OSO CREEK/BAY WATERSHED DATA REPORT

December 2020

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

Photo credit: Sandra Arismendez

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 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 Oso Creek/Bay watershed. Such sources include, but are not limited to, the following:

- Texas Surface Water Quality Standards
- Texas Water Quality Inventory and 303(d) List (Integrated Report)
- Texas Clean Rivers Program (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 Oso Creek/Bay watershed is completely contained within southeastern Nueces County in the Texas Gulf Coast Region, and the larger Nueces-Rio Grande Coastal Basin (Texas Parks and Wildlife staff, n.d.). The Oso Creek/Bay watershed contains Oso Creek, which runs southeasterly across Nueces County before discharging into Oso Bay in Corpus Christi, Texas (Figure 1). The Oso Bay/Creek watershed drains approximately 209.1 square miles within Nueces county, comprising 24.4% of the county land area (Adams & Hauck, 2017). The largest municipality within the Oso Creek/Bay watershed is Corpus Christi, with a population of 429,024 (U.S. Census, 2020).

Oso Creek originates 3 miles from the city of Robstown in northeastern Nueces county and flows for approximately 28 miles before emptying into Oso Bay in Corpus Christi (Total Maximum Daily Load Program, 2020). The main channel of Oso Creek is classified by the Texas Commission on Environmental Quality (TCEQ) as stream Segment 2485A_01. Oso Creek has three unnamed tributaries, comprising TCEQ stream Segments 2485B_01, 2485C_01, and 2485D_01 (Adams & Hauck, 2017).

Oso Bay is an enclosed, shallow body of water along the southern shore of Corpus Christi Bay with a surface area of approximately seven square miles (Total Maximum Daily Load Program, 2020). Oso Bay receives an influx of freshwater from Oso Creek and exchanges saltwater with the adjacent Corpus Christi Bay. Oso Bay is classified by TCEQ as stream Segment 2485 (Total Maximum Daily Load Program, 2020).

The study area for this report will be Oso Creek (2485A_01) and Oso Bay (2485) within the Oso Creek/Bay watershed. The Texas Stream Team monitoring sites included in the data analysis for this report are on these segments.

The Oso Creek/Bay watershed is located within the Texas Gulf Coast Region, characterized by level, slowly draining plains, acidic sands, and sandy loams (Texas Parks and Wildlife, n.d.). The climate surrounding Oso Creek/Bay is categorized as humid subtropical (Cfa), with consistently high relative humidity, hot summers, and mild winters (Adams & Hauck, 2017) (National Weather Service staff, n.d.). Precipitation averages 71.5 inches annually and occurs year-round (Figure 2). The month of peak precipitation is September, with rainfall averaging 5.03 inches. The Oso Creek/Bay watershed is also subject to frequent tropical storms, and hurricane season typically spans June to November (Adams & Hauck, 2017).

Physical Description

Oso Creek originates approximately 3 miles northwest of the municipality of Robstown (population approximately 11,261) (U.S. Census, 2020). Emerging from springs fed by the underlying Gulf Coast aquifer, Oso Creek runs southeasterly for 28 miles across Nueces county and along the western edge of Corpus Christi (George, Mace, & Petrossian, 2011) (Total Maximum Daily Load Program, 2020). Oso Creek drains into the Oso Bay in the City of Corpus Christi, providing the bay with a consistent source of freshwater. Oso Creek is characterized as an effluent-dominated, low gradient stream (Nicolau, 2001). Typical soil composition includes soft, organic mud, silts, and clay, and total depth reaches up to 1.5

meters (typically varying between 0.2 to 0.75 meters on average) (Nicolau, 2001). Along the banks, vegetation consists of grasses and sedges, shrubs, and riparian trees (Nicolau, 2001).

Oso Creek drains into Oso Bay in south western Nueces county in the municipality of Corpus Christi. With a surface area of approximately seven square miles, the bay is located south of Corpus Christi Bay and to the northwest of downtown Corpus Christi (Total Maximum Daily Load Program, 2020). Oso Bay is generally characterized as a soft sediment estuarine system, with sediments primarily composed of sand and silt, and an average depth of <1 meter (Nicolau, 2001). Conditions in Oso Bay are highly dependent on precipitation, tidal stage, and influences from coastal winds (Nicolau, 2001).

The Oso Creek/Bay watershed is characterized by three soil types: Victoria Association, Orelia-Banquete Association, and Galveston-Mustang-Tidal Flats Association (Nicolau, 2001). The Victoria association, often referred to as the Blackland soils (common to the Coastal Plains), is dark-gray, calcareous, and heavy. This association is characterized by a layer of clay approximately 3 feet deep, underlain by layers of calcareous clay. The Orelia-Banquet Association comprise the crusty and depressional soils that formed from ancient lagoons and bays. This soil group is made up of layers of sandy loam and clay that vary in color and consistency. The Galveston-Mustang-Tidal Flats Association consists of coastal sands and deep, loose soils that develop in wave-deposits, typically loosely packed with a fine consistency (United States Department of Agriculture, 1992).

Figure 1. Oso Creek/Bay watershed along the Texas Gulf coast.

