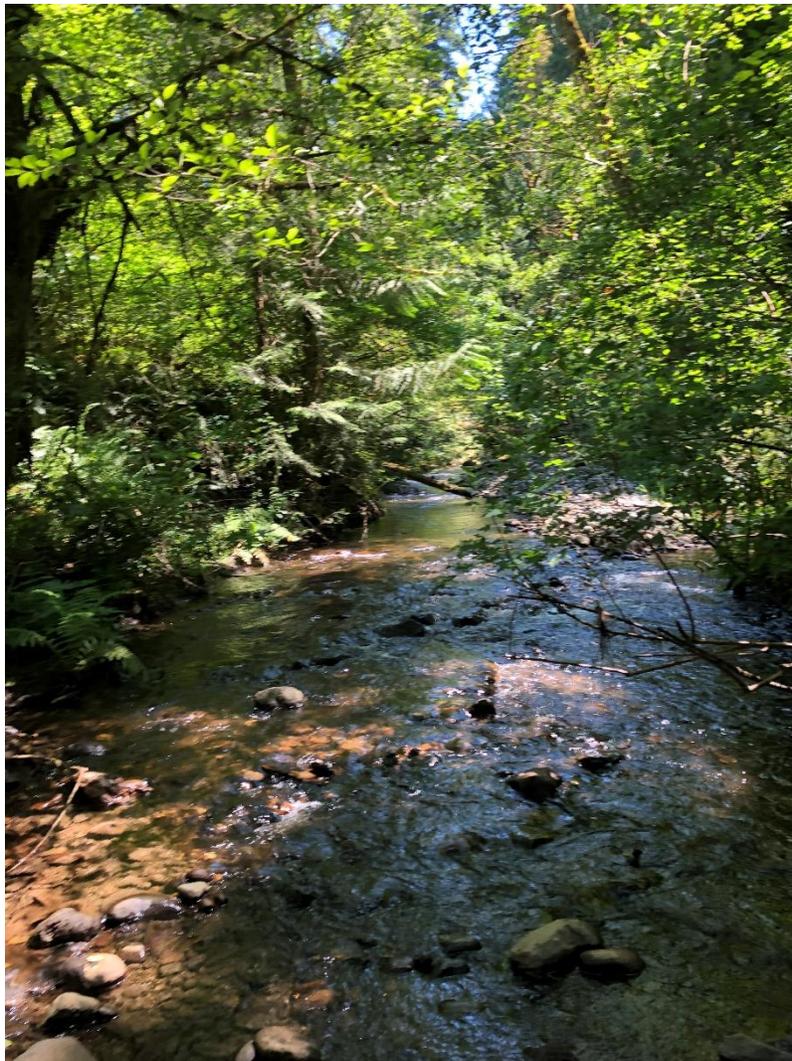


Puyallup River Tributaries Effectiveness Monitoring Quarterly Report

July – September 2020



December 2020

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Data for this project are available at Ecology's [EIM Database](#) under Study ID [EFF_PRT](#). An overview of the project and Year 1 results (July 2019-June 2020) are displayed on a [StoryMap](#).

Results presented in this report are displayed on a public [Tableau](#) page. All data presented in this report are provisional and subject to change.

Cover photo: Boise Creek (Boise_G1 site) taken by Molly Gleason on June 22nd 2020.

Project Overview

The Department of Ecology has completed the first year of sampling for a ten-year water quality effectiveness monitoring study in three tributaries to the Lower White River – Boise, Pussyfoot, and Second Creeks. These three creeks were identified as sources of high fecal coliform bacteria in Ecology’s 2011 Puyallup River Fecal Coliform TMDL (Mathieu and James, 2011, Ecology report 11-10-040) and 2015 source assessment (Dickes, 2015, Ecology report 15-10-048).

Intensive sampling at 26 sites across the three tributaries occur in years 1, 5, and 10. During the intervening years, monthly monitoring continues at the four long-term, status and trends sites. The objective of this continued monitoring is to collect a long term dataset for bacteria, nutrients and conventional water quality parameters at each of the tributaries. The results presented in this Quarterly Report represent the start of the second year of monitoring at the long term stations from July to September 2020. Further details concerning site locations, sample frequency, methods, etc. are described in the study’s Quality Assurance Project Plan (Brownlee, 2019, Ecology report 19-10-040).

