LOWER NUECES RIVER 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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Texas Commission on Environmental Quality

Texas State University
The rising STAR of Texas

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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-based 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 TCEQ-approved Quality Assurance Project Plan (QAPP) to ensure that a standard set of methods are used. The 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. The data collected by Texas Stream Team provide valuable records, often collected in portions of a water body that 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 (TCEQ) 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 lower Nueces River watershed. Such sources include, but are not limited to, the following:

- Texas Surface Water Quality Standards
- Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)
- Texas Clean Rivers Program (CRP) partner reports, such as Basin Summary and Highlight Reports
- TCEQ Total Maximum Daily Load (TMDL) reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including Watershed Protection Plans (WPPs)

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 Nueces River Basin spans approximately 17,000 square miles including all or part of 23 Texas counties. Its origin is in Edwards County, an arid region of Texas, extending in a south-southeasterly direction for approximately 315 miles before intersecting Nueces Bay near Corpus Christi. The Nueces River Basin lies south of the Colorado, Guadalupe, and San Antonio River Basins and the San Antonio-Nueces Coastal Basin, and north of the Rio Grande River Basin and Nueces-Rio Grande Coastal Basin. The Nueces River Basin is comprised of three major rivers and their tributaries: Atascosa, Frio, and Nueces. The rivers throughout the basin are primarily used as a drinking water supply and for recreational purposes. There are two major reservoirs within the basin, the Choke Canyon Reservoir near Three Rivers and Lake Corpus Christi near Mathis, along with numerous state-operated recreational areas.

TCEQ designated 18 segments in the Nueces River Basin. The Texas Stream Team citizen scientist water quality monitoring stations are located on three segments in the lower portion of the basin, 2101-Nueces River Tidal, 2102-Nueces River Below Lake Corpus Christi, and 2103-Lake Corpus Christi (Figure 1). The remaining designated TCEQ river segments are not currently being monitoring by Texas Stream Team citizen scientists. Therefore, the remainder of this report will focus on the three segments being monitored by the Texas Stream Team citizen scientists and this area will be referred to as the lower Nueces River watershed.

Long-term climate data from Mathis (NOAA Station 15661) in the lower Nueces River watershed was acquired from the National Oceanic and Atmospheric Administration, Climate Data Center (Figure 2). The Mathis area exhibits an average of 82.2 cm of precipitation annually. Monthly mean precipitation values had a bimodal distribution, with highs occurring in June (10.7 cm) and September (10.8 cm), and the lowest means occurring in December (3.7 cm). Mean high and low air temperatures in the area occurred in August (29.5 °C) and January (12.6 °C), respectively.

Physical Description

The Nueces River receives its source water from springs on the Edwards Plateau. The Frio and Atascosa rivers converge with the Nueces River in Live Oak County near Three Rivers forming the mainstem. River flow descends through the Balcones Escarpment and flows through the Gulf Coastal Plains of Texas before flowing into Nueces Bay.

The two reservoirs in the basin, Choke Canyon and Lake Corpus Christi, serve as municipal and industrial water supplies, as a source of electric power, and for recreation. Two of the four sites monitored by Texas Stream Team citizen scientists are located on Lake Corpus Christi.

In 1935, then President Franklin Roosevelt funded construction of the Wesley Seale Dam and Lake Corpus Christi was born. In 1958, the present dam was completed in response to concerns surrounding reduced storage capacity due to silting. Lake Corpus Christi is now one of the largest man-made water bodies in Texas expanding 21,000 acres and with a capacity of 300,000-acre feet.

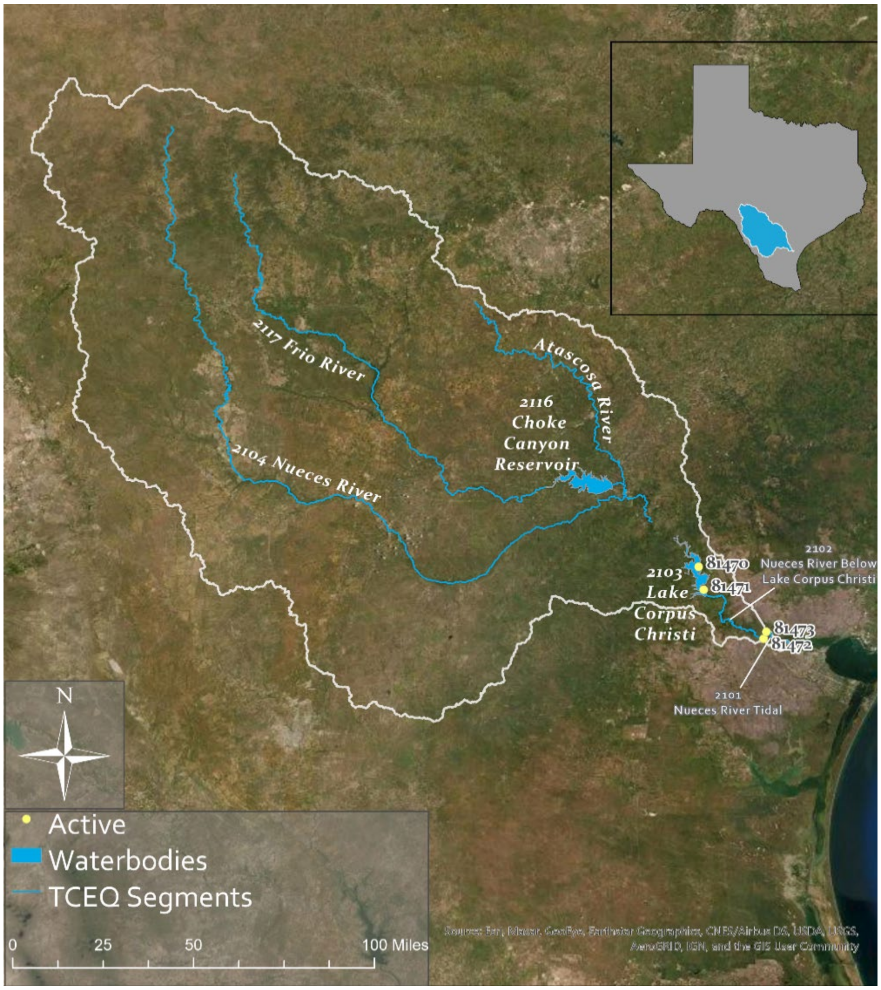

Figure 1. Nueces River Basin and location within the state of Texas.