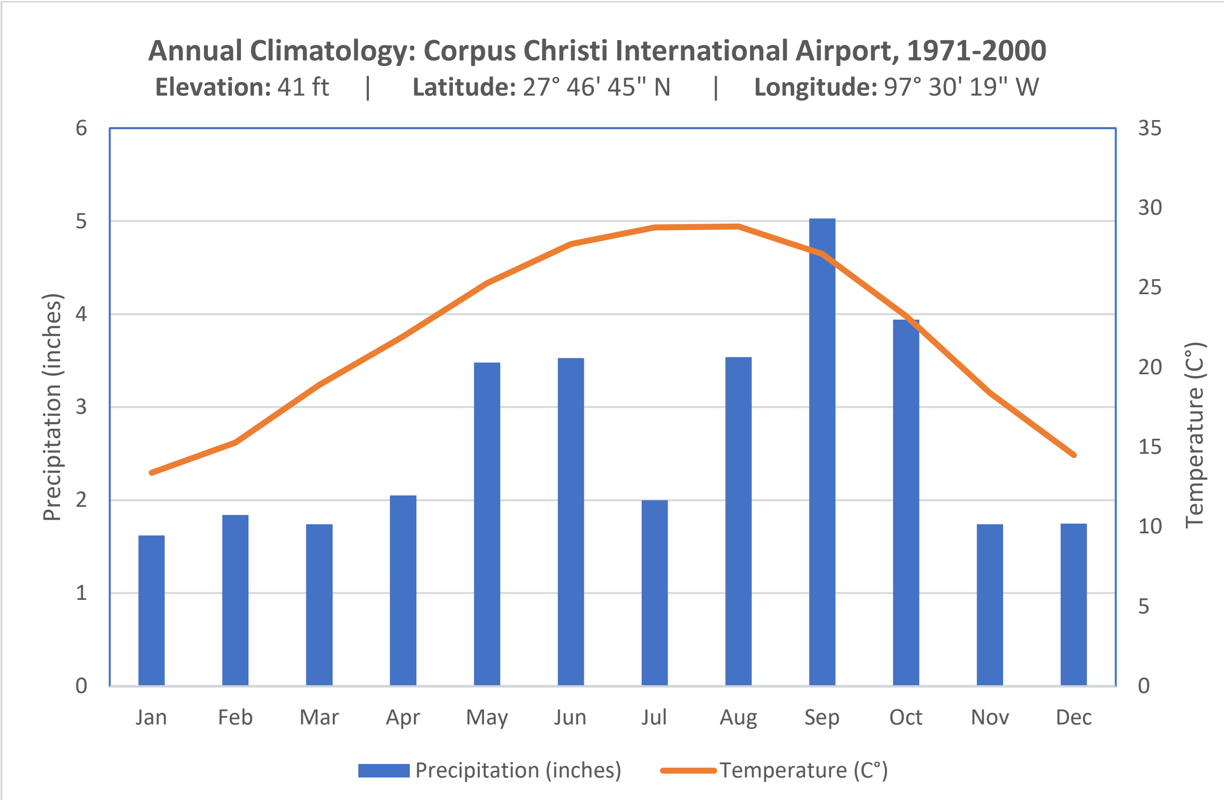

Figure 2. Long-term (1971-2000) monthly average precipitation (in) and air temperature (°C) from Corpus Christi, Texas (NOAA Climate Data, 2020).

Land Use

According to the 2016 U.S. Geological Survey (USGS) National Land Cover Database (NLCD), the Oso Creek/Bay watershed predominantly consists of cultivated crop land, followed by developed land of medium, low, and high intensity (NLCD, 2016) (Adams & Hauck, 2017). The watershed also contains areas of pastureland, scrub/shrub land, and grassland (NLCD, 2016). The agriculture of the surrounding area is noted to be diverse, and includes activities such as wool and mohair production, vegetable crops, farming and ranching, and mineral production such as oil and gas extraction, asphalt mining, and stone mining. The surrounding coastal landscape is also popular with naturalists and outdoorsmen who enjoy the scenic beauty for its hiking, camping, nature study, and hunting and fishing.

Land cover types were calculated for Oso Creek/Bay watershed (Table 1) using the USGS NLCD (2016). Cultivated land cover in the rural areas comprised the largest land cover type making up over 47% of the watershed, followed by developed land cover type in the more urban areas making up slightly over 32% of the watershed (Figure 3). Herbaceous and woody wetland land cover types combined make up over 7% of the watershed and are predominantly located on the barrier island along the windward side of Corpus Christi Bay.

Table 1. Land use and land cover for Oso Creek/Bay watershed (USGS, 2016).

Land Use	Acres	Hectares	Percent (%)
Cultivated	91,267.6	36,934.7	47.2
Developed	61,984.2	25,084.1	32.1
Grassland	15,000.1	6,071.3	7.8
Herbaceous Wetland	12,143.6	4,914.4	6.3
Woody Wetland	1,920.8	777.3	1.0
Open Water	4,862.0	1,967.6	2.5
Bare	3,944.6	1,596.3	2.0
Forest	2,177.9	881.4	1.1
Total	**193,300.9**	**78,227.1**	**100**

