Puyallup River Tributaries Effectiveness Monitoring Quarterly Report: October – December 2021

Abstract

The Department of Ecology is currently in the third year of a ten-year water quality effectiveness monitoring study. Monthly monitoring continued at the four long-term status and trends sites located near the drainages of Boise, Pussyfoot and Second Creek. This report summarizes bacteria, nutrients and conventional water quality parameter results from the four sites from October to December 2021. Additional bacteria samples were collected to support source identification efforts by the City of Enumclaw and Ecology's nonpoint staff. More details concerning site locations, sample frequency, methods, etc. are described in the study's Quality Assurance Project Plan[1] (Brownlee 2019).

Report Summary

- Ecology collected samples and measurements once a month at the two Boise Creek status and trend sites from October to December 2021. Monitoring started in November at Pussyfoot and Second Creek sites due to dry (Pussyfoot Creek) and stagnant (Second Creek) conditions in October.
- November experienced the highest total precipitation of the quarter (10.63 in), due to atmospheric rain events. The highest daily total was 1.95 inches on 11/12/2021.
- Second Creek had the highest total nitrogen and phosphorus levels, followed by Pussyfoot Creek.
- Salmon decomposition in October may have been a natural source of nutrients at Boise Creek.
- Boise Creek tributary, Pussyfoot Creek and Second Creek sites did not meet dissolved oxygen standards in November. The November rain event and the resultant increase in suspended particles (i.e. turbidity) and water temperature may have caused low dissolved oxygen levels.

[1] https://apps.ecology.wa.gov/publications/SummaryPages/1910040.html

Figure 1. Boise Creek sampling sites.

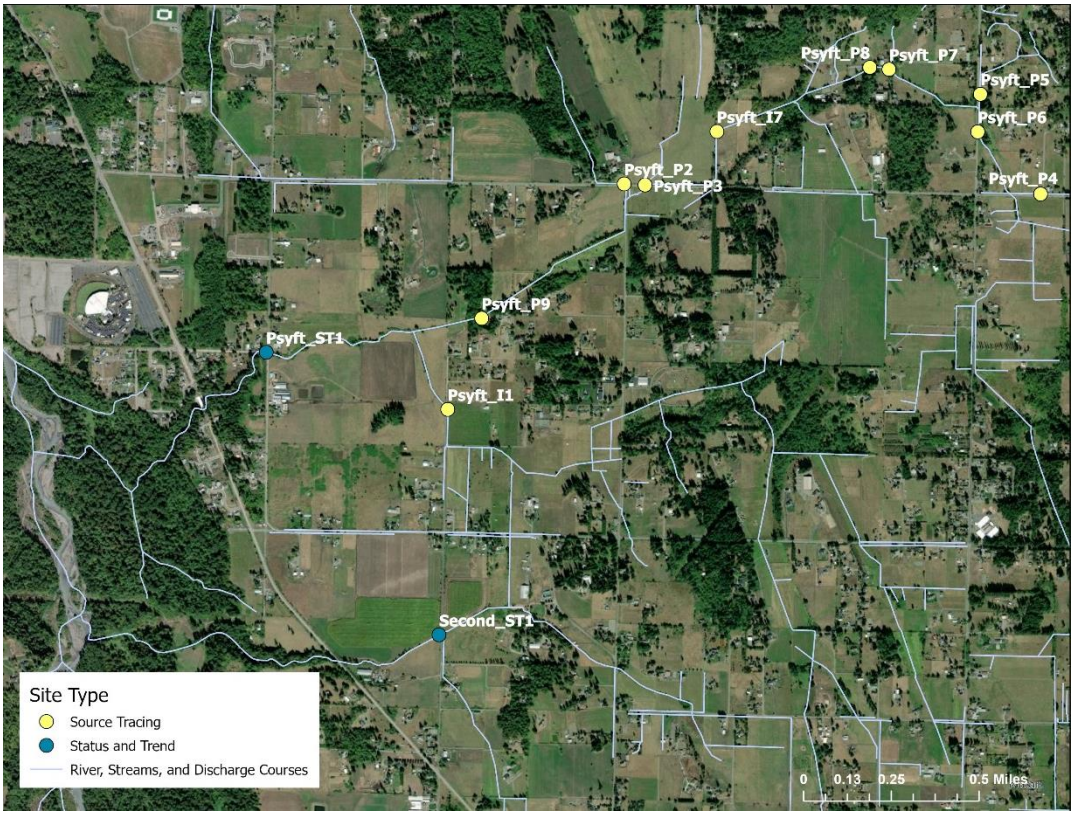

Figure 2. Pussyfoot and Second Creek sampling sites.

Precipitation and Flow

The October - December quarter was the start of the wet season for water year 2022. The plateau experienced an atmospheric river rain event in November, which resulted in an accumulation of 3.64 inches within 72 hours from 11/11 to 11/12.

