SAMMAMISH WATER QUALITY MONITORING

Annual Report 2019

In 2019, the City of Sammamish and King County expanded water-quality monitoring. This included:

- **Ebright Creek watershed:** Stormwater outfalls and wetlands have been monitored since 2015, as required after new developments in the watershed. In 2019, King County took over the monitoring and replaced old gaging equipment. Outfalls continued to be monitored for flow, temperature and turbitidy. Wetland water level also continued to be monitored.
- **George Davis / Allen Lake wetlands:** Two new gages were installed in April 2019 by King County staff to monitor water level in this wetland complex, at the head of the George Davis and Allen Lake watersheds.
- **Rain gauge on City Hall:** A new rain guage on the roof of Sammamish City Hall was installed in April 2019 by King County staff. In addition to providing precipitation data to help understand other monitoring results, this rain gage provides real-time information to help City staff respond to rain events.
- **Zackuse Creek:** Beginning in January 2019, streamflow and temperature in Zackuse were monitored continuously with a new gage installed by King County staff. Each month, Zackuse was also sampled for bacteria, nutrients, and conventionals. Metals concentrations were also measured four times in 2019, twice during baseflow conditions (2/26 and 5/14) and twice during wet-weather conditions (4/9 and 12/19).
- **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 in the George Davis watershed, using aerial imagery from 2017. 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. Stream water-quality data are available on the King County Streams Monitoring website. 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), and are graphed as blue dots connected by a blue line. In contrast, continuous data were collected by automated gages, 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 line (on days with very low variation, the thinner grey lines may be hidden behind the blue line).

Note that most gages are downloaded manually 2-4 times per year. Unless otherwise noted, gages continued to collect data through the end of the year even if that data have not yet been downloaded, processed, and made available.

Ebright Creek Watershed

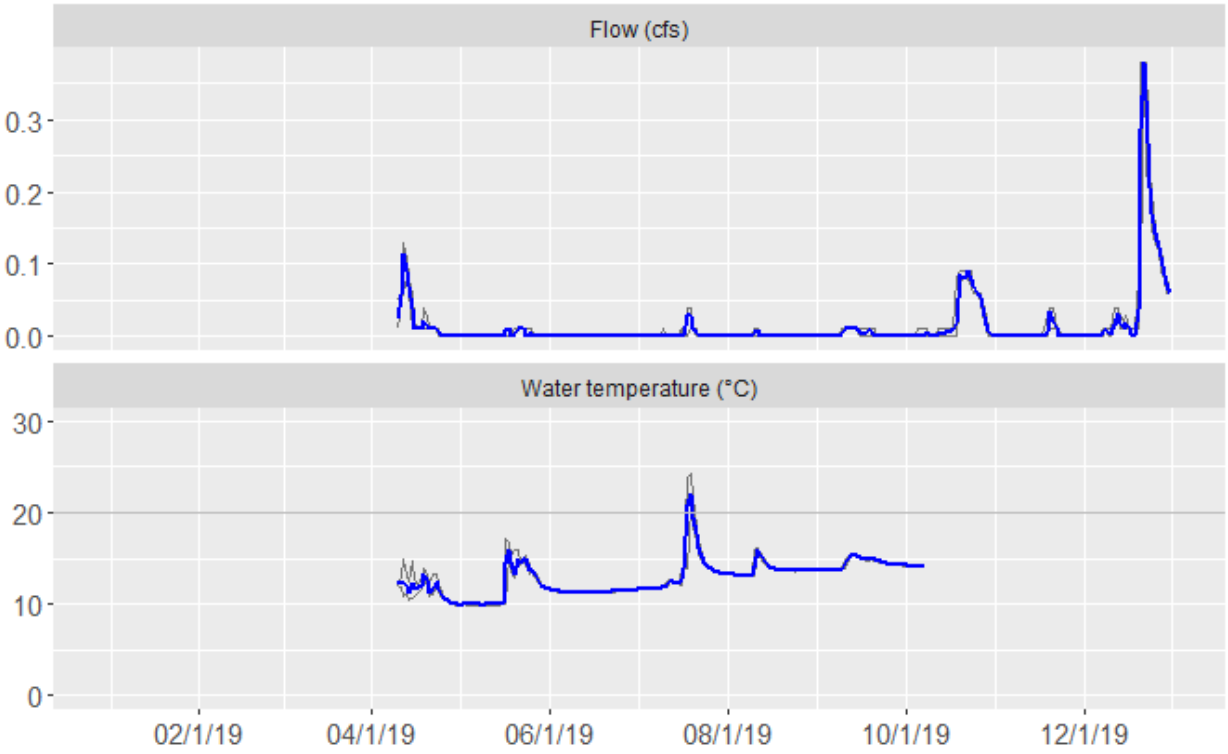
In two developments in the Ebright Creek watershed (Chestnut Estates and the Crossings at Pine Lake), wetlands and stormwater outfalls have been monitored in accordance with plat conditions since 2015. King County took over this monitoring work in 2019. Stormwater outfall flow, temperature, and turbidity were 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.

Most of this work continued the monitoring that has been ongoing since 2015, using the same sites and approaches. The only noticeable change was a shift from continuous turbidity gages (at the stormwater outfalls) to monthly grab samples.

Outflow and Temperature

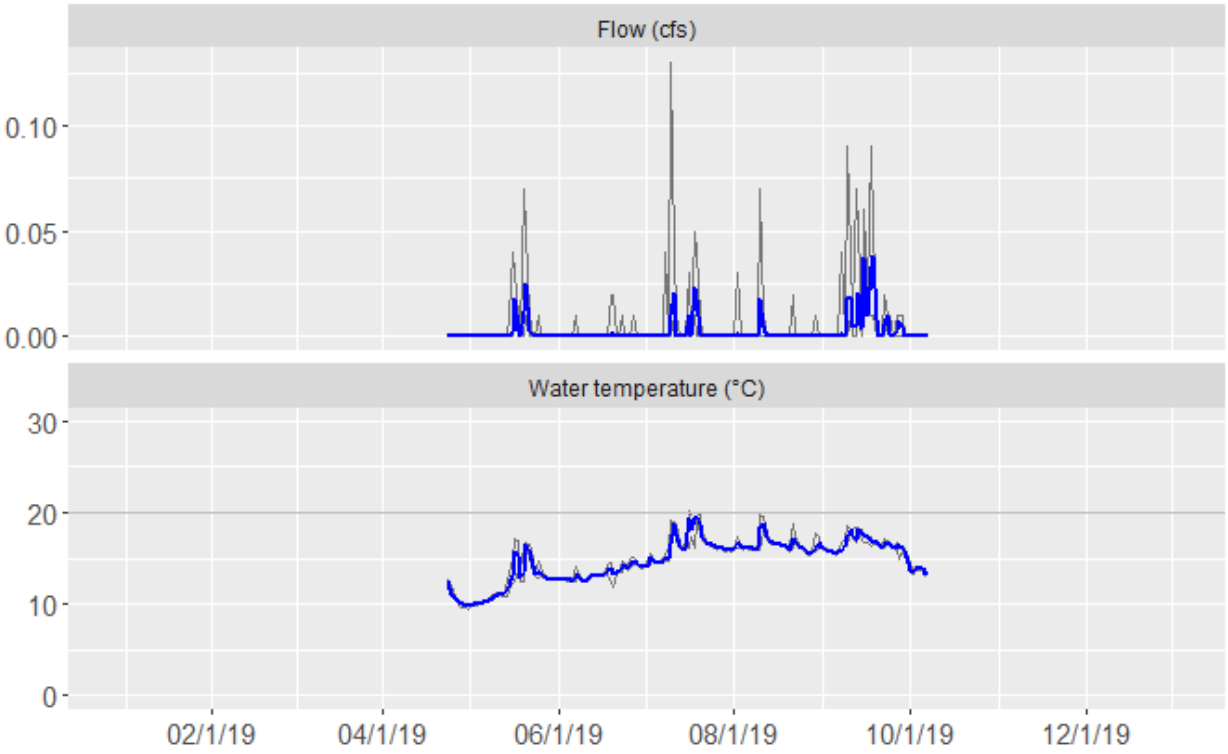
Gages on the outfalls were reactivated or installed in April 2019.

