Data collected through CRP has many uses, including the development of the surface water quality standards, if water bodies meet those standards, and development of wastewater permit limits. This report references the *2014 Texas Integrated Report (IR)* which compares all available quality assured data to the TSWQS — or to screening levels when no standards have been established. TCEQ Commissioners approved the Draft 2014 report on June 3, 2015, and the Environmental Protection Agency approved it on November 19, 2015. The Integrated Report defines the status of each water body as one of the following:

> *1. Meets or Supports — Sufficient data are available to assess. The water body meets all applicable surface water quality standards and fully supports its uses.*
>
> *2. Concern — a) Sufficient data are not available to perform a full assessment and the limited data indicate surface water quality standards are not being met, or b) Surface water quality standards have not yet been established. If water quality data indicate a concern, resources are allocated to collect more data and verify the concern.*
>
> *3. Impaired — Sufficient data are available and show that the water body does not meet surface water quality standards. If monitoring data indicate a water body does not support one or more of its designated uses, then it is said to be impaired. Details of the impairment are published in the Texas Integrated Report and §303(d) List.*

Appendix A of this report contains a detailed explanation of Texas Surface Water Quality Standards and the TCEQ assessment process.

Figure 3: *Sunrise over the Caddo Lake – Mid-lake station 10283*

Impairments in the Cypress Creek River Basin included in the *2014 Texas Integrated Report*:

Segment ID	Water Body	Parameter	Designated Use	Year Listed
0401	Caddo Lake	Depressed dissolved oxygen	Aquatic life	2000
		Mercury in edible tissue	Fish Consumption	1996
		pH	General use	1996
0401A	Harrison Bayou	Depressed dissolved oxygen	Aquatic life	2000
0402	Big Cypress Creek below Lake O' the Pines	Depressed dissolved oxygen	Aquatic life	2010
		Mercury in edible tissue	Fish Consumption	1998
		pH	General use	2000
0404	Big Cypress Creek below Lake Bob Sandlin	Bacteria	Contact Recreation	2002
		Sulfate	General use	2014
0404A	Ellison Creek Reservoir	PCB in edible tissue	Fish Consumption	2006
		Toxicity in sediment	Aquatic life	2006
0404B	Tankersly Creek	Bacteria	Contact Recreation	2000
0404C	Hart Creek	Bacteria	Contact Recreation	2006
0404N	Lake Dangerfield	Mercury in edible tissue	Fish Consumption	2002
0405	Lake Cypress Springs	pH	General use	2012
0405A	Big Cypress Creek	Depressed dissolved oxygen	Aquatic life	2014
0406	Black Bayou	Bacteria	Contact Recreation	2006
		Depressed dissolved oxygen	Aquatic life	2002
0407	James' Bayou	Depressed dissolved oxygen	Aquatic life	2000
		Fish Community	Aquatic life	2014
		Macrobenthic Community	Aquatic life	2014
		pH	General use	2008
0409	Little Cypress Bayou	Bacteria	Contact Recreation	2006
		Depressed dissolved oxygen	Aquatic life	2000
0409B	South Lilly Creek	Bacteria	Contact Recreation	2006
0410	Black Cypress Bayou	Copper in Water	Aquatic life	2010
		Depressed dissolved oxygen	Aquatic life	2000

Figure 4: *Table of Cypress Creek Basin Impairments*

Restoring Impaired Waterbodies

The TCEQ watershed action planning process helps identify and prioritize watershed restoration projects for impaired water bodies. As part of the watershed action planning process, stakeholders and monitoring agencies provide input about local water quality problems. Information about potential sources of pollution, geographic factors in the watershed, and community interest is stored in the state watershed action planning strategy table and used to implement the following water quality protection strategies:

Total Maximum Daily Loads

The first step toward restoration is to determine the source(s) of pollution. One way to determine the source is to develop a scientific model called a total maximum daily load (TMDL). A TMDL involves a historical water quality data review, targeted monitoring, detailed water quality analysis, and determination of the amount or "load" of a pollutant that a water body can receive and still support its designated uses. Once the load is calculated among all potential sources of pollution, an implementation plan, or I-Plan is developed to outline strategies that reduce pollutant loads. The I-Plan is a regulatory document that holds permittees accountable for meeting discharge limits.

Watershed Protection Plans

A Watershed Protection Plan(WPP) is another way to restore impaired water bodies. Unlike the TMDL, a Watershed Protection Plan is non-regulatory. Stakeholders develop the plans to address causes of the identified impairments. Like a TMDL, a Watershed Protection Plan uses monitoring data and local input to outline strategies that reduce pollutant loads.

Use Attainability Analyses

Another option for addressing impaired water bodies is a use attainability analysis (UAA). While a TMDL and Watershed Protection Plan are designed to improve water quality by limiting pollutants, a UAA is designed to evaluate TSWQS and, if appropriate, establish standards that meet the actual use(s) of the waterbody. Similarly, a recreational use attainability analysis (RUAA) is a study that confirms the level of recreation that takes place in a waterway.

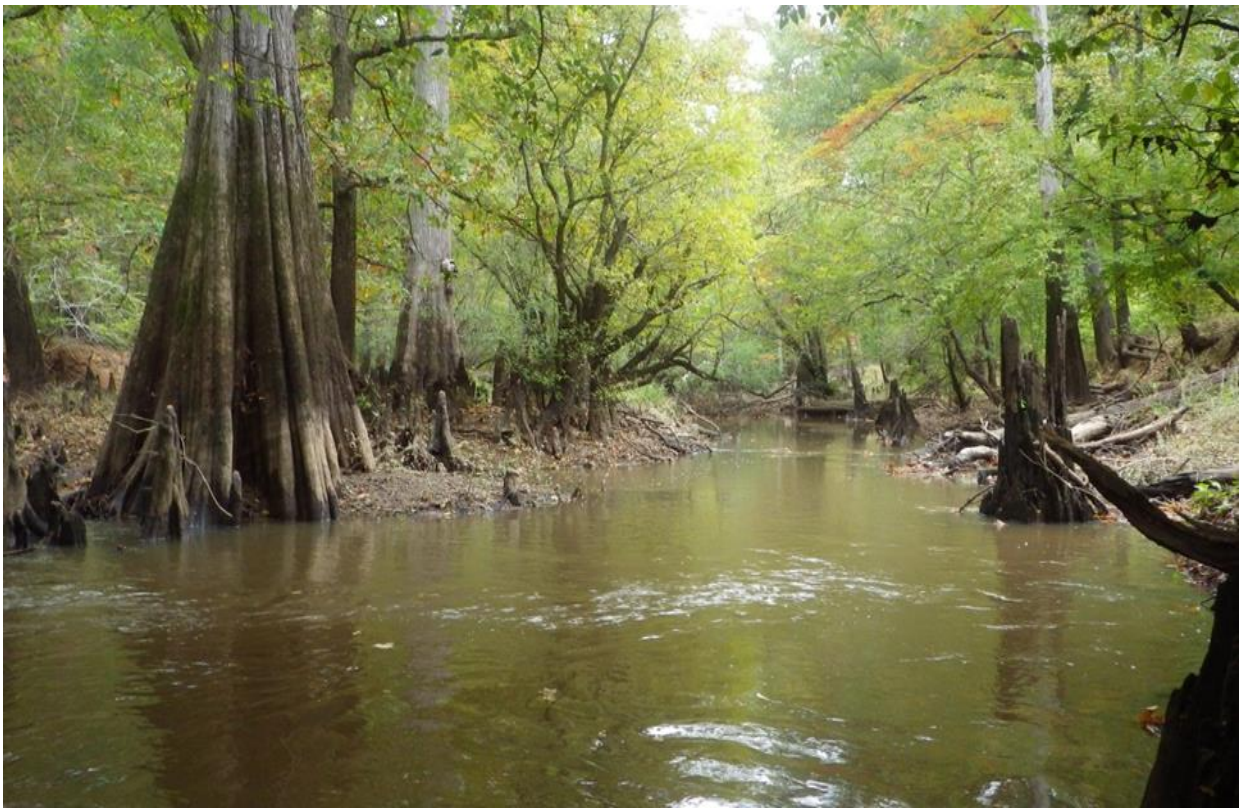

Figure 5: *Big Cypress Bayou below Lake O' the Pines (Photo courtesy of Sarah Robertson, TPWD, River Studies Program)*

2018 Updates on the Paddlefish Project: Caddo Lake Institute

by Laura-Ashley Overdyke, Executive Director

2017 was a positive year for the ongoing experiment in releasing the threatened Paddlefish into the Caddo Lake System. **Paddlefish (*Polyodon spathula*), which used to be found in many Texas rivers and certainly in Caddo Lake, are now a threatened species in the state of Texas. These fish predate the dinosaurs by 50 million years, and are our continent's oldest surviving animal species.**

As part of an effort to evaluate the environmental benefits of increased environmental flows from Lake O' The Pines into Big Cypress Bayou and Caddo Lake, the Caddo Lake Institute (CLI) and partners, U. S. Fish and Wildlife Service (USFWS), Texas Parks and Wildlife Department (TPWD), and the Collins Academy, began reintroduction efforts in 2014. Small scale releases of radio transmitter tagged fish were repeated in 2016. Thanks to our partners at USFWS and U.S. Geological Survey's (USGS) National Wetlands Research Center in Lafayette, Louisiana, paddlefish tracking is available to the public at https://caddolakeinstitute.org/tracking/.

Updates indicate that all tagged fish previously released are doing well and growing, and are still in the Caddo Lake system.

In 2017, during work at Lake O' The Pines Dam, experts found tagged adolescent paddlefish in Big Cypress/Caddo Lake who are thriving.

While the fish previously released have stayed in the system and all seem to be alive and growing well, the true test comes when Paddlefish reach sexual maturity (around age 6 - 9.) New technology is allowing us to prepare for future milestones with improved tracking of paddlefish. USFWS lead efforts to purchase acoustic, as opposed to radio, transmitters, with the U.S. Army Corps of Engineers (USACE), matched by CLI, providing funding. This new technology is less expensive, allowing more tracking stations to be established, and these tags last much longer (up to 10 years.)

Also this year, an additional rearing and education station was established at the Shreveport Aquarium with plans for the first release into the Louisiana side of Caddo Lake in spring 2018.

Additionally, it is proposed to stock larval paddlefish, supplied by Tishimingo National Fish Hatchery, into a newly created oxbow lake on a cooperative landowner's property downstream of the documented gravel/spawning shoals. We will monitor them throughout the year, tracking their ability to survive and grow in the oxbow. We will also attempt to track their movement out of the oxbow and into the Big Cypress Bayou after a flood event reconnects the oxbow to the river by comparing catch per unit of effort data collected in the oxbow before and after the events. This part of the project will begin to evaluate the ability of larval paddlefish to survive in this newly created nursery area and add valuable data on a different part of the paddlefish lifecycle that has not been looked at to date. The viability of oxbow connections in times of inundation is part of the flows work as it progresses into benefits for this threatened species.

The science is coming together to support a larger scale restocking program, with USFWS, TPWD, and Louisiana Department of Wildlife and Fisheries coordinating, along with the support of basin stakeholders.