Table 1. Total precipitation and average discharge at Boise Creek at Mud Mountain Road Station.

Month	Total Precipitation (inches)	Average Discharge (cfs)
October	5.27	18.8
November	10.63	80.53
December	5.45	57.77

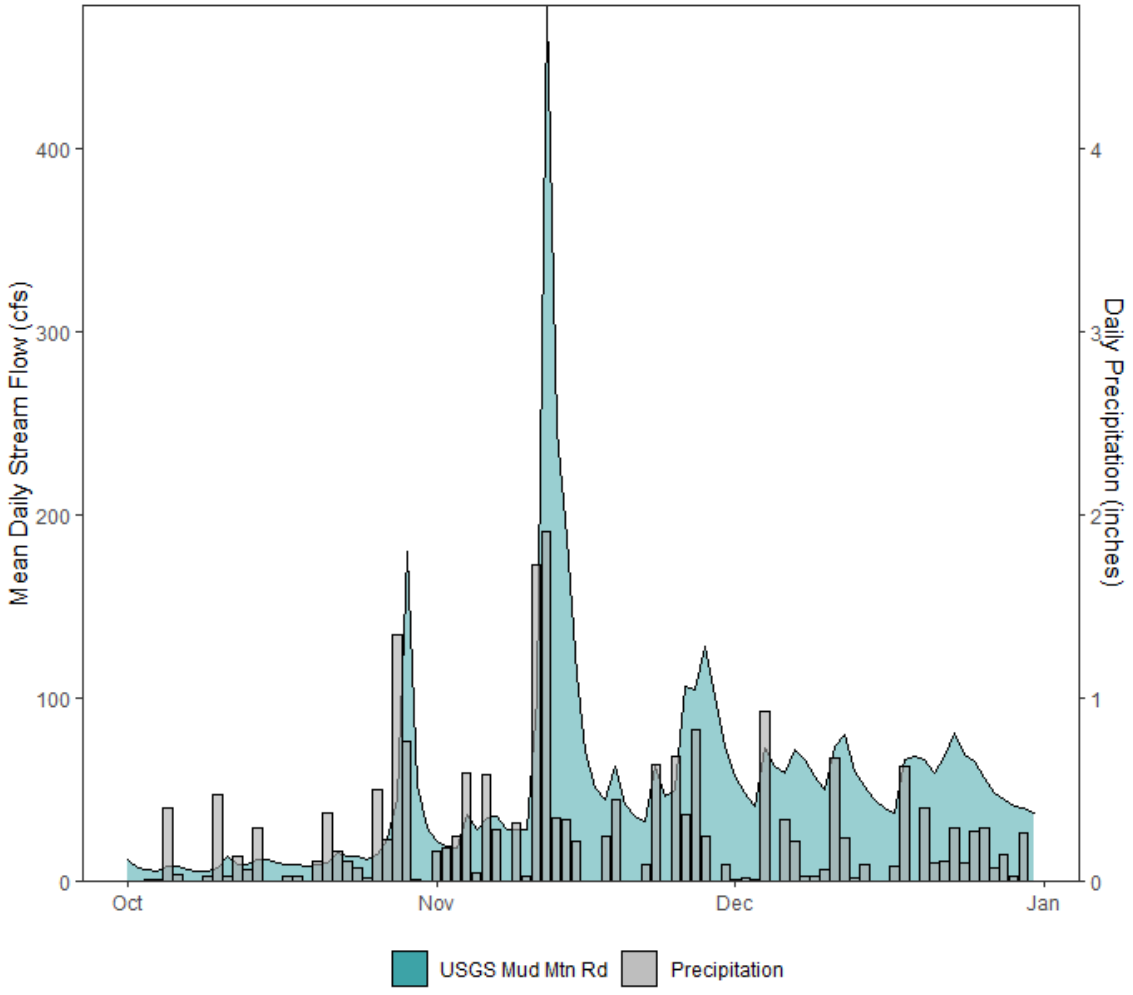

Figure 3. Mean daily stream flow (preliminary data from USGS site 12099600[2]) and daily precipitation (data from King County site 44u[3]) at Boise Creek at Mud Mountain Road station from October to December 2021.

[2] https://waterdata.usgs.gov/wa/nwis/uv/?site_no=12099600&PARAmeter_cd=00060,00065
[3] https://green2.kingcounty.gov/hydrology/DataDownload.aspx

Bacteria

Bacteria standards state 1) the geometric mean for *E. coli* must not exceed 100 cfu/100mL and 2) no more than 10 percent of all samples (or any single sample when less than ten sample points exist) should exceed 320 cfu/100mL. The Boise Creek tributary site did not meet the first criteria for *E. coli* with a geometric mean criteria of 126 cfu/100mL. Pussyfoot and Second Creek were not compared to the geometric mean criteria, since three samples are required for this evaluation. Pussyfoot Creek had the highest detected bacteria levels out of all sites and was the only site to not meet the second criteria.