Chestnut Pond



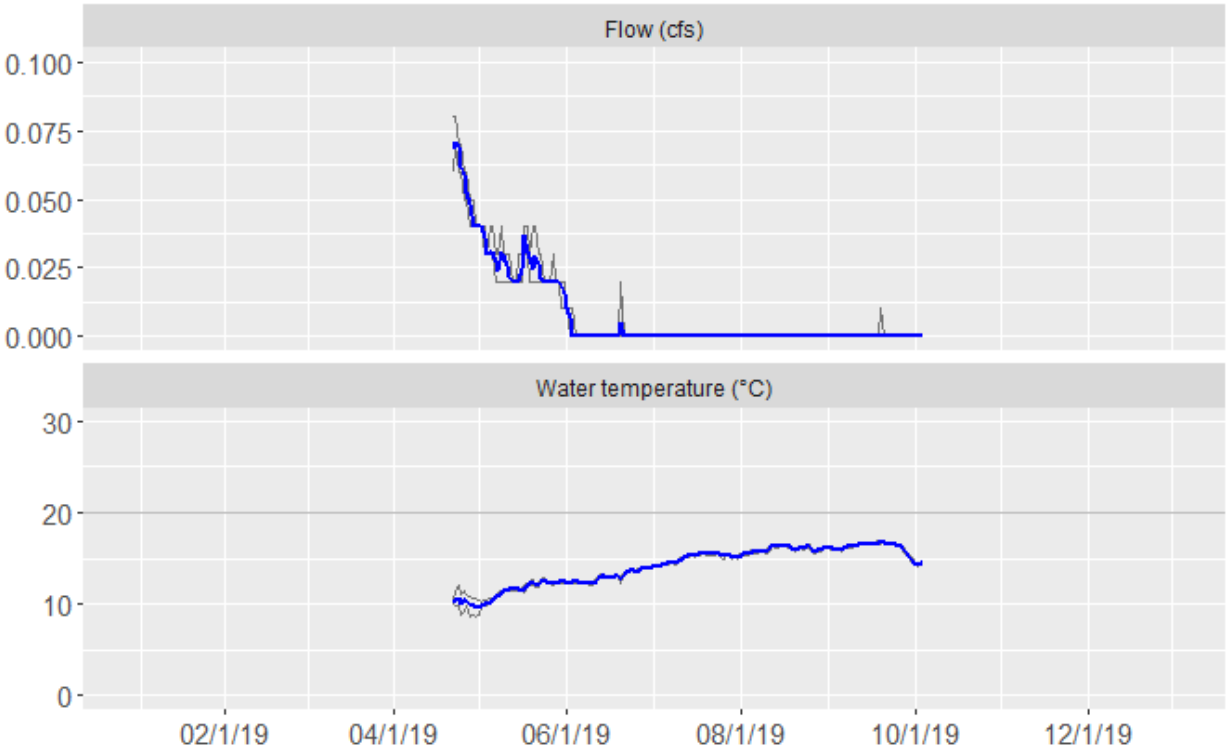
The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Crossings - East pond