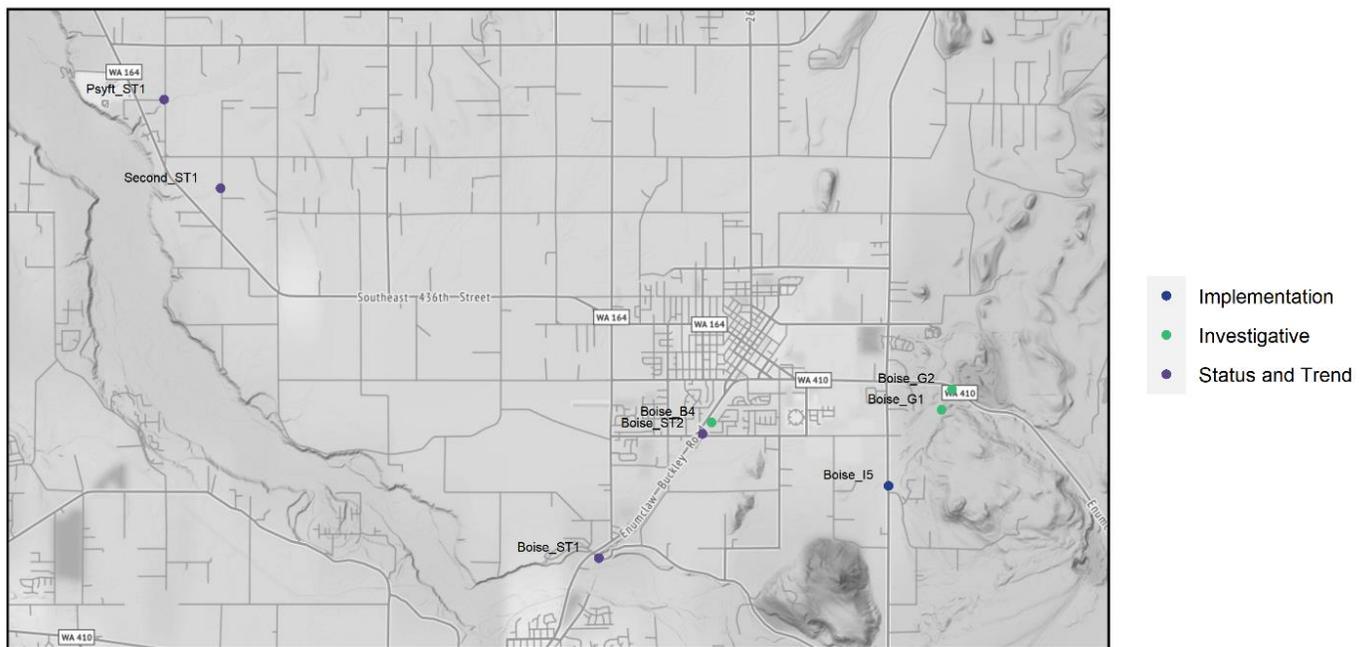


Figure 1. Map of the status and trend, implementation, and investigative sites.

Report Summary

- ❖ From July to September 2020, Pussyfoot and Second Creek sites were either dry or stagnant. Pussyfoot Creek was only sampled in July, and all Boise Creek sites were sampled monthly.

Precipitation and Discharge

From July 01 to September 30, total precipitation recorded [King County's Enumclaw Rain Gauge](#) (44u) was 5.51 inches (data is provisional). Monthly totals are listed below:

- ❖ July: 0.50 in
- ❖ August: 0.70 in
- ❖ September: 4.31 in

From June 01 to September 30, mean discharge at [USGS station 12099600](#) (Boise Creek River Mile 0.1) was 9.61 cfs (data is provisional). Monthly averages are listed below:

- ❖ July: 10.53 cfs
- ❖ August: 6.78 cfs
- ❖ September: 11.55 cfs

Bacteria

- ❖ Boise_ST1 met the geometric mean water quality standard (below 100 cfu/100 mL). The upstream site Boise_ST2 did not meet this standard with a geometric mean of 438.3 and 762.13 cfu/100mL for fecal coliform and *E. coli*, respectively (see Figures 2 and 3).
- ❖ Boise_ST2 had the highest fecal coliform and *E. coli* results (3100 and 1200 cfu/100mL, respectively) in September.
- ❖ Psyft_ST1 met the second water criterion with just one sample collected in July. This criterion states a single sample (when less than 10 samples exist) should be below 200 cfu/100mL for fecal coliform and 320 cfu/100 mL for *E. coli*.

