SAMMAMISH WATER QUALITY MONITORING

Annual Report 2022

In 2022, water-quality monitoring continued largely the same as in 2021. Streambed entombment monitoring resumed in 2022, after a two-year gap (due to social-distancing requirements).

- **Ebright Creek watershed:** Stormwater outfalls continued to be monitored for flow and temperature using continuous gages, and sampled monthly for turbidity. Wetland water level also continued to be monitored continuously.
- **George Davis / Allen Lake wetlands:** Water level continued to be monitored continuously in this wetland complex, at the head of the George Davis and Allen Lake watersheds.
- **Rain gage on City Hall:** The rain gage on City Hall continued to provide precipitation data to help understand other monitoring results, and it also provided real-time information to help City staff respond to rain events.
- **Zackuse Creek:** A stream gage monitored streamflow and temperature. Each month, Zackuse was sampled for bacteria, nutrients, suspended solids, and conventionals (conductivity, pH, alkalinity), and once a year was sampled for stream health (stream bug diversity).
- **Upstream stream-health sites:** Upstream monitoring continued on Ebright, Laughing Jacobs, and Pine Lake Creeks to measure stream health (stream bug diversity) and detect changes over time.
- **Entombment:** Streambeds in Ebright, George Davis, Pine Lake, and Zackuse Creeks were assessed in early June to look for fine sediments capping the gravel, which can entomb and smother kokanee spawning beds.
- **Riparian forest:** Riparian forest canopy cover was mapped for the north end of Sammamish, along small streams and Lake Sammamish, using aerial imagery from 2021. King County staff calculated canopy cover for various stream reaches, both for the entire 60-m riparian zone as well as for 10-m and 20-m zones closest to the stream. These near-stream zones are especially important determinants of stream health.

Data and Graphing

Most data in this report are available to view or download online. Hydrologic data (streamflow, water level, rainfall) are all available on the King County Hydrologic Information Center website: https://green2.kingcounty.gov/hydrology/GaugeMap.aspx. Stream water-quality data are available on the King County Streams Monitoring website: https://green2.kingcounty.gov/streamsdata/. Other data may be requested from either City of Sammamish or King County staff.

This report contains both discrete and continuous data. Discrete data were collected periodically (e.g., monthly water samples for lab analyses), and are graphed as blue dots connected by a blue line. In contrast, continuous data were collected by automated gages (e.g., flow, precipitation, temperature), usually every 15 minutes. For most continuous data in this report, the daily average is graphed as a blue line, and the daily maximum and minimum are graphed as thinner grey lines (on days with very low variation, the thinner grey lines may be hidden behind the blue line).

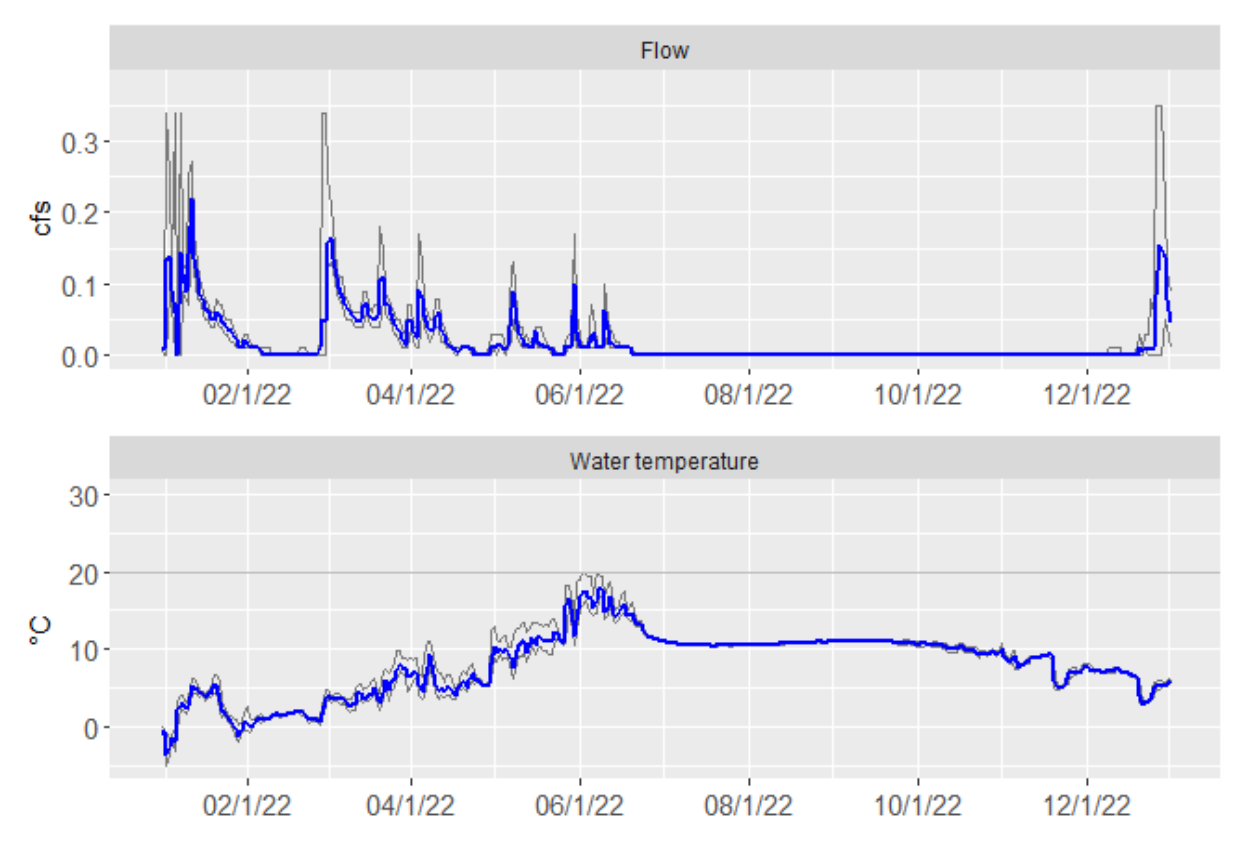
Ebright Creek Watershed

Stormwater outfall flow, temperature, and turbidity continued to be monitored to detect potential impacts to habitat in Ebright Creek. Wetland water level was monitored to detect hydrologic impacts on the wetlands themselves. Flow, temperature, and water level were monitored using continuous gages, and turbidity was measured each month in grab samples.

Outflow and Temperature

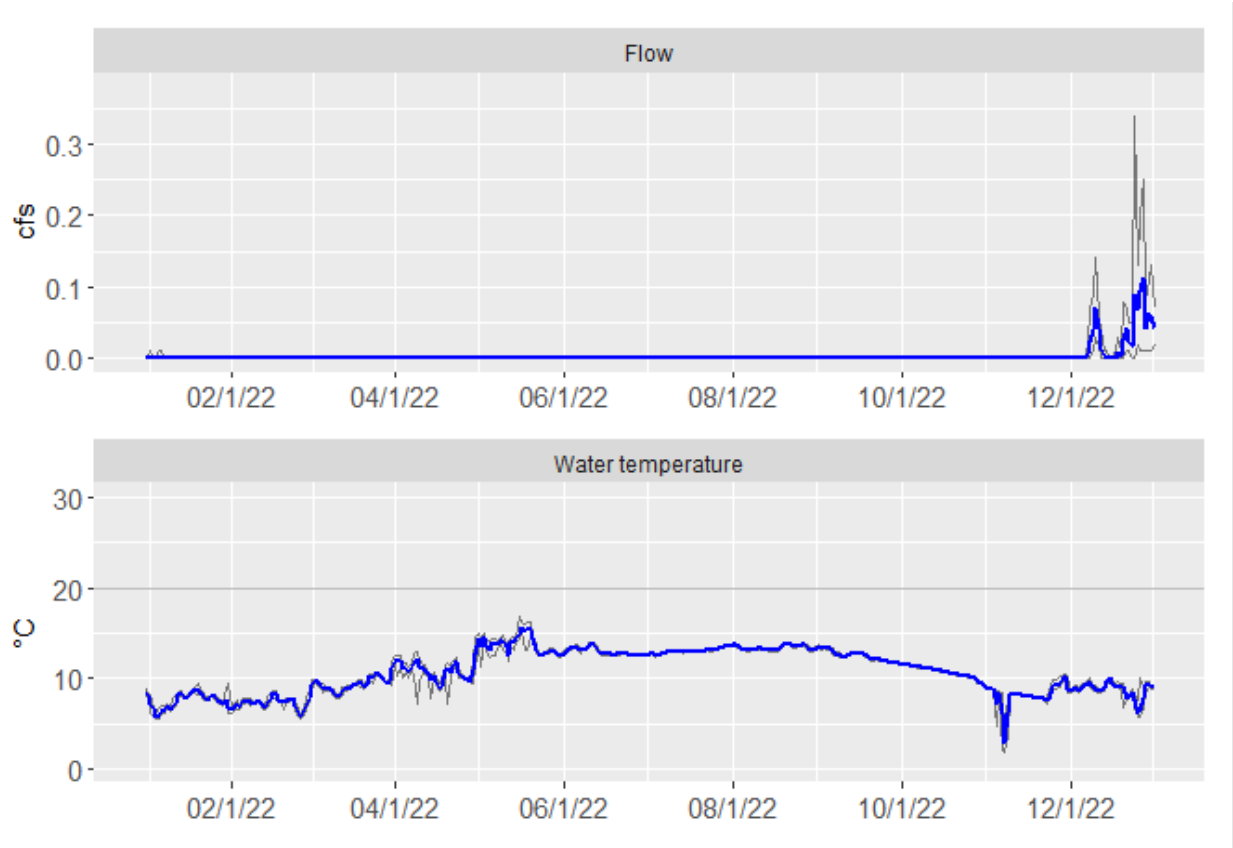
Gages on the outfalls continued to be monitored throughout 2022.

