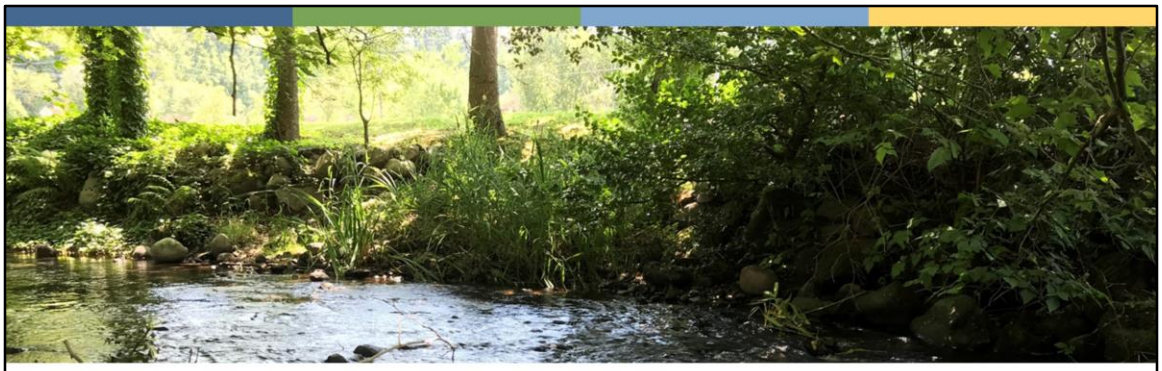

Puyallup River Tributaries Effectiveness Monitoring

Molly Gleason

DEPARTMENT OF ECOLOGY
State of Washington

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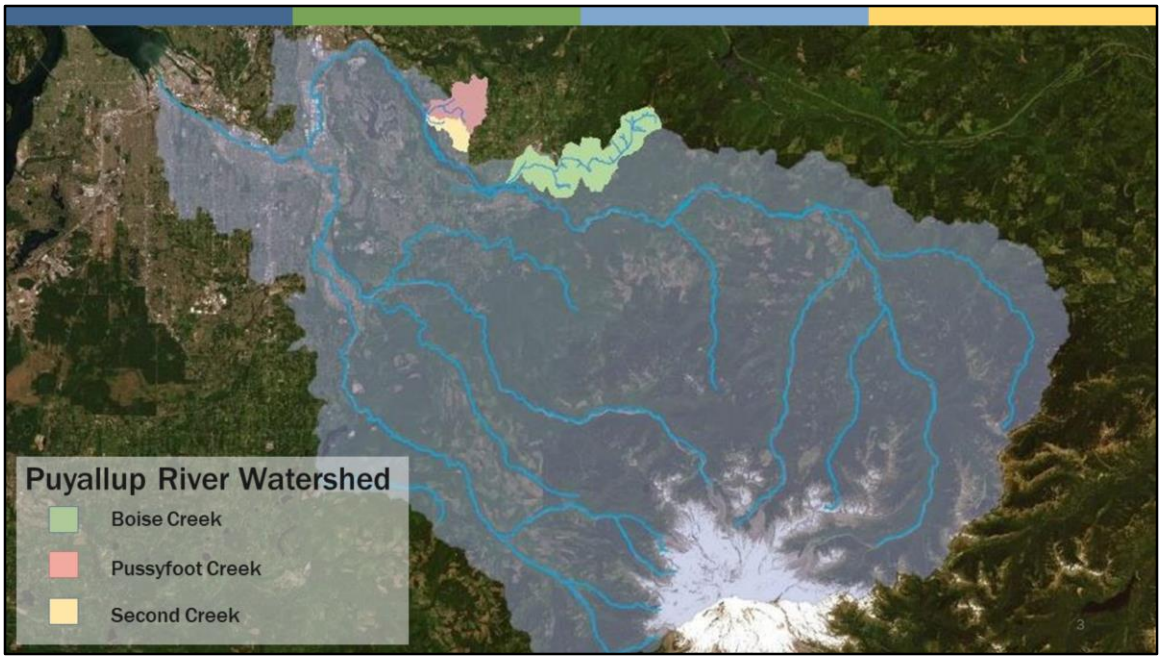
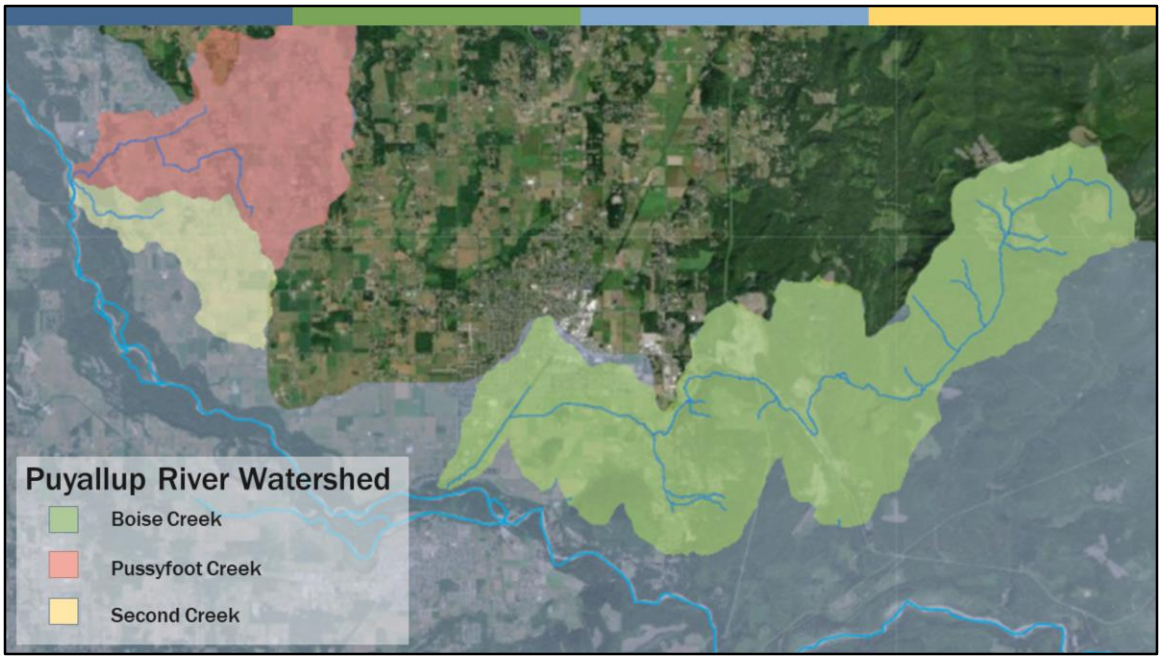
Cleaner Water Through Monitoring

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.

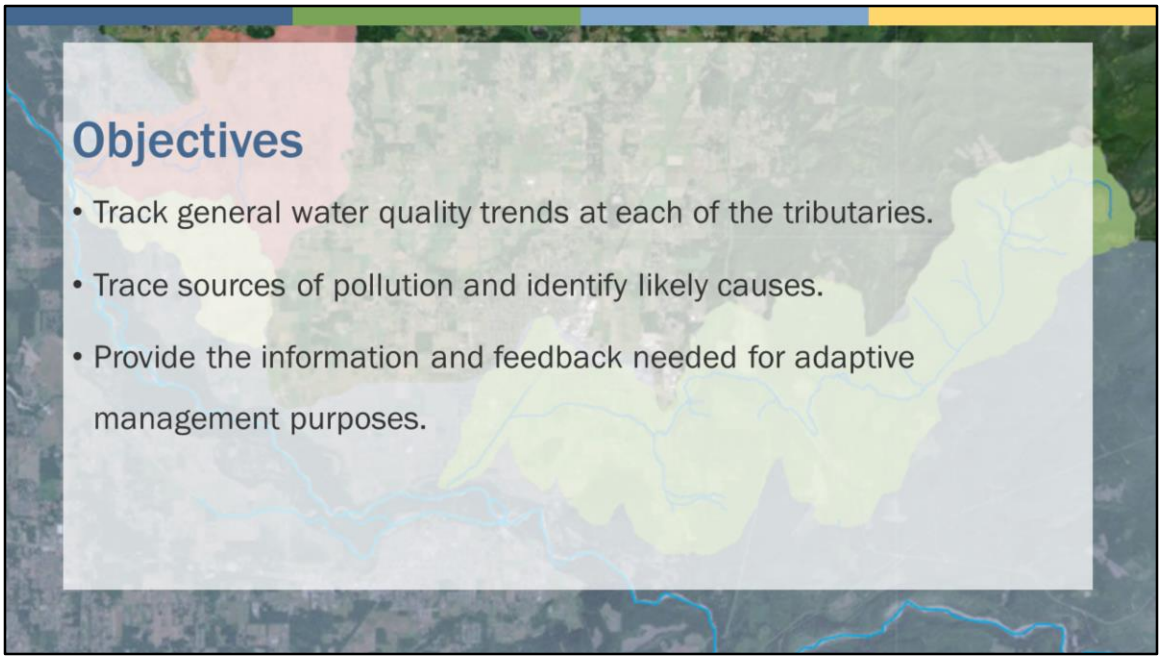
Ecology and our partners have conducted years of monitoring in this area and determined that these subwatersheds are a high priority for water quality improvement. These three tributaries do not meet or exceed water quality standards for a variety of parameters including, bacteria, pH and temperature.



