

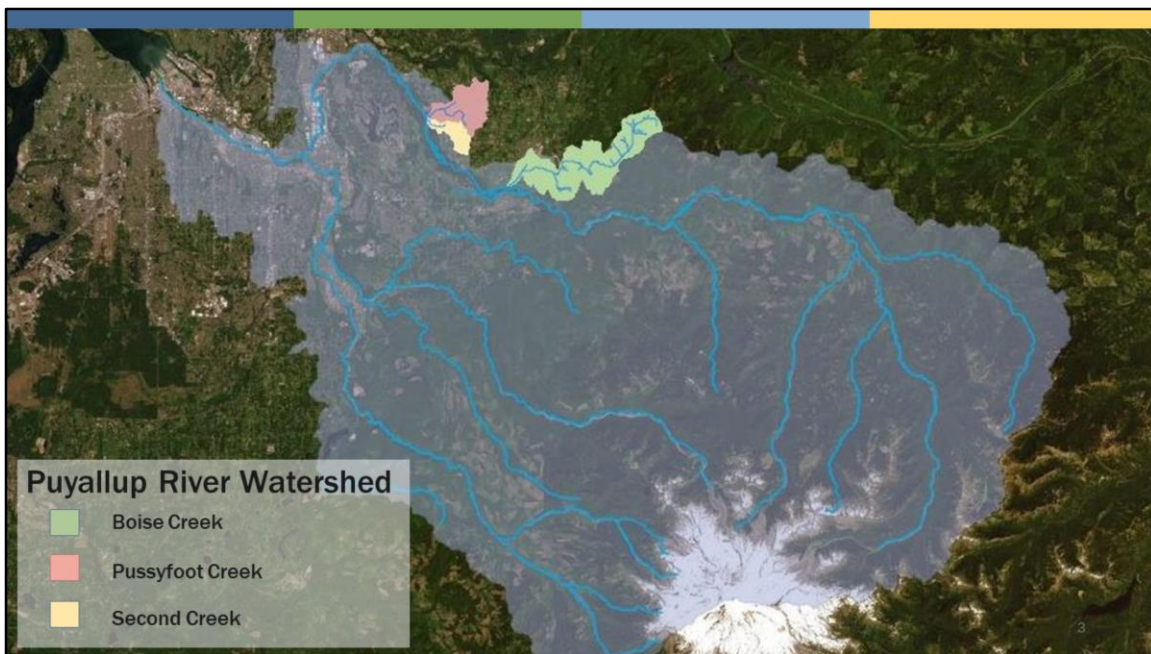


Puyallup River Tributaries Effectiveness Monitoring

Molly Gleason

Cleaner Water Through Monitoring

- I. Background
- II. Results
 - I. Long-term Trends
 - II. Implementation Monitoring
 - III. Investigative Monitoring
- III. TMDL Progress

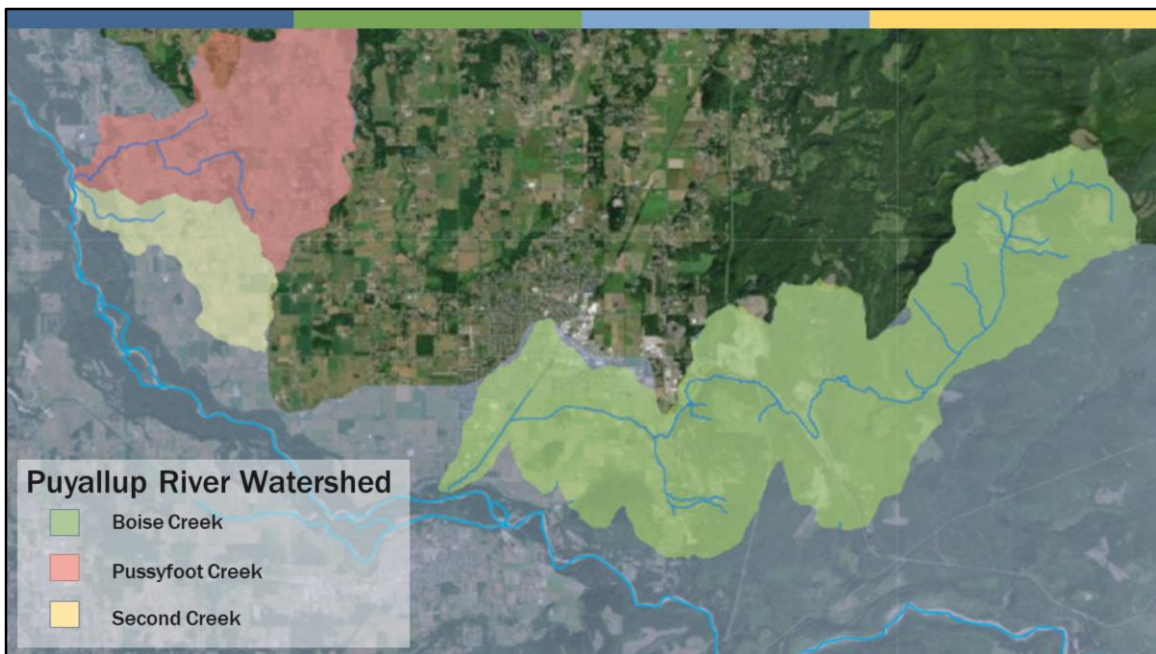


The Puyallup River basin located in Pierce and southern King County. The major rivers of the basin are the Puyallup River and its two largest tributaries: the White River and the Carbon River.