Chestnut Pond



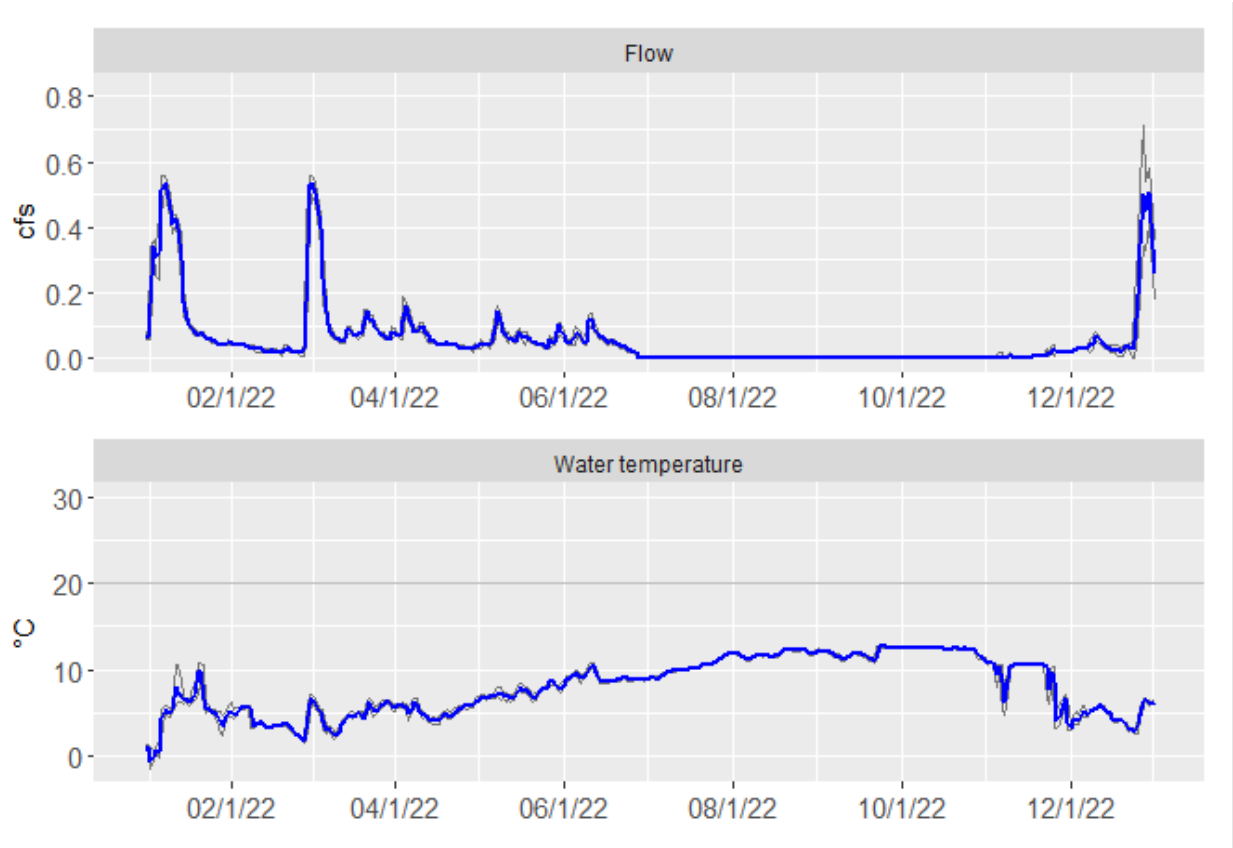
The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Crossings - East pond



