EAST FORK TRINITY RIVER - LAVON LAKE WATERSHED DATA REPORT

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The Meadows Center for Water and the Environment
Texas State University
Texas Stream Team

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ACKNOWLEDGEMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary citizen science programs. We also provide hands-on opportunities for Texas State University students and inspire future careers and studies in natural resource related fields. Preparation of this report fulfills a contract deliverable for the granting entity, but it also serves as a valuable educational experience for the students that assisted in preparing the report. The Texas Stream Team staff values the student contributions and recognizes each individual for their role. The following staff and student workers assisted in the preparation of this report and are acknowledged for their contributions:

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INTRODUCTION

Texas Stream Team

Texas Stream Team is a volunteer citizen science water quality monitoring program. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at approximately the same time of day each month. Information collected by Texas Stream Team citizen scientists is covered by a Texas Commission on Environmental Quality-approved Quality Assurance Project Plan to ensure a standard set of methods are used. Citizen scientist data may be used to identify surface water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures. Texas Stream Team citizen scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality standards. Data collected by Texas Stream Team provide valuable records, often collected in water bodies professionals are not able to monitor frequently or monitor at all.

For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer citizen science monitoring, please refer to the following sources:

- Texas Stream Team Core Water Quality Citizen Scientist Manual
- Texas Stream Team Advanced Water Quality Citizen Scientist Manual
- Texas Stream Team Program Volunteer Water Quality Monitoring Program Quality Assurance Project Plan
- Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures

The purpose of this report is to provide a summary of the data collected by Texas Stream Team citizen scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports for a holistic view of water quality in the East Fork Trinity River –Lavon Lake Watershed in the Trinity River Basin. Such sources may include, but are not limited to, the following:

- Texas Surface Water Quality Standards
- Texas Water Quality Inventory and 303(d) List (Integrated Report)
- Texas Clean Rivers Program partner reports, such as Basin Summary and Highlight Reports
- Texas Commission on Environmental Quality Total Maximum Daily Load reports
- Texas Commission on Environmental Quality and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including watershed protection plans

To get involved with Texas Stream Team or for questions regarding this watershed data report contact us at TxStreamTeam@txstate.edu or at (512) 245-1346. Visit our website for more information on our programs at www.TexasStreamTeam.org.

WATERSHED DESCRIPTION

Location and Climate

The East Fork is one of four branches of the Trinity River that drains the East Fork Trinity River – Lavon Lake Watershed which spans 325.8-square miles (Figure 1). The watershed encompasses the City of McKinney, Texas (66.96 square miles), in Collin County. At the headwaters, the East Fork begins to flow about one and a half miles northwest of Dorchester, Texas, in south central Grayson County (Handbook of Texas, 2022). This area is important locally for aesthetics, recreation, and for the ecosystem it supports, but it is also historically significant, provides recreational opportunities, and a business-friendly environment that allows the community to thrive (McKinney Texas, 2022).

The Trinity River was named by Alonso De León in 1690, called La Santísima Trinidad, "the Most Holy Trinity." Beginning in the early 19th century, the river was used as a commerce highway by steamboats to transport various goods such as groceries, cotton, sugar, cowhides, and more to surrounding communities. Navigation and river traffic fell off with the construction of railroads to Dallas in the early 1870s. Over the past century, the waters of the Trinity have become increasingly polluted from agricultural runoff, dumping of industrial waste, and improper handling of human wastewater (Gard, 2022).

The Texas Commission on Environmental Quality designates classifications for stream segments in the Trinity River Basin and throughout Texas (Table 1). Both Wilson Creek (Segment 0821C) and East Fork Trinity River above Lake Lavon (Segment 0821D) flow into Lake Lavon (Segment 0821) near Lowry Crossing. Lake Lavon is designated as a sole-source surface drinking water supply for the residents of the McKinney area as adopted by the commission under Texas Water Code, §26.023.

The climate in this part of the state is described as humid subtropical with snowfall occurring at least once every winter (Bomar, 2022). National Oceanic and Atmospheric Administration (NOAA) climate data from a weather station at Throckmorton Creek in Anna, Texas, and McKinney Municipal Airport in McKinney was acquired from the National Data Center (NOAA, 2020). Precipitation at Throckmorton was 42.7 inches annually and occurred year-round (Figure 2). Long-term monthly average precipitation has a bimodal distribution with peaks occurring in May and October. Average rainfall during these months was 5.04 and 4.88 inches each month, respectively. The least amount of rainfall (2.34 inches) occurred in August. The warmest and coldest months of the year were July (28.5°C) and January (7.22°C), respectively.

Figure 1. East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin County and Grayson County, Texas.

Table 1. Texas Commission on Environmental Quality segment classifications (Texas Commission on Environmental Quality, 2022).

Segment Number	Segment Name	Segment Description
0821	Lake Lavon	From Lavon Dam in Colling County up to the normal pool elevation of 492 feet (impounds East Fork Trinity River).
0821C	Wilson Creek	From the confluence with Lake Lavon in Collin County up to West FM 455 (NHD RC 12030106000086), just east of Celina, Collin Co., Texas.
0821D	East Fork Trinity River above Lake Lavon	A portion of the East Fork Trinity River extending from the confluence with Lake Lavon (segment 0821) to the upper end of the water body (NHD RC 12030106000074) in Grayson County, Texas.