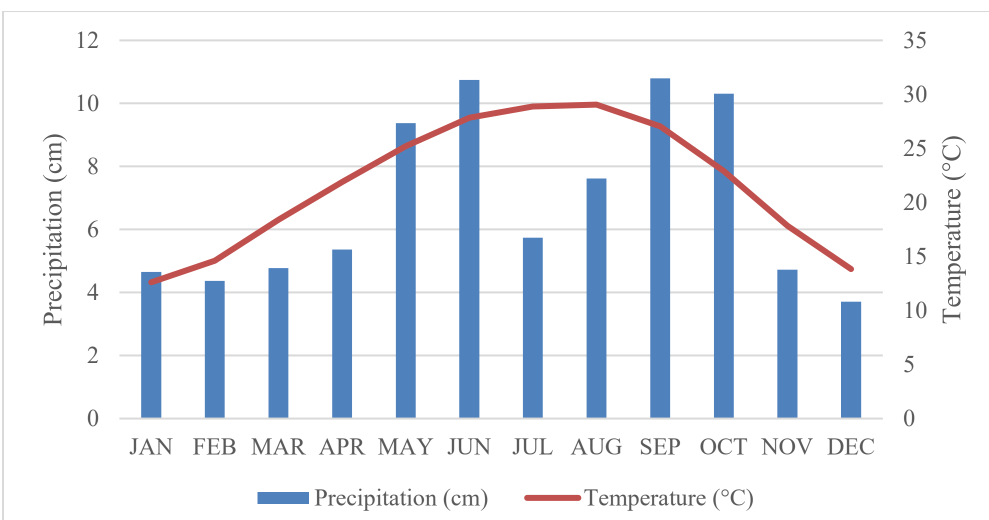

Figure 2. Long-term (1971-2000) monthly average precipitation (cm) and air temperature (°C) from Mathis, Texas (NOAA Climate Data, 2020).

Land Use

The Nueces River watershed is predominantly rural, with the City of Corpus Christi being the only metropolis in the watershed, located on the southern shoreline of Nueces Bay. Land use within the Nueces River Basin is noted for its diverse agriculture. Wool and mohair production, vegetable crops, farming and ranching, and mineral production such as oil and gas extraction and asphalt and stone mining are some of the ways the lands are used in the basin. The area is also popular with naturalists and outdoorsmen who enjoy the scenic beauty for its hiking, camping, nature study, and hunting and fishing.

History

According to the Handbook of Texas, the Nueces River was not explored by European settlers until the eighteenth century and was the first river to appear on a European map named the *Rio Escondido*, or hidden river, due to its obscure river delta located behind a barrier island. Early Spanish explorers later called the Nueces River the *Rio de las Nueces*, in reference to the pecan trees growing on the banks of the river (TWDB, 2020). Its namesake can be translated to "River of Nuts."

Endangered Species and Conservation Needs

The common names of 266 species listed as rare, threatened, or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) within the Nueces River Basin are included in Appendix I at the end of this report. Table 1 provides a summary of the number of species per taxonomic group listed as endangered, threatened, G1 or G2, species of greatest conservation need, endemic, and total counts.

Table 1. State and federally listed species in the Nueces River Basin (TPWD, 2020).

Taxon	Endangered (Federal or State)	Threatened (Federal or State)	G1 or G2 (Critically Imperiled or Imperiled)	Species of Greatest Conservation Need (TPWD) (S1 or S2)	Endemic	Total Count
Mammals	7	3	4	29	7	38
Birds	5	13	2	22	0	24
Reptiles	3	6	3	23	4	24
Plants	7	1	32	103	72	103
Arachnids	0	0	16	17	15	17
Insects	0	0	11	26	5	26
Crustaceans	0	0	5	5	5	5
Mollusks	0	0	6	6	3	6
Arthropods	0	0	0	1	0	1
Fish	0	6	2	14	5	14
Amphibians	0	4	1	6	2	8
Total Count	22	33	82	252	118	266

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 so that it supports public health and protects 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 (drinking water). The criteria for evaluating support of those uses in the Nueces River segments included in this report are listed in Table 2.

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, as well as other information, including water quality studies, occurrences of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference point to indicate when water quality parameters may be approaching levels of concern.

Table 2. State water quality criteria in the lower Nueces River watershed (TCEQ, 2018).

Segment	Chloride (CL^{-1}) (mg/L)	Sulfate (SO_4^{-2}) (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Dissolved Oxygen (DO) (mg/L)	pH Range (SU)	Indicator Bacteria (#/100 mL)	Temperature (°C)
2101 – Nueces River Tidal	NA	NA	NA	4.0	6.5-9.0	35 (enterococci)	35
2102 – Nueces River Below lake Corpus Christi	250	250	500	5.0	6.5-9.0	126 (*E. coli*)	32.8
2103 – Lake Corpus Christi	250	250	750	5.0	6.5-9.0	126 (*E. coli*)	33.9

Watershed Protection Plans and TMDLs

A Nueces River Watershed Partnership was established to develop the Lower Nueces River Watershed Protection Plan (WPP). The lower Nueces River has been on the Texas Integrated Report's 303(d) list for not meeting water quality standards (i.e., being impaired) since 2012. Specifically, it is impaired for Total Dissolved Solids (TDS). The WPP addressed the TDS impairment and was approved in 2016 by the U.S. Environmental Protection Agency (USEPA) and TCEQ and is now in the implementation phase. One of the management strategies being implemented is the On-site Sewage Facility (OSSF) Repair and Replacement Assistance Program. The Nueces River Authority (NRA, 2019) reported a total of 47 pump outs and inspections that have been completed, with 14 systems identified to be in good working condition, 11 systems repaired, and 16 systems replaced.

Water Quality Impairments

The TCEQ determines a water body to be impaired if more than 10-percent of samples, provided by professional monitoring, from the last seven years, exceed the standard for each parameter, except for *E. coli* bacteria (See *E. coli* and enterococci Bacteria below for standards assessment methodology). When the observed sample value does not meet the standard, it is referred to as an exceedance of the water quality standard. At least 10 samples from the last seven years must have been collected with the same reasonable amount of time between samples for a data set to be considered appropriate for assessment. Of the three segments included in this report, only one, the Nueces River Below Lake Corpus Christi (Segment 2102), is listed as impaired for TDS on the 2020 Texas Integrated Report – 303(d) List (TCEQ, 2020).

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 warmer water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases because of the sampling frequency. While citizen scientist data do not show diurnal temperature fluctuations, they may demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and monthly frequencies.

Specific Conductance and Salinity

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 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.