The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

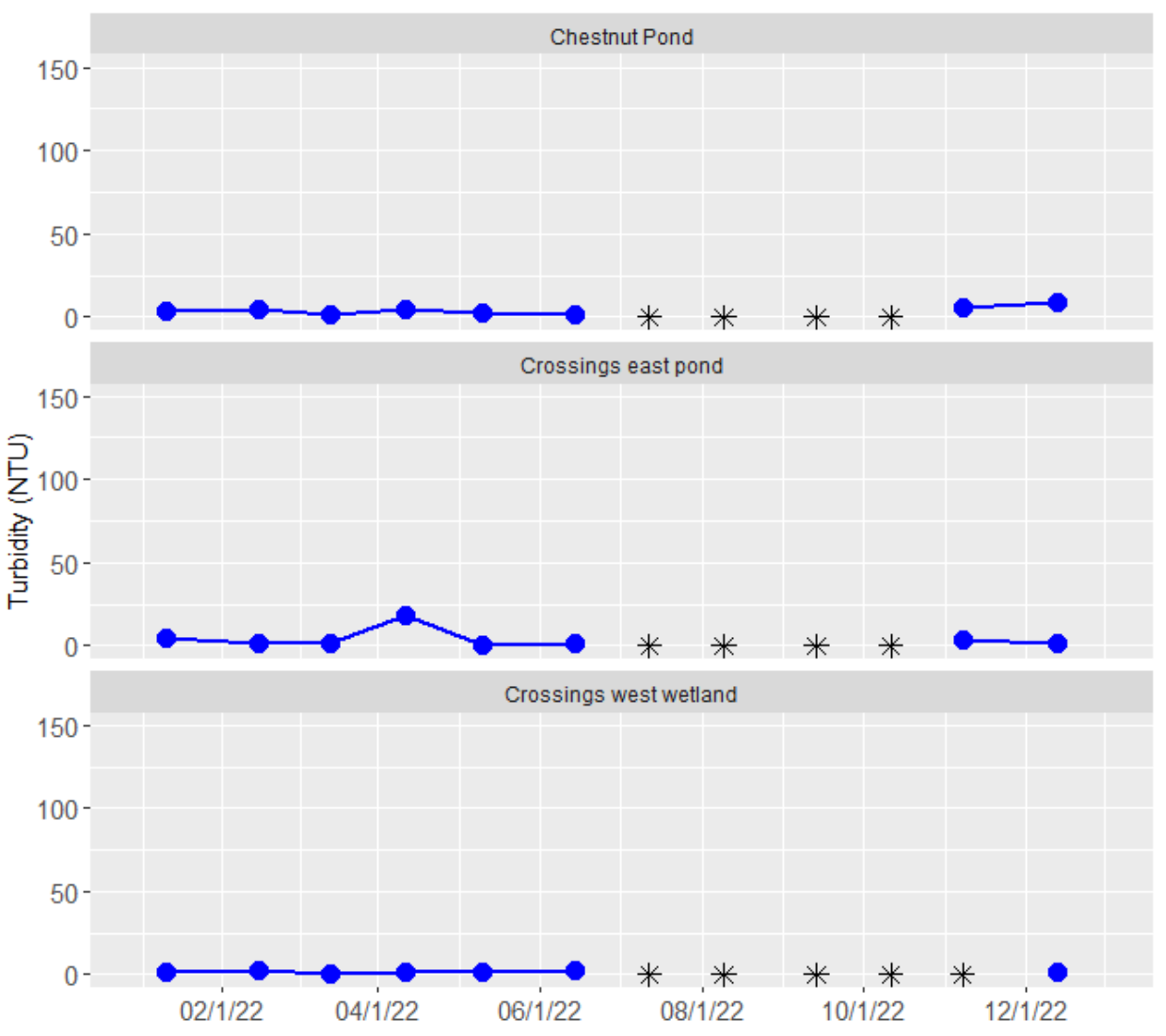
Crossings - West wetland



The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

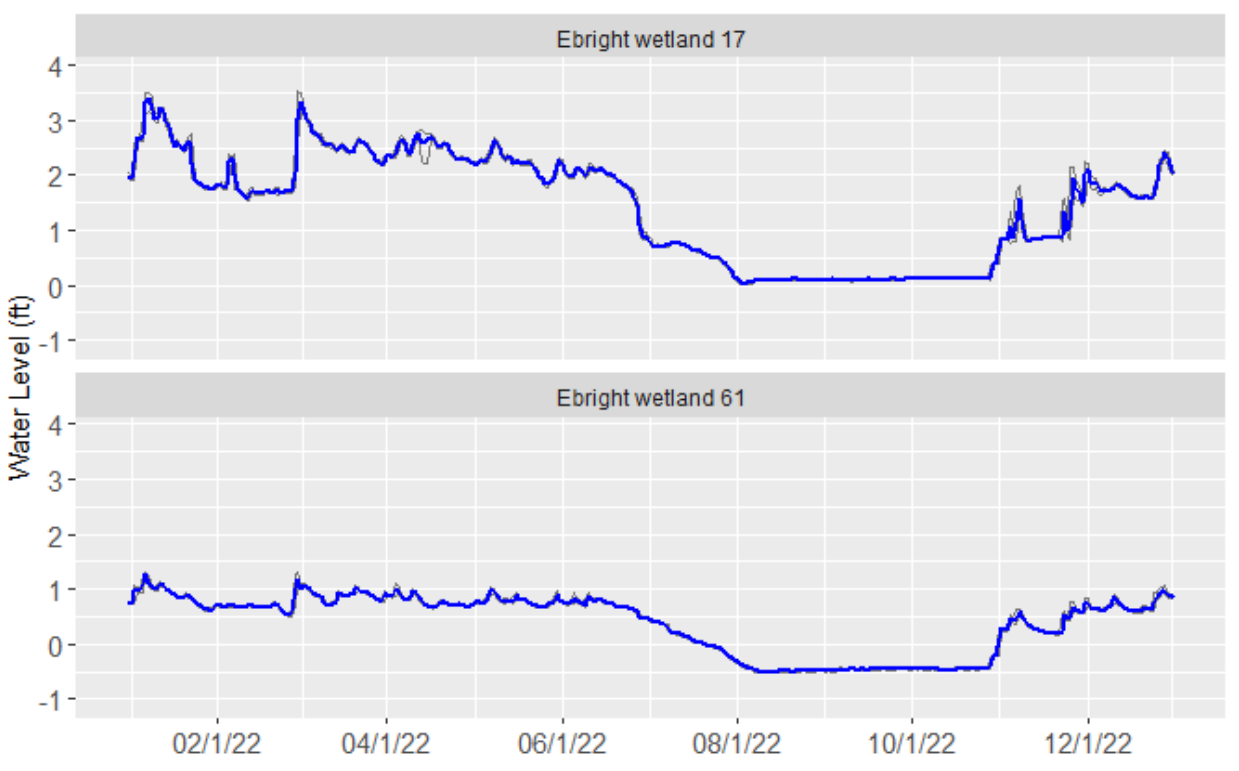
Turbidity

The three stormwater outfalls were visited each month. Unless the outfall was dry, samples were collected for laboratory turbidity analysis. Turbidity was low in all samples in 2022. Note that these samples were collected only once per month and would not necessarily catch brief periods of high turbidity during storms.



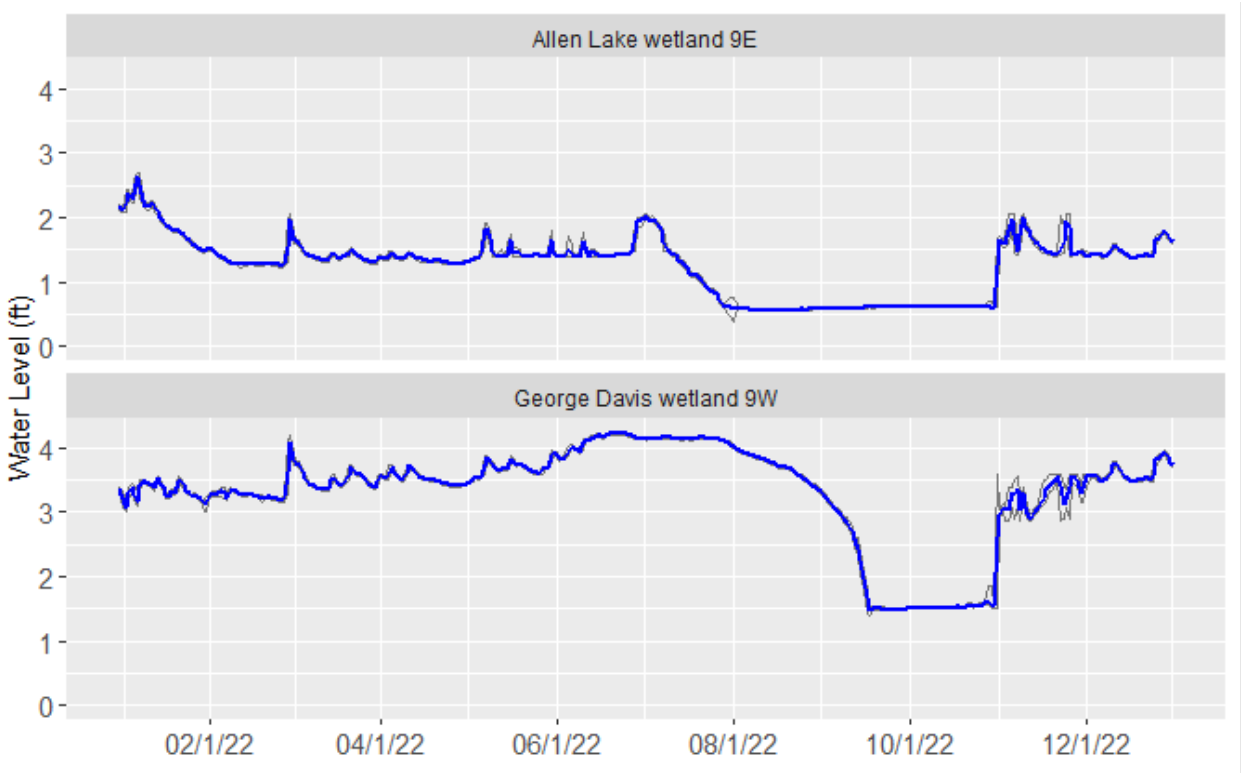
Blue dots show turbidity values, and black asterisks at zero turbidity indicate dates when the outfall was dry.

