SAN BERNARD 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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EPA United States Environmental Protection Agency

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

TEXAS STATE UNIVERSITY
The rising STAR of Texas

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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-based citizen science water quality monitoring program. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at roughly the same time of day each month. The information that Texas Stream Team citizen scientists collect is covered under a TCEQ-approved Quality Assurance Project Plan (QAPP) to ensure that a standard, consistent set of scientifically rigorous methods are implemented state-wide. The data may be used to identify surface water quality trends, target additional data collection needs, identify and document potential pollution events and sources, and to test the effectiveness of water quality management measures. Texas Stream Team citizen scientist data is 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 provides valuable records, often collected in portions of 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 (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 San Bernard 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 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 about our programs at www.TexasStreamTeam.org.

WATERSHED DESCRIPTION

Location and Climate

The San Bernard River watershed is centrally located along the Texas Gulf Coast within the Brazos-Colorado River Basin (Figure 1). The San Bernard River originates from a spring near New Ulm in Southwest Austin County and flows for approximately 120 miles in a southeast direction before entering the Gulf of Mexico (Handbook of Texas Online, 2020). The San Bernard River watershed lies between the Brazos River Basin to the north and the Colorado River Basin to the south. The San Bernard River basin spans approximately 900 square miles and across five counties (Austin, Colorado, Wharton, Fort Bend, and Brazoria). Adjacent to the southernmost portion of the San Bernard River watershed lies the San Bernard National Wildlife Refuge, a 27,000-acre refuge established to protect habitat for wintering waterfowl and estuarine and marine organisms.

The Texas Commission on Environmental Quality (TCEQ) classifies the San Bernard River into two stream segments, the San Bernard River Tidal (Segment 1301) and the San Bernard River Above Tidal (Segment 1302) (Table 1). An unclassified freshwater stream, Mound Creek (Segment 1302E), serves as a tributary to the above tidal segment of the river. Five Texas Stream Team water quality monitoring sites are on the San Bernard River Tidal segment (1301), while two sites are located in the San Bernard National Wildlife Refuge (SBNWR). The two SBNWR sites are on unclassified segments, Cedar Lakes (Segment 2442OW) and Cedar Lake Creek (no designated segment number).

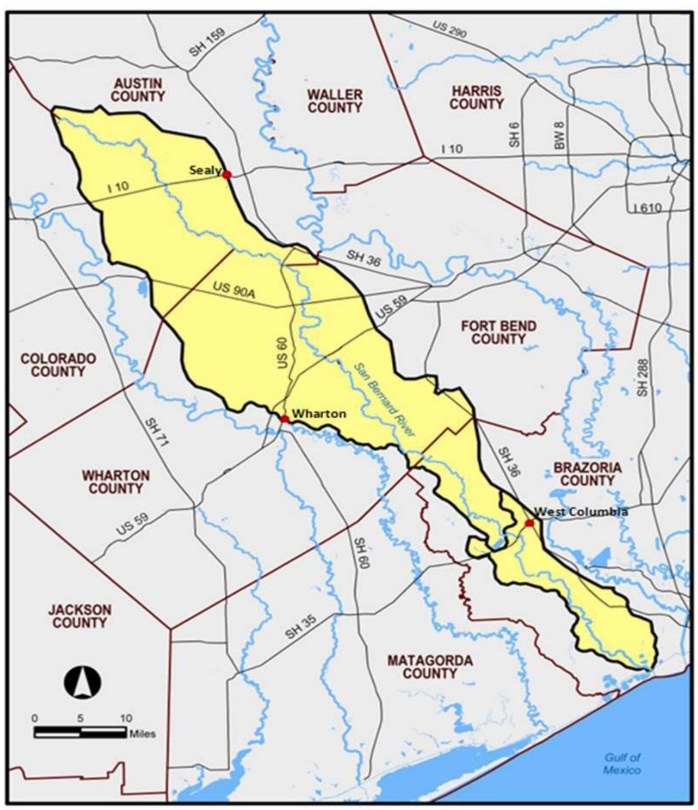

Figure 1. San Bernard River Watershed located along the Texas Gulf coast (H-GAC, 2017).

Table 1. Texas Commission on Environmental Quality stream segments, stream type and descriptions within the San Bernard River watershed and the San Bernard National Wildlife Refuge (TCEQ, 2018).

Segment	Stream type	Description
1301-San Bernard River Tidal	Classified tidal stream	From the confluence with the Intracoastal Waterway in Brazoria County to a point 3.2 km (2.0 mi) upstream of SH 35 in Brazoria County
1302E-Mound Creek	Unclassified freshwater stream	From the confluence with the San Bernard River in Brazoria Co. to the headwaters approximately 400 m upstream of TX Hwy 36 in Ft. Bend Co.
1302-San Bernard River Above Tidal	Classified freshwater stream	From a point 3.2 km (2.0 mi) upstream of SH 35 in Brazoria County to the county road southeast of New Ulm in Austin County
2442OW-Cedar Lakes	Unclassified oyster waters	Cedar Lakes (within the San Bernard Wildlife Refuge)

An average of 101.6 to 137.2 cm (40 to 54 inches) of precipitation falls in the San Bernard River watershed annually, with increasing rainfall towards the Texas Gulf Coast (H-GAC, 2017). Long-term climate data was collected from a site in nearby Freeport, Texas, by the NOAA National Climate Data Center (Figure 2). Average annual rainfall in Freeport was 129 cm (50.7 inches) with the highest rainfall occurring in September (19.8 cm) and the lowest in April (7.2 cm). Long-term annual average air temperature was 21°C, with the highest average monthly temperature recorded in July (28.7 °C) and the lowest in January (12.2°C).

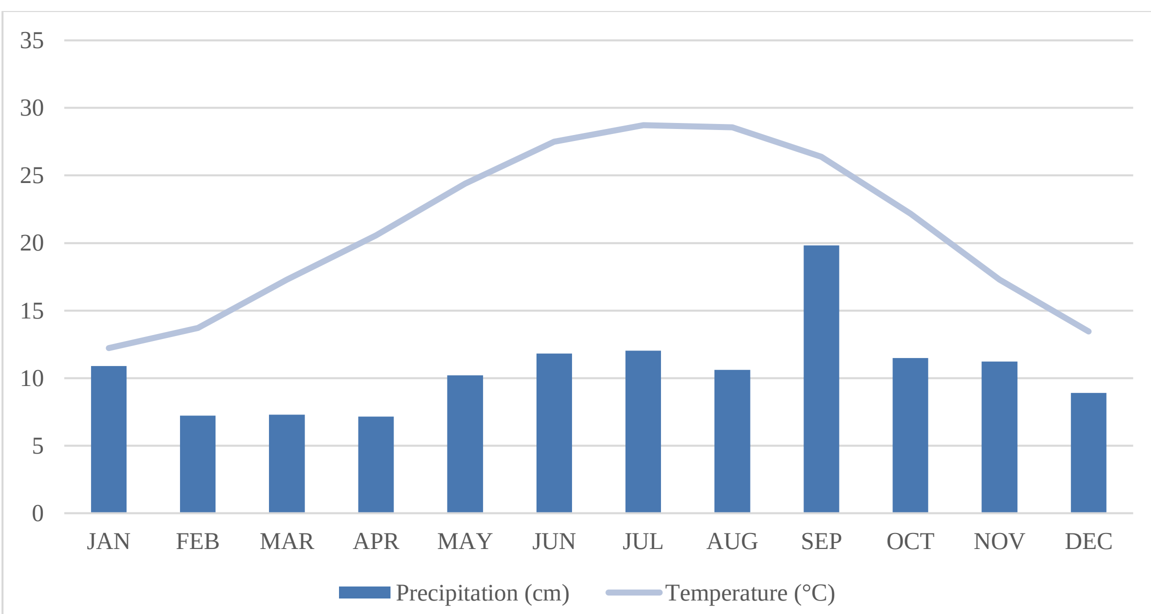

Figure 2. Long-term (1972-2000) monthly average precipitation (cm) and temperature (°C) data from NOAA National Climate Data Center at Freeport 2 NW, Texas (COOP ID: 413340) (NOAA, 2020).

Physical Description

The tidally-influenced portion of the San Bernard River watershed is characterized by the Gulf Prairies and Marshes Ecological Areas of Texas (McMahan et al., 1984). The elevation in this area ranges from 5 to 10 feet, or less, above mean sea level. The Texas Gulf Coast is comprised of land features that include barrier islands, peninsulas, offshore sand bars, bays, mudflats, dunes, and shoals. The wind, waves, storms, tides, climate, sea level rise and human activities in this area serve as the physical and climatic forces that create the landforms represented in this ecoregion.

The low relief in elevation causes this area to be flat and poorly drained. The soils in the Gulf Coast Marshes are characterized as predominantly salty clayey and loamy dark in color.

Land Use

The landscape across the San Bernard River watershed is comprised predominantly of small-town urban areas with no major municipalities and an estimated human population of 23,594 in 2020 (H-GAC, 2017). The majority (68.8%) of the watershed is comprised of cultivated (209,198 ac) and grassland (185,863 ac) land cover types which support crop production and cattle grazing (Figure 3). Major crops produced in the area include hay, rice, sorghum, corn, cotton, and soybeans. The area is also among the top cattle producers in the state. The lower part of the watershed is predominantly comprised of wetland and forest land cover types.

