EA Project Summaries and Findings Report Project

Project 6 – Tracking the Primary Sources of Fecal Pollution in the Recharge and Contributing Zones of Edwards Aquifer in Bexar County, Texas, Using Molecular Tools

Project Summary

Author: UTSA

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Funding Amount

$692,452

1 Summary

The most common source of impairment to Texas waters is fecal pathogens. Fecal pathogens are disease-causing organisms present in feces that can be contracted by humans and other animals through contact or ingestion. Sources can include human waste collection and treatment systems (septic systems, wastewater collection and treatment systems, and discharge), domesticated animals (pets and cattle), and wildlife. These organisms can present health risks to the public during activities where they are exposed such as swimming, kayaking, and fishing.

Waste can enter surface waters from leaking sewer systems, direct deposition by animals, discharge from treatment systems, or through stormwater transport. Instead of fecal pathogens themselves, fecal pathogen indicators (FP indicators), such as *E. coli* and total coliform, are commonly used to assess the quality of waters and the risks for contact recreation activities in these waters. This study assesses both FP indicators and also pathogenic organisms directly.

Stated objectives of the study - *To design and implement an efficient fecal source tracking and evaluation program for the Recharge and Contributing Zones of Edwards Aquifer in Bexar County, TX. The authors seek to identify potential sources of fecal bacteria such as (1) municipal waste/runoff including on-site sewage facilities and sanitary sewer overflows, and (2) animal waste (livestock and domesticated animals) as well as other contributing factors (water temperature, nutrients, and available organic material).*

Justification for the study – *Identifying the types of sources that contribute to bacteria in water systems is important for development of strategies to reduce bacteria and other pollution levels in surface water and groundwater and when evaluating their potential impact on the environment. In a karst region where sources are not easily known or understood, microbial source tracking techniques can provide an opportunity to analyze water samples in a way that identifies the source of fecal bacteria in the sample, from simply identifying whether the source is human or non-human to, at times, identifying the source to the species level (e.g., cow, dog, deer).*

Identification of the sources of fecal pollution is important to help develop strategies to reduce these pollutants and protect the public. This fecal tracking study used newer technology to test genetic material from wells, creeks, and ponds / lakes in the region to identify the loading of fecal pollution from specific sources to the Recharge and Contributing Zones of the Edwards Aquifer. The advanced testing procedures allow classification of the source of the feces into multiple categories. The categories used in this study were:

- Avian (Chicken/Duck),
- Ruminant (Deer and Cattle),
- Porcine (Pig),
- Canine (Dog), and
- Human.

The Fecal Tracking Study was intended to:

- Assess the presence or absence of animal sources of fecal pollution in the Edwards Aquifer using traditional FP indicators,
- Assess the presence or absence of pathogenic organisms directly (since FP indicators are commonly used, it is of interest to also test for the disease-causing organisms themselves),
- Determine the predominant sources and distribution of fecal pollution,
- Assess pollution source trends over time,
- Assess the potential to control or mitigate sources, and
- Provide public outreach and education to improve designs for future mitigation projects.

1.1 Methods

The Fecal Tracking Study included multiple monitoring and lab analysis efforts as outlined in the summary above. Additional detail about the types of analysis is available in the UTSA project report.

Water samples were collected bimonthly from 20 sites within the Recharge and Contributing Zones of the Edwards Aquifer from January 2018 to March 2020. The sites were located within the Cibolo Creek and Leon Creek Watersheds and included:

- Three wells,
- Fourteen creek locations, and
- Three ponds / lakes.

Over 50 events and about 1100 samples were collected. The sites are shown in Figure 1.

Several quality assurance / quality control tests were conducted to evaluate the effectiveness of the project and testing methodologies.

In addition, the study team developed public outreach and education materials based on the study findings and their recommendations. These included materials for students and homeowners.

1.2 Findings

The traditional FP indicators were detected in over 90 percent of the samples, suggesting that fecal pollution is a widespread and persistent concern. However, fecal pathogens were not found in any of the water samples tested. Fecal pathogens are often present in much lower concentrations in the environment than FP indicators, so this is not a surprising result. This may indicate lower health risks; however, additional testing would be beneficial to confirm the findings.