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.

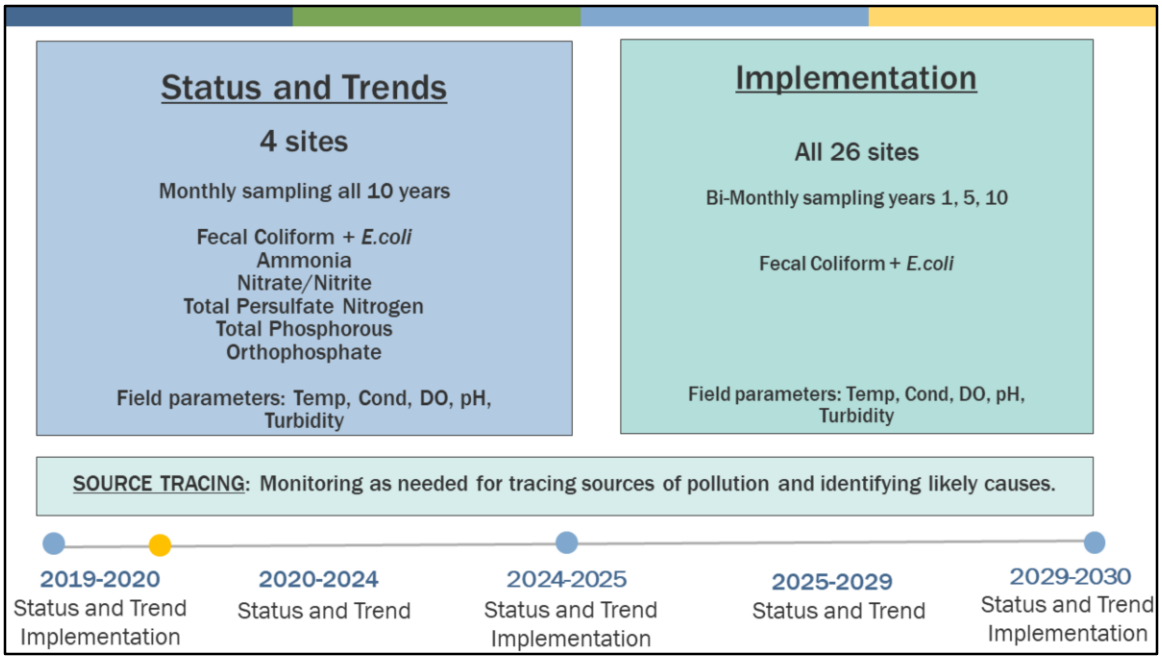
A follow up study by Ecology also found that many of the tributaries and ditches on Pussyfoot Creek and Second Creek exceeded bacteria standards. This is critical to understand the amount of pollutants that are being delivered to the White River and to the Muckleshoot reservation from these tributaries.

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.



Ecology has prioritized water quality monitoring in these three tributaries to provide more information for the TMDLs and track the progress of water quality improvement.

The objectives of this project are to:
Track general water quality trends in each of the tributaries.
Trace sources of pollution for bacteria and nutrients that impact water quality overall and identify likely sources.
Provide the information and data that is necessary to plan for adaptive management and future implementation work.
It is the goal to reduce sources of bacteria and simultaneously improve water quality overall including the other parameters of concern.



In order to achieve these objectives, Ecology developed a long-term monitoring plan to evaluate the progress of water quality improvement over a 10 year period. We have established different site types to provide different perspectives of the watershed over the course of the study.

We have four long-term stations that represent the most downstream locations of each of these tributaries. Boise Creek has two to additionally see the influence of a major stormwater system in the City of Enumclaw. The purpose of these stations is to understand the long-term status and trends of water quality at these three tributaries. We monitor once a month for the full 10 years of this study.

Every 5 years we do a more intensive sampling at 22 implementation locations across the three tributaries. The implementation sites are designed to explore the subwatershed and to understand existing water quality across the watershed.

During our ongoing routine monitoring, we also collect supplementary samples at areas of high concern to investigate bacteria and nutrient levels that might be affecting these core sites.

So currently, we wrapped up the first of our intensive sampling that included monitoring at all core sites and we are in the second year of monitoring at only the long term sites.

Monitoring in the watershed

- Standardize methods, QA, cross-training
- Strengthen local connections
- Share results

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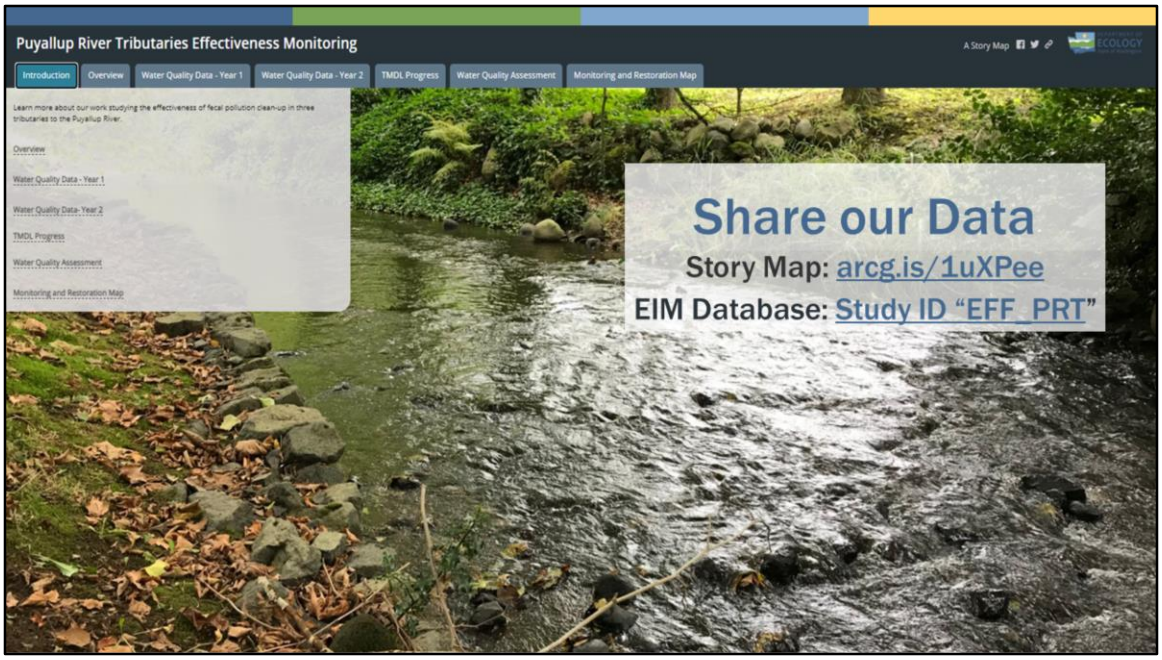
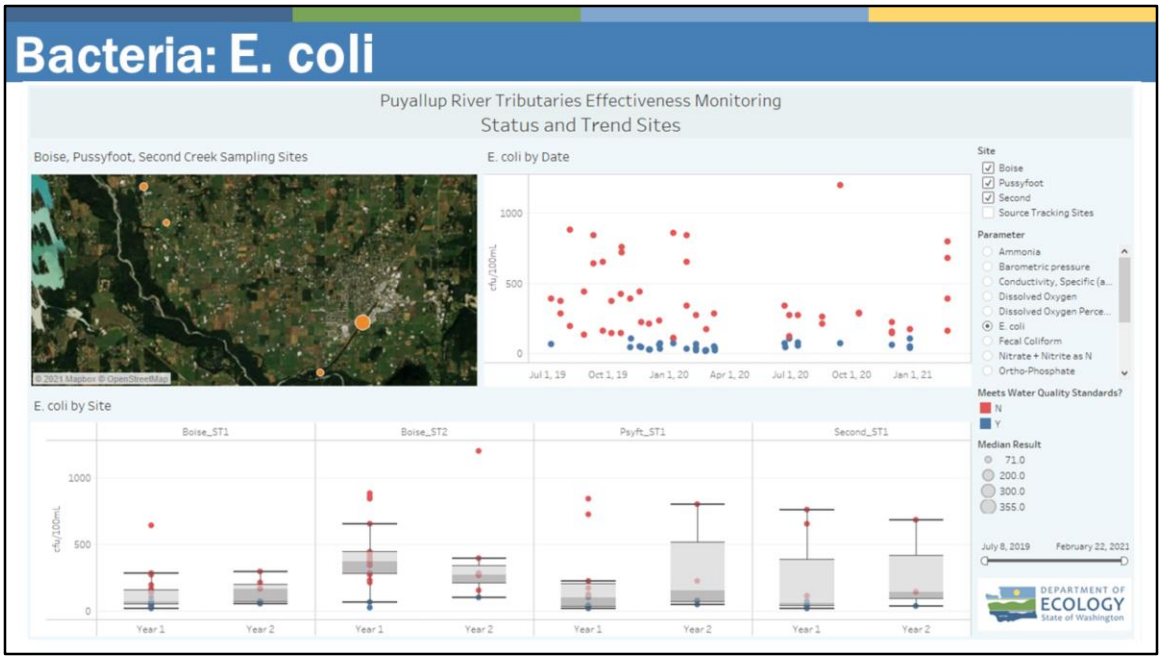
To continue a 10 year monitoring effort, a project plan was developed specifically for this monitoring work which is available on our Ecology publication website. This has served as a guide to standardize our procedures and direct the course of this long-term project. This project has been shepherded by many people at Ecology, and each of us has been trained in performing water quality to ensure consistency and accuracy throughout this study.