Other abundant subsurface natural resources in the area include oil, gas, sulfur, and salt. Of particular significance is the Boling Dome situated along the western bank of the San Bernard River in Wharton County. As of 1990, this feature produced more sulfur than any other mine in the world. The river is used by tankers and barges for the transport of mined natural resources.

Although estimates of the human population in the San Bernard River watershed are relatively low, they are projected to increase in the coming years. The H-GAC estimated the human population would more than double (45,746) in the next 20 years, which has the potential to have major impacts on water quality due to increases in urban and residential uses (H-GAC, 2017).

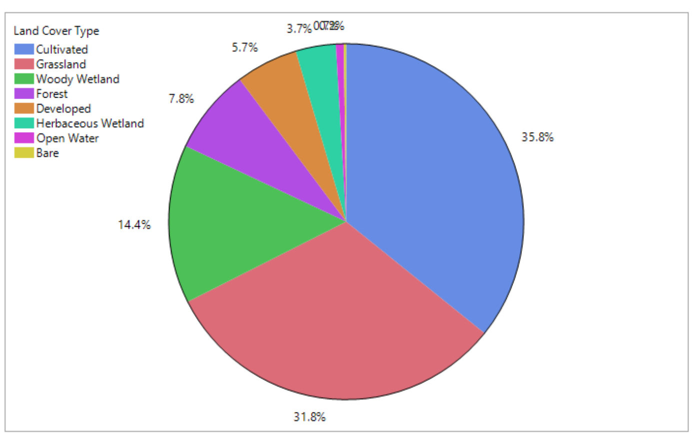

Figure 3. 2006 National Land Cover Data for the San Bernard River watershed (H-GAC, 2017).

History

The San Bernard River was originally named by Spanish inhabitants to the area as "El Rio de San Bernardo." For more than 100 years the San Bernard River has been referred to by locals as the "Singing River" due to reports of the "wail of a violin" along the river. These sounds are believed to be the result of escaping gas from natural gas reserves below ground (Handbook of Texas Online, 2020). The San Bernard River is rather unique in that it empties directly into the Gulf of Mexico, not into a bay environment like other Texas rivers.

The San Bernard National Wildlife Refuge is located along the Texas Coast south of the San Bernard River providing habitat to more than 320 species of birds and is home to the largest live oak in Texas (USFWS, 2020). In 2000, the champion tree was identified and measured to stand 67 feet high with a circumference greater than 32 feet. The ancient tree is situated in an area believed to be remnants of the shifting river and bayou channels. The tree's crown extends more than 100 feet and provides shelter, food and a resting place for countless numbers of migratory birds.

Endangered Species and Conservation Needs

Table 2 provides a summary of the number of species per group listed as rare, threatened, or endangered under the authority of Texas state law and/or under the United States Endangered Species Act within the San Bernard River watershed. A full list with explanations of the listing categories can be found in Appendix I at the end of this report.

Table 2. State and federally listed species in the San Bernard River watershed (TPWD, 2019).

Taxon	Endangered (Federal or State)	Threatened (Federal or State)	G1 or G2 (Critically Imperiled or Imperiled)	Species of Greatest Conservation Need (TPWD)	Endemic
Amphibians	1	0	1	5	1
Birds	3	9	1	16	0
Crustaceans	0	0	1	1	1
Fish	1	2	0	12	2
Insects	1	0	4	6	2
Mammals	6	2	3	18	0
Mollusks	0	2	3	3	3
Plants	1	0	9	28	18
Reptiles	2	4	2	16	3

Watershed Protection Plans and Water Quality Management Plans

In September 2009, H-GAC initiated a watershed protection planning (WPP) process for the San Bernard River watershed to address the contact recreation use impairment due to elevated levels of bacteria in portions of the San Bernard River. During the planning process, H-GAC worked with community organizations, citizens, government agencies, and local industries to improve water quality in the San Bernard watershed with the goal of meeting the water quality standard for contact recreation by 2025 and maintaining the standard through 2040.

The WPP development was a stakeholder-driven process designed to study and identify pollutant sources and to develop a plan to address the pollutants causing the impairment in the watershed. The planning process provided local decision makers the opportunity to be active participants in improving water quality by preparing for growth, incorporating best management practices (BMPs), and coordinating the framework for implementing and integrating water quality protection and restoration strategies. More information about the WPP can be located on the H-GAC website here.

The Texas State Soil and Water Conservation Board (TSSWCB) works with local landowners to develop Water Quality Management Plans (WQMPs) in the San Bernard River watershed. As of 2017, the TSSWCB had 152 WQMPs covering approximately 9 percent of the watershed. These plans are designed to prevent water pollution by implementing appropriate land treatment practices, production practices, management measures, and technologies with the goal of achieving state water quality standards.

Texas Water Quality Standards

The TCEQ's Texas Surface Water Quality Standards establish explicit goals to protect, maintain and restore the quality of streams, rivers, lakes, and bays throughout the state. The water quality 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, fishing, oyster waters, and drinking water supply. Site-specific criteria are developed for classified segments to evaluate general uses such as water temperature, pH, chloride, sulfate, and total dissolved solids (TDS) or specific conductance. The numeric criteria to determine water quality standards attainment of the designated uses in the San Bernard River are provided in Table 3.

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, existence 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.

TCEQ considers segments to be tidally influenced when there is observed tidal activity, TDS is greater than or equal to 2,000 mg/L, salinity is greater than or equal to 2 parts per thousand, or specific conductance is greater than or equal to approximately 3,000 microsiemens per centimeter (uS/cm).

Table 3. Water quality criteria for San Bernard River (TCEQ, 2018).

Parameter	Criterion	Description
Temperature	35°C/ 80°F	Maximum value
Dissolved Oxygen (DO)	4.0 mg/L	Minimum 24-hour means for high ALU subcategory
	3.0 mg/L	Absolute grab minimum
pH Range	6.5-9.0 SU	Absolute minima and maxima
Oyster waters (OW) (fecal coliform)	14 colonies/100 mL	Department of State and Health Services shellfish harvesting maps
Indicator Bacteria (*Enterococcus*)	35 CFU/100mL	Geometric mean
	130 CFU/100mL	Single sample maximum

Water Quality Impairments

The TCEQ conducts water quality assessments to determine the quality of water in water bodies across the state. A minimum of 10 samples (20 for bacteria) from the previous seven-year period of record are required to conduct the assessment. As few as four samples can be used for the assessment to identify a concern. Other variables considered for the assessment may include flow (low/high), flood/drought, and best professional judgement. A water body is considered impaired if more than 10-percent (20 percent for bacteria) of the samples being assessed from the last seven years, exceed the standard for each parameter. When the observed sample value does not meet the water quality standard, it is referred to as an exceedance and results in an impairment or concern designation.

The 2018 Texas Integrated Report 303(d) List includes the San Bernard River Tidal (Segment 1301) for non-support of the contact recreation use. The bacteria criterion for the contract recreation use was not met, therefore, the segment is listed as Category 5c - additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected. The 2018 Texas Integrated Report also reported a concern for depressed dissolved oxygen (DO) in water because 11 of 79 assessed values fell below the 24-hour average criterion (4.0 mg/L).

WATER QUALITY PARAMETERS

Water Temperature

Water temperature influences the physiological processes of aquatic organisms, and each species has an optimum temperature for survival. As water temperatures increase, oxygen-demand for aquatic communities increases too 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.

Natural sources of warm water are seasonal, 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 release 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 does not show diurnal temperature fluctuations, it may demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and 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 of 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 centimeter (µS/cm). 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 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.

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, salinity and temperature. High concentrations of nutrients can lead to excessive surface vegetation growth and algae, which may starve subsurface vegetation of sunlight and, therefore, limit the amount of DO in a water body due to reduced photosynthesis. This process, known as eutrophication, is enhanced when the subsurface vegetation and algae die, and oxygen is consumed by bacteria during decomposition of organic matter. Low DO levels may also result from high groundwater inflows due to minimal groundwater aeration, high temperatures that reduce oxygen solubility, increased salinities in coastal waters, 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 from 0 to 14 and is reported in standard units (su). 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/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 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. The most suitable pH range for healthy organisms is between 6.5 and 9.0 su.

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. 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. Average Secchi disk depth measurements that are less than the total depth of the monitoring site are indicative of turbid water. Readings that are equal to total depth indicate clear water.

Enterococci Bacteria

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 the TCEQ as an indicator in coastal water bodies of the potential presence of pathogens in recreational waters. A pathogen is a biological agent that causes disease. The San Bernard River is designated a primary contact recreation 1 (PCR1) use. This means that recreation activities in the San Bernard 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).

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. Although there are no *Enterococci* bacteria data to analyze for this report, there are a limited number (10) of *E. coli* sampling results from Hanson Park (Site 81005) included in this report.

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 nitrogen has on a water body is known as eutrophication and was described previously in the "Dissolved Oxygen" section (page 12). Nitrate-nitrogen dissolves more readily than orthophosphate, which tends 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 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, and depth, sample collector's name/signature, group identification number, conductivity meter calibration information, and reagent expiration dates are checked and recorded if expired.

