Technical Report:

Assessment of Fecal Indicator Bacteria and Microbial Source Tracking Data from Jolly Giant Creek

September 2024

California Regional Water Quality Control Board

North Coast Region

Executive Summary

This report provides a summary and evaluation of fecal indicator bacteria (FIB) levels and microbial source tracking (MST) data detected at five sample locations within Jolly Giant Creek. Staff collected these samples in response to the initial evaluation of FIB results collected in association with the Coastal Pathogen Project (North Coast Regional Water Quality Control Board, 2023). Jolly Giant Creek was placed on the Clean Water Act Section 303(d) List of Impaired Waters in 2012 for impairment of the Water Contact Recreation (REC-1) beneficial use due to pathogen contamination.

For this technical report, FIB and MST data are used to determine whether the water quality objective for fecal indicator bacteria is being exceeded and, if detected, evidence of the fecal waste source(s). FIB data from five Jolly Giant Creek sampling stations were compared to the REC-1 Objective for *E. coli* in freshwater, and all stations had at least one exceedance. Each site had at least one detection for each species-specific MST marker, with the most detections for the human marker, and increased detections at the downstream sites.

Additional investigation of the human sources of FIB in lower Jolly Giant Creek is needed to define and prioritize source control actions. Investigations should be made into potential sources of human FIB like leaking septic systems, sanitary sewer leaks, undocumented pipes, and potential pollution from houseless populations.

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1. Introduction

This report provides a summary and evaluation of fecal indicator bacteria (FIB) levels and microbial source tracking (MST) data detected at five sample locations within Jolly Giant Creek. Staff collected these samples in response to the initial evaluation of FIB results collected in association with the Coastal Pathogen Project (North Coast Regional Water Quality Control Board, 2015).

Jolly Giant Creek is a small urban stream, starting six miles north of Humboldt Bay in the Arcata Community Forest and flowing through Cal Poly Humboldt's campus, Arcata High School's campus, and Arcata's downtown area. The lower watershed is extensively channelized running under and through the city of Arcata. There are nonpoint source runoff inputs to the watershed from the surrounding mostly developed landscape, as well as runoff directed to the creek through Arcata's stormwater infrastructure. Land use and land cover maps

Jolly Giant Creek was placed on the Clean Water Act Section 303(d) List of Impaired Waters in 2012 for impairment of the Water Contact Recreation (REC-1) beneficial use due to pathogen contamination.

Monitoring of FIB is an important method for understanding possible links to adverse health outcomes in recreational waterbodies. While FIB monitoring results have limited capacity to discern human from non-human sources, microbial source tracking (MST) provides a mechanism to determine the source of fecal contamination through the understanding of the association of certain fecal microorganisms with a particular host.

1.1. Monitoring Plan Development and Site Selection

Between 2016 and 2018, in collaboration with Humboldt Baykeeper, Planning Staff collected dry weather and wet weather water quality data for the Coastal Pathogen Project, to support analysis of water quality conditions and suspected sources of fecal pollution. Under the Coastal Pathogen Project, samples were collected from a sampling station at the terminus of Jolly Giant Creek – Jolly Giant Creek at Samoa Boulevard. The initial analysis of that data has identified consistent human-source fecal pollution near the terminus of Jolly Giant Creek exceeding state water quality objectives for fecal indicator bacteria.

The City of Arcata implemented several sewer system infrastructure improvements after the previous sampling events. Planning Staff, along with the staff members from the Environmental Services Department of the City of Arcata and the Humboldt Baykeeper non-profit, developed a monitoring plan to collect additional wet and dry weather samples to determine the current status of fecal pollution in Jolly Giant Creek, identify the potential source(s) of pollution, and develop pollution control strategies if needed.

Sampling sites were selected along Jolly Giant Creek at locations where it is above ground and near potential human fecal pollution sources (leaking sewage pipes, illegal sewage dumping and/or houseless population inputs). The five sampling stations selected are displayed in Figure 1.