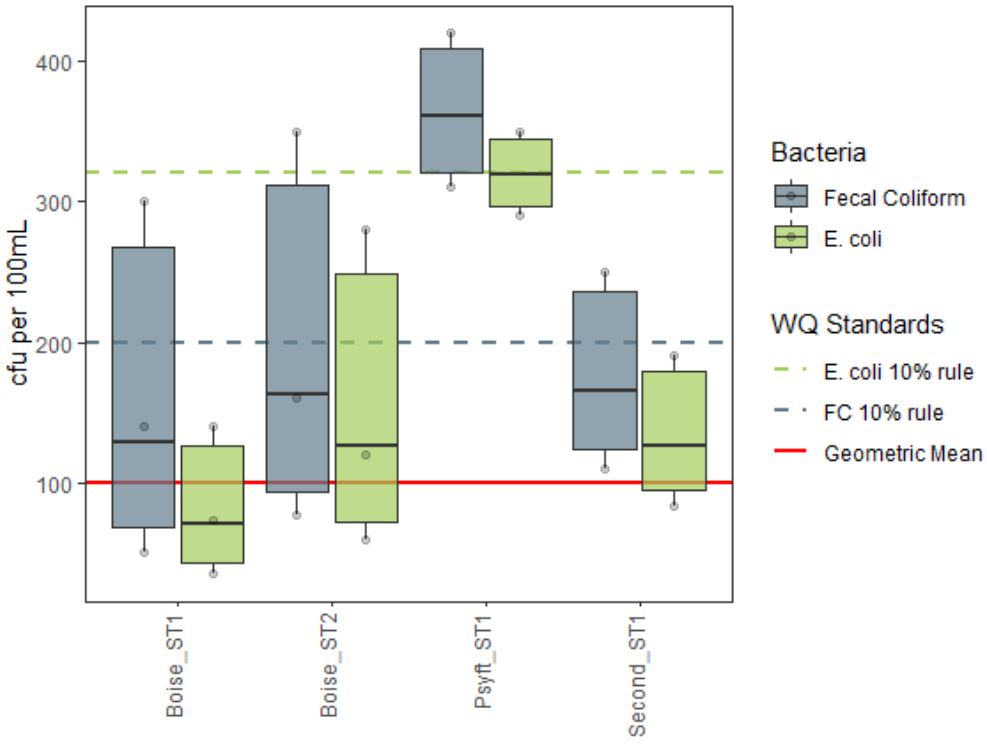

Figure 4. Bacteria levels from October to December 2021 with geometric mean (black solid line in boxplot). Water quality standards displayed as horizontal lines.

Source Tracing

In November, Ecology conducted a watershed-wide sampling effort focused in the Pussyfoot Creek watershed to track runoff of bacteria after a rain event and identify properties with greater runoff issues. Levels were comparable along the mainstem (shown in blue in Figure 3), yet there were slightly elevated results at several drainges (shown in green in Figure 3). The South Fork Pussyfoot site (Psyft_I1) near lower Pussyfoot Creek had relatively high levels compared to the Pussyfoot Creek mainstem. High wet season bacteria levels were also detected at this site in 2019.

Source tracing continued along the City of Enumclaw's stormwater flume, which connects as a tributary to Boise Creek. The status and trend site downstream of the flume (Boise_ST2) was relatively comparable to the the upstream sites for most of the quarter. Yet, in October before the larger rain events, the site downstream of Lateral B (Boise_B4) had higher result. Dog waste has been observed in the area near the mouth of Lateral B, which may be a source of bacteria.

