SAMMAMISH WATER QUALITY MONITORING

Annual Report 2020

In 2020, water-quality monitoring continued largely the same as in 2019 with the addition of stream-health monitoring (measuring stream bug diversity) on Zackuse Creek and at upstream sites on a few stream. Some data gaps exist due to the pandemic; no field sampling took place during April 2020, and in May 2020 only field parameters were measured (no water samples were collected for lab analyses). Sampling in September 2020 took place later in the month than usual due to wildfire smoke.

- **Ebright Creek watershed:** Stormwater outfalls continued to be monitored for flow and temperature using continuous gages, and sampled monthly for turbitidy. Wetland water level also continued to be monitored continuously.
- **George Davis / Allen Lake wetlands:** Water level continued to be monitored continuous 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). In 2020, two wet-weather samples were collected for metals analyses, completing the short-term metals assessment started in 2019.
- **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. A quantitative measurement was not possible this year due to social-distancing requirements, but staff observations noted that streambed sediments were similar to those measured in 2019.
- **Upstream stream-health sites:** Upstream monitoring sites were established on Ebright, Laughing Jacobs, and Pine Lake Creeks to measure stream health (stream bug diversity) and detect changes over time. These sites were chosen to help focus on areas that are expected to develop or redevelop in the near future.
- **Riparian forest:** Riparian forest canopy cover was mapped in the Zackuse, Ebright, and Pine Lake Creek watersheds, using aerial imagery from 2019. 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), 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).

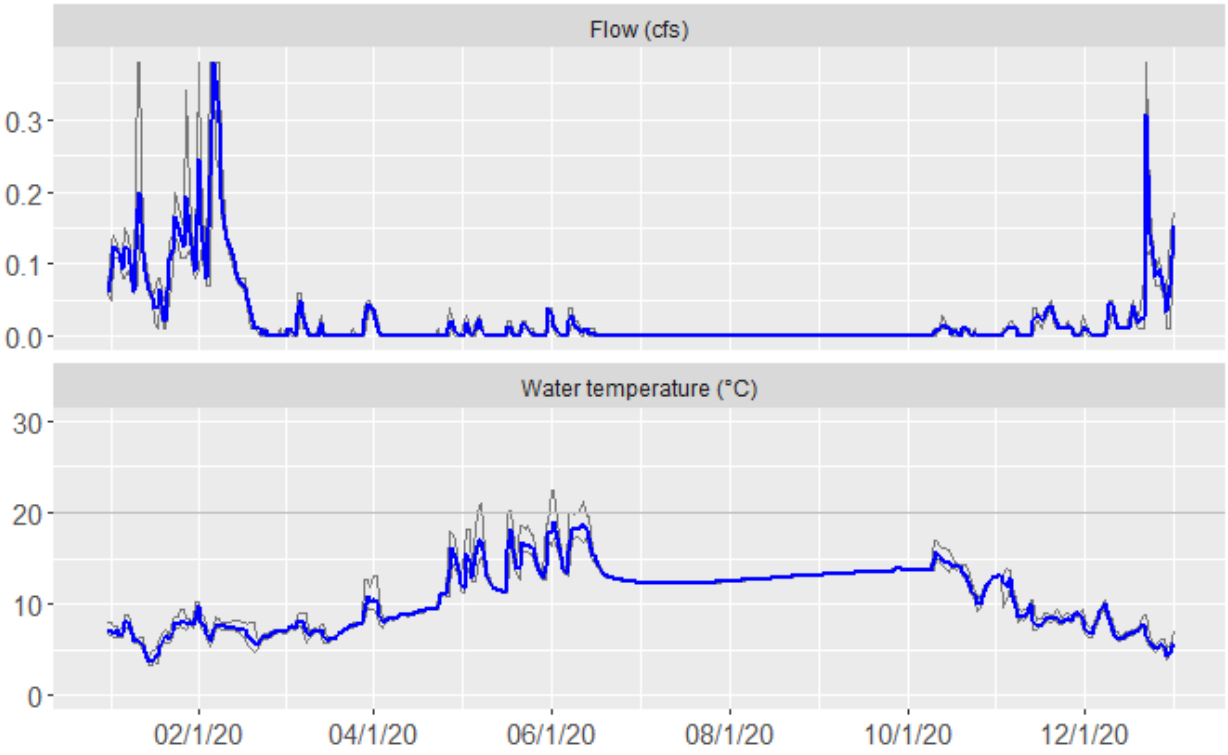
Ebright Creek Watershed

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

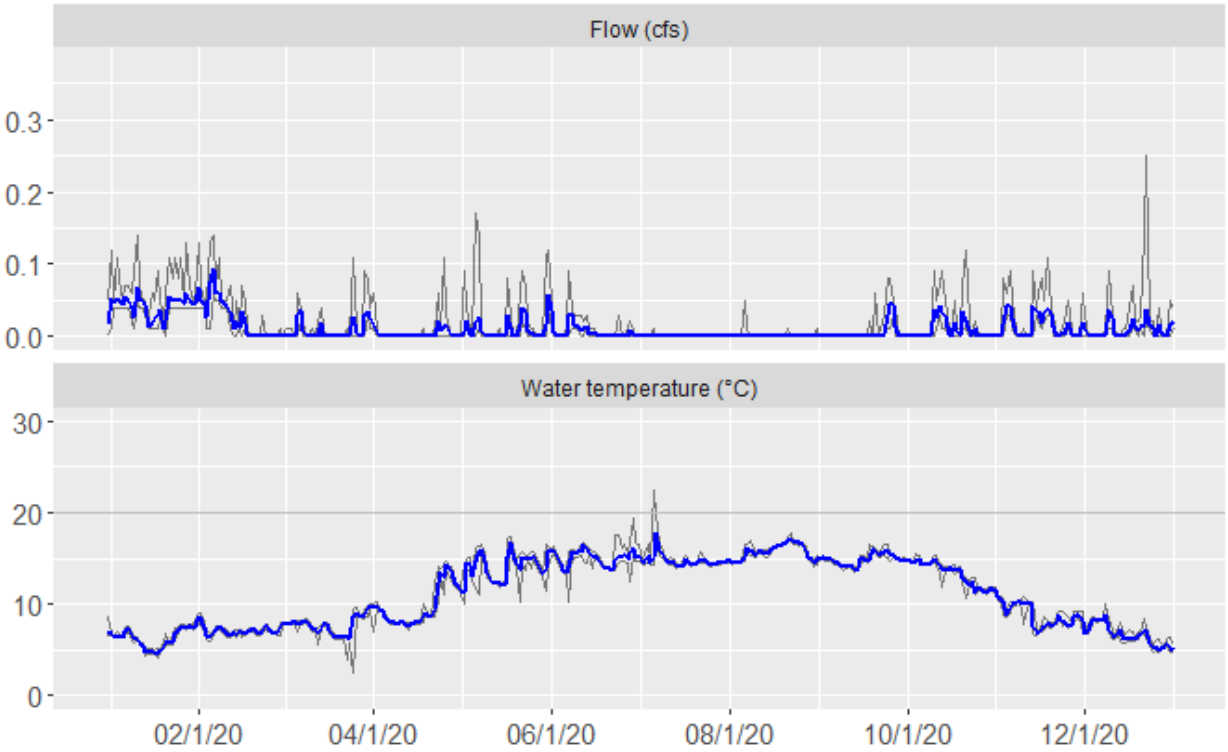
Gages on the outfalls continued to be monitored throughout 2020.