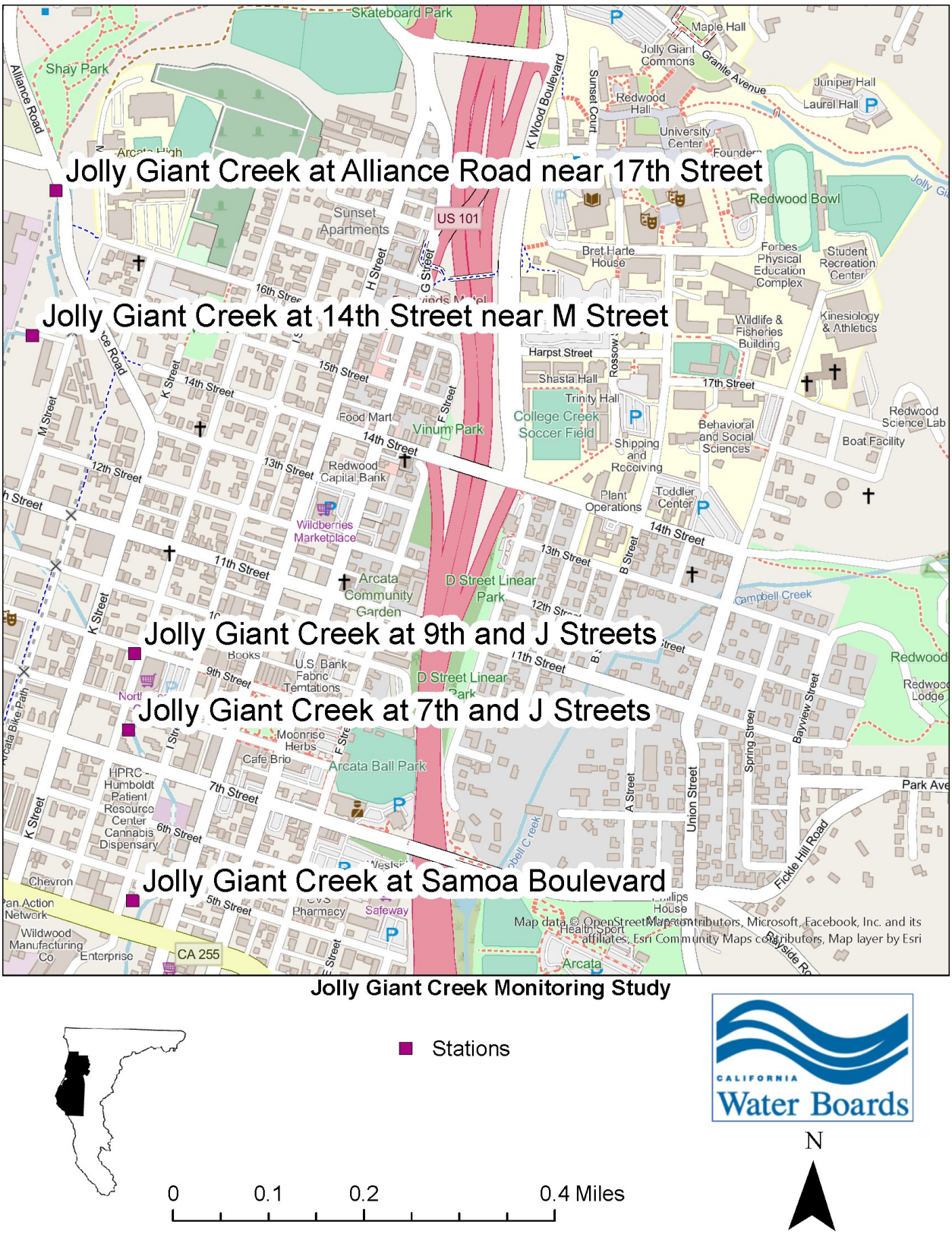

Figure 1: Map of Jolly Giant Creek Monitoring Locations

1.2. Monitoring Parameters

Fecal indicator bacteria (FIB) and microbial source tracking (MST) data were collected to determine bacterial pollution factors in Jolly Giant Creek. Fecal indicator bacteria provide evidence of fecal pollution, and microbial source tracking helps identify the source of that fecal pollution. The 2016-2018 FIB and MST analysis of samples collected from Jolly Giant Creek at Samoa Boulevard sampling station indicated exceedances of the statewide REC-1 fecal indicator objectives, with evidence of human fecal waste as the potential source (North Coast Regional Water Quality Control Board, 2022). For this technical report, FIB and MST are used to determine whether the water quality objective for fecal indicator bacteria is being exceeded in Jolly Giant Creek, and, if detected, evidence of the fecal waste source(s).

FIB monitoring results include the detection and enumeration of *Escherichia coli* (*E. coli*). Fecal indicator bacteria live in the intestines of warm-blooded animals (including humans) and enter waterbodies through fecal matter. These bacteria are often harmless to human beings themselves, but are used as indicators of fecal pollution and proxies for harmful pathogens that may also exist in the intestines of animals along with fecal indicator bacteria. This type of surrogate or indicator method is used since it is impossible to measure all potentially harmful pathogens that may exist in the waterbody being investigated. The use of FIB in this manner is very common, scientifically accepted, and approved by the Environmental Protection Agency (EPA). Fecal indicator bacteria testing is performed in government-accredited labs using culture-based methods.

Microbial source tracking results include the detection and quantification of human-, ruminant- and dog-specific *Bacteroides* markers and a gull-specific *Catellicoccus* marker. Microbial source tracking is a tool used by scientists and approved for use by the EPA and by the United States Geological Survey (USGS), to identify the source of fecal contamination. The basis of this tool is that the microorganisms present in the feces of different types of animals (including humans) have