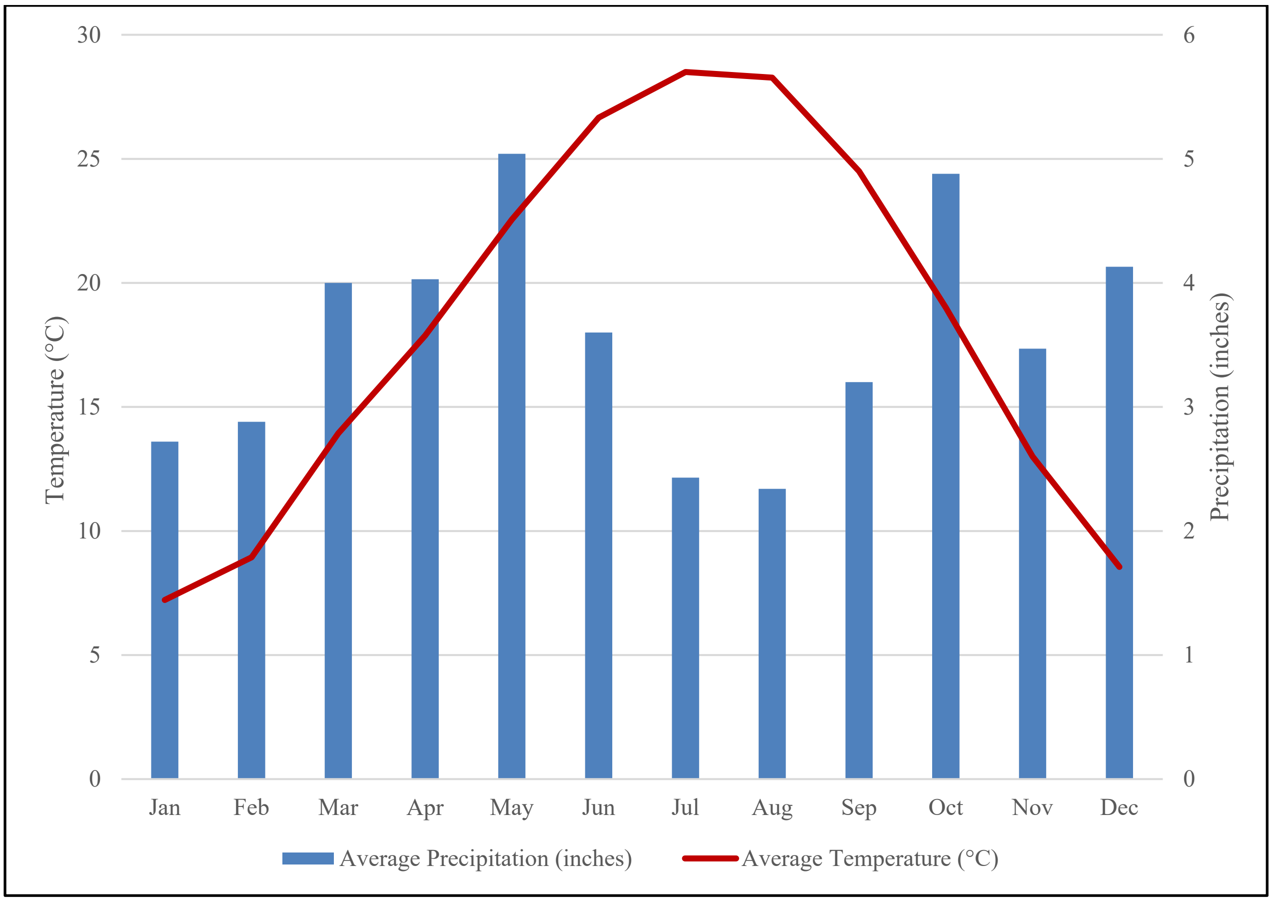

Figure 2. Long-term (1991-2020) monthly average precipitation (inches) and air temperature (°C) from Throckmorton Creek in Anna, Texas and McKinney Municipal Airport in McKinney, Texas (National Oceanic and Atmospheric Administration Climate Data, 2020).

Physical Description

The East Fork Trinity River – Lavon Lake Watershed is in the upper Trinity River Basin near McKinney, Texas, where Wilson Creek and the East Fork Trinity River drain into Lake Lavon. The landscape is described as flat to rolling terrain with Cross Timbers and Blackland Prairie comprised of oak, juniper, water-tolerant hardwoods, conifers, and grasses. Soils that support the landscape include deep to shallow clay soils, clay loam, and sandy loam (Gard, 2022). Mineral resources found in the area include limestone, sand, gravel, oil, gas, and bituminous coal (Minor and Kumler, 2022).

This area supports diverse wildlife including deer, opossums, raccoons, skunks, snakes, foxes, bobcats, bats, squirrels, and armadillos along with an assortment of birds, fish, and reptiles (McKinney Texas, 2022). Historically, before widespread urbanization, the area also supported black bears (TPWD, 2022).

Land Use

Land cover types were identified and mapped for the East Fork Trinity River – Lavon Lake Watershed (Figure 3) (National Land Cover Data, 2016). Eighty-four percent of the land cover in the watershed consists of grassland (33.4%), planted/cultivated (25.65%), developed land (21.82%), and open water (3.65%) (Table 2). The remaining land use types, open water (3.65%), shrub (1.2%), woody wetlands (0.6%), emergent herbaceous wetlands (0.4%), and bare (0.1%), comprise less than 6% of the remainder of the watershed by area.

Table 2. Land use in the East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin County and Grayson County, Texas (National Land Cover Data, 2016).

Land Use Type	Acres (ac)	Hectares (ha)	Percent (%)
Grassland	69,651.98	28,187.16	33.40
Cultivated	53,497.68	21,649.74	25.65
Developed	45,497.92	18,412.35	21.82
Forest	27,713.63	11,215.31	13.29
Open Water	7,622.19	3,084.59	3.65
Shrub	2,461.96	996.32	1.18
Woody Wetlands	1,228.87	497.31	0.59
Emergent Herbaceous Wetlands	752.91	304.69	0.36
Bare	126.15	51.05	0.06
Total	**208,553.29**	**84,398.52**	**100.00**

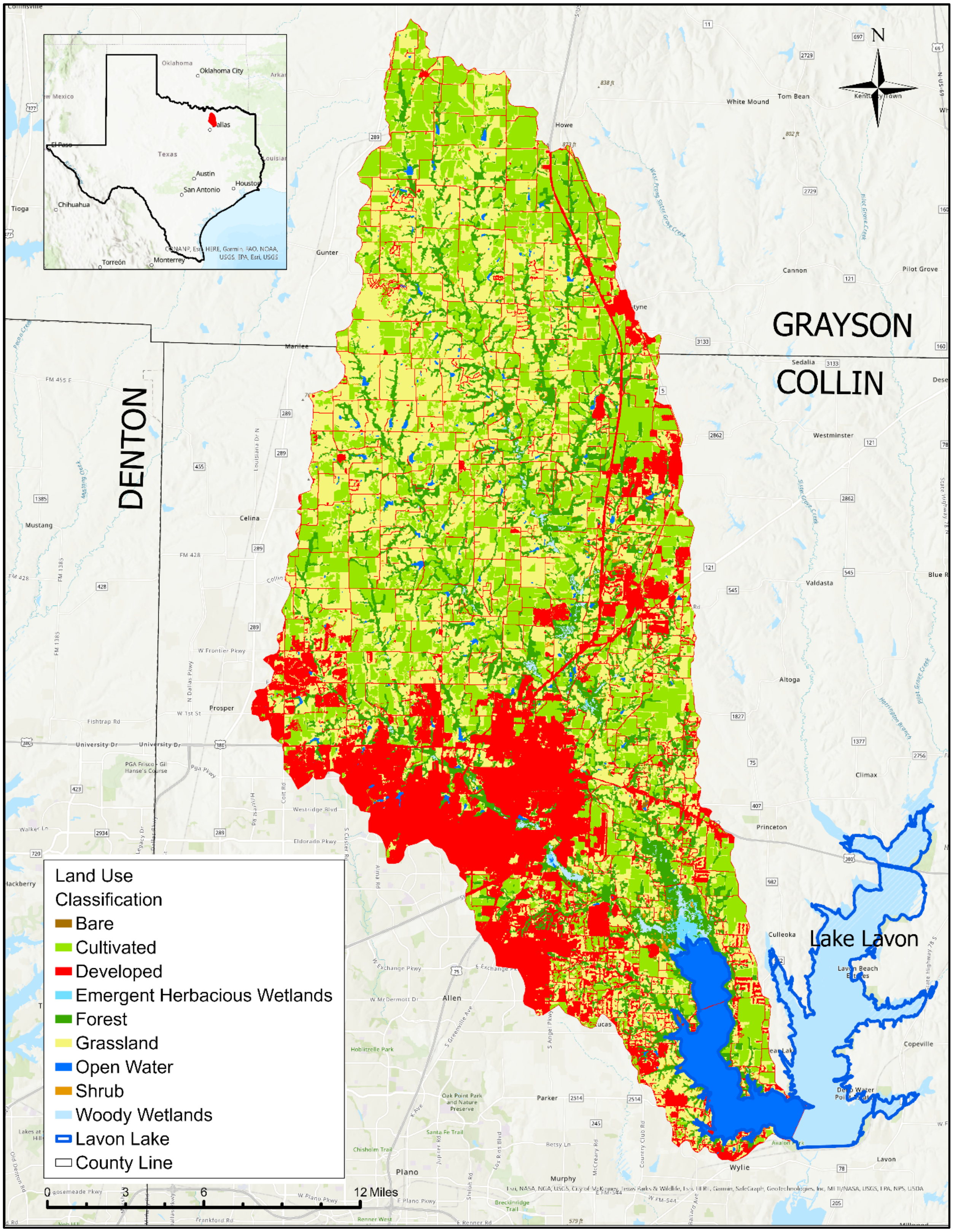

Figure 3. Land cover for East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin County and Grayson County, Texas (National Land Cover Data, 2016).