Water Quality Parameters

- ❖ The following sites did not meet state water quality standards:
 - Boise_ST1: Temperature (Sept)¹
 - Boise_ST2: Dissolved Oxygen, Temperature (July-Sept)¹
 - Boise_G2 (Investigative): Dissolved Oxygen, Temperature (July-Sept)¹
 - Psyft_ST1: Dissolved Oxygen

¹ *Discrete temperature results are not directly comparable to the 7-DADMax water quality criteria, however more than one result above the standard suggests a possible exceedance. Boise Creek has supplemental spawning and incubation criteria of 13°C from September 1 to July 1 (Table 5, Water Quality Program, 2018).

Nutrients

- ❖ Psyft_ST1 had the highest detected nitrogen result with 0.68 mg/L of total persulfate nitrogen sampled in July.
- ❖ All forms of nitrogen sampled (ammonia, nitrate-nitrite, and total persulfate nitrogen) were each below 0.6 mg/L at Boise Creek sites. Boise_ST2 nitrogen results were slightly elevated compared to Boise_ST1 (see Figure 5).
- ❖ The maximum ortho-phosphate and total phosphorus results were collected at Psyft_ST1 (0.23 mg/L and 0.29 mg/L, respectively).

Investigative Sampling

- ❖ Nutrient samples were collected on the northern tributary of Boise Creek to bracket the Enumclaw Golf Course. The sites are located where Boise Creek enters the golf course (Boise_G1) and where the northern tributary comes out from under 410 (Boise_G2). The investigative sites were either comparable or lower than Boise_I5, the downstream site, which indicates low influence of the golf course on nutrient levels (see Figure 6).
- ❖ Samples were collected at Boise_B4, a site upstream of Boise_ST2 and stormwater flume Lateral A. Bacteria results were consistently higher than Boise_ST2 during sampling events July 13 and August 18 (see Figure 7). Despite the recent clean-up efforts and sewer corrections by the City of Enumclaw, results indicate continued monitoring upstream and along stormwater flume Lateral B is necessary to find additional pollution sources.