unique characteristics that allow us to determine what specific animal the fecal matter being tested came from. In other words, the physiological differences in various hosts (animals whose feces is being analyzed) lead to differences in specific characteristics of microorganisms that are present in their intestines. Microbial source tracking is a culture-independent method which is also performed in government-accredited labs.

FIB and MST are complementary tools which, when used together, allow scientists and regulators to determine, not only the presence of fecal pollution, but also its source, which in turn helps with the development of appropriate solutions to address the source of fecal pollution and improve water quality.

In addition to monitoring parameters explicitly associated with bacterial water quality, other parameters were measured including, but not limited to: geographic coordinates, 24-hour rainfall, estimated stream flow, water temperature, turbidity, electrical

conductivity, pH, and visual observations of habitat and the environment surrounding the sampling site.

1.2.1. State Fecal Indicator Bacteria Water Quality Objectives

FIB concentrations are compared to the applicable water quality objective (WQO) for protecting beneficial uses in the waterbody. An updated water quality objective for indicator bacteria for the protection of waters with the REC-1 beneficial use was adopted under the statewide Bacteria Provisions, which superseded the North Coast Water Board regional numeric objective in 2019 (State Water Resources Control Board, 2019). When assessing water quality for REC-1 beneficial use, the water quality objective selected for comparison is based on the salinity of the waterbody being analyzed. Salinity measurements from Jolly Giant Creek monitoring stations determined the system to be freshwater and therefore, *E. coli* concentrations were used.

Bacteria Provisions will ultimately be incorporated into the Water Quality Control Plan for the North Coast Region (Basin Plan). The adopted language includes protection of REC-1 based on the U.S. EPA federal Recreational Water Quality Criteria of 32 gastrointestinal illnesses per 1,000 recreators as the threshold in freshwaters for *E. coli* (State Water Resources Control Board, 2019).