Wetland water level



The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

George Davis / Allen Lake Wetlands

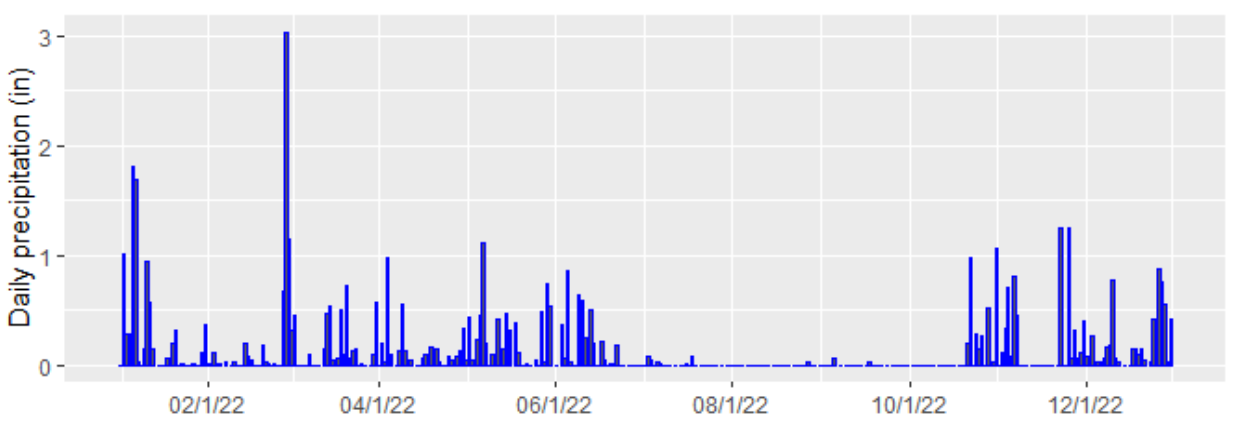


The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Precipitation

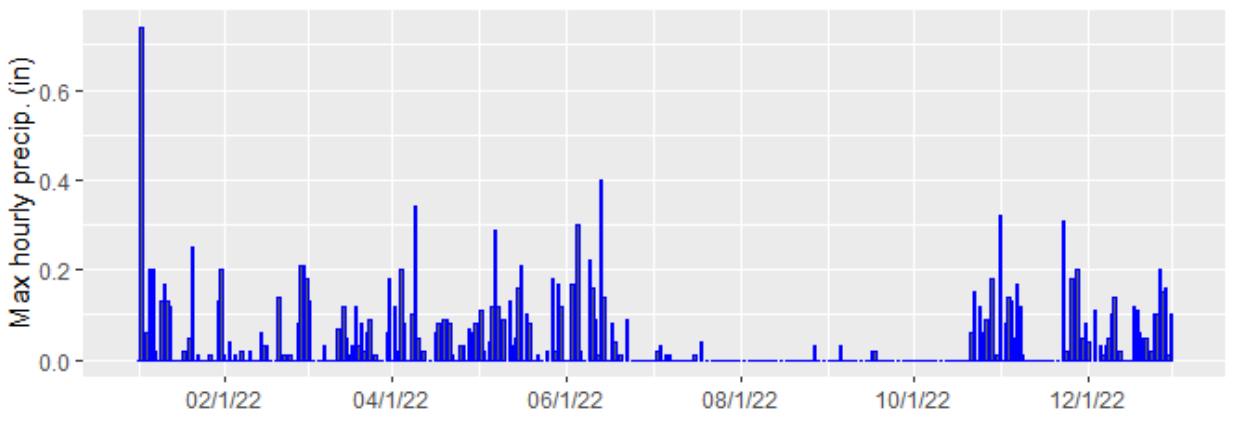
Precipitation (rain and snow) was measured by a rain gage on top of Sammamish City Hall.

Daily totals



Precipitation intensity

In addition to the total amount of precipitation during a rain or snow event, the precipitation intensity (inches per hour) also affects runoff, erosion, and other processes. As a measure of intensity, this graph shows each day's maximum hourly precipitation.



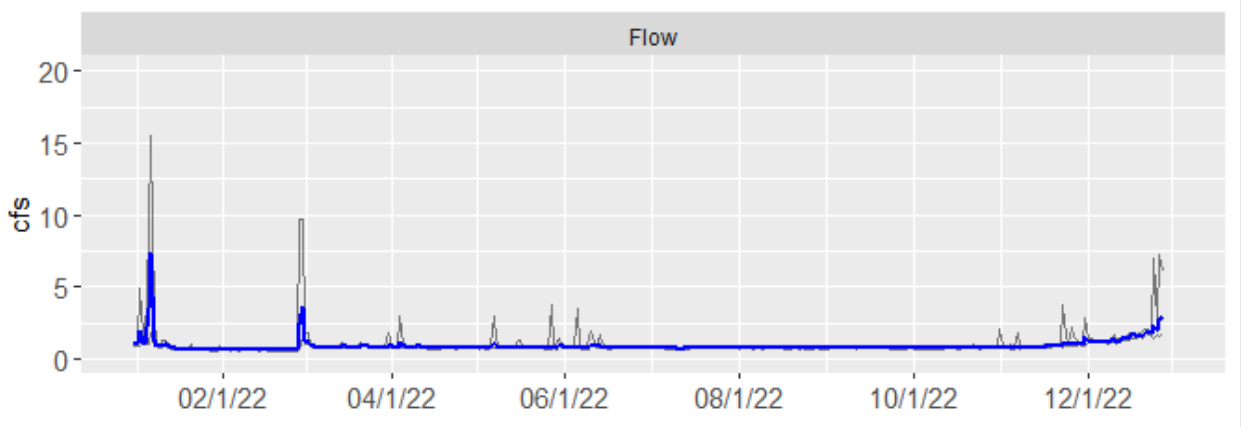
Note that the scale on the y-axis is considerably smaller than on the daily precipitation graph above.

Zackuse Creek

Zackuse Creek was monitored each month for bacteria, nutrients, and conventionals (conductivity, pH, and alkalinity). In addition, a gage measured streamflow and temperature continuously. Starting in 2020, Zackuse Creek has been monitored annually for stream health by measuring benthic macroinvertebrate ("stream bug") diversity.

Streamflow

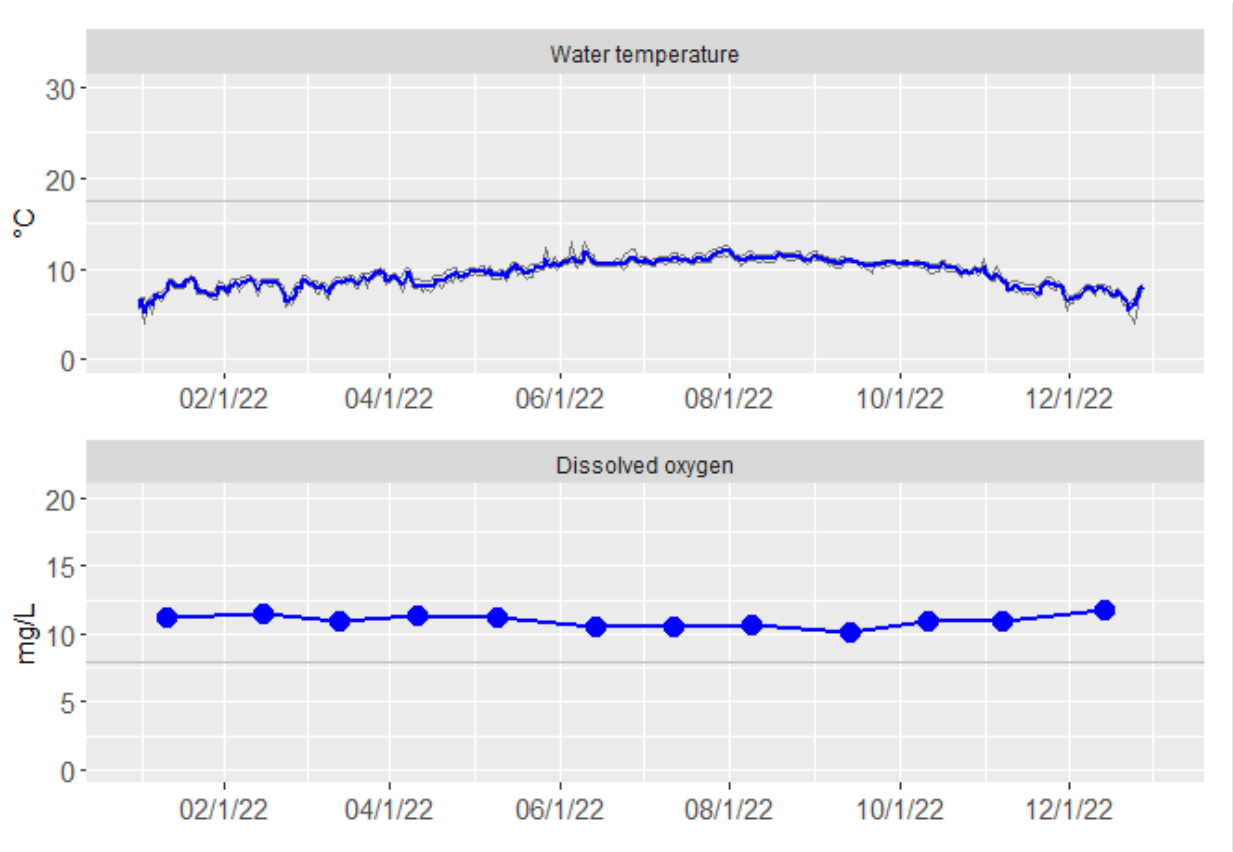
A gage near the mouth of Zackuse Creek measured streamflow and temperature continuously throughout the year.