History

The area known as Collin County was first inhabited by the Caddo Indians before being colonized and settled by pioneers in 1841 (Minor, 2022). The county and city were named after Collin McKinney who signed the Texas Declaration of Independence in 1836, and the city was voted to be the county seat in 1848. (McKinney Texas, 2022).

The city experienced population growth, primarily because of the prosperous cotton industry. The area later flourished due to the Houston and Texas Central Railway and the navigable Trinity River being used as commerce highways to ship goods (Gard and Minor, 2022). The rich fertile soils of the Blackland Prairie allowed farmers to produce large amounts of corn, wheat, and oats making Collin County a top producer in the state during the late 1800s. This prosperity meant increased construction of needed facilities and would sow the seeds of the growing city we know today as McKinney (McKinney Texas, 2022).

Endangered Species and Conservation Needs

The common names of 15 species listed as threatened or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) within the McKinney area are included in Appendix A at the end of this report. A summary of the number of species per taxonomic group listed as state or federally endangered, threatened, G1 or G2 (critically imperiled or imperiled), species of greatest conservation need, and/or endemic are provided in Table 3.

Table 3. State and federally listed species in the East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin and Grayson Counties, Texas.

Taxon	Endangered (Federal or State)	Threatened (Federal or State)	G1 or G2 (Critically imperiled or imperiled)	Species of Greatest Conservation Need (NPWD) (S1 or S2)	Endemic Total Count
Amphibians	0	0	0	0	4
Birds	1	5	1	6	11
Fish	0	4	0	2	9
Mammals	0	1	0	3	11
Reptiles	0	2	0	4	10
Crustaceans	0	0	2	2	2
Insects	0	0	1	0	2
Mollusks	0	2	2	2	2
Plants	0	0	0	2	6
Total Count	**1**	**14**	**6**	**21**	**57**

Texas Water Quality Standards

The Texas Surface Water Quality Standards establish explicit goals for the quality of streams, rivers, lakes, and bays throughout the state. The standards are developed to maintain the quality of surface waters in Texas to support public health and protect aquatic life, consistent with the sustainable economic development of the state. Water quality standards identify appropriate uses for the state's surface waters, including aquatic life, recreation, and sources of public water supply as drinking water. The criteria for evaluating support of those uses in the classified segments of Wilson Creek (Segment 0821C) and the East Fork Trinity River above Lake Lavon (Segment 0821D) included in this report are provided in Table 4. The total dissolved solids criteria are for maximum annual averages, the dissolved oxygen criteria are for minimum 24-hour dissolved oxygen means at any site within the segment, the minimum and maximum values for pH apply to any site within the segment, the *E. coli* indicator bacteria for freshwater is a geometric mean, and the temperature criteria is a maximum value at any site within the segment.

The Texas Surface Water Quality Standards also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, and other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference to indicate when water quality parameters may be approaching levels of concern.

Table 4. State water quality criteria in the East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin County and Grayson County, Texas (Texas Commission on Environmental Quality, 2018).

Segment	**Total Dissolved Solids (mg/L)**	**Dissolved Oxygen (mg/L)**	**pH Range (s.u.)**	***E. coli* Bacteria (#/100 mL)**	**Temperature (°C)**
0821C – Wilson Creek	400	Minimum 24-hour mean: 4.0 Grab minimum: 3.0	6.5-9.0	Primary Contact Recreation: 126 geometric mean, 399 single sample	33.9
0821D – East Fork Trinity River above Lake Lavon	400	Minimum 24-hour mean: 4.0 Grab minimum: 3.0	6.5-9.0	Primary Contact Recreation: 126 geometric mean, 399 single sample	33.9

Water Quality Impairments

The *2022 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Integrated Report) assessed Lavon Lake (Segment 0821), Wilson Creek (Segment 0821C) and the East Fork Trinity River above Lake Lavon (Segment 0821D) and found bacteria in water (recreation use) as an impairment in the latter two segments. These segments are designated as a Category 5C, additional data and information will be collected or evaluated before a management strategy is selected.

WATER QUALITY PARAMETERS

Water Temperature

Water temperature influences the physiological processes of aquatic organisms, and each species has an optimum temperature for survival. High water temperatures increase oxygen-demand for aquatic communities and can become stressful for fish and aquatic insects. Water temperature variations are most detrimental when they occur rapidly, leaving the aquatic community no time to adjust. Additionally, the ability of water to hold oxygen in solution (solubility) decreases as temperature increases. This effect is exacerbated in coastal water bodies influenced by tidal, saline waters.

Warm water temperatures occur naturally with seasonal variation, as water temperatures tend to increase during summer and decrease in winter in the Northern Hemisphere. Daily (diurnal) water temperature changes occur during normal heating and cooling patterns. Man-made sources of warm water include power plant effluent after it has been used for cooling or hydroelectric plants that discharge warm water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases because of the monthly sampling frequency. While citizen scientist data may not show diurnal temperature fluctuations, they could demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and monthly frequencies.

Specific Conductance and Salinity

Specific conductance is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per centimeter (µS/cm). A body of water is more conductive if it has more total dissolved solids such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lead to eutrophication, which results in lower levels of dissolved oxygen. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of total dissolved solids can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants.

Salinity is a measure of the saltiness or the dissolved inorganic salt concentration in water. Salinity is often measured in ocean, estuarine, or tidally-influenced waters, but in Texas there are some inland streams that have a high salt content due to the local geology and require salinity measurements. Some common ions measured as salinity include sodium, chloride, magnesium, sulfate, calcium, and potassium. Seawater typically has a salt content of 35 parts per thousand (ppt or ‰). Like other water quality parameters, salinity affects the homeostasis or the balance of water and solutes within both plants and animals. Too much or too little salt can affect plant and animal cell survival and growth, therefore salinity is an important measurement.

Dissolved Oxygen

Oxygen is necessary for the survival of organisms like fish and aquatic insects. The amount of oxygen needed for survival and reproduction of aquatic communities varies according to species composition and adaptations to watershed characteristics like stream gradient, habitat, and available streamflow.

The dissolved oxygen concentrations can be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation and algae growth, which may starve subsurface vegetation of sunlight and, therefore, reduce the amount of oxygen they produce via photosynthesis. This process is known as eutrophication. Low dissolved oxygen can also result from high groundwater inflows (which have low dissolved oxygen due to minimal aeration), high temperatures, or water releases from deeper portions of dams where dissolved oxygen stratification occurs. Supersaturation typically occurs underneath waterfalls or dams with water flowing over the top where aeration is abundant.

pH

The pH scale measures the concentration of hydrogen ions on a range from zero to 14 and is reported in standard units (s.u.). The pH of water can provide information regarding acidity or alkalinity. The range is logarithmic; therefore, every one-unit change is representative of a 10-fold increase or decrease in acidity or alkalinity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is predominantly caused by coal powered plants with minimal contributions from the burning of other fossil fuels and other natural processes, such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields that have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition, as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water soluble, and as it dissolves it forms carbonic acid. A suitable pH range for healthy organisms is between 6.5 and 9.0 s.u.

Water Transparency and Total Depth

Two instruments can be used by Texas Stream Team citizen scientists to measure water transparency, a Secchi disc or a transparency tube. Both instruments are used to measure water transparency or to determine the clarity of the water, a condition known as turbidity. The Secchi disc is lowered into the water until it is no longer visible, then raised until it becomes visible, and the average of the two depth measurements is recorded. A transparency tube is filled with sample water and water is released until the Secchi pattern at the bottom of the tube can be seen. The tube is marked with two-millimeter increments and is used to measure water transparency. Transparency measurements less than the total depth of the monitoring site are indicative of turbid water. Readings that are equal to total depth indicate clear water. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow less light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the dissolved oxygen in the water due to reduced photosynthesis. Contaminants are mostly transported in sediment rather than in the water. Turbid waters can result from sediment runoff from construction sites, erosion of farms, or mining operations.