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

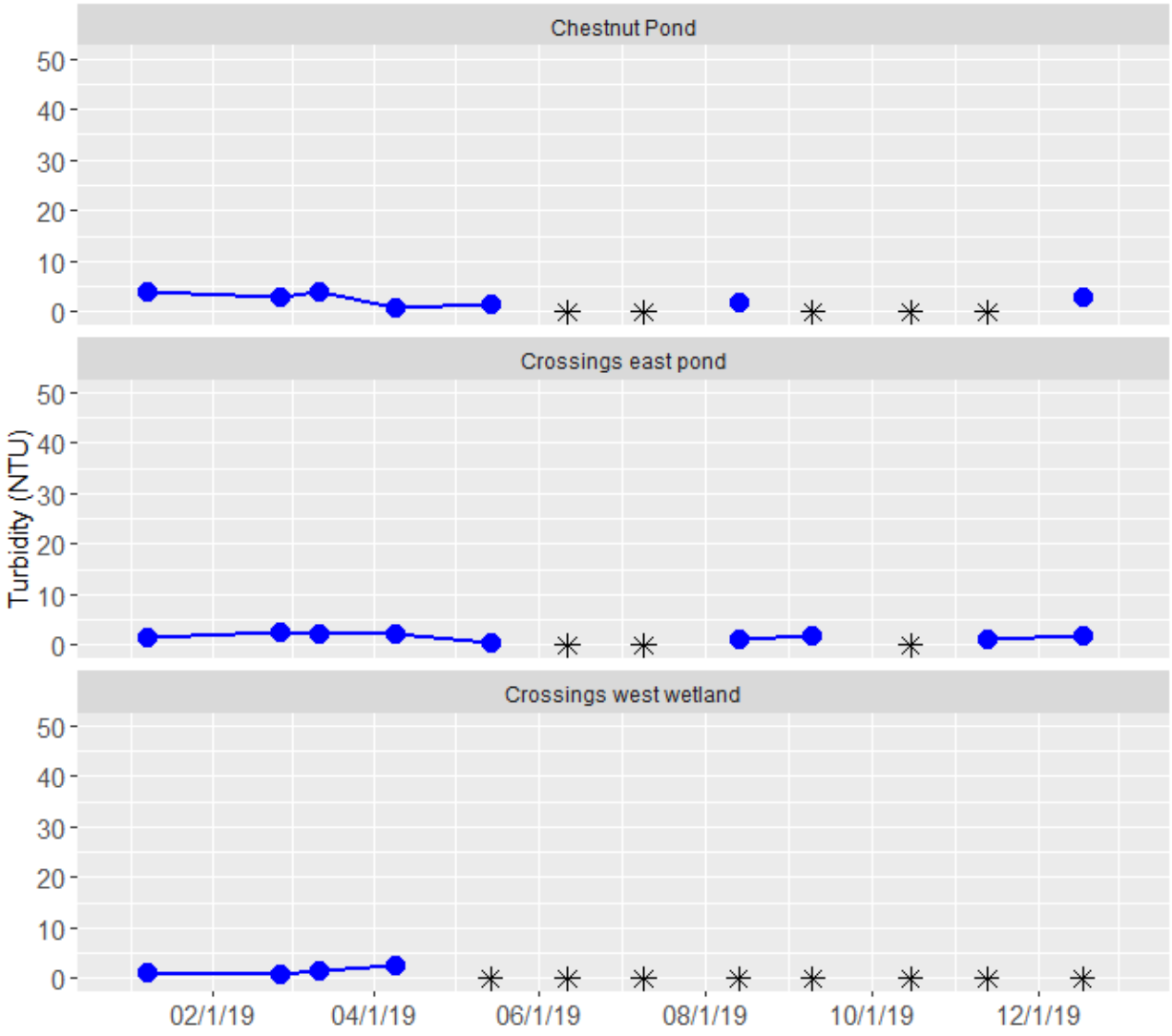
Crossings - West wetland



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

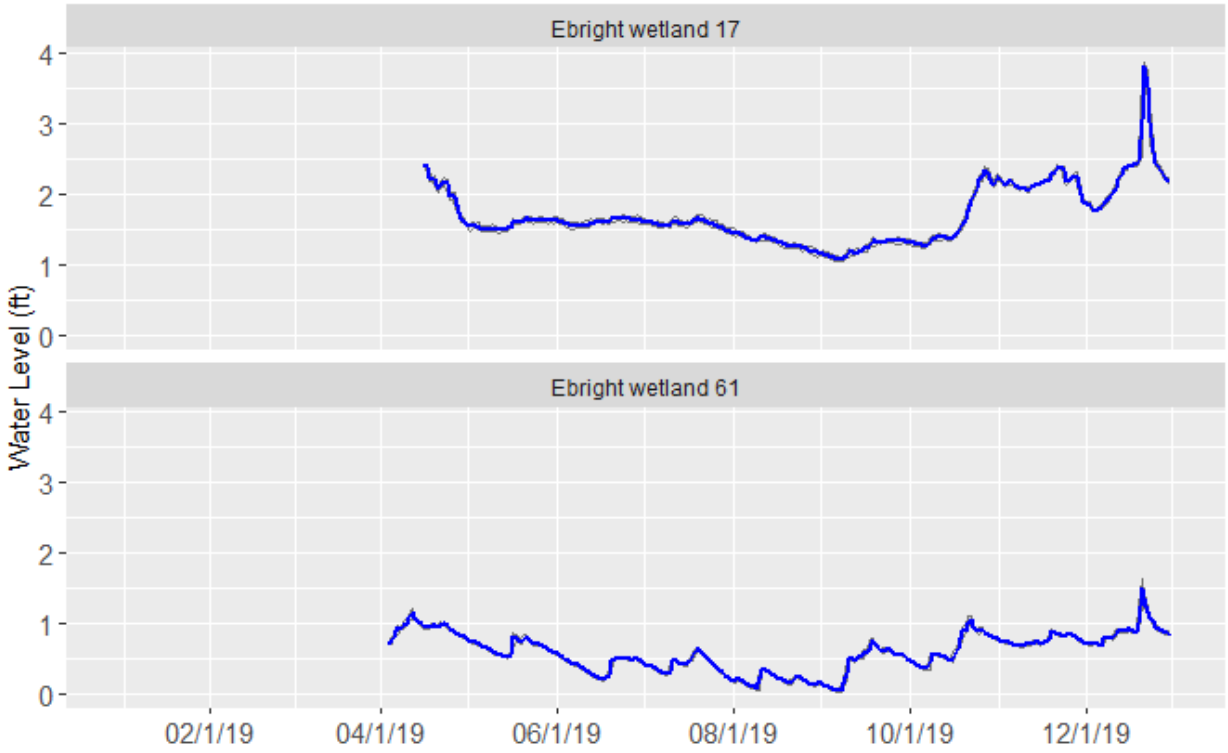
Turbidity

The three stormwater outfalls were sampled for turbidity each month. Turbidity was consistently low in all samples in 2019.



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

Wetland water level



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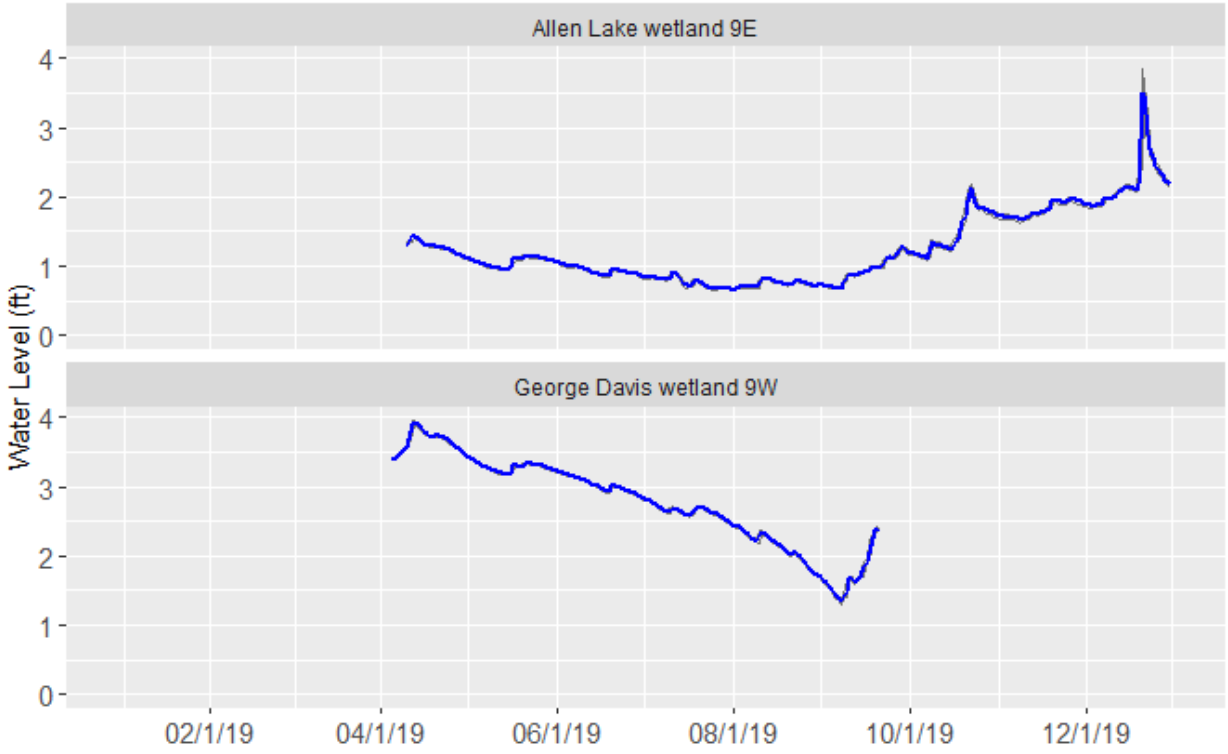
George Davis / Allen Lake Wetlands