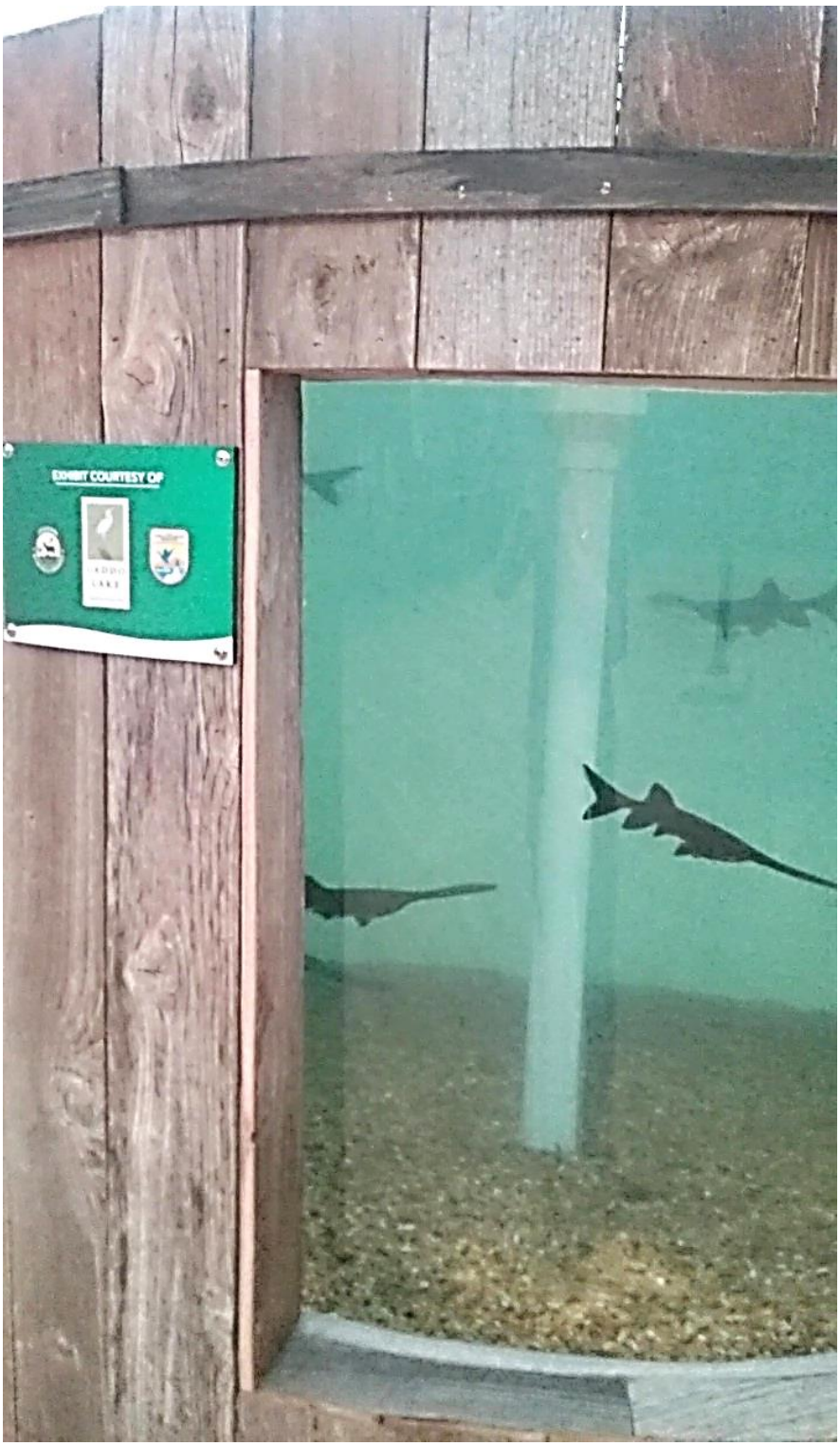

Figure 6: *Paddlefish exhibit at the Shreveport Aquarium*

Watershed Discussion

Caddo Lake Watershed

The Caddo Lake watershed straddles the Texas and Louisiana border. It is in the rolling terrain of the Pineywoods Ecoregion. The landscape is a mix of rich bottomlands and pine and oak forests with scattered areas of cropland, planted pastures and native pastures. The Texas portion of the watershed encompasses approximately 358 square miles. Caddo Lake and much of the surrounding watershed are swampland with shallow waters and towering bald cypress trees.

Urban development is sparse. The largest city is Jefferson, with a population of about 2,400. The land is predominantly used for agriculture, including forestry, poultry, and cattle production. Major tributaries include Black Cypress Bayou (0410), Little Cypress Bayou (0409), Kitchen Creek (0401B), Haggerty Creek (0401C), and Big Cypress Creek below Lake O' the Pines (0402). Black Cypress and Little Cypress Bayous are discussed in detail in their respective sections below.

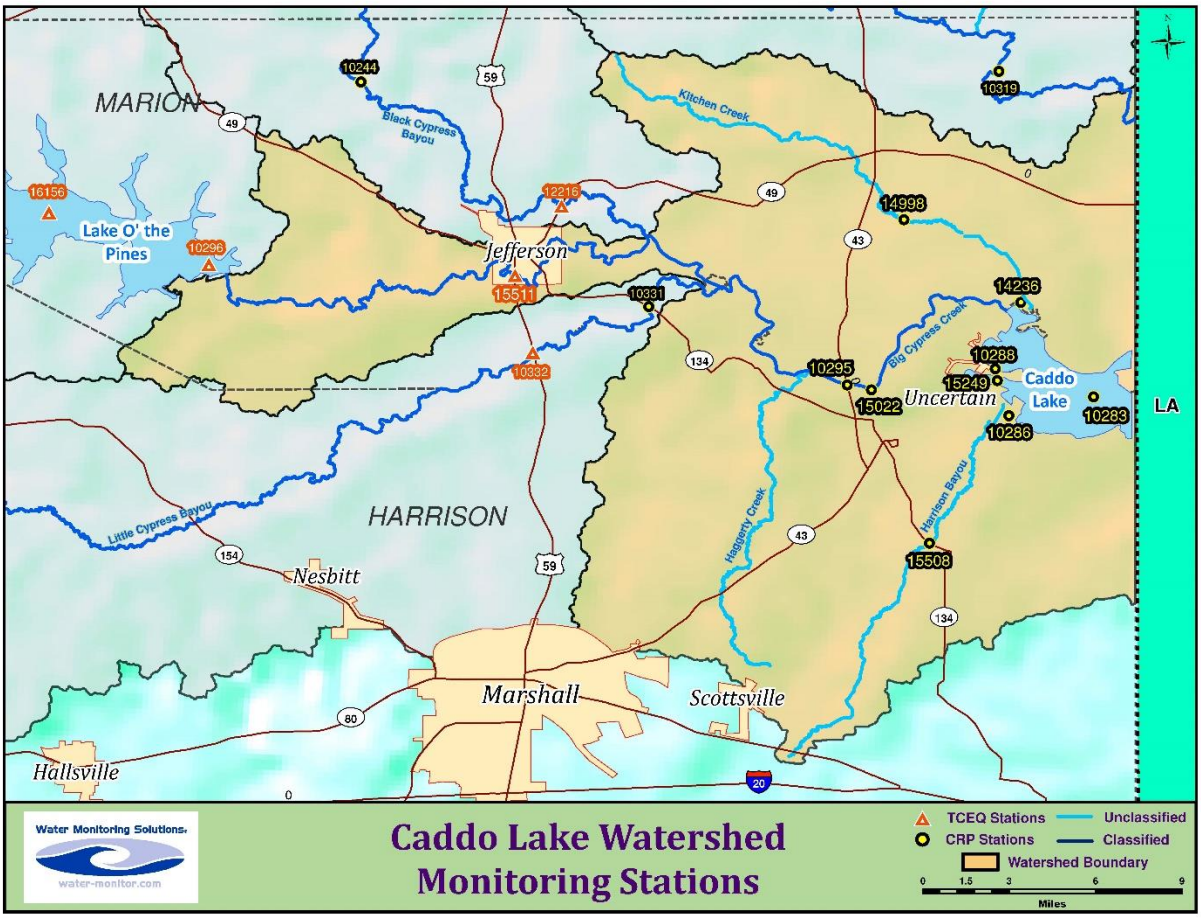

Figure 7: *Caddo Lake Watershed Monitoring Stations*

Segment 0401 – Caddo Lake

Caddo Lake is impounded by Caddo Dam in Caddo Parish, Louisiana. The uppermost portion of the lake extends into Harrison and Marion Counties in East Texas. Thought to have been formed behind a log jam in the Red River, Caddo Lake was one of the largest natural lakes in the South before it was dammed in 1914. The upper half of the Lake is shallow and swamp-like creating a unique and diverse ecosystem that is one of the best examples in the southern United States of a mature Bald Cypress forest. In recent years it has been invaded by nonnative plants such as Hydrilla, water hyacinth (*Eichhoria crassipes*), and giant salvinia (*Salvinia molesta*).

Water quality data indicate that the lake has persistently low dissolved oxygen levels and elevated levels of mercury in edible fish tissue. The Goose Prairie arm routinely exhibits low pH. There are concerns for iron in sediment and total phosphorus. Five stations in Segment 0401 were monitored by CLI and Water Monitoring Solutions, Inc. (WMS) in 2017: 10286, 10288, 14236, 10283, and 15249.

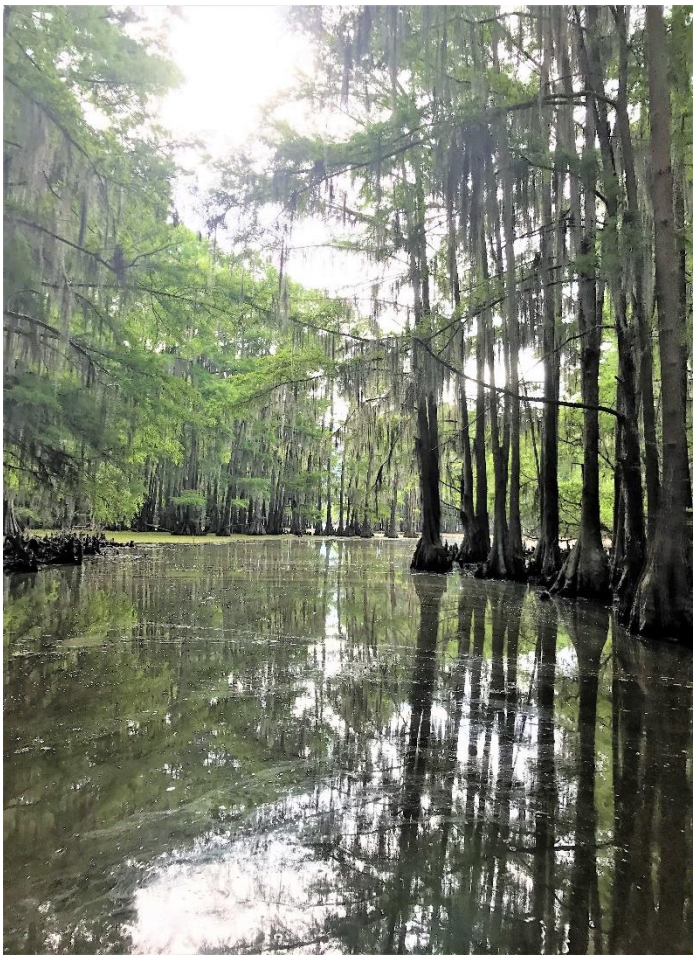

Figure 8: *Caddo Lake near Turtle Shell*

The Healing Power of Giant Salvinia

Stephen F. Austin State University Web Site December 12, 2017 Excerpt from an Article by Sarah Fuller

A team of researchers at Stephen F. Austin State University's National Center for Pharmaceutical Crops (NCPC), recently received a U.S. patent for an anti-cancer compound developed from giant salvinia. Lab trials conducted at the NCPC verify Salvinol can slow and, in some cases, completely inhibit the growth of a wide range of cancer cells.

The anti-cancer research also led to a breakthrough in the control of invasive species. Researchers have developed compounds from chemicals naturally occurring within the plant that may be used to control its growth. These biocidal effects are species specific, meaning surrounding unrelated species are not negatively affected. While this concept initially focused on giant salvinia, research has shown that the concept can be used to control numerous other plant and animal species.

http://www.sfasu.edu/9696.asp

GIANT SALVINIA

The battle to control giant salvinia in Caddo Lake captured state and national attention in 2017. A feature story in *Texas Monthly* magazine discussed the problems caused by giant salvinia and the use of salvinia weevils (*Cyrtobagous salviniae*) as a means of a biological control. To read the full story, visit the link: https://features.texasmonthly.com/editorial/creature-green-lagoon/. This article caught the attention of television producers which lead to the creation of a video about the volunteer efforts in the fight against giant salvina titled "*Fear No Weevil. Taking on the World's Worst Weed*".

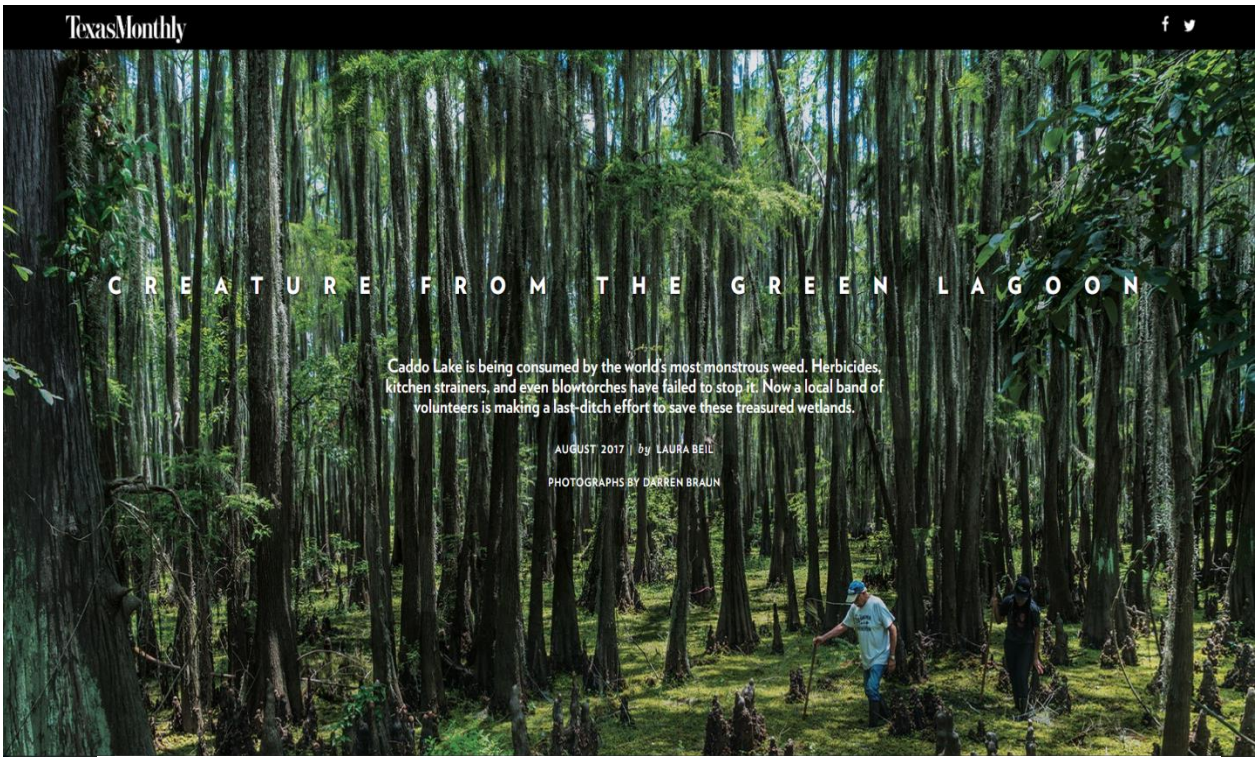

Figure 9: *Texas Monthly article about giant salvinia in Caddo Lake*

Figure 11: *Salvinia weevil*

Figure 10: *Salvinia weevil greenhouse in Uncertain, Texas*

Fear No Weevil Video

The ongoing spread of giant salvinia continues to impact navigation as well as native plant and animal species in Caddo Lake. In October, CNN produced a video about a group of citizens who think there may be a natural solution to the problem. Robert Speight, Vice President of the Greater Caddo Lake Association explained that salvinia weevils, from Brazil, feed on giant salvinia. In 2013, the group established a weevil greenhouse in Uncertain, Texas to grow weevils for release into Caddo Lake. To date, 350,000 weevils have been released. Pine Island Pond native, Angela Simpson, credits the weevils for a slow but dramatic reduction in giant salvinia.