Chestnut Pond



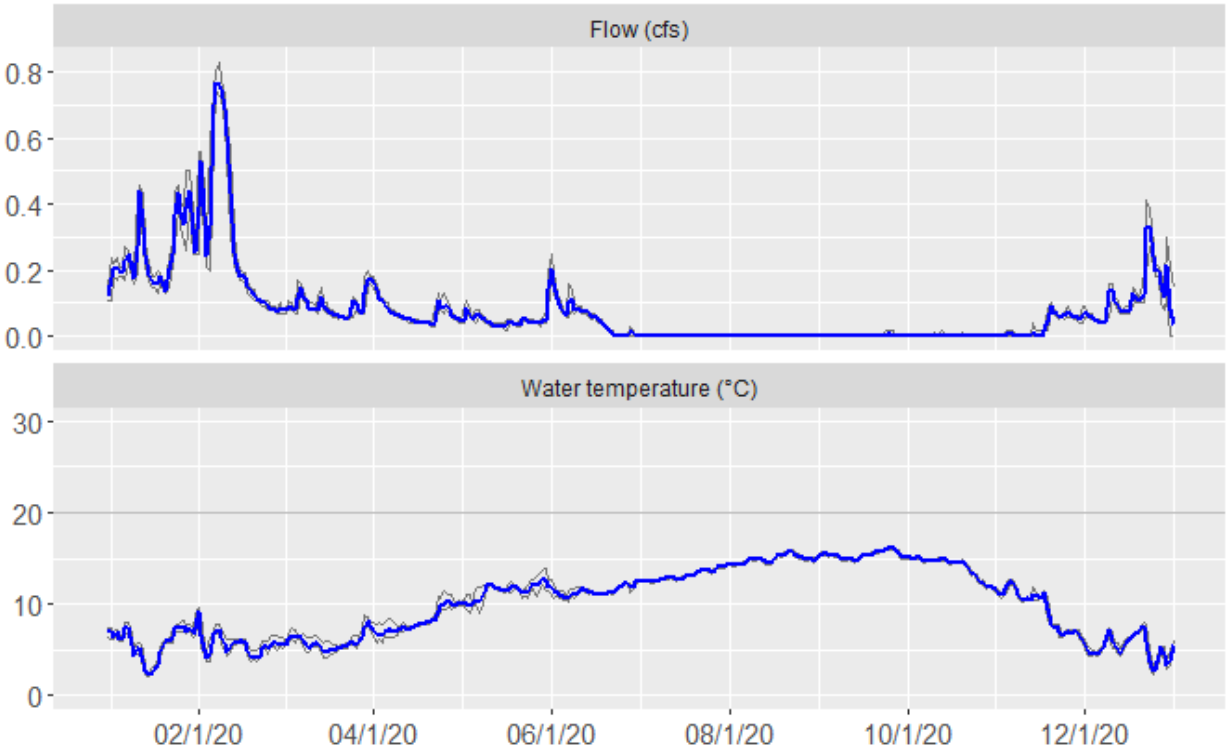
The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Crossings - East pond



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

Crossings - West wetland

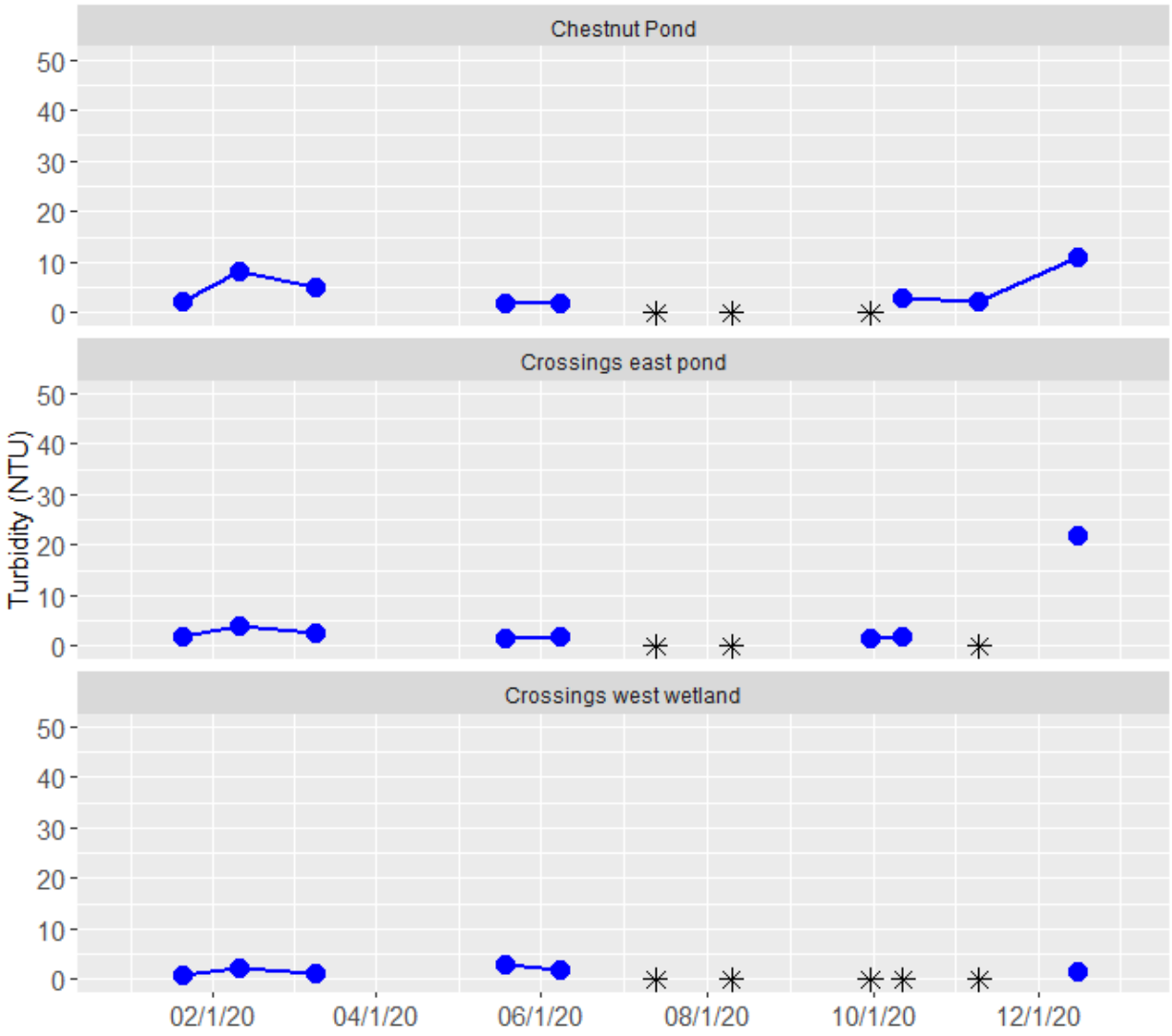


The blue line shows daily average values, and the thinner grey lines show daily maximum and minimum values.