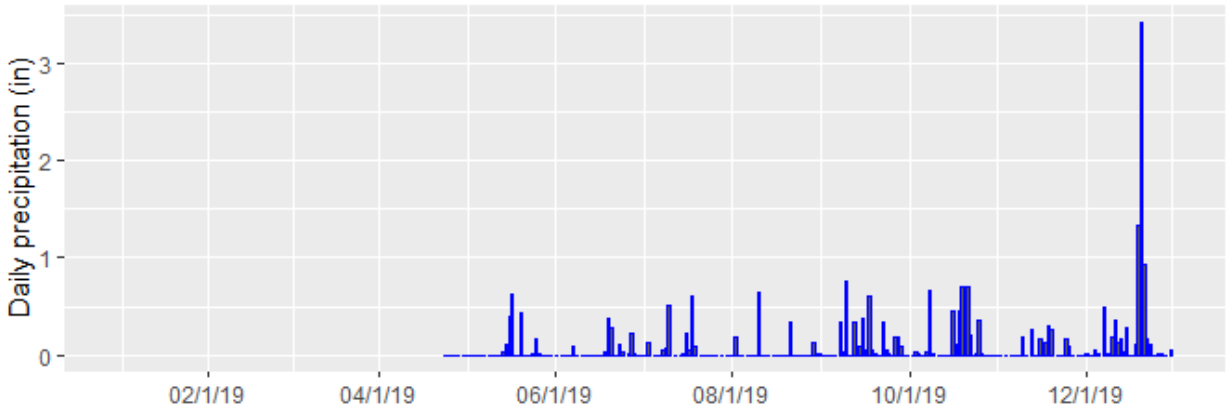


The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Precipitation

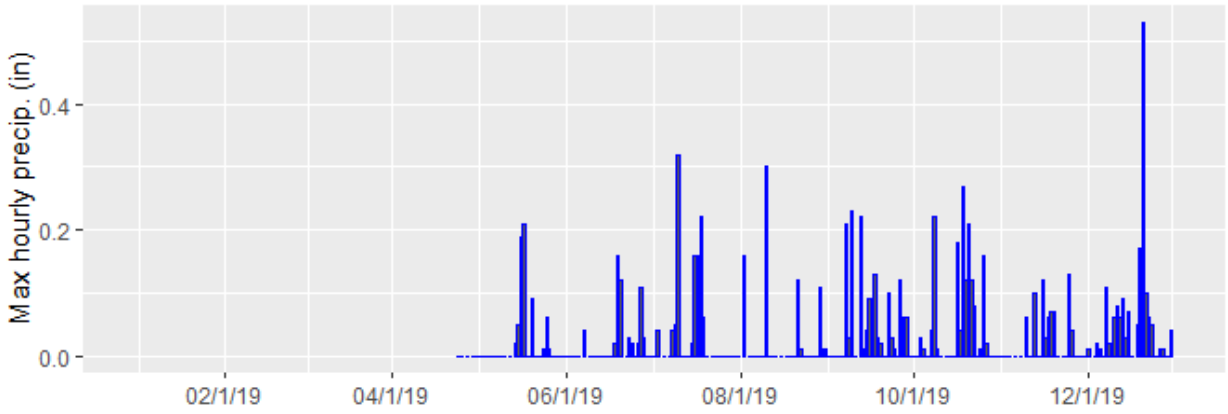
Precipitation (rain and snow) was measured by a rain gage on top of Sammammish City Hall.

Daily totals



Precipitation intensity

In addition to the total amount of precipitation, 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.



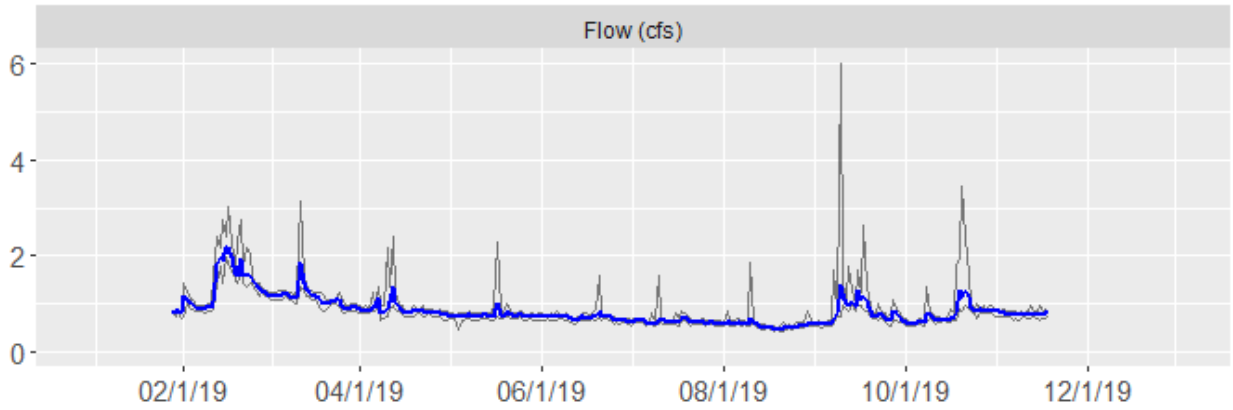
Note that the scale on the y-axis is considerably smaller than on the daily precipitation graph above.

Zackuse Creek

Zackuse Creek was monitored each month for bacteria, nutrients, and conventionals. In addition, a new gage measured streamflow and temperature continuously.

Streamflow

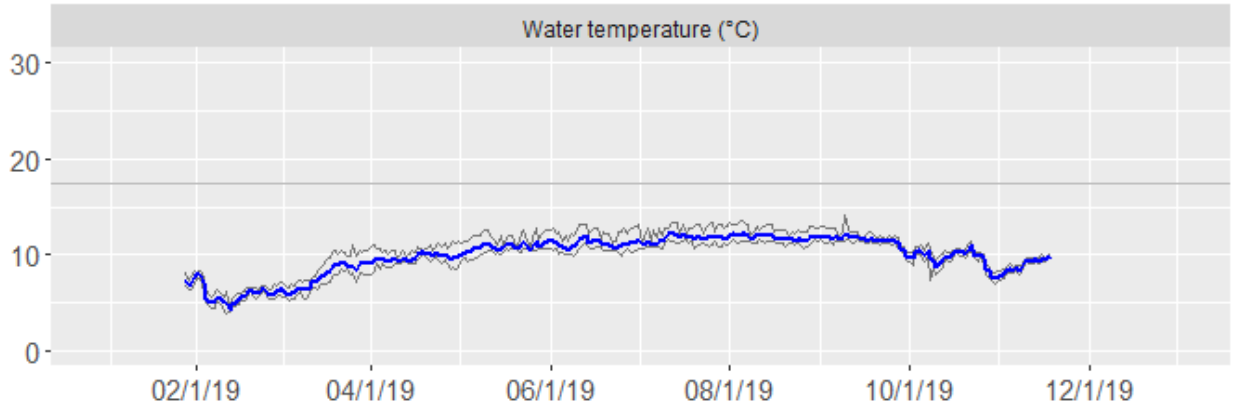
Streamflow and temperature data are not yet available later than mid-November 2019. A large rainfall on December 20th caused high flows in Zackuse Creek. This deposited a considerable amount of sand and gravel in the lower reach and buried the gage. Once the gage is dug out (expected in late spring 2020), we expect to recover all data up until the storm buried it. We also installed a temporary gage shortly after the storm, and will re-install a permanent gage after the channel is dug back out. We expect to piece together a nearly complete streamflow and temperature record from these sources.



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

Temperature & Dissolved Oxygen

Good salmon habitat is cooler than 17.5°C and has at least 8 mg/L of dissolved oxygen. In 2019, Zackuse Creek stayed cool and well-oxygenated throughout the year.