The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Temperature & Dissolved Oxygen

Good water conditions for salmon survival include temperatures cooler than 17.5°C and dissolved oxygen concentrations of at least 8 mg/L (J. Bower, pers. comm.). In 2022, Zackuse Creek stayed cool and well-oxygenated throughout the year.



On the temperature plot, the blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values

Biotic Stream Health

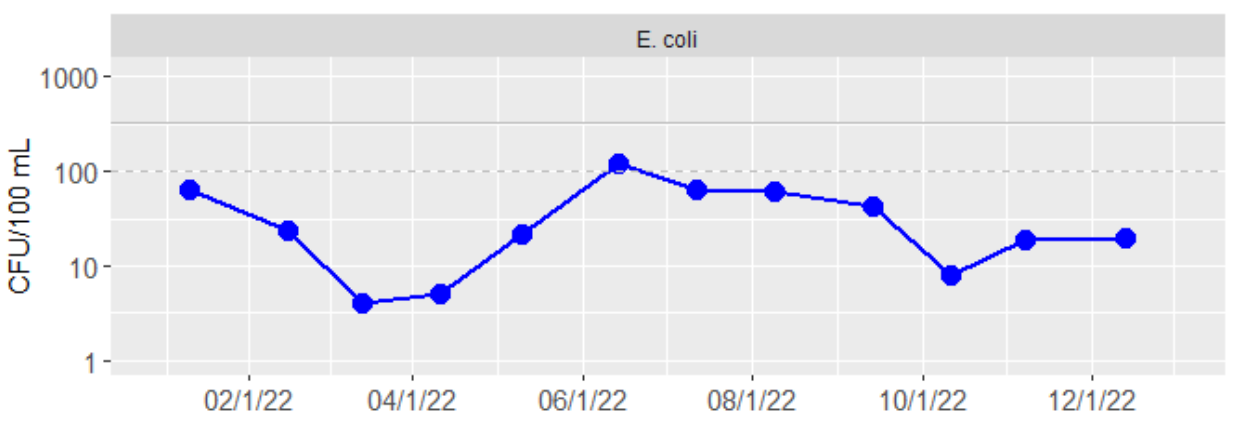
As an overall measure of stream health, Zackuse Creek was sampled once each summer for benthic macroinvertebrate ("stream bug") diversity.

In 2022, Zackuse Creek's overall Benthic Index of Biotic Integrity (B-IBI) score was 21.9 (on a 0-100 scale). This score is generally interpreted as "poor" stream health. This section of Zackuse Creek was extensively restored in 2018, and we expect to see B-IBI scores increase over time as the stream settles into its new configuration. At least five years of data are recommended before assessing a trend.

Full results and individual taxon scores for Zackuse Creek are available on the Puget Sound Stream Benthos website at: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=ZAK

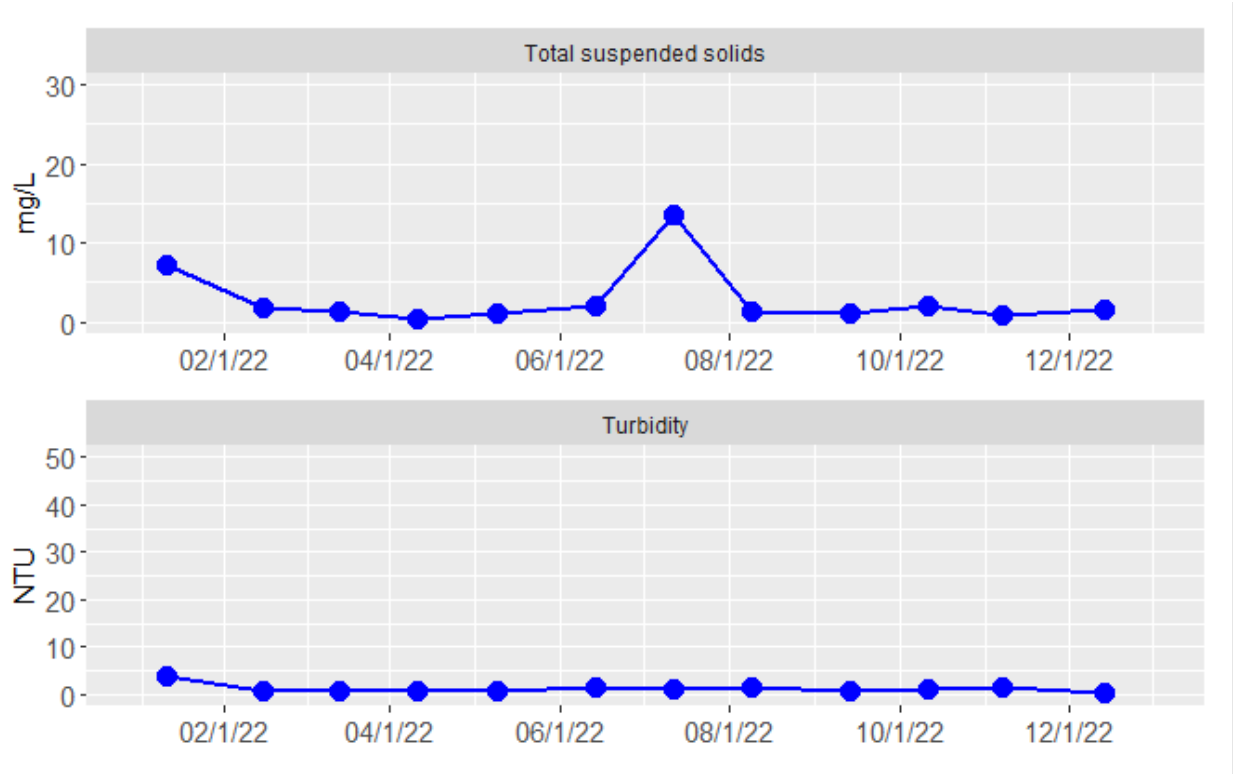
Bacteria

To meet Washington's recreational water-quality criteria, streams should average less than 100 CFU/100 mL of *E. coli* bacteria (dashed horizontal line in the graph below), with no more than 10% of samples above 320 CFU/100 mL (solid horizontal line). Zackuse Creek met this goal in 2022, and all samples had relatively low bacteria concentrations.



