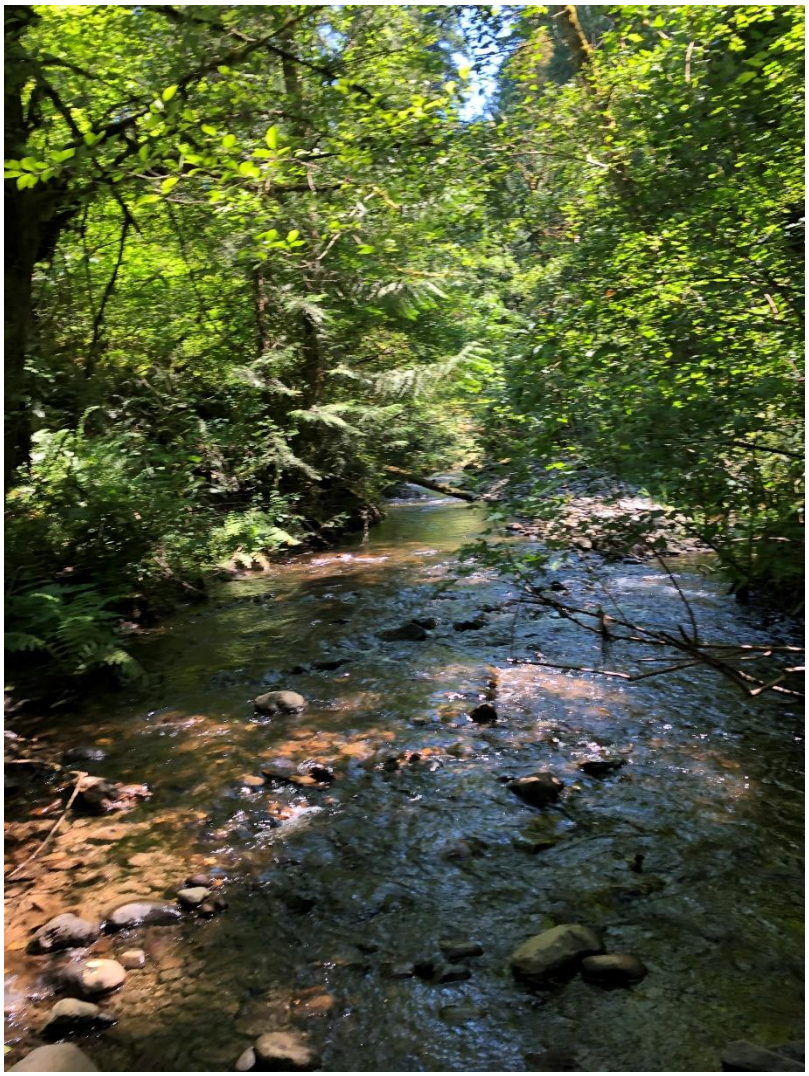
DEPARTMENT OF ECOLOGY
State of Washington

Puyallup River Tributaries Effectiveness Monitoring Interim Report

October 2019– March 2020



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Data for this project are available in Ecology's EIM Database (Study ID: EFF_PRT) and displayed on a Public Tableau webpage.
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 Puyallup River watershed has been an area of focused monitoring and TMDL implementation due to the concerns of bacteria exceedances in the three tributaries: Boise, Pussyfoot and Second Creeks. These exceedances were previously reported in Ecology's 2011 Puyalllup River Watershed Total Maximum Daily Load (TMDL; Mathieu and James, 2011, Ecology report 11-10-040) and 2015 source assessment study (Dickes, 2015, Ecology report 15-10-048). This effectiveness monitoring study is a follow up effort to pinpoint pollution sources in order to reduce bacteria levels and improve the overall water quality including other parameters of concern. The study has the following objectives:

- Identify water quality trends in each of the tributaries with routine ambient monitoring.
- Trace sources of pollution with investigative sampling.
- Report information in order to provide feedback necessary for adaptive management actions.

To meet these objectives, monitoring was conducted at 26 core locations across the three tributaries. The five status and trends sites represent the lower sections of each tributary. The implementation and adaptive management sites represent sections of the tributary upstream of the status and trends sites. Sites are monitored for bacteria and in-situ water quality parameters (dissolved oxygen, temperature, pH, conductivity), and status and trends sites are additionally monitored for nutrients. Additional sites of concern were included to further investigate bacteria and nutrient levels that might be affecting core sites.

This report is a continuation of the 2019 Puyallup River Tributaries Effectiveness Monitoring Quarterly Report (Brownlee, 2019) which evaluated the first quarter of results spanning from the start of the project July 2019 to September 2019. In order to stay consistent with this design, results were evaluated based on a three-month quarter: October to December and January to March. The last sampling event of March was not conducted due to an emergency shutdown in response to the coronavirus. 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).

Report Summary

Bacteria

- Numerous sites on Second and Pussyfoot Creek were either too stagnant or dry to sample from October to December.
- All status and trends sites except Boise_ST1 exceeded the geometric mean water quality standard for *E. coli* for the October to December quarter.
- Boise_ST2 was the only site from the tributary to exceed the geometric mean water quality criteria and the site with the greatest calculated geometric mean for both fecal coliform and *E. coli* from October to December.
- Boise_ST2 had the highest discrete *E. coli* result (860 cfu/100mL); Pussyfoot Creek sites had the highest discrete fecal coliform results for both quarters.
- See Appendix A and B for list of sites that did not meet geometric mean water quality criteria for each quarter.

Nutrients

- An increase in nutrient concentrations was observed for all sites in January which was the month with the highest precipitation levels.

Field Parameters

- From October to December, the following sites did not meet water quality standard for dissolved oxygen (9.5 mg/L):
  - Boise_ST2
  - Boise_I9
  - Second_ST1
  - Second_I3
  - Psyft_ST1
  - Psyft_I1
  - Psyft_I2
  - Psyft_I3
  - Psyft_I5
  - Psyft_I7
  - Psyft_I9
- All parameters were within range of water quality standards for all stations from January to March.

Investigative Sampling

- Sampling upstream of Boise_ST2 near connections to the main stormwater flume revealed illicit discharge on the Lateral C connection. The City of Enumclaw was able to respond and resolve the pollution issue.
- Two sites immediately upstream of Lateral A and Lateral B (Boise_B4 and Boise_B5 respectively) had noticeably high or comparable results to Boise_ST2 which necessitates continued monitoring in the area.
- Nutrient sampling was conducted on the northern tributary of Boise Creek at sites bracketing the Enumclaw Golf Course. The investigative sites were either comparable or lower than Boise_I5 indicating low influence of the golf course on nutrient levels.

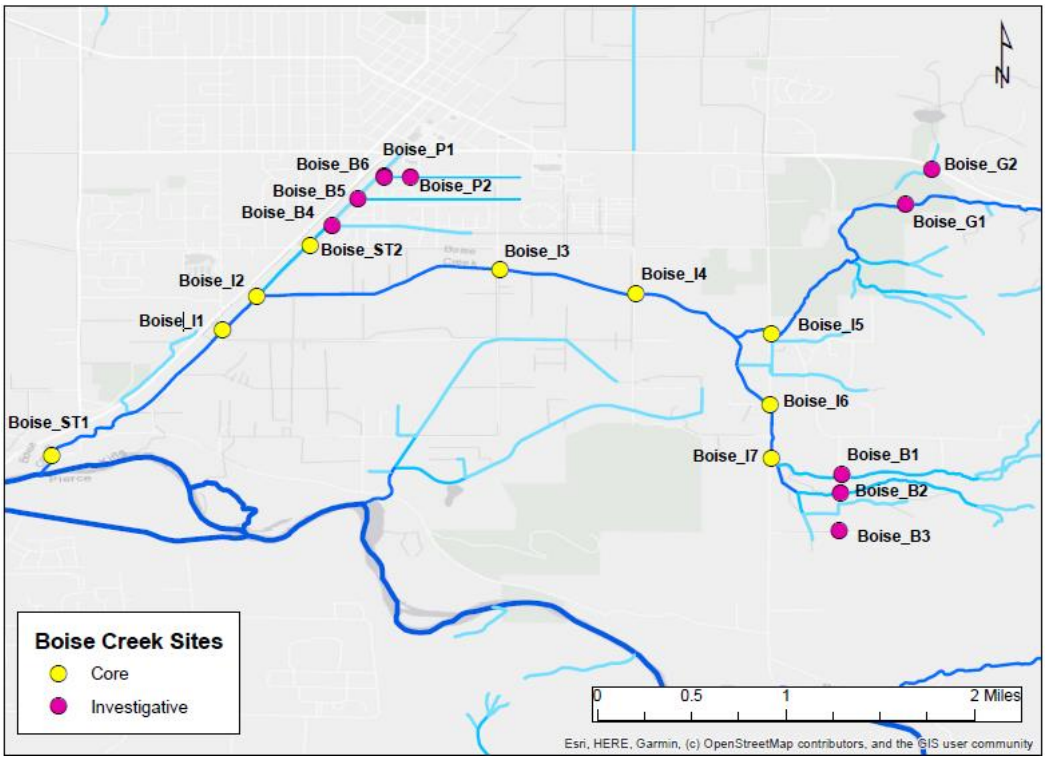

Figure 1. Map of status and trend, implementation and investigative sites along Boise Creek.

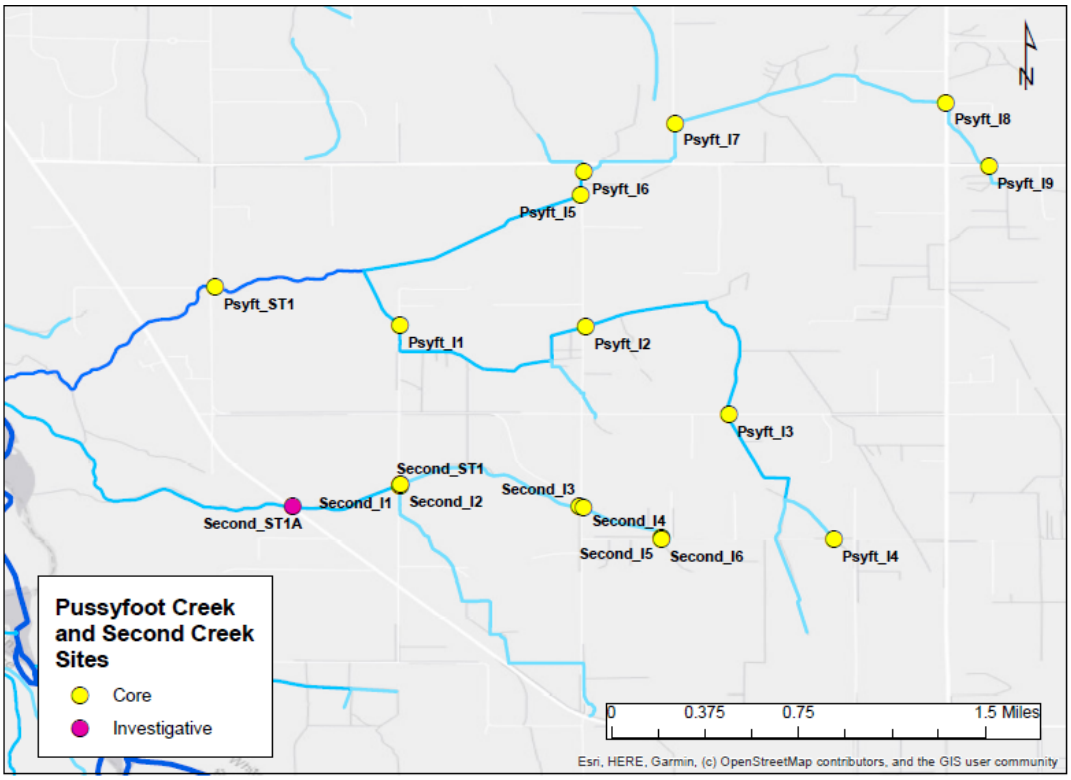

Figure 2. Map of status and trend, implementation and investigative sites along Pussyfoot and Second Creeks.