Bacteria

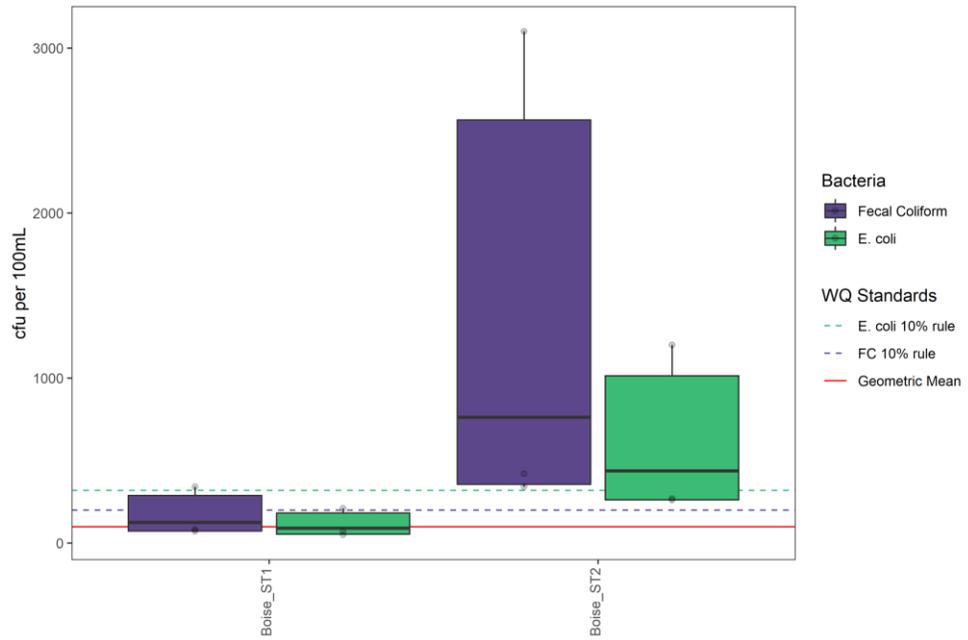


Figure 2. Boxplot of Boise Creek fecal coliform and *E. coli* results from July to September 2020. Horizontal black bars represent geometric mean, the boxes represent the 10th and 90th percentiles with the maximum and minimum values delineated by whiskers. Water quality standards are shown for geometric mean criteria (100 cfu/100mL; solid red line) and fecal coliform or *E. coli* 10 percent rule (200 and 320 cfu per 100 mL, respectively). Sites with less than three samples were not included.

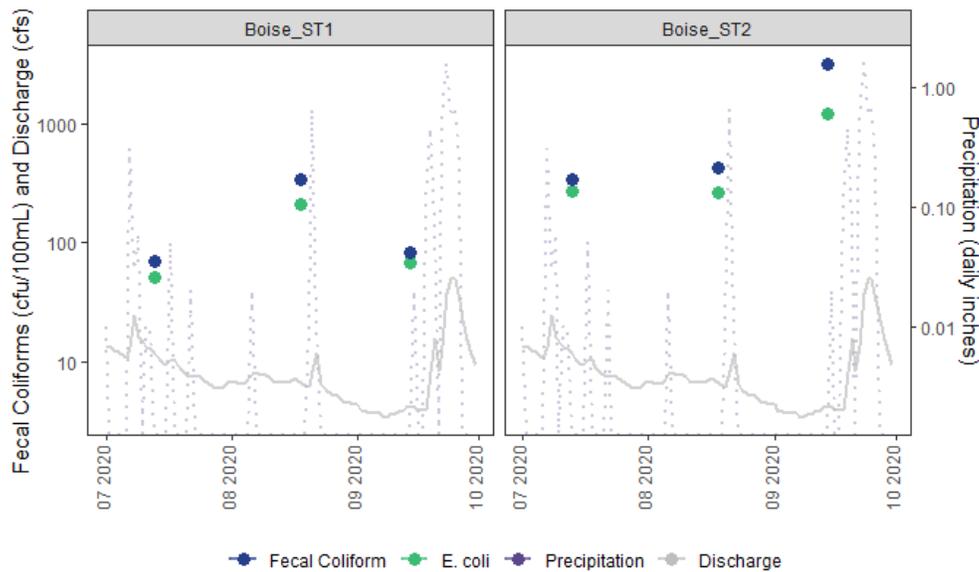


Figure 3. Boise Creek bacteria results over time with daily precipitation ([King County Station 44u](#)) and stream flow ([USGS station 12099600](#)).