In the northern part of this watershed we have three major creeks or tributaries that feed into the White River, Boise Pussyfoot and Second Creek. **Boise Creek** flows along the border of the city of Enumclaw and is a mix of rural and residential land use.

Pussyfoot and Second Creek are located to the east in King County south of Auburn and have a largely rural and agricultural character with many small acreage farms with livestock, dairies and a few residential developments. Many small tributaries feed into Pussyfoot and Second Creek and both flow into the White River through the Muckleshoot reservation.

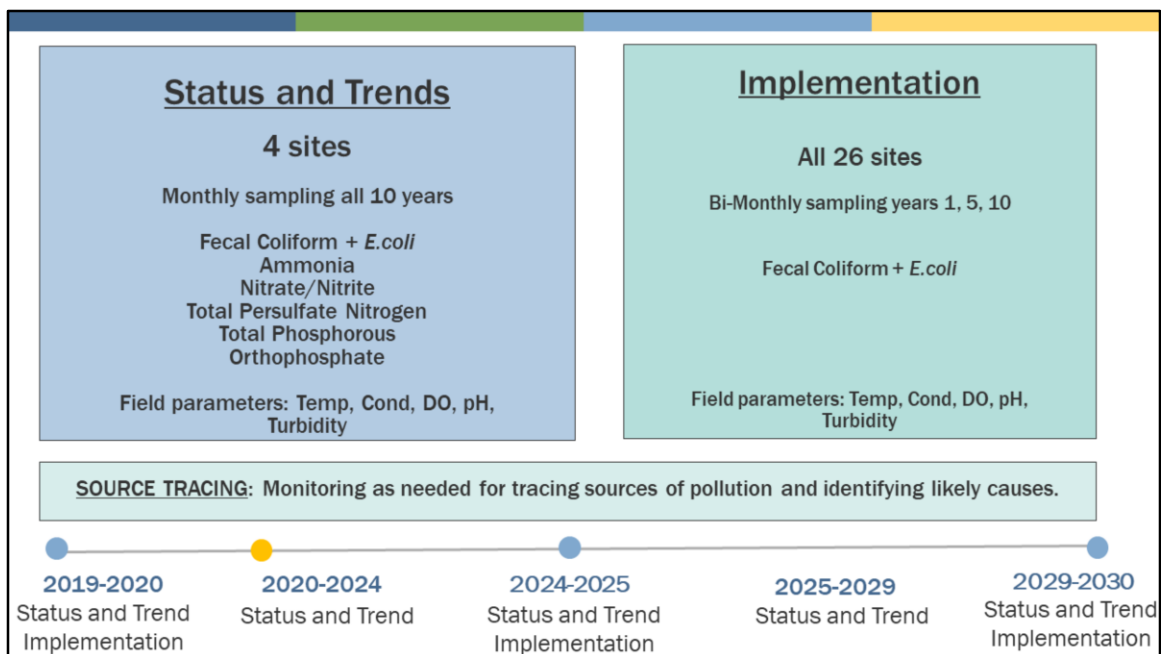
Ecology and our partners have conducted years of monitoring in this area and determined that these subwatersheds are a high priority for water quality improvement. These three tributaries do not meet or exceed water quality standards for a variety of parameters including, bacteria, pH and temperature.



In 2011, an Ecology Bacteria Total Maximum Daily Load (TMDL) was developed to address these bacteria issues. Based on that study, Boise Creek was found to be the largest fecal coliform source of any tributary in this watershed.

A follow up study by Ecology also found that many of the tributaries and ditches on Pussyfoot Creek and Second Creek exceeded bacteria standards. This is critical to understand the amount of pollutants that are being delivered to the White River and to the Muckleshoot reservation from these tributaries.

In addition to bacteria, other water quality parameters are of concern. Ecology is preparing a pH TMDL in the Lower White River with a focus on reducing nutrients, such as nitrogen and phosphorus. By reducing the nutrient levels, this can help reduce extreme peaks in pH in the river.