Precipitation

Total precipitation recorded at King County's Enumclaw Rain Gauge (44u) was 15.62 inches from October to December and 29.24 inches from January to March. January experienced a historically significant total precipitation of 8.94 inches, while February experienced the greatest daily total precipitation of 2.11 inches on February 5th.

Table 1. Total precipitation by month from King County Enumclaw Rain Gauge (data is provisional).

Month	Total Precipitation (inches)
October	5.42
November	2.34
December	7.86
January	8.94
February	8.40
March	2.01

Discharge

Mean discharge at USGS station 12099600 (Boise Creek River Mile 0.1) was 39.30 cfs from October to December and 93.22 cfs from January to March.

Table 2. Mean discharge by month from USGS station 12099600 (data is provisional).

Month	Mean discharge (cfs)
October	26.27
November	19.34
December	60.1
January	72.61
February	148.92
March	42.82

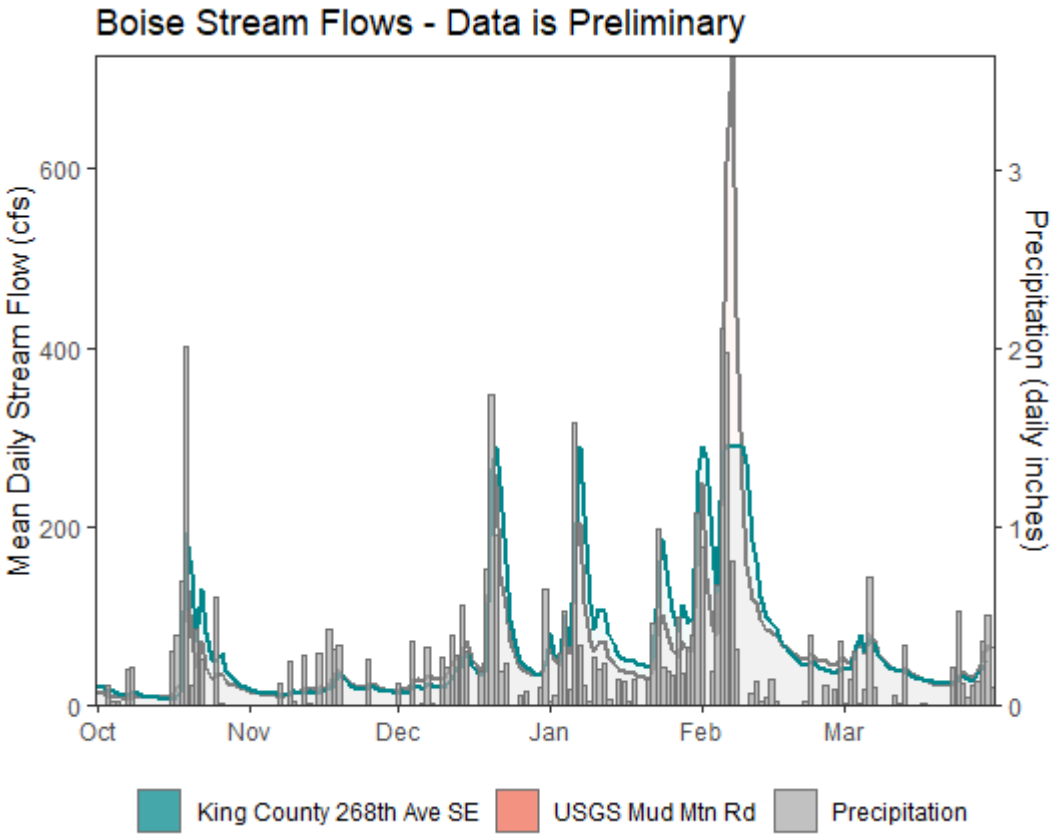

Figure 3: Mean daily stream flow at USGS station 12099600 (Boise Creek River Mile 0.1) with precipitation from King County's Enumclaw Rain Gauge.

Bacteria

October to December

Numerous sites particularly Second Creek sites were either stagnant or dry during this quarter. No samples were collected at Second_I5 or Second_I6 from October to December due to stagnant or dry conditions. A single sample was collected at Second_I2 and Psyft_I3. Sites that did not pass the three sample criteria were not included in the water quality standard evaluation for either fecal coliform or *E. coli* (200 and 320 cfu per 100 mL, respectively).

All status and trends sites except Boise_ST1 exceeded the geometric mean water quality standard for fecal coliform bacteria and *E. coli* (100 cfu per 100 mL). The highest fecal and *E. coli* results were collected on October 22nd at Pussyfoot Creek sites. Psyft_I9, Psyft_ST1, Psyft_I4 had the three highest discrete fecal coliform results (3000, 2500 and 1400 cfu/100mL, respectively). Psyft_I9 also had the highest *E. coli* result of 840 cfu/100mL. Psyft_I4 and Psyft I9 are the most upstream sites of the tributary and routinely had the lowest flow during the sampling period.

The upstream status and trend site Boise_ST2 was the only site from the tributary to exceed all water quality criteria and the site with the greatest calculated geometric mean for both fecal coliform and *E. coli*. Further investigative sampling was conducted to determine potential pollution sources that could have contributed to the noticeably high results (see *Investigative Sampling* section for details and results).

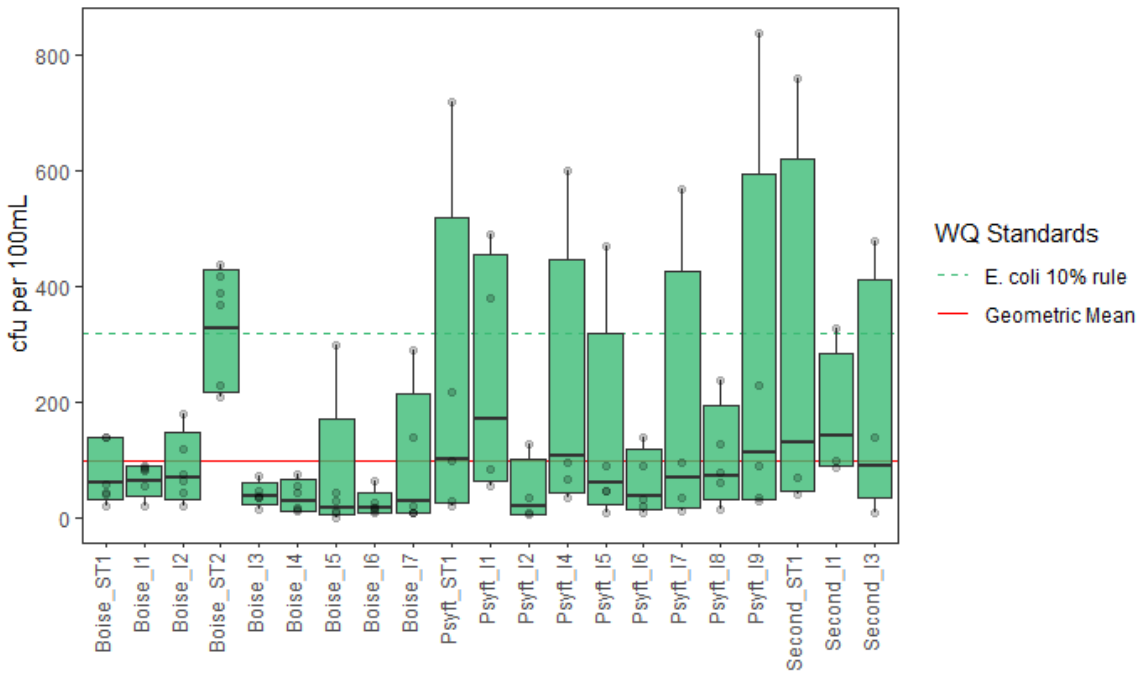

Figure 4: Boxplot of *E. coli* from October to December. Horizontal black bars represent geometric mean, the boxes represent the 10th and 90th percentiles with the maximum and minimum values delineated by whiskers. Water quality standards are presented for geometric mean criteria (100 cfu/100mL; solid red line) and *E. coli* 10 percent rule (320 cfu per 100 mL).

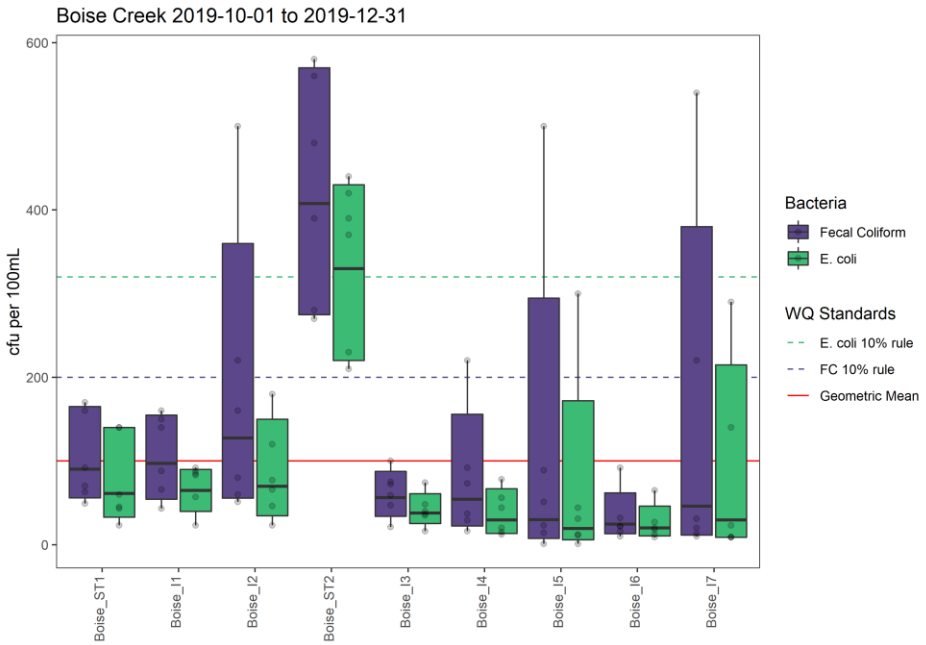

Figure 5: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Boise Creek sites from October to December. Water quality standards are presented for geometric mean criteria (100 cfu/100mL; solid red line) and fecal coliform or *E. coli* 10 percent rule (200 and 320 cfu per 100 mL, respectively).