Suspended sediment

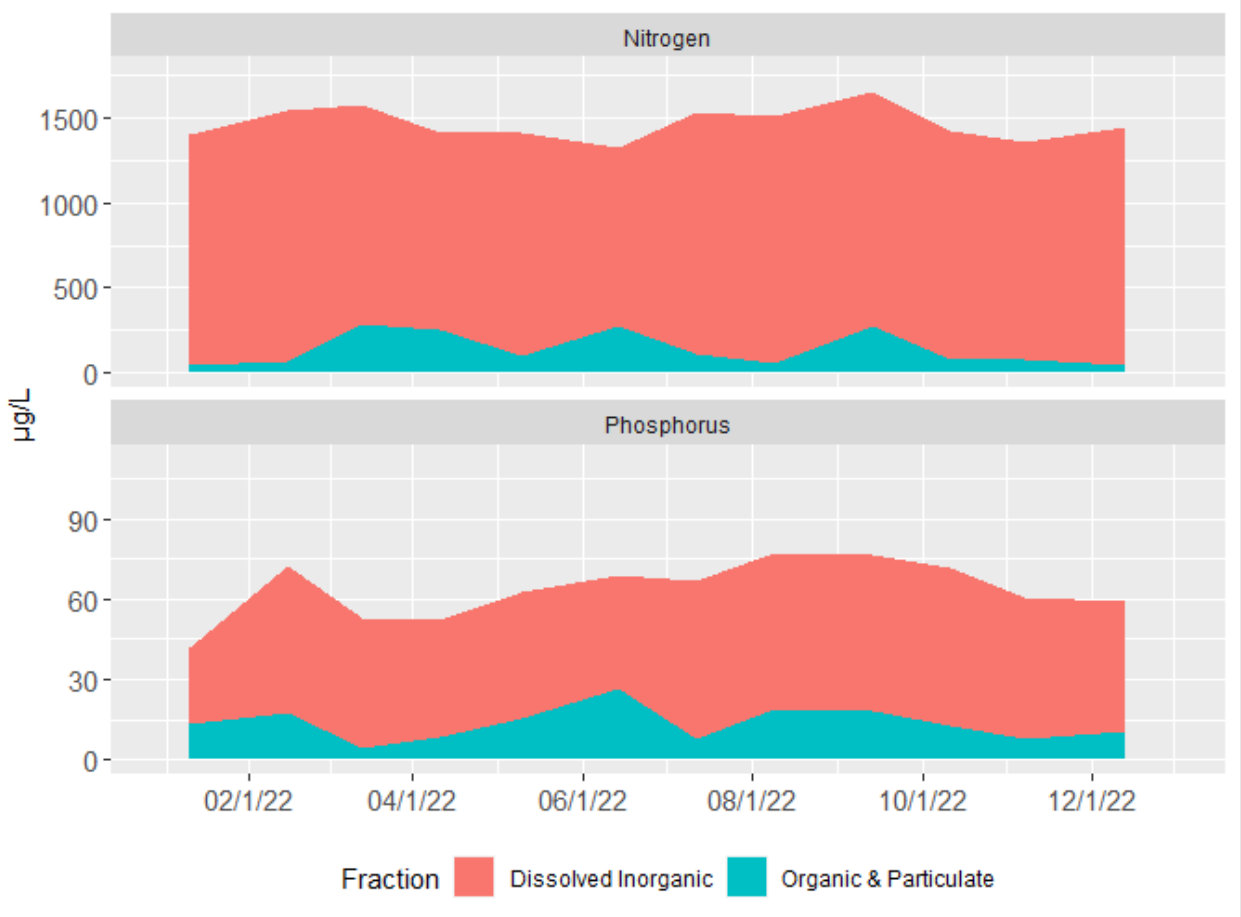
Sediment in the water was measured two ways: as the mass of total suspended solids (TSS), and as turbidity (an optical measurement). In 2022, suspended sediment values were reasonably low in Zackuse Creek. Note that these samples were collected only once per month and would not necessarily catch brief periods of high sediment during high-flow events.



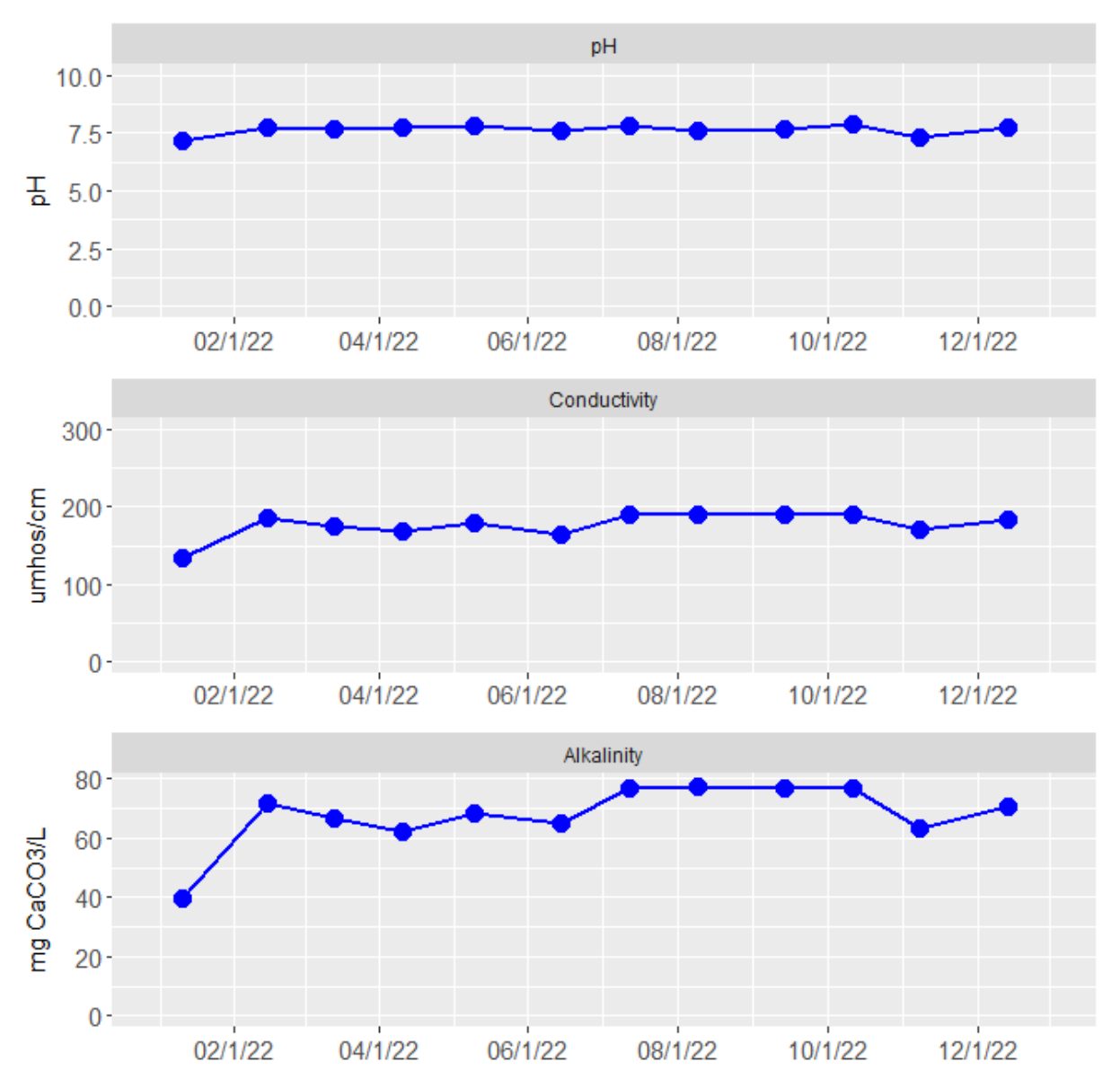
Nutrients

The following graphs show nitrogen and phosphorus concentrations, split out into two fractions: dissolved inorganic, and organic plus particulate. The dissolved-inorganic fraction can be taken up and used more readily by algae (many organic and particulate forms need to be decomposed first). These are stacked-area graphs; the total height of the colored area is the total concentration.

In 2022, Zackuse Creek continued to have fairly high nutrient concentrations. This is typical of streams in Sammamish and is not unique to Zackuse. Continuing to reduce nutrient inputs to these streams, especially phosphorus, would likely benefit Lake Sammamish. Lake Sammamish, designated a Water of Statewide Significance, has had a Lake Management Plan in place since 1994 to reduce phosphorus.



Conventionals



Upstream stream health

Starting in 2020, three new upstream sites were established for annual stream-health monitoring on Ebright, Laughing Jacobs, and Pine Lake Creeks. Benthic macroinvertebrate ("stream bug") diversity is measured at these new upstream sites each spring (May or early June). These three sites were chosen to help focus on portions of the watershed that are expected to develop or redevelop in the near future. Using data from these new upstream sites as well as from the existing monitoring sites near the stream mouth, we hope to detect whether this development/redevelopment has positive or negative effects on stream water quality.

These sites often go dry in the summer, so they are sampled before the usual macroinvertebrate summer sampling period of July-October. As a result, these sites' Benthic Index of Biotic Integrity (B-IBI) scores cannot be interpreted using the usual Excellent/Good/Fair/Poor thresholds. Those thresholds were developed for July-October samples, and for streams that do not dry up in the summer. Those thresholds are therefore not meaningful for these sites. We recommend focusing solely on how the B-IBI scores change over time rather than trying to interpret these scores as good or poor.