Turbidity

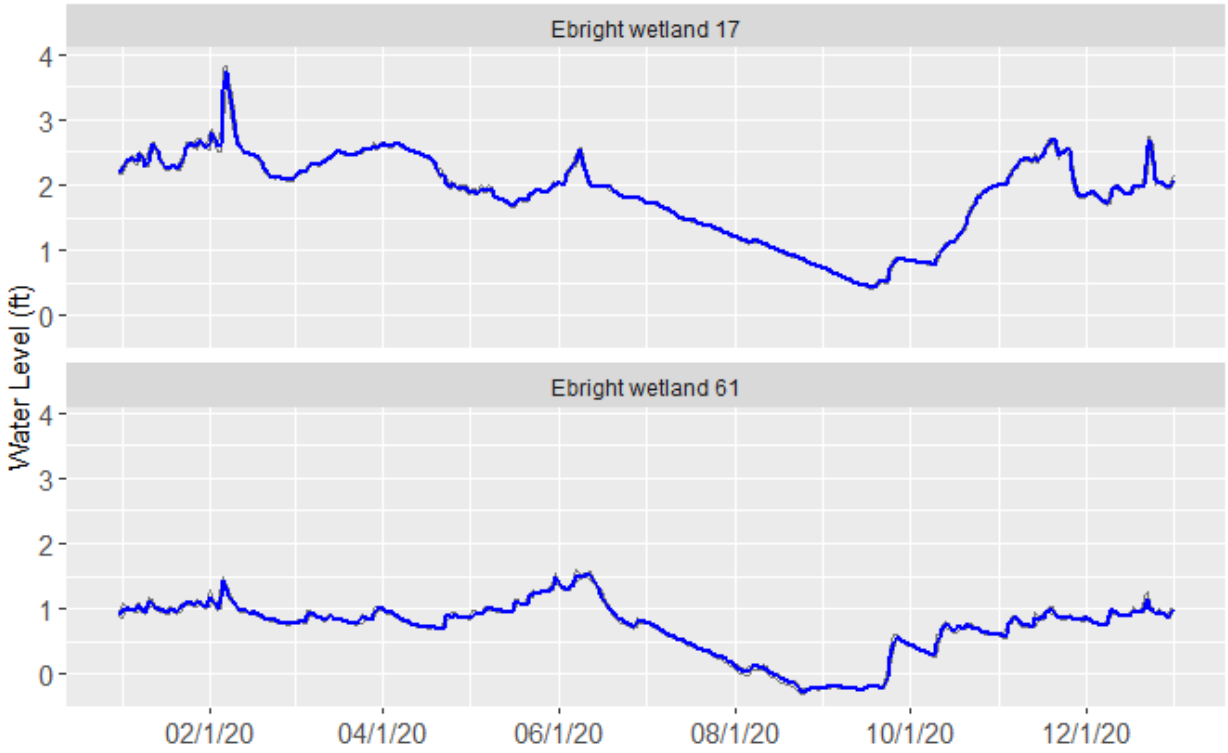
The three stormwater outfalls were visited each month except April, due to the pandemic. Unless the outfall was dry, samples were collected for laboratory turbidity analysis. In May 2020, turbidity was measured in the field instead of its usual lab measurement due to laboratory constraints during the pandemic. That data point has been included in this graph.

Turbidity was consistently low in all samples in 2020.



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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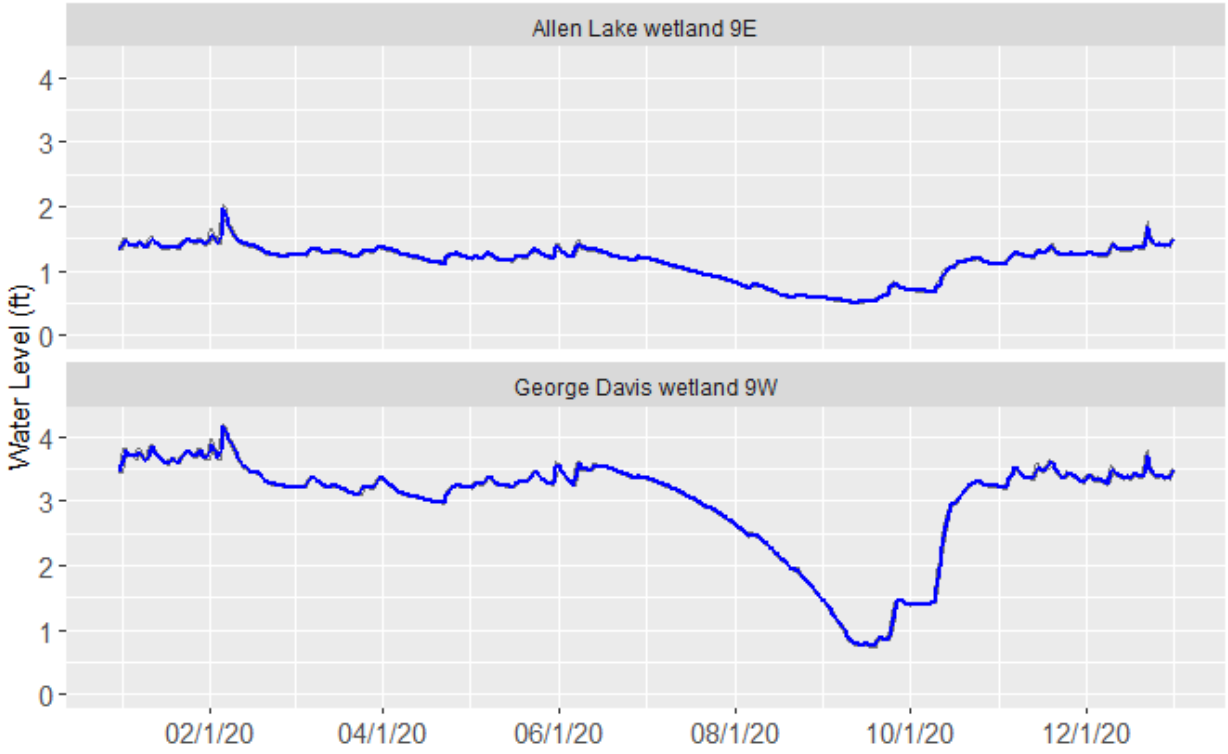
George Davis / Allen Lake Wetlands