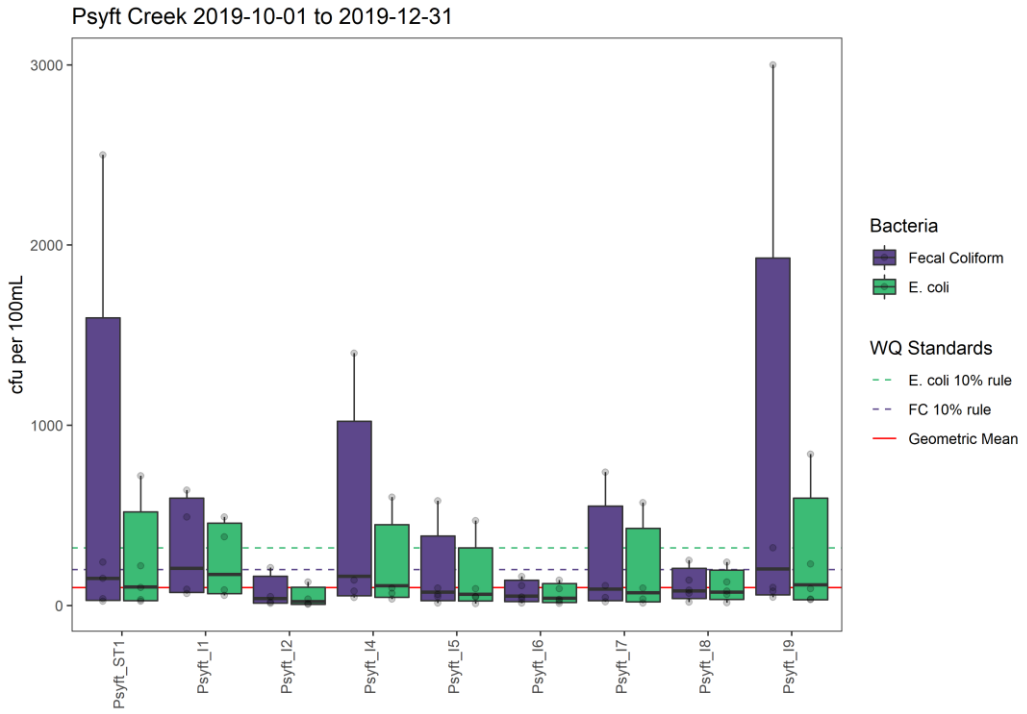

Figure 6: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Pussyfoot Creek sites from October to December.

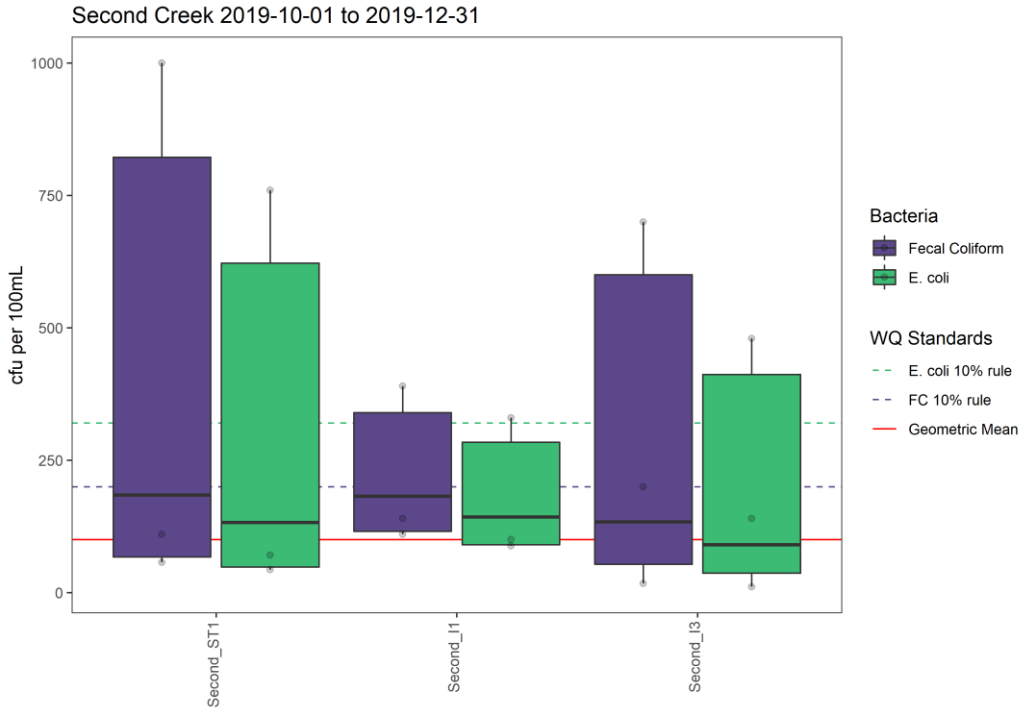

Figure 7: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Second Creek sites from October to December. Second_I2, Second_I4, Second_I5 and Second I_6 not included due to low sample number.

January to March

There were fewer water quality standard exceedances compared to the past quarter (see Appendix B for list of sites that did not meet the geometric mean water quality criteria). Only Boise_ST2 and Second_I1 exceeded the geometric mean water quality standard for *E. coli*.

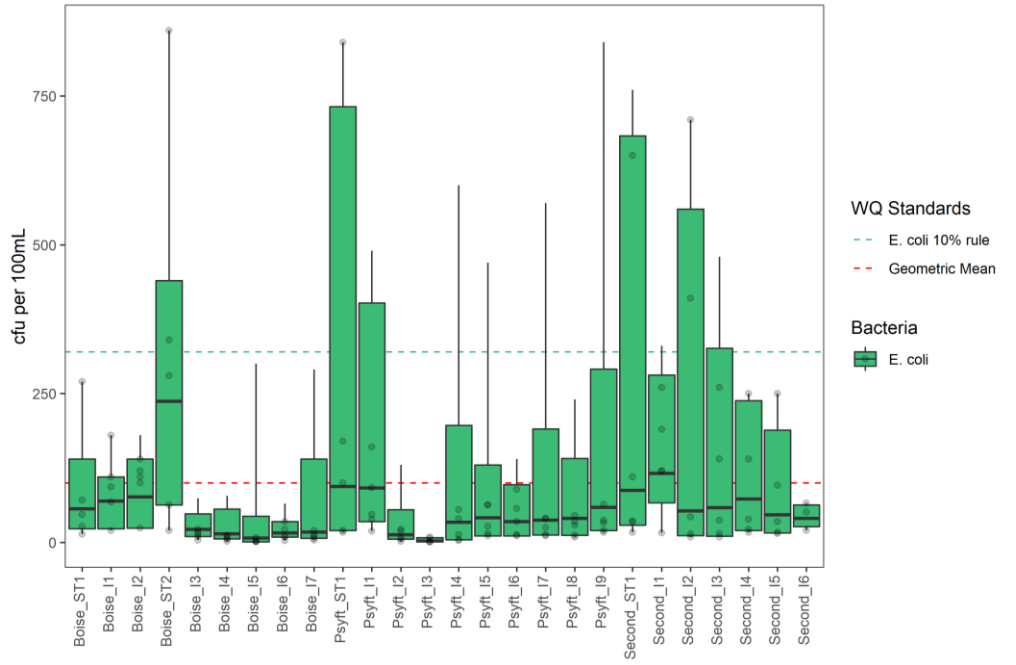

Figure 8: Boxplot of *E. coli* with water quality criteria for Boise Creek sites from January to March.

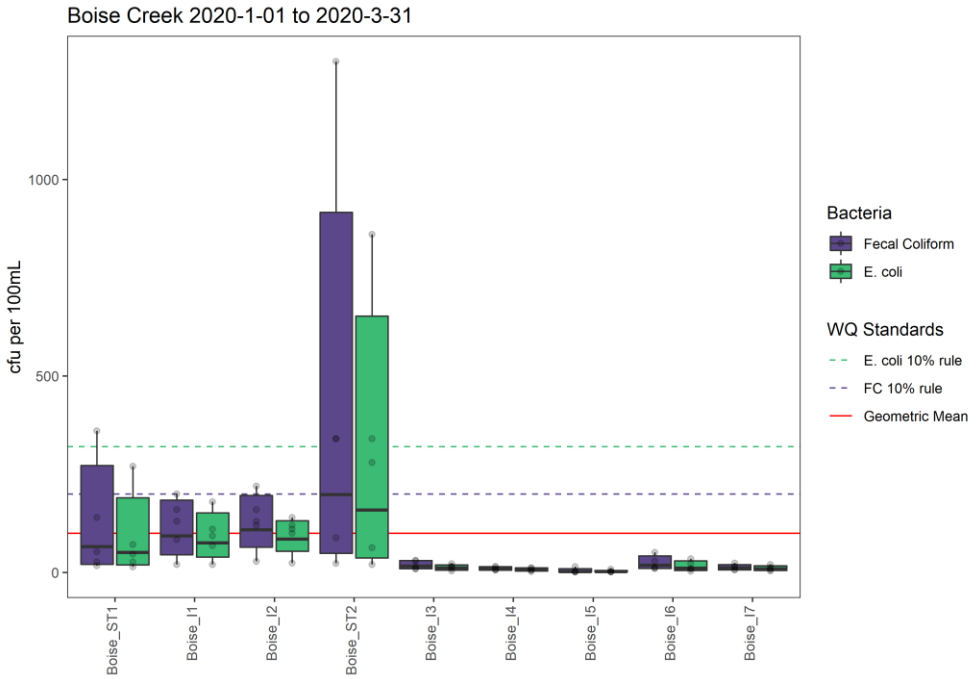

Figure 9: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Boise Creek sites from January to March.

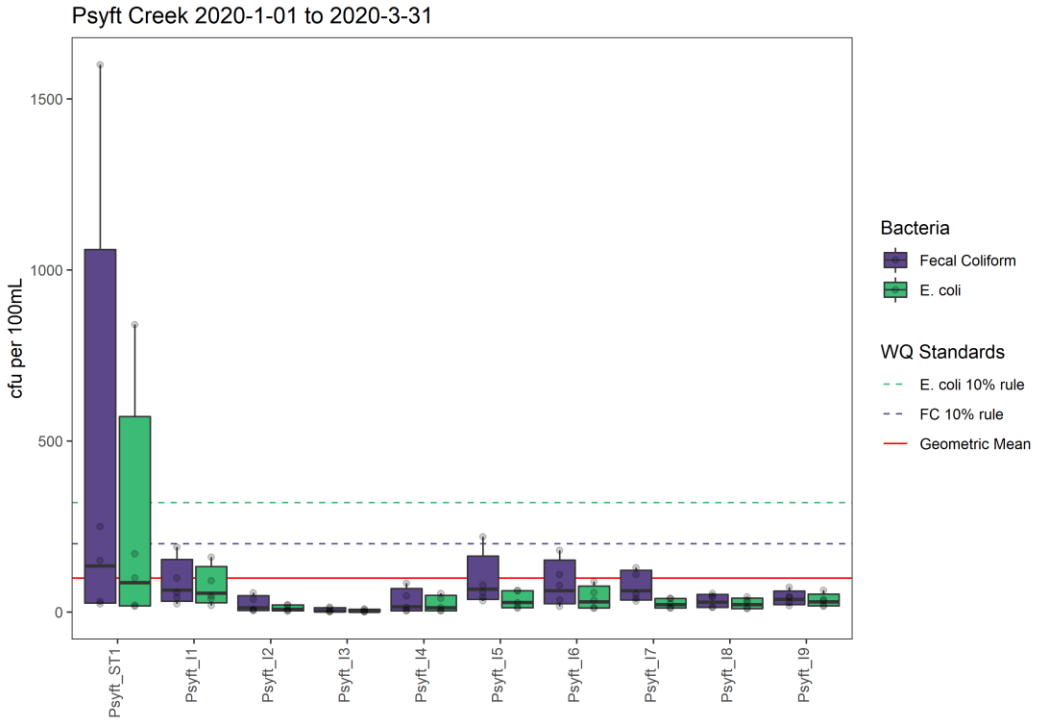

Figure 10: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Pussyfoot Creek sites from January to March.