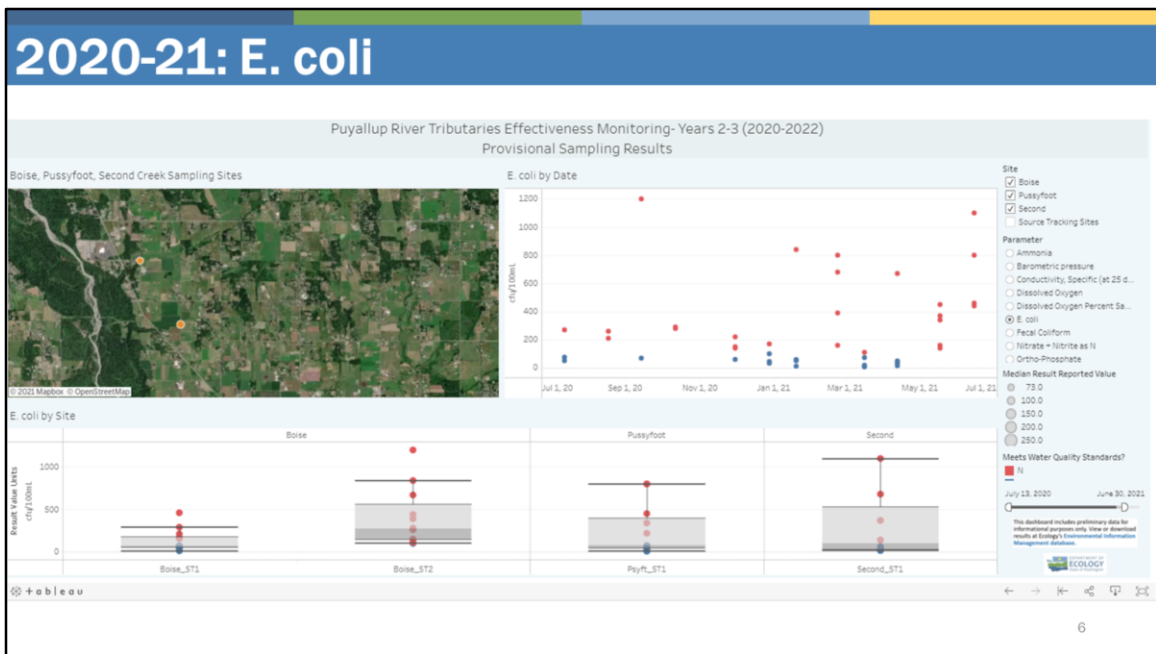


Currently, we are in the third year of monitoring for this 10 year effectiveness monitoring study. For the full 10 years, Ecology monitors at long-term stations known as status and trend sites that represent the most downstream locations of, Boise, Pussyfoot and Second Creeks. We sample these sites monthly to understand the long-term status and trends of water quality at these three tributaries. We sample for a full suite of parameters.

It's only every 5 years we do a watershed-wide intensive sampling at 22 sites watershed. We only sample for bacteria and collect field measurements.

We are currently in the in between years of that intensive monitoring. Since we last met in March, I wrapped up year 2 of the monitoring end of June, so the presentation below focuses on year 2 results at the core sites. I have also been adding a few investigative sites to understand the particularly high bacteria levels in Boise Creek and high nutrients in Second and Pussyfoot and investigate what may be affecting the core sites.

2020-21: E. coli



Just as Ecology's past results have found in the fecal coliform TMDL, Boise Creek has the highest levels of bacteria compared to the rest of this watershed. The highest bacteria concentrations are located in the upstream, more urbanized area of Enumclaw, downstream of a major stormwater flume (Boise_ST2). This was the same result concluded from the first couple of years from this effectiveness monitoring.

Higher levels in Boise Creek were detected during the dry season, due to slowing flows, increasing temperatures. For the summer months, Pussyfoot and Second Creek are stagnant or dry until November. There are instances where all sites have bacteria levels above 100 cfu/100mL; there distinctive peaks in February 2021. February had the largest accumulation of rain for this past wet season.

We can infer that heavy rain of the winter season generates runoff that contributes to these increases in bacteria. Runoff can be from multiple agricultural and urban sources:

- Fields where there may be animal or livestock waste.
- Stormwater that washes the surfaces of urban landscapes and pavement with pet waste can transport fecal matter to these creeks that are within the boundaries of the City, such as Boise Creek.

All sites were high once again in June, when Washington State experienced record-breaking heat. The slowing flow and high temperature conditions may have allowed bacteria to thrive.

There were consistently high results at the upstream Boise Creek site (Boise_ST2), where all results were above 100cfu/100mL. This site had the greatest number of exceedances during the first year of sampling compared to the sites along Boise Creek mainstem and tributaries. These results drove the need to investigate why we're seeing such high levels at this site.

2020-21: E. coli, Boise Creek



Ecology has been helping the City of Enumclaw explore the bacteria levels along the city's stormwater laterals. Ecology has the established long term site at the most downstream location of the main flume and additionally sampled along the laterals that feed to the main flume and flow through neighborhoods. The main flow year round is from Lateral A the furthest southern lateral.

The map displays the geometric mean for E. coli for each three month period. This is how Ecology evaluates bacteria standards. This date represents the start of the three month period; so what I'm showing here is the geometric mean calculated for July-September period. Any geometric mean that is above 100 for that three month period is not meeting water quality standards.

- During rain events in Nov 2020 and Feb 2021, there is significant runoff flow flowing to Lateral A from unincorporated King County. Cattle have been observed in close proximity to the ditch along Warner and were not sufficiently excluded from the stormwater ditch. By bracket sampling this property, the results indicated a significant increase in bacteria from upstream (Boise D2) to downstream (Boise_D1) of the property.
- Potential Illicit discharge from a stormwater swale: the water emanating from this swale is very milky in color but also very slow moving. We would need to gather

more data to confirm whether it is a major source of bacteria.

- Disturbed sediment can reintroduce bacteria into the water column and cause peaks in bacteria. Maintenance work along the laterals happened to cause a coincidental disturbance and *high E. coli* that both Ecology and the city detected in results.