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 blanks, and media expiration dates are checked and recorded if expired.

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 by email/mail or by entering the data electronically 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 Waterways Dataviewer.

Data Analysis

Data were compiled, summarized, and compared to state 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 complicated monitoring methods and oversight than those used by citizen scientists and staff in this report. The citizen 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.

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. The cut off for 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 matches actual conditions in nature increases.

DATA RESULTS

Water quality data from seven Texas Stream Team monitoring sites were acquired for this report (Figure 4, Table 4). Five of the seven sites are within the San Bernard River watershed (81005, 80594, 90775, 81091, and 80509), while two are within the San Bernard National Wildlife Refuge (81208 and 81209). Three of the monitoring sites only had data from one sampling event (81091, 81209, and 81208). The remaining four sites (81005, 80594, 90775, and 80509) comprised 99% of the data in the Waterways Dataviewer and were included in subsequent watershed and site analyses for this report.

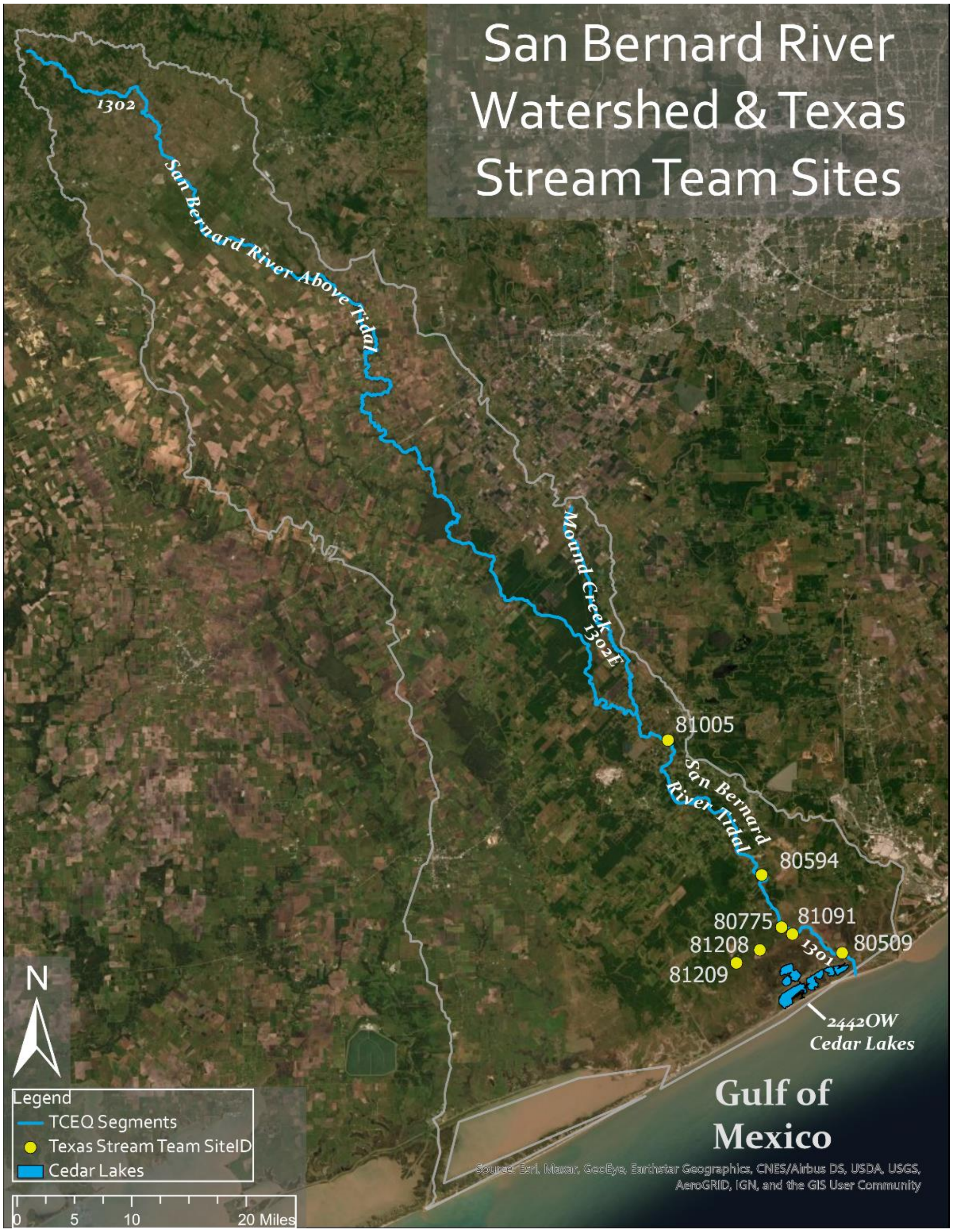

Figure 4. Texas Stream Team monitoring sites in the San Bernard River (tidal segment 1301) watershed and the San Bernard National Wildlife Refuge.

Table 2. Texas Stream Team monitoring sites and number of samples reported at each site in the San Bernard River watershed and the San Bernard National Wildlife Refuge.

Station ID	Description	Latitude	Longitude	Number of Samples
81005	San Bernard @ Hanson Park	29.11	-95.67	11
80594	H-GAC site, San Bernard River @2649 County Road 496	28.96	-95.56	72
80775	San Bernard River @Cox's Reef	28.91	-95.53	46
81091	San Bernard River @ Rio Vista Dock in Brazoria	28.90	-95.52	1
80509	H-GAC – San Bernard River @Fisherman's Isle	28.88	-95.45	196
81209	Cocklebur Slough Kayak Launch @ San Bernard National Wildlife Refuge	28.87	-95.59	1
81208	Moccasin Pond @San Bernard National Wildlife Refuge	28.88	-95.56	1

Watershed Analysis

Sampling Trends Over Time

The period of record for data analyzed for this report spanned from May 2008 to April 2020. Data from 328 monitoring events conducted at seven sites were acquired, but only data from four sites representing 325 events or 99% of all the data are included in Table 5. The number of samples, mean, standard deviation, minimum and maximum values are listed in Table 5 for all parameters except for *E. coli* which is represented as the geometric mean.

The total number of samples for the Texas Stream Team core water quality monitoring parameters (air and water temperature, specific conductance/salinity, dissolved oxygen, pH, and Secchi disk) remained somewhat consistent for the period of record. Substantially fewer results were reported for the advanced parameters (*E. coli* and nitrate-nitrogen).

A total of 322 flow severity observations were documented by Texas Stream team citizen scientists from May 2008 through April 2020 (Figure 5). Most sampling events occurred under normal (157), low (123), or no flow (29) conditions respectively. Only a few sampling events took place under flood (8) or high (5) flow conditions.

Air and Water Temperature

A total of 325 and 324 air and water temperatures, respectively, were measured in the San Bernard River watershed between May 2008 and April 2020 (Table 5). Mean air temperature for all sites was 23.5°C, and varied between 3 and 34°C. Mean water temperature for all sites was 23.0°C and the maximum was 33.2°C, both well below the TCEQ water temperature criterion (35°C).

Specific Conductance and Salinity

Citizen scientists measured specific conductance 43 times in the San Bernard River watershed (Table 5). The average specific conductance for all sites was 5,152.7 µS/cm and measurements ranged from 0.2 to 18,500 µS/cm. These measurements reflect the tidally influenced saline waters in the river. The conductivity meter used for measurements by trained Texas Stream Team citizen scientists has a range of 0-1,999 µS/cm. Therefore, measurements greater than 1,999 µS/cm are suspect due to the limited instrument capabilities.

Citizen scientists measured salinity 235 times for a mean of 17.8 ppt (Table 5). This segment (1301) of the San Bernard River is tidally influenced which is reflected by the reported salinities ranging from 0 to 41 ppt.

Table 3. Descriptive statistics of Texas Stream Team data in the San Bernard River tidal May 2008 – April 2020.