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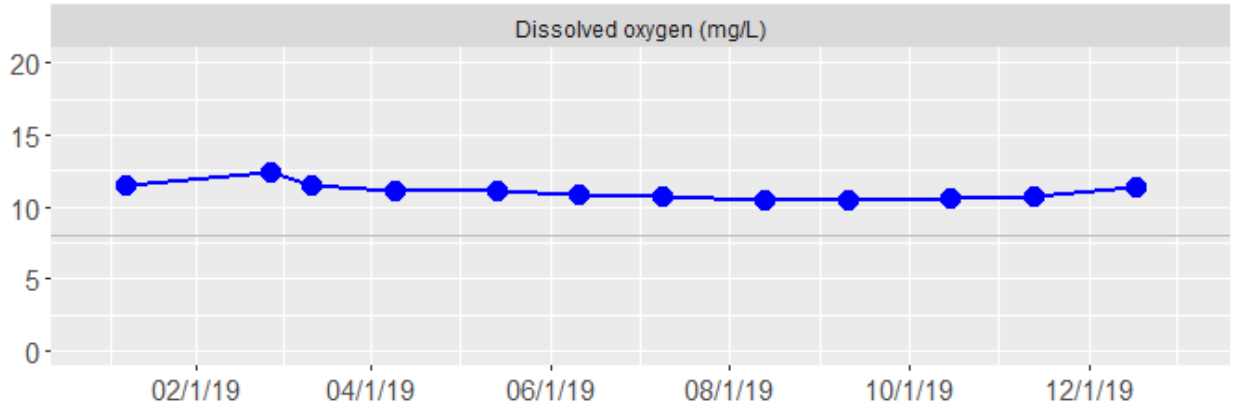
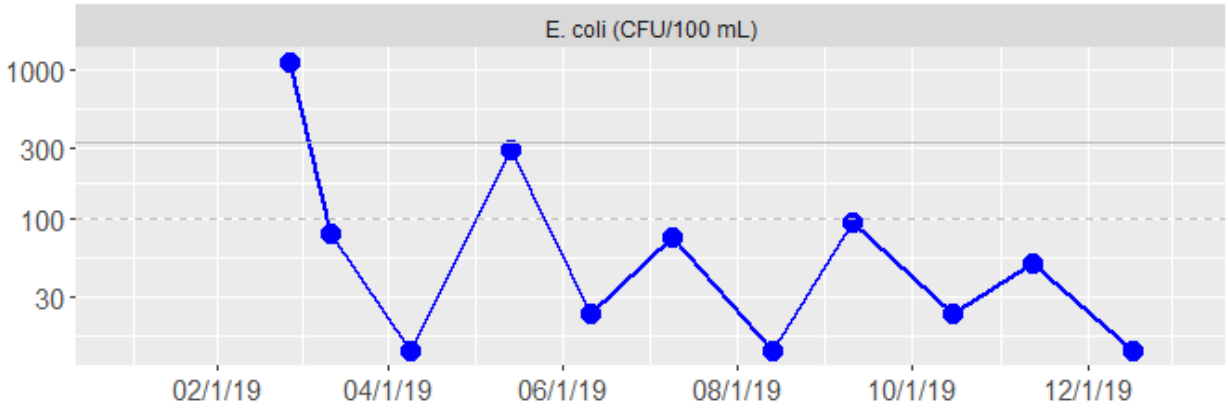


Bacteria

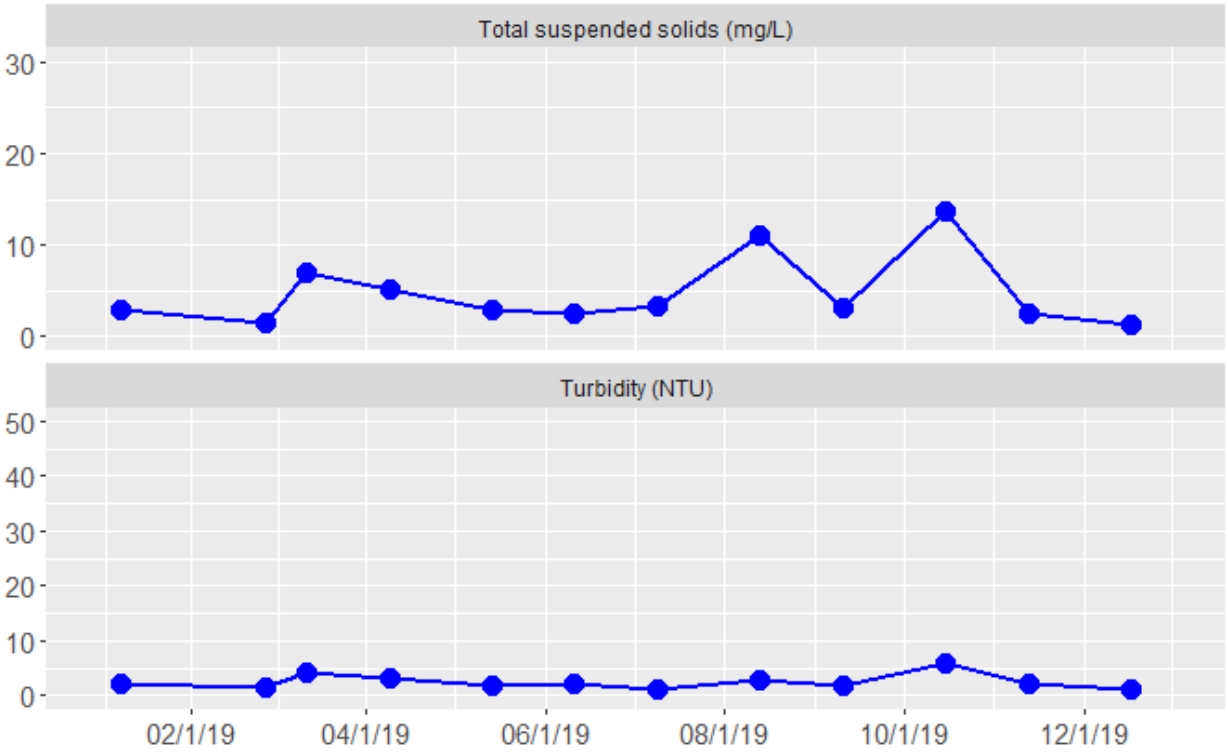
Streams should average less than 100 CFU/100 mL of *E. coli* (dashed horizontal line in the graph below), with no more than 10% of samples above 320 CFU/100 mL (solid horizontal line). Zackuse Creek met this goal in 2019, with only one sample (February 2019) over 320. Isolated high bacteria concentrations like this are common in streams, and tracking down periodic sources like this would be very difficult.

There were no *E. coli* data for January 2019; *E. coli* measurements (for the new state criteria) began in February. In January, only fecal coliform bacteria were measured, and had a concentration of 42 CFU/100 mL.



Suspended sediment

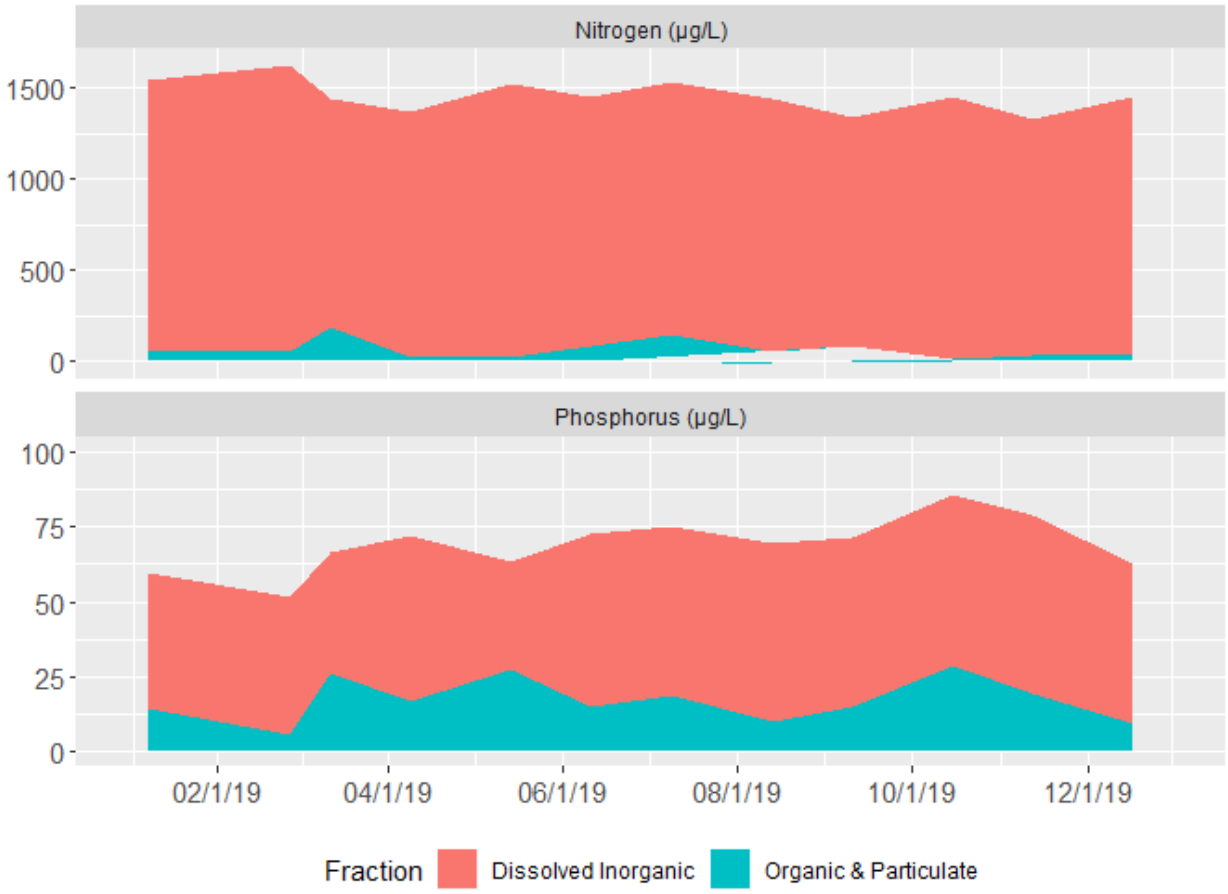
Sediment in the water is measured two ways: as the mass of total suspended solids (TSS), and as turbidity (an optical measurement). In 2019, suspended sediment values were reasonably low. Note that these samples were collected only once per month and would not necessarily measure brief periods of high sediment during high-flow events.