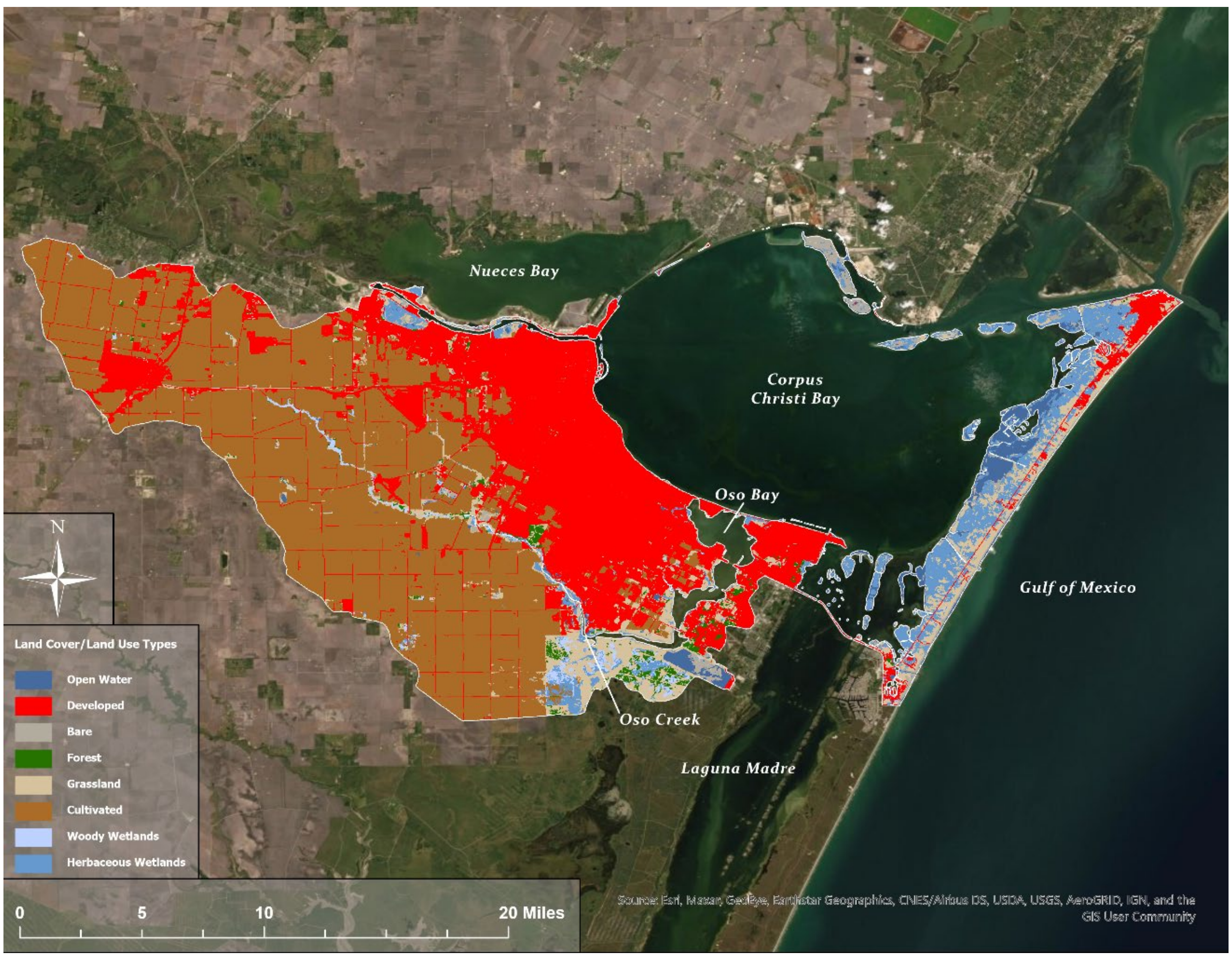

Figure 3. Land cover for Oso Creek/Bay watershed (USGS, 2016).

History

The area surrounding Oso Bay has been inhabited by humans dating as far back as 800 B.C., as evidenced by radiocarbon dating found on buried remains in the northwestern region of the Bay (Whelan, 2009). Extensive archaeological surveying conducted in 1933 and again in 1996 uncovered large quantities of Paleoindian artifacts, such as spearpoints and stone tools (Whelan, 2009). Human remains were consistently discovered in large numbers around Oso Bay, leading archaeologists to conclude that certain areas around the bay were used as burial grounds as far back as 2,800 years ago (Whelan, 2009).

Oso Bay and the surrounding Texas Gulf Coastal Region were first explored by Spanish Conquistadors in 1747, the most notable being Captain Joaquín Orobio y Basterra. According to the Handbook of Texas, Captain Orobio y Basterra reportedly identified Oso Creek, naming it "La Purísma Concepción" (Handbook of Texas Online, n.d.).

Endangered Species and Conservation Needs

The common names of 25 species listed as threatened or endangered (under the authority of Texas state law and/or under the US Endangered Species Act) within the Oso Creek/Bay watershed are included in Appendix I at the end of this report. Table 2 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 2. State and federally listed species in the Oso Creek/Bay watershed (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
Amphibians	0	3	0	1	0
Birds	2	11	1	11	0
Fish	0	2	0	2	0
Mammals	7	2	3	9	3
Reptiles	3	5	3	7	2
Insects	0	0	3	3	2
Mollusks	0	0	2	2	0
Plants	3	0	9	11	18
Total Count	**15**	**23**	**21**	**46**	**25**

Texas Water Quality Standards

The Texas Surface Water Quality Standards (TSWQS) 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 Oso Creek and Oso Bay segments included in this report are listed 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, 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 3. State water quality criteria in the Oso Creek/Bay Watershed (TCEQ, 2018).

Segment	Dissolved Oxygen Grab (mg/L)	pH Range (SU)	Bacteria (#/100 mL)	Temperature (°C)
2485 – Oso Bay (Oyster Waters)	4.0 (3.5)*	6.5-9.0	PCR1: 35 Enterococcus geomean OW: 14 – fecal coliform	35
2485A - Oso Creek	4.0 (3.0)*	6.5-9.0	35	35

*The 24-hour minimum DO criteria is in parentheses ().