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Air Temperature (°C)	325	23.5±6.7	3	34
Water Temperature (°C)	324	23.0±6.8	4.8	33.2
Specific Conductance (µS/cm)	43	5,152.7±5,999.6	0.2	18,500
Salinity (ppt)	235	17.8±12.2	0	41
Dissolved Oxygen (mg/L)	320	6.4±1.7	2.0	11.2
pH (su)	325	7.7±0.4	6.7	9.5
Secchi Disk (m)	273	0.37±0.2	0.01	0.9
E. coli (CFU/100mL)	10	167.8±750.0	0	2,760
Nitrate-Nitrogen (mg/L)	7	1.3±0.8	1	3

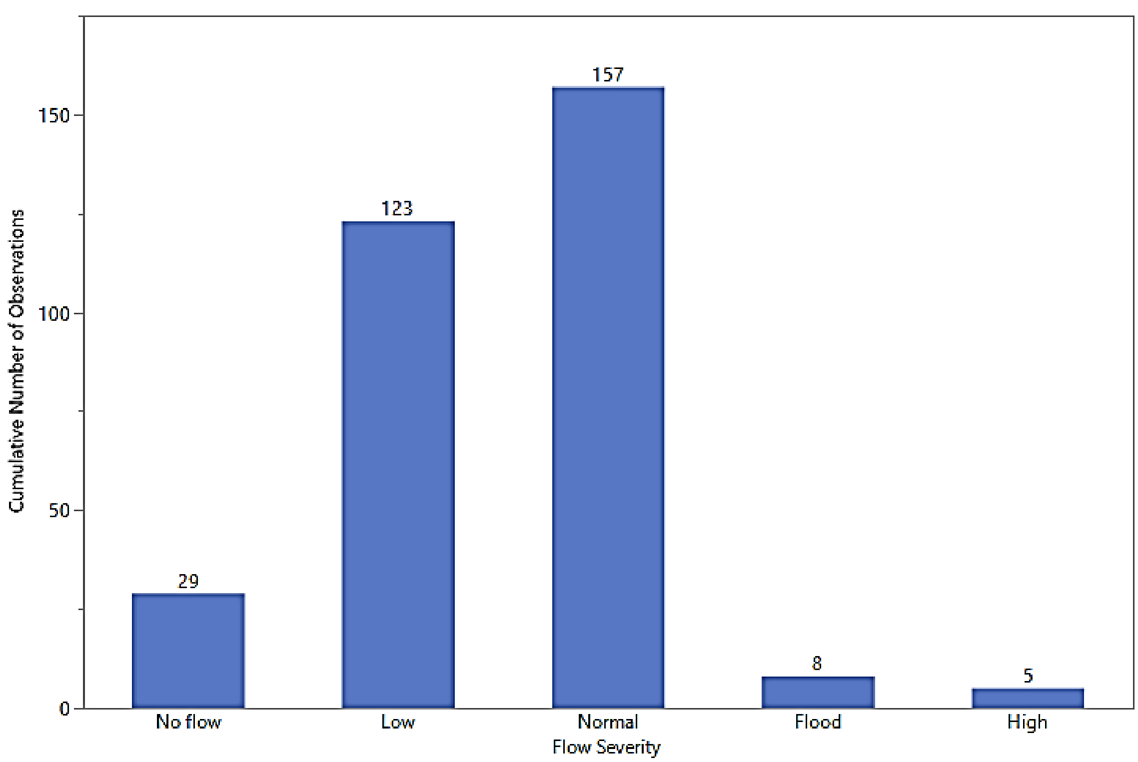

Figure 5. Cumulative number of flow severity observations in the San Bernard River tidal May 2008 to April 2020.

Dissolved Oxygen

Citizen scientists collected 320 DO measurements in the San Bernard River (Table 5). The mean DO was 6.4 mg/L. Measurements ranged from a low of 2.0 mg/L to a high of 11.2 mg/L. Twelve values were less than the 24-hour mean water quality criterion (4.0 mg/L), while four values equaled 4.0 mg/L.

pH

The pH was measured 325 times in the San Bernard River watershed and the mean was 7.7 su (Table 5). The pH values ranged from 6.7 to 9.5 su.

Secchi Disk

Secchi disk measurements were collected 273 times at sites in the San Bernard River watershed (Table 5). The mean Secchi depth at sites in the watershed was 0.37 m and ranged from 0.01 m to 0.9 mg/L.

E. coli Bacteria

A limited number (10) of *E. coli* samples were collected and analyzed in the San Bernard River tidal segment (Table 5). The geomean for *E. coli* was 167.8 CFU/100 mL. The *E. coli* counts ranged from 0 CFU/100 mL to a high of 2,760 CFU/100 mL. When compared to the freshwater *E. coli* criterion (126 CFU/100mL), the geomean at Hanson Park exceeded the standard for primary contact recreation in freshwater streams.

Nitrate-Nitrogen

Nitrate-nitrogen concentrations were measured seven times in the San Bernard River watershed (Table 5). The mean nitrate-nitrogen concentration in the watershed was 1.3 mg/L and ranged from 1 to 3 mg/L. Although there are no numeric criteria for maximum nutrient levels allowed in a stream or river, there are screening levels that will trigger a concern. The screening level for nitrate nitrogen is 1.95 mg/L. The mean value (1.3 mg/L) for this study is below the screening criterion, however there was one sample (3.0 mg/L) that was higher than the screening criterion.

Site Analysis

Water quality monitoring data for each of the seven sites in the San Bernard River watershed were analyzed and summarized (Table 6). The four sites on the San Bernard River tidal (segment 1301) with the greatest number of measurements in the Waterways Dataviewer were Hanson Park (n=11), CR496 (n=73), Cox's Reef (n=44), and Fisherman's Isle (n=197). The remaining three sites (81091, 81209, and 81208) only had one sampling event in 2019, but it is anticipated that more data are forthcoming due to the recent activity at those sites. The site and parameter results discussed below will only make reference to the four sites on the San Bernard River tidal segment and are presented graphically from upstream (Hanson Park - 81005) to downstream (Fisherman's Isle - 80509). The three sites with only one event are included in Table 6 for informational purposes, but are not included in the subsequent graphs.

Air and water Temperature

Average air temperature for sites on the San Bernard River ranged from 19.3°C at Cox's Reef to 24.4°C at Fisherman's Isle (*Figure* 6). Average water temperature ranged from 21.1°C at Cox's Reef to 23.5°C at CR 496. Average water temperatures for all sites were below the temperature water quality criterion (35°C) (*Figure* 7).

Table 4. Summary statistics for monitoring sites in the San Bernard River tidal and the San Bernard National Wildlife Refuge May 2008 to April 2020.

Parameter	Hanson Park 81005 n=11 Mean±SD (Range)	CR496 80594 n=73 Mean±SD (Range)	Cox's Reef 80775 n=44 Mean±SD (Range)	Rio Vista Dock 81091 n=1 Mean±SD (Range)	Fisherman's Isle 80509 n=197 Mean±SD (Range)	Cocklebur Slough-NWR 81209 n=1 Mean±SD (Range)	Moccasin Pond-NWR 81208 n=1 Mean±SD (Range)
Air Temperature (°C)	23.9±7.7 (12.0-33.5)	23.3±6.0 (5.0-32.0)	19.3±7.4 (3.0-29.3)	14.0	24.4±6.4 (8.0-34.0)	21.3	23.3
Water Temperature (°C)	22.4±9.1 (9.5-33.2)	23.5±6.2 (13.5-33.0)	21.1±7.3 (4.8-30.8)	15.0	23.3±6.8 (8-33.0)	14.8	11.9
Specific Conductance (µS/cm)	753.3±751.6 (280-1,620)	5,482.7±6,093.9 (0.2-18,500)	ND	ND	ND	ND	ND
Salinity (ppt)	1.1±3.7 (0-12.2)	19.1±8.9 (0.2-31.7)	10-9±9.8 (0-30.8)	ND	18.9±12.3 (0-41.0)	ND	ND
Dissolved Oxygen (mg/L)	7.6±1.9 (5.5-11.2)	6.7±1.7 (3.4-11.2)	6.0±1.9 (2.0-9.7)	7.5	6.2±1.7 (3.2-10.0)	6.9	7.9
pH (su)	8.0±0.63 (7.3-9.5)	7.7±0.36 (7-8.5)	7.7±0.34 (6.7-8.3)	7.0	7.6±0.33 (6.7-8.1)	7.7	7.8
Secchi Disk (m)	0.28±0.12 (0.1-0.40)	0.41±0.17 (0.12-0.72)	0.51±0.23 (0.10-0.90)	0.2	0.34±0.16 (0.01-0.65)	0.25	1.05
***E. coli* (CFU/100mL)**	n=10 167.8 (0-2,760)	ND	ND	ND	ND	ND	ND
Nitrate-Nitrogen (mg/L)	n=7 1.3±0.76 (1.0-3.0)	ND	ND	ND	ND	ND	ND

Specific Conductance and Salinity

Specific conductance was measured at the two most upstream sites (Hanson Park and CR 496), while salinity was measured at the three downstream sites (CR 496, Cox's Reef, and Fisherman's Isle) (Table 6). Mean conductance at Hanson Park was 753.3 µS/cm, while mean conductance at CR 496 was 5,482 µS/cm. The conductivity meter used by Texas Stream citizen scientists has a range of 0-1999 µS/cm, therefore it is unlikely that the measurements at CR 496 are representative of actual conditions.

Salinity values exhibited a low to high gradient from upstream (Hanson Park) to downstream (Fisherman's Isle) (Figure 8). The CR 496 site has outliers at both the high and low spectrums indicative of the transitional area from freshwater (above tidal) to tidally-influenced saltwater. Fisherman's Isle (80509) is the most downstream site closest to the Gulf Coast and has the highest average salinity (18.9 ppt) of all sites.