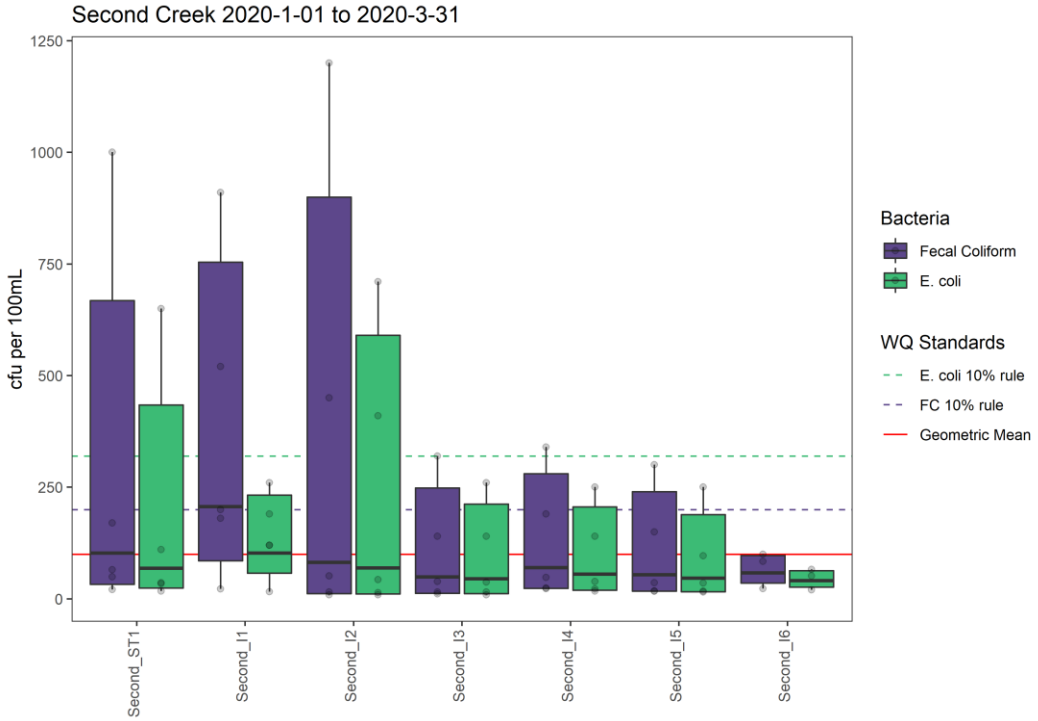

Figure 11: Boxplot of bacteria (fecal coliform and *E. coli*) with water quality criteria for Second Creek sites from January to March.

Precipitation and Bacteria

Most sites appeared to experience a trend of higher bacteria concentrations in response to increased precipitation particularly in January. Yet, there was no significant correlation between precipitation and bacteria for all sites including the ones that did not exceed water quality standards.

For certain sites that did not exceed the geometric mean standard, bacteria concentrations were not as responsive to precipitation during certain periods of the year. For example, bacteria concentration at Boise_ST2 did not fluctuate with precipitation from October to December (see Figure 12). This may indicate a potential steady pollution source that elevates bacteria levels regardless of changes in precipitation.

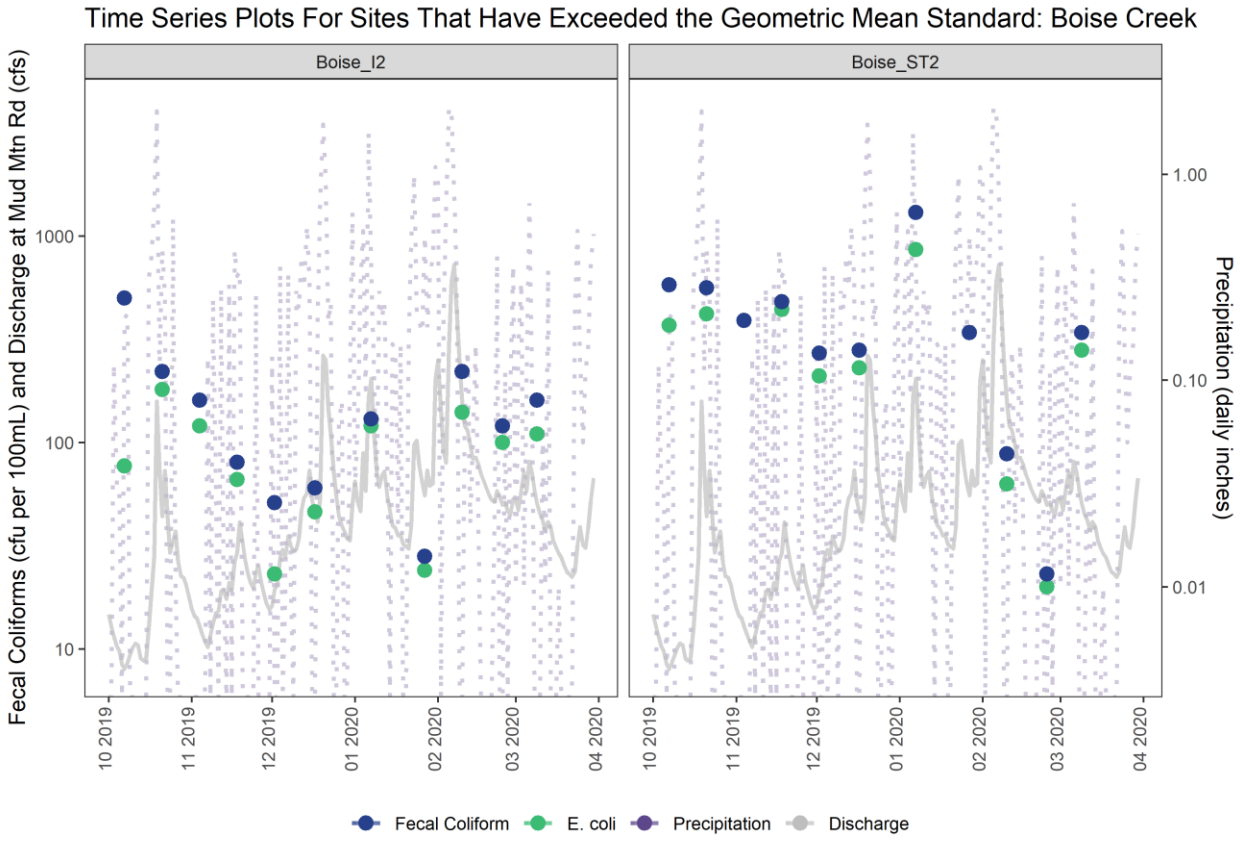

Figure 12: Time series plots of bacteria (fecal coliform and *E. coli*) for the Boise Creek sites that exceeded the Washington state geometric mean water quality standard (see Appendices A and B) with daily precipitation (provisional, King County station 44u) and discharge (provisional, USGS station 12099600).

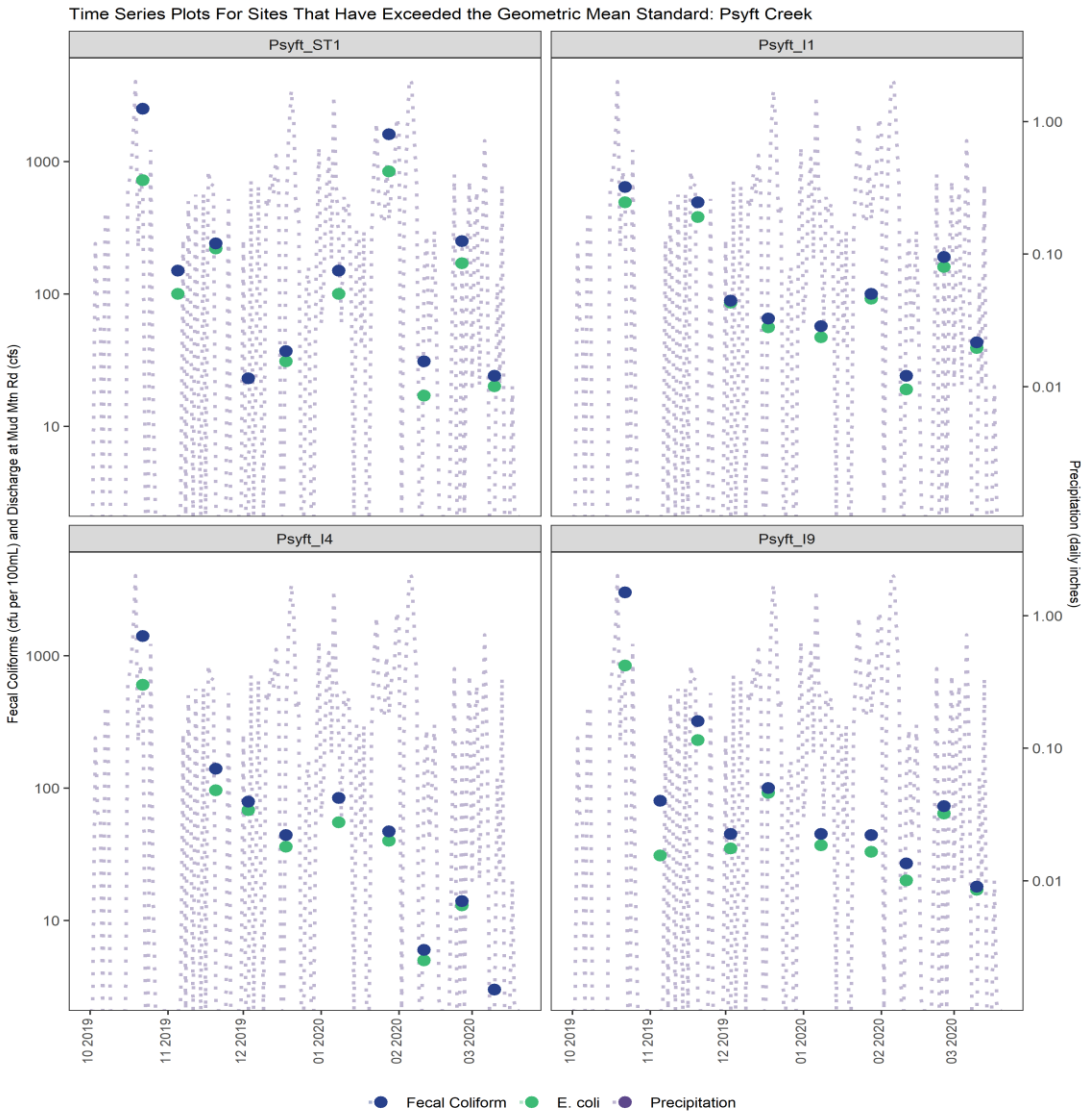

Figure 13: Time series plots of bacteria for the Pussyfoot Creek sites that exceeded the Washington state geometric mean water quality standard (see Appendices A and B) with daily precipitation (King County station 44u).