Watershed Protection Plans and TMDLs

In September 2004, the Center for Coastal Studies, with support from the Texas Commission on Environmental Quality, initiated a Total Maximum Daily Load (TMDL) for Oso Bay to address the bacteria impairment for contact recreation. In 2013, a project began to address the bacteria impairment on Oso Creek by the Texas State Soil and Water Conservation Board in collaboration with the Texas Institute for Applied Environmental Research at Tarleton State. Both TMDLs are now complete and stakeholders in the watershed are currently working on preparing an Implementation Plan that will serve as a road map for reducing bacteria loads to both Oso Creek and Oso Bay as described in the TMDL documents.

Water Quality Impairments

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 bacteria (see 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.

The creek and bay segments included in this report are on the EPA-approved 2020 Texas Integrated Report – 303(d) List (TCEQ, 2020). Oso Bay (Segment 2485) is listed as category 5b – review of the standards for one or more parameters will be conducted before a management strategy is selected, including the possible revision to the TSWQS, for depressed dissolved oxygen in water and has been on the 303(d) List since 1996. Oso Bay is also on the 303(d) List for bacteria in oyster waters and is listed as a category 5a – TMDLs are underway, scheduled, or will be scheduled for one or more parameters. Oso Creek (Segment 2485A_01) is also listed as a category 5a for bacteria in water for not meeting the primary contact recreation use and has been on the 303(d) List since 2006.

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. Specific conductivity values are typically 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.

Water Transparency and Total Depth

Two instruments can be used by Texas Stream Team Citizen scientist to measure water transparency, a Secchi disk or a transparency tube. Both instruments are used to measure water transparency or to determine the clarity of the water, a condition known as turbidity. The Secchi 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. A transparency tube is filled with sample water and water is released using the release valve until the black and white pattern at the bottom of the tube can be seen. The tube is marked with two-millimeter increments and is used to measure water transparency. Transparency measurements less than the total depth of the monitoring site are indicative of turbid water. Readings that are equal to total depth indicate clear water. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow 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 United States Environmental Protection Agency (EPA) 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.

Oso Bay and Oso Creek are designated a primary contact recreation 1 (PCR1) use. This means that recreation activities in Oso Bay and Oso Creek 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* in freshwater or 35 CFU/100 mL for enterococci in saltwater. A water body is considered impaired if the geometric mean is higher than the corresponding water quality standard.

Oso Bay has an oyster water (OW) use designation and is assessed using the Texas Department of State Health Services oyster water indicator, 14 fecal coliform/100 mL. Texas Stream citizen scientists do not monitor for fecal coliform, therefore this parameter will not be evaluated in this report.

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 three Texas Stream Team monitoring sites in the Oso Creek/Bay watershed were acquired for this report (Figure 4). One site (13026) is located on Oso Creek at Yorktown Road. The remaining two sites (17119 and 81186) are on Oso Bay. Between 12 and 13 sampling events occurred at each site, for a total of 37 sampling events (Table 4). The period of record for the sampling events ranged from August 2018 to April 2020.

Table 4. Oso Creek/Bay watershed active Texas Stream Team monitoring sites.

Station ID	Description	Number of Samples (n)	Period of Record
13026	Oso Creek @ Yorktown Rd. Bridge	12	August 2018-April 2020
17119	Oso Bay NE of Holly Road	12	August 2018-April 2020
81186	Wooden Bridge @ Drainage Ditch located NW of Oso Bay	13	August 2018-April 2020

Figure 4. Oso Creek/Bay watershed active Texas Stream Team citizen scientist monitoring sites.

Site Analysis

The period of record for data analyzed for this report spanned from August of 2018 to April 2020. Data from 37 monitoring events conducted at three sites were acquired from the Waterways Dataviewer (Table 4). Water quality monitoring data for the three sites in the Oso Creek/Bay watershed were analyzed and summarized in Table 5 including the number of samples, mean, standard deviation, minimum and maximum values. Citizen scientists monitored all three 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 at the monitoring sites included in this report. The total number of sampling events for the Texas Stream Team core water quality monitoring parameters (air and water temperature, dissolved oxygen, pH, Secchi disk, transparency tube and total depth) remained somewhat consistent for the period of record, except for salinity. Salinity was only measured a couple times at each site, probably because the range of the conductivity meter cannot measure the salinity in estuarine waters due to limitations of the meter used by citizen scientists. In 2020, Texas Stream Team introduced the use of a refractometer for measuring salinity to remedy this discrepancy, however it is still being introduced to citizen scientists on the Texas coast and inland waters of west Texas with high salt content.

Air and water Temperature

Average air temperatures for all the sites remained within 25.5 and 21.8°C (Table 5). The higher mean value for air temperature (25.5 °C) was observed further inland at Oso Creek at Yorktown Bridge (13026). The two sites on Oso Bay (17119 and 81186) had slightly lower mean air temperature values, 22.5 and 21.8°C respectively, likely a result of the frequent southeastern coastal breeze (Figure 5).

Water temperatures at all sites were well below the water quality standards (WQS). Average water temperature for all three sites ranged from 23.4°C at Oso Creek at Yorktown Bridge (13026) to 21.8°C at the Oso Bay Wooden Bridge (81186) site (Figure 6).