Dissolved Oxygen

Average DO values for the four San Bernard River sites ranged from 6.0 to 7.6 mg/L (Table 6). The lowest average DO value was recorded at Cox's Reef (6.0 mg/L) and the highest average value (7.6 mg/L) at Hanson Park (Figure 9). There was a general high to low DO gradient from freshwater to saltwater. Average DO values from all four sites met the water quality criteria for minimum 24-hour means (4.0 mg/L). However, individual measurements at Cox's Reef exceeded both 24-hour mean and absolute grab minimums (3.0 mg/L), and some measurements at CR 496 and Fisherman's Isle exceeded the 24-hour mean criterion. A strong correlation (r^2>0.5) is depicted between warmer water and DO for Cox's Reef and Fisherman's Isle down river near the coast at sites influenced by saltwater (Figure 10).

pH

Average pH values for sites on the San Bernard River ranged from 7.6 to 8.0 s.u. (Table 6). The lowest average value (7.6 su) was from Fisherman's Isle (80509), the most seaward site, while the highest average value was from Hanson Park (81005), the most upstream site. Average pH values for all sites were within the low and high criteria (6.5 – 9.0 su) for pH, however some individual measurements at Hanson Park exceeded the high criterion (Figure 11).

Secchi Disk

The mean Secchi disk transparency measurements ranged from 0.28 m at Hanson Park and 0.51 m at Cox's Reef. Cox's Reef exhibited the most variability with a range of 0.10 to 0.90 m (Figure 12). The range of Secchi disk measurements at the three down river sites (CR 496, Cox's Reef, and Fisherman's Isle) are representative of the tidal amplitude in the Gulf of Mexico.

E. coli Bacteria

Ten *E. coli* samples were recorded in the Waterways Dataviewer for Hanson Park (Table 6). The water quality criterion for primary contact recreation in tidal waters is based on a geometric mean for *Enterococci* bacteria, not *E. coli.* Since there are no *Enterococci* data available, no comparison is made to the saltwater criterion for *Enterococci*. The *E. coli* geometric mean at Hanson Park is 167.8 CFU/100 mL. This value exceeds the freshwater primary contact recreation criterion (126 CFU/100mL).

Nitrate-Nitrogen

Limited data (n=7) are available in the Waterways Dataviewer for nitrate-nitrogen from Hanson Park (Table 6). The average nitrate-nitrogen value for Hanson Park is 1.3 mg/L, with a range of 1.0 to 3.0 mg/L. As noted previously, there are no numeric criteria for maximum nutrient levels allowed in a stream or river, however there are screening levels that trigger a concern. The screening level for nitrate nitrogen is 1.95 mg/L. The mean value (1.3 mg/L) for this study is below the screening criterion, however there was one sample (3.0 mg/L) that was higher than the screening criterion.

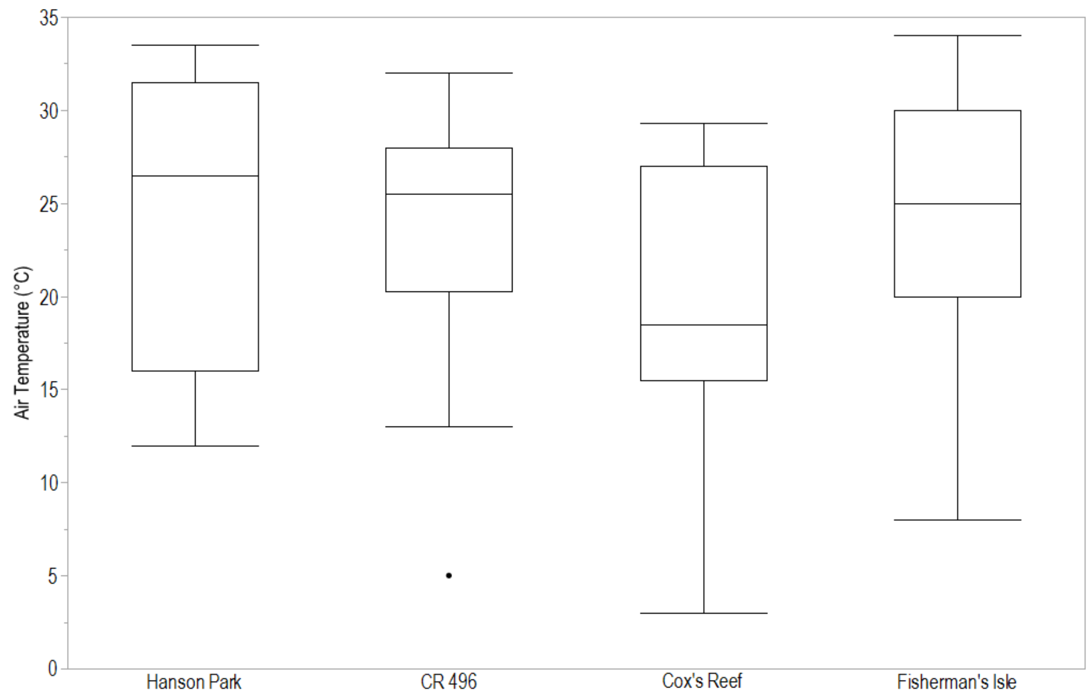

Figure 6. Air temperature (°C) for sites in the San Bernard River tidal May 2008 to April 2020.

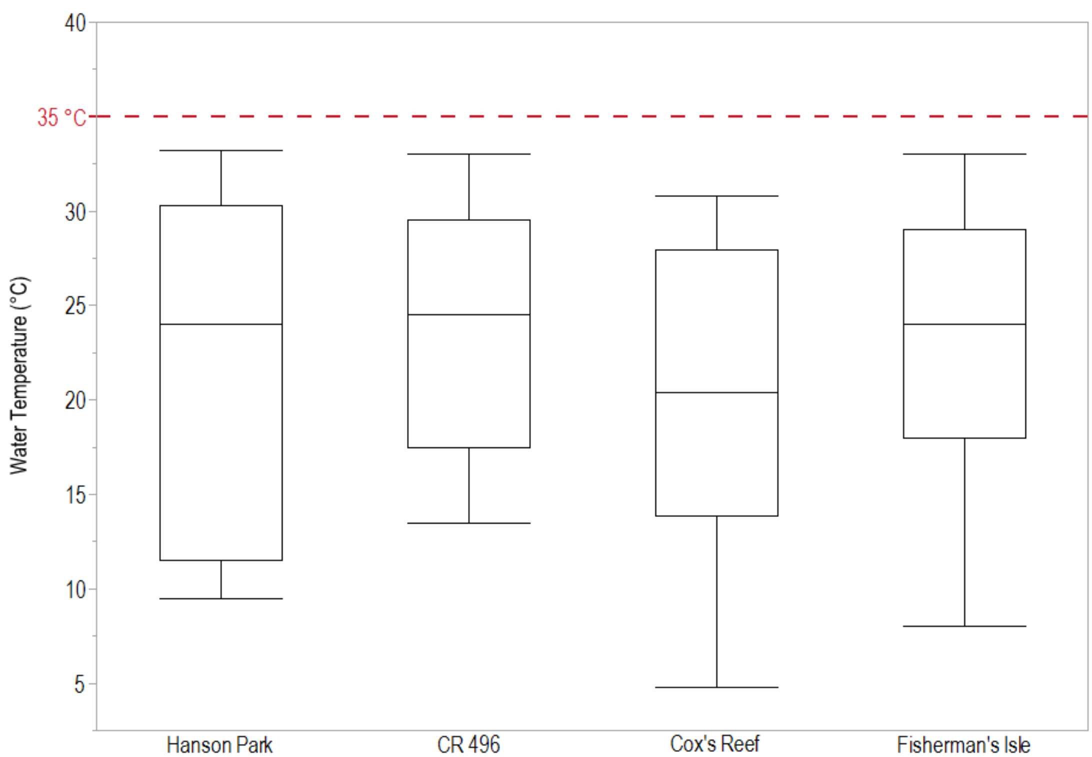

Figure 7. Water temperature (°C) in the San Bernard River tidal May 2008 to April 2020.

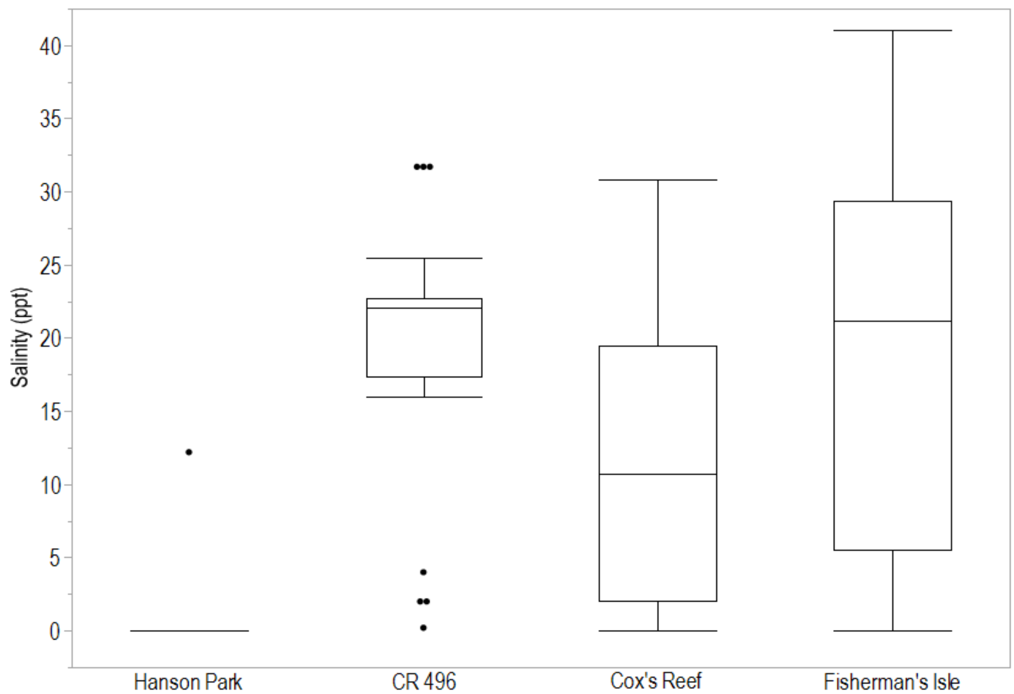

Figure 8. Salinity (ppt) in the San Bernard River tidal May 2008 to April 2020.