2020-21: E. coli, Boise Creek



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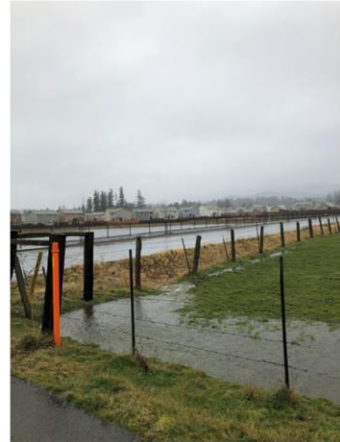
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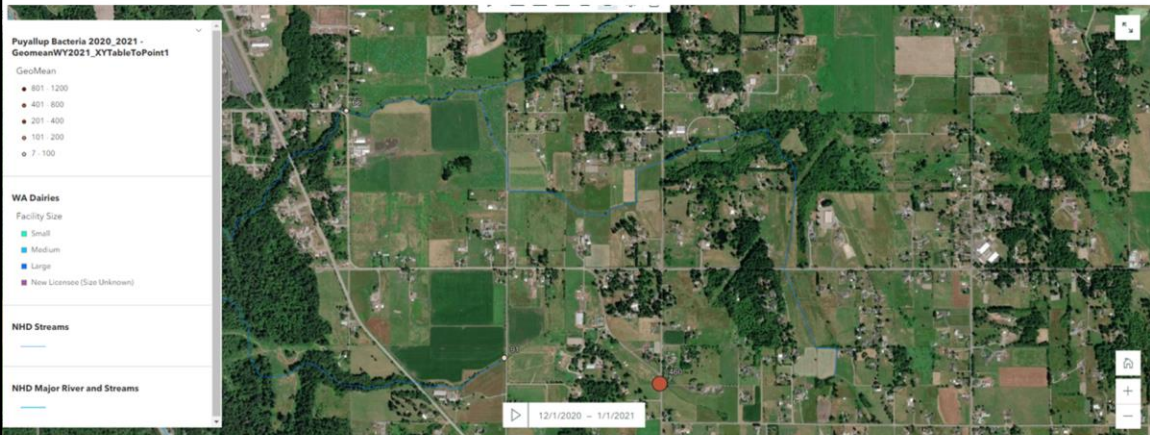
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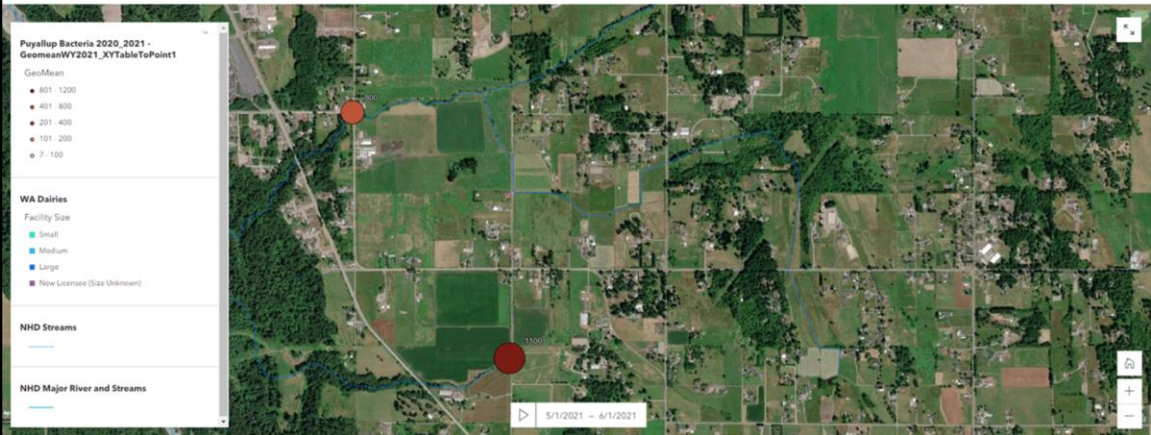
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In summary: there are multiple sources of pollution in Lateral A depending on the season. During the dry season, elevated bacteria could originate from dog waste and wildlife bordering these laterals, from potential illicit discharges (further sampling during higher flows necessary to confirm), and resuspension of sediment in the lateral from basic maintenance work. During the wet season, there is the influx of bacteria from rural unincorporated areas bordering the city's stormwater system.

2020-21 : E. coli, Pussyfoot and Second Creeks



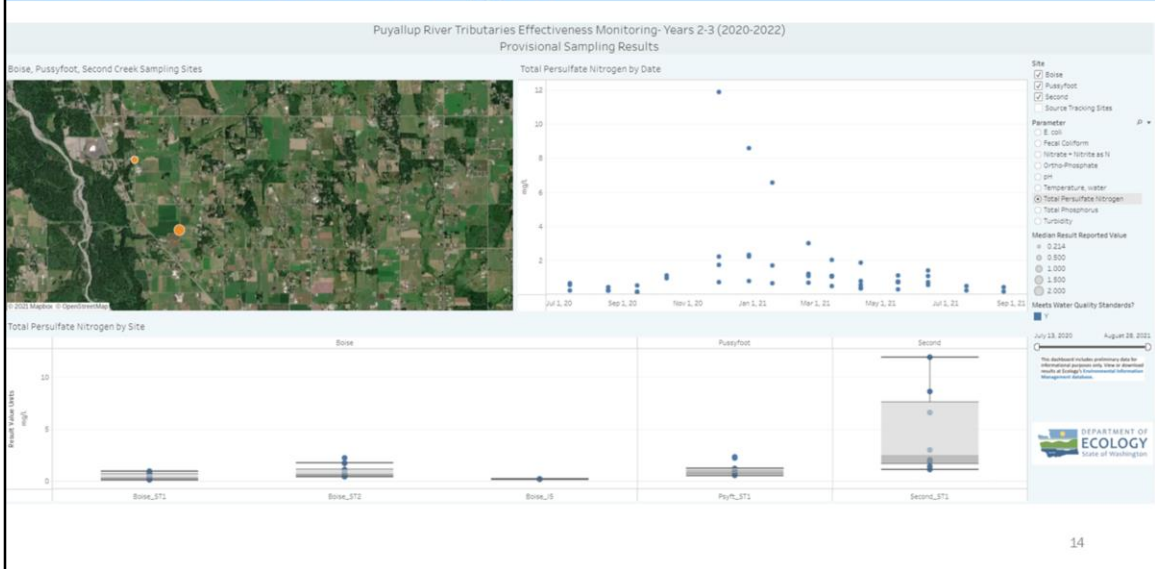
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Elevated bacteria from in June from slowing flow and increasing temperatures.