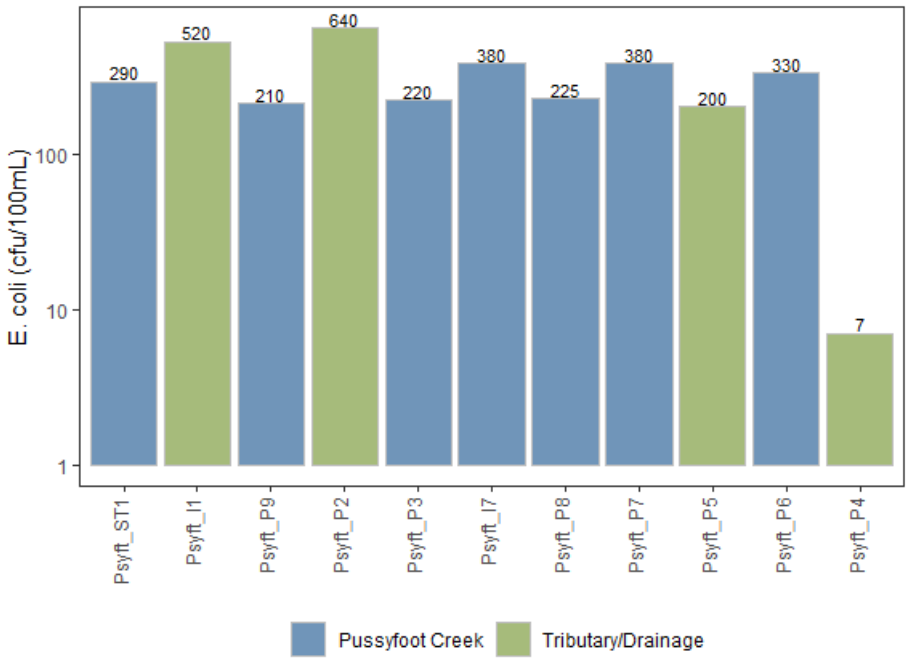

Figure 5. E. coli levels at Pussyfoot Creek sites along the mainstem and connecting tributaries/drainages. Y-axis is log transformed; x-axis ordered downstream to upstream.

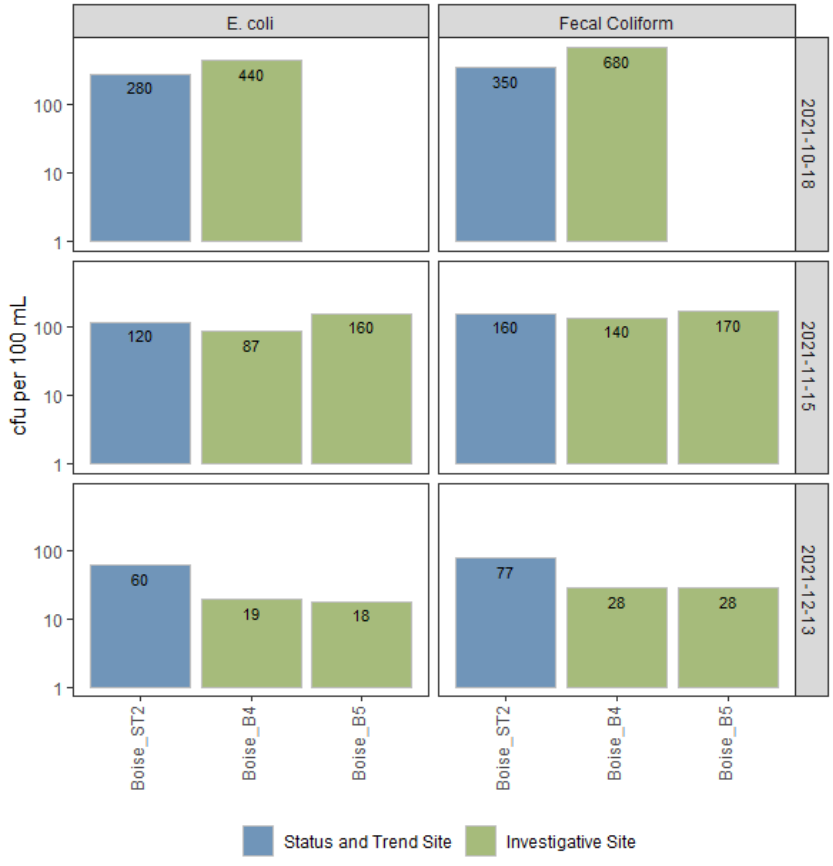

Figure 6. Bacteria levels at Boise Creek tributary status and trend site (Boise_ST2) and upstream investigative sites. Y-axis is log transformed; x-axis ordered downstream to upstream.

Nutrients

The greater rainfall in November generated increases in nitrogen and phosphorus levels. Second Creek had the highest total nitrogen (Second_ST1; 8.55 mg/L), followed by the upstream Boise Creek site (Boise_ST2; 3.2 mg/L). Second Creek had the highest total phosphorus levels (Second_ST1; 0.51mg/L), and Pussyfoot had the second highest levels (Psyft_ST1; 0.25mg/L) in November.

The Boise Creek tributary site (Boise_ST2) typically has had higher nutrient levels than the downstream Boise Creek site near White River (Boise_ST1) for most of the year. Yet, Boise_ST1 had higher nutrients (i.e. total nitrogen and total phosphorus) in October. Higher nutrient levels at this site has also been documented by Ecology in October 2019 and 2020. This trend was also confirmed by nutrient data collected at the same site by King County's Streams and River Monitoring Program[4].

Higher nutrients may be from a natural cause, in particular the decomposition of salmon. From September to October, salmon were migrating up Boise Creek. During the October sampling, salmon carcasses were scattered upstream and downstream at the Boise Creek site. The input of nutrients from the decay of organic matter from salmon has been documented in the Puget Sound (Cederholm 1989; 1999).