Table 1: Statewide Bacteria Water Quality Objectives

Objective Elements	**Estimated Illness Rate (NGI): 32 per 1,000 water contact recreators**	
	Magnitude	
Indicator	**GM (cfu/100 mL)**	**STV (cfu/100 mL)**
E. coli	100	320
The waterbody GM shall not be greater than the applicable GM magnitude in any six-week interval, calculated weekly. The applicable STV shall not be exceeded by more than 10 percent of the samples collected in a CALENDAR MONTH, calculated in a static manner.		
NGI = National Epidemiological and Environmental Assessment of Recreational Water gastrointestinal illness rate	GM = geometric mean STV = statistical threshold value	cfu = colony forming units mL = milliliters

1.2.2. Microbial Source Tracking

For the microbial source tracking data, the Rum2Bac, LeeSeaGull, DogBact, and HF183 markers were used to detect ruminant, gull, dog, and human fecal waste respectively. These markers correspond to the suspected fecal source categories of cattle, wildlife, dogs, and humans in the watershed. Each MST analyte is assessed as detected or not detected at each monitoring station to guide pollution control strategies.

2. Methods

2.1. Sample Collection

Water grab samples were collected from five sites on Jolly Giant Creek between October 2021 and November 2022. Sample collection was performed according to the monitoring plan and standard operating procedures (SOP) included in the Quality Assurance Project Plan (QAPP) developed for this project (North Coast Regional Water Quality Control Board, 2015). See Table 2 below for all sampling locations and parameters.

Six samples were collected: three during dry period, and three during wet period. For the assessment of exceedance of the Statewide REC-1 WQO, April 1 through October 31 is defined as the summer period and November 1 through March 31 is defined as the winter period. For MST samples, dry weather sampling was conducted after 72 hours of dry weather, and wet weather sampling was conducted during or following storm events that were predicted to generate 0.2 inches or greater rainfall.

Replicate samples were collected at a small number of randomly selected sampling stations to serve as field replicates for quality assurance and quality control (QA/QC) purposes.

Table 2: Sampling Locations and Parameters

Sample Location Name	Monitoring Parameters	Dry Samples	Wet Samples
Jolly Giant Creek at Alliance Road near 17th Street	FIB	3	3
	MST		
Jolly Giant Creek at 14th Street near M Street	FIB	3	3
	MST		
Jolly Giant Creek at 9th and J Streets	FIB	3	3
	MST		
Jolly Giant Creek at 7th and J Streets	FIB	3	3
	MST		
Jolly Giant Creek at Samoa Boulevard	FIB	3	3
	MST		

2.2. Laboratory Analysis

Samples collected during five sampling events were analyzed by the Humboldt County Public Health Laboratory for both FIB and MST. FIB samples from the May 6, 2022, sampling event were sent to North Coast Laboratories for analysis due to timing constraints of the Humboldt County Public Health Laboratory.

All samples were analyzed for the detection and enumeration of *E. coli* according to the standard operating procedures described in the QAPP for the Coastal Pathogen Project (North Coast Regional Water Quality Control Board, 2015). The Colilert test was used for the detection and enumeration of *E. coli* according to the USEPA Standard Method 9223B (Enzyme Substrate Coliform Test).

All samples were tested for MST markers that identify human, ruminant, dog, and bird fecal sources. The MST markers and identification techniques used for analysis were developed by the Southern California Coastal Water Research Project (SCCWRP) (Griffith et al., 2013). Further details about the analytical methods used for species-specific marker detection can be found in the guidance document developed by SCCWRP – “The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches” (Griffith et al., 2013). Specific details of the standard operating procedures used for sample analysis as part of the Coastal

Pathogen Project are provided in the QAPP developed for the Coastal Pathogen Project (North Coast Regional Water Quality Control Board, 2015). Quality control information about the MST analytical techniques used by the Humboldt County Public Health Laboratory is provided in the document entitled “Microbial Source Tracking (MST) Study Quality Control (QC) Report for the Coastal Pathogen Project” (Corrigan & Akre, 2019).