Table 5. Texas Stream Team data summary in the Oso Creek/Bay watershed (August 2018 - April 2020).

Parameter	Oso Creek Yorktown Bridge-13026 n=12 Mean±SD (Range)	Oso Bay Holly Rd. -17119 n=12 Mean±SD (Range)	Oso Bay Wooden Bridge - 81186 n=13 Mean±SD (Range)
Air Temperature (°C)	25.5±7.1 (9-33)	22.5±6.1 (9-29)	21.8±6.6 (8-29)
Water Temperature (°C)	23.4±6.2 (10-30)	22.3±6.2 (10-32)	20.7±6.3 (11-29)
Salinity (ppt)	1.0± (1.0-1.0)	1.0± (1.0-1.0)	1.0± (1.0-1.0)
Dissolved Oxygen (mg/L)	5.5±1.6 (3.7-8.5)	5.3±1.9 (2.5-8.5)	3.9±2.4 (1.7-8.7)
pH (s.u.)	8.3±0.2 (8-8.5)	8.4±0.2 (8-8.5)	7.8±0.3 (7.5-8.5)
Secchi Disk Transparency (m)	0.4±0.1 (0.2-0.5)	0.3±0.1 (0.2-0.5)	0.5±0.3 (0.2-1.0)
Transparency Tube (m)	0.4±0.4 (0.2-1.5)	0.2±0.1 (0.1-0.5)	0.6±0.3 (0.2-1.3)
Total Depth (m)	1.1±0.4 (0.2-2.0)	0.4±0.1 (0.3-0.6)	0.6±0.3 (0.1-1.0)

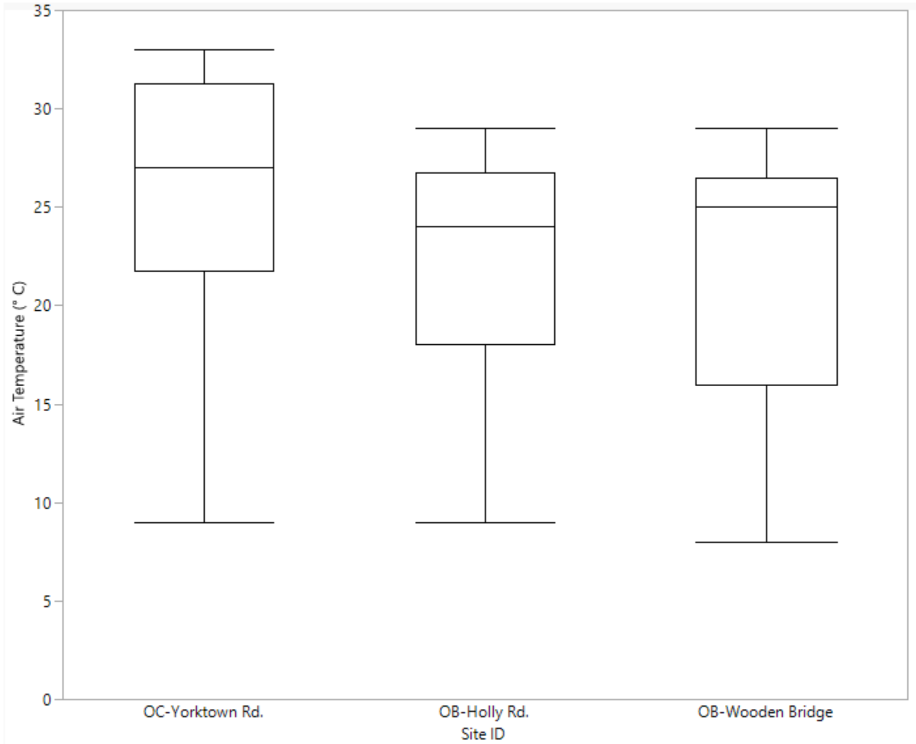

Figure 5. Air temperature (°C) for sites in the Oso Creek/Bay watershed (August 2018 to May 2020).

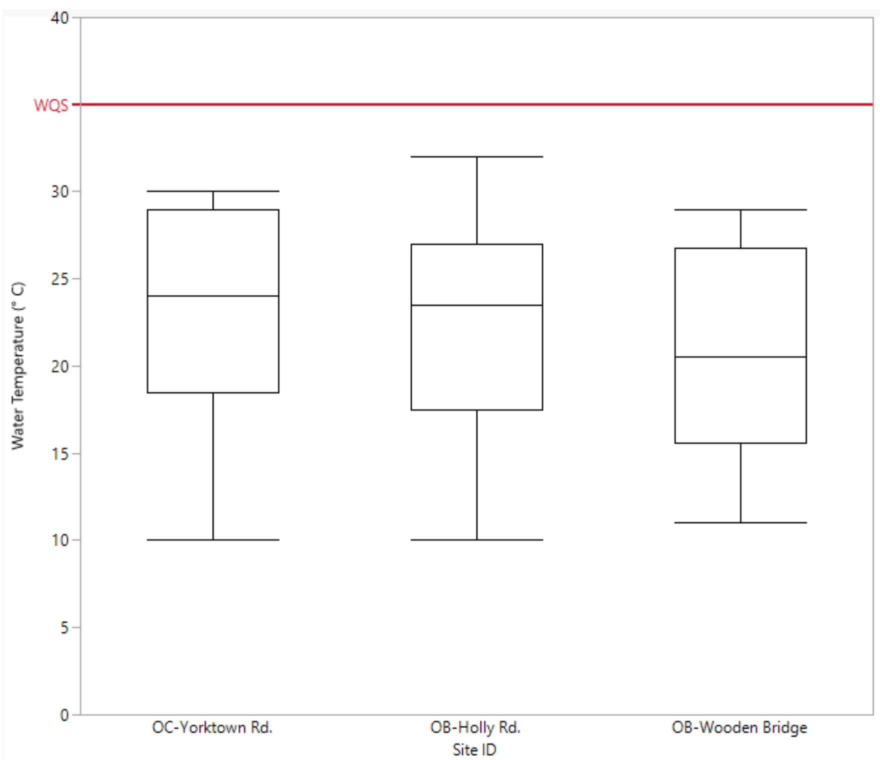

Figure 6. Water temperature (°C) for sites in the Oso Creek/Bay watershed (August 2018 to May 2020).