E. coli and Enterococci Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The United States Environmental Protection Agency has determined *E. coli* to be the best indicator of the degree of pathogens in a freshwater system. A pathogen is a biological agent that causes disease.

Enterococci bacteria are a subgroup of fecal streptococci bacteria (mainly *Streptococcus faecalis* and *Streptococcus faecium*) that are present in the intestinal tracts and feces of warm-blooded animals. It is used by the Texas Commission on Environmental Quality as an indicator of the potential presence of pathogens in tidally-influenced saltwater along the Texas Gulf Coast.

The segments within the East Fork Trinity River -Lavon Lake Watershed are designated a primary contact recreation 1 use. This means that recreation activities are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, hand fishing as defined by Texas Parks and Wildlife Code, §66.115, and the following whitewater activities: kayaking, canoeing, and rafting).

The standard for a bacteria impairment is based on the geometric mean (geomean) of the bacteria measurements collected. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* and enterococci which can vary from zero to tens of thousands of colony forming units per 100 milliliters (CFU/100 mL). The standard for contact recreational use of a water body is 126 CFU/100 mL for *E. coli* in freshwater or 35

CFU/100 mL for enterococci in saltwater. A water body is considered impaired if the geometric mean is higher than the corresponding water quality standard.

Texas Stream Team does not monitor water quality for enterococci in coastal waters, instead citizen scientists can get certified in *E. coli* bacteria monitoring, the indicator used by the Texas Commission on Environmental Quality for freshwater streams.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as nitrate-nitrogen, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with Texas Commission on Environmental Quality (TCEQ) and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most living organisms. Nitrogen inputs into a water body may be from livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect excess nitrogen has on a water body is known as eutrophication and is described previously in the "Dissolved Oxygen" section. Nitrate-nitrogen dissolves more readily than orthophosphate, which tend to be attached to sediment, and, therefore, can serve as a better indicator of possible sewage or manure pollution during dry weather.

Orthophosphate

Orthophosphate is the phosphate molecule all by itself. Phosphorus almost always exists in the natural environment as phosphate, which continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for orthophosphate detects the amount of phosphate in the water itself, excluding the phosphate bound up in plant and animal tissue. There are other methods to retrieve the phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by citizen scientists. Testing for orthophosphate provides an idea of the degree of phosphate in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be caused by the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect excess orthophosphate has on a water body is known as eutrophication and is described above in the "Dissolved Oxygen" section.

DATA COLLECTION, MANAGEMENT AND ANALYSIS

Data Collection

The field sampling procedures implemented by trained citizen scientists are documented in the Texas Stream Team Core Water Quality Citizen Scientist Manual and the Texas Stream Team

Advanced Water Quality Citizen Scientist Manual. The sampling protocols in the manuals adhere closely to the Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team's approved Quality Assurance Project Plan.

Procedures documented in Texas Stream Team Water Quality Citizen Scientist Manuals or the Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field quality control samples are collected and analyzed to detect whether contamination has occurred and to ensure data accuracy and precision.

Field sampling activities are documented on Environmental Monitoring Forms. The following items are recorded for each field sampling event: station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, meter calibration information, and reagent expiration dates. Specific conductance values are converted to total dissolved solids using a conversion factor of 0.65 and are reported as mg/L.

Values for measured parameters are recorded. If reagents or media are expired, it is noted, and data are flagged and communicated to Texas Stream Team staff. Sampling is not permitted with expired reagents or bacteria media; the corresponding values will be flagged in the database and excluded from data reports. Detailed observational data recorded include water appearance, weather, field observations (biological activity and stream uses), algae cover, unusual odors, days since last significant rainfall, and flow severity. Comments related to field measurements, number of participants, total time spent sampling, and total round-trip distance traveled to the sampling site are also recorded for grant reporting and administrative purposes.

Data Management

The citizen scientists collect field data and report the measurement results to Texas Stream Team, by submitting a hard copy of the Environmental Monitoring Form, entering the data directly into the online Waterways Dataviewer, or by using the Electronic Monitoring Form. All data are reviewed to ensure they are representative of the samples analyzed and locations where measurements were made. The measurements and associated quality control data are also reviewed to ensure they conform to specified monitoring procedures and project specifications as stated in the approved Quality Assurance Project Plan.

Data review and verification is performed using a quality control checklist and self-assessments, as appropriate to the project task, followed by automated database functions that validate data as the information is entered into the database. The data are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. Once entered, the data can be accessible publicly through the online Texas Stream Team Datamap.

Data Analysis

Data were compiled, analyzed, summarized, and compared to state water quality standards and/or criteria to provide readers with a reference point for parameters that may be of concern. The statewide, biennial assessment performed by the Texas Commission on Environmental Quality involves more stringent monitoring methods and oversight than those used by citizen scientists and staff in this report. The Texas Stream Team citizen scientist water quality monitoring data are not currently used in the Texas Commission on Environmental Quality assessments mentioned above. However, the Texas Stream Team data are intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern to plan future monitoring efforts.

All data collected by citizen scientists in the study watersheds were exported from the Texas Stream Team database and grouped by site. Sites with 10 or more monitoring events were maintained in the dataset for analysis. Sites with fewer than 10 monitoring events were excluded from the analysis for this report but may be used in future data summary reports. Once compiled, data were sorted, summary statistics were generated and reviewed, and results were graphed in JMP Pro 14.0.0 (SAS Institute Inc., 2018) using standard methods. Best professional judgement was used to verify outliers. Outlier box or scatter plots were prepared to provide a compact view of the distribution of the data for each parameter and site(s). The horizontal line within the box plot represents the median sample value, while the ends of the box represent the 25^{th} and 75^{th} quantiles or the interquartile range. The lines extending from each end of the box, or whiskers, are computed using the $25^{th}/75^{th}$ quartiles ± 1.5 x (interquartile range). Outliers are plotted as points outside the box plot.

DATA RESULTS

Water quality data from eight Texas Stream Team monitoring sites in the East Fork Trinity River – Lavon Lake Watershed were acquired for analysis (Figure 4). Two sites are representative of the water quality in the East Fork Trinity River, five sites are representative of Wilson Creek, then the remaining site represents the unclassified tributary White Rock Creek which flows into Lavon Lake. Trained citizen scientists conducted between 16 and 189 sampling events at each site, for a total of 730 monitoring events (Table 5). The period of record for the sampling events ranged from June 1995 to July 2022, with all sites experiencing temporal intermittent sampling.

Site Analysis

Water quality monitoring data from the eight sites were analyzed and summarized including the number of samples, mean/geometric mean, standard deviation, and range of values (Table 6).

Citizen scientists monitored the sites for standard core, *E. coli* bacteria, and advanced water quality monitoring parameters, including air and water temperature, conductivity, total dissolved solids, dissolved oxygen, pH, Secchi disc/tube transparency, total depth, *E. coli*, nitrate-nitrogen, and orthophosphate.

Air and Water Temperature

Average air temperature for all sites ranged from 24.9 to 18.4°C (Table 6). The lowest mean air temperature (18.4°C) was observed in an unnamed tributary to Wilson Creek (Site 15064). The highest mean air temperature (24.9°C) was observed in the East Fork Trinity River (Site 81254).

Average water temperature ranged from 21.5°C in the East Fork Trinity River (Site 81254) to 17.4°C at Jean's Creek (Site 81019), a tributary to Wilson Creek (Table 6). Water temperatures were below the water quality standard at all sites except site 81020 on Wilson Creek (35.1°C) on July 31, 2022 (Figure 5), during one of the hottest years on record.