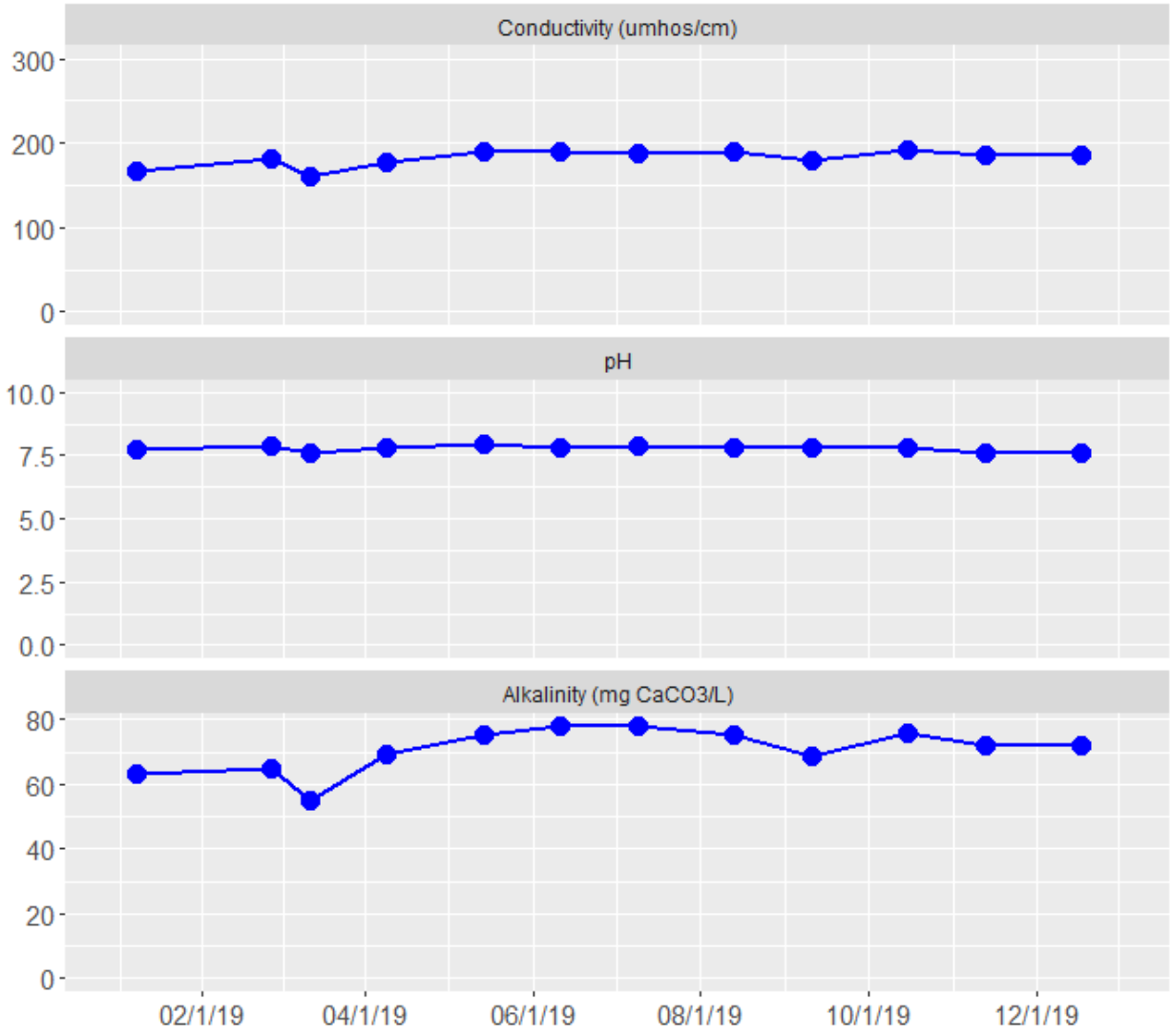
Nutrients

The following graphs show nitrogen and phosphorus concentrations, split out into two fractions: dissolved inorganic (the most readily available forms), and organic plus particulate. These are stacked-area graphs; the total height of the colored area is the total concentration (dissolved inorganic + dissolved organic + particulate).

In 2019, Zackuse Creek had 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



Metals

Samples analyzed for metals were from baseflow conditions on 2/26/2019 and 5/14/2019, and from wet-weather conditions (during or shortly after rainfall) on 4/9/2019 and 12/19/2019. All values are given in µg/L. Results in parentheses were less than the laboratory method detection limit (<MDL).

Parameter	2/26	4/9	5/14	12/19
Arsenic, Dissolved	1.21	1.55	1.45	1.53
Arsenic, Total	1.25	1.73	1.46	1.99
Cadmium, Dissolved	(<0.05)	(<0.05)	(<0.05)	(<0.05)
Cadmium, Total	(<0.05)	(<0.05)	(<0.05)	(<0.05)
Calcium, Dissolved	17200	16200	18300	14900
Calcium, Total	16900	16200	18400	15600
Chromium, Dissolved	0.21	0.41	(<0.2)	0.37
Chromium, Total	0.28	0.67	0.28	1.26
Copper, Dissolved	0.43	1	(<0.2)	1
Copper, Total	0.48	1.3	0.25	2.11
Iron, Dissolved	31	109	15	83.3
Iron, Total	79.2	333	83.4	688
Lead, Dissolved	(<0.1)	(<0.1)	(<0.1)	(<0.1)
Lead, Total	(<0.1)	0.18	(<0.1)	0.48
Magnesium, Dissolved	7670	7950	8800	7000
Magnesium, Total	7660	8460	8960	7260
Mercury, Dissolved	(<0.005)	(<0.005)	(<0.005)	(<0.005)
Mercury, Total	(<0.005)	(<0.005)	(<0.005)	(<0.005)
Nickel, Dissolved	0.21	0.45	0.11	0.4
Nickel, Total	0.26	0.662	0.25	1.16
Selenium, Dissolved	(<0.5)	(<0.5)	(<0.5)	(<0.5)
Selenium, Total	(<0.5)	(<0.5)	(<0.5)	(<0.5)
Silver, Dissolved	(<0.04)	(<0.04)	(<0.04)	(<0.04)
Silver, Total	(<0.04)	(<0.04)	(<0.04)	(<0.04)
Vanadium, Dissolved	1.56	1.85	2.05	1.77
Vanadium, Total	1.72	2.37	2.16	3.03
Zinc, Dissolved	1.2	2.3	0.88	9.98
Zinc, Total	1.6	4.25	1.3	20.3

Metals screening thresholds

To assess whether metals concentrations posed a concern for salmonids or other aquatic life in Zackuse Creek, we compared them to screening thresholds from two sources: the Washington State Water Quality Standards (WQSs), and a draft set of salmonid-specific

screening values (salmonid SVs) (Colton 2007, *unpublished King County draft*). The WQSs are designed to protect at least 95% of the aquatic community, and the salmonid SVs help address the concern that salmonids can be harmed at metals concentrations below the WQSs. Many WQSs are calculated based on the water hardness in each sample, because higher hardness (higher concentrations of calcium and magnesium ions) helps block metals from binding to and harming gills or other tissues.