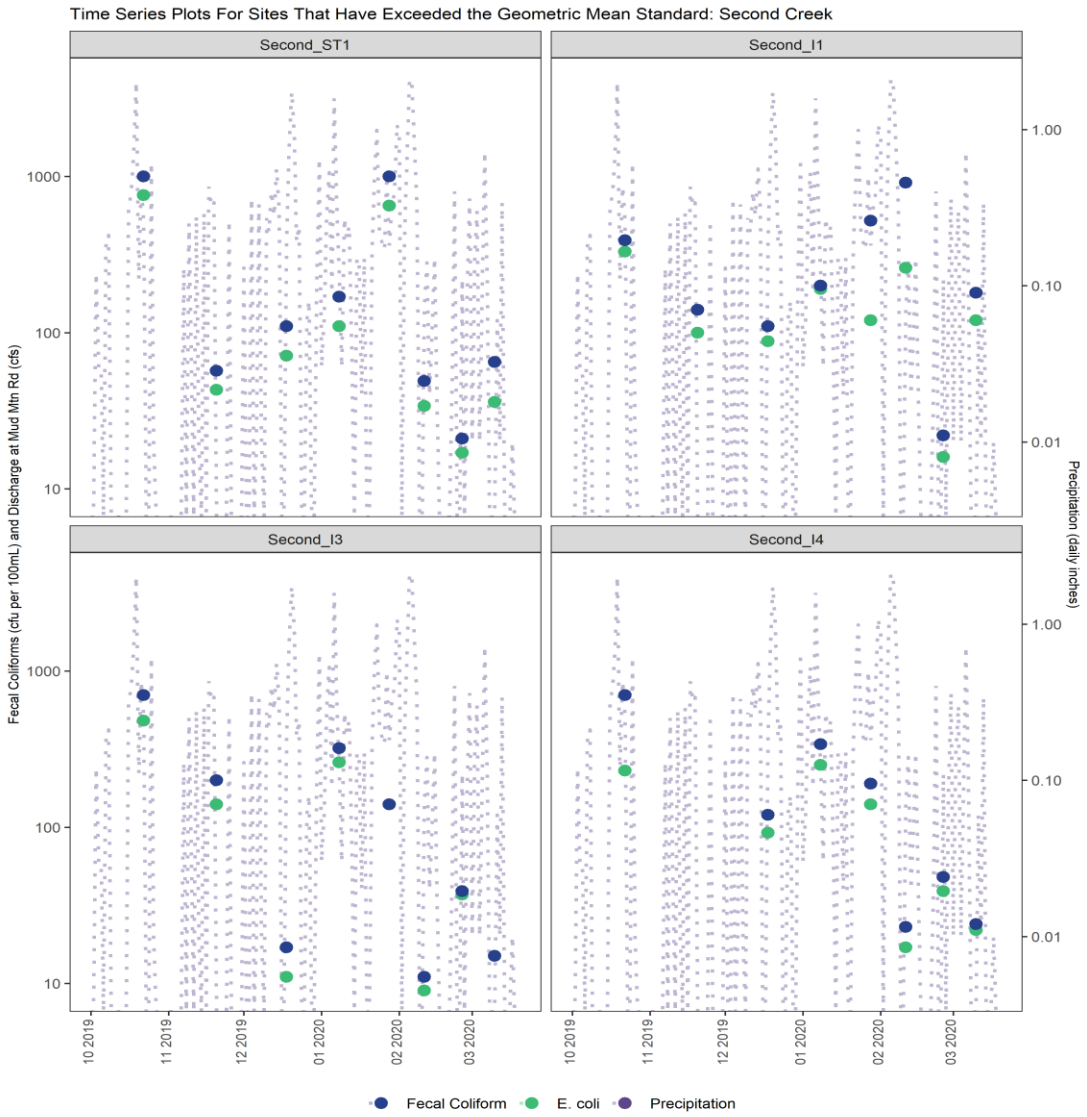

Figure 14: Time series plots of bacteria for the Second Creek sites that exceeded the Washington state geometric mean water quality standard (see Appendices A and B) with daily precipitation (King County station 44u).

Nutrients

Nutrients were sampled at status and trend sites on a monthly basis. Nutrient samples were not collected at Second_ST1 until January due to dry or stagnant conditions.

Similar to the trend with bacteria levels, there was an increase in nutrient concentrations for all sites in January which was the month with the highest precipitation levels. The first heavy rain of the winter season may have generated runoff from local farms near the rural sites (Pussyfoot and Second) or urban stormwater. Second Creek, a site with the lowest flows, had the highest levels with 13mg/L for total persulfate nitrogen and 9.03 mg/L for nitrate/nitrite as N in January.

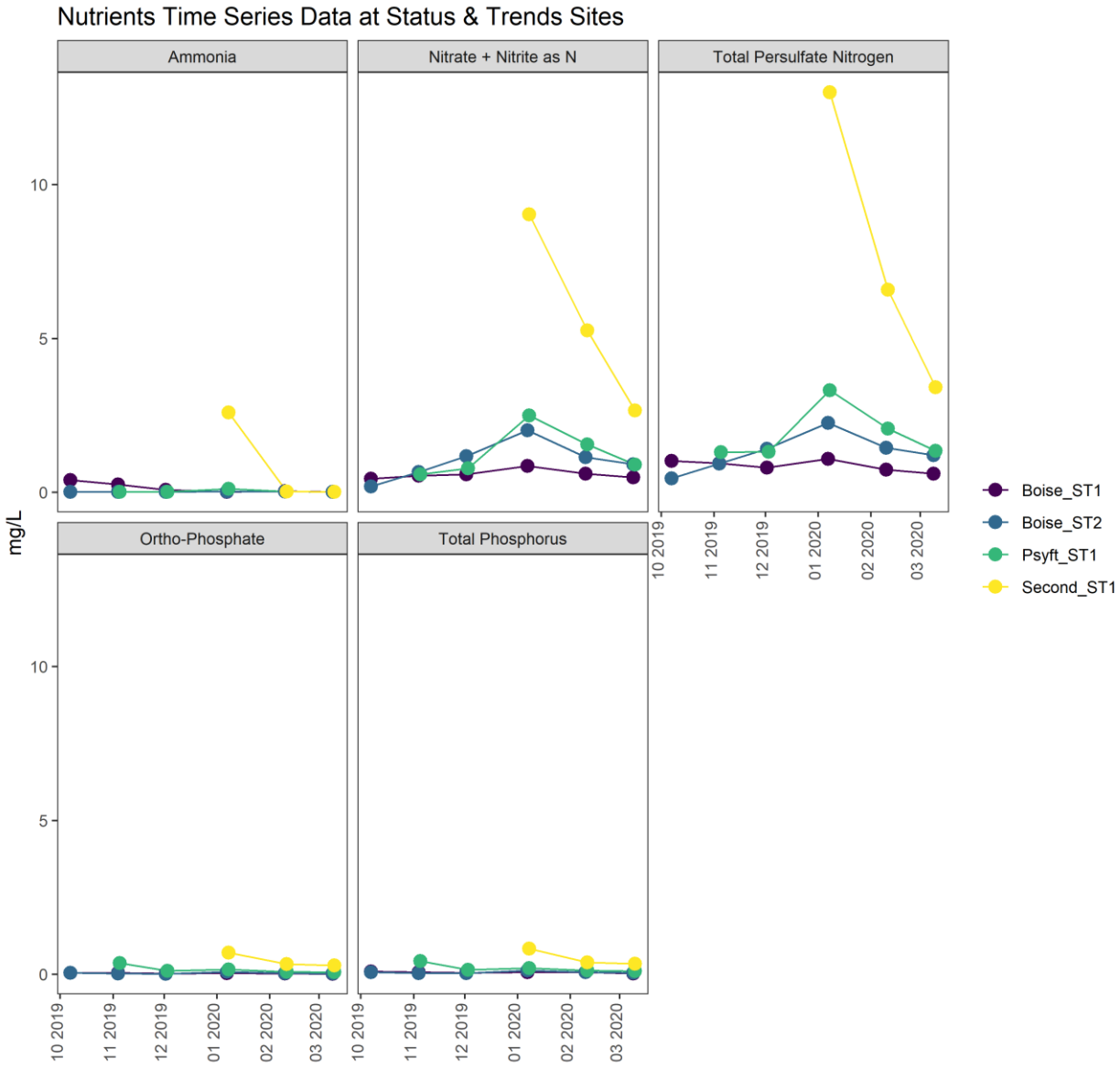

Figure 15: Time series plots for nutrient parameters for status and trend sites.

Field Parameters

October to December

Dissolved oxygen was the only in-situ water quality parameter that sites did not meet the water quality standard (9.5 mg/L). Similar to the July to September quarter, Boise_ST2 and Boise_I6 did not meet the water quality standard. All Pussyfoot Creek Sites except Psyft_I4, Psyft_I6, and Psyft_I9 did not meet this standard. Due to low or stagnant conditions, only a few Second Creek sites were measured for in-situ water quality.

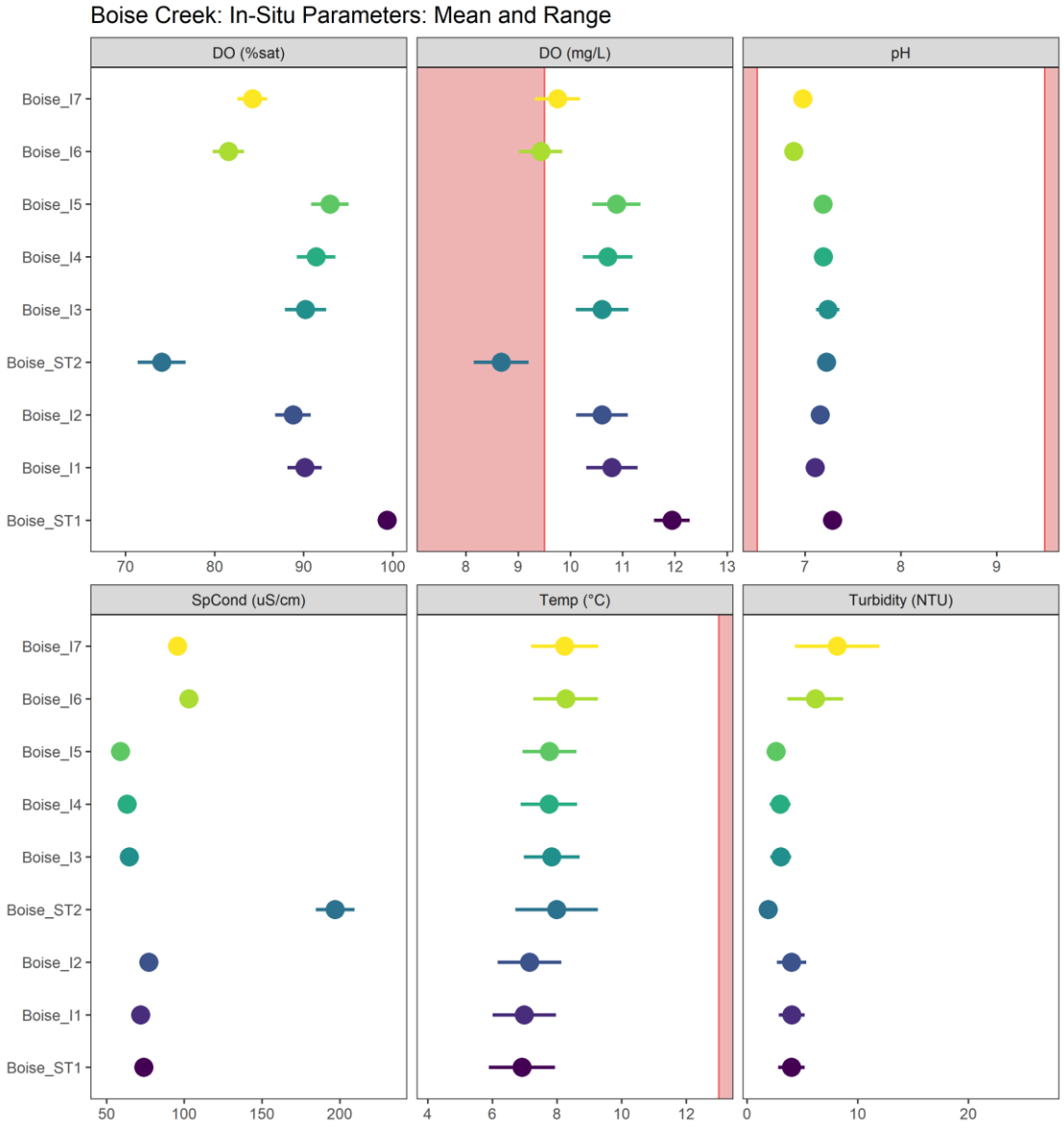

Figure 16: In-situ field parameters means (dots) and ranges (lines) at Boise Creek sites from October to December. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