The video can be viewed on You-Tube at: https://www.youtube.com/watch?v=zQfUUTyyTdg&t=1s

Figure 12: *Left to right: Sal Masakela (host of National Geographic's Explorer program), Daren Horton (President of the Caddo Biocontrol Alliance (CBA), and Ted Barrow (Greenhouse Manager for CBA) discuss giant salvinia in Caddo Lake while filming Fear No Weevil story for NATGEO.*

Invasive Species Control Activities in 2017

by Tim Bister, TPWD

Lake Cypress Springs

Alligatorweed is present in Lake Cypress Springs. An estimated 9 acres were documented during TPWD's 2017 annual survey. Alligatorweed flea beetles have been released in the past to help control the plant. Hydrilla was not detected during the 2017 survey, but it has been present in the past. The presence of triploid (non-reproducing) grass carp has prevented hydrilla regrowth.

Lake Monticello

Hydrilla coverage increased in Lake Monticello in 2017. It jumped from 9 acres (0.4 percent of the surface area) in 2016 to 61 acres (three percent) in 2017. Water hyacinth coverage in 2017 was similar to the previous year. Herbicide treatments were conducted by Luminant and TPWD to reduce the amount of water hyacinth in the reservoir. Luminant is shutting down operation of the power plant in 2018 and will allow the Lake Monticello water level to equalize with Lake Bob Sandlin. This will lower the normal level of the reservoir by 2.5 feet. The lower water level will strand much of the water hyacinth on dry ground and hopefully reduce its coverage in 2018.

Lake Welsh

Hydrilla and alligatorweed are present in the reservoir, but have not required any treatment.

Gilmer Reservoir

Hydrilla coverage was estimated at 314 acres (31 percent of the surface area) during TPWD's 2017 survey. The depth contours of Gilmer Reservoir usually restrict hydrilla growth to about 10 feet deep. This results in hydrilla coverage along the shoreline, but does not restrict boater access.

Lake Bob Sandlin

During TPWD's routine invasive vegetation survey, water hyacinth was detected in small amounts at several locations in the upper end of Lake Bob Sandlin. Titus County Freshwater Supply District No. 1 officials physically removed 3,255 individual plants in an effort to eliminate water hyacinth on Lake Bob Sandlin. Alligatorweed is present in Lake Bob Sandlin. Alligatorweed flea beetles were released during 2015 to help control the plant. Individual homeowners have submitted

aquatic vegetation treatment proposals to treat alligatorweed (herbicide or physical removal) in localized areas. Hydrilla was not detected during the 2017 survey.

LAKE O' THE PINES

TPWD discovered 28 acres of giant salvinia in the upper end of Lake O' the Pines during their routine invasive species survey in August 2017. Upon further inspection, the plants likely covered almost 50 acres or 0.2 percent of the surface area. Herbicide treatment was conducted by TPWD immediately to spray approximately 20 acres. USACE and NETMWD contracted with private herbicide applicators to conduct additional treatments. Throughout the year, giant salvinia has also been found on boat trailers at many of the boat ramps at the reservoir. Routine trailer inspections by USACE staff are conducted in an attempt to keep giant salvinia out of the reservoir. Water hyacinth only covered 12 acres (0.06 percent of the surface area) TPWD's 2017 survey. This reduction was largely due to the high water levels in 2016. High water levels during 2016 also suppressed hydrilla growth, but TPWD estimated 191 acres (1%) during their 2017 survey. Alligatorweed continues to be present at Lake O' the Pines. Alligatorweed flea beetles have been released in the past to help control this species.

Figure 13: *TCFWSD boat filled with water hyacinth removed from Lake Bob Sandlin*

CADDO LAKE

Giant salvinia, water hyacinth, hydrilla, and crested floating heart are the primary species of concern at Caddo Lake. Giant salvinia has been the priority for invasive species management. There were 5,313 acres (21 percent of the surface area) of giant salvinia observed during the September 2017 Caddo Lake (Texas side) aquatic vegetation survey. This is a slight increase from the 4,943 acres (19 percent) observed in 2016. Herbicide contractors sprayed over 9,000 acres (35 percent) of giant salvinia in 2017. TPWD released 140,819 adult giant salvinia weevils in Caddo. An additional 151,952 weevils were released by the Caddo Biocontrol Alliance. Weevils in Pine Island Pond had reduced the amount of giant salvinia present in early 2017 to the point that herbicide treatment of that area eliminated much of the plants that remained. Giant salvinia is still present in Pine Island Pond, but weevils are still present as well. Periodic herbicide treatments are planned to prevent plant growth from getting out of control. Water hyacinth and hydrilla did not require any treatment on Caddo Lake in 2017. First discovered in 2014, crested floating heart has been monitored and treated with herbicide in 2017. Further monitoring of crested floating heart locations and herbicide treatment will be necessary in the future.

ELLISON CREEK RESERVOIR (LAKE LONE STAR)

Hydrilla coverage was reduced from 38 acres in 2015 to 4 acres in 2016. This is a result of a shoreline homeowner group that organized to hire a contractor to conduct herbicide treatment of hydrilla in the reservoir. Hydrilla coverage in August 2017 was estimated at only 8 acres or 0.5 percent of the surface area. Homeowner's are preparing for potential hydrilla treatment in 2018. Water hyacinth was first discovered by TPWD during their routine aquatic invasive species survey in 2016. Plants were removed by hand and treated with herbicide in hopes of eradication. TPWD met with concerned lake homeowners to discuss the water hyacinth infestation. TPWD encouraged residents to form a "Shoreline Watch" approach to help monitor the reservoir for any further water hyacinth. A small amount of water hyacinth was found and removed by TPWD during their 2017 survey. Alligatorweed coverage was estimated at 11 acres (0.7 percent of the surface area) in 2017, which is similar to previous years.

0401A – Harrison Bayou

Harrison Bayou (0401A) is a tributary of Caddo Lake. The stream is approximately 14 miles long. It extends from its confluence with Caddo Lake toward the southwest to a point just upstream of FM 1998 east of Marshall, Texas.

Harrison Bayou is monitored quarterly at Station 15508 for flow, bacteria, and for field and conventional parameters. It was listed for low dissolved oxygen in 2000. The impairment, which is likely due to natural conditions, remained on the *2014 Texas §303(d) List* and will carry forward. In 2014, bacteria became a concern for non-attainment of standards. Bacteria sampling was added in FY 2016 in response to the concern and will continue in 2018.

0401B – Kitchen Creek

Kitchen Creek is an unclassified water body and a tributary of Caddo Lake. The stream crosses SH 49 near Smithland and drains into Clinton Lake east of Goat Island. Kitchen Creek was monitored at Station 14998 in 2017. There were no impairments or concerns for this tributary.

0402 – Big Cypress Creek (Bayou) Below Lake O' the Pines

Segment 0402 is the portion of Big Cypress Creek that flows between Ferrell's Bridge Dam and Caddo Lake. This segment is generally deep, wide, and supports heavy recreational use including boating and camping activities. The Big Cypress Creek watershed contains over five thousand acres of bottomland hardwood forest dominated by cypress swamps. Because of the uniqueness of the habitat, the TPWD has designated it an important recovery area for the state-threatened paddlefish.

The segment was identified on the *Texas §303(d) List* as having elevated mercury in fish tissue, low pH, and depressed dissolved oxygen in 1998, 2000, and 2010, respectively. The impairments remained on the *2014 Texas §303(d) List*. However, pH samples collected since 2014 show that the standard is being met and will likely be removed from the *2016 §303(d) List*. In 2017, TCEQ Region 5 sampled Station 15511 quarterly for flow, bacteria, and for field and conventional parameters; CLI monitored Station 15022 monthly for field parameters and flow, and station 10295 bimonthly for flow, field, and conventional parameters.

TPWD Cypress Basin Bioassessments

Four bioassessment and 10 supplemental fish collection sites were sampled in Marion and Harrison counties, Texas in the fall of 2014. Two sites on Big Cypress Bayou, one on Black Cypress Bayou, and one on Little Cypress Bayou were selected to collect fish, aquatic macroinvertebrate, freshwater mussel, riparian, and instream habitat data in an effort to support the science needs of the Cypress Environmental Flows Project and recreational initiatives such as TPWD's Texas Paddling Trails and River Access and Conservation Area programs.

Overall 56 species of fish, 19 species of mussels, and 37 taxa of aquatic macroinvertebrates were collected from the Cypress Basin, including three fish species and one mussel species of greatest conservation need. This study found that the Cypress Basin aquatic and riparian communities appear to be healthy with rich communities of fish, mussels, and riparian plants and trees at the four bioassessment sites. While the invertebrate community scores indicate some level of impairment, the low scores could also be indicative of a non-regionalized scoring system or lower than recommended sample size. The recommendation is to continue biological and habitat monitoring at the four bioassessment sites to quantify how flow-ecology relationships in the Big Cypress and its major tributaries continue to respond to flow releases from Lake O' the Pines.