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per cubic centimeter ($\mu S/cm^3$). A body of water is more conductive if it has more total dissolved solids (TDS) such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of dissolved oxygen (DO), leading to eutrophication. 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 TDS can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants. For this report, specific conductivity values have been converted to TDS using a conversion factor of 0.65 and are reported as mg/L.

Dissolved Oxygen (DO)

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 DO 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 DO can also result from high groundwater inflows (which have low DO due to minimal aeration), high temperatures, or water releases from deeper portions of dams where DO stratification occurs. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

pH

The pH scale measures the concentration of hydrogen ions on a range of zero to 14 and is reported in standard units (s.u.). The pH of water can provide useful 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 mostly caused by coal power 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. The most suitable pH range for healthy organisms is between 6.5 and 9.0 s.u.

Secchi Disk and Total Depth

The Secchi disk is used to determine the clarity of the water, a condition known as turbidity. The disk 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. Average Secchi disk depth 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 very little light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the DO in the water due to reduced photosynthesis. Contaminants are most commonly transported in sediment rather than in the water. Turbid waters can result from sediment washing away 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 USEPA 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 is present in the intestinal tracts and feces of warm-blooded animals. It is used by TCEQ as an indicator of the potential presence of pathogens in saltwater along the Texas Gulf coast.

The Nueces River is designated a primary contact recreation 1 (PCR1) use. This means that recreation activities in the Nueces River are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, handfishing 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 CFU/100 mL. The standard for contact recreational use of a water body is 126 CFU/100 mL for *E. coli* or 35 CFU/100 mL for enterococci. 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, instead citizen scientists can get certified in *E. coli* bacteria monitoring, the indicator used by TCEQ for freshwater streams.

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 under the “Dissolved Oxygen” section.

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 TCEQ and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most 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 the possibility of sewage or manure pollution during dry weather.

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 both manuals adhere closely to the TCEQ 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 (QAPP).

Procedures documented in Texas Stream Team Water Quality Citizen Scientist Manuals or the TCEQ 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.

Field sampling activities are documented on field data sheets. For all field sampling events the following items are recorded: station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, meter calibration information, and reagent expiration dates.

For all *E. coli* sampling events, station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, incubation temperature, incubation duration, *E. coli* colony counts, dilution aliquot, field duplicates and blank, and media expiration dates are recorded.

Values for all 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 and 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, either by submitting a hard copy of the form or by entering the data directly to the online Waterways Dataviewer. All data are reviewed to ensure they are representative of the samples analyzed and locations where measurements were made, and the data and associated quality control data conform to specified monitoring procedures and project specifications as stated in the approved QAPP.

Data review and verification is performed using a data management checklist and self-assessments, as appropriate to the project task, followed by automated database functions that will 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 through the online Texas Stream Team Datamap.

Data Analysis

Data were compiled, analyzed, summarized, and compared to state water quality standards and screening criteria to provide readers with a reference point for parameters that may be of concern. The assessment performed by TCEQ involves more stringent monitoring methods and oversight than those used by citizen scientists and staff in this report. The citizen scientist water quality monitoring data are not currently used in the TCEQ assessments mentioned above but 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 from the watershed and its tributaries were exported from the Texas Stream Team database and grouped by site. 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. Statistically significant trends were analyzed further. R-squared is a statistical measure of how close the data are to the fitted regression line. Zero indicates that the model explains none of the variability of the response data around its mean. The p-value is the level of marginal significance within a statistical hypothesis test representing the probability of the occurrence of a given event. Statistical significance was set to a p-value of ≤ 0.05. A p-value of ≤ 0.05 means that the probability that the observed data matches the actual conditions found in nature is 95-precent. As the p-value decreases, the confidence that it simulates actual conditions in nature increases.

DATA RESULTS

Water quality data from four Texas Stream Team monitoring sites were acquired for this report (Table 3). Two sites (81470 and 81471) are on Lake Corpus Christi (segment 2103), one site (81472) is on Nueces River Below Lake Corpus Christi (segment 2102), and one site (81473) is on the upper reach of the Nueces

River Tidal segment (2101). Each site has between 9 and 12 sampling events, for a total of 42. The period of record for the sampling events ranged from November 2018 to April 2020.

Site Analysis

The period of record for data analyzed for this report spanned from November of 2018 to April 2020. Data from 42 monitoring events conducted at four sites were acquired from the Waterways Dataviewer (Table 3). Water quality monitoring data for the four sites in the lower Nueces River watershed were analyzed and summarized in Table 4 including the number of samples, mean, standard deviation, minimum and maximum values. Citizen scientists monitored all four sites for the core water quality monitoring parameters; *E. coli* bacteria or advanced water quality monitoring parameters were not measured or reported for the period of record for this report. The total number of samples for the Texas Stream Team core water quality monitoring parameters (air and water temperature, specific conductance, dissolved oxygen, pH, Secchi disk, and total depth) remained somewhat consistent for the period of record.

Air and water Temperature

Average air temperatures for the two sites at Lake Corpus Christi, Brown Ranch (22.9°C) and State Park (23.2°C), were slightly lower than the two Nueces River sites, Hazel Bazemore (23.7 °C) and Labonte Park (23.9 °C) (Figure 3). The Brown Ranch site at Lake Corpus Christi and the Hazel Bazemore site on the Nueces River below Lake Corpus Christi both exhibited greater variability with the Brown Ranch site skewed toward lower temperatures and the Hazel Bazemore site skewed toward higher temperatures.

Water temperatures at all sites were well below the water quality standards (Figure 4). Average water temperature for the two sites at Lake Corpus Christi, Brown Ranch (21.4°C) and State Park (21.4°C), were lower than the two Nueces River sites, Hazel Bazemore (22.9 °C) and Labonte Park (22.3 °C).

Table 3. Lower Nueces River watershed active Texas Stream Team sites.

Station ID	Description	Number of Samples (n)	Period of Record
81470	Lake Corpus Christi @ Brown Ranch Pier	12	November 2018-April 2020
81471	Lake Corpus Christi @ State Park Pier	11	November 2018-April 2020
81472	Nueces River @ Hazel Bazemore Boat Ramp	9	November 2018-April 2020
81473	Nueces River @ Labonte Park Boat Ramp	10	November 2018-April 2020

Table 4. Texas Stream Team data summary in lower Nueces River watershed (Nov. 2018 to Apr. 2020).