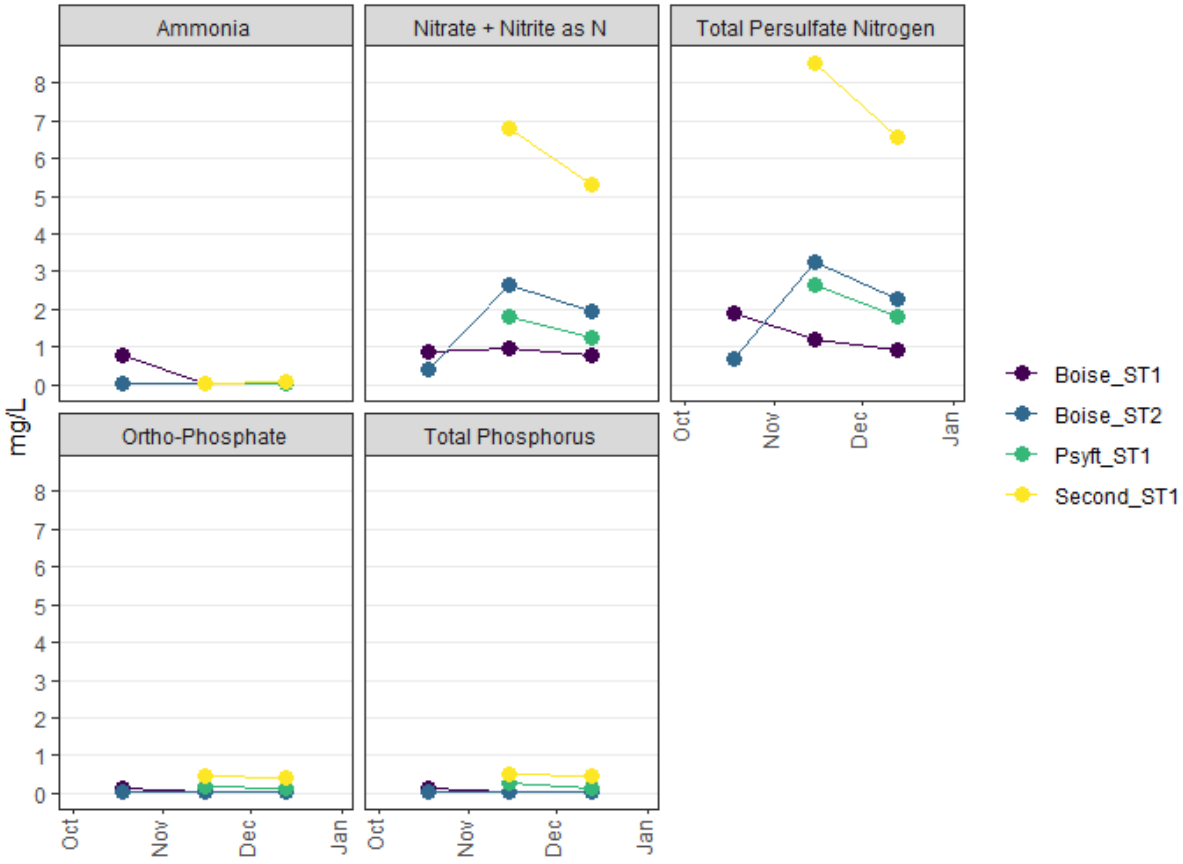

Figure 7. Nutrient levels over time from October to December 2021.

[4] https://green2.kingcounty.gov/streamsdata/Nutrient.aspx?Locator=BSE_1MUDMTNRD