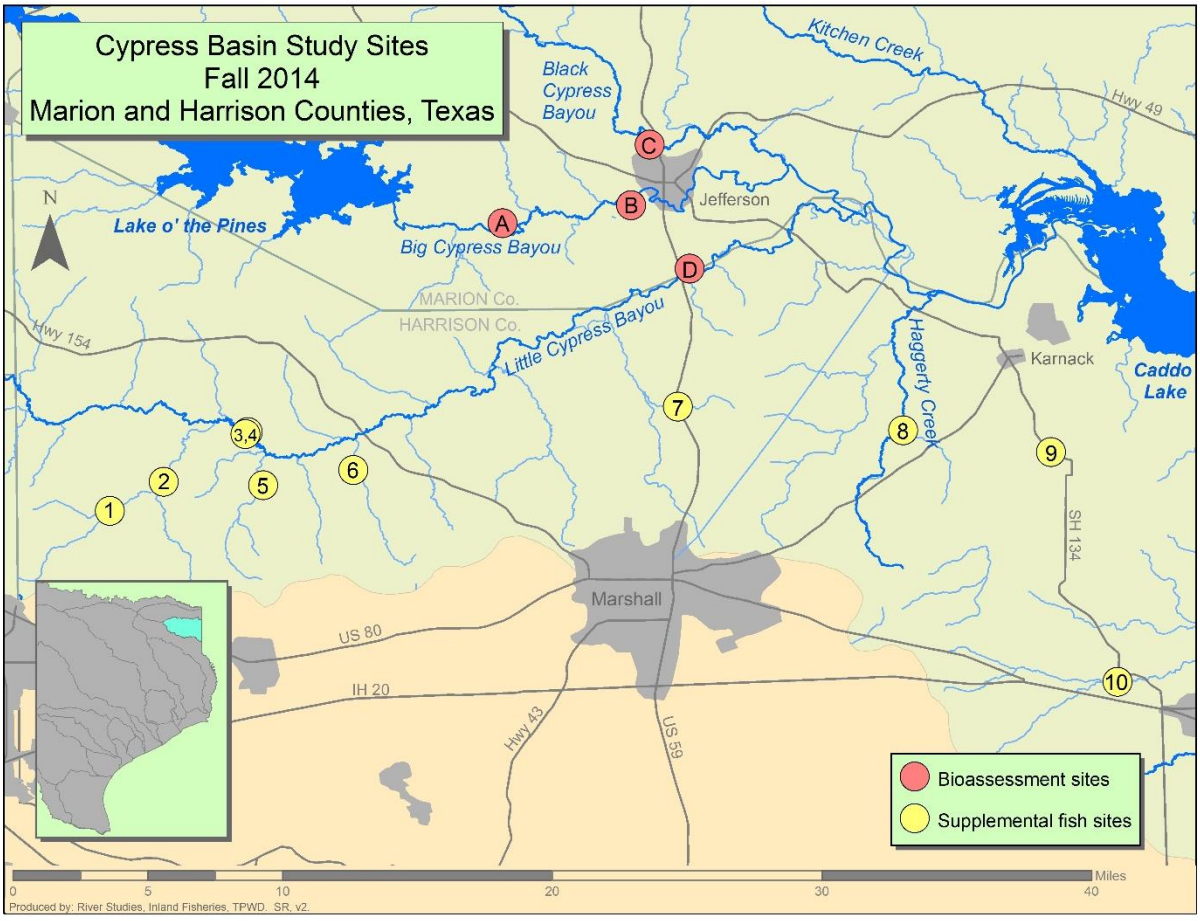

Figure 14: *Map of the TPWD Bioassessment Stations in the Cypress Creek Basin*

Lake 'O the Pines Watershed

The Lake 'O the Pines watershed encompasses approximately 885 square miles. The lower portion of the watershed lies in the Pineywoods Ecoregion and is composed of hardwood and pine forests. The upper portion, near Lake Bob Sandlin is in the Post Oak Savanah Ecoregion which is comprised of patches of oak woodlands interspersed with grasslands. The watershed is rural. Land is predominantly used for agriculture, including silviculture, poultry, and cattle. Population centers include Mt. Pleasant (pop. 16,273), Pittsburg (pop. 4,707), Daingerfield (pop. 2,460), and Ore City (pop. 1,204). Major tributaries include Big Cypress Bayou (0404), Tankersley Creek (0404B), Hart Creek (0404C), Dry Creek (0404E), Sparks Branch (0404F), Prairie Creek (0404J), Dragoo Creek (0404O), Big Cypress Creek above Lake Cypress Springs (0405A), Panther Creek (0405B), and Brushy Creek (0408C). Reservoirs in the Lake 'O the Pines Watershed include Lake 'O the Pines (0403), Ellison Creek Reservoir (0404A), Welsh Reservoir (0404D), Lake Dangerfield (0404N), Lake Cypress Springs (0405), Lake Bob Sandlin (0408), and Lake Monticello (0408A).

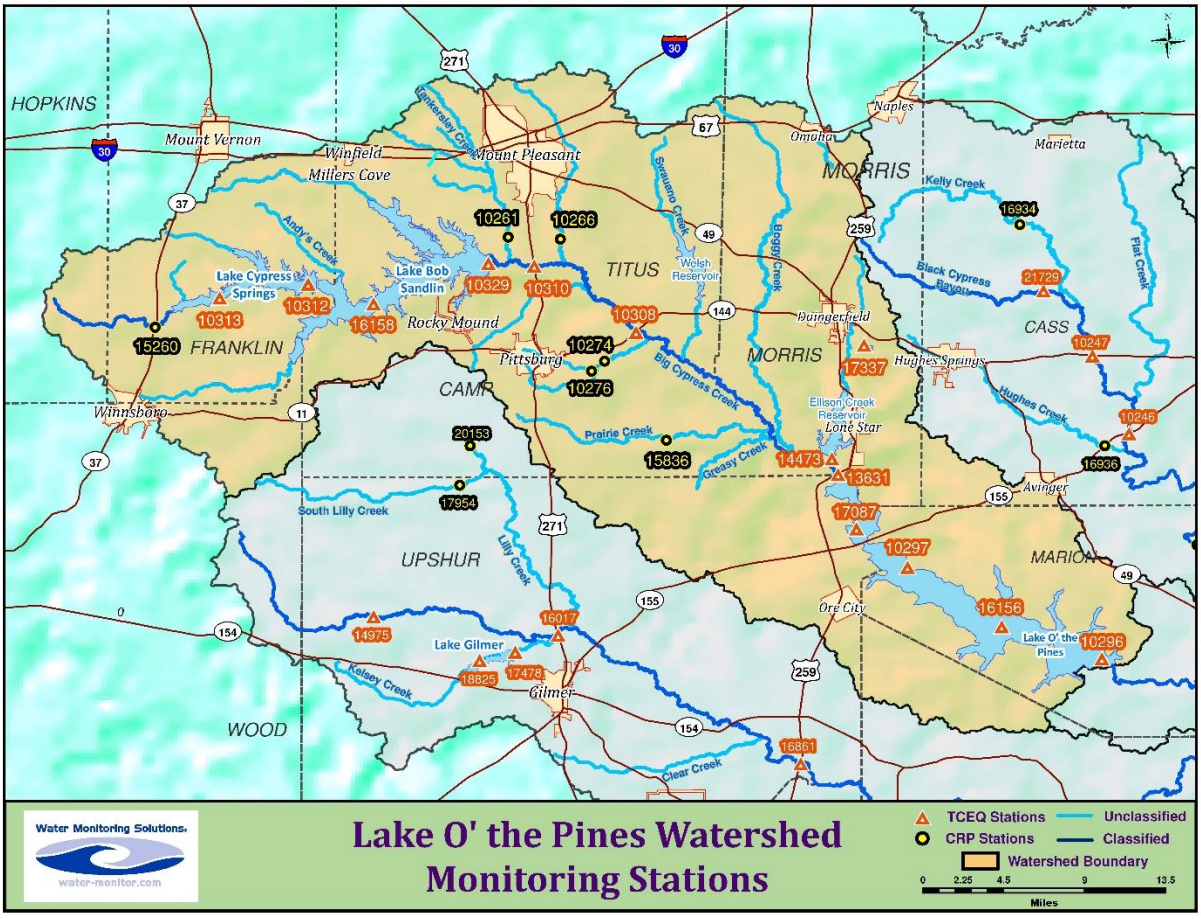

Figure 15: *Lake O' the Pines Watershed Monitoring Stations*

0403 – Lake O' the Pines

Lake O' the Pines was created by construction of the Ferrell's Bridge Dam on Big Cypress Bayou in 1959. The reservoir, which is about 18,700 acres, was created for flood control, but has become a recreation destination and a major source of water for the region. The lake has a total drainage area of 850 square miles.

Lake O' the Pines TMDL Implementation

Monitoring data indicated that the low dissolved oxygen in Lake O' the Pines resulted from high nutrient levels, and phosphorus was identified as the limiting factor in the reservoir. The Lake O' the Pines I-Plan was developed to reduce phosphorus loading into Lake O' the Pines which was approved on July 9, 2008.

Stakeholder meetings were held throughout the basin. As a result, milestones were developed by individuals with an interest in improving water quality. The I-Plan detailed priority controls that included descriptions of the control measures, responsible parties, and timeline along with goals to measure, track, evaluate, and report progress. The scope of the I-Plan included an adaptive approach to phosphorus reduction allowing for updates that may later be identified in the project.

Stakeholders specified voluntary actions aimed at reducing non-point source contributions, like stormwater runoff. Technical and financial programs were created for agricultural producers; and local/county programs were created for on-site sewage facilities, marine sanitation, and education. Loading from point sources were addressed through the limitation of phosphorus in discharges from wastewater facilities.

Phosphorus reduction is being accomplished by using a Total Phosphorus Load Agreement (TPLA) between NETMWD and entities with waste water treatment plant (WWTP) outfalls in the Lake O' the Pines watershed. In 2014, construction on a multi-million dollar upgrade to the Pilgrim's Pride WWTP was initiated to reduce its contribution of phosphorus into the watershed. In 2016, the plant discharged less than 25% of its phosphorus allocation. For all systems combined in 2016, less than 30% of the annual allocation was discharged into the receiving waters upstream of Lake O' the Pines. Since the TPLA program began in 2015, the combined amount of phosphorus discharged from the WWTPs into the Lake O' the Pines watershed was approximately 56,700 pounds, or less than the allocation of a single year.

TPLA TOTAL PHOSPHORUS TRACKING 2016 Phosphorus Discharge in Pounds			
WWTP	**Annual Allocation**	**Actual Discharge**	**Difference**
Daingerfield	510	630	120
Lone Star	4,050	2,569	(1,481)
Mt. Pleasant	2,180	1,051	(1,129)
Omaha	260	553	293
Ore City	1,000	546	(454)
Pilgrim's Pride	53,200	12,213	(40,987)
Pittsburg/Dry Creek	570	135	(435)
Pittsburg/Sparks Branch	1,780	1,151	(629)
Total	**63,550**	**18,848**	**(44,702)**

Figure 16: *2016 TPLA WWTP Total Phosphorus Discharged in pounds*

USACE LAKE O' THE PINES MASTER PLAN REVISION

Lake O' the Pines is a multi-purpose reservoir constructed for flood risk management, water supply, fish, wildlife, and recreation, and is managed by the Fort Worth District, USACE.

The current Master Plan for Lake O' the Pines was prepared in May 1989 as an update to the 1975 Master Plan. Revisions are needed to address changes in regional land use, population, outdoor recreation trends including recreation facility needs, special topics such as invasive species management, and updates to USACE management policy.

The Master Plan study area includes Lake O' the Pines proper and all adjacent recreational and natural resources properties under USACE administration. Revision of the Master Plan does not address in detail the technical operational aspects of the reservoir related to the water supply or flood risk management missions of the project. Since public participation is critical to the successful revision of the Master Plan, USACE hosted two public meetings in April 2017 to provide information and solicit input as it prepares to revise the Master Plan for Lake O' The Pines.

DEWATERING BELOW LAKE O' THE PINES FERRELL'S BRIDGE DAM

by Adam Whisenant and Greg Conley, TPWD

In April 2017, the USACE constructed a temporary coffer dam in Big Cypress Creek below the Ferrell's Bridge Dam in order to perform repairs to the stilling basin and scour area below the flood gates. While water was being drained above coffer dam, the TPWD Kills and Spills Team (KAST) and TPWD Inland Fisheries Marshall management team monitored the dewatering process. To minimize impacts to state resources, TPWD KAST worked with USACE to develop an Aquatic Resource Relocation Plan to move fish and freshwater mussels downstream of the dewatered area in Big Cypress Creek. USACE relocated several thousand fish representing 21 species. A contracted biologist relocated 746 freshwater mussels representing 17 different species, including one Texas Pigtoe, a state threatened species. The TPWD Marshall office assisted USFWS with relocating 101 previously stocked Paddlefish, tagging 15 with radio transmitters to monitor their movement in the river basin. (*Photos courtesy of Adam Whisenant, TPWD*)

Figure 17: *Mussels relocated from below Ferrell's Bridge Dam*

Figure 18: *Paddlefish being tagged with radio transmitter*

Lake O' the Pines National Water Quality Initiative Phase I Update

by Lucas Gregory, PhD., Texas Water Resources Institute

In 2014, the USDA Natural Resources Conservation Service's Lake O' the Pines National Water Quality Initiative (NWQI) program began. TWRI subsequently began efforts to monitor and assess the effects of conservation practices implemented through this program on water quality in January 2016. Water Monitoring Solutions, Inc. and Hoffman Environmental, Inc. provided local runoff event monitoring support. However, after three years of program implementation, Natural Resource Conservation Service ended the program in the watershed. As a result, monitoring was completed for the project at the end of August 2017. This resulted in 18 months of water quality data collection. While this is a short-term data set, several informative comparisons are described below.

Water samples were collected from 10 sites (2 sub-basin, 4 farm scale, and 4 field scale) during the monitoring period. Samples were processed to determine nutrient, sediment, and bacteria concentrations Flow volume was recorded to allow for loading calculations. Monitoring was set up to compare management practice scenarios which are intended to reduce offsite nutrient, bacteria, and sediment loads from the treated area compared to untreated areas (Figure 19). Runoff samples collected from farm and field sites following rain events ranged in number from 5 to 22. Creek sites on Boggy and Prairie Creeks produced 35 and 34 samples, respectively. Both creeks did go dry during the summer of 2016, but did not in 2017.