Another important aspect of this monitoring effort is communicating to our partners to strengthen those local connections and provide information that can be useful for their efforts in finding pollution sources and guiding implementation work.



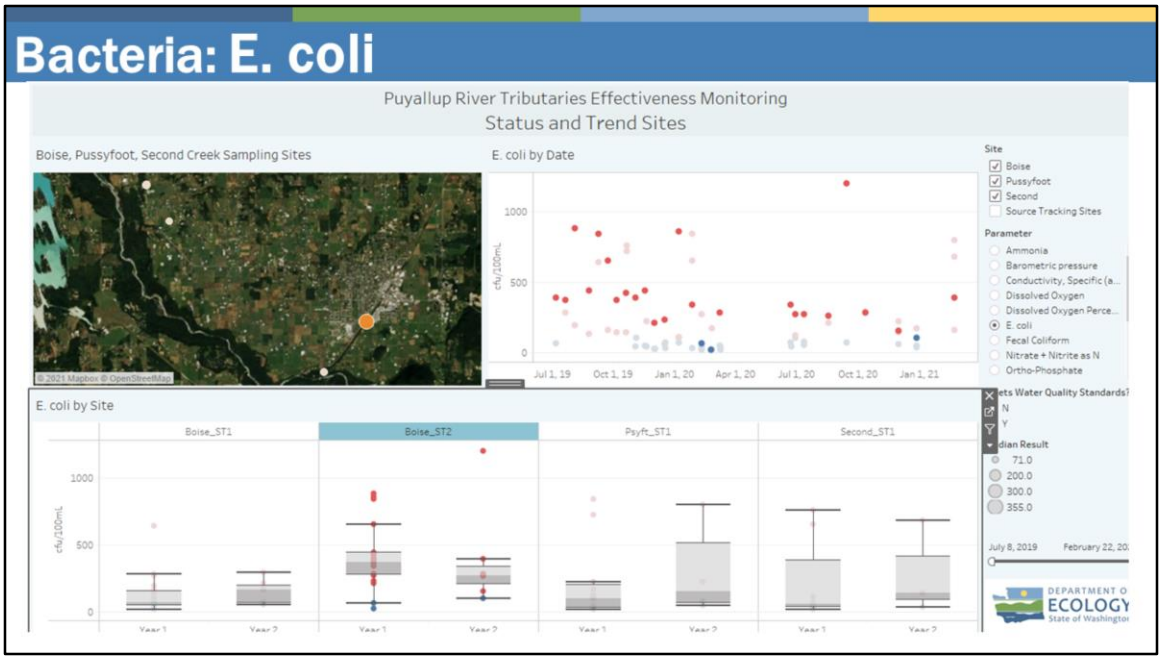
This past year we have depended on more virtual communication by email. This year has taught us the important of making this data readily available on a virtual platform such as Ecology data EIM and created a Storymap. This created this for this project to be an efficient summary of our results and an interactive display where we can see the data and the location of the sites.

Status and Trend Sites



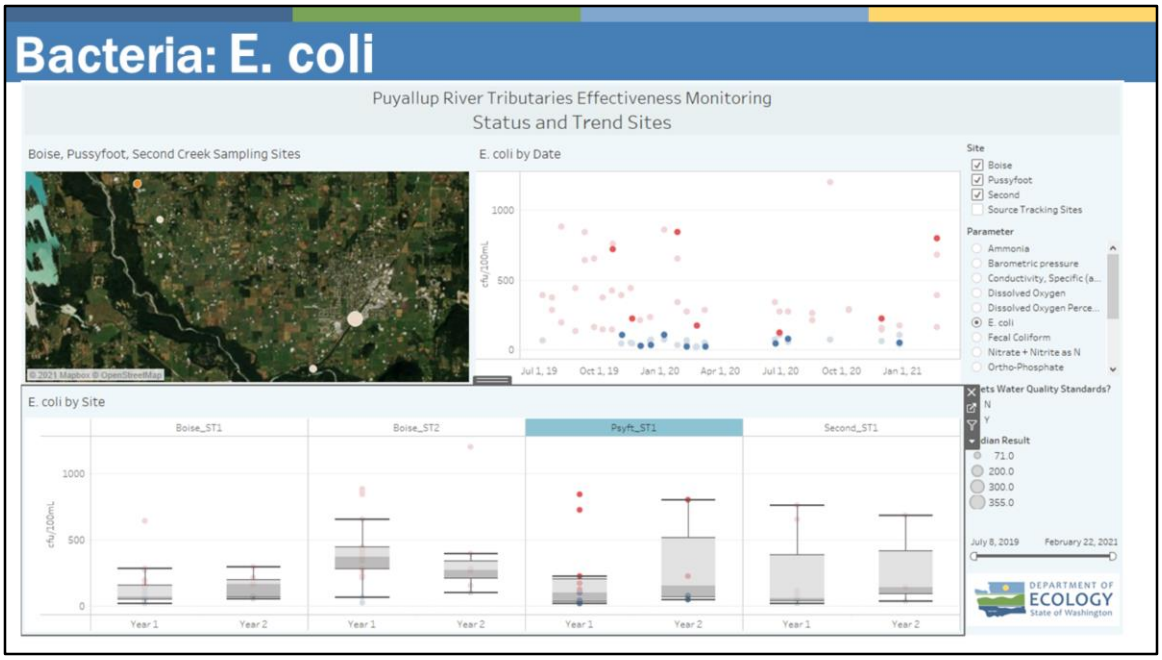
I am showing you the full dataset we have collected so far for at the long term sites which includes the first year and part of the second year of monitoring. We started sampling in July 2019; There was a brief period where we were not able to collect samples late March to early June due to covid restrictions, but we were able to return to our routine sampling end of June. As we continue monitoring over the course of the 10 years, we can continue collecting data and filling those seasonal gaps of information.