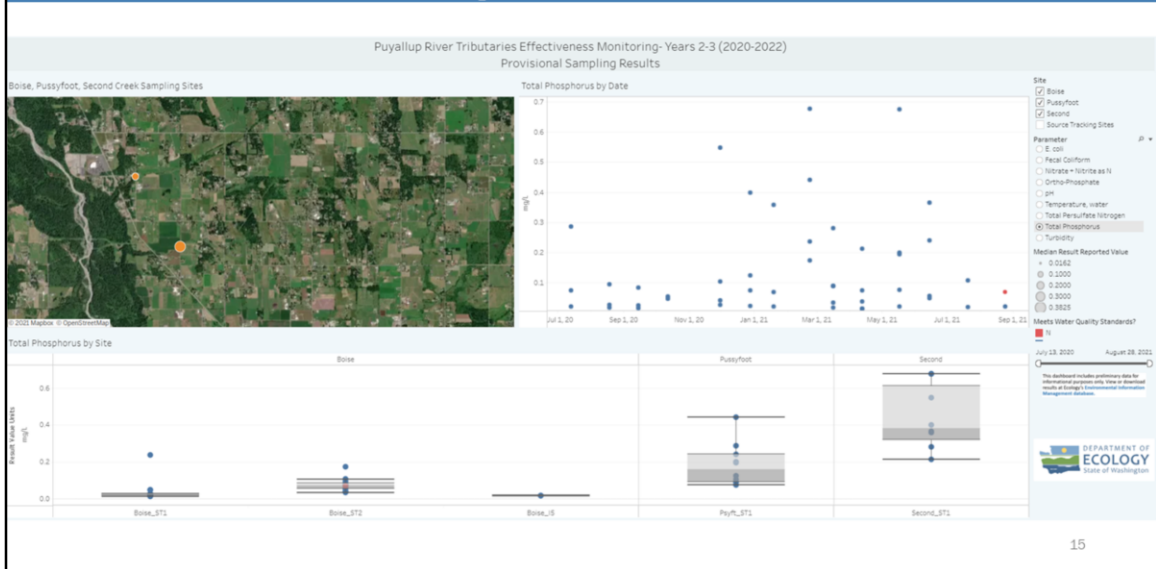
2020-21: Total Nitrogen



Pussyfoot and Second Creeks have the highest nutrient levels in the basin. Even though these creeks are dry during the summer, during this winter season there are higher flows and thus greater delivery of nutrients directly to White River from Pussyfoot and Second Creeks.

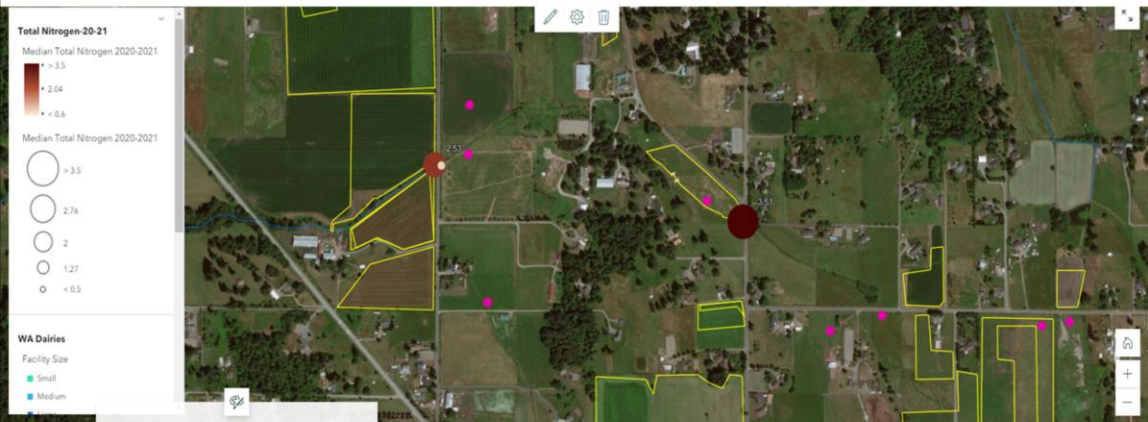
There was a peak in nitrogen in November signifying the first flush and it tapered off after the first flush. Second Creek had the highest levels during the each of the sampling events in the winter season, and the highest was detected in November during a rain event of 11.9 mg/L. The highest detected levels at Pussyfoot Creek was 2.24 mg/L during the same November rain event.