Specific Conductance and Total Dissolved Solids

Specific conductance values were derived from total dissolved solids. Average total dissolved solid values ranged from 476 mg/L in an unnamed tributary flowing to Wilson Creek (Site 15064) to 181 mg/L in the East Fork Trinity River (Site 81254) (Table 6). The total dissolved solid water quality standard for the East Fork Trinity River – Lavon Lake Watershed is 400 mg/L. Average total dissolved solids were below the standard at most sites except two, 15064 and 81019, both on Wilson Creek (Table 6). However, all sites flowing to Wilson Creek and White Rock Creek exhibited values greater than the water quality standard (>400 mg/L) during the period of record for this study (Figure 6), therefore the data were distributed above that threshold.

Table 5. Texas Stream Team monitoring sites in the East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin and Grayson Counties, Texas.

Site ID	Description	Number of Samples (n)	Period of Record
East Fork Trinity River			
81254	Chambersville Lake @ CR 971	16	7/2/2016 – 2/5/2019
81253	Pond @ Erwin Park	35	8/16/2016 - 6/30/2022
Wilson Creek			
81020	Wilson Creek @ Lake Forest Dr.	93	3/26/2014 - 7/31/2022
81019	Jean's Creek @ University Dr.	91	3/26/2014 – 7/31/2022
15611	Wilson Creek East of US 75 SW of McKinney	189	4/16/1996 – 7/19/2022
15064	Unnamed Tributary @ Wilson Creek	170	11/27/2006 – 7/19/2022
15610	Wilson Creek @ Collin CR 323 East of Fairview	109	6/28/1995 - 7/17/2022
White Rock Creek			
81435	White Rock Creek at Snider Lane outside Lucas	27	5/21/2018 – 9/30/2020
	TOTAL	**730**	

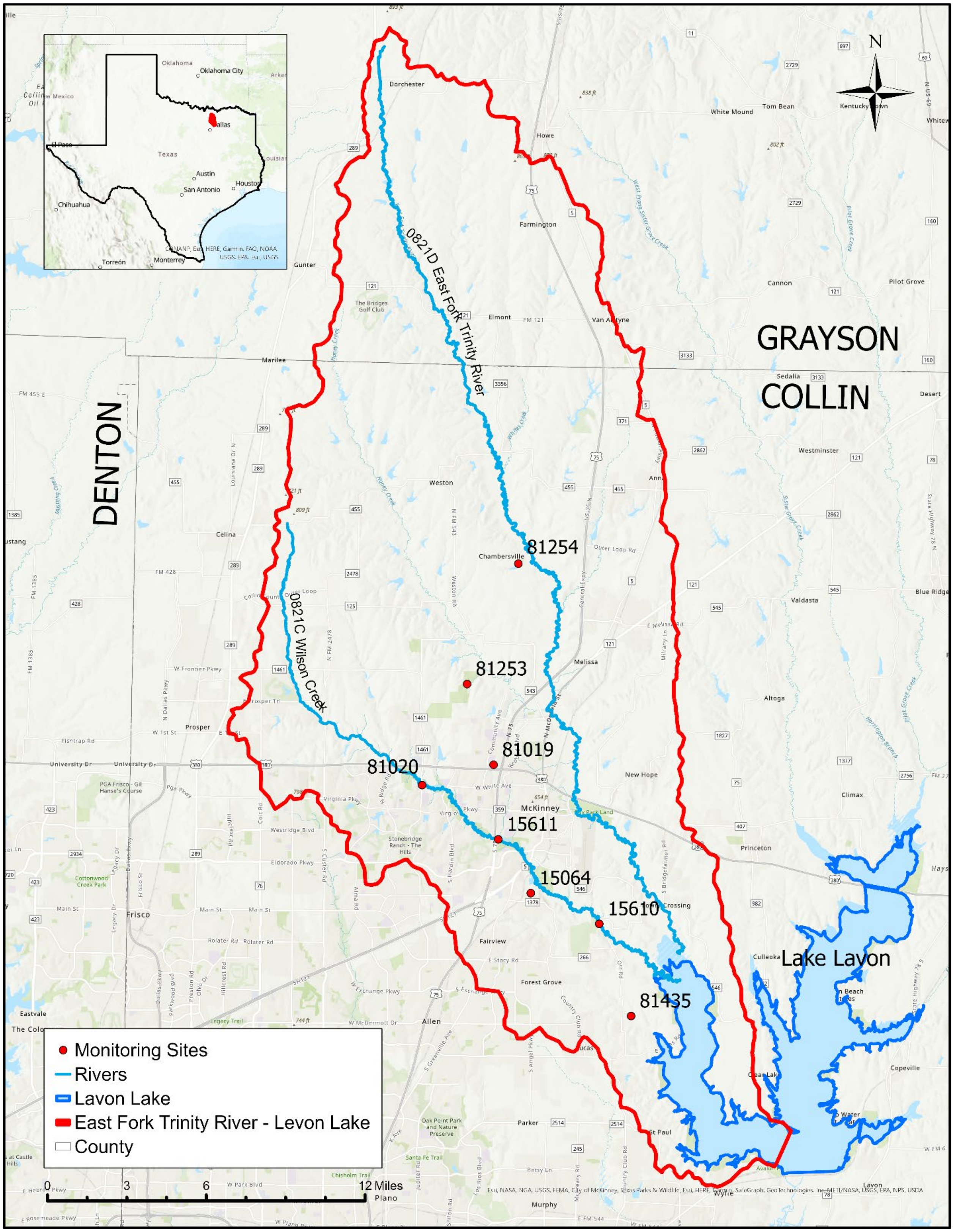

Figure 4. Texas Stream Team monitoring sites in East Fork Trinity River – Lavon Lake Watershed within the Upper Trinity River Basin in Collin and Grayson Counties, Texas.

Table 6. Texas Stream Team data summary for sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022).

Parameter	East Fork Trinity River		Wilson Creek					White Rock Creek
	ID 81254 n=16	ID 81253 n=35	ID 81020 n=93	ID 81019 n=91	ID 15611 n=189	ID 15064 n=170	ID 15610 n=109	ID 81435 n=27
Air Temp. (°C)	24.9±8.1 (32.0)	22.3±7.1 (30.0)	19.5±8.3 (34.0)	19.0±7.5 (36.0)	20.9±7.9 (35.5)	18.4±7.3 (32.5)	19.6±7.6 (35.0)	23.0±5.1 (17.0)
Water Temp. (°C)	21.5±7.8 (25.0)	20.2±6.4 (23.0)	18.1±7.0 (30.1)	17.4±6.1 (23.0)	18.3±7.7 (32.5)	17.8±5.6 (27.5)	18.4±6.3 (24.0)	18.7±5.7 (16.0)
Specific Conductance (µS/cm)	278±46 (160)	441±90 (387)	607±120 (670)	644±129 (680)	592±99.7 (480)	732±126 (770)	602±108 (470)	601±84 (290)
*Total Dissolved Solids (mg/L)	181±30 (104)	286±59 (252)	395±78 (436)	419±84 (442)	385±65 (312)	476±82 (501)	391±40 (306)	391±55 (189)
Dissolved Oxygen (mg/L)	6.6±1.9 (7.3)	5.6±2.1 (9.1)	8.2±2.0 (10.4)	6.9±2.3 (11.1)	7.8±1.8 (8.3)	5.4±1.8 (8.7)	7.5±2.1 (11.1)	6.6±1.5 (5.2)
pH (s.u.)	7.1±0.2 (0.5)	7.6±0.4 (1.2)	7.5±1.0 (8.9)	7.5±0.5 (3.4)	7.9±0.2 (1.8)	7.4±0.3 (1.1)	7.6±0.3 (1.1)	7.4±0.2 (0.5)
Secchi Tube Transp. (m)	ND	0.8±0.3 (1.1)	0.9±0.9 (7.2)	0.6±0.4 (1.1)	0.6±0.4 (1.2)	0.8±0.3 (1.0)	0.7±1.0 (7.5)	1.2±0.1 (0.4)
Secchi Disc Transp. (m)	1.7±0.6 (1.9)	ND	0.5±0.5 (2.2)	0.2±0.1 (0.2)	0.4±0.2 (0.9)	0.4±0.2 (0.7)	0.6±0.3 (0.9)	ND
Total Depth (m)	2.4±0.7 (2.7)	0.7±0.2 (0.7)	0.5±0.4 (1.4)	0.4±0.6 (4.4)	0.5±0.3 (1.4)	0.4±0.2 (0.8)	0.7±0.9 (4.1)	0.9±0.3 (1.3)
E. coli (CFU/100 ml)	ND	ND	295 (1,768)	425 (3,432)	342 (4,000)	195 (2,664)	436 (4,710)	ND
Nitrate-nitrogen (mg/L)	ND	ND	ND	0.5±0.7 (1.0)	0.4±0.5 (1.0)	0.5±0.5 (1.5)	0.6±0.5 (1.0)	ND
Orthophosphate (mg/L)	ND	ND	0.02±0.02 (0.02)	0.02±0.02 (0.0)	0.01±0.01 (0.02)	0.01±0.01 (0.0)	0.4±0.5 (0.08)	ND