Site	Type	County	Practices Applied	Acres	Data Collection Period	# Sampling Events
1A	Field	Titus	Pasture Platnting, prescribed grazing, nutrient mgmt, waste application	1	Feb 2016-Aug 2017	16
2A	Field	Titus	Silvopasture, Forest stand Improvement,prescribed grazing nutrent mgmt	1.12	Mar 2016-April 2017	5
3A	Field	Camp	Control: natural forest revegetation only	0.81	Mar 2016-June 2017	10
4A	Field	Camp	Forest planting, forest stand improvement	0.58	Mar 2016-June 2017	8
1B	Farm	Titus	Cover crop, prescribed grazing, nutrient mgmt, waste application	4.56	Feb 2016-July2017	16
2B	Farm	Titus	Silvopasture, Forest stand Improvement,prescribed grazing nutrent mgmt	9.34	Feb 2016-Aug 2017	12
3B	Farm	Titus	Cover crop, prescribed grazing, nutrient mgmt	4.63	Feb 2016-Aug 2017	20
4B	Farm	Camp	Control: continous grazing, periodic fertilizer application	2.92	Feb 2016-Aug2017	22
Boggy SH 11	Instream	Morris	Pasture Planting, Litter Application, Prescribed Grazing, Cover Crop, Silvopasture Establishment, Waste Treatment, Pond, Incinerator, Herbaceous Weed Control, Forage Planting, Fencing, Forest Site Preparation, Tree/Shrub Establishment, Forest Stand Improvement	50,060	Jan 2016-Aug 2017	35
Prairie FM 557	Instream	Camp	Forest Site Preparation, Tree/Shrub Establishment, Forest Stand Improvement	18,024	Jan 2016-Aug 2017	34

Figure 19: *Descriptive information for sampling sites*

For comparison purposes, data were aggregated by treatment type to evaluate changes in management within similar usage scenarios. In managed forest areas, planned reforestation activities were compared to natural revegetation and in livestock grazing operations prescribed grazing was compared to continuous grazing. Similarly, monitored creeks were compared with Boggy Creek representing the 'treated' watershed and Prairie Creek representing the 'control.'

As expected with runoff water quality data, considerable variations in concentrations and loads occurred. Effects from site specific factors including rain event characteristics, recent management operations (change in ground cover, soil disturbance, stocking rates, etc.), and wildlife presence were all factors influencing results. Despite this, several significant differences in constituent loading rates between some treatments and controls were identified during the monitoring period. In the forested setting, no significant differences in median constituent loads were identified. This result is likely a function of time.

Each plot was clear-cut followed by debris stacking prior to pine tree planting in the treated area. The 18-month monitoring period did not allow sufficient time for stand establishment to occur and significant differences in water quality to materialize. On properties managed for livestock, some significant differences were observed between treated (prescribed grazing) and control (continuous grazing) sites. Only median loads for *E. coli,* total suspended solids (TSS) and nitrate-nitrite nitrogen were statistically different between treatment types (Figure 20).

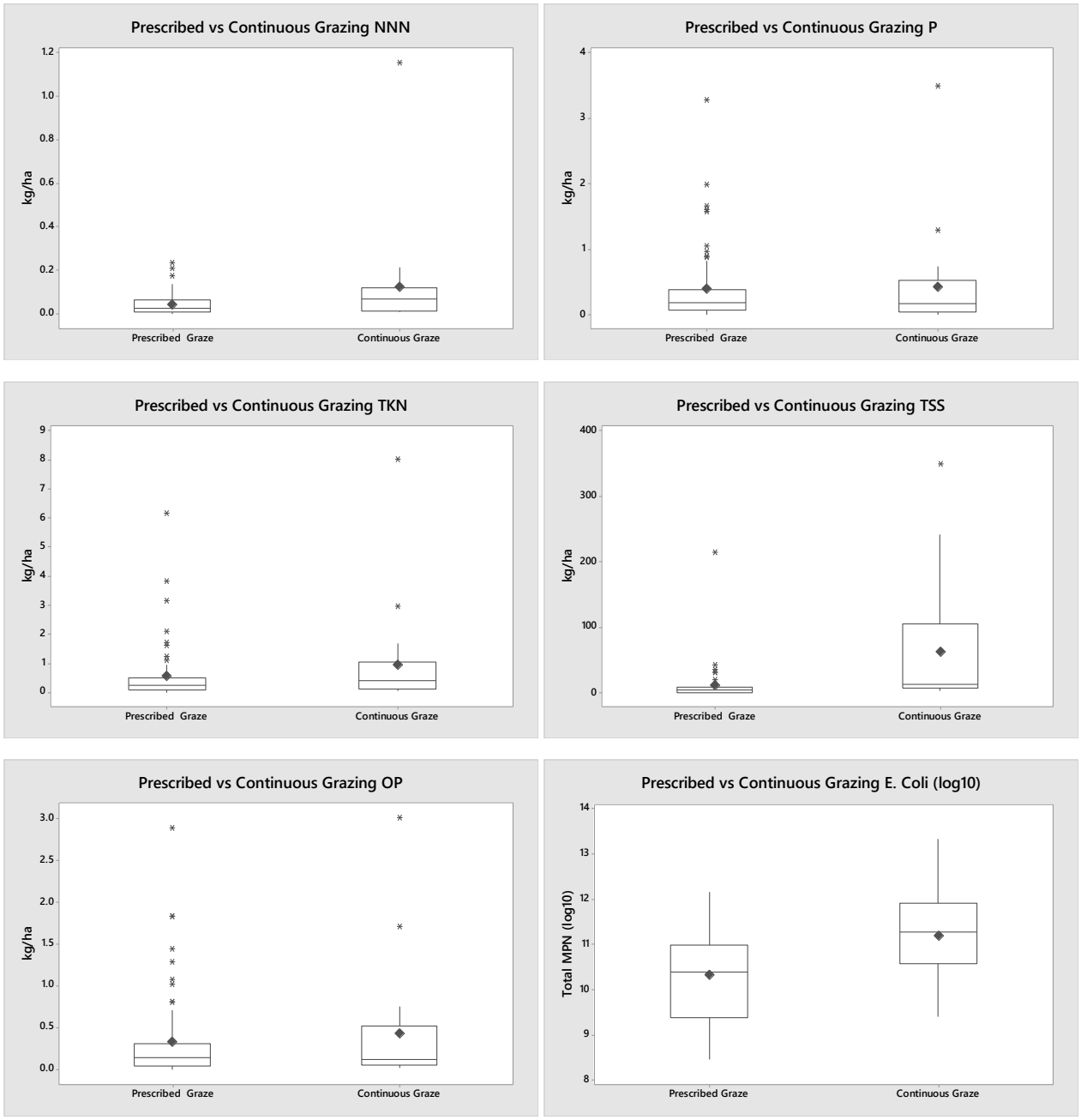

Figure 20: *Prescribed versus continuous grazing data boxplots*

Total Kjeldahl Nitrogen (TKN), total phosphorus, and ortho-phosphorus were not significantly different between treated and control plots. However, loadings for all parameters trended higher for the

continuous grazing plot than those under prescribed grazing management. This outcome is expected due to the improved health and proper functioning of the watershed under prescribed grazing conditions compared to continuous grazing. Proper grazing management maintains increased ground cover on-site and promotes enhanced root growth, increased water infiltration, decreased runoff, and subsequently leads to lower overall constituent losses in runoff. Grazing timing relative to runoff events can yield large constituent loads; but over time, total loads are commonly reduced from those produced on continuously grazed sites. The short monitoring duration likely moderated the observed differences in water quality between sites.

Instream water quality differences between Boggy Creek (treatment) and Prairie Creek (control) produced some significant differences. Median loads for TKN, ortho-phosphorus, total phosphorus, and *E. coli* were significantly different while nitrite-nitrate-nitrogen and TSS were not statistically different. Median constituent loads from Boggy Creek were higher than in Prairie Creek. Management practice implementation in the watershed was much lower than anticipated making it difficult to identify differences in water quality based on management effects. In the Boggy Creek watershed, less than 6% of the total watershed area received management implementation making it quite difficult to observe changes in water quality because of management implementation.

0404 – Big Cypress Creek

Segment 0404 begins just downstream of Fort Sherman Dam on Lake Bob Sandlin. Stream flow is influenced directly by releases from the dam. This section of Big Cypress Creek is the most urban-influenced segment in the Cypress Creek basin. Population centers include Mount Pleasant, Pittsburg, and Daingerfield. During periods of drought or low flow, the creek is primarily composed of treated municipal and industrial wastewater effluent. The Big Cypress Creek watershed also contains numerous poultry operations.

Segment 0404 was listed for bacteria in 2002, and for sulfate in 2014. Water samples collected since the last assessment indicate that for bacteria and sulfate continue to exceed water quality standards in this segment. TCEQ will use information from a bacteria study completed in 2011 to determine the best management strategy to address the bacteria impairment. Sulfate monitoring will continue in 2018. Concerns for screening levels for chlorophyll *a*, nitrate, and total phosphorus are shown in the2014 IR. TCEQ Region 5 monitors stations 10308 (Big Cypress Creek at SH 11) and 10310 (Big Cypress Creek at US 271) each month for flow, bacteria, and for field and conventional parameters. Station 13631 (Big Cypress Creek at US 259) is monitored by TCEQ Region 5 quarterly for bacteria, and for conventional and field parameters.

WILD TURKEY REINTRODUCTION

Eastern turkeys were once numerous in East Texas. Thanks to a restocking program by TPWD, they may once again inhabit the pineywoods in large numbers. In December 2017, NETMWD staff joined TPWD to release ten Eastern Wild Turkeys in Camp County. The turkeys, which were captured in Missouri, were released onto land upstream of Lake O' the Pines.

The release site is a 10,000-acre ranch that has undergone significant improvement to provide critical habitat for the turkeys. Tree thinning, controlled burns, understory clearing, and replacing clogged culverts will improve habitat, increase stream flow, and improve water quality. These land management practices along several miles of Big Cypress Bayou will give the turkeys a suitable environment for survival and reproduction. "It's good for the turkeys, and the landowner. The restoration also helps the quality of water in streams and therefore, helps our watershed." Laura-Ashley Overdyke, CLI.

More stockings are planned for 2018.

Figure 21: Ten healthy turkeys took flight in their new home in Camp County

0404A – Ellison Creek Reservoir

Ellison Creek (sometimes called Lone Star) Reservoir is just west of Lone Star in southern Morris County. The drainage area of the Ellison Creek watershed is thirty-seven square miles and has a surface area of approximately 1,516 acres. The reservoir provides process water and cooling water for Lone Star Steel Company and the Southwest Gas and Electric Company Power Plant.

Ellison Creek Reservoir is on the *2014 Texas §303(d) List* for Polychlorinated biphenyls (PCBs) in fish tissue and sediment toxicity. The 2014 IR lists Ellison Reservoir with concerns for screening levels for cadmium, iron, lead, manganese, nickel, and zinc in sediment. TCEQ Region 5 monitors Station 14473, located at the dam, quarterly, for metals in water and field parameters.

0404B – Tankersley Creek

Tankersley Creek arises in Titus County northwest of the city of Mount Pleasant. The stream flows in a southeasterly direction for approximately two miles before it enters Tankersley Lake. Downstream of the impoundment, the stream flows about eight miles to its confluence with Big Cypress Creek at the Titus-Camp county line.

The 2014 IR indicates an impairment for bacteria. The creek was first listed as impaired for bacteria in 2000 and concerns for screening levels of ammonia and total phosphorous have also been identified. TCEQ will use information from a bacteria study completed in 2011 to determine the best management strategy to address the impairment. Data collected since the last assessment indicates that bacteria concentrations on Tankersley Creek continue to exceed water quality standards. Quarterly sampling for flow, bacteria, and for field and conventional parameters will continue at station 10261 (Tankersley Creek at FM 3417) in 2018.

0404C – Hart Creek

Hart Creek, an unclassified water body, rises 4.5 miles north of Mount Pleasant and runs southeast for twelve miles to its confluence with Big Cypress Creek. It receives surface drainage from Hayes Creek and Evans Creek, small tributaries east of Mount Pleasant. The City of Mount Pleasant WWTP outfall is located on Hart Creek upstream of County Road 4550.

The 2014 IR indicates an impairment for bacteria. Hart Creek was first identified as not meeting the water quality standard for bacteria in 2006 and concerns for nitrate have also been identified. TCEQ will use information from a bacteria study completed in 2011 to determine the best management strategy to address the impairment. Data collected since the last assessment indicates that bacteria concentrations on Hart Creek continue to exceed water quality standards Quarterly sampling for flow, bacteria, and for field and conventional parameters will continue at station 10266 (Hart Creek at County Road 4550) in 2018.

0404E – Dry Creek

The headwaters of Dry Creek are located south of Pittsburg, Texas. The creek flows toward the east to its confluence with Big Cypress Creek in northeast Camp County. The 2014 IR identifies a concern for

screening levels for nitrate. Station 10274 (Dry Creek at McMinn Road) is monitored quarterly for flow, bacteria, and for field and conventional parameters in 2018.

0404F – Sparks Branch

Sparks Branch is tributary of Dry Creek. It begins in City Park in Pittsburg and flows approximately 4 miles to the east toward the confluence with Dry Creek. There is little riparian vegetation along the stream as land in the Sparks Branch watershed is intensively used for pastures and grazing. Sparks Branch was not assessed in the 2014 IR due to lack of data. Sampling at County Road 4220 began in 2016.

Figure 22: *Sparks Branch at County Road 4220*

0404J – Prairie Creek

Prairie Creek flows on the southern border of Camp County before its confluence with Big Cypress Creek near US 259. The stream remains on the 2014 IR with a concern for non-attainment of the 24-hour dissolved oxygen average and minimum criteria. The Lake O' the Pines I-Plan workgroup identified 24-hour dissolved oxygen-monitoring as a priority for this watershed to determine potential impacts on loading into the reservoir.