Parameter	Brown Ranch Pier-81470 n=12 Mean±SD (Range)	State Park Pier-81471 n=11 Mean±SD (Range)	Hazel Bazemore Boat Ramp-81472 n=9 Mean±SD (Range)	Labonte Park Boat Ramp-81473 n=10 Mean±SD (Range)
Air Temperature (°C)	22.9±5 (12-30)	23.2±4.7 (15-29)	23.7±5.6 (14-34)	23.9±5.8 (13.5-36)
Water Temperature (°C)	21.8±5.8 (14-30)	21.4±5.5 (14-31)	22.9±5.6 (14-32)	22.3±5.3 (14-31)
Specific Conductance (µS/cm)	560±240 (7-760)	614±157 (220-770)	932±228 (580-1380)	790±821 (2.6-2900)
TDS (mg/L)*	364±156 (4.6-494)	399±102 (143-501)	606±148 (377-897)	514±534 (1.7-1,885)
Dissolved Oxygen (mg/L)	7.1±1.4 (4.9-9.5)	7.2±0.8 (5.9-8.7)	6.4±1.1 (4.5-8.7)	6.1±1.3 (3.3-7.8)
pH (s.u.)	8.2±0.2 (8-8.5)	8.3±0.2 (8-8.5)	8.0±0.2 (7.5-8.3)	8.1±0.2 (8-8.5)
Secchi Disk (m)	0.3±0.1 (0.2-0.5)	0.5±0.2 (0.3-0.8)	0.3±0.1 (0.2-0.5)	0.4±0.1 (0.3-0.7)
Total Depth (m)	0.9±0.6 (0.1-1.7)	1.8±0.7 (0.7-2.8)	0.6±0.2 (0.3-1.0)	0.9±0.3 (0.5-1.5)

*TDS was calculated from specific conductance (TDS = specific conductance * 0.65)

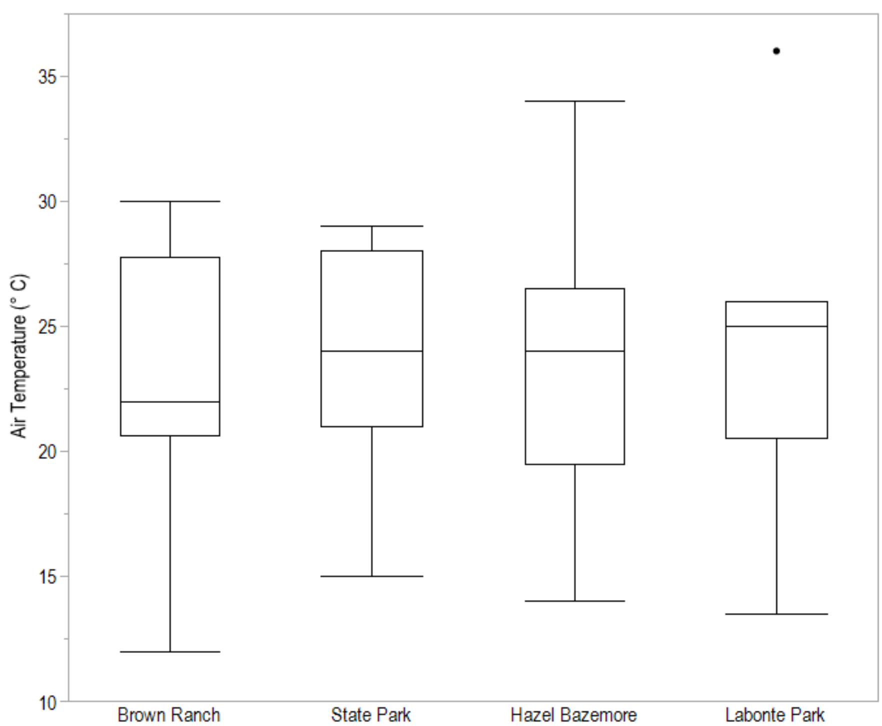

Figure 3. Air temperature (°C) for sites in the lower Nueces River watershed (November 2018 to May 2020).

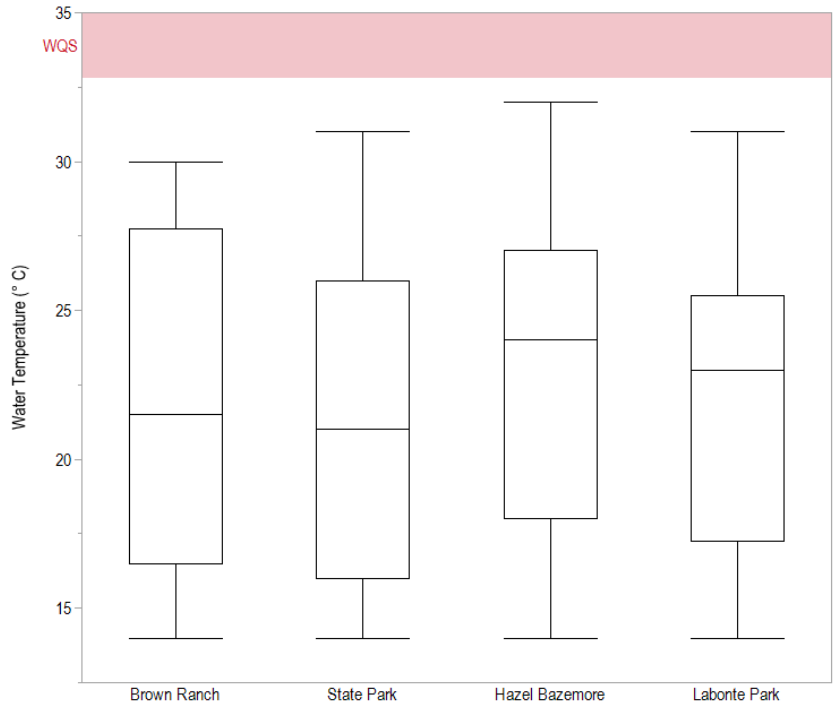

Figure 4. Water temperature (°C) for sites in the lower Nueces River watershed (November 2018 to May 2020).

Specific Conductance (Total Dissolved Solids)

Specific conductance was measured at all four sites in the lower Nueces River watershed, with slightly lower measurements at the two Lake Corpus Christi sites, Brown Ranch (560 µS/cm) and State Park (614 µS/cm), than at the two Nueces River sites, Hazel Bazemore (932 µS/cm) and LaBonte Park (790 µS/cm) (Figure 5).

Calculated TDS values reflected a similar spatial pattern as for specific conductance. No water quality standard for TDS is established for the Labonte Park site on the Nueces River tidal segment (2101), but standards do exist for the monitoring sites located on Nueces River below Lake Corpus Christi (500 mg/L) and Lake Corpus Christi (750 mg/L). The mean TDS value for the Hazel Bazemore site was 606 mg/L, which exceeded the water quality standard (Figure 6). The mean TDS values for the Lake Corpus Christi sites, Brown Ranch and State Park, both were below the water quality standard.