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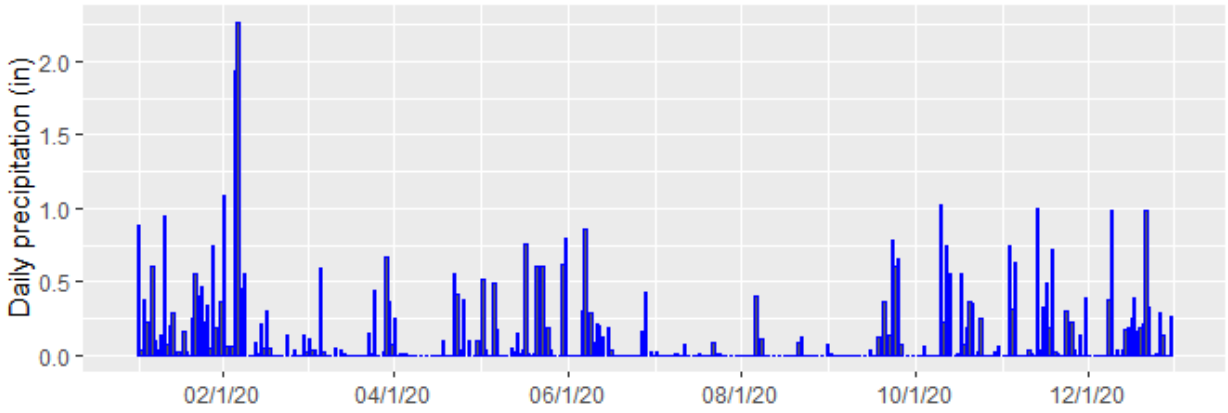
Precipitation

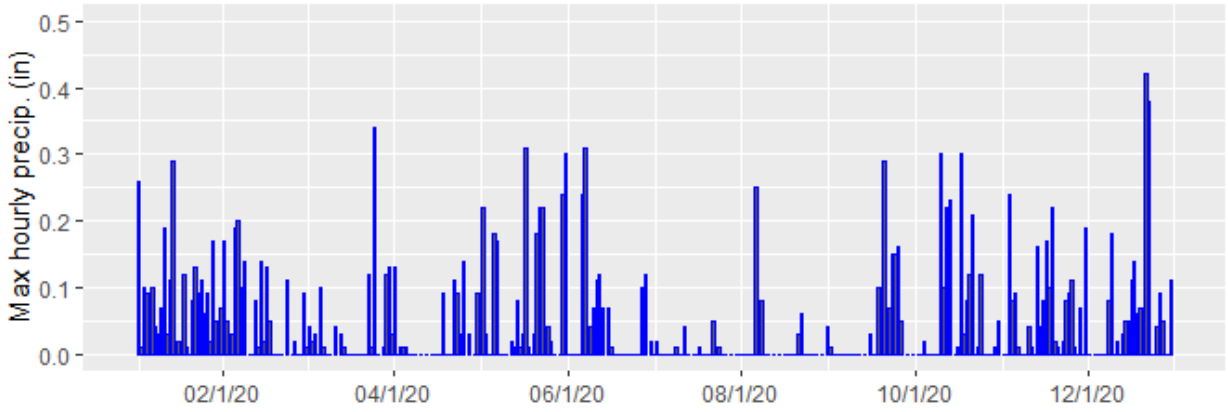
Precipitation (rain and snow) was measured by a rain gage on top of Sammamish City Hall.

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 was monitored annually for stream health by measuring benthic macroinvertebrate ("stream bug") diversity.

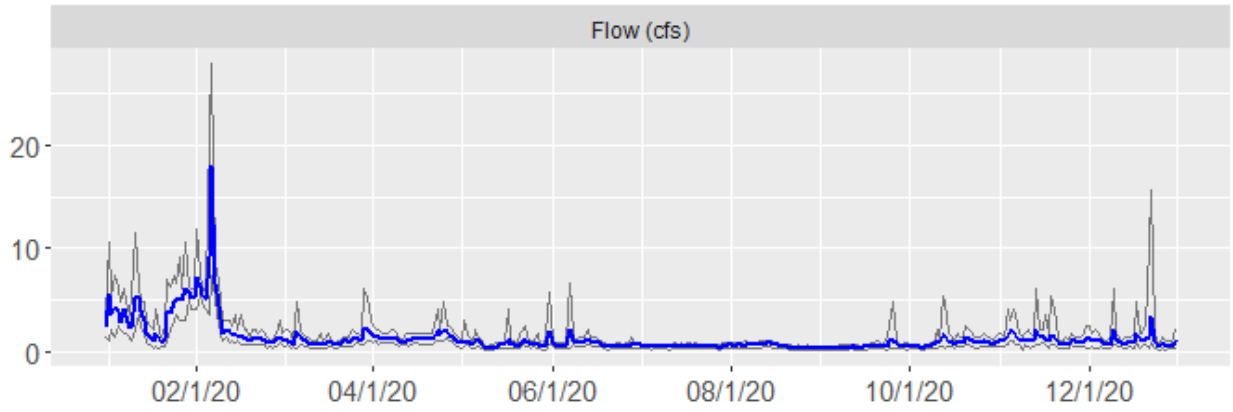
In 2020, monthly monitoring was reduced in April (no monitoring) and May (field parameters only; no lab analyses) due to the pandemic. Sampling in September 2020 took place later in the month than usual due to wildfire smoke.

Two wet-weather metals samples were also collected in early 2020 to complete the short-term metals assessment started in 2019.

Streamflow

Monitoring streamflow on Zackuse Creek has proven to be challenging since the December 2019 storm mostly filled in the culvert under East Lake Sammamish Parkway and buried the original streamflow gage. A temporary gage was set up after that storm, and we had planned to establish a new permanent gage once the culvert was dug out in summer 2020. When it was decided not to dig out the culvert and let natural processes continue to reshape the streambed, we moved the gage in spring 2020 to a new permanent location downstream from the trail.

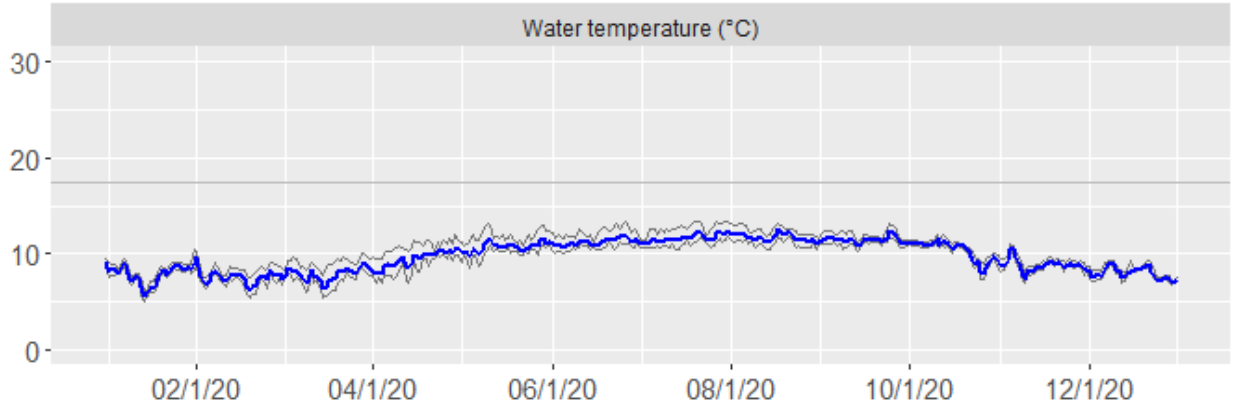
Unfortunately, data analysis has raised questions about the accuracy of streamflow measurements at this location during high storm flows. As a result, the gage was relocated again to a location that we think will yield reliable data. We consider the early 2020 high storm flow data to be questionable, so please contact King County for a more in-depth discussion about its issues and limitations before using it for decision-making.