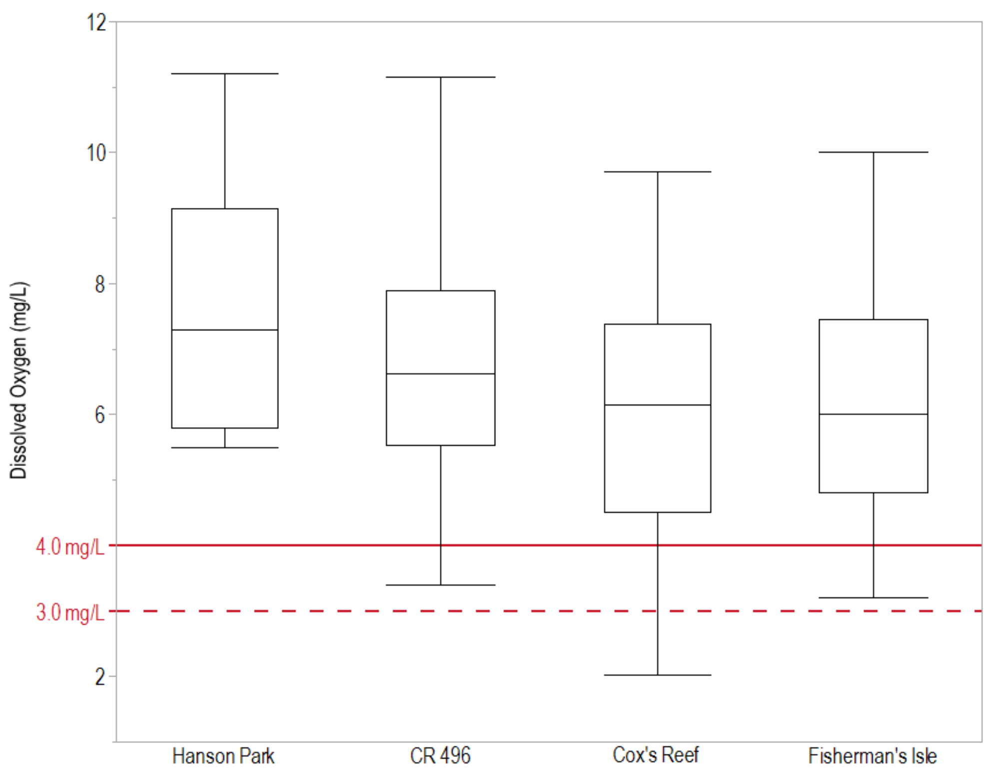

Figure 9. Dissolved oxygen (mg/L) in the San Bernard River tidal May 2008 to April 2020.

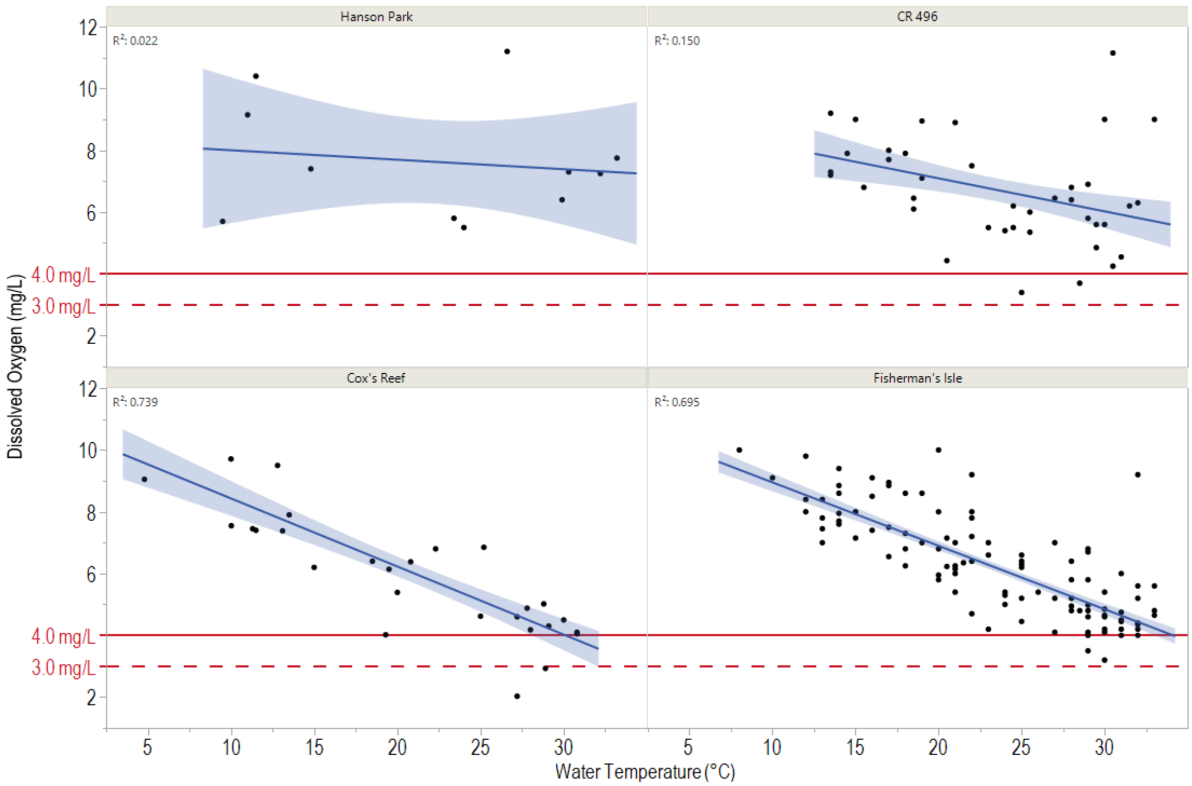

Figure 10. Relationship between water temperature (°C) and dissolved oxygen (mg/L) in the Sn Bernard River May 2008 to April 2020.

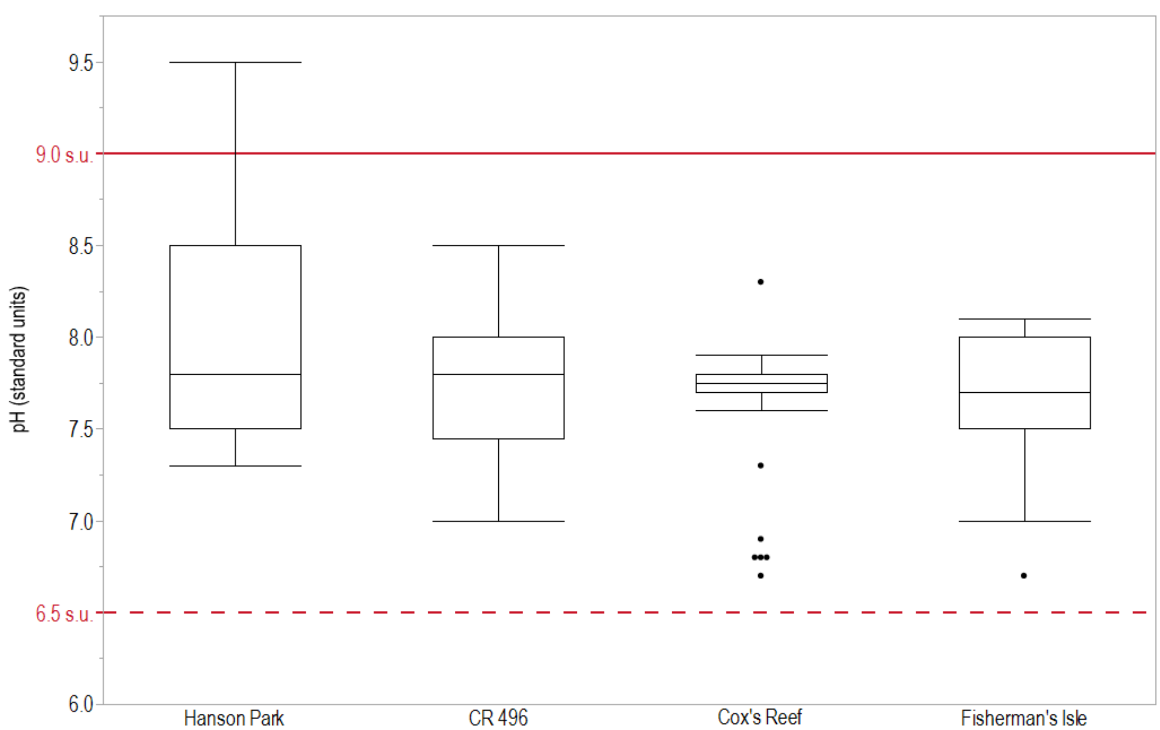

Figure 11. pH (s.u.) in the San Bernard River tidal May 2008 to April 2020.