0404N – Lake Daingerfield

Lake Daingerfield is an eighty-acre reservoir which was completed in 1935 as a Civilian Conservation Corps project. This segment is listed on the *Texas §303(d) List* for non-support and concern for the screening level of mercury in fish tissue.

0405 – Lake Cypress Springs

Lake Cypress Springs is located near the headwaters of Big Cypress Creek in Franklin County, south of the City of Mount Vernon. The watershed is primarily rural though homes have been constructed on the lakefront in recent years. Nearby agricultural activity includes dairy, poultry, cow/calf operations, and hay meadows. Lake Cypress Springs is regulated by the Franklin County Water District and is a popular recreational reservoir.

Lake Cypress Springs was first identified as impaired for elevated pH in the 2012 IR. The listing continued in the 2014 IR as did concerns for chlorophyll *a*. Data collected through 2017 confirm that high pH is still

an issue in the reservoir. TCEQ Region 5 sampled quarterly for bacteria and for conventional and field parameters at three locations in Lake Cypress Springs in 2017.

0405A – Big Cypress Creek Above Lake Cypress Springs

This section of Big Cypress Creek flows through land and grazing pastures. Several poultry operations are located within its watershed. Much of the riparian vegetation along the creek has been removed. Big Cypress Creek was placed on the *Texas §303(d) List* for depressed dissolved oxygen in 2014. A preliminary review of data collected since the 2014 listing indicates that dissolved oxygen in the creek remains low. The 2014 IR also shows a concern for bacteria. Quarterly sampling for flow, bacteria, and for field and conventional parameters at Station 15260 (Big Cypress Creek at SH 37) continues in 2018.

Figure 23: *Stream flow measurement on Big Cypress Creek at SH 37*

0408 – Lake Bob Sandlin

Lake Bob Sandlin is located immediately below Lake Cypress Springs and Lake Monticello. The reservoir is a popular recreational and fishing lake that is regulated by the Titus County Freshwater Supply District #1. No impairments or concerns were identified in the2014 IR. Conventional and field parameters and bacteria samples were collected quarterly at three stations by TCEQ Region 5 in 2017.

Rainfall in the Cypress Creek Basin

The 39-year average annual rainfall recorded at Lake Bob Sandlin Ft. Sherman Dam was 52 inches per year, while 48.5 inches of rain was measured in 2017. The area experienced an unusually wet August receiving approximately 8.5 inches of rain, followed by a dry fall, with only 4.04 inches combined in September through November. Due to the dry fall, no water was released from Lake Bob Sandlin after September 5, 2017. The release total for 2017 was approximately 25 percent lower than the historical average of 90,354 acre-feet, and significantly less than the 280,000 and 170,000 acre-feet of water released in 2015 and 2016, respectively.

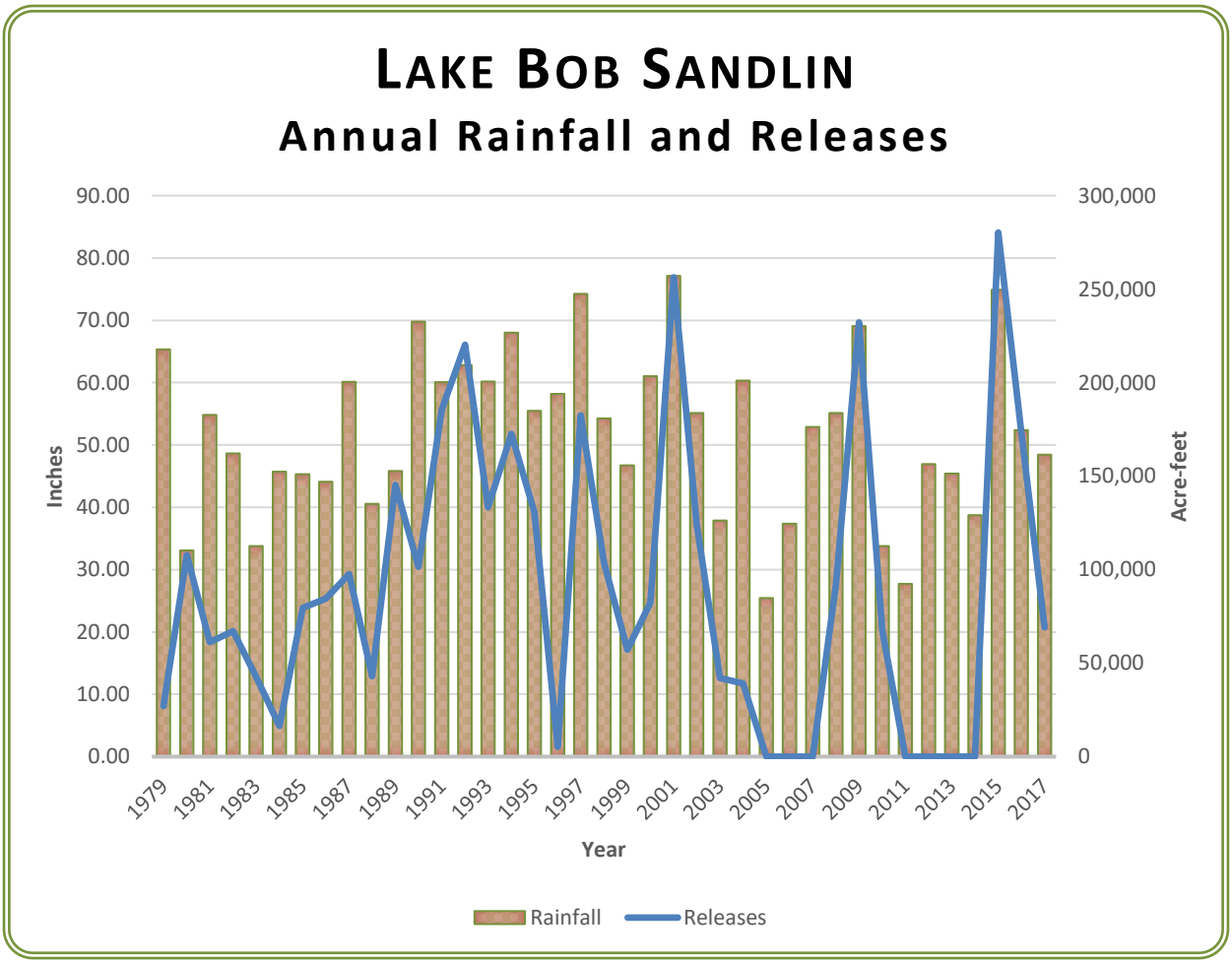

Figure 24: *Annual Rainfall and Releases from Lake Bob Sandlin*

CADDO LAKE FLOODING

The thirteen-month period from March 2015 to April 2016 was unusually wet with the basin receiving record rainfall in 2015. An interesting note is that Caddo Lake has reached flood stage (172.00 feet) only 34 times since April 1921. Five of the 34 flood stage events came within this recent thirteen-month period including the fourth highest water level ever recorded at 179.95 feet on March 15, 2016. Prior to this, the only other times that Caddo Lake has reached flood stage five times in a single period was in the decades of the 1930's and 1940's which was prior to the construction of Lake O' the Pines.

Date	Level (feet)	Date	Level (feet)	Date	Level (feet)	Date	Level (feet)
5/5/1958	182.92	5/24/1953	176.64	5/8/1991	174.90	4/23/1927	173.44
4/5/1945	182.31	6/9/1946	176.32	4/29/1921	174.34	3/15/2015	173.05
5/3/1966	180.70	4/5/2016	175.90	5/4/1922	174.14	1/4/2016	173.00
3/15/2016	179.95	4/30/1973	175.78	4/17/1942	174.14	3/13/1990	172.80
5/4/1957	179.22	3/7/2001	175.60	12/16/1961	173.95	7/28/1933	172.74
5/24/1930	178.74	2/20/1950	175.34	1/5/1938	173.94	1/4/1941	172.64
5/9/1944	178.54	1/13/1932	175.24	12/26/1929	173.84	5/14/1935	172.54
4/2/1989	177.10	10/20/2009	175.20	12/8/1974	173.75	5/14/2015	172.00
1/1/1988	176.70			12/21/2001	173.60		

Figure 25: *Caddo Lake Historical Flood Stage Levels*

Figure 26: *Big Cypress Bayou flooding on April 2, 1945*

Black Bayou, James' Bayou, and Black Cypress Bayou Watersheds

The Black Cypress, James' Bayou, and Black Bayou Watersheds are in the Pineywoods Ecoregion. The watershed is approximately 835 square miles and is composed of a mix of rich bottomlands of pine and oak forests with scattered areas of cropland, planted pastures, and native pastures. Continuous and well-developed riparian woodlands help define the landscape. Population centers include Hughes Springs, Linden, Atlanta, and a portion of Jefferson.

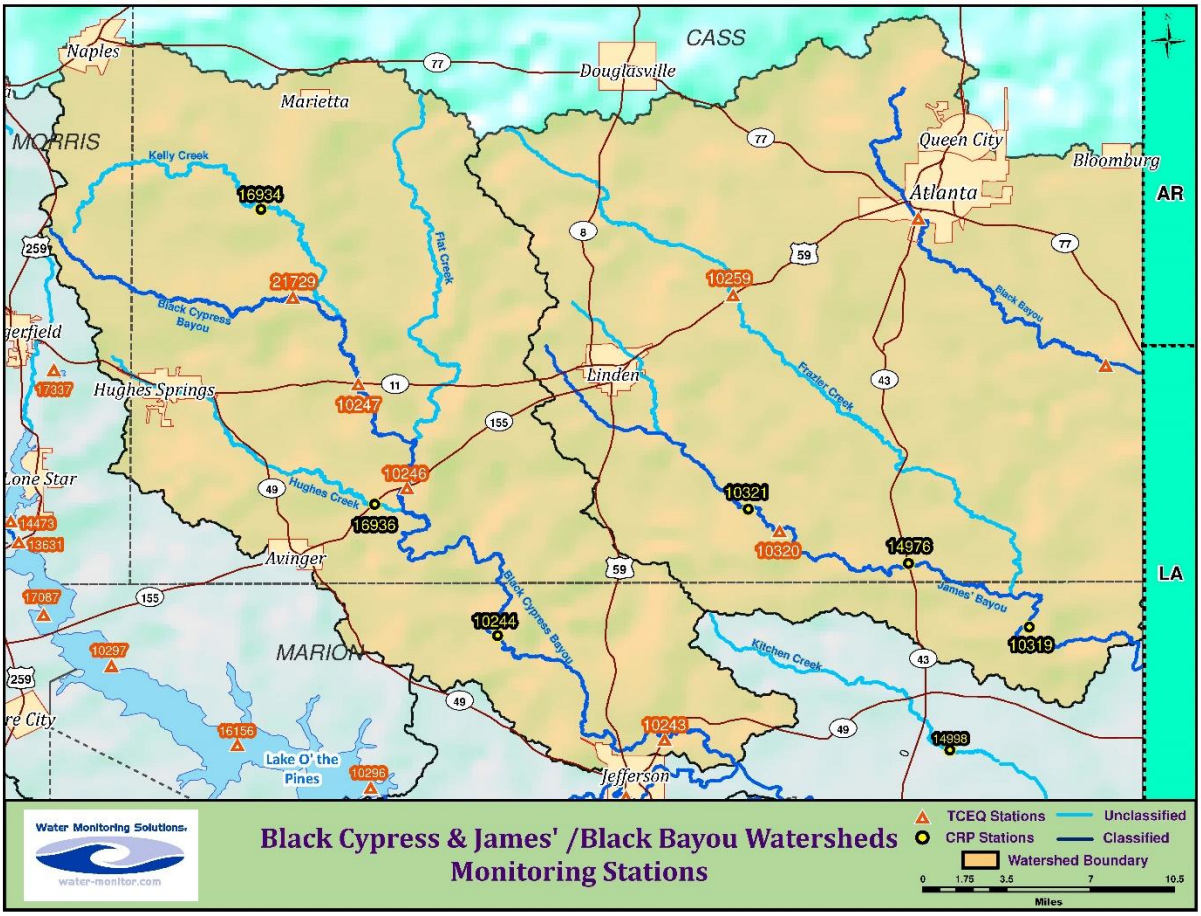

Figure 27: *Black Cypress, James' Bayou, and Black Bayou Watersheds and Monitoring Stations*

0406 – Black Bayou

Black Bayou emerges south of Wright Patman Reservoir, flows through Atlanta, Texas and on to the Louisiana border. The watershed is comprised of pastures and forest land. Much of the riparian vegetation in the upper portion of the stream has been removed. Black Bayou was first identified as impaired for depressed dissolved oxygen in 2002 and for bacteria in 2006. Both impairments continued in the 2014 Texas §303(d) List and a preliminary review of data collected since 2014 indicate that Black Bayou continues to not meet TSWQS for these parameters. There is a concern for elevated levels of chlorophyll *a* in the upper portion of the segment. In 2017, quarterly sampling for flow, bacteria, and for field and conventional parameters was performed by TCEQ Region 5 at stations 10314 (Black Bayou at Cass County Road 4659) and 10318 (Black Bayou at SH 43).