Water Quality Parameters

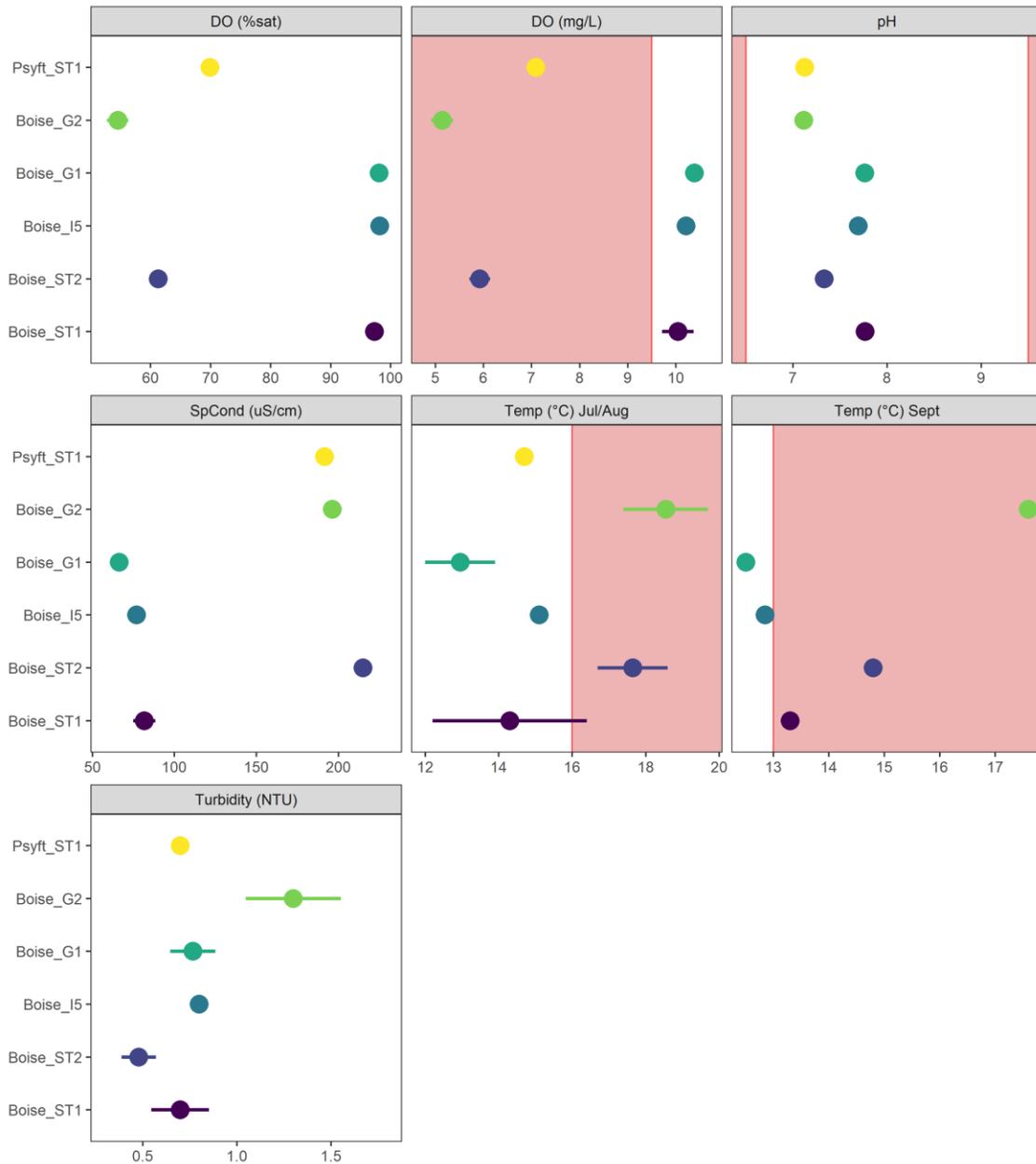


Figure 4. Mean (dots) and range (lines) of water quality parameters at long-term sites (Boise_ST1, Boise_ST2, Boise_I5, Psyft_ST1) and investigative sites (Boise_G1, Boise_G2). Red shaded areas represent values outside of water quality standards. Temperature for Boise Creek has two seasonal maximum standards: 16°C from July 2 to August 31 and 13°C from September 1 to July 1.