In 2022, the overall B-IBI scores were:

- Ebright Creek: 23.5
- Laughing Jacobs Creek: 1.9
- Pine Lake Creek: 7.2

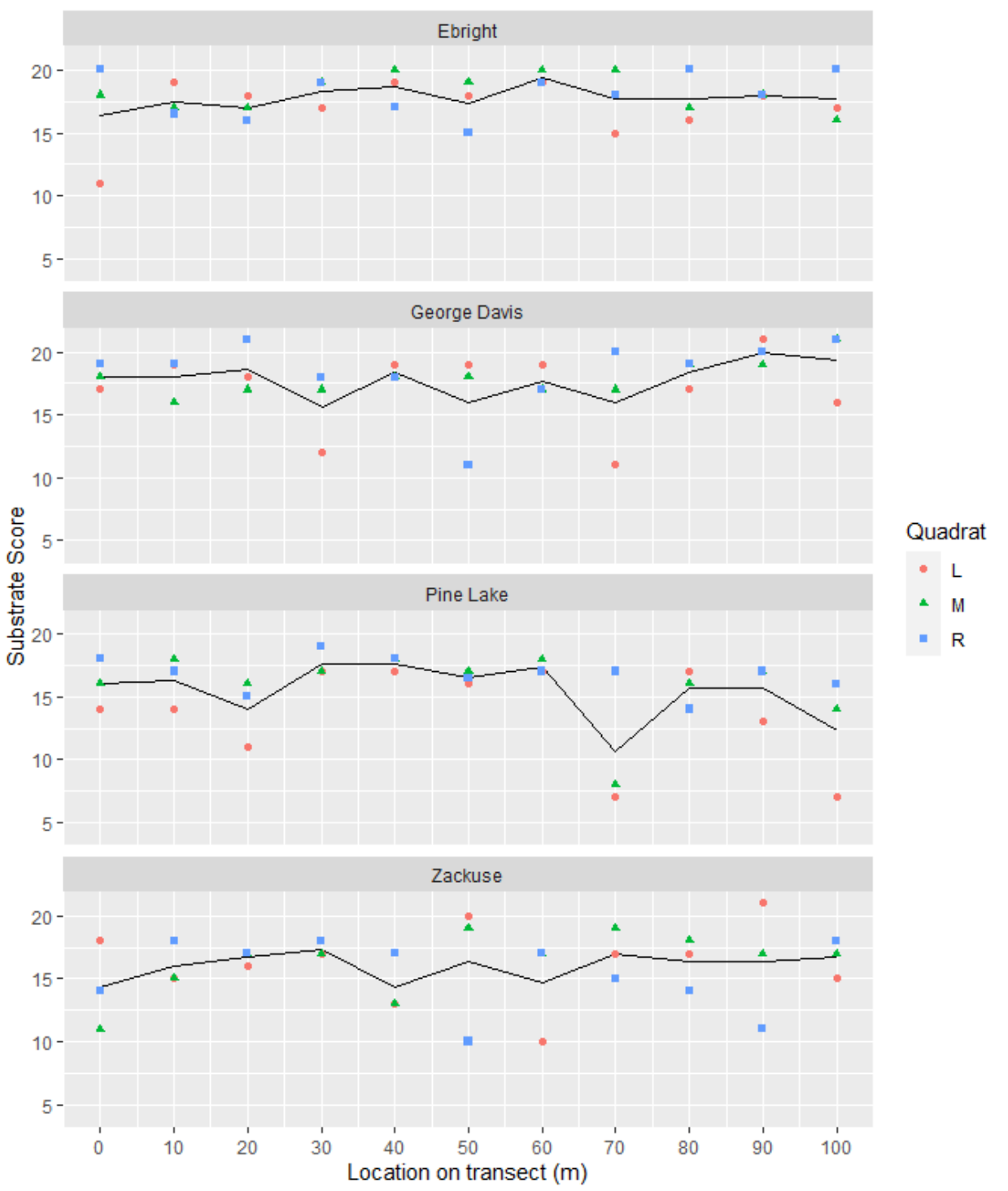
Full results for all years and individual taxon scores are available on the Puget Sound Stream Benthos website:

- Ebright Creek data: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=EBR&d=4
- Laughing Jacobs Creek data: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=LJU&d=4
- Pine Lake Creek data: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=PINE&d=4

Entombment monitoring 2022

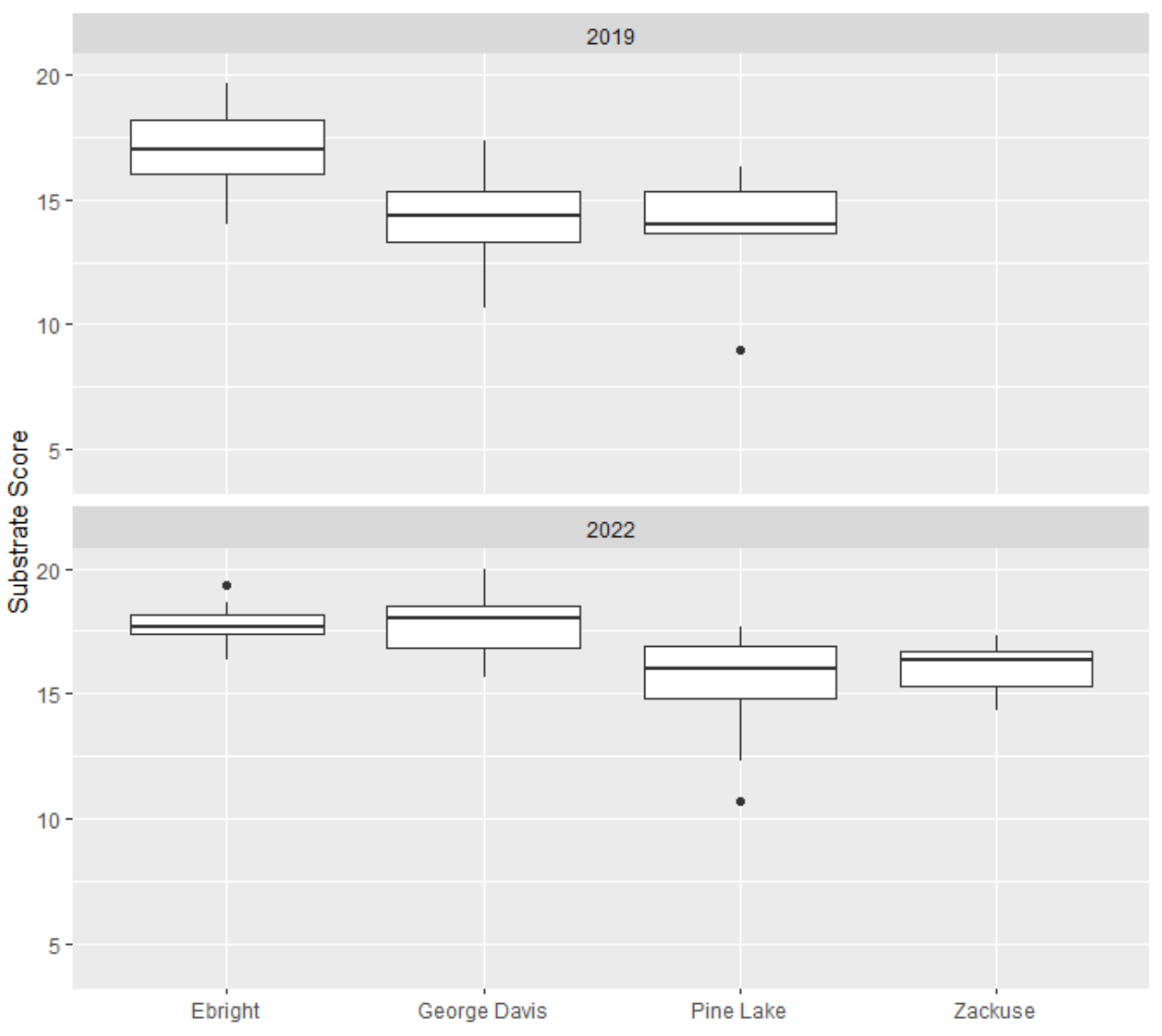
In early June 2022, we assessed the streambed along a 100-m transect in four streams: Ebright, George Davis, Pine Lake, and Zackuse Creek. The transects were located at the bottom of the Sammamish Plateau, where the stream flattens out and slows down. This is where the stream is most likely to drop fine sediment that can cap and entomb gravel spawning beds.