Aquatic Life and Stream Health

One way to determine if a stream is healthy is by measuring the diversity of aquatic life in the water. Biologists sample streams and collect data about aquatic life such as fish and benthic macroinvertebrate organisms (insects, mussels, worms, and other bottom-dwelling aquatic animals) to make a broad assessment of aquatic ecosystem health. Data from biological monitoring and habitat assessments are then plugged into a grading system called the Index of Biotic Integrity or IBI. The IBI uses criteria such as a species' sensitivity to pollutants and population diversity to rank water bodies into five categories: exceptional, high, intermediate, limited and minimal. As a rule, perennial streams are presumed to support a high aquatic life use, but periodic intensive surveys such as those done by TCEQ and Water Monitoring Solutions, Inc. offer confirmation of the presumption and a holistic view of the health of streams in the Cypress Creek basin.

Below are the biological assessment results for station 10318 Black Bayou at SH 43 during 2012 and 2014.

Station 10318 Black Bayou at SH 43	2012		2014	
	6-Sep	11-Oct	21-May	31-Jul
Fish	49 (High)	41 (Int.)	43 (High)	45 (High)
Benthos	22 (Int.)	25 (Int.)	23 (Int.)	22 (Int.)
Habitat	19 (Int.)	20 (High)	19 (Int.)	20 (High)

Figure 28: *Biological Assessment Results from station 10318 in Black Bayou at SH 43*

0407 – James' Bayou

The headwaters for James' Bayou are just west of Linden. The stream flows toward the southeast through pine and hardwood forests before crossing the Louisiana border to ultimately flow into Caddo Lake. In 2017, James' Bayou was monitored at four sites for conventional and field parameters and bacteria. Two sites were monitored for biological parameters.

James' Bayou is impaired for multiple parameters: dissolved oxygen (2000), bacteria (2006), pH (2008), and for fish and macrobenthic communities (2014). There is also a concern for screening level for impaired habitat. Biological monitoring was conducted at station 14976 (Jim's Bayou at SH 43) in 2016 and 2017 in response to the biological impairments and habitat concern. Preliminary review of the data indicate that the stream meets its high aquatic life use criteria for the fish community but not for the benthic community. Bacteria data collected since 2014 indicate that the stream meets the state standard.

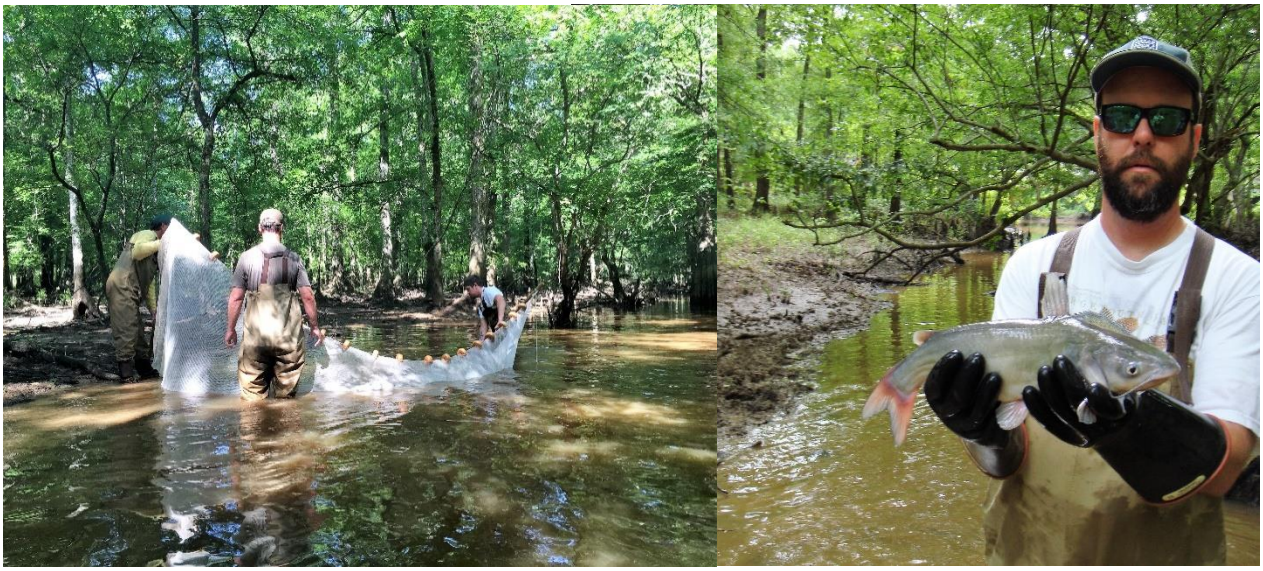

Figure 29: *Biological Sampling in Jim's Bayou at SH 43*

Station 14976 Jim's Bayou at SH 43	2016		2017	
	16-Jun	2-Aug	10-May	6-Jul
Fish	37 (Int.)	42 (High)	51 (High)	46 (High)
Benthos	22 (Int.)	28 (Int.)	23 (Int.)	26 (Int.)
Habitat	15 (Int.)	15 (Int.)	16.5 (Int.)	17.5 (Int.)

Figure 30**:** *Biological Assessment Results from Monitoring Site 14976 Jim's Bayou at SH 43*

MUSSELS SAMPLING

After completing the benthic and fish sample collection in July 2017, Lauren Pulliam with TCEQ demonstrated a mussels sampling protocol that is currently being developed. Mussels were collected using timed tactile searches in all available habitat types by feeling for them in the soft sediments (Figure 32). Sampling was conducted by 5 surveyors for ten to fifteen minutes at each survey area for a total survey time of six person-hours. The survey area totaled approximately 415 m^2 across the entire reach which included riffle, run, bank, and mid-channel bar habitats. Once collected, the mussels were identified, photographed, and returned to the stream. A total of 70 individuals were collected; all from the same species, *Uniomerus tetralasmus* (Pondhorn)(Figure 31).

Figure 31: *Pondhorn mussels collected in Jim's Bayou at SH 43*

MICROPLASTICS SAMPLING

Microplastics are plastic particles smaller than five millimeters in size and that pose a significant environmental risk when they enter our waterways. Pollutants including pesticides and manufacturing chemicals can adhere to microplastic particles and bioaccumulate in aquatic life. Microplastics have been shown to affect feeding behavior and predator avoidance, and can interact with other pollutants to affect cell function in fish. They are also able to move from the digestive tract of organisms into the bloodstream.

Figure 32: *Mussels sampling in Jim's Bayou at SH 43; July 2017*

Microplastics have several sources including laundered nylon clothing, cosmetics, and toothpastes, and plastic debris such as bottles and bags. Preliminary results have revealed microplastics in the vast majority of marine samples collected around the globe while nearly half of the freshwater samples contain microplastics.

On May 10, 2017, Adam Whisenant with TPWD collected a sample in Jim's Bayou at SH 43 which currently, is the only microplastics sample collected east of the I-45/US-75 corridor in Texas. Lab analysis resulted in no microplastics present in the sample. Visit the Adventure Scientists website at:

http://www.adventurescience.org/microplastics.html to learn more about microplastics sampling efforts around the world.

Figure 33: *Microplastics samples collected around the world*

0407B – Frazier Creek

Frazier Creek, an unclassified tributary to James' Bayou, has a relatively low level of human disturbance and serves as an ecoregion reference stream for the watershed. The 2014 IR identifies a concern for screening levels of dissolved oxygen in Frazier Creek. TCEQ (Region 5) monitors station 10259 (Frazier Creek at US 59) quarterly for field parameters, bacteria, and flow.

0410 – Black Cypress Creek (Bayou) / Formerly 0402A

Black Cypress Bayou was formerly an unclassified water body (0402A). In 2016, the TCEQ designated it as a classified waterbody and assigned it Segment 0410. The new designation will be published in the 2016 IR. The segment boundary begins at the confluence with Big Cypress Creek up to FM 250. According to the 2014 IR, Black Cypress Bayou is impaired for low dissolved oxygen, bacteria, copper in water, and mercury in edible fish tissue. Four diel monitoring events were performed at station 10245 (Black Cypress Creek at US 59) in 2016 and in 2017. Preliminary analysis of the data indicate that the creek meets water quality standards and the dissolved oxygen impairment will be removed in a future IR. Quarterly samples for flow, bacteria, and for field and conventional parameters were collected by TCEQ Region 5 in 2017.

Figure 34: *Alligator crossing SH 49 at Black Cypress Bayou*

Segments 0402B Hughes Creek and 0402E Kelly Creek

Hughes Creek and Kelly Creek are tributaries to Black Cypress Bayou. No concerns or impairments have been found on these segments. Stations 16936 (Hughes Creek at SH 155) and 16934 (Kelley Creek at FM 250) are being sampled quarterly for field parameters and stream flow.

Figure 35: *Black Cypress Creek at US 59*

Little Cypress Watershed

The Little Cypress Creek watershed is approximately 712 square miles. The watershed straddles the Pineywoods and Post Oak Savanah ecoregions. The majority of the watershed lies in the Pineywoods Ecoregion and is composed of hardwood and pine forests. The upper reaches of the watershed is in the Post Oak Savanah Ecoregion which is comprised of patches of oak woodlands interspersed with grasslands. Land is predominantly used for agriculture, including forestry, poultry, and cattle. Population centers include Gilmer and a portion of Marshall.

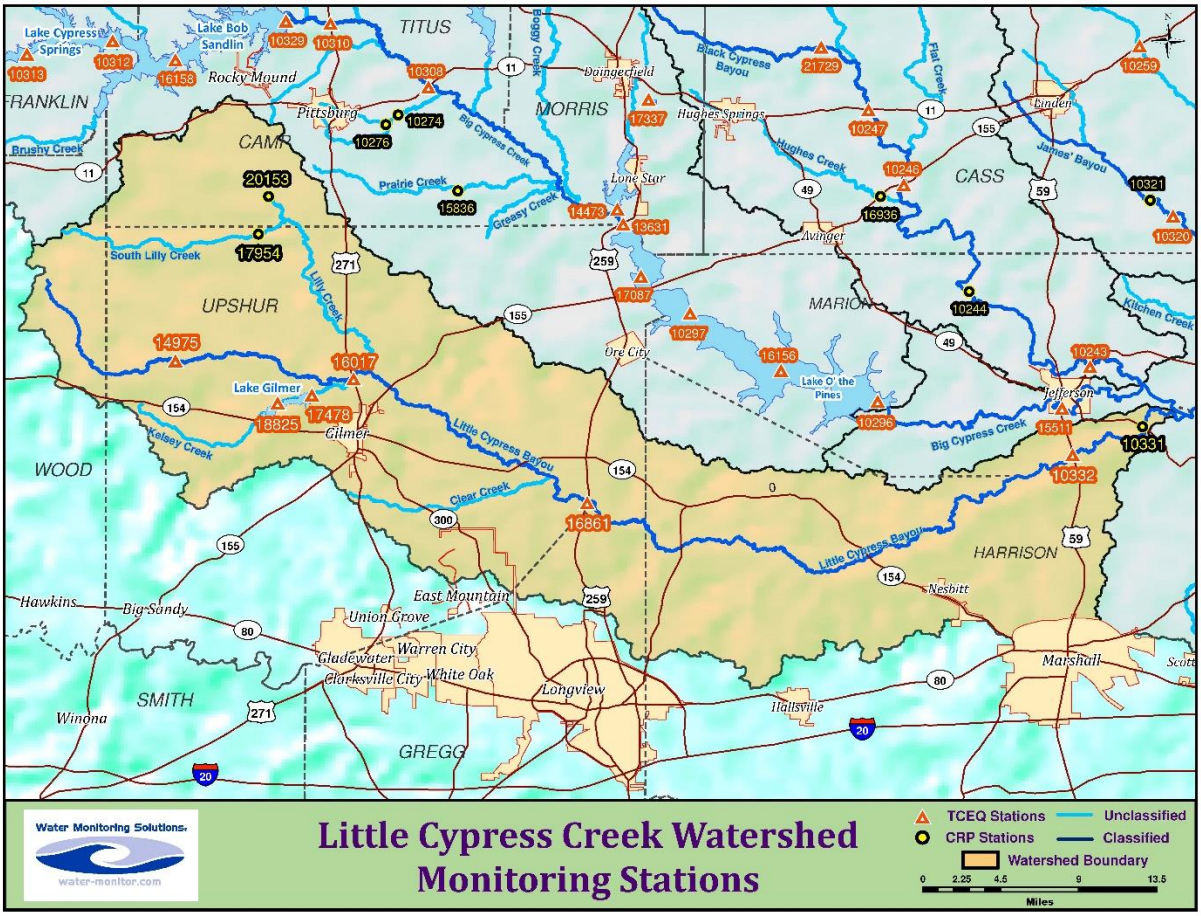

Figure 36: *Little Cypress Creek Watershed Monitoring Stations*

0409 – Little Cypress Bayou (Creek)

Little Cypress Bayou emerges in the pineywoods southeast of Winnsboro. The bayou forms much of the southern boundary of the Cypress Creek Basin, and joins Big Cypress Creek east of Jefferson. The segment was identified as impaired for low levels of dissolved oxygen in 2000 and for elevated bacteria levels in 2006. The *2014 Texas §303(d) List* confirmed the impairment. Data collected since 2014 indicate elevated bacteria and low dissolved oxygen levels are still present. TCEQ Region 5 sampled flow, bacteria, and for field and conventional parameters quarterly at stations 10332, 15773, 16017, and 16861 in 2017.