2020-21: Total Phosphorus



Phosphorus levels were more sporadic and did not follow this same first flush peak. Phosphorus levels seemed to peak and pulsate with every rainfall event. This means there's a delivery of total phosphorus with every rainfall.

2020-21: Total Nitrogen, Second Creek



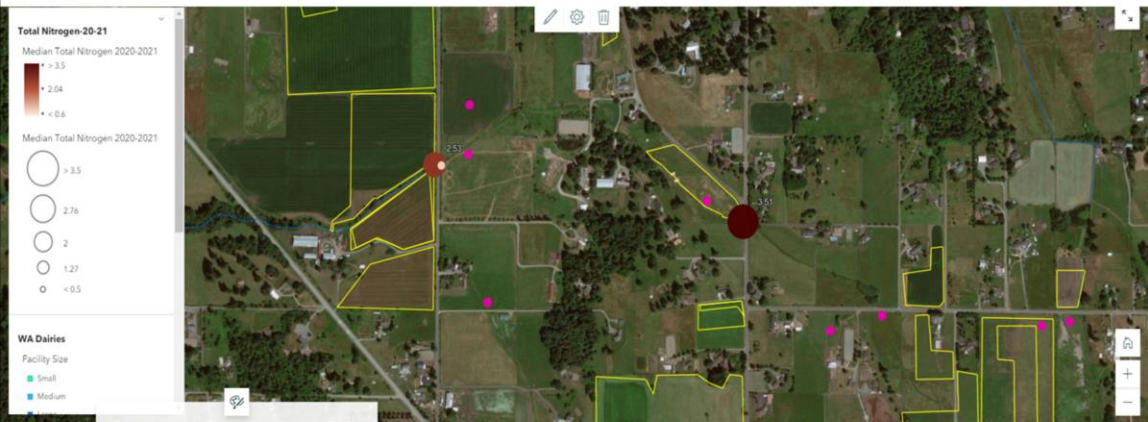
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The high results at Second Creek necessitated further investigation of nutrient sources upstream of the long-term site (Second_ST1). We don't have nutrient data further upstream of this creek, only at the downstream location. So I bracketed the area where there are known nonpoint sources of pollution and our bacteria data from the first year of sampling at these sites indicated a significant increase from this upstream to downstream site. There are so many other nonpoint issues on our radar just within this subwatershed so it doesn't mean these properties are necessarily a higher priority, so this was a *start* to try to understand why we're seeing such high nutrients particularly at Second Creek.

I sampled both the southern tributary that flows to Second Creek and an upstream site along the mainstem from December to April. Out of the three sampling events, the upstream site was higher than the downstream site. Two of the samplings indicated that the levels were almost double than downstream levels. Total phosphorus followed a similar pattern.

This brief period of sampling indicates a greater source of nutrients in these upstream locations at the headwaters of Second Creek and connecting tributaries that flow to this site.

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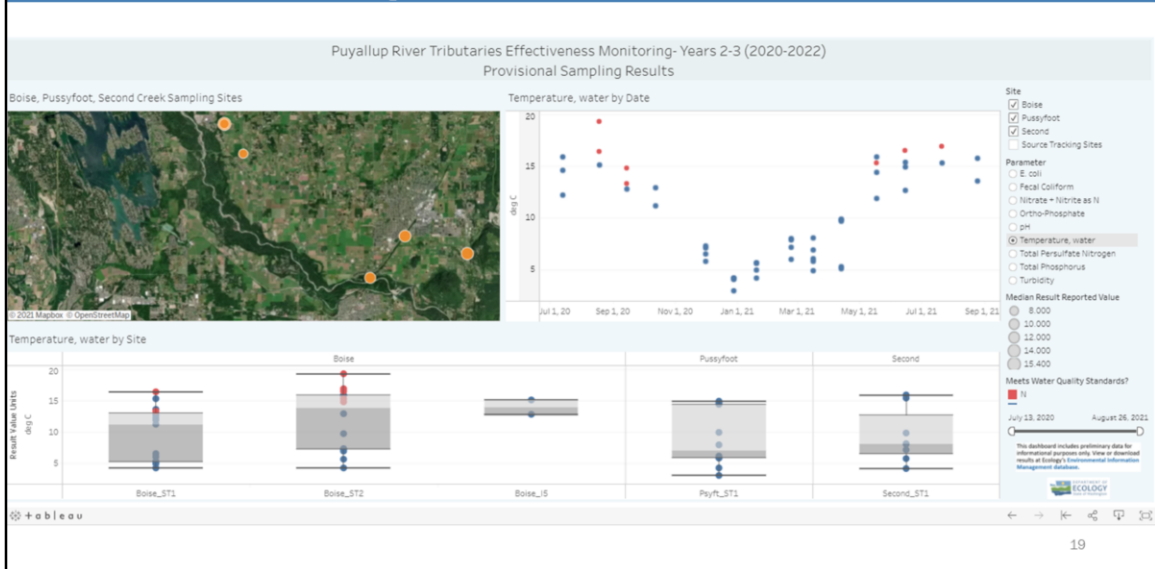
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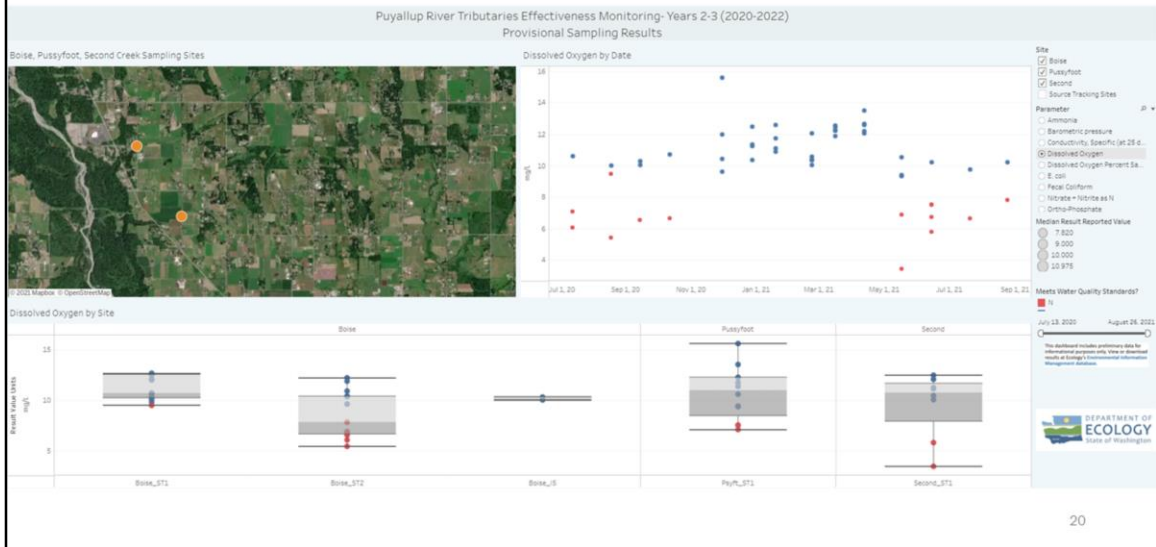
2020-2021 Temperature