Dissolved Oxygen

Mean dissolved oxygen grab values at the three sites in the Oso Creek/Bay watershed ranged from 5.5 to 3.9 mg/L (Table 5). The Oso Creek site (13026) on Yorktown Bridge exhibited higher dissolved oxygen values than the two Oso Bay sites at Holly Rd. and Wooden Bridge (Figure 7). The mean dissolved oxygen value for the Oso Bay site at Wooden Bridge did not meet the corresponding water quality standard for grab samples, while the means of the other two sites (13026 and 17119) did. There was a gradual decline in mean dissolved oxygen values over the period of record from the upstream Oso Creek site (13026) to the downstream Oso Bay site (81186).

pH

Mean pH values for all sites ranged from 7.8 to 8.4 s.u. (Table 5) with the Oso Bay at Holly Rd. site exhibiting the highest mean and Oso Creek at Yorktown bridge exhibiting the lowest mean. Mean pH values for all sites were within the high and low water quality standard (Figure 8).

Transparency

Transparency was measured using both a Secchi disk and a transparency tube (Figure 9). Values reported for both instruments and methods were very similar. When compared to total depth (Table 5), transparency at Oso Creek Yorktown bridge was about a third of the total depth at the site (0.36 m), while transparency at the Oso Bay sites was over half the total depth (.63 m). Overall, the Oso Creek site was deeper (1.1 m) than the Oso Bay sites (0.4-0.6 m) (Figure 10).

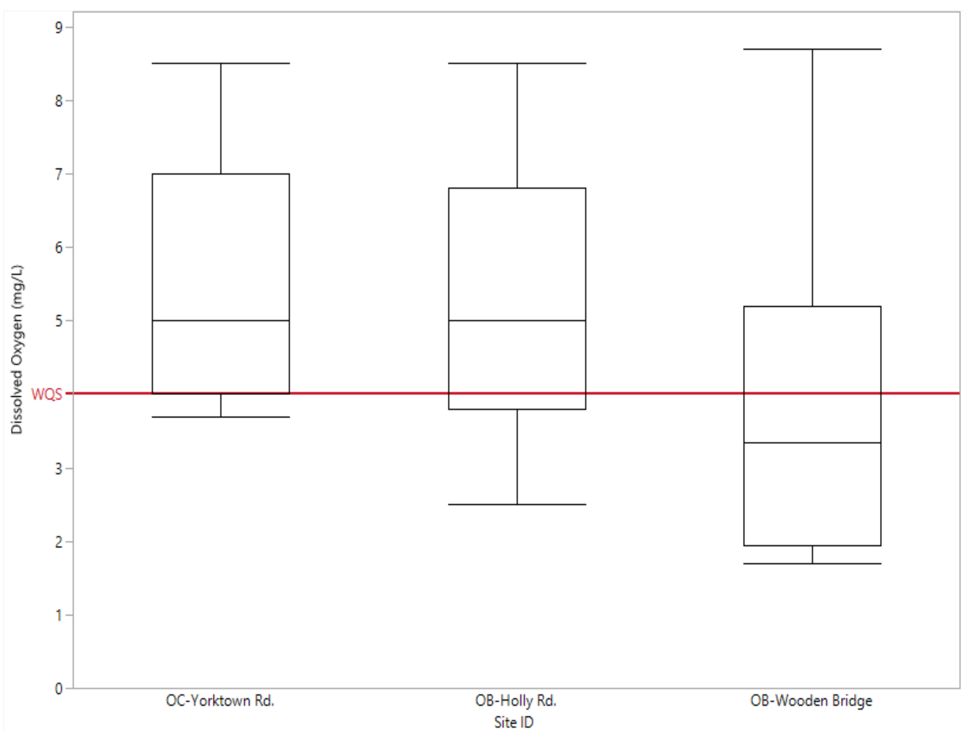

Figure 7. Dissolved oxygen (mg/L) for sites in the Oso Creek/Bay watershed (August 2018 to May 2020).