Bacteria: E. coli



Just as Ecology's bacteria TMDL found, Boise Creek has the highest levels of bacteria compared to the rest of this watershed.
We are able to expand on that, by showing the highest bacteria concentrations are located in the upstream, more urbanized area of Enumclaw. This Boise_ST2 site is at the most downstream location of a major stormwater flume and had the highest bacteria levels. If you look at the chart on the top right, exceedances happened over the course of the full year during the dry and wet season.

These high results indicated that we needed to do further monitoring. We also saw a trend of higher bacteria during the dry season from July to October. This is likely due to low flows, bacteria levels can become more concentrated as flows begin to stagnate. Consistently high bacteria during the dry season indicates that the pollution source may not be from stormwater runoff but may be associated with a consistent input of bacteria from sources such as leaky septic system, cross-connection or direct discharge.



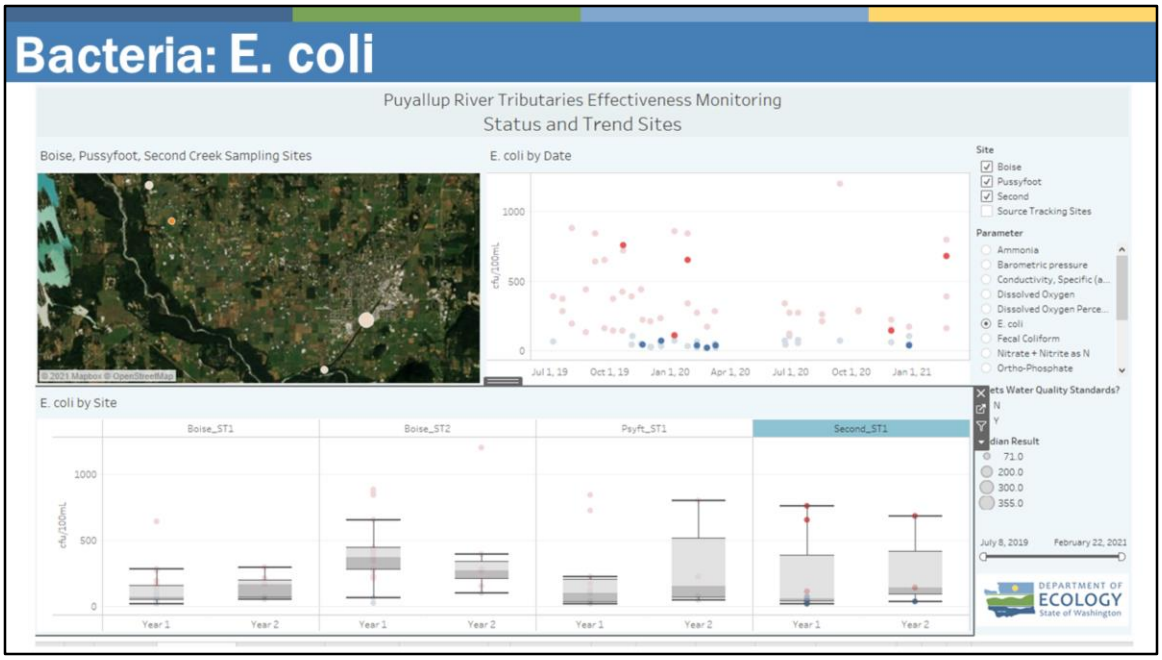
Seasonal trends are important to highlight, especially for the Pussyfoot and Second Creek subwatersheds. These creeks are ephemeral streams, meaning the flow is either stagnant or dry typically from June-October and we can't start sampling until November or late October, as you can see on the time series graph.

One trend that is worth noting that is most distinctive about bacteria levels at these sites, there are distinctive peaks during October 2019, February 2020 and February 2021. During these months, there a significant amount of rain; October was the first flush of rain for 2019, and February had the largest accumulation of rain. We missed this first flush for this second year of October, but there were still responses to heavy rain.

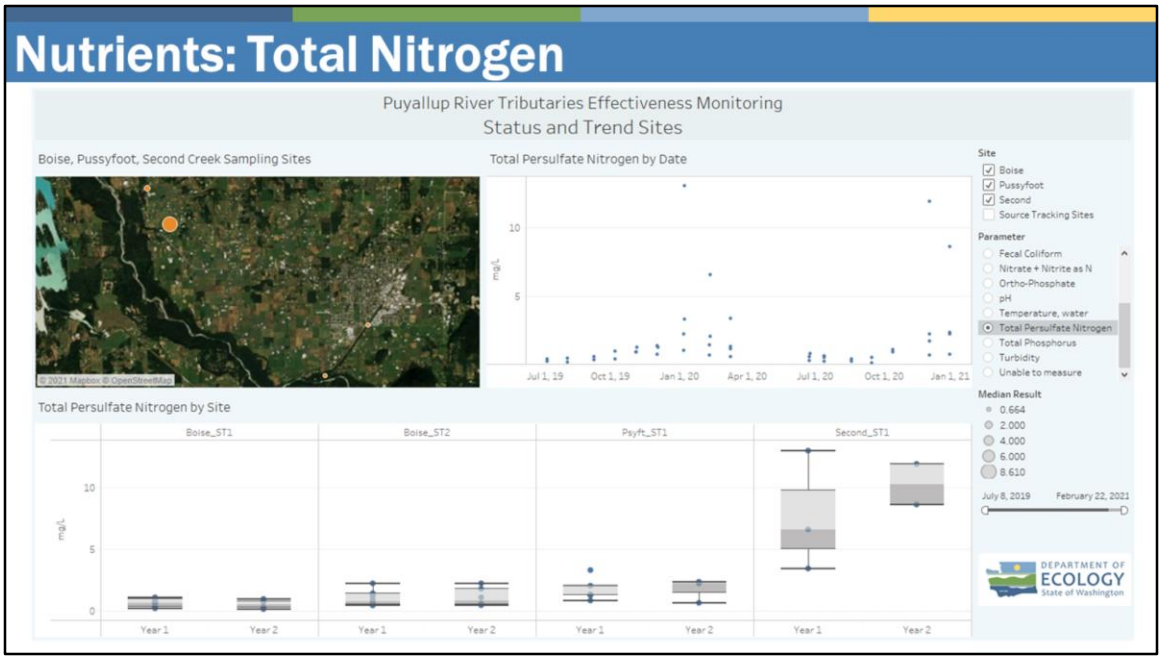
We can infer that heavy rain of the winter season generates runoff that contributes to these increases in bacteria. Runoff can be from multiple agricultural and urban sources:

- 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.