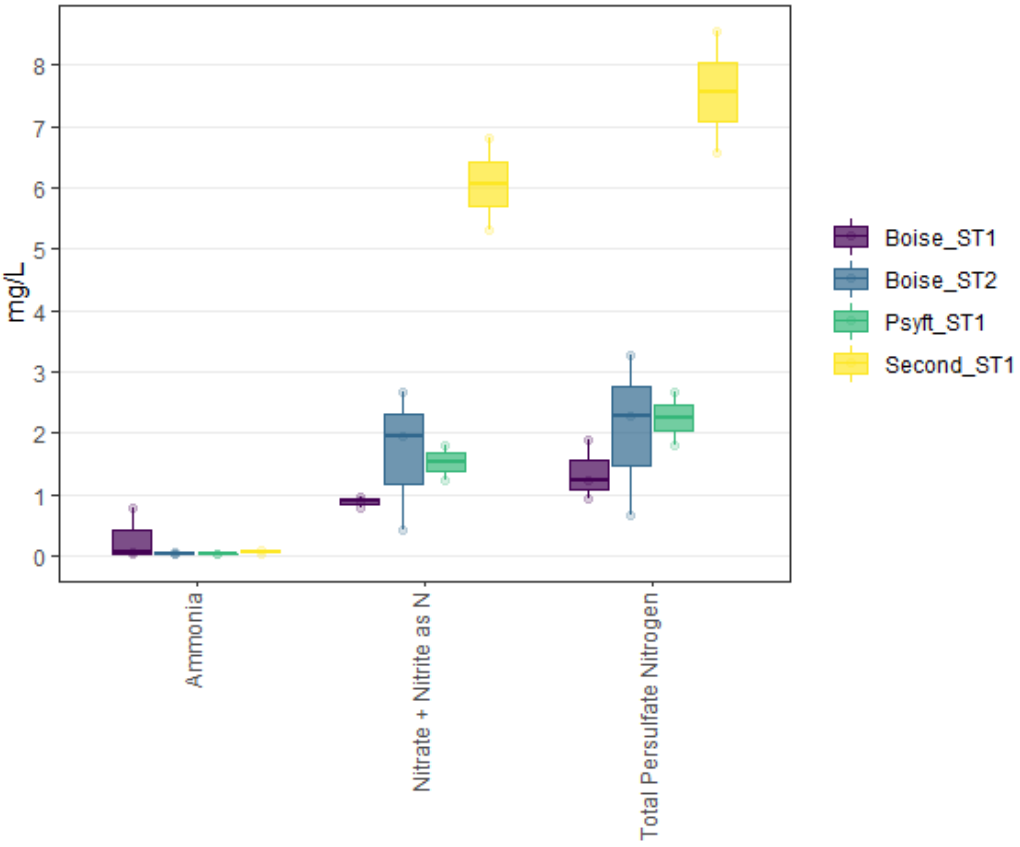

Figure 8. Nitrogen levels with median value represented as solid line in the boxplot.

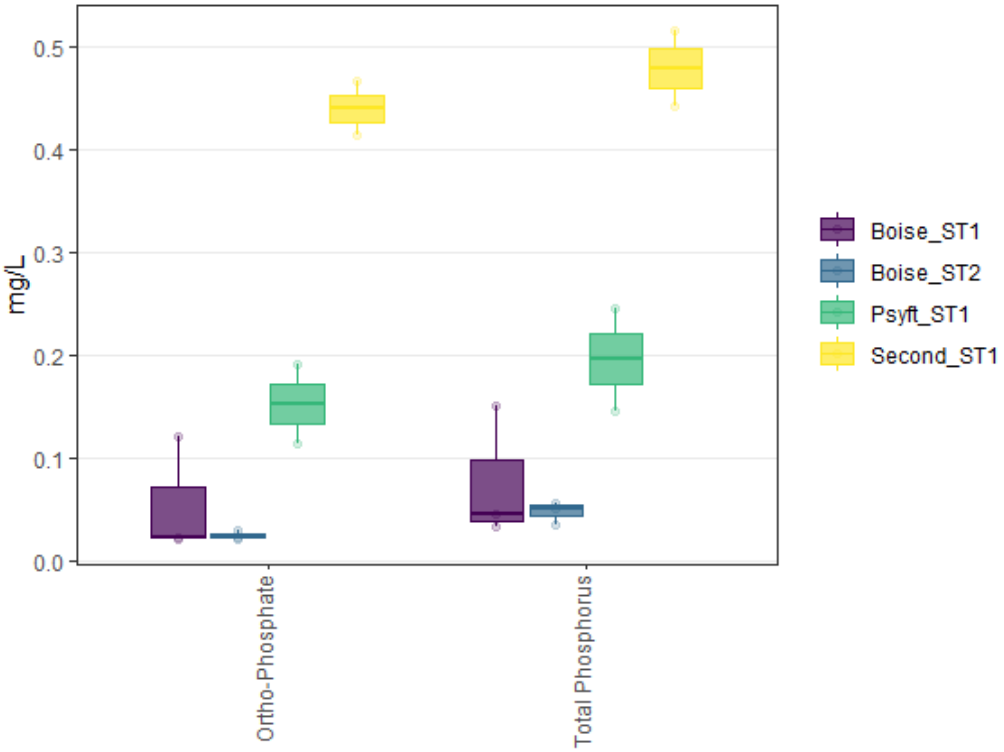

Figure 9. Phosphate levels with median value represented as solid line in the boxplot.

Water Quality Measurements

Turbidity

There was an increase in turbidity from the November atmospheric rain event. All sites were within the water quality standard of being below 50 NTU at the time of sampling. The downstream Boise Creek site had the highest turbidity (Boise_ST1). Ecology detected high turbidity levels at this site above 50 NTU in February 2021. There currently is ongoing Foothill Trail restoration and construction project just upstream and construction in the developing areas of Enumclaw; these projects and rural runoff could be contributing to high turbidity at this site, which is a known salmon habitat.

Dissolved Oxygen

Dissolved oxygen levels at Boise Creek tributary, Pussyfoot and Second Creek sites were below the acceptable criteria of 8.5 mg/L. The relatively higher turbidity and temperature that month may have affected dissolved oxygen. Suspended particles absorb more heat and can cause water temperature to increase. These factors can lead to a lower dissolved oxygen levels.

Temperature, Specific Conductivity, and pH

All sites met standards for temperature and pH.