*Total dissolved solids (TDS) were calculated from specific conductance (TDS = specific conductance * 0.65).

**Geometric mean was calculated for *E. coli*.

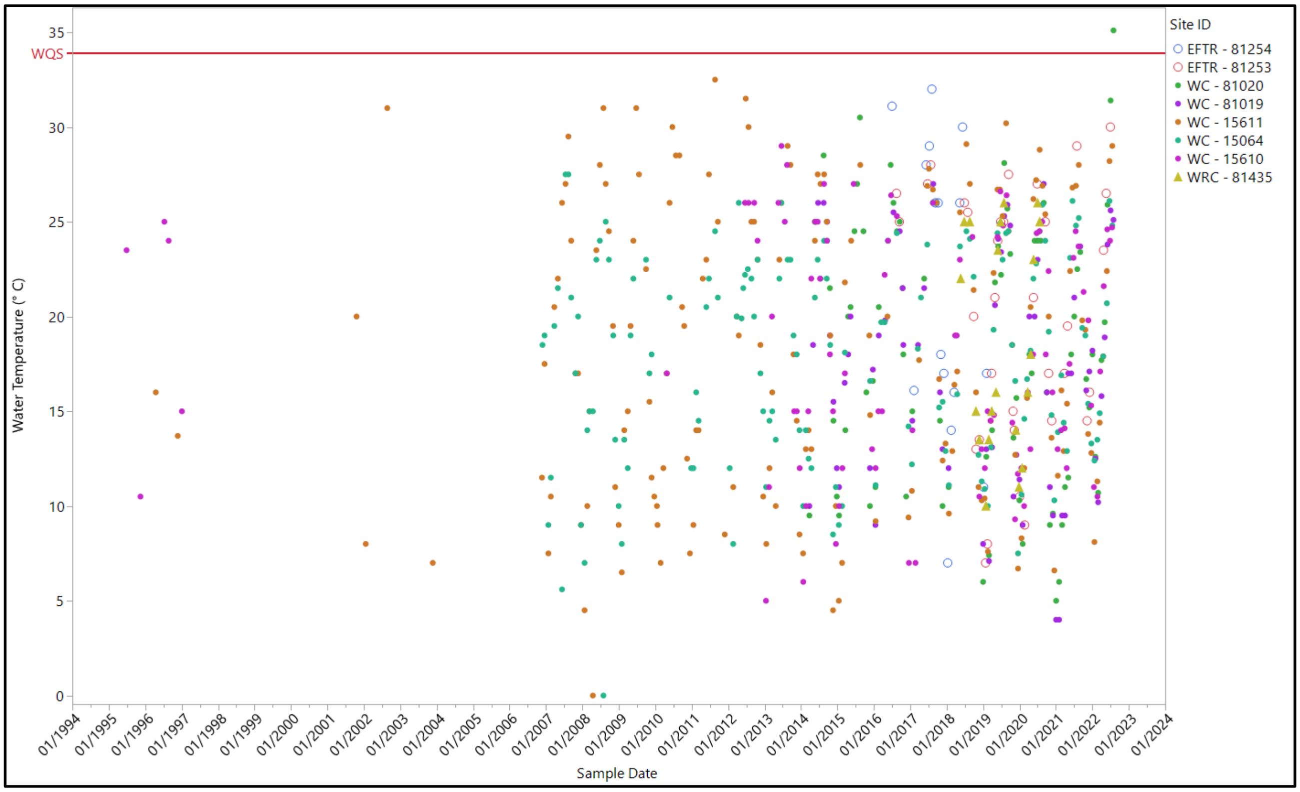

Figure 5. Water temperature for Texas Stream Team sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022). WQS = Water Quality Standard.

Dissolved Oxygen

Average dissolved oxygen values at all eight sites in both watersheds were above the water quality standard of 5.0 mg/L (Table 6). The range of average dissolved oxygen values for all sites spanned from 5.4 to 8.2 mg/L. The distribution of dissolved oxygen measurements for each site are displayed in Figure 7. Individual dissolved oxygen values extended below the average and minimum water quality standard at four sites (Sites EFTR-81253, WC-81019, WC-15064, and WC-15610) during the period of record evaluated, but all sites had averages at or above the water quality standard (Table 6).

pH

Average pH values at all sites were within the range of the water quality standards (6.5 to 9.0 s.u.) (Table 6). The average range of values was between 7.9 and 7.1 s.u. at all sites. Two sites on Wilson Creek, WC-81020 and WC-81019, exhibited values below the minimum water quality standard (Figure 8).

Transparency and Total Depth

Secchi tubes and discs were used for measuring transparency at the sites monitored in the East Fork Trinity River – Lavon Lake Watershed (Table 6). The average Secchi tube transparency values reported at seven sites (81253, 81020, 81019, 15611, 15064, 15610, and 81435) where this parameter was measured ranged from 0.6 to 1.2 m. The average range of Secchi disc transparency values where this parameter was measured was from 0.2 to1.7 m (Table 6).

Total depth was measured at all sites monitored (Table 6). The average deepest site (2.4 m) was at Chambersville Lake on the East Fork Trinity River (Site 81254), while the two shallowest sites (0.4 m) were on Wilson Creek at 81019 and 15064.

E. coli Bacteria

E. coli bacteria was measured at five sites on Wilson Creek, but not at any of the remaining sites on the East Fork Trinity River or White Rock Creek. The geometric means of *E. coli* bacteria at all sites exceeded the water quality standard (126 CFU/100mL) and ranged from 195 to 436 CFU/100 mL (Table 6). The distribution of *E. coli* values at all sites on Wilson Creek are predominantly above the water quality standard (Figure 9).

Nitrate-Nitrogen

Nitrate-nitrogen (mg/L) was measured at four sites on Wilson Creek from June 1995 to July 2022 (n=59), but not at any of the other sites on East Fork Trinity River or White Rock Creek. The TCEQ established a screening criterion for nitrate (1.95 mg/L), but not a water quality standard. The average range of the measurements was from 0.4 to 0.6 mg/L (Table 6), all well below the screening criterion. The highest value (0.6 mg/L) was measured at site 15610 – CR 323 east of Fairview, while the lowest value (0.4 mg/L) was measured at site 15611 - east of US 75 southwest of McKinney.