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. In 2020, Zackuse Creek stayed cool and well-oxygenated throughout the year.



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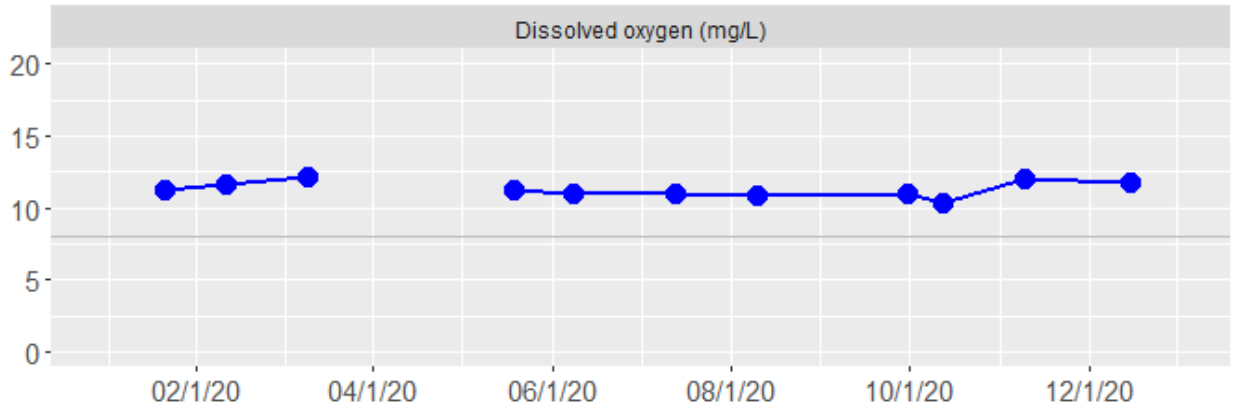


Biotic Stream Health

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

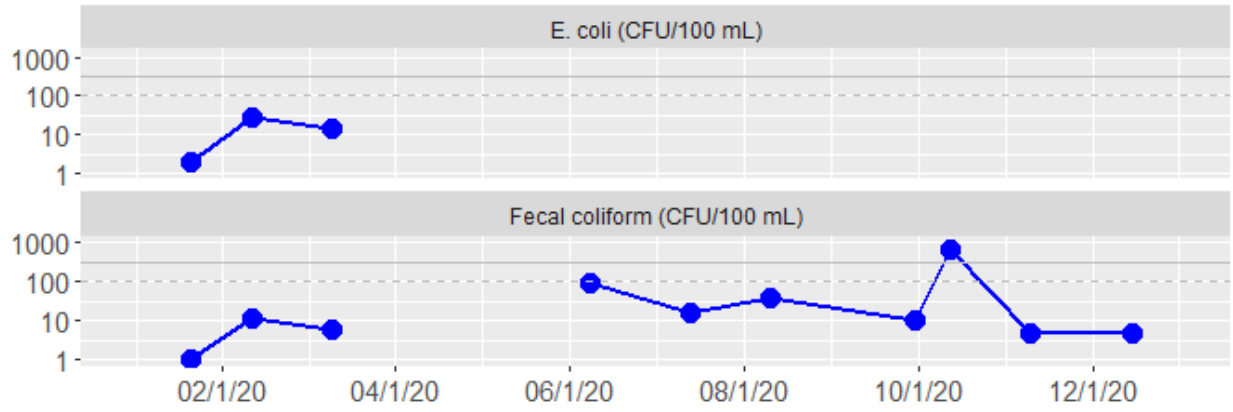
In 2020, Zackuse Creek's overall Benthic Index of Biotic Integrity (B-IBI) score was 47.5 (on a 0-100 scale). This score is generally interpreted as "fair" stream health. This section of Zackuse Creek was extensively restored in 2018, and we expect to see B-IBI scores increase over time as the stream settles into its new configuration.

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 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 2019, with only one sample (October 2020) over 320. Isolated high bacteria concentrations like this are common in streams and tracking down periodic sources like this would be very difficult.

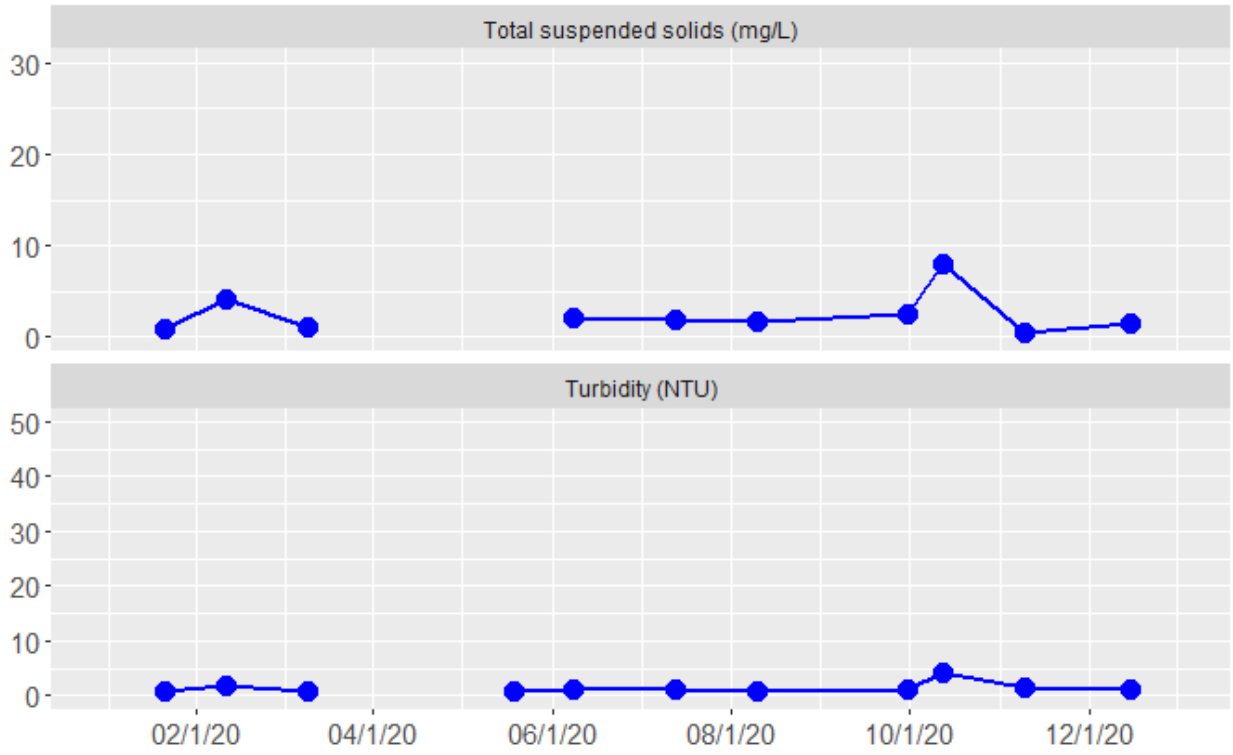
The King County microbiology lab was not able to measure both *E. coli* and fecal coliform bacteria during the pandemic, so for all streams only fecal coliform bacteria was measured from June onwards.