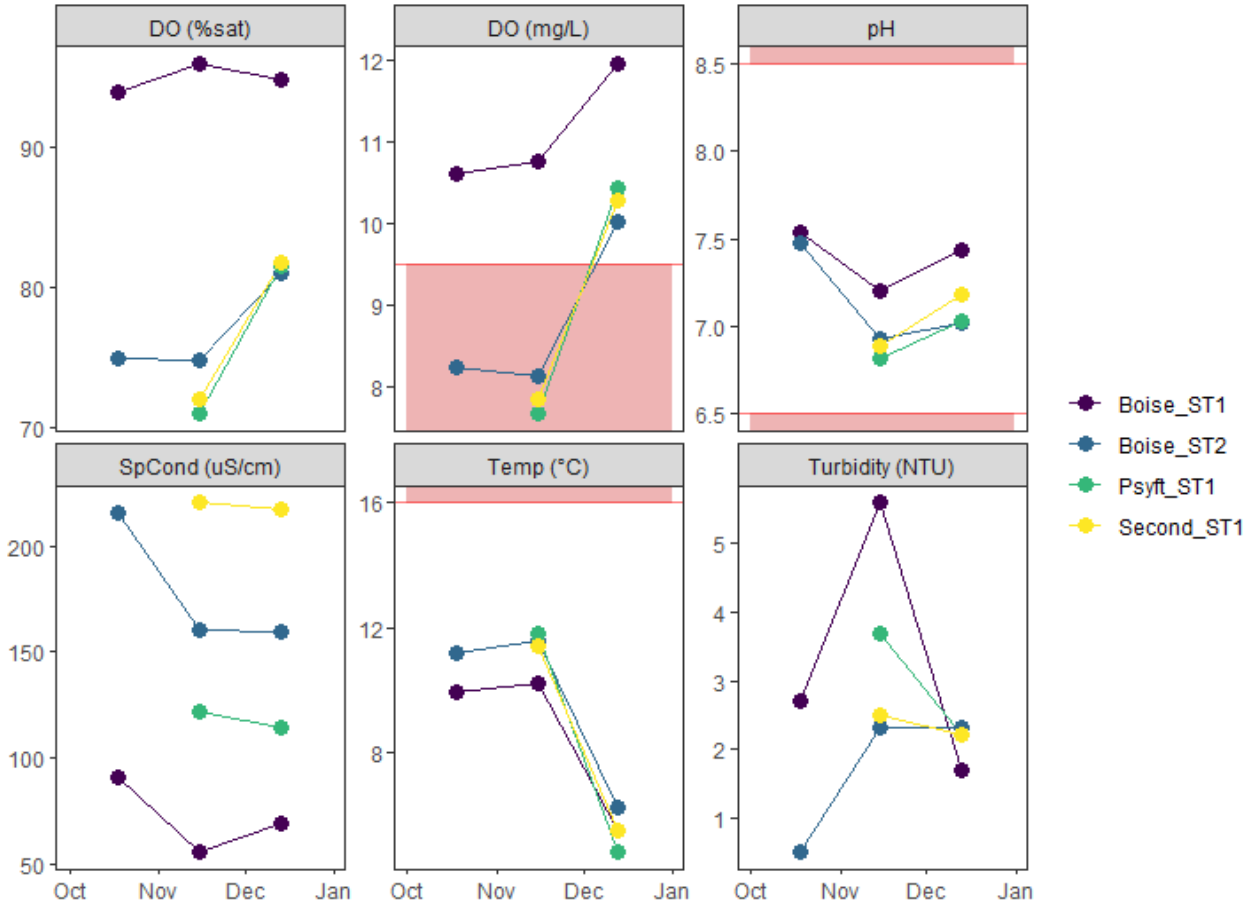

Figure 10. In-situ water quality parameters displayed over time with water quality exceedances marked in red.

References

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

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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

Appendix

Table A1. Preliminary results for all Boise, Pussyfoot and Second Creek sites. Dash marks represent that sample or measurement was not collected.