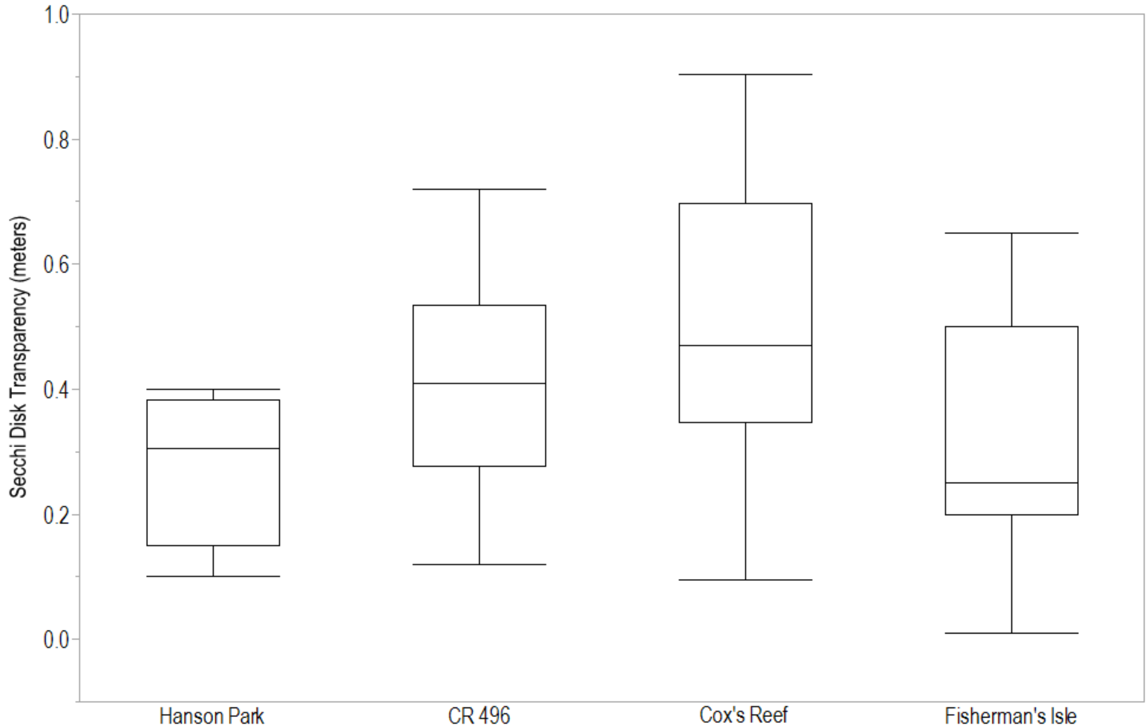

Figure 12. Secchi disk transparency (m) in the San Bernard River tidal May 2008 to April 2020.

WATERSHED SUMMARY

Texas Stream Team citizen scientists monitored water quality parameters from seven sites in the San Bernard River tidal segment (1301) and the San Bernard National Wildlife Refuge (2442OW) from May 2008 to April 2020. This report focused on four (Hanson Park-81005, CR 496-80594, Cox's Reef-80775 and Fisherman's Isle-80509) of the seven sites with the most data. A total of 328 monitoring events were recorded on the Waterways Dataviewer and included measurements for flow severity, air and water temperature, DO, pH, salinity, specific conductance, Secchi disk, *E. coli,* and nitrate-nitrogen. Results from four monitoring sites with the most data were analyzed and compared to established water quality criteria when appropriate.

The 2018 Texas Integrated Report lists the San Bernard River tidal segment as "impaired" for not meeting the *Enterococci* criterion for the primary contact recreation use and as a "concern" for depressed DO associated with the aquatic life use. Texas Stream Team citizen scientists only monitor *E. coli*, not *Enterococci*, and there were only 10 sampling events for *E. coli*. Therefore, no data was available to assess the primary contact recreation use impairment in the San Bernard River tidal segment. The DO data, however, appear to support a concern for the aquatic life use. Of the 320 DO discreet measurements, 12 values were below the 4.0 mg/L criterion and an additional four values were equal to the 4.0 mg/L criterion.

Highlights of the results presented in this report include:

- Sampling was conducted under no flow, low flow, and normal flow conditions 96% of the time, therefore the results are representative of those conditions.
- Both air and water temperatures appear normal for this area with the most variability exhibited at Cox's Reef for both parameters. Average water temperatures for all sites met the temperature water quality criterion (35°C).
- Conductivity was measured at the two upstream sites, Hanson Park and CR 496. The conductivity values reported at CR 496 were outside the range of the conductivity meter used by Texas Stream Team citizen scientists, therefore those data are suspect.
- Salinity values exhibited a low to high gradient from upstream (Hanson Park) to downstream (Fisherman's Isle) (Figure 8). The CR 496 site has outliers at both the high and low spectrums indicative of the transitional area from freshwater to tidally-influenced saltwater. TCEQ considers segments to be tidally influenced when there is observed tidal activity, TDS is greater than or equal to 2,000 mg/L, salinity is greater than or equal to 2 parts per thousand, or specific conductance is greater than or equal to approximately 3,000 µS/cm. These data support the TCEQ criteria for tidally influenced streams.
- DO values reflect a high to low gradient from the upstream, freshwater sites, to the downstream, saltwater sites (Figure 9). Physical attributes of water such as higher salt content and warmer water, naturally result in lower DO concentrations. Although average DO values for all sites met both 24-hour average and grab minimum criteria, some samples at both CR 495 and Fisherman's Isle did not. The strong correlation between warmer water and DO for those sites (Figure 10) further supports the 2018 Texas Integrated Report designation as a concern in the San Bernard River Tidal segment.
- Average pH values at all sites met the high and low criteria, however some measurements at Hanson Park exceeded the high criterion (Figure 11).
- A limited number of samples (10) and a difference in bacteria used to assess contact recreation in saltwater (Enterococcus as opposed to *E. coli*) prevented a comparison of the Texas Stream Team bacteria data to the appropriate water quality criterion. However, when compared to the freshwater criterion (126 CFU/100mL), the average exceeded that threshold. This area is on the 2018 Texas Integrated Report for not meeting the *E. coli* criterion for primary contact recreation, therefore it is prudent that monitoring takes place in the San Bernard River to ensure safe recreation.
- H-GAC estimated the human population would more than double in the next 20 years. In light of this prediction, it is critical to continue implementing WPP management measures to prevent major impacts on water quality and to continue monitoring water quality to detect changes resulting from impacts of urbanization.

There are numerous active Texas Stream Team citizen scientists and groups that monitor water quality in the San Bernard River watershed. Texas Stream Team staff will continue to support the on-going monitoring efforts currently underway and look forward to training new citizen scientists to expand and grow the water quality monitoring efforts in this area and beyond. The H-GAC has a very active Texas

Stream Team citizen scientist group monitoring water quality in the San Bernard River watershed and the surrounding areas. This group is led by Kendall Guidroz, Planner, with the H-GAC. For more information about Texas Stream Team and upcoming trainings contact either stream.team@h-gac.com or Txstreamteam@txstate.edu.

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Appendix I. Endangered, threatened, and rare species within the San Bernard River watershed in Austin, Colorado, Wharton, Fort Bend, and Brazoria Counties.

Definitions

Federal and State Listing Status: Animal and plant species of conservation concern that are listed under the authority of the U.S. Endangered Species Act or under the authority of Texas state law.

Listing Status	Description
LE	Federally Listed as Endangered
LT	Federally Listed as Threatened
PE	Federally Proposed as Endangered
PT	Federally Proposed as Threatened
C	Federal Candidate for Listing
E	State Listed as Endangered
T	State Listed as Threatened
"blank"	Species of Greatest Concern (SGCN) (no regulatory listing status)

NatureServe Conservation Status: A ranking system developed by The Nature Conservancy and maintained by NatureServe in order to categorize the vulnerability and imperilment of species around the world.

Global Rank	Description
G1	Critically Imperiled: Species is at very high risk of extinction
G2	Imperiled: Species is at high risk of extinction
G3	Vulnerable: Species is at moderate risk of extinction
G4	Apparently Secure: Species is at fairly low risk of extinction
G5	Secure: Species is at very low risk of extinction
GH	Possibly Extinct: No occurrence of the species has been observed in recent history. Some hope of rediscovery
GNR	Unranked: Rank has not yet been assessed
GNA	Not Applicable: A rank is not applicable because this species is not a suitable candidate for conservation activities

Species of Greatest Conservation Need (SGCN): A statewide list developed and maintained by the Texas Parks and Wildlife Department that includes over 1,300 species of conservation concern. Species of Great Concern are species that are declining, rare, and/or in need of immediate conservation action.

Designation	Description
Yes	Species is declining, rare, and/or in need of conservation action
No	Species is not considered in need of immediate conservation action

Threatened and Endangered Species List

All data was obtained from the Texas Parks and Wildlife Department Rare, Threatened, and Endangered Species of Texas by County online application (Texas Parks and Wildlife, 2019).