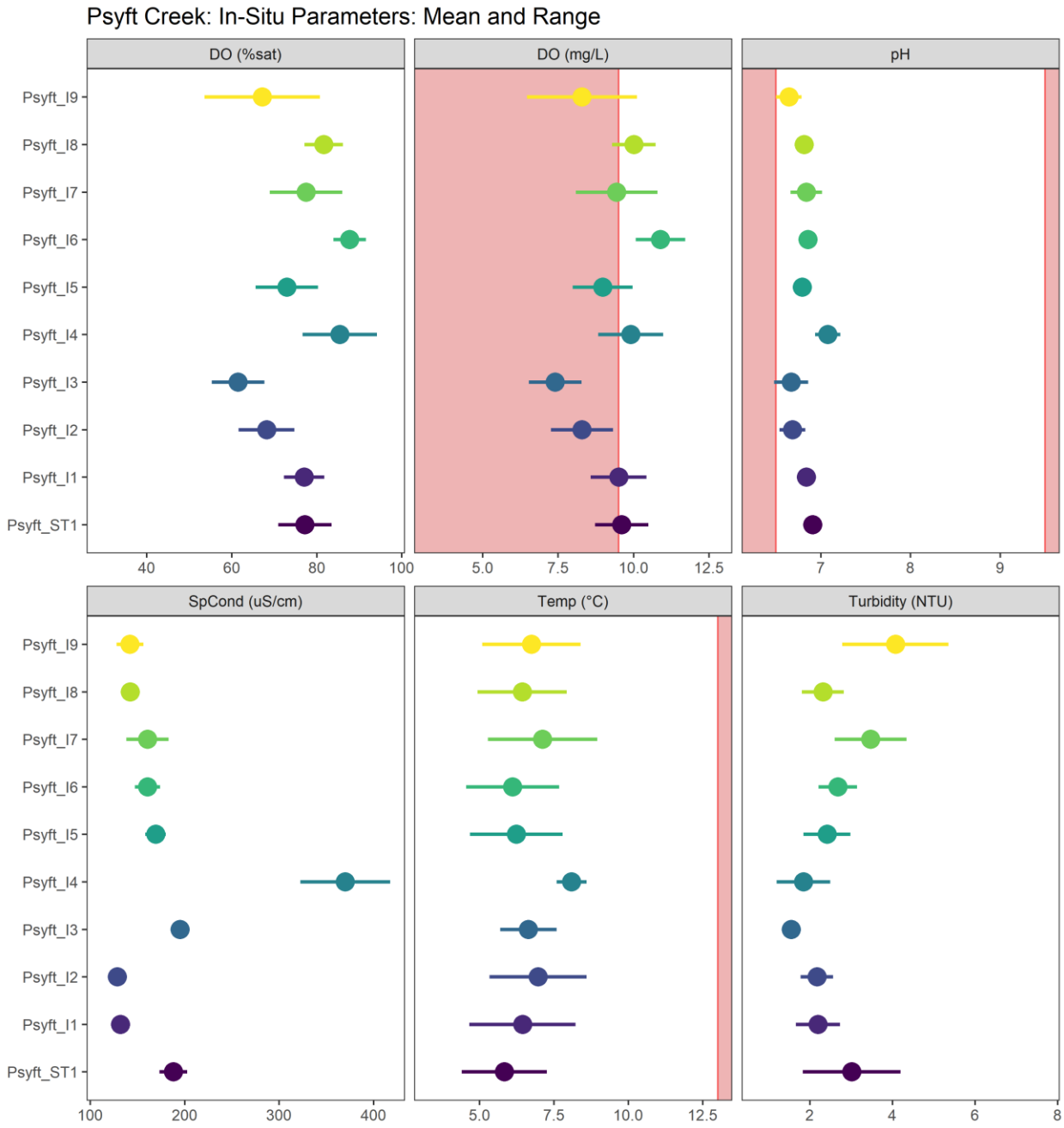

Figure 17: In-situ field parameters means (dots) and ranges (lines) at Pussyfoot Creek sites from October to December. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

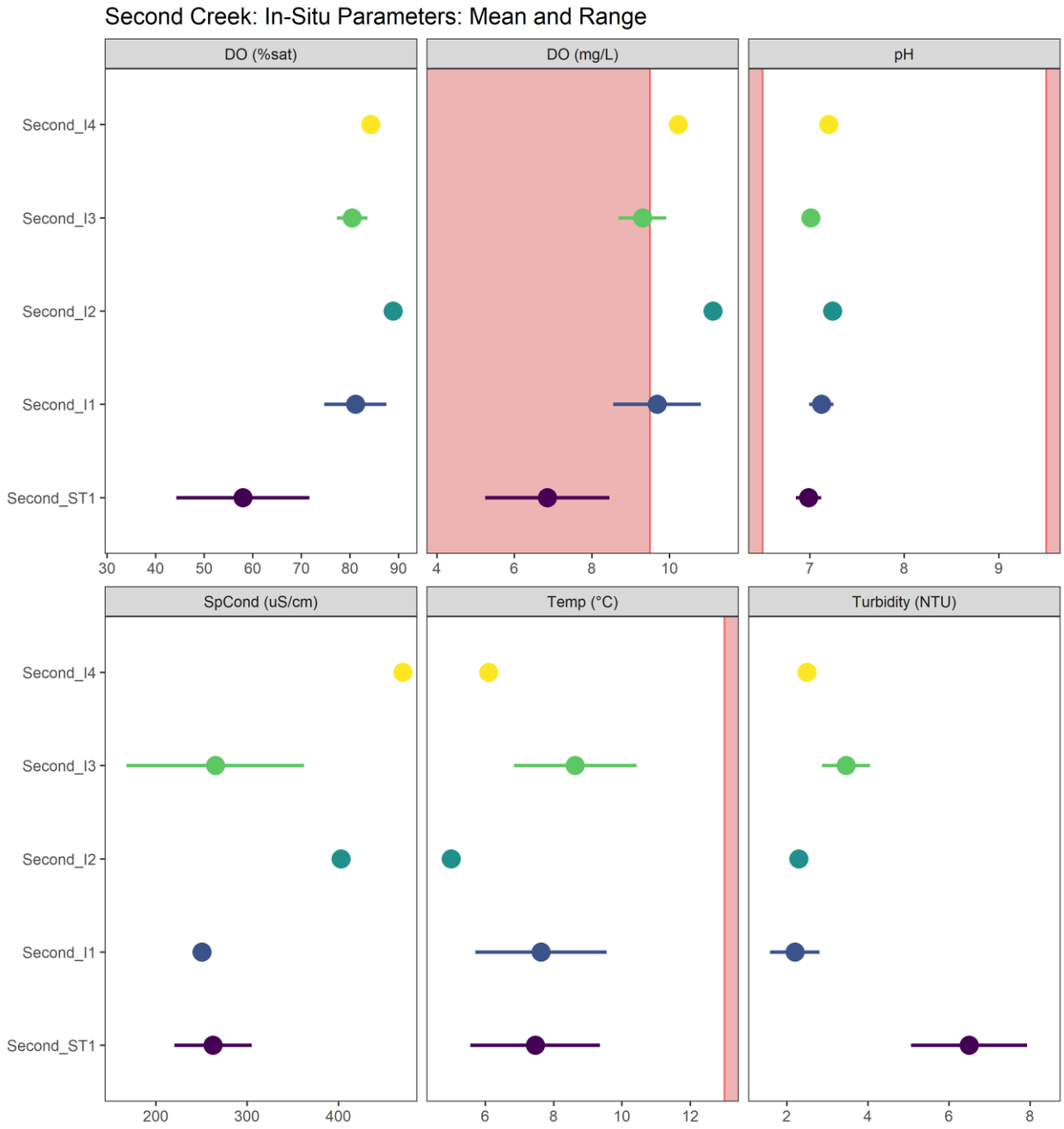

Figure 18: In-situ field parameters means (dots) and ranges (lines) at Second Creek sites from October to December. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

January to March

All parameters were within range of water quality standards for all stations from January to March. This may be a result of higher flows generated from greater precipitation.

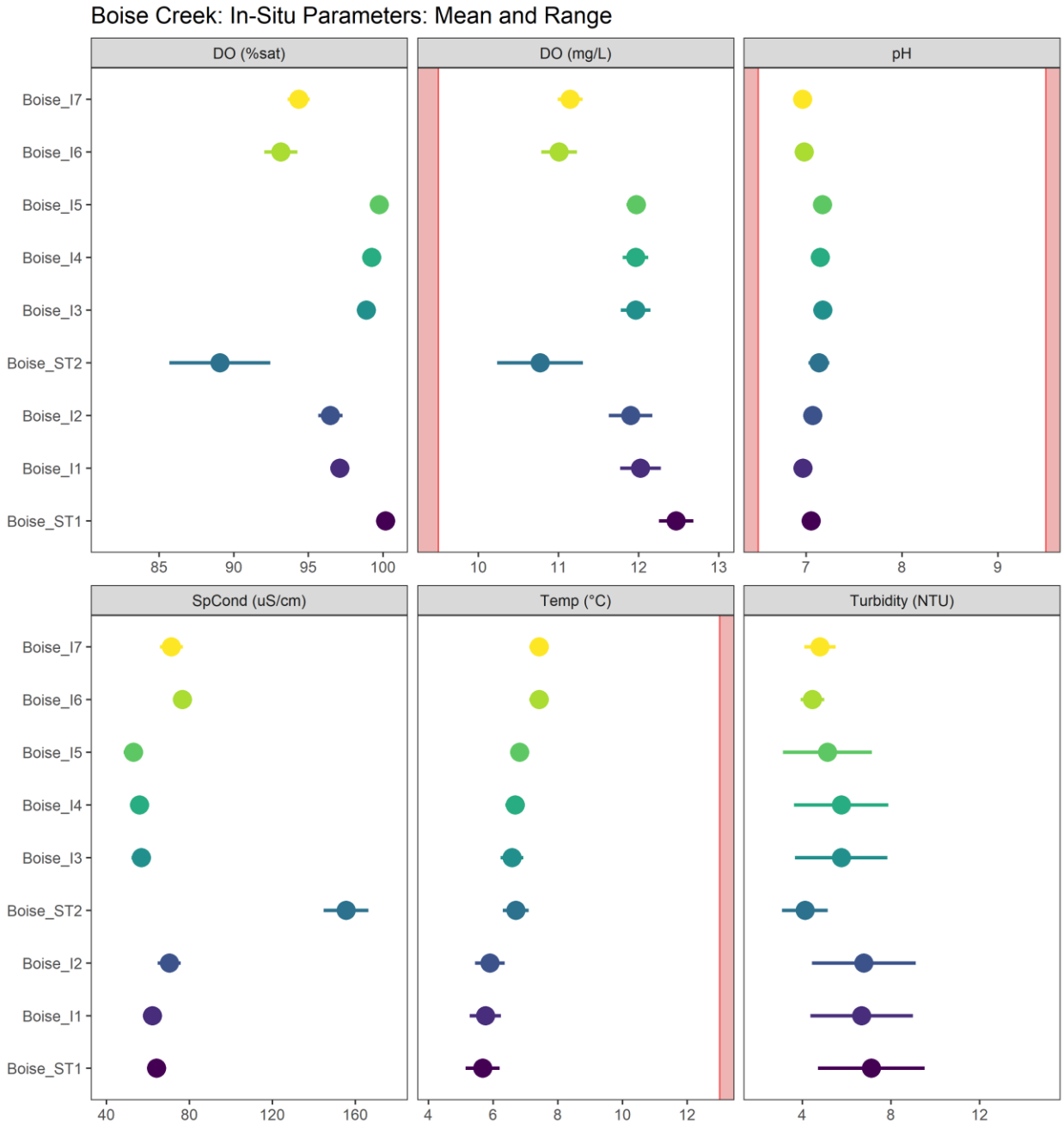

Figure 19: In-situ field parameters means (dots) and ranges (lines) at Boise Creek sites from January to March. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