Nutrients

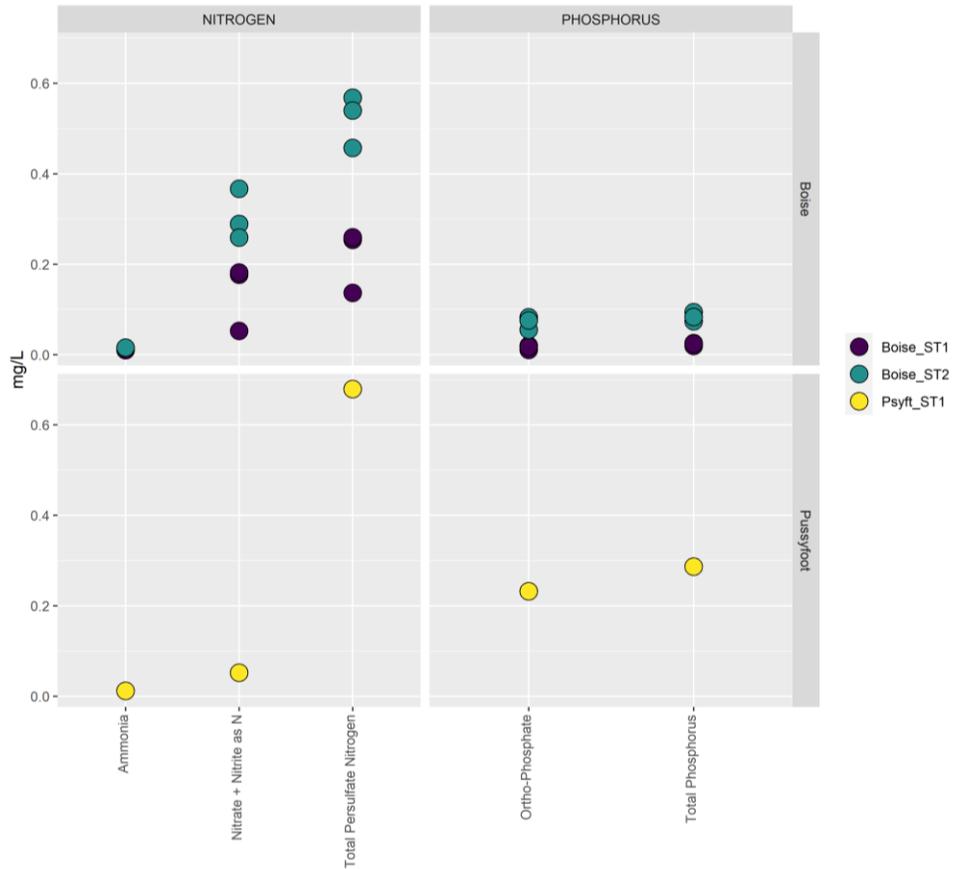


Figure 5. Nutrient results at status and trend sites from July to September.

Investigative Sampling

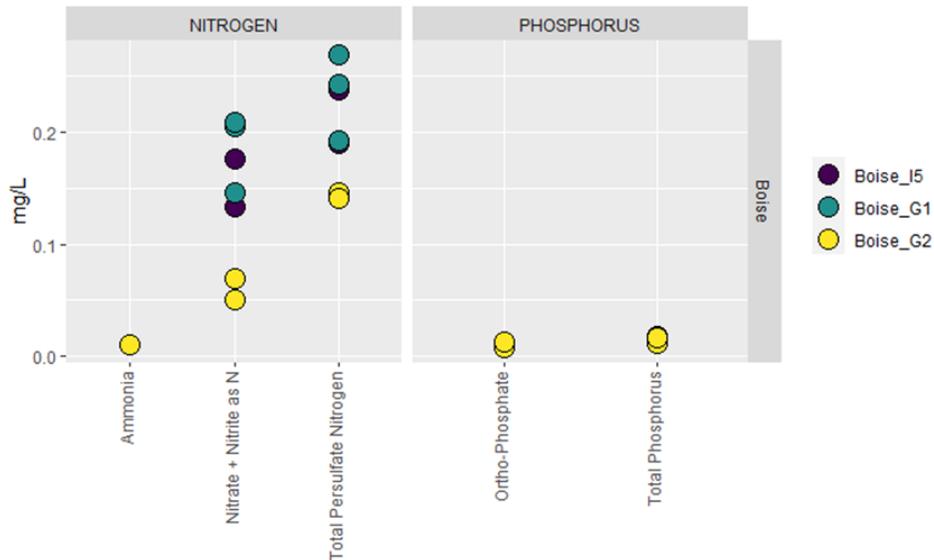


Figure 6. Nutrient results at sites upstream (Boise_G1, Boise_G2) and downstream (Boise_I5) of golf course.