Bacteria: E. coli

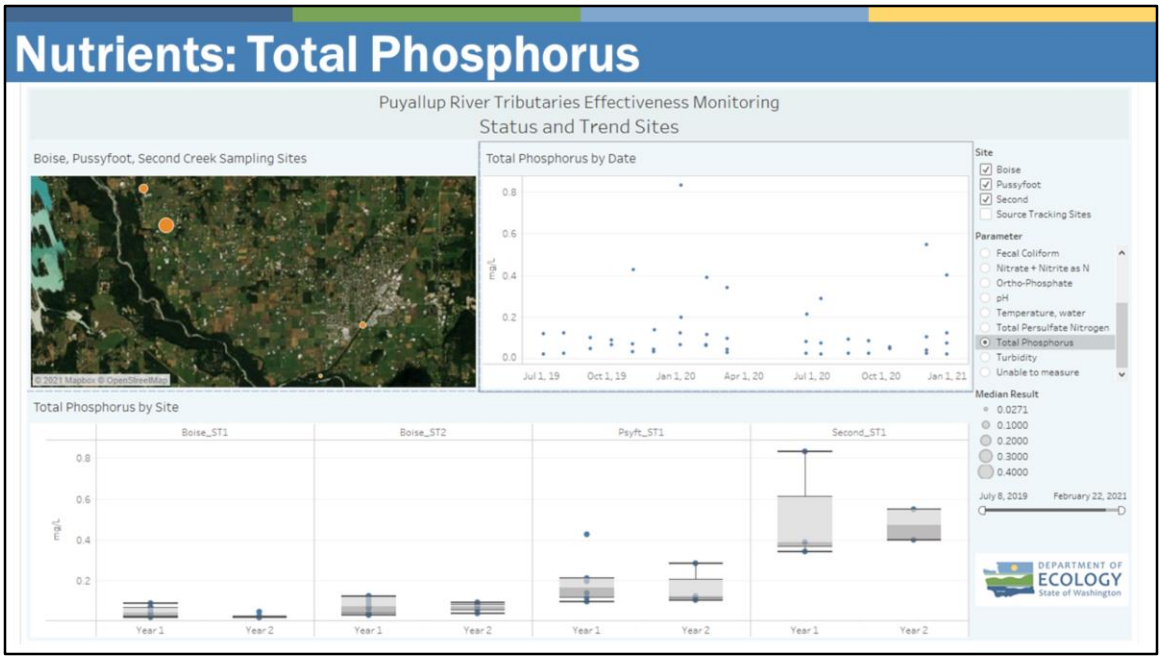


Nutrients: Total Nitrogen



There was a similar increase in nutrients for all sites following rain events for both **Nitrogen** and **Phosphorus** levels. These nutrient levels were the highest in agricultural areas such as Pussyfoot and Second Creeks. 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.

We were able to capture this increase in both bacteria and nutrients which highlights the impact of runoff from rainfall.



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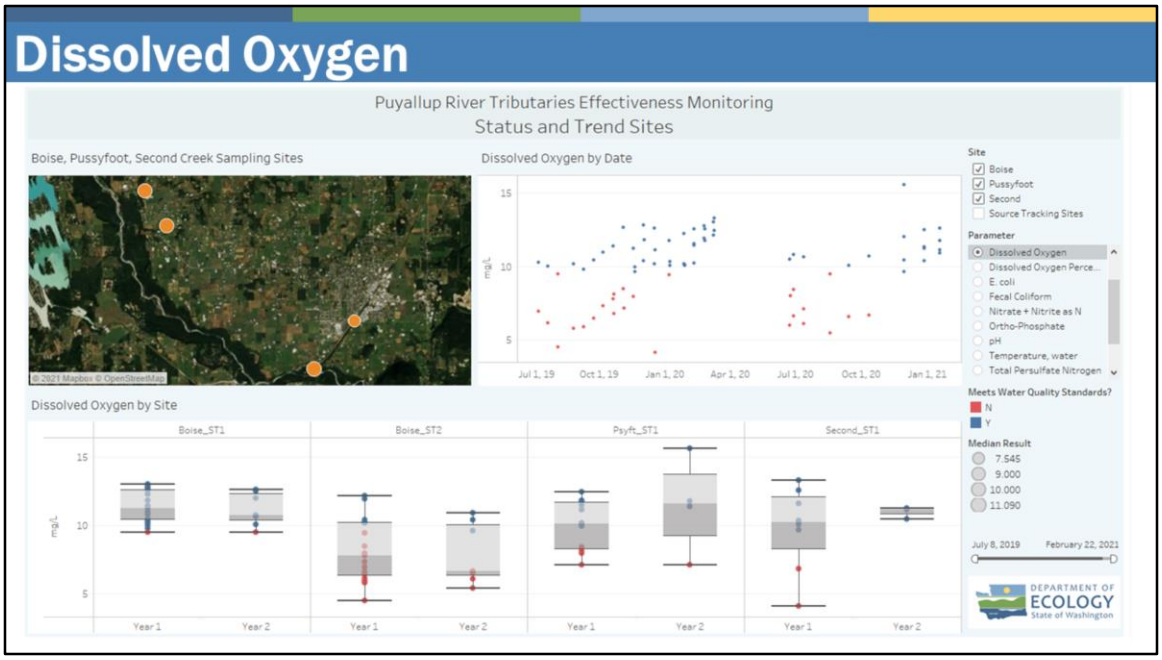
Dissolved Oxygen



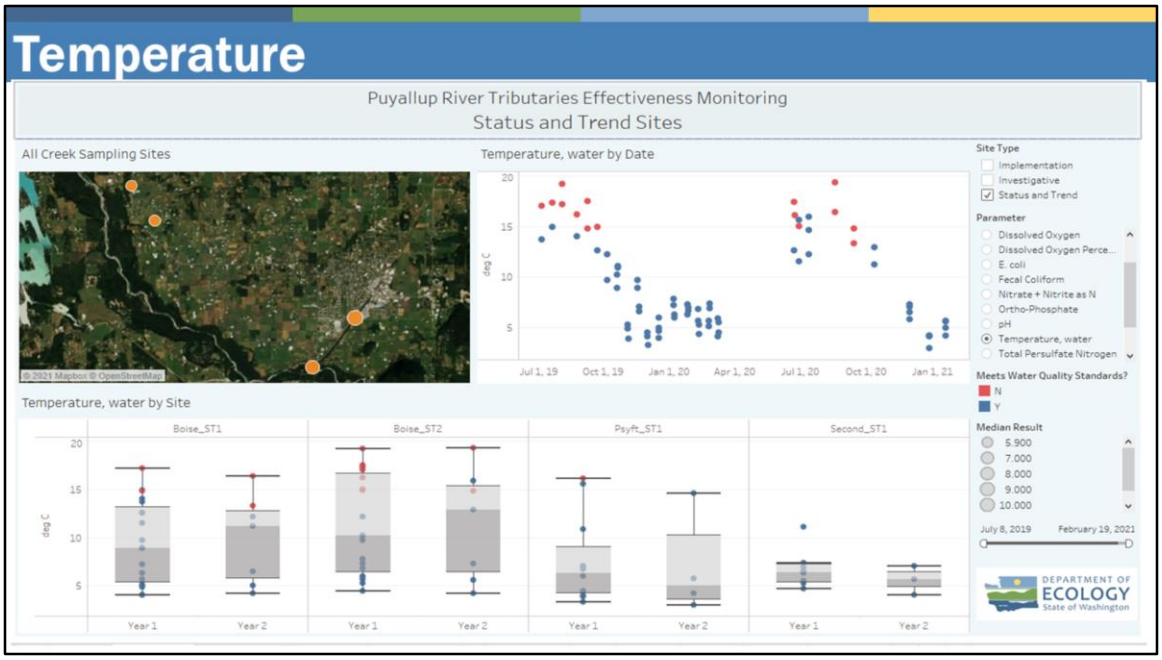
When excess nutrients is available, excessive algal growth can ultimately lead to lower dissolved oxygen below the acceptable standard of 9.5 mg/L.

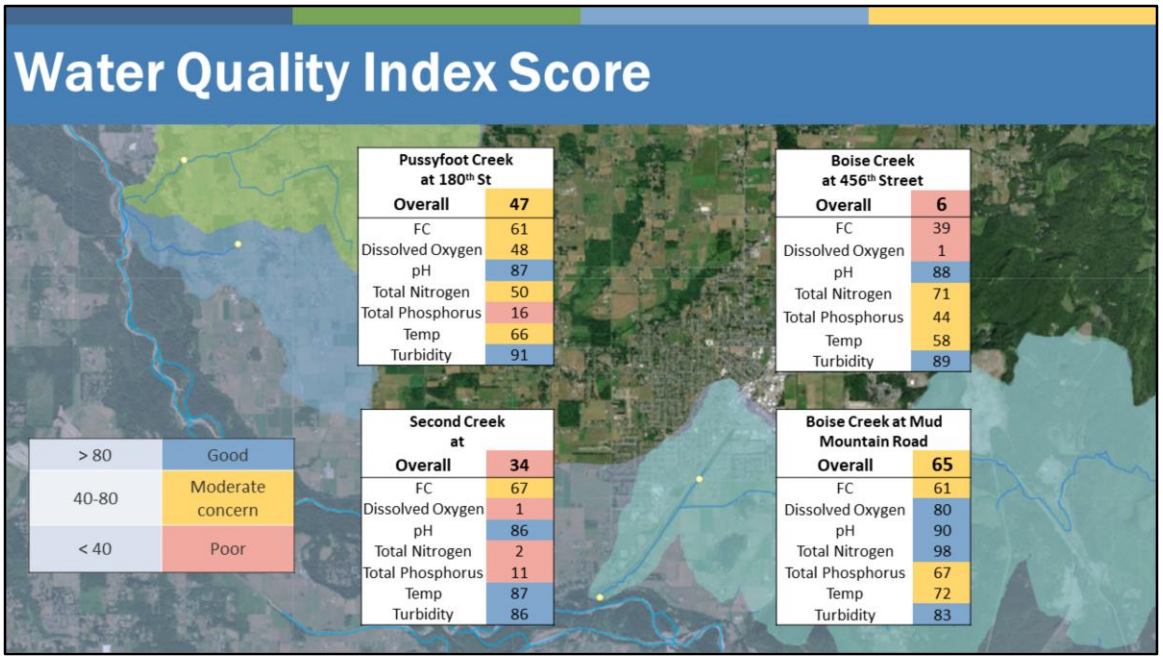
These low dissolved oxygen levels can be from factors such as low flow during the summer and increasing temperatures that de-saturates the amount of oxygen in a stream.