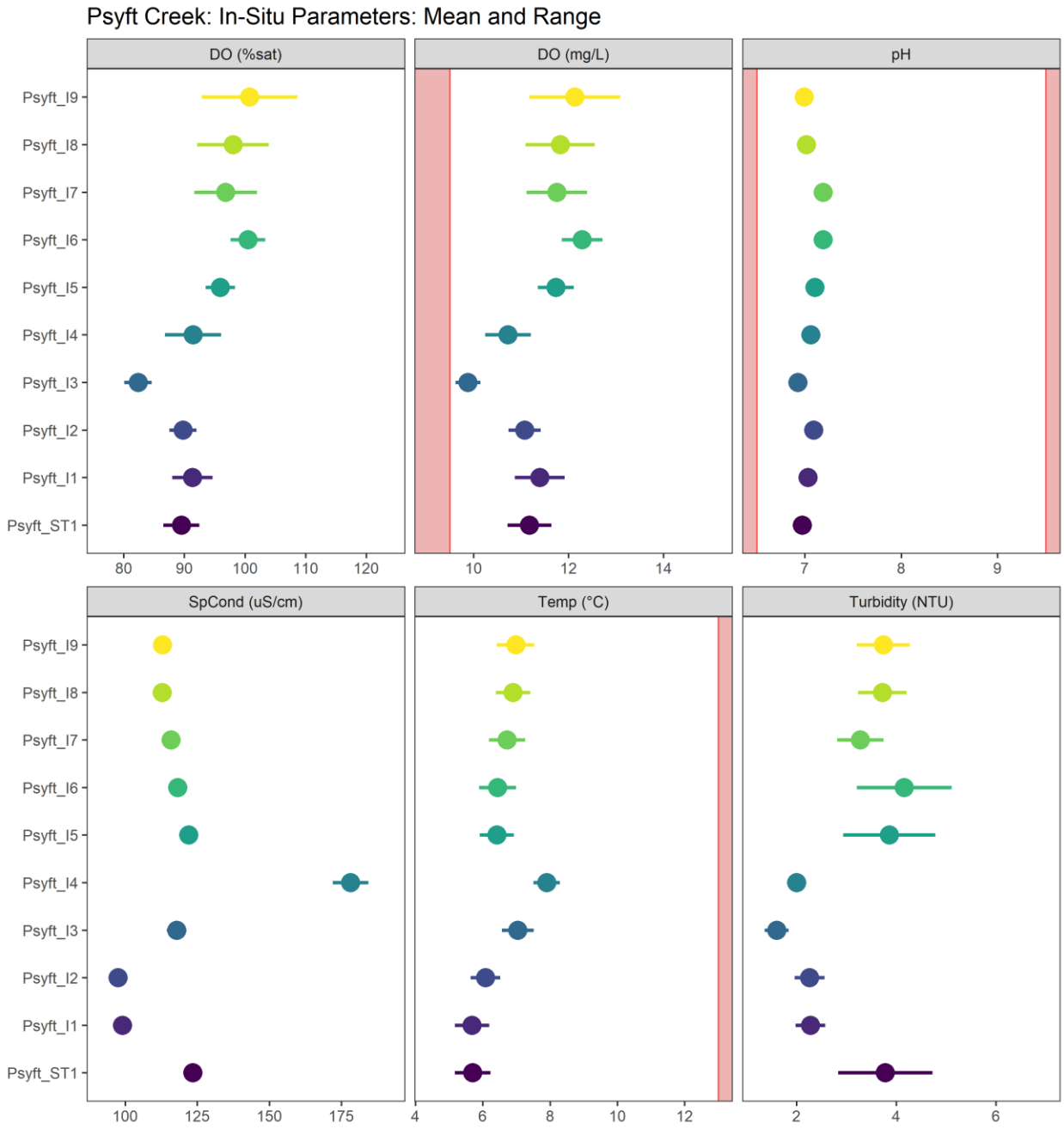

Figure 20: In-situ field parameters means (dots) and ranges (lines) at Pussyfoot Creek sites from January to March. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

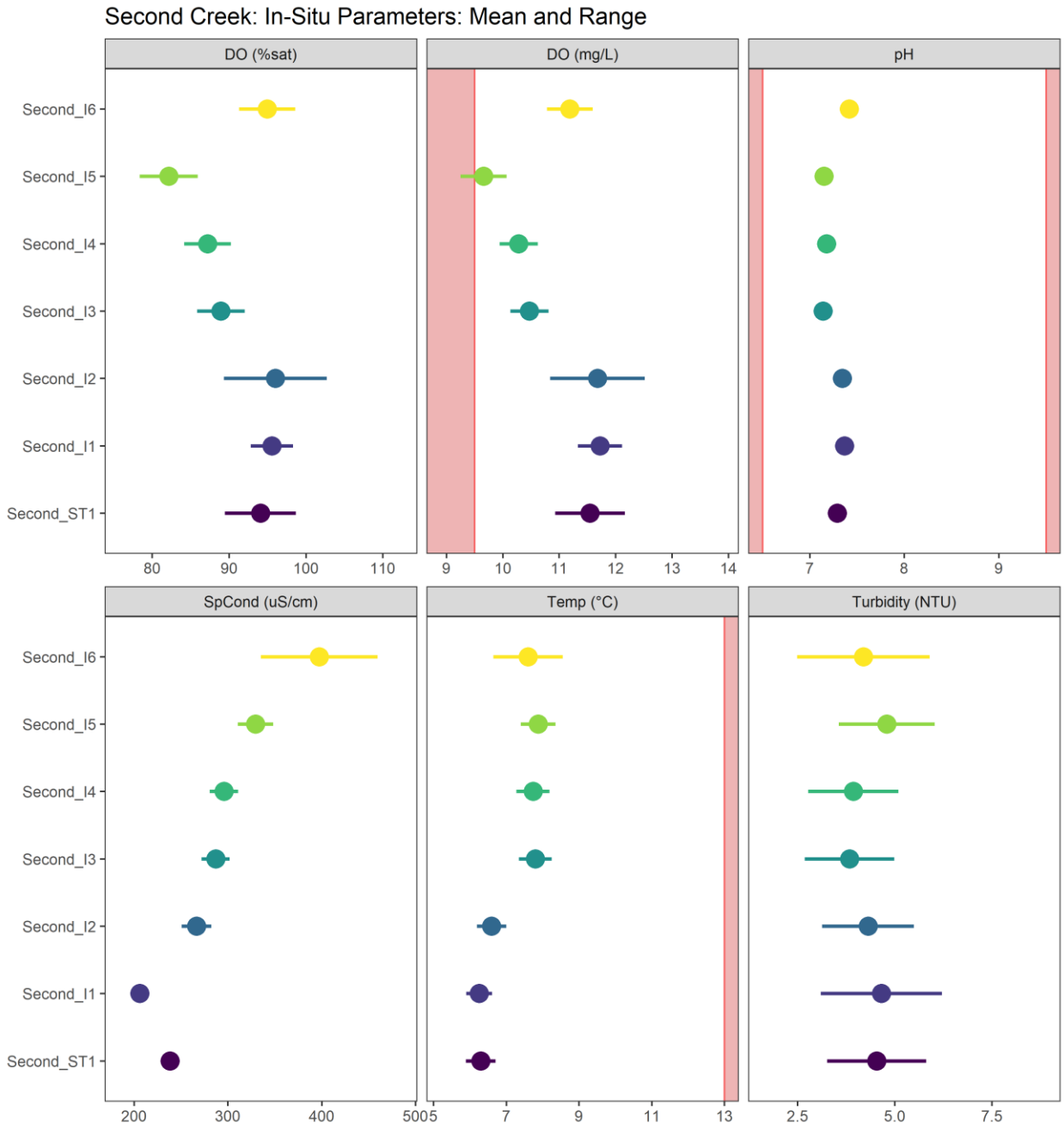

Figure 21: In-situ field parameters means (dots) and ranges (lines) at Second Creek sites from January to March. Red shaded areas represent values that are outside of Washington state water quality standards; the standards are a maximum of 13°C for temperature and minimum of 9.5 mg/L for dissolved oxygen.

Investigative Sampling

Due to concerns of the exceedances at Boise_ST2, investigative sampling was conducted at locations upstream of the main stormwater flume in order to determine pollution sources. The selected sites were adjacent to connections to the stormwater flume (Lateral A, Lateral B and Lateral C).

Two sites immediately upstream of Lateral A and Lateral B (Boise_B4 and Boise_B5 respectively) had noticeably high or comparable results to Boise_ST2. Bacteria concentrations decreased over time at these two sites except for a spike on January 21th. No observed source or illicit discharge have been identified, yet sampling is planned to continue through the summer.

Two more samples were collected upstream of Boise_ST2 on Lateral C on October 21st near the output of black pipes. At Boise P1, papery material found in the vicinity of the pipe and high fecal results indicated a potentially unconnected septic system discharging from the pipe. With this information provided from Ecology, the City of Enumclaw was able to investigate, identify the suspect septic systems and work towards properly connecting the pollution source to a sewer line. This successful development demonstrates the efficacy of source identification monitoring and importance of partner collaboration to solve pollution issues.

An additional investigative sample collected upstream the Lateral C sites at a third pipe (Boise P3) on February 25th had non-detectable bacteria results.