Site	Date	Fecal Coliform (cfu/100mL)	*E. coli* (cfu/100mL)	Ammonia (mg/L)	Nitrate + Nitrite as N (mg/L)	Total Persulfate Nitrogen (mg/L)	Ortho-Phosphate (mg/L)	Total Phosphorus (mg/L)	Temperature (°C)	Barometric pressure (in/Hg)	Specific Conductivity	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	pH	Turbidity (NTU)
Boise_ST1	10/18/21	140	300	0.763	0.89	1.88	0.122	0.151	9.9	29.3	90.7	10.62	93.9	7.54	2.7
Boise_ST2	10/18/21	280	350	0.02	0.413	0.668	0.0242	0.0365	11.2	29.2	215.5	8.24	75	7.47	0.5
Boise_B4	10/18/21	440	680	-	-	-	-	-	-	-	-	-	-	-	-
Psyft_ST1	10/18/21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Second_ST1	10/18/21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boise_ST1	11/15/21	73	140	0.043	0.963	1.22	0.0228	0.0455	10.2	29.884	55.8	10.77	95.9	7.2	5.6
Boise_ST2	11/15/21	120	160	0.051	2.66	3.26	0.0299	0.0572	11.6	29.727	160.4	8.14	74.9	6.93	2.3
Boise_S1	11/15/21		68	-	-	-	-	-	-	-	-	-	-	-	-
Boise_B4	11/15/21	87	140	-	-	-	-	-	-	-	-	-	-	-	-
Boise_B5	11/15/21	160	170												
Boise_B10	11/15/2021		170												
Boise_B14	11/15/2021		800												
Boise_B15	11/15/2021		390												
Psyft_I7	11/15/21		380												
Psyft_P2	11/15/21		640												
Psyft_P3	11/15/21		220												
Psyft_P4	11/15/21		7												
Psyft_P5	11/15/21		200												
Psyft_P6	11/15/21		330												
Psyft_P7	11/15/21		380												
Psyft_P8	11/15/21		225												
Psyft_P9	11/15/21		210												
Psyft_ST1	11/15/21	290	310	0.03	1.81	2.66	0.192	0.246	11.8	29.194	121.7	7.69	71.1	6.81	3.7
Psyft_I1	11/15/21	520	1100	-	-	-	-	-	-	-	-	-	-	-	-
Second_ST1	11/15/21	190	250	0.036	6.8	8.55	0.466	0.516	11.4	29.22	220.5	7.86	72.1	6.88	2.5
Boise_ST1	12/13/21	35	51	0.013	0.779	0.912	0.0226	0.0344	5.5	28.716	68.7	11.96	94.8	7.43	1.7
Boise_ST2	12/13/21	60	77	0.031	1.94	2.28	0.0226	0.0522	6.2	28.597	159.7	10.04	81.1	7.02	2.3
Boise_B4	12/13/21	19	28	-	-	-	-	-	-	-	-	-	-	-	-
Boise_B5	12/13/21	18	28	-	-	-	-	-	-	-	-	-	-	-	-
Boise_B7	12/13/21	69	82	-	-	-	-	-	-	-	-	-	-	-	-
Psyft_ST1	12/13/21	350	420	0.022	1.23	1.81	0.114	0.147	4.8	28.816	114.7	10.45	81.5	7.03	2.2
Second_ST1	12/13/21	84	110	0.1	5.32	6.57	0.414	0.442	5.5	28.757	217.7	10.3	81.8	7.18	2.2

Table A2. Dates with total daily precipitation greater than 0.1 inches (data from King County site 44u[5]).

Date	Daily Precipitation (inches)
10/5/2021	0.4
10/10/2021	0.47
10/12/2021	0.14
10/14/2021	0.29
10/20/2021	0.11
10/21/2021	0.37
10/22/2021	0.16
10/23/2021	0.11
10/26/2021	0.5
10/27/2021	0.23
10/28/2021	1.35
10/29/2021	0.76
11/1/2021	0.16
11/2/2021	0.18
11/3/2021	0.25
11/4/2021	0.59
11/6/2021	0.58
11/7/2021	0.28
11/9/2021	0.32
11/11/2021	1.73
11/12/2021	1.91
11/13/2021	0.35
11/14/2021	0.34
11/15/2021	0.22
11/18/2021	0.25
11/19/2021	0.45
11/23/2021	0.64
11/25/2021	0.68
11/26/2021	0.36
11/27/2021	0.83
11/28/2021	0.25
12/4/2021	0.93
12/6/2021	0.34
12/7/2021	0.22
12/11/2021	0.67
12/12/2021	0.24
12/18/2021	0.63
12/20/2021	0.4
12/22/2021	0.11
12/23/2021	0.29

[5] https://green2.kingcounty.gov/hydrology/DataDownload.aspx

Date	Daily Precipitation (inches)
12/25/2021	0.27
12/26/2021	0.29
12/28/2021	0.15
12/30/2021	0.26

Contact information

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Related Information

- This report is available on the Puyallup Partnership webpage[6].
- Data for this project is available in Ecology's EIM Database,[7] Study ID: EFF_PRT.
- Data is displayed on Puyallup River Tributaries Effectiveness Monitoring StoryMap[8].
- Bacteria data is displayed on Whatcom Conservation District StoryMap[9].

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[6] https://www.ezview.wa.gov/site/alias__1962/37699/puyallup_river_watershed_improvement_project.aspx
[7]https://apps.ecology.wa.gov/eim/search/Eim/EIMSearchResults.aspx?ResultType=EIMStudyTab&StudyUserIdSearchType=Contains&StudyUserIds=EFF_PRT
[8] https://waecy.maps.arcgis.com/apps/MapSeries/index.html?appid=20f291f848cb48fd8c879704f5464461
[9] https://www.arcgis.com/apps/webappviewer/index.html?id=5395274198aa4365b96fbaf01b4db43b&extent=-13894004.8062%2C6045956.0065%2C-13306968.4289%2C6336110.9659%2C102100