What's interesting is that we did see low oxygen levels even during the winter season when there is more flow. At Second Creek, there was a detected 4 mg/L level of oxygen in December.

We see sites with the highest bacteria and nutrient levels tended to the poorest dissolved oxygen conditions.

Temperature





Water quality index can be used as a report card for water quality for each stream. This score presents water-quality on a scale ranging from 1 to 100, with a higher number indicating better water quality. Each parameter is evaluated and.the overall score takes into account all of the evaluated parameters. The index does not replace a technical evaluation and comparing to state's water quality standards, but an index is useful for comparative purposes and for answer general questions (And what particular parameters are of greatest concern at each sites).

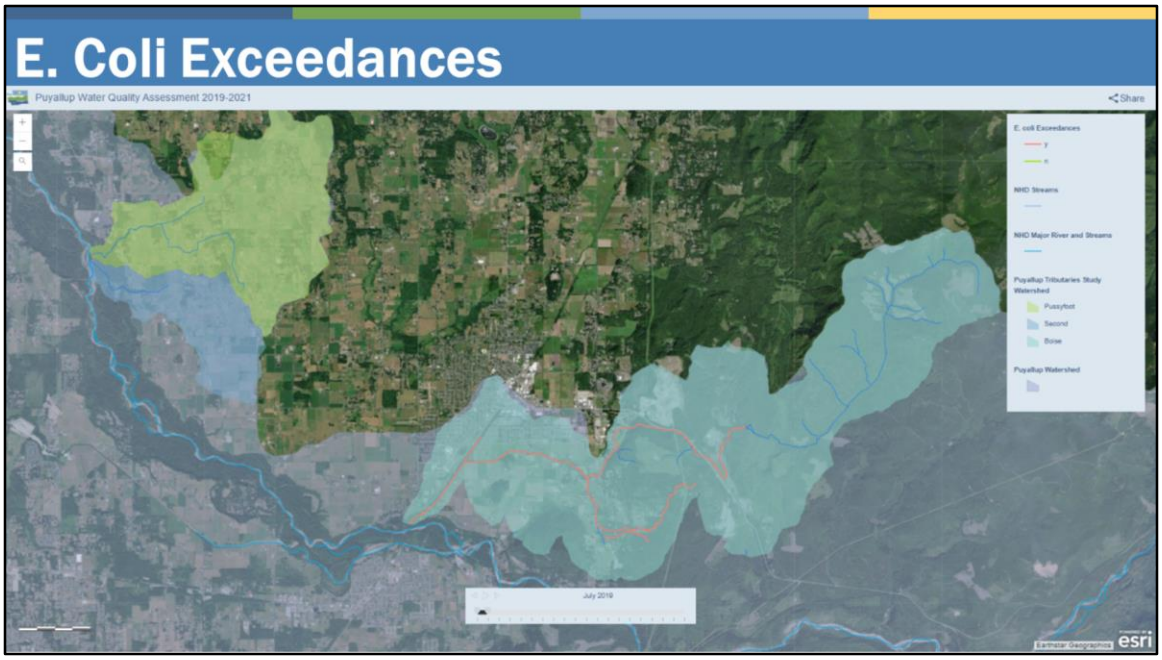
To start with the Boise Creek sites on the right, we see that the most downstream location has relatively better water quality compared to other long-term sites, yet there are fecal and temperature issues that are still a concern. The upstream Boise Creek site that is directly downstream of the stormwater outputs has an overall poor water quality score with poor fecal coliform and dissolved oxygen conditions. This poor score for a majority of the parameters highlights this area as likely impacted by pollution.

As we move towards the outskirts of the Enumclaw, these sites in this area of the watershed seem to have a poor nutrient issue. Though it might be an ephemeral stream during the summer months, Second Creek has very high nutrient levels

especially during the winter. These nutrient levels combined with poor dissolved oxygen drives down the overall score.
Pussyfoot Creek also has a moderate fecal and dissolved oxygen scores.

The status and trend sites provides a well-rounded picture of water quality at each of these tributaries. Now I'd like to expand that and describe the water quality trends across the watershed.

Implementation Sites



The implementation sites are more exploratory in design to find those sources of pollution and find areas to prioritize implementation work. Again we do this intensive sampling every 5 years, so I am going to show the first year of sampling.

We have established this network of sampling sites that stretches across the reach of each creek. This map extrapolates that data from each site and represents it as the reach or section of a creek. The advantages of having this network of sites is that we're able to target where in the creek we are seeing the highest water quality issues and find the hot spots.

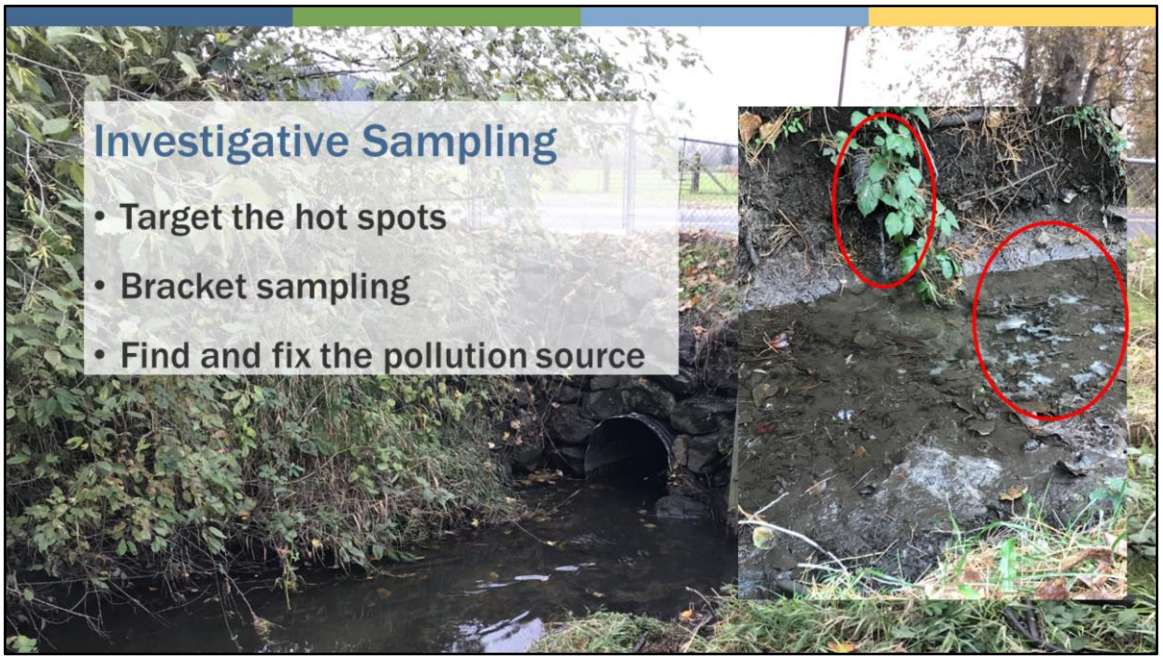
With the recent updated water quality standards for E. coli, we assess these tributaries on a rolling three-month period, meaning we determine whether they are meeting water quality criteria for each three-month period. the month at the bottom of this map represents the mid point of the three month period (July represents June-September)
As we go through each three month period and through the different seasons, we see how bacteria levels change over time. During the summer, we see more red, meaning that stretch is not meeting criteria. Dry and stagnant conditions prevented us from assessing the full dry season for Pussyfoot and Second Creek, so they show in neutral

blue.