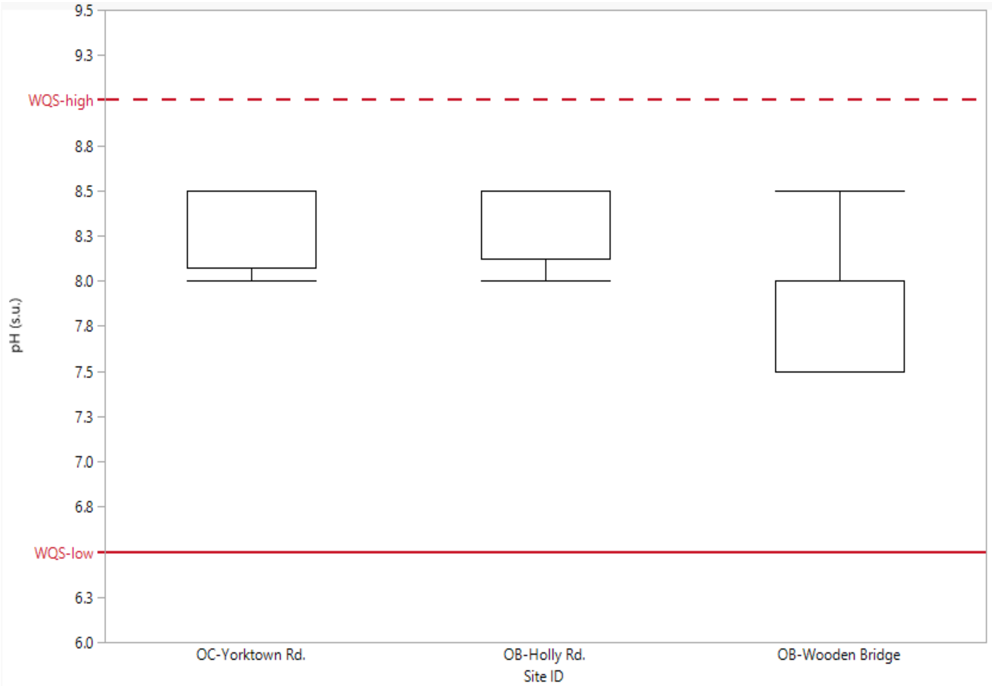

Figure 8. pH (s.u.) for sites in the Oso Creek/Bay watershed (August 2018 to May 2020).

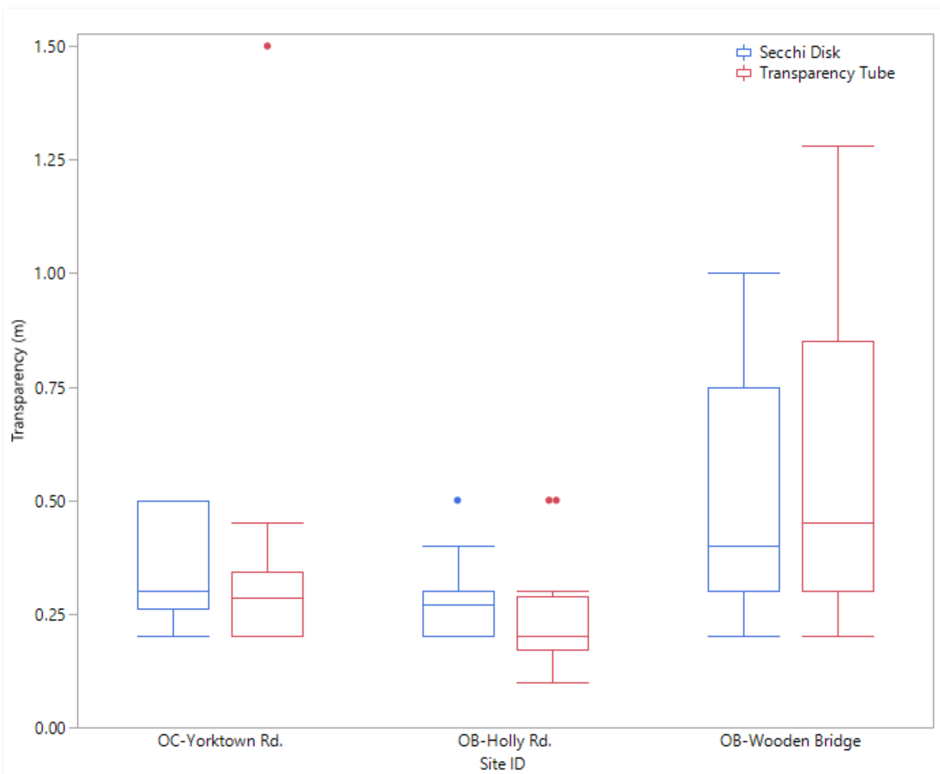

Figure 9. Secchi disk and transparency tube (m) in Oso Creek/Bay watershed (August 2018 to May 2020).