Dissolved Oxygen

Average dissolved oxygen values for the four sites in the lower Nueces River watershed ranged from 7.2 to 6.1 mg/L (Table 4). The two sites on Lake Corpus Christi, Brown Ranch and State Park, exhibited higher dissolved oxygen values than the two Nueces River sites, Hazel Bazemore and Labonte Park (Figure 7). Average dissolved oxygen values for all sites met the corresponding water quality standard.

pH

Average pH values for all sites ranged from 8.0 to 8.3 s.u. (Table 4). The Lake Corpus Christi sites, Brown Ranch and State Park, exhibited slightly higher pH values than the Nueces River sites, Hazel Bazemore and Labonte Park (Figure 8). All sites were within the high and low water quality standard for pH.

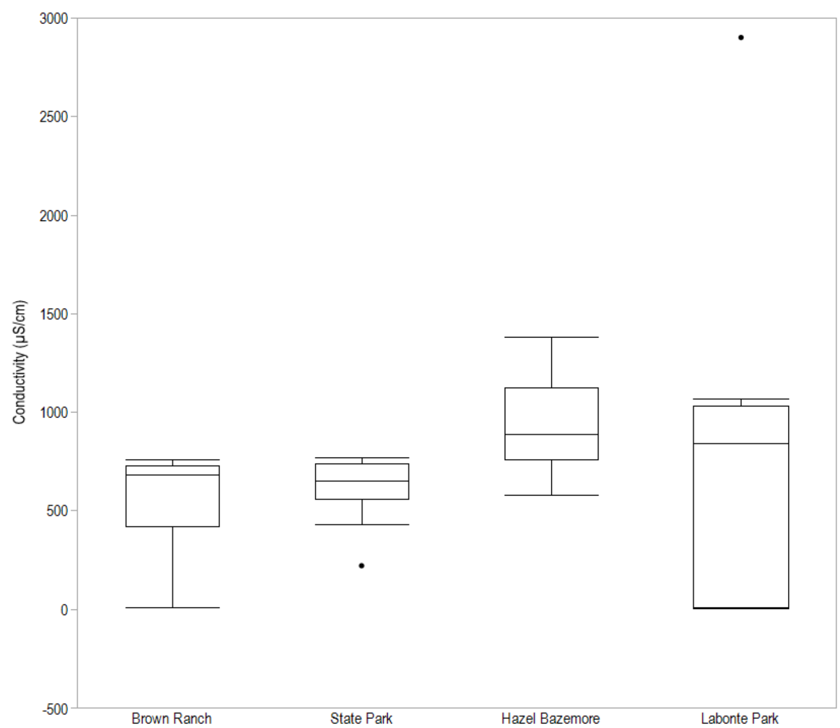

Figure 5. Conductivity (µS/cm) for sites in the lower Nueces River watershed (November 2018 to May 2020).

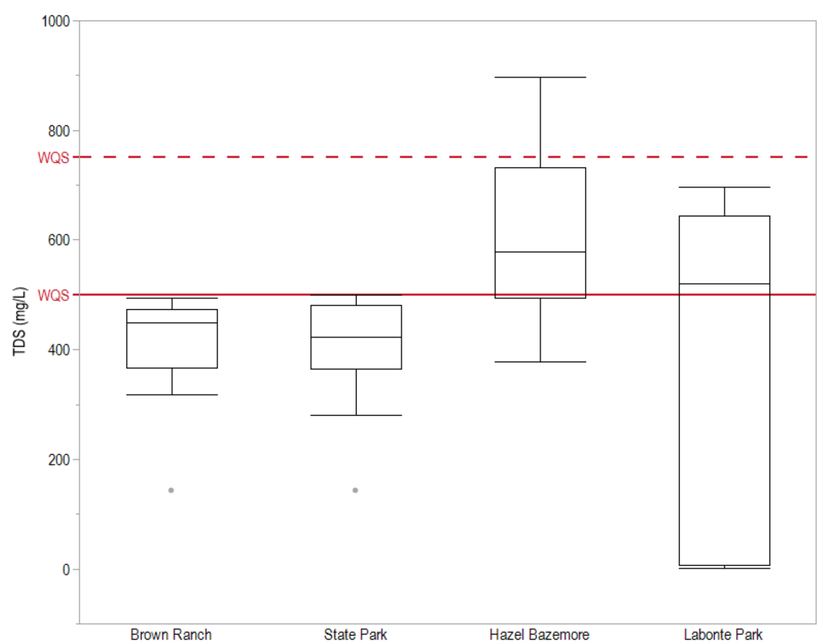

Figure 6. Total dissolved solids (TDS) (mg/L) for sites in the lower Nueces River watershed (WQS for Lake Corpus Christi = 750 mg/L, WQS for Nueces River below Lake Corpus Christi = 500 mg/L), (November 2018 to May 2020).