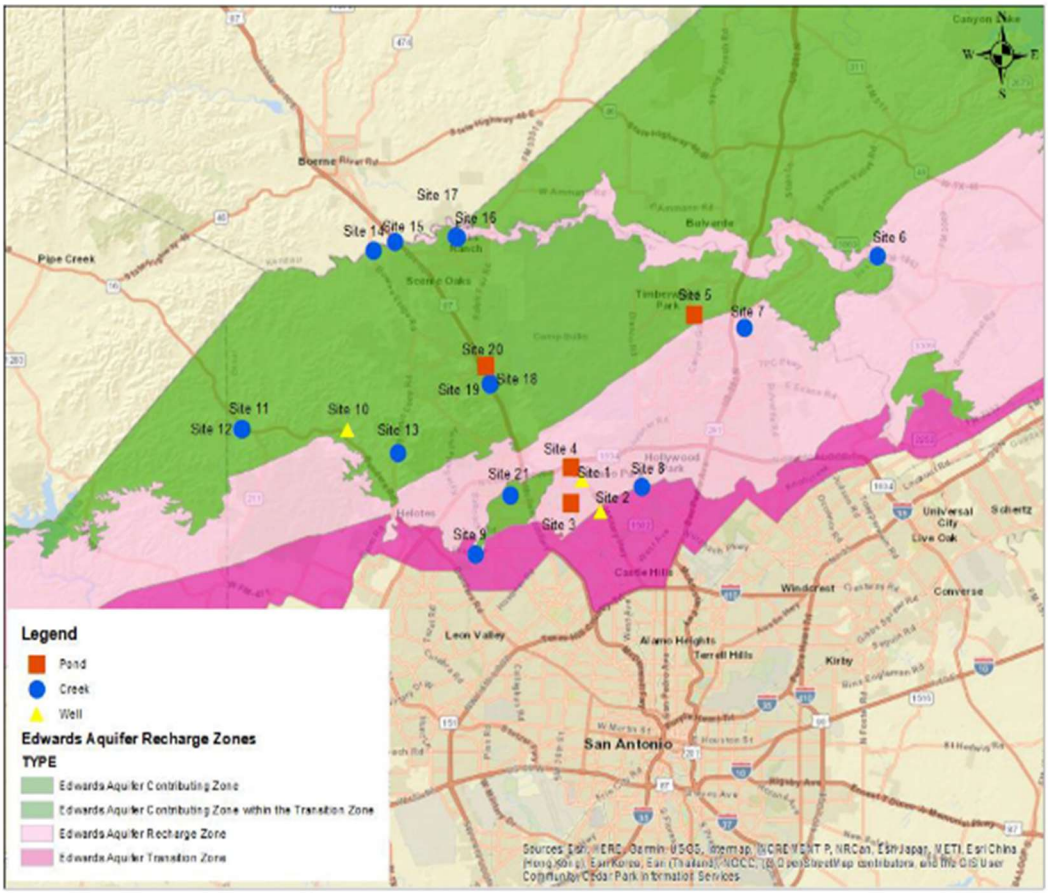

Figure 1 – Sample Collection Locations

Surface runoff from stormwater events showed relatively high concentrations, suggesting this is a primary source of fecal pathogens. The lowest levels were observed at groundwater well sites, suggesting that there is some mitigation of FP indicators during transport to the aquifer.

One of the key findings of the study was the distribution of FP indicators from different animal sources. The percent of samples where each type of FP indicator was identified from highest to lowest were:

- Avian, including gull and ducks (85%),
- Ruminant, including cattle and deer (67%),
- Canine, including dog (40%),
- Human (17%), and
- Porcine, including pig (5% although this was discontinued later in the study).

The study found several key patterns, most of which suggested correlations with proximity and density. Sources were higher at surface water sites than wells. Cow / ruminant marker concentrations were higher at Balcones Creek that transects a rural area. Higher levels of canine indicators were observed at pond sites near residential areas where many residents walk their pets and may not always clean up their waste. The indicator for chickens and ducks was higher in the pond sites since there are many ducks observed at the ponds. Human indicators were detected mostly at surface water sites near densely populated areas and rural areas with high septic tank density.

In addition, the study assessed correlations between FP indicators and other water quality parameters, including temperature, dissolved oxygen, and nutrients. However, strong correlations were not identified.

1.3 Challenges and Limitations

The traditional FP indicators used to assess fecal pollution in the environment and potential impacts to health have multiple challenges. These include limited epidemiological data (limited in the number of studies and the spatial extent of these), studies showing long term survival in the environment, and lack of differentiation between sources. This study provides data to help overcome some of these challenges by directly testing for pathogens and using FP indicators that are specific to different types of animals.

The authors acknowledge that bacteria "may survive and grow in a variety of environmental habitats, such as soil and aquatic". This is a limitation of FP indicators and is difficult (if not impossible) to control in the environment. However, by testing pathogens directly additional data has been obtained to understand the direct impacts of contact with waters.

The most common challenge with these studies is related to the variability in the environment and the amount of data that must be collected to identify trends and correlations. In addition, data collection is costly and can be challenging. This study collected a lot of valuable data to help. Monitoring efforts should continue to build on this effort to refine our understanding of the issues and impacts of different mitigation efforts, including those suggested in the study.

2 Benefits

This study provides multiple benefits for the understanding of the sources and potential impacts of fecal pathogens to receiving waters downstream. In addition to the data analysis and discussion provided in this study, the authors provided recommendations based on their results.

The benefits of the study include:

- The authors collected important information about the sources of fecal pollution.
- The authors expanded the data set for traditional fecal pathogen indicators.
- The authors provided management recommendations based on the findings of the study.
- The authors developed multiple public outreach and education tools based on the findings and recommendations of the study for students, homeowners, pet owners, and agricultural facilities.

The authors recommend that the findings be used to select mitigation efforts that address the largest sources of FP indicators. They recommend additional education and outreach to pet owners and homeowners about proper disposal of pet waste, not feeding wildlife, and maintaining septic systems. In addition, the recommendations include promoting Low Impact Development to mitigate stormwater sources of fecal pollution.

Project Deliverables:

Kapoor, V., and Johnson, D. (2022). Tracking the primary sources of fecal pollution in the recharge and contributing zones of Edwards aquifer in Bexar County, TX using molecular tools. The University of Texas at San Antonio.

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Fact Sheet

Benefits

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Project Graphic

Project 6 – Tracking the Primary Sources of Fecal Pollution in the Recharge and Contributing Zones of Edwards Aquifer in Bexar County, Texas, Using Molecular Tools

Identifying sources of fecal bacteria to discover pollutant pathways that may be controllable