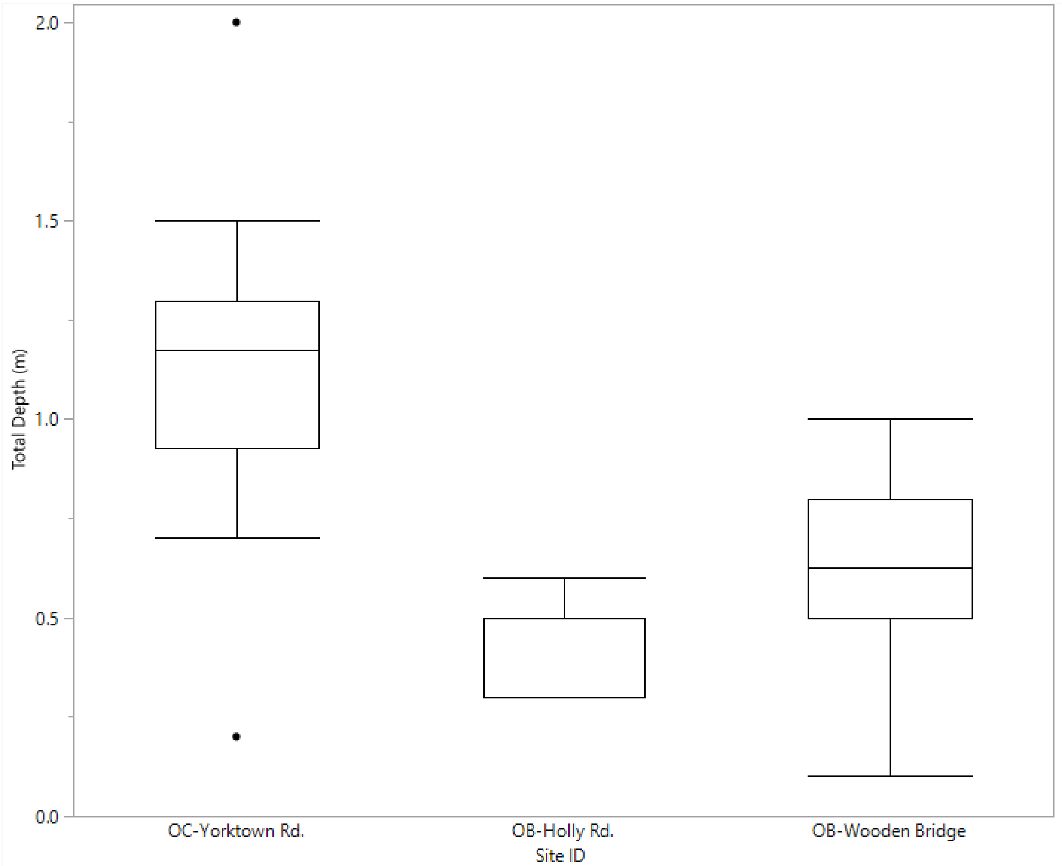

Figure 10. Total depth (m) in Oso Creek/Bay watershed (August 2018 to May 2020).

WATERSHED SUMMARY

Texas Stream Team citizen scientists monitored standard core water quality parameters at three sites in the Oso Creek/Bay watershed from August 2018 to May 2020. Parameters monitored included water and air temperature, salinity, dissolved oxygen, pH, transparency and total depth. Monitoring for bacteria or the Advanced Texas Stream Team parameters, nitrate-nitrogen and orthophosphate, did not take place in the Oso Creek/Bay watershed during the period of record for this report. Data from the three monitoring sites were analyzed and summarized.

The means for water temperature and pH at all sites met or exceeded the TCEQ water quality standards. However, mean dissolved oxygen at Oso Bay Wood Bridge (81186) did not meet the standard for grab samples. There were also individual observations at the Oso Bay Holly Rd. (17119) and Oso Creek Yorktown Bridge (13026) sites that exceeded the dissolved oxygen standard, but the means at both sites met the standard.

Oso Bay is listed for not meeting the dissolved oxygen water quality standard in support of the aquatic life use, as was revealed in this data summary report using Texas Stream Team volunteer citizen scientist monitoring data. This finding is consistent with the 2020 Integrated Report. The upstream site in Oso Creek is predominantly a freshwater site, while the two downstream sites in Oso Bay are comprised of saltwater. Notably, as the water transitions from fresh to salt the dissolved oxygen decreases since salty water is known to retain less oxygen.

The Texas Stream Team citizen scientists monitoring water quality in the Oso Creek/Bay 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 dissolved oxygen listed in the 2020 Integrated Report. 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

Table 6. Endangered species located within the Oso Creek/Bay Watershed.

Species Type	Common Name	Federal/State Listing
Birds	northern aplomado falcon	Endangered (Federal); Endangered (State)
	whooping crane	Endangered (Federal); Endangered (State)
Mammals	sperm whale	Endangered (Federal); Endangered (State)
	Sei Whale	Endangered (Federal); Endangered (State)
	blue whale	Endangered (Federal); Endangered (State)
	Gulf of Mexico Bryde's Whale	Endangered (Federal); Endangered (State)
	humpback whale	Endangered (Federal)
	North Atlantic right whale	Endangered (Federal); Endangered (State)
	ocelot	Endangered (Federal); Endangered (State)
Reptiles	Atlantic hawksbill sea turtle	Endangered (Federal); Endangered (State)
	Kemp's Ridley sea turtle	Endangered (Federal); Endangered (State)
	leatherback sea turtle	Endangered (Federal); Endangered (State)
Plants	South Texas ambrosia	Endangered (Federal); Endangered (State)
	black lace cactus	Endangered (Federal); Endangered (State)
	slender rush-pea	Endangered (Federal); Endangered (State)

Table 7. Threatened species located within the Oso Creek/Bay Watershed.

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

	Black Rail	Potentially Threatened (Federal); Threatened (State)
	piping plover	Threatened (Federal); Threatened (State)
	Rufa Red Knot	Threatened (Federal); Threatened (State)
	sooty tern	Threatened (State)
	tropical parula	Threatened (State)
	Texas Botteri's sparrow	Threatened (State)
Fish	Shortfin Mako Shark	Threatened (State)
	Oceanic Whitetip Shark	Threatened (Federal); Threatened (State)
Mammals	white-nosed coati	Threatened (State)
	West Indian manatee	Threatened (Federal); Threatened (State)
Reptiles	loggerhead sea turtle	Threatened (Federal); Threatened (State)
	green sea turtle	Threatened (Federal); Threatened (State)
	Texas tortoise	Threatened (State)
	Texas horned lizard	Threatened (State)
	Texas scarlet snake	Threatened (State)