2.3. Data Analysis

An analysis of FIB and MST data provides evidence of fecal pollution extent and sources in the watershed.

2.3.1. FIB Data Analysis

FIB data for all samples were assessed for exceedance of the Regional Water Board REC-1 Objective as described in Section 1.2.1 of this report. The REC-1 Objective establishes numeric thresholds applicable to waters with REC-1 beneficial use designation, depending on salinity level (State Water Resources Control Board, 2019). The *E. coli* Objective Element applies to freshwater, which applies to all Jolly Giant Creek monitoring locations in this report.

An insufficient number of samples were collected to calculate a six-week rolling geometric mean (GM), so the Statistical Threshold Value (STV) was used to determine exceedances. A Statistical Threshold Value (STV) is a set value that approximates the 90th percentile of the water quality distribution of a bacterial population (State Water Resources Control Board, 2019). A minimum of one grab sample is required to calculate an STV, using a static window covering one calendar month. If more than 10 percent of the month’s grab samples exceed the STV, then that month is considered to violate the objective.

Data from each sampling station were grouped by the following sampling periods for analysis of seasonality of exceedances: year-round, Winter (November 1 through March 31), and Summer (April 1 through October 31). Number of exceedances of the WQO for each assessment period were counted and compared to the total number of STV calculations for that assessment period.

2.3.2. MST Data Analysis

Species-specific markers were classified as “detected” if they were either “detected and quantified” or “detected below limit of quantification” in a given sample, and classified as “not detected” if they were not detected in a given sample. Data from each sampling station were grouped by dry weather sampling, conducted after 72 hours of dry weather, and wet weather sampling, conducted during or following storm events that were predicted to generate 0.2 inches or greater of rainfall. For each sampling station and sampling period, the number of samples in which each species-specific marker type was detected was counted and compared to the total number of samples for that period.

3. Results

3.1. Comparison of FIB Data to the Statewide Numeric Bacteria Water Quality Objectives for the Protection of REC-1

FIB data from the five Jolly Giant Creek sampling stations were compared to the REC-1 Objective for *E. coli* in freshwater. There are not sufficient data to calculate a geometric mean (GM) for any assessment period, so the statistical threshold value (STV) was calculated to evaluate exceedances. The assessment results are presented in Table 3, below. See Appendix A for numeric sampling results from each sampling event.

All five sampling locations had at least one exceedance of the STV threshold of the objective.

Table 3: Exceedances of the STV threshold of the Statewide REC-1 WQO

Sampling Station Name at Jolly Giant Creek	Number of Exceedances/ Total Number of Calculations		
	Year-Round	Winter	Summer
Alliance Rd near 17th St.	2/6	1/3	1/3
14th near M St.	3/6	1/3	2/3
9th and J St.	3/6	1/3	2/3
7th and J St.	5/6	3/3	2/3
Samoa Blvd.	5/6	3/3	2/3

3.2. Summary of MST Data

Species-specific MST data from the five Jolly Giant Creek sampling stations were analyzed for presence or absence at each site during the different sampling periods. Results listing the number of samples in which each species-specific marker type was detected, for each sampling station and sampling period are presented in Table 4, below. Individual bar charts for each sampling station follow in Figures 2-6.

Each site had at least one detection for each species marker, with the most detections for the human-specific MST marker, and increased detections at the downstream sites.