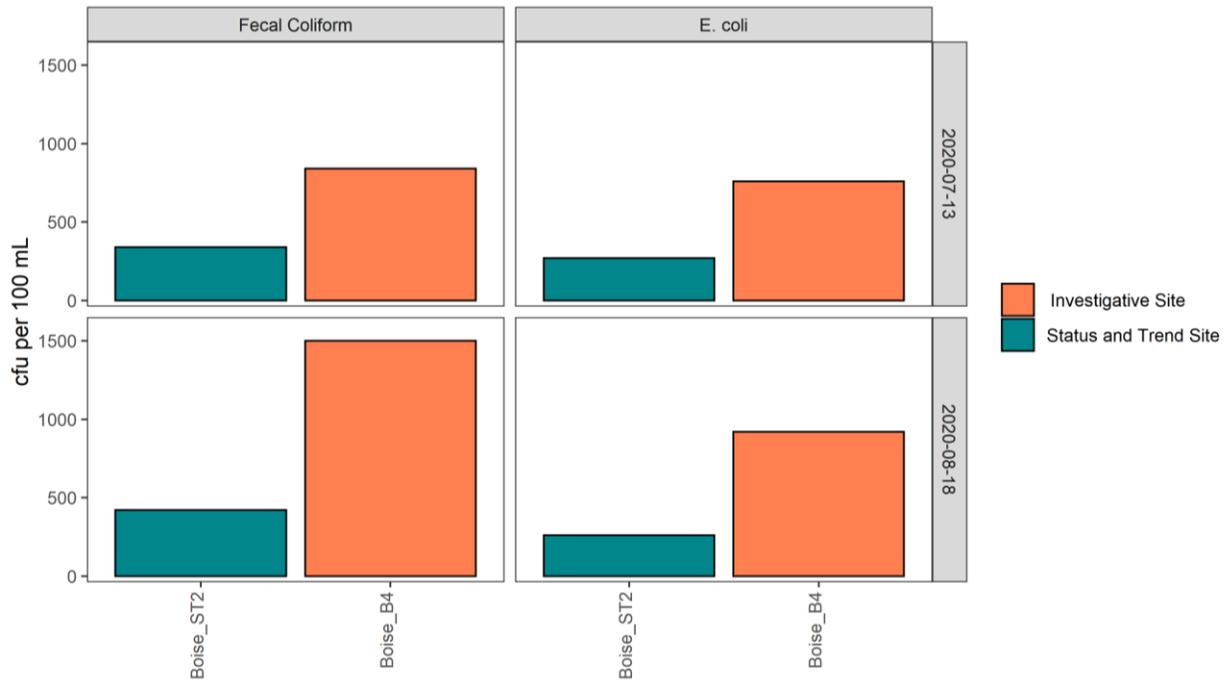


Figure 7. Bacteria results from investigative site and adjacent status and trend site.

References

Brownlee, A. 2019. Quality Assurance Project Plan: Puyallup River Tributaries Effectiveness Monitoring. Ecology publication 19-10-040.

Dickes, B. 2015. Pussyfoot Creek and Second Creek Fecal Coliform Characterization Monitoring: Two Tributaries to the White River. Washington State Department of Ecology, Olympia, WA. Publication No. 15-10-048.
<https://testfortress.wa.gov/ecy/publications/SummaryPages/1510048.html>

Kahle, D and H. Wickham. ggmap: Spatial Visualization with ggplot2. The R Journal, 5(1), 144-161. URL <http://journal.r-project.org/archive/2013-1/kahle-wickham.pdf>

Mathieu, N. and James, C. 2011. Puyallup River Watershed: Fecal Coliform Total Maximum Daily Load – Water Quality Improvement Report and Implementation Plan. Washington State Department of Ecology, Olympia, WA. Publication No. 11-10-040. <https://testfortress.wa.gov/ecy/publications/SummaryPages/1110040.html>

Water Quality Program, 2018. Water Quality Program Policy 1-11: Washington’s Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements. [Ecology publication 18-10-035](https://fortress.wa.gov/ecy/publications/SummaryPages/1810035.html). <https://fortress.wa.gov/ecy/publications/SummaryPages/1810035.html>

Water Quality Standards for Surface Waters of the State of Washington Section 173-201A. <https://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A>

Appendices

Appendix 1. Statistics for sites monitored for bacteria from July 2020- September 2020. Geometric mean (geomean) was not calculated or compared to water quality standards for sites with less than three samples.