Taxon	Scientific Name	Common Name	Federal Listing Status	State Listing Status	Nature Serve Global Rank	Species of Greatest Conservation Need (TPWD)	Endemism
Amphibians	Anaxyrus houstonensis	Houston toad	LE	E	G1	Y	Y
	Anaxyrus woodhousii	Woodhouse's toad			G5	Y	N
	Pseudacris streckeri	Strecker's chorus frog			G5	Y	N
	Pseudacris fouquettei	Cajun chorus frog			G5	Y	N
	Lithobates areolatus areolatus	Southern crawfish frog			G4T4	Y	N
Birds	Egretta rufescens	Reddish egret		T	G4	Y	N
	Plegadis chihi	White-faced ibis		T	G5	Y	N
	Mycteria americana	Wood stork		T	G4	Y	N
	Elanoides forficatus	Swallow-tailed kite		T	G5	Y	N
	Haliaeetus leucocephalus	Bald eagle			G5	Y	N

	Buteo albicaudatus	White-tailed hawk		T	G4G5	Y	N
	Buteo albonotatus	Zone-tailed hawk		T	G4	Y	N
	Tympanuchus cupido attwateri	Attwater's greater prairie-chicken	LE	E	G4T1	Y	N
	Laterallus jamaicensis	Black Rail	PT	T	G3G4	Y	N
	Grus americana	Whooping crane	LE	E	G1	Y	N
	Charadrius melodus	Piping plover	LT	T	G3	Y	N
	Calidris canutus rufa	Rufa Red Knot	LT	T	G4T2	Y	N
	Leucophaeus pipixcan	Franklin's gull			G5	Y	N
	Sternula antillarum athalassos	Interior least tern	LE	E	G4T3Q	Y	N
	Athene cunicularia hypugaea	Western burrowing owl			G4T4	Y	N
Crustaceans	Procambarus brazoriensis	Brazoria crayfish			G1	Y	Y
Fish	Atractosteus spatula	Alligator gar			G3G4	Y	N
	Anguilla rostrata	American eel			G4	Y	N

	Notropis atrocaudalis	Blackspot shiner			G4	Y	N
	Notropis oxyrhynchus	Sharpnose shiner	LE	E	G3	Y	Y
	Notropis shumardi	Silverband shiner			G5	Y	N
	Macrhybopsis storeriana	Silver chub			G5	Y	N
	Fundulus jenkinsi	Saltmarsh topminnow			G3	Y	N
	Microphis brachyurus	Opossum pipefish			G4G5	Y	N
	Micropterus treculii	Guadalupe bass			G3	Y	Y
	Paralichthys lethostigma	Southern flounder			G5	Y	N
	Isurus oxyrinchus	Shortfin Mako Shark		T	GNR	Y	N
	Carcharhinus longimanus	Oceanic Whitetip Shark	LT	T	GNR	Y	N
Insects	Nicrophorus americanus	American burying beetle			G3	Y	N
	Sparbarus coushatta	No accepted common name			G1G2	Y	

	Plauditus texanus	No accepted common name			G2G3	Y	N
	Pseudocentroptiloides morihari	A mayfly			G2G3	Y	Y
	Bombus pensylvanicus	American bumblebee			G3G4	Y	
	Trimerotropis schaefferi	Gulf Dune Grasshopper			G2G3	Y	Y
Mammals	Blarina carolinensis	Southern short-tailed shrew			G5	Y	N
	Myotis austroriparius	Southeastern myotis bat			G4	Y	N
	Perimyotis subflavus	Tricolored bat			G2G3	Y	N
	Eptesicus fuscus	Big brown bat			G5	Y	N
	Lasiurus borealis	Eastern red bat			G3G4	Y	N
	Lasiurus cinereus	Hoary bat			G3G4	Y	N
	Corynorhinus rafinesquii	Rafinesque's big-eared bat		T	G3G4	Y	N
	Tadarida brasiliensis	Mexican free-tailed bat			G5	Y	N
	Nyctinomops macrotis	Big free-tailed bat			G5	Y	
	Sylvilagus aquaticus	Swamp rabbit			G5	Y	N

	Ictidomys tridecemlineatus	Thirteen-lined ground squirrel			G5	Y	N
	Physeter macrocephalus	Sperm whale	LE	E	G3G4	N	N
	Balaenoptera borealis	Sei Whale	LE	E	G3	N	N
	Balaenoptera musculus	Blue whale	LE	E	G3G4	N	N
	Balaenoptera edeni	Gulf of Mexico Bryde's Whale	LE	E	G4	N	N
	Megaptera novaeangliae	Humpback whale	LE		G4	N	N
	Eubalaena glacialis	North Atlantic right whale	LE	E	G1	N	N
	Mustela frenata	Long-tailed weasel			G5	Y	N
	Neovison vison	Mink			G5	Y	N
	Taxidea taxus	American badger			G5	Y	N
	Spilogale putorius	Eastern spotted skunk			G4	Y	N
	Spilogale putorius interrupta	Plains spotted skunk			G4T4	N	N

	Conepatus leuconotus	Western hog-nosed skunk			G4	Y	N
	Puma concolor	Mountain lion			G5	Y	N
	Trichechus manatus	West Indian manatee	LT	T	G2	Y	N
Mollusks	Quadrula houstonensis	Smooth pimpleback			G2	Y	Y
	Cyclonaias petrina	Texas pimpleback	C	T	G1	Y	Y
	Truncilla macrodon	Texas fawnsfoot	C	T	G1	Y	Y
Plants	Justicia runyonii	Runyon's water-willow			G2	Y	N
	Tauschia texana	Texas tauschia			G3	Y	Y
	Pseudognaphalium austrotexanum	South Texas false cudweed			G3	Y	N
	Helianthus occidentalis ssp. Plantagineus	Shinner's sunflower			G5T2T3	Y	N
	Helianthus praecox ssp. Praecox	Texas sunflower	LE	E	G4T2	Y	Y
	Hymenoxys texana	Texas prairie dawn			G2	Y	Y

	Liatris bracteata	Coastal gay-feather			G2G3	Y	Y
	Thurovia triflora	Threeflower broomweed			G2G3	Y	Y
	Onosmodium helleri	Heller's marbleseed			G3	Y	Y
	Amorpha paniculata	Panicled indigobush			G2G3	Y	N
	Monarda viridissima	Texas beebalm			G3	Y	Y
	Rhododon ciliatus	Texas sandmint			G3	Y	Y
	Leitneria pilosa ssp. Pilosa	Corkwood			G2G3T 2	Y	N
	Spigelia texana	Florida pinkroot			G3	Y	Y
	Oenothera cordata	Heartleaf evening-primrose			G3	Y	Y
	Thalictrum texanum	Texas meadow-rue			G2Q	Y	Y
	Seymeria texana	Texas seymeria			G3	Y	Y
	Cyperus cephalanthus	Giant sharpstem umbrella-sedge			G3?Q	Y	N

	Cyperus grayioides	Mohlenbrock's sedge			G3G4	Y	N
	Eleocharis austrotexana	South Texas spikesedge			G3	Y	Y
	Rhynchospora indianolensis	Indianola beakrush			G3Q	Y	Y
	Cooperia traubii	Traub's rainlily			G3	Y	Y
	Schoenolirion wrightii	Texas sunnybell			G3	Y	N
	Calopogon oklahomensis	Oklahoma grass pink			G2	Y	N
	Bothriochloa exaristata	Awnless bluestem			G4	Y	N
	Chloris texensis	Texas windmill grass			G2	Y	Y
	Sporobolus tharpii	Tharp's dropseed			G3	Y	Y
	Willkommia texana var. Texana	Texas willkommia			G3G4T3	Y	Y
Reptiles	Trichechus manatus	West Indian manatee	LT	T	G3	Y	
	Caretta caretta	Loggerhead sea turtle	LT	T	G3	Y	

	Chelonia mydas	Green sea turtle	LT	T	G1	Y	
	Lepidochelys kempii	Kemp's Ridley sea turtle	LE	E	G3G4	Y	N
	Macrochelys temminckii	Alligator snapping turtle		T	G2	Y	
	Dermochelys coriacea	Leatherback sea turtle	LE	E	G4	Y	Y
	Graptemys versa	Texas map turtle			G4T3Q	Y	Y
	Malaclemys terrapin littoralis	Texas diamondback terrapin			G5	Y	N
	Terrapene carolina	Eastern box turtle			G5	Y	N
	Terrapene ornata	Western box turtle			G5	Y	N
	Apalone mutica	Smooth softshell			G5	Y	N
	Ophisaurus attenuatus	Slender glass lizard			G4G5	Y	N
	Phrynosoma cornutum	Texas horned lizard		T	G5	Y	N
	Heterodon nasicus	Western hognose snake			G5	N	

	Thamnophis sirtalis	Common garter snake			G5T4	Y	Y
	Thamnophis sirtalis annectens	Texas garter snake			G4	Y	N
	Crotalus horridus	Timber (canebrake) rattlesnake			G3G4	Y	N
	Sistrurus tergeminus	Massasauga			G3	Y	