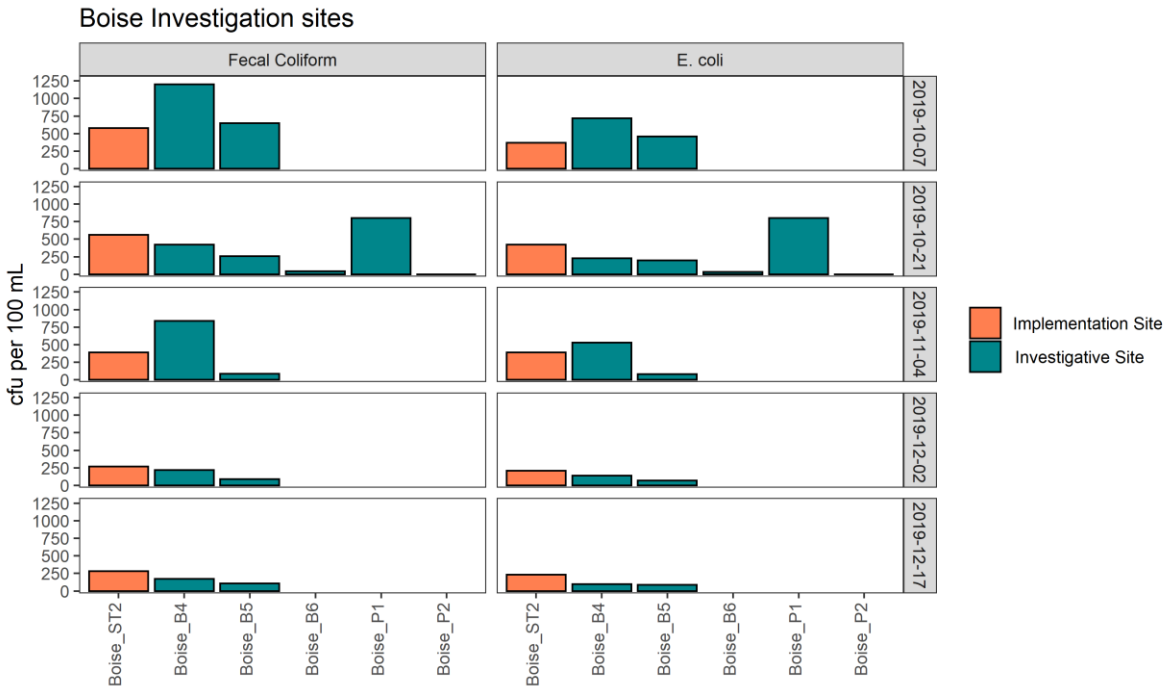

Figure 22: Bacteria results from investigative sites and adjacent implementation site collected October to January.

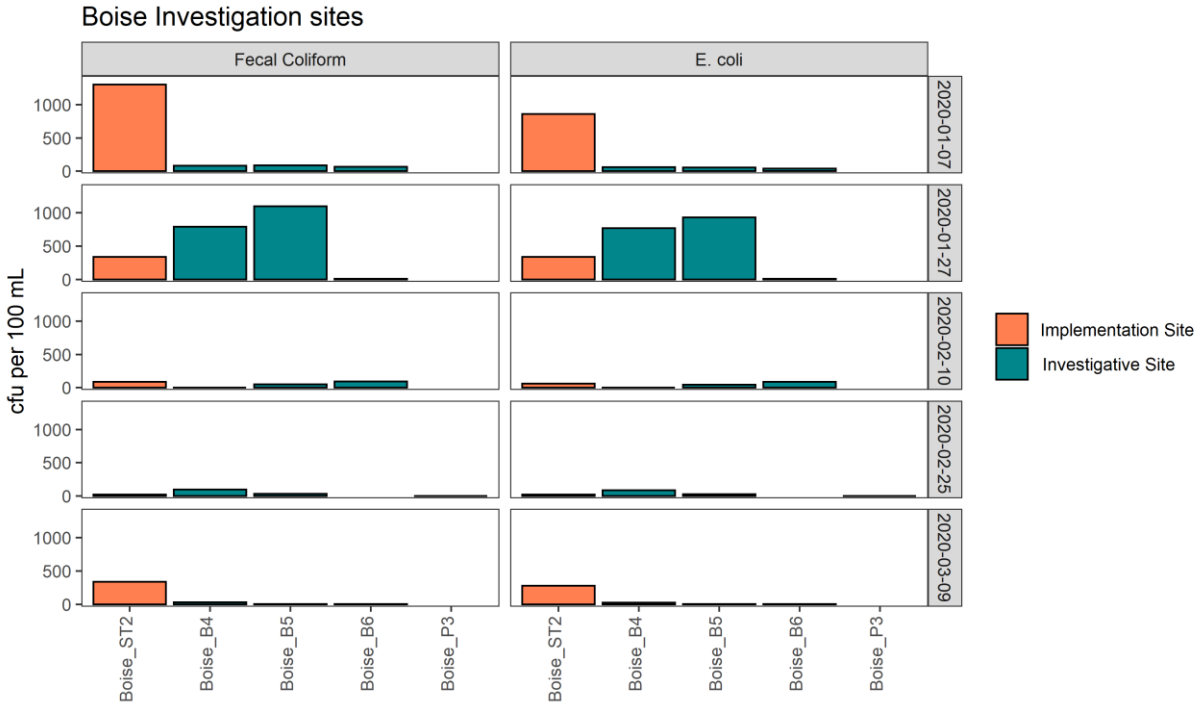

Figure 23: Bacteria results from investigative sites and adjacent implementation site collected January to March.

Additional investigative sampling for nutrients was conducted at sites on the northern tributary of Boise Creek which bracketed the Enumclaw Golf Course. The sites are located where Boise Creek enters golf course (Boise_G1) and where the northern tributary comes out from under 410 (Boise_G2). Implementation site Boise_I5 was used as a comparative location downstream of the two sites. The investigative sites were either comparable or lower than Boise_I5 indicating low influence of the golf course on nutrient levels. Similar to the status and trend sites, an increase in nutrient concentrations was observed with increased precipitation in January and February.

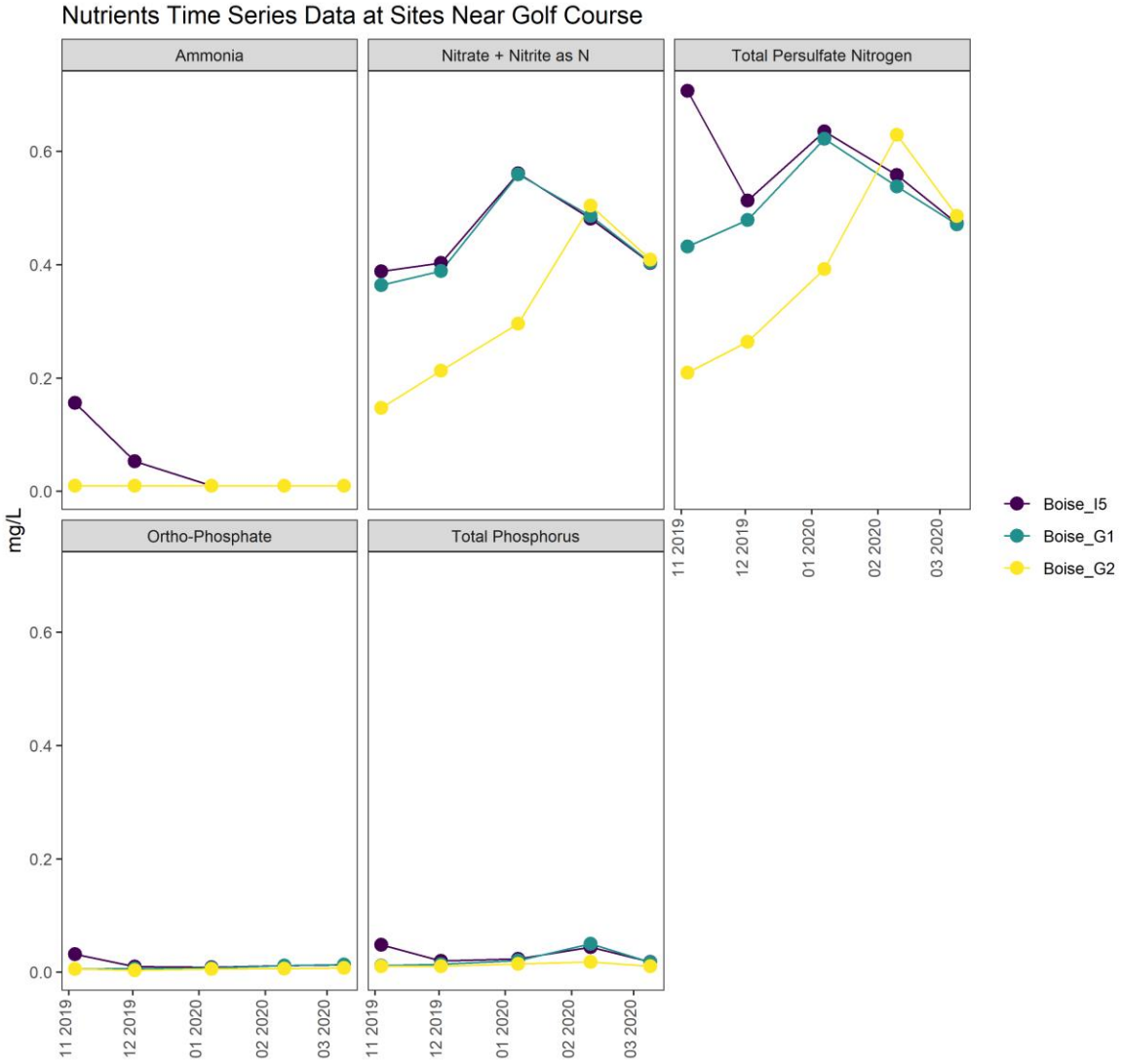

Figure 24: Time series plots for nutrient parameters for Enumclaw Golf Course sites and downstream implementation site.

References

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

Brownlee, A. 2019. Puyallup River Tributaries Effectiveness Monitoring Quarterly Report. Ecology publication; no publication number.

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

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://test-fortress.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

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 A: Statistics for sites that did not meet the geomean water quality standards for October to December quarter.

Site	Parameter	Geomean	Min	Max	10th Percentile	90th Percentile
Boise_I2	Fecal Coliform	127.5618	51	500	55.5	360
Boise_ST2	E. coli	329.8521	210	440	220	430
Boise_ST2	Fecal Coliform	407.7625	270	580	275	570
Psyft_ST1	E. coli	102.4634	23	720	26.2	520
Psyft_ST1	Fecal Coliform	150.2569	23	2500	28.6	1596
Psyft_I1	E. coli	173.048	56	490	65	457
Psyft_I1	Fecal Coliform	206.3811	65	640	72.2	595
Psyft_I4	E. coli	108.9704	36	600	45.6	448.8
Psyft_I4	Fecal Coliform	161.56	44	1400	54.5	1022
Psyft_I9	E. coli	114.0368	31	840	32.6	596
Psyft_I9	Fecal Coliform	203.1023	45	3000	59	1928
Second_ST1	E. coli	132.3874	43	760	48.6	622.2
Second_ST1	Fecal Coliform	184.3978	57	1000	67.6	822
Second_I1	E. coli	142.6698	88	330	90.4	284
Second_I1	Fecal Coliform	181.7726	110	390	116	340
Second_I3	Fecal Coliform	133.5136	17	700	53.6	600
Second_I4	E. coli	145.4648	92	230	105.8	216.2
Second_I4	Fecal Coliform	289.8275	120	700	178	642

Appendix B: Statistics for sites that did not meet the geomean water quality standards for January to March quarter.

Site	Parameter	Geomean	Min	Max	10th Percentile	90th Percentile
Boise_I2	Fecal Coliform	108.9846	28	220	64.8	196
Boise_ST2	E. coli	159.4781	20	860	37.2	652
Boise_ST2	Fecal Coliform	197.9805	23	1300	49	916
Psyft_ST1	Fecal Coliform	134.8792	24	1600	26.8	1060
Second_I1	E. coli	102.6223	16	260	57.6	232
Second_I1	Fecal Coliform	206.4211	22	910	85.2	754
Second_ST1	Fecal Coliform	102.6019	21	1000	32.2	668