- **October**: As Pussyfoot and Second Creek start to have more flow in October, it's evident that there are exceedances throughout both watersheds
- **November:** With increased flow, Boise Creek starts to have better water quality along the mainstem. However, the stormwater stretch of Boise Creek still has high exceedances. It's important to **i**dentify stretches of the creek that do not meet criteria during both the dry and wet months. Exceedances throughout the year indicate a more serious pollution problem.
- **January**. We sampled different branches of the Pussyfoot Creek, and we identified that the highest levels are at the long-term site at the downstream location where both branches flow to.
- We were also able to target which sections of Second Creek may have contributed to higher bacteria levels. For Second Creek, there are relatively high levels of bacteria across this creek. There are particular sites that stand out, there site located downstream of this tributary to Second Creek, and despite not having as high hits of bacteria, this site has consistently high levels of bacteria. **The plan is for future investigation of this area to determine the source of bacteria and nutrients.**

Given the predominant land use in this area, nonpoint pollution sources could be a major contributor to the high bacteria. Nonpoint pollution includes agricultural runoff and livestock having direct access to streams which has been observed in this northern area of the Pussyfoot Creek during our surveys.

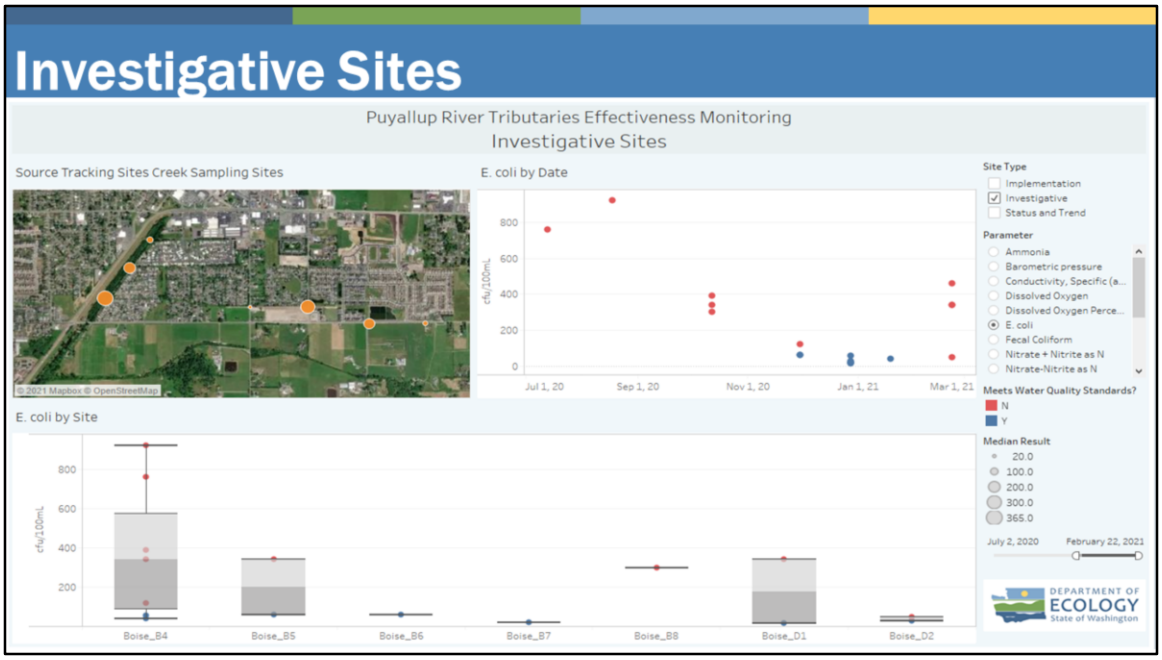
Sampling across this watershed allowed us to identify critical areas with poor water quality issues. By finding those hotspots, we can focus and prioritize investigative work in those areas.



To find the pollution problem, we first identify the hot spots and do more intensive monitoring that brackets that hot spot.

There has been a collaborative effort to track bacteria sources in the main stormwater flume. Both Ecology and City of Enumclaw have detected high bacteria hits at the lower drainage from the stormwater channel (Boise_ST2) and outfall from an upstream laterals that feed to this site and run through the neighboring subdivisions.

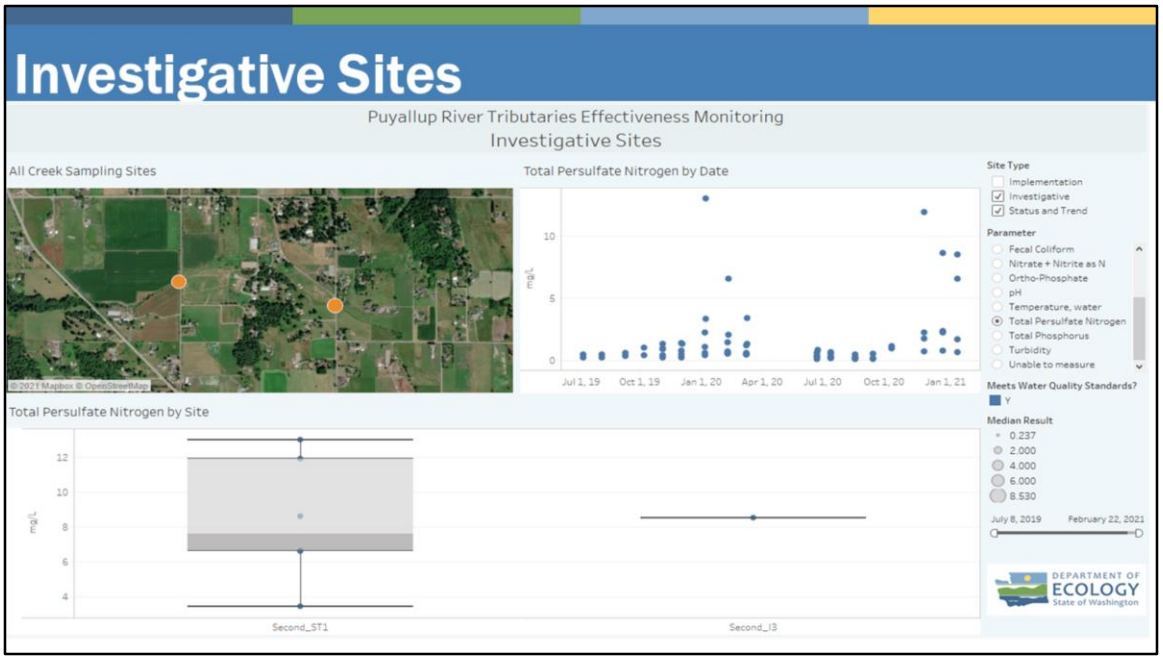
By focusing on this area, this has lead to the successful identification of illicit sewer discharges to the stormwater channels. Ecology shared these results with the City of Enumclaw and they were able to investigate and effectively fix the prolem. This shows the importance for source identification monitoring and shows the effectiveness of collaborating with our partners to solve pollution issues. Despite the corrections, there still is a lingering problem.



Both Ecology and City of Enumclaw have detected high bacteria hits at the lower drainage from the stormwater channel (Boise_ST2) and outfall from an upstream Lateral A which furthest south stormwater lateral runs parallel to Warner Ave. Lateral A is typically the predominant flow to the stormwater flume. Both of Ecology and the City have found evidence of dog waste being prevalent in the stormwater flume; Eric Palmer with the City sent letters to local residences and code enforcement letters. Eric also suspected the influence of wildlife and birds in the stormwater ponds and has sent letters encouraging neighbors to not feed the birds. Homeless encampments along the main flume could also be contributing to high bacteria levels.