Table 4: Detections of MST Markers

Sampling Station Name at Jolly Giant Creek	Number of Exceedances/Total Samples MST Data							
	Gull		Ruminant		Dog		Human	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Alliance Rd near 17th St.	0/3	2/3	0/3	1/3	2/3	2/3	0/3	1/3
14th near M St.	0/3	2/3	0/3	1/3	0/3	3/3	0/3	2/3
9th and J St.	0/3	2/3	1/3	3/3	2/3	3/3	3/3	3/3
7th and J St.	0/3	2/3	0/3	2/3	2/3	3/3	3/3	3/3
Samoa Blvd.	1/3	2/3	0/3	2/3	2/3	3/3	3/3	3/3

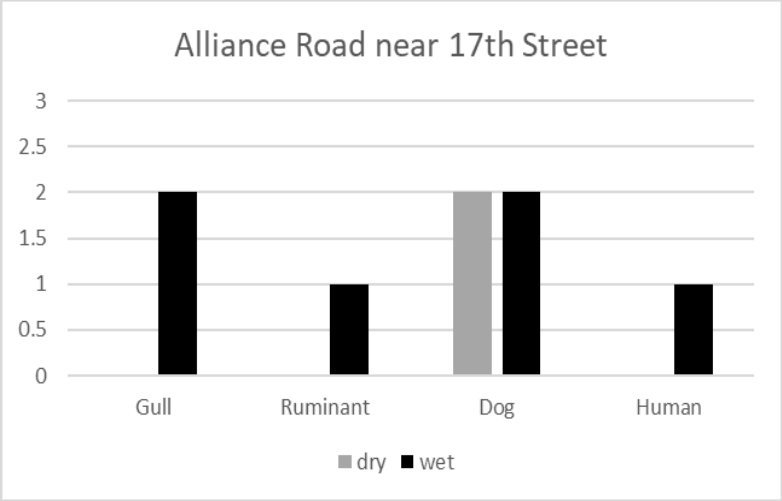

Figure 2: MST results for Alliance Road near 17th Street

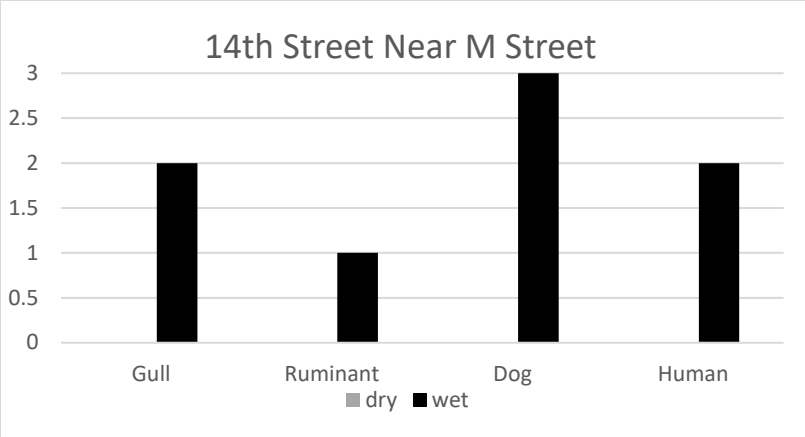

Figure 3: MST Results for 14th Street Near M Street

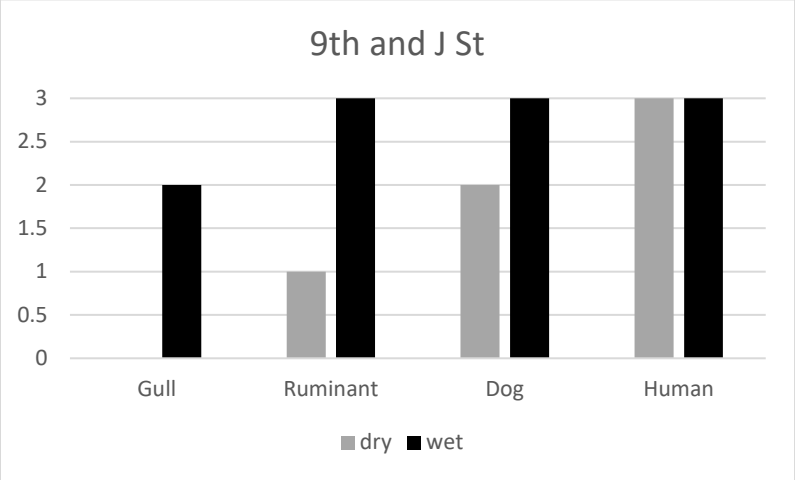

Figure 4: MST Results for 9th and J Street

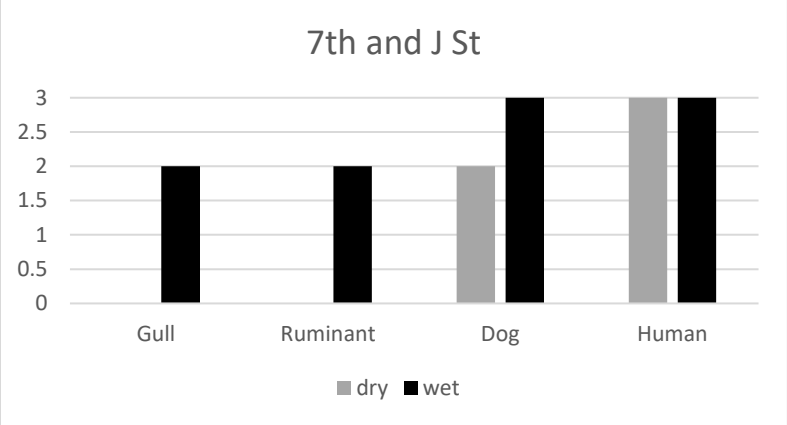

Figure 5: MST Results at 7th and J Street

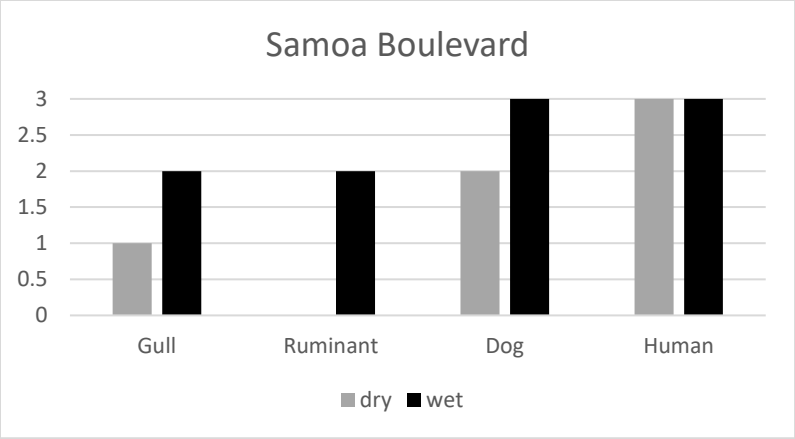

Figure 6: MST Results at Samoa Boulevard

4. Discussion

This technical report presents an assessment of FIB and MST data collected in 2021 and 2022 from five sites on Jolly Giant Creek, following up on previous FIB data collection efforts as part of the Coastal Pathogen Project. Exceedances of the REC-1 bacteria objective may require source control actions. MST data provide information about the sources of fecal waste to guide additional investigations and source control actions.

Jolly Giant Creek had frequent exceedances of the REC-1 bacteria objective during this sampling effort, with increased frequency of exceedances in the furthest downstream reaches. MST data reveal detections of each species-specific marker at least once at each site, with the dog and human markers detected more frequently. The human MST marker was detected in 100% of the samples at the lowest three sampling sites: 9th and J Street, 7th and J Street, and Samoa Boulevard.

Additional investigation of the human sources of FIB in lower Jolly Giant Creek is needed to define and prioritize source control actions, as human fecal material contains a greater number of human pathogens than other fecal sources (Griffith et al., 2013). Investigations should be made into potential sources of human FIB like leaking septic systems, sanitary sewer leaks, undocumented pipes, and potential pollution from houseless populations.

5. References

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