The following table presents screening thresholds for several metals. In cases where there is both a WQS and a salmonid SV for a metal, this table lists only the lower, more protective threshold.

Except for zinc, all other metals concentrations in Zackuse Creek were well below the screening thresholds. Dissolved zinc concentrations were high enough to be a concern for salmonids. Zinc is a concern in all King County streams, though, and the concentrations in Zackuse were fairly typical for the region.

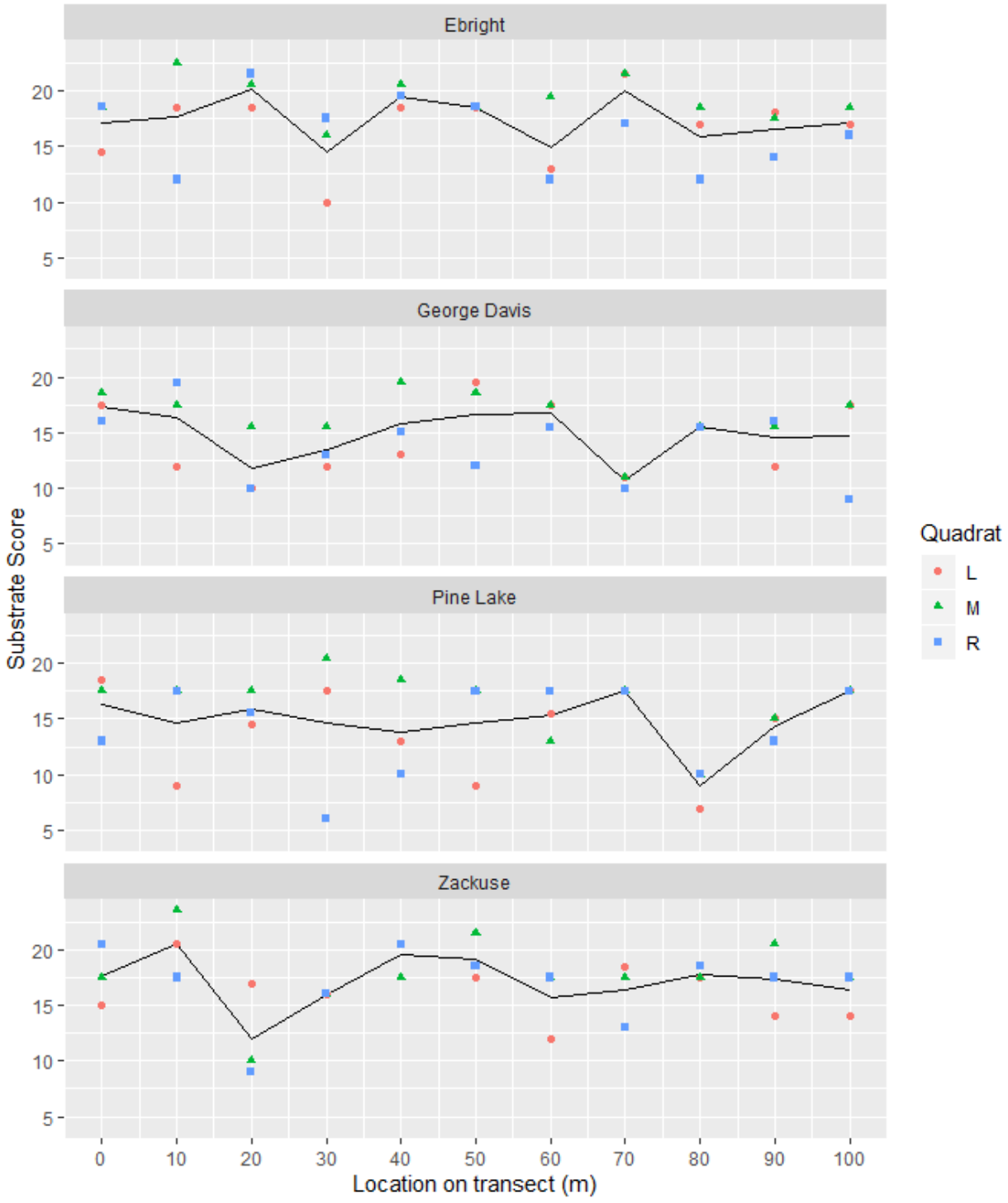
Metal	Acute threshold (µg/L)	Chronic threshold (µg/L)	Source
Arsenic, dissolved	360	190	WQS
Cadmium, dissolved	0.055	0.047	Salmonid SV
Chromium, dissolved	715	9	Salmonid SV
Chromium, total	404 - 470	131 - 153	WQS (calculated)
Copper, dissolved	12.0 - 14.3	8.3 - 9.7	WQS (calculated)
Lead, dissolved	43 – 53	1.7 – 2.0	WQS (calculated)
Nickel, dissolved	1032 – 1207	115 – 134	WQS (calculated)
Mercury, dissolved	2.1	(NA)	WQS
Mercury, total	(NA)	0.012	WQS
Selenium, total	20	5	WQS
Silver, total	0.31	0.3	Salmonid SV
Vanadium, total	350	(NA)	Salmonid SV
Zinc, dissolved	0.2	0.1	Salmonid SV

NAs indicate that this threshold is not defined for a given metal or fraction.