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 2020, 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.

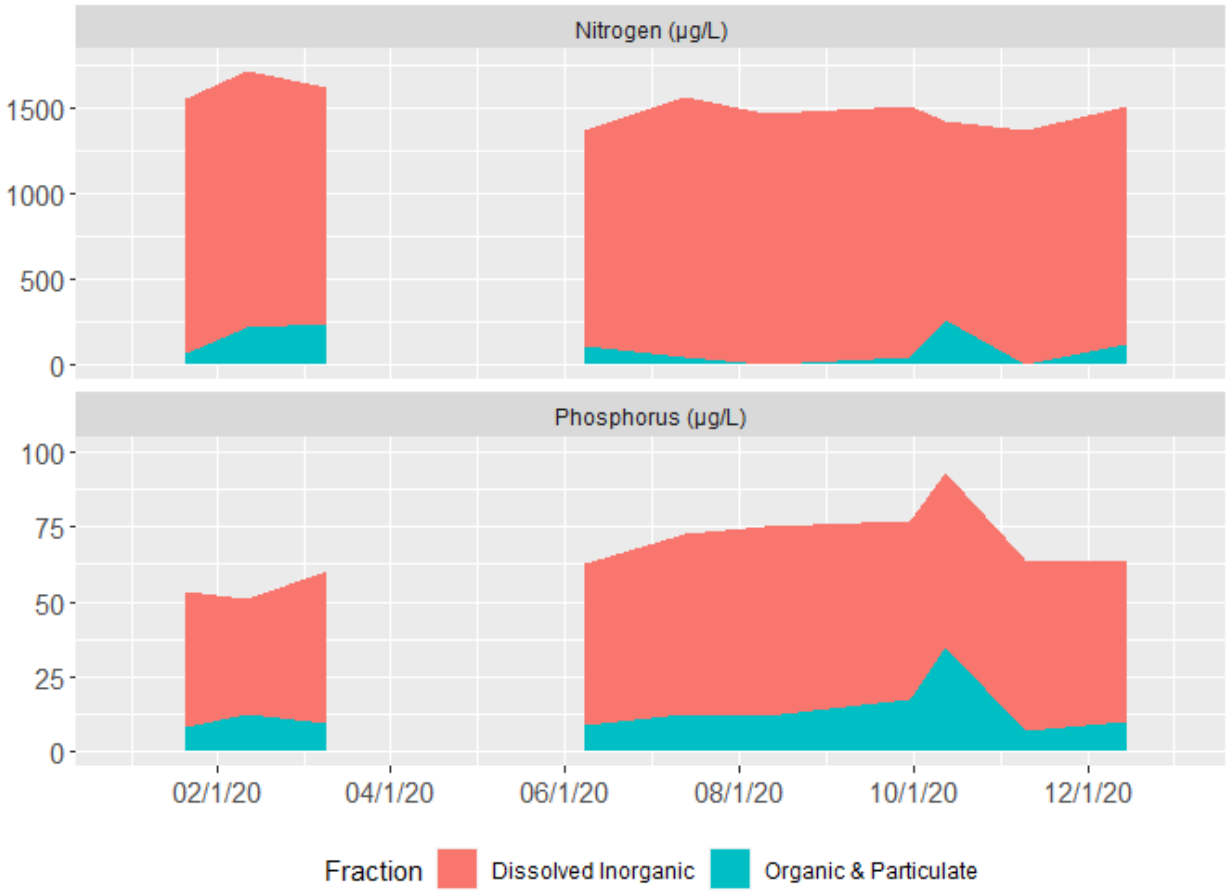
In May 2020, turbidity was measured in the field instead of its usual lab measurement. That data point has been included in this graph.