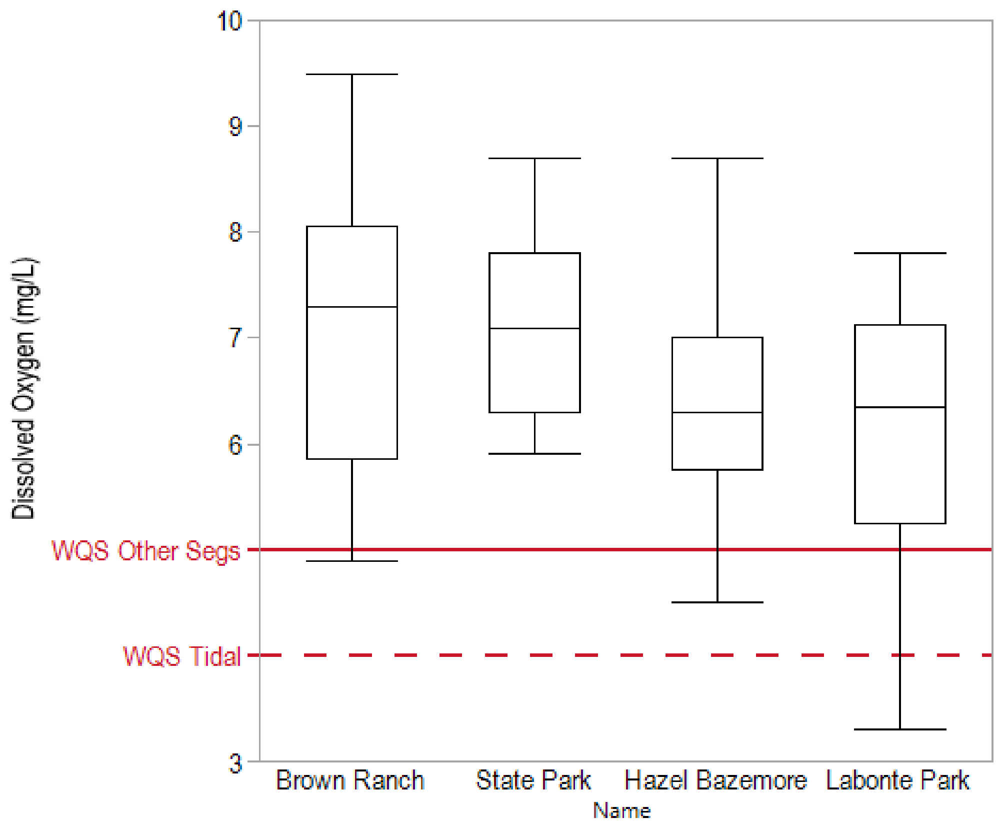

Figure 7. Dissolved oxygen (mg/L) for sites in the lower Nueces River watershed (November 2018 to May 2020).

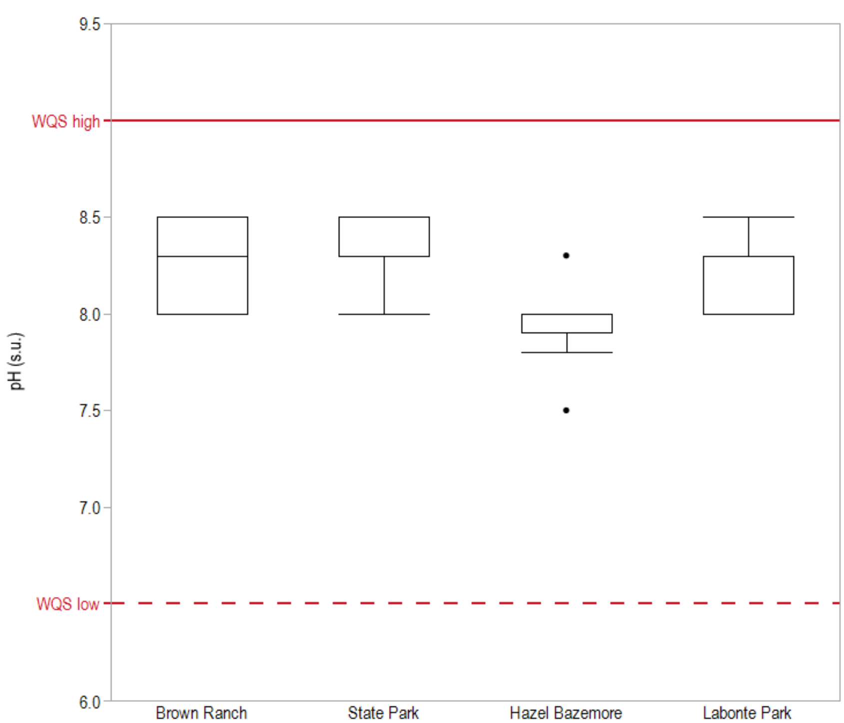

Figure 8. pH (s.u.) for sites in the lower Nueces River watershed (November 2018 to May 2020).

WATERSHED SUMMARY

Texas Stream Team citizen scientists monitored standard core water quality parameters at four sites in the lower Nueces River watershed from November 2018 to May 2020. Parameters monitored included water and air temperature, specific conductance, total dissolved solids, dissolved oxygen, and pH. Monitoring for *E. coli* Bacteria or the Advanced Texas Stream Team parameters, nitrate-nitrogen and orthophosphate, did not take place in the lower Nueces River watershed during the period of record for this report. Data from the four monitoring sites were analyzed and summarized.

The averages for water temperature, dissolved oxygen, and pH at all sites met or exceeded the TCEQ water quality standards. The two Lake Corpus Christi sites differed from the two Nueces River sites for most parameters measured. For example, average water and air temperatures for the two sites at Lake Corpus Christi, Brown Ranch and State Park, were lower than the two Nueces River sites, Hazel Bazemore and Labonte Park. Average dissolved oxygen values for the two sites on Lake Corpus Christi exhibited higher dissolved oxygen values than the two Nueces River sites. And, average pH values for the two Lake Corpus Christi sites revealed slightly higher pH values than the two Nueces River sites.

Specific conductance was measured at all four sites in the lower Nueces River watershed, with slightly lower measurements at the two Lake Corpus Christi sites, Brown Ranch (560 µS/cm) and State Park (614 µS/cm), than at the two Nueces River sites, Hazel Bazemore (932 µS/cm) and LaBonte Park (790 µS/cm). TDS values were calculated from the specific conductance measurements for all four sites. The calculated TDS values reflected a similar spatial pattern as for specific conductance. No water quality standard for TDS is established for the Labonte Park site, but standards do exist for the monitoring sites located on Nueces River below Lake Corpus Christi (500 mg/L) and Lake Corpus Christi (750 mg/L). The mean TDS value for the Hazel Bazemore site on the Nueces River below Lake Corpus Christi exceeded the water quality standard, while the mean TDS values for the Lake Corpus Christi sites both were below the water quality standard. Exceedance of the water quality standard at the Hazel Bazemore site reflects the TCEQ 2020 Integrated Report and 303(d) listing for the Nueces River below Lake Corpus Christi.

The Texas Stream Team citizen scientists monitoring water quality in the lower Nueces River watershed are encouraged to continue monitoring and consider pursuing the Advanced and *E.coli* Bacteria trainings. There is a need for this type of monitoring to continue for the development of long-term water quality data sets. The information gathered thus far has been useful to support the water quality impairment for TDS listed on the Texas Integrated Report and 303(d) List. Continuation of this monitoring will allow future trend analysis to capture changes in water quality over time. Texas Stream Team will continue to support current citizen scientists as needed by providing technical support, creating new monitoring sites and re-activate existing sites, and we look forward to training new citizen scientists to expand and grow 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 I: Endangered Species and Conservation Needs

Within the Nueces River watershed, the common names of 266 species listed as rare, threatened, or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) include:

Table 1: Endangered species located within the Nueces watershed

Species Type	Common Name	Federal/State Listing
BIRDS	northern aplomado falcon	Endangered
	whooping crane	Endangered
	Eskimo curlew	Endangered
	interior least tern	Endangered
	golden-cheeked warbler	Endangered
MAMMALS	sperm whale	Endangered
	Sei Whale	Endangered
	blue whale	Endangered
	Gulf of Mexico Bryde's Whale	Endangered
	humpback whale	Endangered
	North Atlantic right whale	Endangered
	Ocelot	Endangered
REPTILES	Atlantic hawksbill sea turtle	Endangered
	Kemp's Ridley sea turtle	Endangered
	leatherback sea turtle	Endangered
PLANTS	South Texas ambrosia	Endangered
	Texas prairie dawn	Endangered
	black lace cactus	Endangered
	Tobusch fishhook cactus	Federally Listed Threatened; State Listed Endangered
	Walker's manioc	Endangered
	slender rush-pea	Endangered
	Texas snowbells	Endangered

Table 2: Threatened species located within the Nueces watershed

Species Type	Common Name	Federal/State Listing
AMPHIBIANS	Texas salamander	Threatened
	black-spotted newt	Threatened
	South Texas siren (Large Form)	Threatened
	sheep frog	Threatened
BIRDS	reddish egret	Threatened
	white-faced ibis	Threatened
	wood stork	Threatened
	swallow-tailed kite	Threatened
	white-tailed hawk	Threatened

Species Type	Common Name	Federal/State Listing
	zone-tailed hawk	Threatened
	gray hawk	Threatened
	Black Rail	Threatened
	piping plover	Threatened
	Rufa Red Knot	Threatened
	sooty tern	Threatened
	tropical parula	Threatened
	Texas Botteri's sparrow	Threatened
FISH	Nueces roundnose minnow	Threatened
	Medina roundnose minnow	Threatened
	plateau shiner	Threatened
	headwater catfish	Threatened
	Shortfin Mako Shark	Threatened
	Oceanic Whitetip Shark	Threatened
MAMMALS	black bear	Threatened
	white-nosed coati	Threatened
	West Indian manatee	Threatened
REPTILES	loggerhead sea turtle	Threatened
	green sea turtle	Threatened
	Texas tortoise	Threatened
	Texas horned lizard	Threatened
	northern scarlet snake	Threatened
	Texas scarlet snake	Threatened
PLANTS	Tobusch fishhook cactus	Federally Listed Threatened; State Listed Endangered

Table 3: All rare, threatened or endangered species located within the Nueces watershed

Species Type	Common Name	Federal/State Listing
AMPHIBIANS	southern dusky salamander	Other
	Texas salamander	Threatened
	Valdina Farms sinkhole salamander	Other
	black-spotted newt	Threatened
	South Texas siren (Large Form)	Threatened
	Woodhouse's toad	Other
	Strecker's chorus frog	Other
	sheep frog	Threatened
BIRDS	reddish egret	Threatened
	white-faced ibis	Threatened
	wood stork	Threatened
	swallow-tailed kite	Threatened
	bald eagle	Other

Species Type	Common Name	Federal/State Listing
	white-tailed hawk	Threatened
	zone-tailed hawk	Threatened
	gray hawk	Threatened
	northern aplomado falcon	Endangered
	Black Rail	Threatened
	whooping crane	Endangered
	piping plover	Threatened
	mountain plover	Other
	Eskimo curlew	Endangered
	Rufa Red Knot	Threatened
	Franklin's gull	Other
	interior least tern	Endangered
	sooty tern	Threatened
	western burrowing owl	Other
	tropical kingbird	Other
	black-capped vireo	Other
	tropical parula	Threatened
	golden-cheeked warbler	Endangered
	Texas Botteri's sparrow	Threatened
FISH	american eel	Other
	Nueces roundnose minnow	Threatened
	Medina roundnose minnow	Threatened
	Texas shiner	Other
	plateau shiner	Threatened
	Nueces River shiner	Other
	headwater catfish	Threatened
	opossum pipefish	Other
	Guadalupe bass	Other
	fat snook	Other
	snook	Other
	southern flounder	Other
	Shortfin Mako Shark	Threatened
	Oceanic Whitetip Shark	Threatened
MAMMALS	cave myotis bat	Other
	tricolored bat	Other
	big brown bat	Other
	eastern red bat	Other
	hoary bat	Other
	southern yellow bat	Other
	Townsend's big-eared bat	Other
	Mexican free-tailed bat	Other

Species Type	Common Name	Federal/State Listing
	big free-tailed bat	Other
	swamp rabbit	Other
	thirteen-lined ground squirrel	Other
	black-tailed prairie dog	Other
	maritime pocket gopher	Other
	Texas pocket gopher	Other
	Davis pocket gopher	Other
	barrier island Texas pocket gopher	Other
	Frio pocket gopher	Other
	Strecker's pocket gopher	Other
	Padre Island kangaroo rat	Other
	woodland vole	Other
	sperm whale	Endangered
	Sei Whale	Endangered
	blue whale	Endangered
	Gulf of Mexico Bryde's Whale	Endangered
	humpback whale	Endangered
	North Atlantic right whale	Endangered
	black bear	Threatened
	white-nosed coati	Threatened
	long-tailed weasel	Other
	mink	Other
	American badger	Other
	eastern spotted skunk	Other
	plains spotted skunk	Other
	western spotted skunk	Other
	western hog-nosed skunk	Other
	mountain lion	Other
	ocelot	Endangered
	West Indian manatee	Threatened
REPTILES	loggerhead sea turtle	Threatened
	green sea turtle	Threatened
	Atlantic hawksbill sea turtle	Endangered
	Kemp's Ridley sea turtle	Endangered
	leatherback sea turtle	Endangered
	Texas diamondback terrapin	Other
	Rio Grande river cooter	Other
	western box turtle	Other
	Texas tortoise	Threatened
	slender glass lizard	Other
	reticulate collared lizard	Other