Site	Parameter	Geomean	Median	Min	Max	10th Percentile	90th Percentile	# of samples
Boise_ST1	E. coli	90.41	69	51	210	54.6	181.8	3
Boise_ST2	E. coli	438.37	270	260	1200	262	1014	3
Boise_B4	E. coli	-	840	760	920	776	904	2
Psyft_ST1	E. coli	-	76	76	76	76	76	1
Boise_ST1	Fecal Coliform	125.56	82	71	340	73.2	288.4	3
Boise_ST2	Fecal Coliform	762.13	420	340	3100	356	2564	3
Boise_B4	Fecal Coliform	-	1170	840	1500	906	1434	2
Psyft_ST1	Fecal Coliform	-	200	200	200	200	200	1

Appendix 2. Raw data collected at sites on Boise Creek.

Site	Date	E. coli (cfu/100mL)	Fecal Coliform (cfu/100mL)	Ammonia (mg/L)	Nitrate + Nitrite as N (mg/L)	Total Persulfate Nitrogen (mg/L)	Ortho-Phosphate (mg/L)	Total Phosphorus (mg/L)	Barometric pressure (in Hg)	Specific Conductivity (uS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH	Temperature ©	Turbidity (NTU)
Boise_ST1	7/13/20	51	71	0.01	0.18	0.25	0.01	0.02	29.45	70	10.6	99.1	7.8	12.2	1.0
Boise_ST1	8/18/20	210	340	0.01	0.18	0.26	0.02	0.03	29.47	81	9.5	96.9	7.8	16.4	0.6
Boise_ST1	9/14/20	69	82	0.01	0.05	0.14	0.02	0.02	29.28	94	10.0	95.9	7.7	13.3	0.5
Boise_ST2	7/13/20	270	340	0.02	0.29	0.57	0.06	0.07	29.34	208	6.1	61.4	7.3	15.9	0.7
Boise_ST2	8/18/20	260	420	0.02	0.26	0.46	0.08	0.09	29.38	214	5.4	58.9	7.3	19.3	0.4
Boise_ST2	9/14/20	1200	3100	0.02	0.37	0.54	0.08	0.08	29.18	230	6.6	64.8	7.4	14.8	0.3
Boise_I5	8/18/20	-	-	0.01	0.18	0.24	0.01	0.02	29.34	73	10.0	99.5	7.8	15.1	0.8

Site	Date	E. coli (cfu/100mL)	Fecal Coliform (cfu/100mL)	Ammonia (mg/L)	Nitrate + Nitrite as N (mg/L)	Total Persulfate Nitrogen (mg/L)	Ortho-Phosphate (mg/L)	Total Phosphorus (mg/L)	Barometric pressure (in Hg)	Specific Conductivity (uS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH	Temperature ©	Turbidity (NTU)
Boise_I5	9/14/20	-	-	0.01	0.13	0.19	0.01	0.02	29.13	79	10.3	97.4	7.7	12.8	0.8
Boise_B4	7/13/20	760	840	-	-	-	-	-	-	-	-	-	-	-	-
Boise_B4	8/18/20	920	1500	-	-	-	-	-	-	-	-	-	-	-	-
Boise_G1	7/13/20	-	-	0.01	0.21	0.27	0.01	0.01	29.26	58	10.7	99.0	7.8	12.0	1.0
Boise_G1	8/18/20	-	-	0.01	0.21	0.24	0.01	0.02	29.29	67	10.1	98.2	7.8	13.9	0.7
Boise_G1	9/14/20	-	-	0.01	0.15	0.19	0.01	0.02	29.08	74	10.3	97.0	7.8	12.5	0.6
Boise_G2	7/13/20	-	-	0.01	0.07	0.15	0.01	0.01	29.26	194	5.6	58.1	7.2	17.4	1.0
Boise_G2	8/18/20	-	-	0.01	0.05	0.14	0.01	0.02	29.29	191	4.8	52.4	7.0	19.7	1.8
Boise_G2	9/14/20	-	-	-	-	-	-	-	29.08	205	5.1	53.2	7.2	17.6	1.1
Psyft_ST1	7/13/20	76	200	0.01	0.05	0.68	0.23	0.29	29.58	192	7.1	69.8	7.1	14.6	0.7