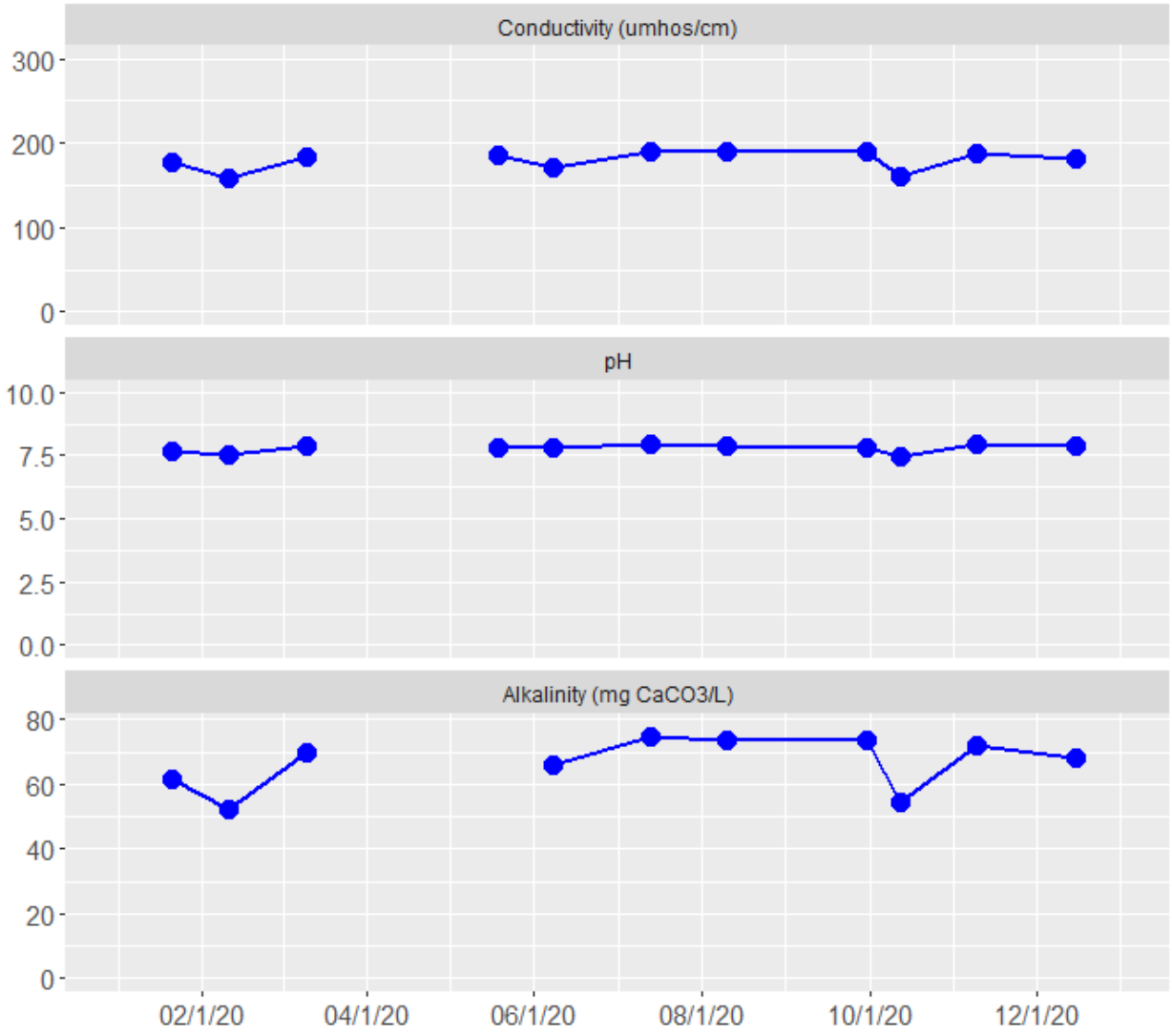
Nutrients

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.

In 2020, 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



Metals

Two samples were collected and analyzed for metals in early 2020, both from wet-weather conditions (during or shortly after rainfall). All values are given in µg/L. Results in parentheses were less than the laboratory method detection limit (<MDL).

Parameter	2020-01-23	2020-02-05
Arsenic, Dissolved	1.24	0.995
Arsenic, Total	1.45	1.87
Cadmium, Dissolved	(<0.05)	(<0.05)
Cadmium, Total	(<0.05)	(<0.05)
Calcium, Dissolved	13000	9070
Calcium, Total	13200	9540
Chromium, Dissolved	0.49	0.57
Chromium, Total	0.92	4.52
Copper, Dissolved	1.4	2.06
Copper, Total	1.7	4.73
Iron, Dissolved	102	131
Iron, Total	318	1900
Lead, Dissolved	(<0.1)	0.11
Lead, Total	0.23	1.73
Magnesium, Dissolved	5770	3530
Magnesium, Total	5790	3990
Mercury, Dissolved	(<0.005)	(<0.005)
Mercury, Total	(<0.005)	0.011
Nickel, Dissolved	0.598	0.752
Nickel, Total	0.979	4.11
Selenium, Dissolved	(<0.5)	(<0.5)
Selenium, Total	(<0.5)	(<0.5)
Silver, Dissolved	(<0.04)	(<0.04)
Silver, Total	(<0.04)	(<0.04)
Vanadium, Dissolved	1.54	1.31
Vanadium, Total	2.01	5.51
Zinc, Dissolved	7.23	6.74
Zinc, Total	9.56	21.6

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	260 - 470	84 - 153	WQS (calculated)
Copper, dissolved	7.2 - 14.3	5.2 - 9.7	WQS (calculated)
Lead, dissolved	24 – 53	0.9 – 2.0	WQS (calculated)
Nickel, dissolved	655 – 1207	73 – 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

Entombment

In 2020, quantitative substrate monitoring was not conducted due to social-distancing requirements. Instead, we did a visual qualitative assessment of the stream transect reaches in early June. Despite the large storms in winter 2019-2020, substrate quality appeared to be good and similar to conditions found in 2019.

We observed the effects of considerable streambed movement in Zackuse Creek, which had reshaped the streambed into a more complex, natural geometry. We did note fine sediment deposits on the streambed slightly upstream from our original transect reach. In 2021, we will reassess whether that upstream reach would be a more useful sentinel location for assessing entombment and sedimentation.

Upstream stream health

In 2020, three new upstream sites were established for annual stream-health monitoring on Ebright, Laughing Jacobs, and Pine Lake Creeks (see the following map). 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. As such, those thresholds are 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.

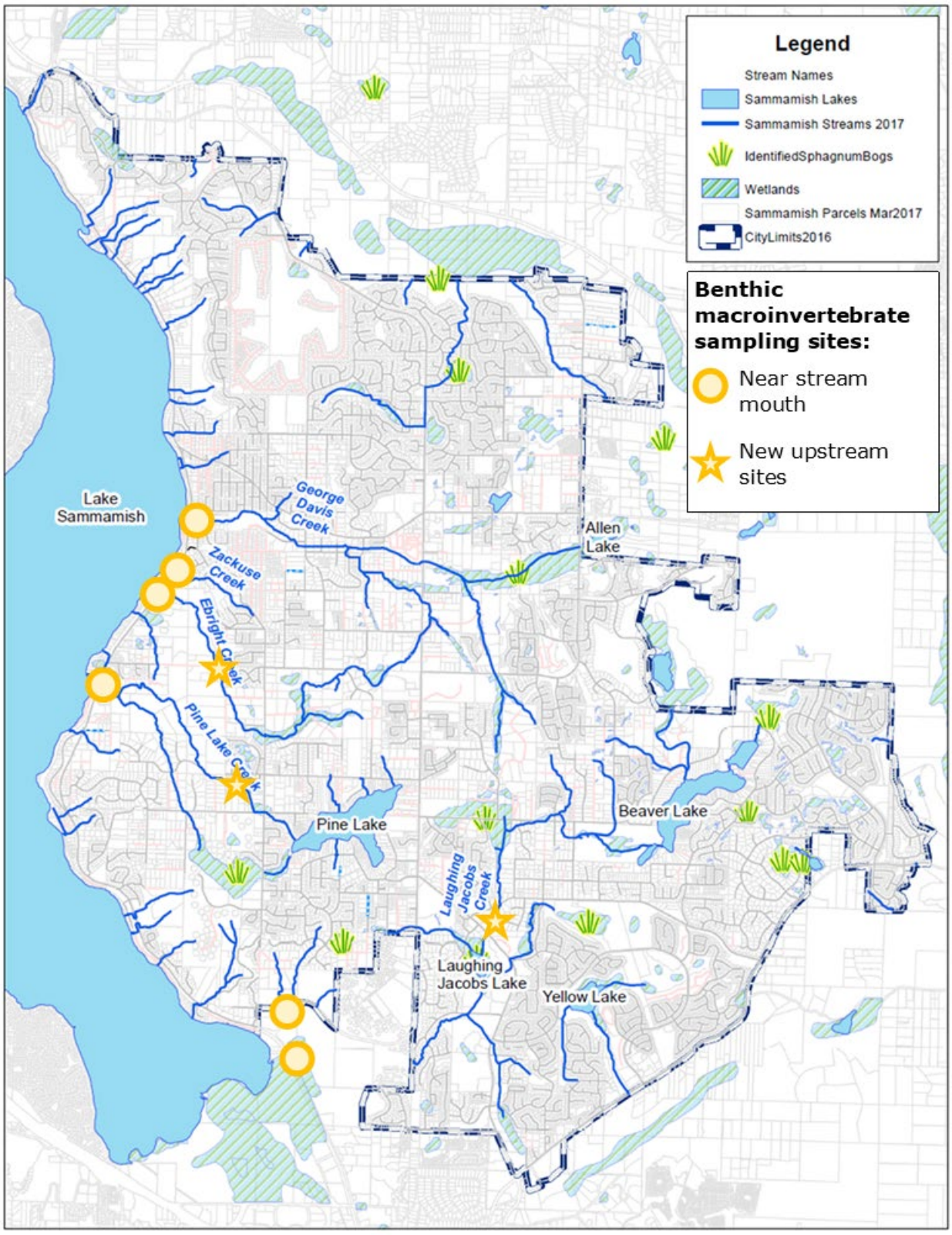
In 2020, the overall B-IBI scores were:

- Ebright Creek: 12.9
- Laughing Jacobs Creek: 1.6
- Pine Lake Creek: 14.5

Full results 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
- Laughing Jacobs Creek data: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=LJU
- Pine Lake Creek data: https://pugetsoundstreambenthos.org/Biotic-Integrity-Scores.aspx?k=PINE

Map of new upstream stream-health monitoring (benthic macroinvertebrate diversity) sites:



Riparian canopy cover

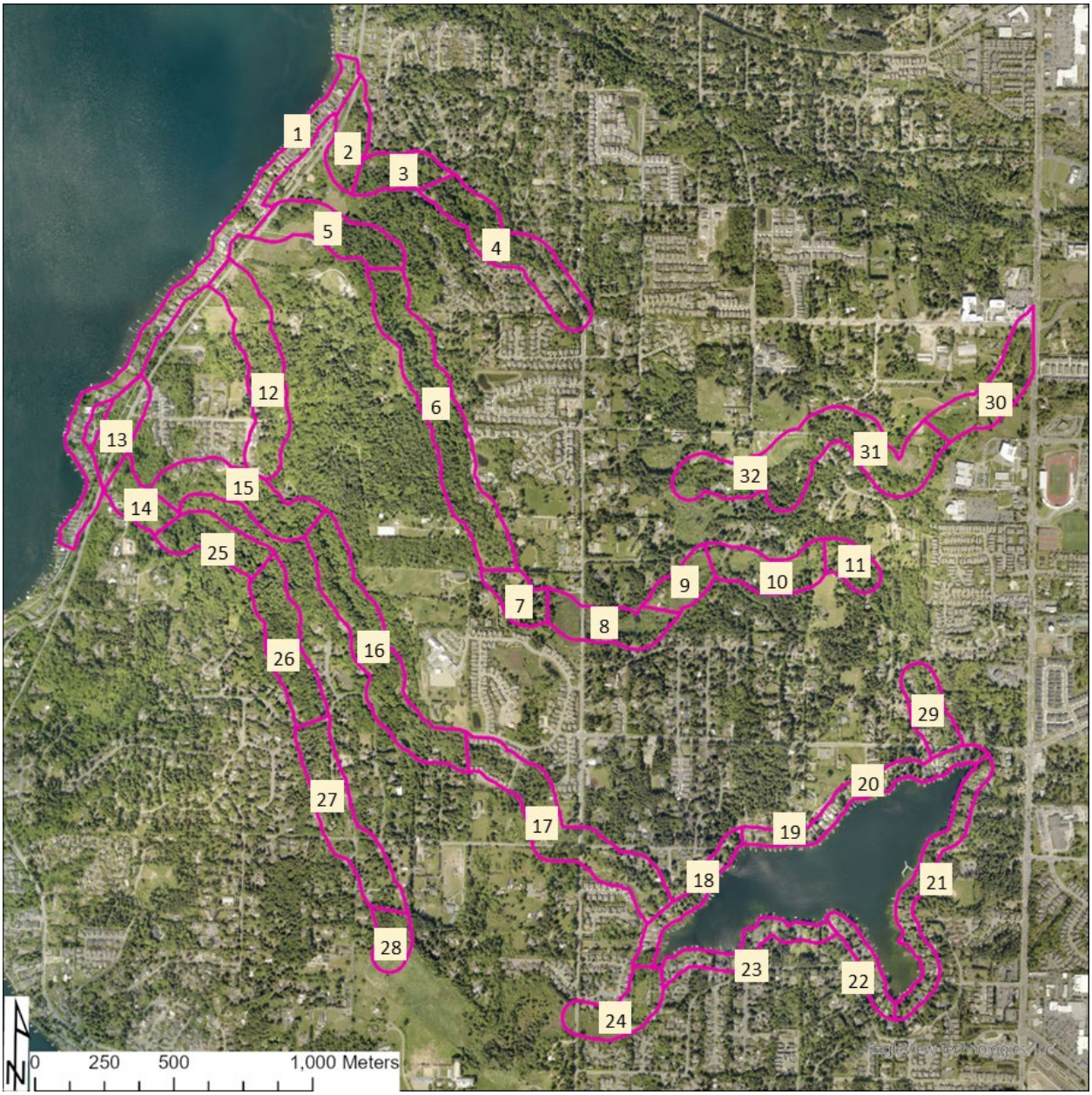
We measured riparian tree canopy cover for the basin containing Zackuse, Ebright, and Pine Lake Creeks, using aerial photos taken in 2019. Tree cover (presence/absence) was mapped within 60 m (200 ft) of streams and shorelines, on a grid of points 5 m apart. Full results are provided separately as a GIS file and high-resolution PDF map.

Total canopy cover in the riparian zone was 64%. 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 on the next page, followed by a table of the canopy cover results for each reach.

On the slope of the plateau, the creeks generally had very high canopy cover, especially in the zones closest to the stream. But upstream and along Lake Sammamish and Pine Lake, riparian cover was much more variable, usually due to development. 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:



Canopy cover for each reach:

Reach	Land Cover	60 m	20 m	10 m
1	lake shoreline	23	44	48
2	trees	67	73	73
3	trees and few homes	86	95	96
4	riparian buffer near homes	69	78	87
5	trees and few homes	66	83	90
6	riparian buffer	91	99	100
7	trees and few homes	64	76	82
8	wetlands	35	16	12
9	wetlands	41	21	22
10	wetlands	52	42	41
11	trees	86	71	62
12	riparian buffer	73	87	85
13	road	56	50	55
14	riparian buffer	79	89	91
15	riparian buffer near homes	85	88	91
16	riparian buffer	93	97	96
17	trees in neighborhood	58	74	77
18	lake shoreline	46	29	21
19	lake shoreline	34	NA	NA
20	lake shoreline	32	49	62
21	lake shoreline	48	NA	NA
22	lake shoreline	31	NA	NA
23	lake shoreline	36	NA	NA
24	wetlands	45	43	49
25	riparian buffer	96	98	98
26	riparian buffer	95	100	100
27	trees in neighborhood	66	74	78
28	wetlands	52	36	39
29	trees in neighborhood	50	44	46
30	wetlands	59	59	58
31	riparian buffer near homes	86	84	86
31	trees and few homes	61	76	77
32	riparian buffer near homes	62	74	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. Some riparian areas along the Pine Lake shoreline do not contain a stream, and therefore those reaches do not include results for the 10-m or 20-m zones (shown as NAs).

King County

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