Every 10 meters along the transect, we measured the substrate score in three quadrats in the left, middle, and right of the stream channel (L, M, R in the following graph). The following graph shows the results for 2022, with the black line showing the average substrate score for each location along the transect. Locations go from the downstream end (0 meters) to the upstream end (100 meters) of the transect. Lower substrate scores indicate finer substrates and/or more embeddedness, which are likely to negatively impact salmonid spawning beds.



There was normal variability among quadrats and locations; no stream reaches stood out as having substantially higher or lower substrate scores than other parts of the stream.

The following boxplots summarize the data from each stream for each year, using the average score from each transect location (instead of individual quadrat data). Streambeds were not monitored in 2020 or 2021 due to social distancing requirements. Also note that the 2019 data for Zackuse have been removed. Those data are not comparable with data from later years because they were from a different part of the stream. After 2019, we moved the Zackuse monitoring transect further upstream to a section of stream that had noticeably more fine sediment and served as a better "sentinel" reach.



Substrate scores do not have established interpretations for what constitutes a "good" or "poor" result. These streams all had median scores around 14 to 18, which are high enough to suggest that entombment was unlikely to be a problem in these streams during these winters (J. Bower, pers. comm.). Because we monitored the stream reaches most vulnerable to entombment, other stream reaches likely had similar or higher substrate scores this year.

Riparian canopy cover

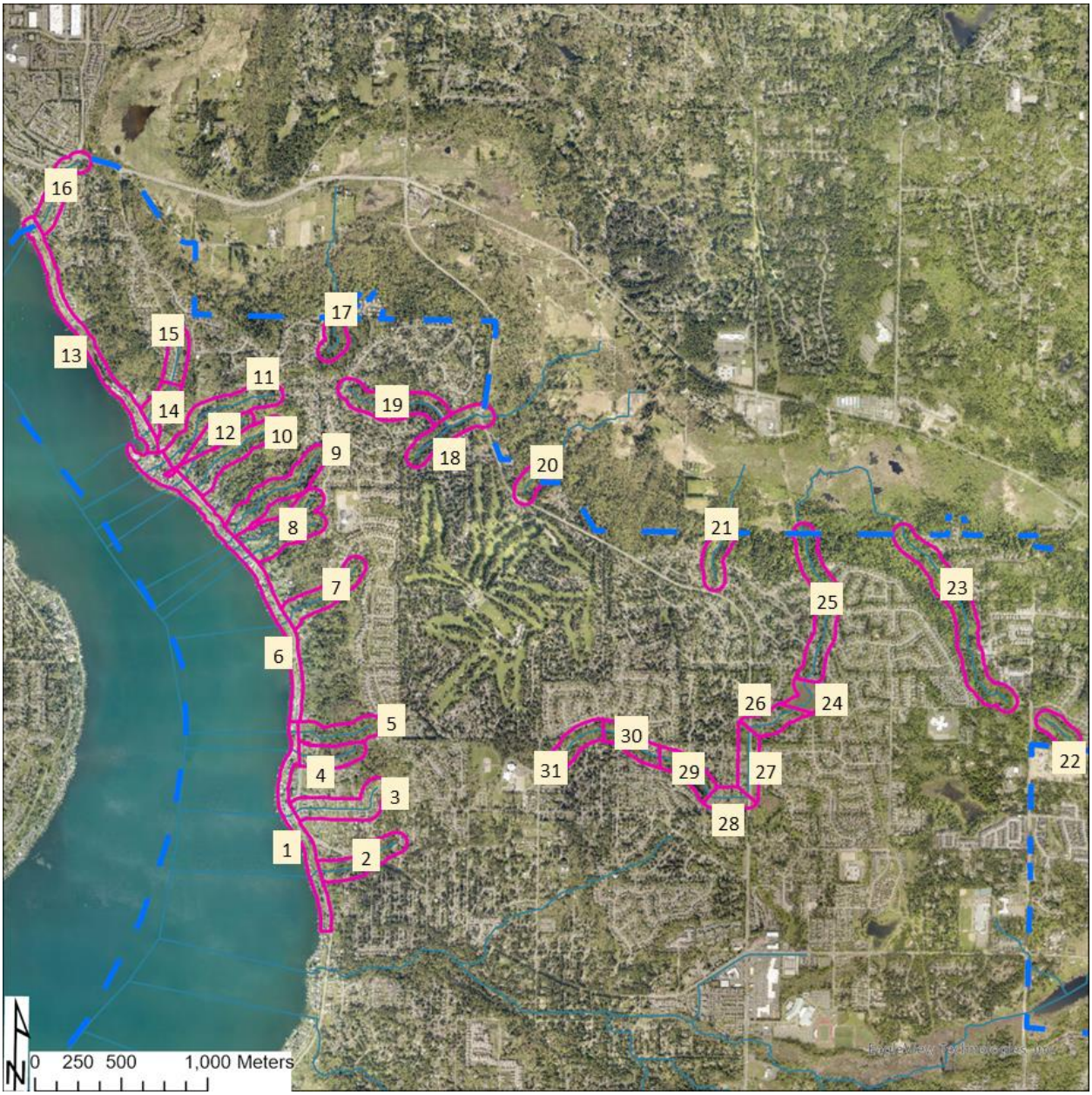
We measured riparian tree canopy cover for the north end of Sammamish, including the Lake Sammamish shoreline and many small streams. This used aerial photos taken in 2021. Tree cover (presence/absence) was mapped within 60 m (200 ft) of streams and shorelines, on a grid of points 5 m apart. Full results are provided separately as a GIS file and high-resolution PDF map.

Total canopy cover in the riparian zone was 63%. We also divided the watershed into multiple reaches; in each reach, we calculated canopy cover for the entire 60-m riparian area plus 20-m and 10-m zones closest to the streams. Canopy cover within 10-20 meters of the stream is especially important for certain ecological functions such as shading and sediment reduction. A map of the reaches is shown below, followed by a table of the canopy cover results for each reach.

Tree canopy cover was variable across this basin. Some reaches were well forested, especially the portions nearest to the stream, while other reaches with lower canopy cover were mostly houses. Wetland areas also had low canopy cover, as expected.

Repeated monitoring (currently planned for every 5 years) will be especially important to track canopy cover gains and losses over time, assess the effectiveness of ordinances and policies, and identify important areas to focus conservation and restoration work.

Map of watershed showing individual numbered reaches:



Percent canopy cover for each reach:

Reach	Land Cover	60 m	20 m	10 m
1	lake shoreline	39	31	32
2	trees and few homes	66	79	82
3	neighborhood	18	13	14
4	rip buffer near homes	61	64	67
5	rip buffer near homes	87	89	91
6	lake shoreline	30	39	39
7	rip buffer near homes	75	81	78
8	rip buffer near homes	79	84	86
9	rip buffer near homes	81	81	80
10	rip buffer near homes	70	68	69
11	rip buffer	68	69	66
12	rip buffer	87	87	82
13	lake shoreline	43	24	20
14	rip buffer	92	91	91
15	neighborhood	39	14	18
16	neighborhood	43	78	91
17	rip buffer near homes	83	93	94
18	trees and few homes	77	61	54
19	rip buffer near homes	78	82	81
20	rip buffer	87	88	84
21	rip buffer near homes	82	90	85
22	rip buffer near homes	62	67	48
23	rip buffer	88	94	94
24	wetlands	17	21	33
25	rip buffer near homes	63	73	73
26	trees in neighborhood	53	43	41
27	trees in neighborhood	42	38	36
28	trees in neighborhood	34	40	45
29	wetlands/pond	46	30	30
30	wetlands near homes	70	58	47
31	rip buffer near homes	69	69	69

Note that along the lake shorelines, the 10-m and 20-m zones refer to areas within 10 or 20 m of a stream, respectively, not areas within 10 or 20 m of the lake shoreline. In contrast, the 60-m zone is areas within 60 m of either a stream or the lake shoreline.