Figure 37: *Little Cypress Creek at FM 134*

0409A – Lilly Creek

Lilly Creek originates two miles west of Pine in Camp County and flows southeast for nine miles to its confluence with Little Cypress Creek. Concerns for depressed dissolved oxygen and bacteria are shown in the2014 IR. In 2017, quarterly sampling was conducted at station 20153 (Lilly Creek at FM 556) for bacteria and for conventional and field parameters.

0409B – South Lilly Creek

South Lilly Creek is an intermittent tributary of Lilly Creek in Upshur County. The watershed is comprised of pastures and forested land; there are no population centers. Much of riparian vegetation along the stream has been removed. South Lilly Creek was first identified as impaired for bacteria on the *2006 Texas §303(d) List*. The impairment continued in the 2014 assessment. Data collected since 2014 indicates that bacteria levels remain elevated. Sampling continues in 2018.

0409D – Lake Gilmer

Lake Gilmer is located in central Upshur County and has no concerns or impairments. Quarterly monitoring is conducted by TCEQ Region 5 at stations 17478 and 18825 for bacteria and for conventional and field parameters.

0409E – Clear Creek

Clear Creek is a small stream located in Upshur County and is a tributary to Little Cypress Creek. The 2014 IR shows a concern for non-attainment for impaired benthic community along with a concern for screening level of an impaired habitat.

Outreach and Education

Each year NETMWD provides a venue for local stakeholders to learn about water in their region and provide input on projects in their communities. In 2017, NETMWD and its Clean Rivers Program partners continued to reach out to the public to educate and help resolve local water quality issues. A CRP Steering Committee meeting was held in March at NETMWD executive offices in Hughes Springs. Topics included zebra mussel research by USGS, upgrades to Pilgrim's Pride WWTP, Camp County water monitoring by TWRI, an invasive species update from TPWD, and an update on the Lake 'O the Pines TMDL.

Please visit http://www.netmwd.com/cleanriversprogram.html to learn more about the Cypress Creek Basin or if you are interested in becoming a Clean Rivers Program Steering Committee member.

Figure 38: *Stakeholder property tour of Best Management Implementation project*

References

Beil, L. “Creature from the Green Lagoon.” *Texas Monthly* Aug. 2017. Online.
https://features.texasmonthly.com/editorial/creature-green-lagoon/
(December 2, 2017)

Fuller, S. (2017, Dec. 12). *Compound patented by SFA's National Center for Pharmaceutical Crops shows promise in treating cancer.*
http://www.sfasu.edu/9696.asp
(December 16, 2017)

LCRA. 2017. Texas Coordinated Monitoring Schedule
https://cms.lcra.org/
(December 17, 2017w).

Robertson, S., Mayes, K., Linam, G., Parker, M., Robertson, C., Grubh, A., Magnelia, S. & Casarez, M. *2016. Cypress Basin Bioassessment Marion and Harrison Counties, Texas* (River Studies Report No. 24). Austin, TX: Texas Parks and Wildlife Dept.

State of Texas. *Texas Administrative Code. Chapter 307, in Part One, of Title 30*.
https://texreg.sos.state.tx.us/public/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y
(December 4, 2017).

TCEQ. Watershed Protection Plans for Nonpoint Source Water Pollution.
https://www.tceq.texas.gov/waterquality/nonpoint-source/mgmt-plan/watershed-pp.html
(December 20, 2017)

TCEQ. Recreational Use Attainability Analyses
https://www.tceq.texas.gov/waterquality/standards/ruaas
(December 20, 2017)

TCEQ. 2006. Clean Rivers Program Long Term Plan.
https://www.tceq.texas.gov/waterquality/clean-rivers
(December 2, 2017).

TCEQ. 2010. Preserving and Improving Water Quality: Programs of the Texas Commission on Environmental Quality for Managing the Quality of Surface Waters. GI-351.
https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/08twqi/pollution_control.pdf

TCEQ. 2012. *Surface Water Quality Monitoring Procedures. Volume One.*
https://www.tceq.texas.gov/publications/rg/rg-415
(December 15, 2017).

TCEQ. 2014. *Surface Water Quality Monitoring Procedures. Volume Two.*
https://www.tceq.texas.gov/publications/rg/rg-416
(December 15, 2017).

TCEQ. 2014. *Total Maximum Daily Load and Implementation Plan for Lake O' the Pines*
http://www.tceq.texas.gov/waterquality/tmdl/nav/19-lakepines/19-pinelakes-tmdlplan
(January 16, 2018).

TCEQ. 2014. *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d).*
https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir
(December 1, 2017).

TCEQ. 2015. *Texas Clean Rivers Program Guidance, FY 2016-2017*.
http://www.tceq.texas.gov/waterquality/clean-rivers/guidance/index.html
(November 30, 2017).

USACE. Lake O' the Pines Master Plan Revision
http://www.swf.usace.army.mil/About/Lakes-and-Recreation-Information/Master-Plan-Updates/Lake-O-The-Pines/
(January 15, 2018)

Appendix A

A Summary of Regulatory Framework for Texas Surface Water Quality

Texas Surface Water Quality:

What Is It, and How Is It Measured?

In order to protect water quality, we must define and measure it. The state of Texas has established standards that protect the purposes for which the streams, lakes, and estuaries in the state will be used, and defined measurements that determine whether the water quality is good enough to attain those uses. Based on these standards, the Texas Commission on Environmental Quality (TCEQ), in concert with other federal, regional, and local organizations, carries out a regular program of monitoring and assessment to determine which water bodies are meeting the standards set for their use, and which are not. The state produces a periodic report, the *Texas Water Quality Integrated Report for Clean Water Act Sections §305(b) and §303(d)*, which compares water quality conditions to established standards, as required by the federal Clean Water Act (CWA).

Texas Surface Water Quality Standards

- designate the uses, or purposes, for which the state's waterways should be suitable;
- establish numerical and narrative criteria for water quality throughout the state;
- provide a basis on which TCEQ regulatory programs can establish reasonable methods to implement and attain the state's goals (criteria) for water quality.

Water quality criteria are designed to be protective of uses. Substantial deviations from criteria indicate that related uses might be impaired. For example, the concentration of dissolved oxygen is one criterion for determining the attainment of the aquatic life use. Where oxygen concentrations are low, the use of the water body to support aquatic life might be impaired. However, since other factors affect the health of an aquatic environment, additional data, such as the presence of a high number and variety of species, may show that the use is fully attained, even if oxygen concentrations are lower than the criterion.

Four major categories for water use are defined in the *Texas Surface Water Quality Standards*:

- Aquatic life use
- Contact recreation (swimming)
- Public water supply
- Fish and shellfish consumption

Aquatic Life Use

The standards associated with this use are designed to protect aquatic species, and to protect the propagation of both aquatic and terrestrial species. They establish optimal conditions for the support of aquatic life and define indicators used to measure whether these conditions are met. Some pollutants or conditions that may violate this standard include low levels of dissolved oxygen, or high concentrations of toxics such as metals or pesticides dissolved in water.

Contact Recreation

The standard associated with this use measures the level of certain bacteria in water that indicate the relative risk of swimming or other water sports involving direct contact with the water. It is possible to swim in water that does not meet this standard without becoming ill; however, the probability of becoming ill is higher than it would be if bacteria levels were lower.

Public Water Supply

Standards associated with this use indicate whether water from a lake or river is suitable for use as a source for a public water supply system. Source water is treated before it is delivered to the tap. A separate set of standards governs treated drinking water. Indicators used to measure the safety or usability of surface water bodies as a source for drinking water include the presence or absence of substances such as metals or pesticides. Concentrations of salts, such as sulfate or chloride, are also measured, since treatment to remove elevated levels of salts from drinking water may be expensive.

Fish Consumption

The standards associated with this use are designed to protect the public from consuming fish or shellfish that may be contaminated by pollutants in the water. The standards identify levels at which there is a significant risk that certain toxic substances dissolved in water may accumulate in the tissue of aquatic species. Because toxic substances in water may exceed these levels while no accumulation in fish tissue is observable, the state conducts tests on fish and shellfish tissue to determine if there is a risk to the public from consuming fish caught in state waters. The standards also specify bacterial levels in marine waters to assure that oysters or other shellfish subject to commercial harvest and marketing are safe for public sale and consumption. Indicators of water quality that are not tied to specific uses—such as dissolved solids, nutrients, and toxic substances in sediment—are also described in the standards.

Texas Water Quality Integrated Report

The *Texas Water Quality Integrated Report for Clean Water Act Sections §305(b) and §303(d)* is an overview of the status of surface waters of the state, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources. More than 700 water bodies are assessed in Texas. The *Texas §303(d) List*, a subset of the report, identifies:

- water bodies that do not attain one or more of the standards set for their use, or are expected not to meet one or more uses in the near future;
- which pollutants or conditions are responsible for the failure of a water body to attain standards;

Common limitations in water quality include:

- bacteria levels that exceed the criterion established to assure the safety of contact recreation
- dissolved oxygen levels that are lower than the criterion established to assure optimum conditions for aquatic life
- total dissolved solids, sulfate, and chloride that exceed the criteria established to safeguard general water quality uses
- contaminants in fish tissue that pose a risk to consumers

Some water bodies also have:

- toxic substances in water that exceed the criterion to protect aquatic life
- conditions of acidity (measured as pH) and high temperature that exceed the criteria to safeguard general water quality uses

Indicators of Water Quality

Several different parameters are measured to determine whether a water body meets the standards for its use. Some of the most common are listed here, with an explanation of why they are important to the health of a water body.

Bacteria

E. coli and Enterococci bacteria are measured to determine the relative risk of swimming (contact recreation), depending on whether the water body is fresh or marine. These bacteria originate from the wastes of warm-blooded animals. The presence of these bacteria indicates that associated pathogens from these wastes may be reaching a body of water. Sources may include inadequately treated sewage, improperly managed animal waste from livestock, pets in urban areas, aquatic birds and mammals, or failing septic systems.

Dissolved Oxygen

The concentration of dissolved oxygen is a single, easy-to-measure characteristic of water that correlates with the occurrence and diversity of aquatic life in a water body. A water body that can support diverse, abundant aquatic life is a good indication of high water quality. A problem frequently related to dissolved oxygen concentrations are an excess of nutrients in water. Large quantities of nutrients in water can cause excessive growth of vegetation. This excessive vegetation, in turn, can cause low dissolved oxygen.

Dissolved Solids

Elevated levels of dissolved solids such as chloride and sulfate can cause water to be unusable, or simply too costly to treat for drinking water uses. Changes in dissolved solids concentrations also affect the quality of habitat for aquatic life.

Metals

High concentrations of metals such as cadmium, mercury, and lead pose a threat to drinking water supplies and human health. Eating fish contaminated with metals can cause these toxic substances to accumulate in human tissue, posing a long-term significant health threat. Metals also pose a threat to livestock and aquatic life. Potentially dangerous levels of metals and other toxic substances are identified through chemical analysis of water, sediment, and fish tissue.

Organics

Toxic substances from pesticides and industrial chemicals pose the same concerns as metals. PCBs, for example, are industrial chemicals that are toxic and probably carcinogenic. Although banned in the United States in 1977, PCBs remain in the environment, and they accumulate in fish and human tissues when consumed.

Fish Consumption Advisories and Closures

The Texas Department of State Health Services conducts chemical testing of fish tissue to determine whether there is a risk to human health from consuming fish or shellfish caught in Texas streams, lakes, and bays. Fish seldom contain levels of contaminants high enough to cause an imminent threat to human health, even to someone who eats fish regularly. When a fish consumption advisory is issued, a person may legally take fish or shellfish from the water body, but fish advisories may recommend an amount of fish that should be consumed. When a fish consumption closure is issued for a water body, the taking of fish or shellfish is legally prohibited.

The mission of the North East Texas Municipal Water District is to protect the water quality in the Cypress Creek Basin and to provide a sufficient supply of water to Northeast Texas.

To participate in the Cypress Creek Basin Clean Rivers Program, contact:

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4180 FM 250 S
Hughes Springs, Texas 75656
903-639-7538
www.netmwd.com

This report was prepared by Water Monitoring Solutions, Inc. for the Northeast Texas Municipal Water District in cooperation with the Texas Commission on Environmental Quality Clean Rivers Program.