Both Boise Creek sites at the mainstem and tributary did not meet temperature standards the past summer of 2020. In August, the creek exceeded the 16C criteria at both sites. In September, the creeks exceeded 13C temperature criteria (Boise Creek has supplementary standards to protect salmon spawning and incubation from September through July 1st).

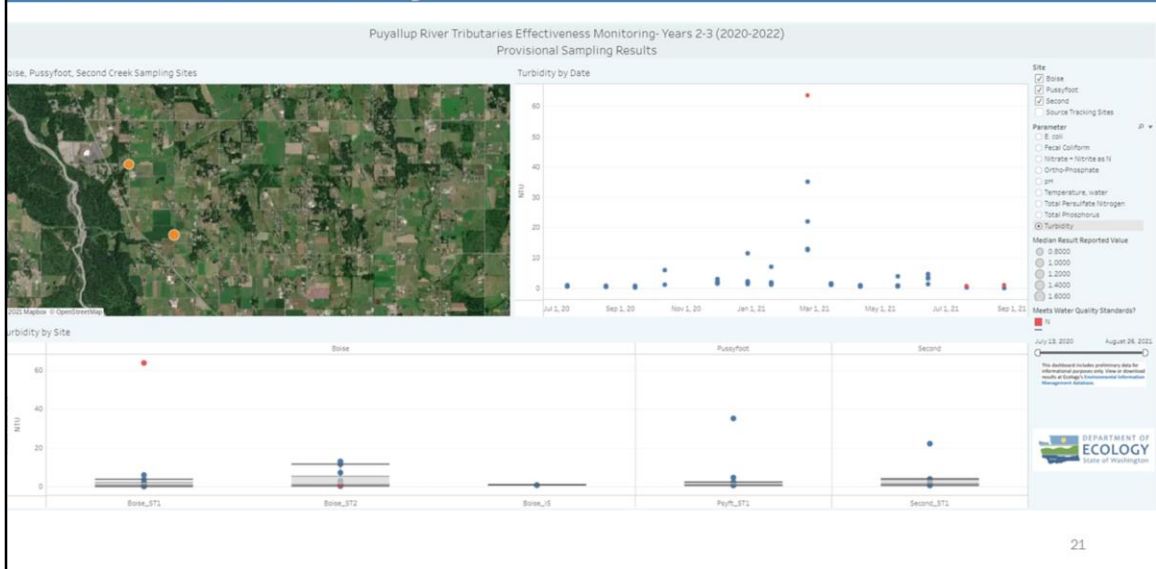
From May to July of 2021, the upstream Boise Creek site did not meet temperature standards.

2020-21: Dissolved Oxygen



Low dissolved oxygen levels seen in 2020-21 may have been caused by low flow during the summer and increasing temperatures that de-saturate the amount of oxygen in a stream. This was the case for summer of 2020 where both Boise Creek sites did not meet dissolved oxygen standards of 9.5 mg/L. There was a draw down of dissolved oxygen levels starting in May through June for Second and Pussyfoot Creeks. This may be from the start of sluggish flow for these creeks and the combination of excess nutrients from winter storms, increasing spring temperatures, excessive algal growth, which can ultimately lead to lower dissolved oxygen. We see sites with poorer water quality with the highest bacteria (Boise_ST1) and nutrient levels (Second_ST1) tended to the poorest dissolved oxygen conditions.