Entombment

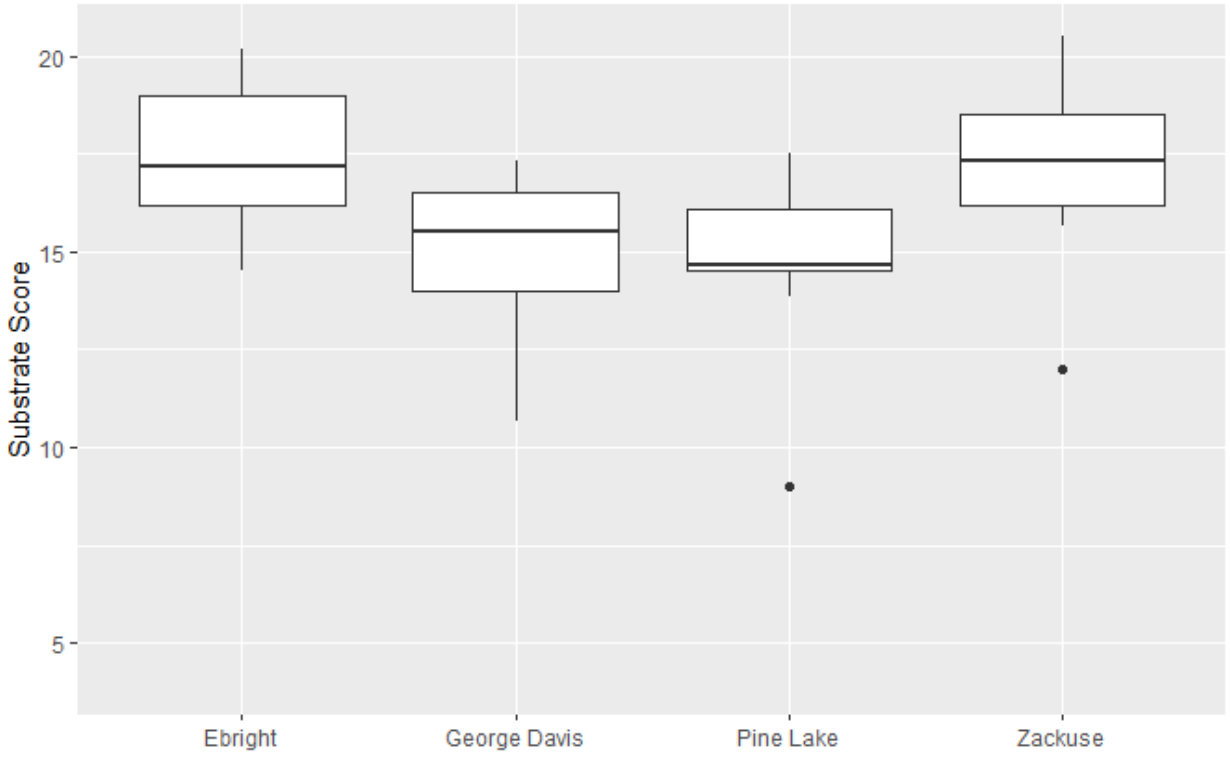
In early June, we assessed the streambed along a 100-m transect in four streams: Ebright, George Davis, Pine Lake, and Zackuse Creek. The transects were located at the bottom of the Sammamish Plateau, where the stream flattens out and slows down. This is where the stream is most likely to drop fine sediment 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 2019, with the black line showing the average substrate score for each location along the transect. Lower substrate scores indicate finer substrates and/or more embeddedness, which are likely to negatively impact salmonid spawning beds.



Points show scores for individual quadrats; the black line shows the average at each transect location.

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, using the average score from each transect location (instead of individual quadrat data).



Substrate scores do not have established interpretations for what constitutes a "good" or "poor" result. In 2019, though, these streams all had median scores around 15 to 17, which are high enough to suggest that entombment was unlikely to be a problem in these streams last winter (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.

Entombment patterns can change markedly from one year to the next. High streamflows in mid-December 2019 reshaped many streambeds, for example, and may result in substantially different substrate scores in June 2020. We recommend continuing entombment monitoring for at least three years before drawing any more general conclusions about entombment in these streams.

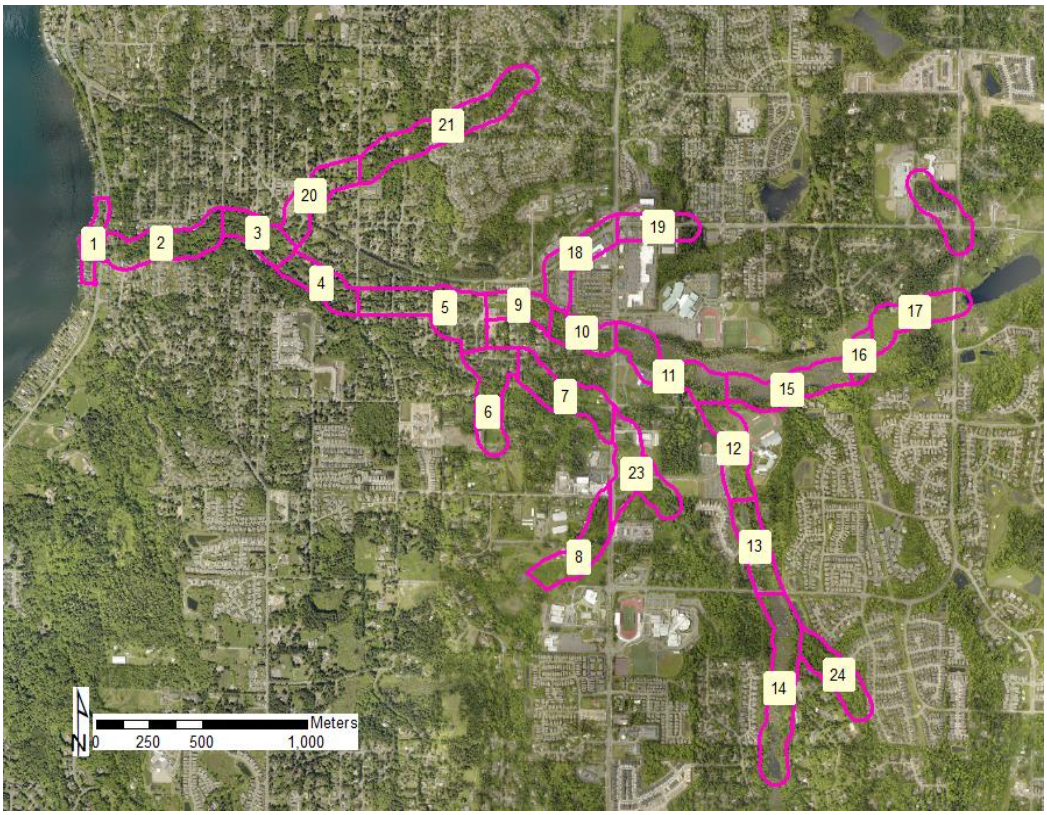
One of the most useful applications of entombment monitoring will be detecting trends in the substrate scores. If some parts of these watersheds develop or re-develop, this monitoring will be able to detect changes over time in sedimentation and entombment.

Riparian canopy cover

We measured riparian tree canopy cover for the George Davis watershed, using aerial photos taken in 2017. Tree cover (presence/absence) was mapped within 60 m (200 ft) of streams and shorelines, on a grid of points 5 m apart.

Total canopy cover in the riparian zone was 53%. 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.

On the slope of the plateau (reaches 2-4), George Davis Creek had very high canopy cover, especially in the zones closest to the stream. But upstream and along Lake Sammamish, riparian cover was much more variable, usually due to development. Note that low canopy cover is expected in wetland areas, such as the George Davis / Allen Lake headwater wetlands. As development increases in this watershed with the Town Center and other projects, it will be important to preserve and increase riparian tree cover in the upper reaches of George Davis Creek. 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.



		% canopy cover		
Reach	**Land Cover**	**60 m**	**20 m**	**10 m**
1	lake shoreline	35	49	56
2	riparian buffer near homes	79	90	89
3	riparian buffer near homes	94	98	97
4	trees and few homes	77	90	94
5	trees in neighborhood	58	63	69
6	neighborhood	60	64	66
7	trees and few homes	71	71	72
8	open space short stream	43	52	46
9	neighborhood	39	51	60
10	trees and few homes	69	87	88
11	wetlands and some development	57	66	69
12	wetlands between school fields	45	63	67
13	wetlands near neighborhood	53	48	45
14	wetlands	54	36	29
15	wetlands	41	32	28
16	wetlands	13	4	4
17	wetlands	29	18	15
18	impervious	16	14	18
19	impervious	26	24	31
20	trees in neighborhood	40	48	55
21	trees and few homes	64	80	82
22	trees in neighborhood	43	46	46
23	open space short stream	27	34	31
24	riparian buffer	87	98	99