Species Type	Common Name	Federal/State Listing
	plateau spot-tailed earless lizard	Other
	Tamaulipan spot-tailed earless lizard	Other
	keeled earless lizard	Other
	Texas horned lizard	Threatened
	northern scarlet snake	Threatened
	Texas scarlet snake	Threatened
	Texas indigo snake	Other
	western hognose snake	Other
	Mexican blackhead snake	Other
	common garter snake	Other
	Texas garter snake	Other
	timber (canebrake) rattlesnake	Other
	massasauga	Other
CRUSTACEANS	Devil's Sinkhole amphipod	Other
	Nueces crayfish	Other
	No common name accepted *(Mexiweckelia hardeni)*	Other
	No common name accepted *(Seborgia hershleri)*	Other
	No common name accepted *(Brackenridgia reddelli)*	Other
INSECTS	No common name accepted *(Disonycha stenosticha)*	Other
	No common name accepted *(Ormiscus albofasciatus)*	Other
	No common name accepted *(Spectralia prosternalis)*	Other
	No common name accepted *(Cenophengus pallidus)*	Other
	No common name accepted *(Dacoderus steineri)*	Other
	No common name accepted *(Cryptocephalus downiei)*	Other
	American bumblebee	Other
	Comanche harvester ant	Other
	Coelioxys piercei	Other
	Manfreda giant-skipper	Other
	Oxyelophila callista	Other
	sage sphinx moth	Other
	Pygarctia lorula	Other
	Gulf Dune Grasshopper	Other
	a Katydid *(Amblycorypha uhleri)*	Other
	Texas angle-wing katydid	Other
	Daedelus sheildback katydid	Other
	Mitchell's sheildback katydid	Other
	Pratt's sheildback katydid	Other
	Gladiator short-winged katydid	Other
	a Katydid *(Dichopetala catinata)*	Other
	No accepted common name	Other
	purse casemaker caddisfly	Other

Species Type	Common Name	Federal/State Listing
	a caddisfly *(Ochrotrichia capitana)*	Other
	a caddisfly *(Neotrichia juani)*	Other
	Texas austrotinodes caddisfly	Other
ARACHNIDS	No common name accepted *(Texella brevistyla)*	Other
	No common name accepted *(Texella hardeni)*	Other
	No common name accepted *(Cicurina bandera)*	Other
	No common name accepted *(Cicurina mckenziei)*	Other
	No common name accepted *(Cicurina medina)*	Other
	No common name accepted *(Cicurina obscura)*	Other
	No common name accepted *(Cicurina orellia)*	Other
	No common name accepted *(Cicurina pablo)*	Other
	No common name accepted *(Cicurina selecta)*	Other
	No common name accepted *(Cicurina serena)*	Other
	No common name accepted *(Cicurina sheari)*	Other
	No common name accepted *(Cicurina sprousei)*	Other
	No common name accepted *(Cicurina uvalde)*	Other
	No common name accepted *(Cicurina watersi)*	Other
	No common name accepted *(Speodesmus reddelli)*	Other
	No common name accepted *(Eidmannella nasuta)*	Other
	No common name accepted *(Leucohya texana)*	Other
MOLLUSKS	glossy wolfsnail	Other
	No common name accepted *(Holospira goldfussi)*	Other
	No common name accepted *(Millerelix gracilis)*	Other
	No common name accepted *(Praticolella candida)*	Other
	No common name accepted *(Marstonia comalensis)*	Other
	No common name accepted *(Elimia comalensis)*	Other
ARTHROPODS	No common name accepted *(Speodesmus falcatus)*	Other
PLANTS	Texas shrimp-plant	Other
	roughseed sea-purslane	Other
	shortcrown milkvine	Other
	plateau milkvine	Other
	Falfurrias milkvine	Other
	arrowleaf milkvine	Other
	South Texas ambrosia	Endangered
	gravelbar brickellbush	Other
	narrowleaf brickellbush	Other
	spreading leastdaisy	Other
	awnless leastdaisy	Other
	South Texas false cudweed	Other
	plains gumweed	Other
	sandhill woolywhite	Other

Species Type	Common Name	Federal/State Listing
	Texas prairie dawn	Endangered
	coastal gay-feather	Other
	Welder machaeranthera	Other
	barbed rattlesnake-root	Other
	canyon rattlesnake-root	Other
	Burridge greenthread	Other
	springrun whitehead	Other
	Wright's trichocoronis	Other
	threeflower broomweed	Other
	Billie's bitterweed	Other
	Texas barberry	Other
	Heller's marbleseed	Other
	Texas largeseed bittercress	Other
	Engelmann's bladderpod	Other
	large selenia	Other
	bracted twistflower	Candidate for Federal Listing
	broadpod twistflower	Other
	black lace cactus	Endangered
	yellow-flowered alicoche	Other
	Texas claret-cup cactus	Other
	Tobusch fishhook cactus	Federally Listed Threatened; State Listed Endangered
	Jones' nailwort	Other
	bristle nailwort	Other
	Kleberg saltbush	Other
	South Texas yellow clammyweed	Other
	Texas stonecrop	Other
	Texas greasebush	Other
	tree dodder	Other
	Hill Country wild-mercury	Other
	silvery wild-mercury	Other
	Cory's croton	Other
	velvet spurge	Other
	low spurge	Other
	Walker's manioc	Endangered
	darkstem noseburn	Other
	Texas amorpha	Other
	Texas milk vetch	Other
	Wright's milkvetch	Other

Species Type	Common Name	Federal/State Listing
	Drummond's rushpea	Other
	South Texas rushpea	Other
	Hall's prairie clover	Other
	Sabinal prairie clover	Other
	net-leaf bundleflower	Other
	Lindheimer's tickseed	Other
	Watson's milk-pea	Other
	slender rush-pea	Endangered
	canyon bean	Other
	turnip-root scurfpea	Other
	Texas mock-orange	Other
	sand Brazos mint	Other
	seaside beebalm	Other
	Texas beebalm	Other
	Tharp's rhododon	Other
	big red sage	Other
	Plateau loosestrife	Other
	longstalk heimia	Other
	Amelia's Sand-verbena	Other
	woolly butterfly-weed	Other
	Parks' jointweed	Other
	South Texas gilia	Other
	scarlet leather-flower	Other
	Texas almond	Other
	Texas peachbush	Other
	Croft's bluet	Other
	Greenman's bluet	Other
	threeflower penstemon	Other
	Texas seymeria	Other
	hairy sycamore-leaf snowbell	Other
	sycamore-leaf snowbell	Other
	Texas snowbells	Endangered
	bigflower cornsalad	Other
	Bailey's ballmoss	Other
	Buckley's spiderwort	Other
	canyon sedge	Other
	South Texas spikesedge	Other
	Indianola beakrush	Other
	crestless onion	Other
	Elmendorf's onion	Other
	Jones's rainlilly	Other

Species Type	Common Name	Federal/State Listing
	Refugio rainlily	Other
	lila de los llanos	Other
	Glass Mountains coral-root	Other
	Warnock's coral-root	Other
	Texas windmill grass	Other
	Texas fescue	Other
	Tharp's dropseed	Other
	Buckley tridens	Other
	Texas willkommia	Other
	Mexican mud-plantain	Other

NOTE: *Species listed as "other" are classified as Species of Greatest Conservation Need (SGCN) by the Texas Parks and Wildlife Department (TPWD) but are not currently federally and/or state listed as threatened or endangered. Please visit the TPWD SGCN webpage to learn more.*