2020-21: Turbidity



For the rain events starting in October and in February during the largest accumulation of rain, the most downstream Boise Creek site had the highest. 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 all be contributing to this high turbidity at this site that is a known salmon habitat.

Bacteria

- Boise Creek has the highest exceedances in *E. coli*, particularly at the site downstream of Enumclaw's stormwater system.
- First year of bacteria sampling shows increase/doubling of bacteria levels at creek segments that bracket nonpoint sites of concern at upstream sections of Pussyfoot, Second and Boise Creek.

Nutrients

- Second Creek has the highest level of total nitrogen and total phosphorus, followed by Pussyfoot Creek.
- Sampling in Second Creek indicated larger nutrient sources upstream.

Temperature

- Boise Creek sites did not meet temperature standards the past summer of 2020 (July-September).

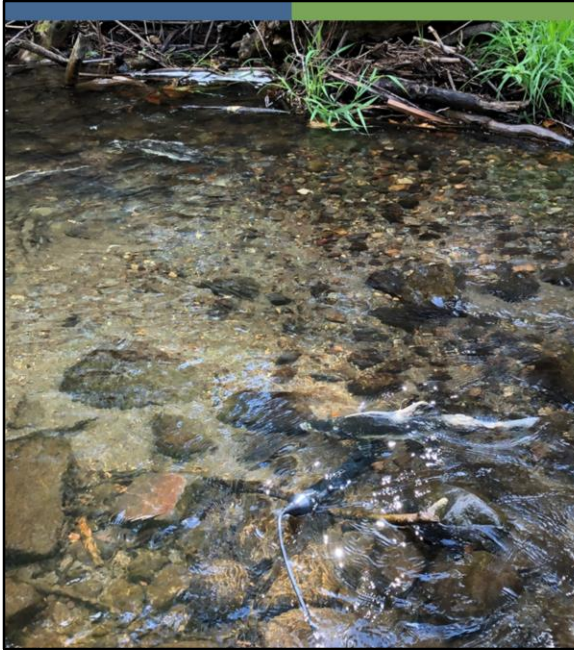
Dissolved Oxygen

- Boise Creek sites did not meet dissolved oxygen standards the past summer of 2020 (July-September).
- Pussyfoot and Second Creeks did not meet standards May-June 2021 while still flowing.

Turbidity

- Boise Creek exceeded standards during the February 2021 storm event, possibly showing the impact of upstream construction and rural runoff.

Summary of 2020-21 Data.

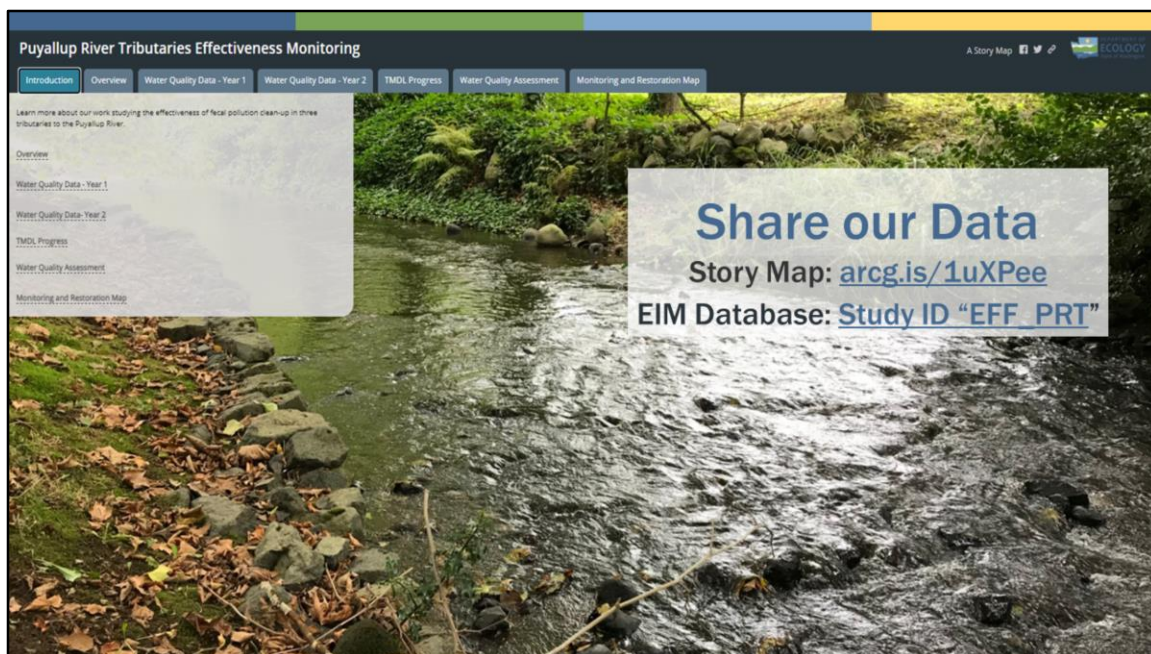


Thank You!

Questions?

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Visualization of this data as well as download links are available on this project's **Storymap** (arcg.is/1uXPee).