Orthophosphate

Orthophosphate (mg/L) was measured at five sites on Wilson Creek from January 2013 to April 2021 (n=62), but not at any of the other sites on East Fork Trinity River or White Rock Creek. The TCEQ established a screening criterion for phosphates (0.69 mg/L), but not a water quality standard. The average range of orthophosphate measurements was from 0.4 to 0.01 mg/L (Table 6), all below the screening criterion. The highest value (0.4 mg/L) was measured at site 15610 – CR 323 east of Fairview, while the lowest value (0.01 mg/L) was measured at site 15064 – unnamed tributary to Wilson Creek.

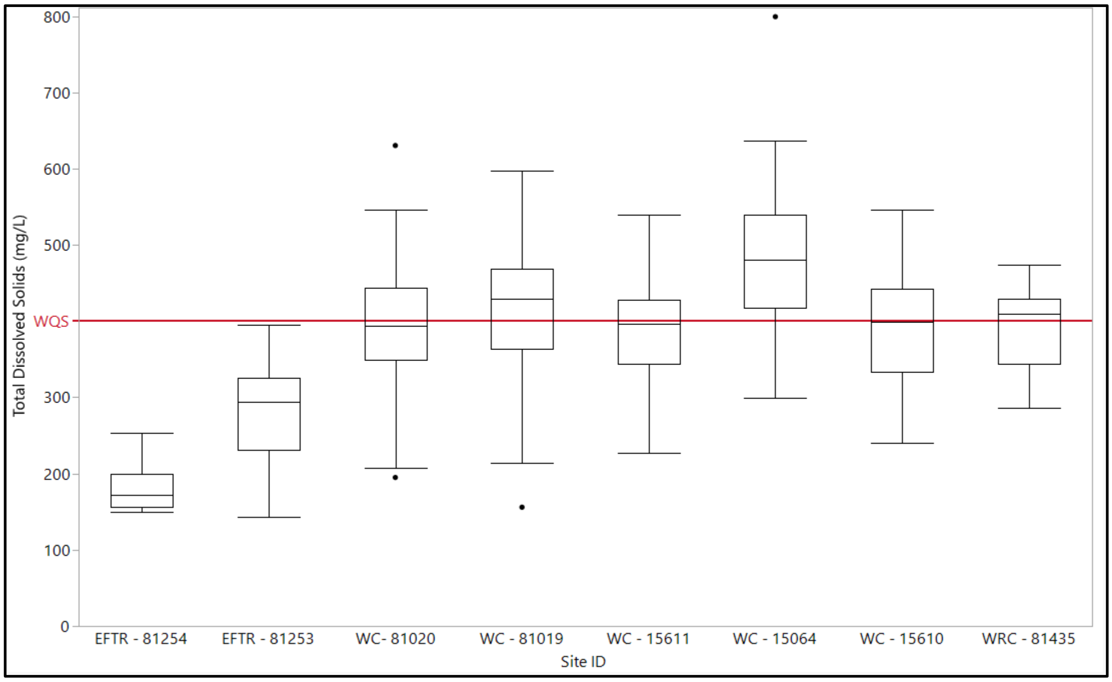

Figure 6. Total dissolved solids (mg/L) for Texas Stream Team sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022). WQS = Water Quality Standard.

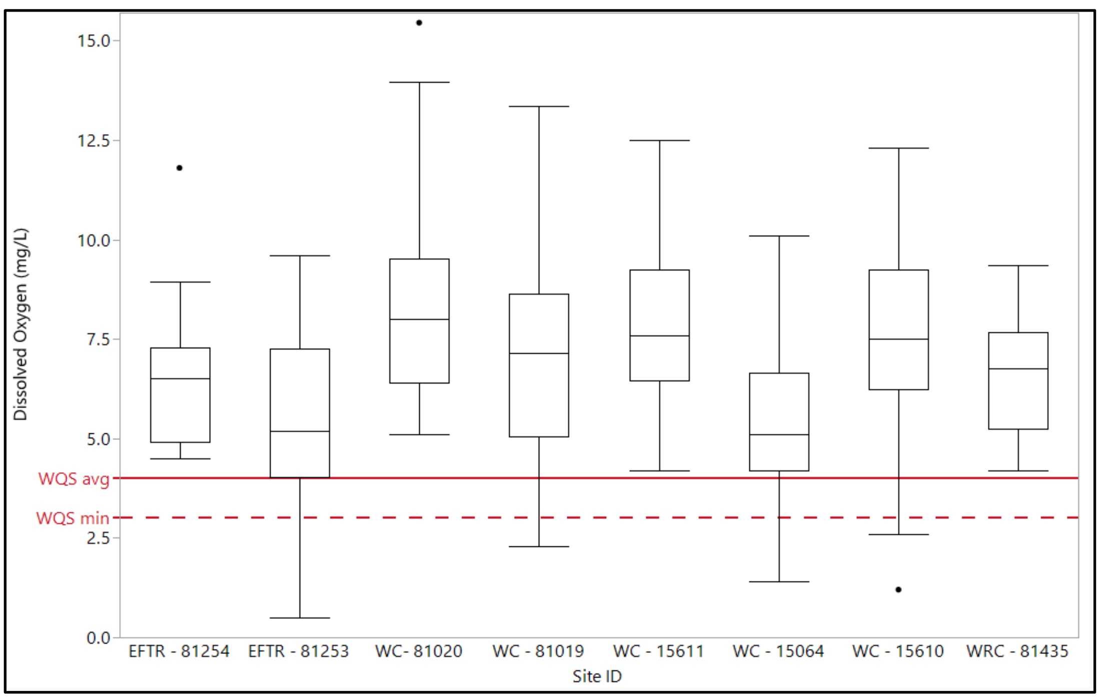

Figure 7. Dissolved oxygen (mg/L) for Texas Stream Team sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022). WQS avg = 24-hour mean Water Quality Standard, and WQS min = grab minimum.

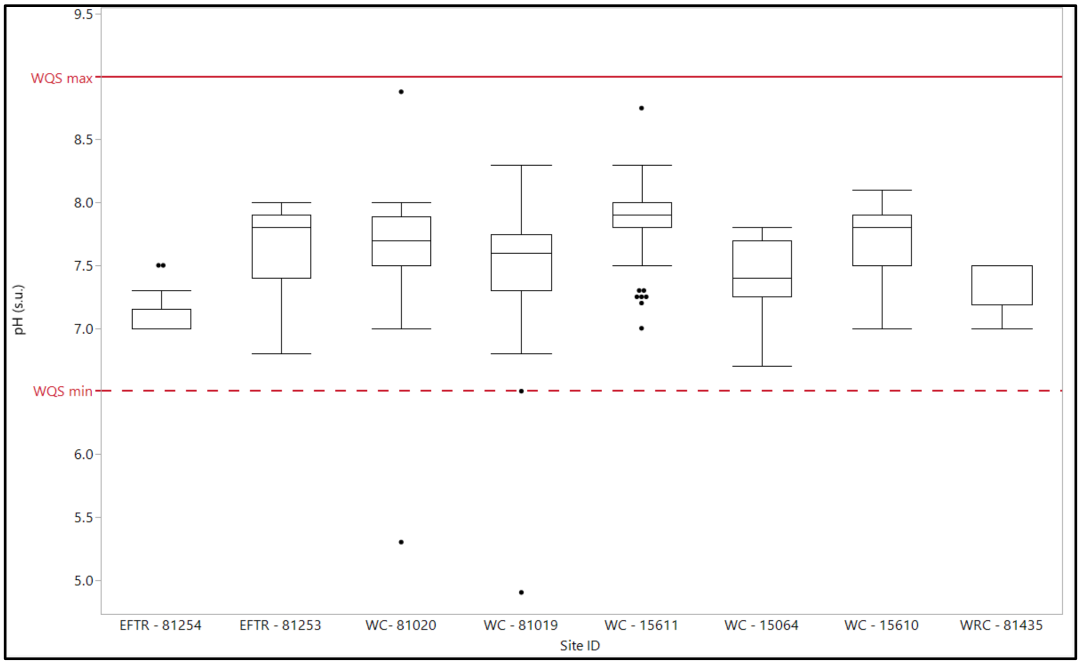

Figure 8. pH (s.u.) for Texas Stream Team sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022).

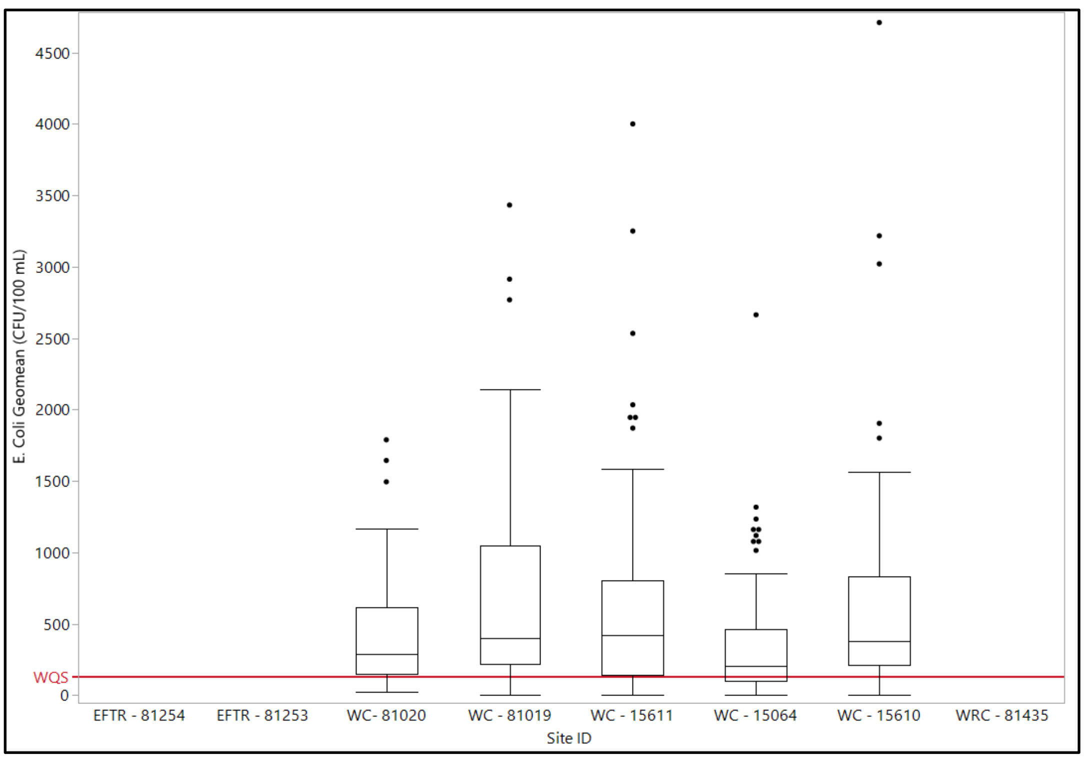

Figure 9. E. coli bacteria (CFU/100 mL) for Texas Stream Team sites on the East Fork Trinity River (EFTR), Wilson Creek (WC), and White Rock Creek (WRC) within the East Fork Trinity River – Lavon Lake Watershed (Jun 1995 to Jul 2022).

WATERSHED SUMMARY

Texas Stream Team citizen scientists monitored standard core, advanced and *E. coli* bacteria water quality parameters at eight sites in the East Fork Trinity River – Lavon Lake Watershed from June 1995 to July 2022. Two sites are on the East Fork Trinity River, five sites are on Wilson Creek, while the remaining site is on the unclassified segment White Rock Creek. The East Fork Trinity River – Lavon Lake Watershed receives river water from the two classified segments included in this report, the East Fork Trinity River and Wilson Creek.

Parameters monitored by Texas Stream Team citizen scientists included water and air temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, transparency, total depth, *E. coli* bacteria, nitrate-nitrogen, and orthophosphate. Data from the eight monitoring sites were analyzed and summarized in this report.

The classified segments included in this report, the East Fork Trinity River and Wilson Creek, were assessed by the Texas Commission on Environmental Quality in the *2020 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)*. The assessment resulted in impairments or exceedances of the water quality standard for the contact recreation use and the corresponding indicator bacteria *E. coli*. The TCEQ findings coincide with findings in this data summary report, whereby all five sites monitored for *E. coli* on Wilson Creek also exceeded the geometric mean water quality standard of 126 CFU/100 mL. In addition, the distribution of most measurements from each site were also above the water quality standard. With the growing human population and increased development in this part of the state, these findings should be of concern to residents and decision-makers.

Other noteworthy results presented in this data summary report includes an exceedance of the water temperature standard in July 2022 at site 81020 on Wilson Creek. The value reported was 35.1°C and it is the only exceedance of the water quality standard in the past 27-year period of record, during one of the hottest years on record. The average total dissolved solids standard was also exceeded at two sites on Wilson Creek and four sites were within 10-20 mg/L of exceeding the standard on Wilson and White Rock Creeks.

Dissolved oxygen, nitrate-nitrogen, and orthophosphate measurements were well within the corresponding water quality standard. However, it is noteworthy to praise the volunteers in the watershed for taking the initiative to monitor these and other advanced parameters continuously for almost three decades. These data will serve as background conditions for future monitoring as this area continues to grow.

The Texas Stream Team citizen scientists monitoring standard core, advanced, and *E. coli* bacteria water quality parameters in the East Fork Trinity River – Lavon Lake Watershed are encouraged to continue monitoring. Continuation of the ongoing monitoring is crucial due to the results presented here and the potential for increased development in the watershed. There is a need for continued water quality monitoring for the development of long-term data sets. Information gathered thus far has been useful to describe current water quality conditions. Continuation of this monitoring will allow future trend analysis to capture changes in water quality as the area grows. Texas Stream Team will continue to support citizen scientists by providing technical support, creating new monitoring sites, and re-activating existing sites. We look forward to training new citizen scientists to expand, grow, and sustain the water quality monitoring efforts in this area and beyond. For more information about Texas Stream Team and upcoming trainings contact us at TxStreamTeam@txstate.edu or visit the calendar of events on our website at www.TexasStreamTeam.org.

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Appendix A.

Table 7. Endangered species located within the East Fork Trinity River – Lavon Lake Watershed.

Species Type	Common Name	Federal/State Listing
Birds	Whooping Crane	Federally Listed as Endangered, State Listed as Endangered

Table 8. Threatened species located within the East Fork Trinity River – Lavon Lake Watershed.

Species Type	Common Name	Federal/State Listing
Birds	White-faced Ibis	State Listed as Threatened
	Wood Stork	State Listed as Threatened
	Black Rail	Federally Listed as Threatened, State Listed as Endangered
	Piping Plover	Federally Listed as Threatened, State Listed as Endangered
	Rufa Red Knot	Federally Listed as Threatened, State Listed as Endangered
Fish	Shovelnose Sturgeon	State Listed as Threatened
	Paddlefish	State Listed as Threatened
	Chub Shiner	State Listed as Threatened
	Blue Sucker	State Listed as Threatened
Mammals	Black Bear	State Listed as Threatened
Reptiles	Alligator Snapping Turtle	State Listed as Threatened
	Texas Horned Lizard	State Listed as Threatened
Mollusks	Louisiana Pigtoe	State Listed as Threatened
	Texas Heelsplitter	State Listed as Threatened