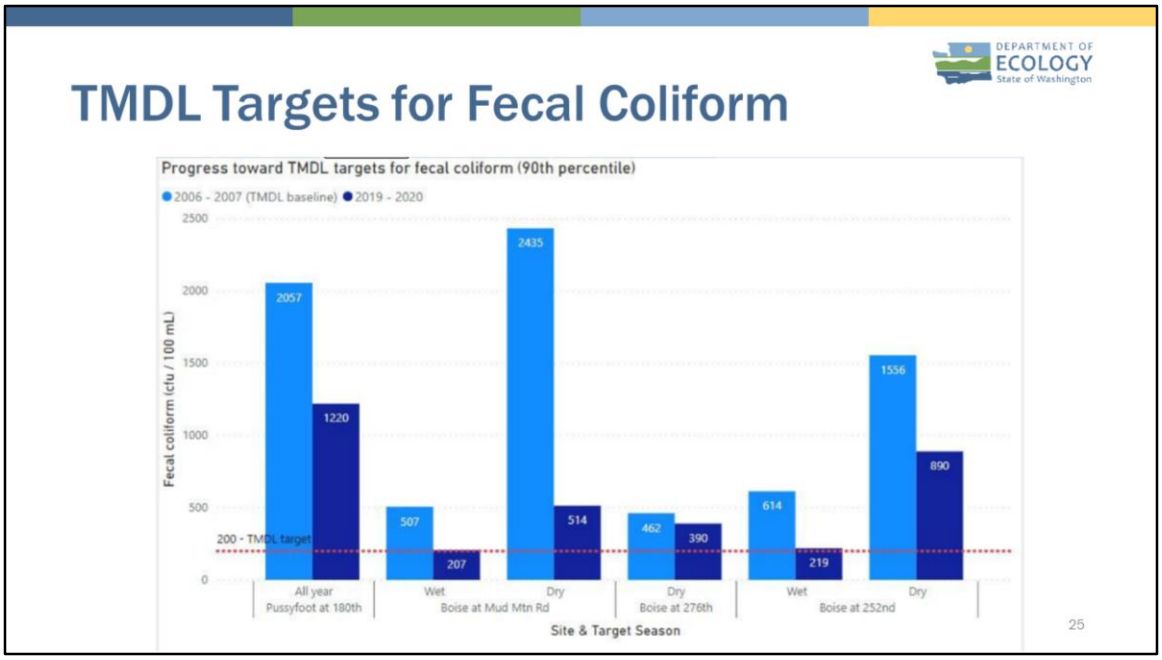
During rain events in Nov 2020 and Feb 2021, **there is significant runoff flow flowing into Lateral A from unincorporated King County on the south side of warner**. Cattle have been observed in close proximity to the ditch along Warner and were not sufficiently excluded from the stormwater ditch. Sampling was conducted throughout November by the City and in February by Ecology. By bracket sampling this property, the results indicated a significant increase in bacteria from upstream (Boise D2) to downstream (Boise_D1) of the property. This shows these rural areas are a significant bacteria source to the stormwater system and to Boise Creek source during the wet season.

During the 2011 Puyallup TMDL, Boise Creek was found to be the largest fecal coliform loading source of any tributary to the Puyallup River. Since 2011, some sources of bacteria have been found and resolved, while other sources remain or have been newly identified.



There's also an interest to further explore and understand the nutrient dynamics in the Pussyfoot and Second Creek subwatersheds. The high results at Second Creek necessitated further investigation of potential nutrient sources upstream of the long-term site (Second_ST1). There are potential nonpoint sources of pollution that have been identified in the area; the investigative sampling brackets those areas to determine the influence on nutrient levels. Follow-up investigative sampling for nutrients at implementation sites is planned from Jan to at least May 2021.

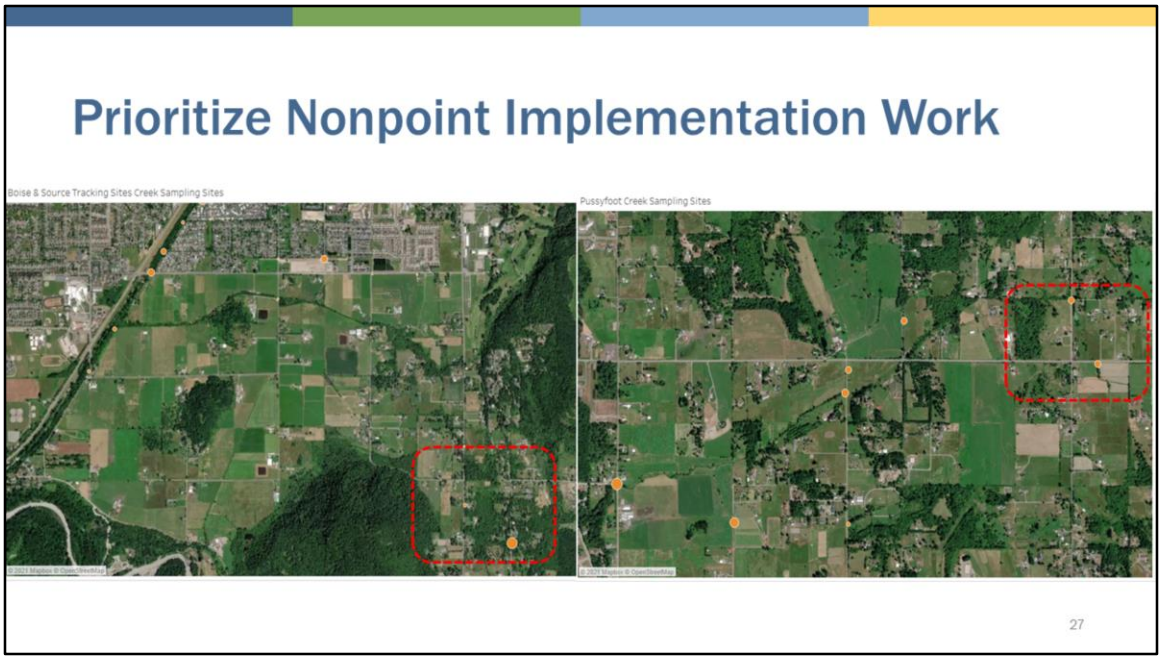
So with the combined information of the core sites and the follow-up investigative sampling, this can help guide us towards correcting problems.



Overall, in each of the three tributaries there are still exceedances. But in the broader perspective, we might be seeing improvements in bacteria in each of these creeks. This graph shows the 90th percentile of fecal coliform; which is a standard we use to compare to water quality standards.
At the sites that were previously monitored for fecal coliform in Ecology's initial study, we are seeing an overall reduction in bacteria levels compared to 10 years ago. This may demonstrate the effectiveness of restoration activities in the area.

In the long run, how do we continue to work towards improvement when there still evident water quality issues

How do we continue to improve water quality?



Nonpoint Work: Results and field survey observations have helped guide prioritization of non-point implementation work. Our nonpoint specialist in this area, Anne Baxter, strategies the best way to effectively approach these efforts.

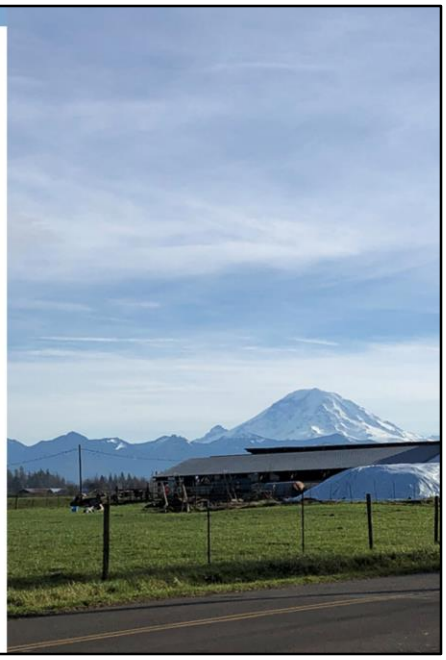
There have been reports of nonpoint pollution sources in the most upstream branches of Boise Creek located near a site that had high bacteria results. Due to the concentration of properties in this area with nonpoint issues and the results from the downstream site, this would be an ideal area to prioritize nonpoint work such as sending mailers, sending outreach letters and promoting site visits.

Properties upstream of the northern branch of Pussyfoot creek and site with poor water quality is another location for targeted outreach and communication.

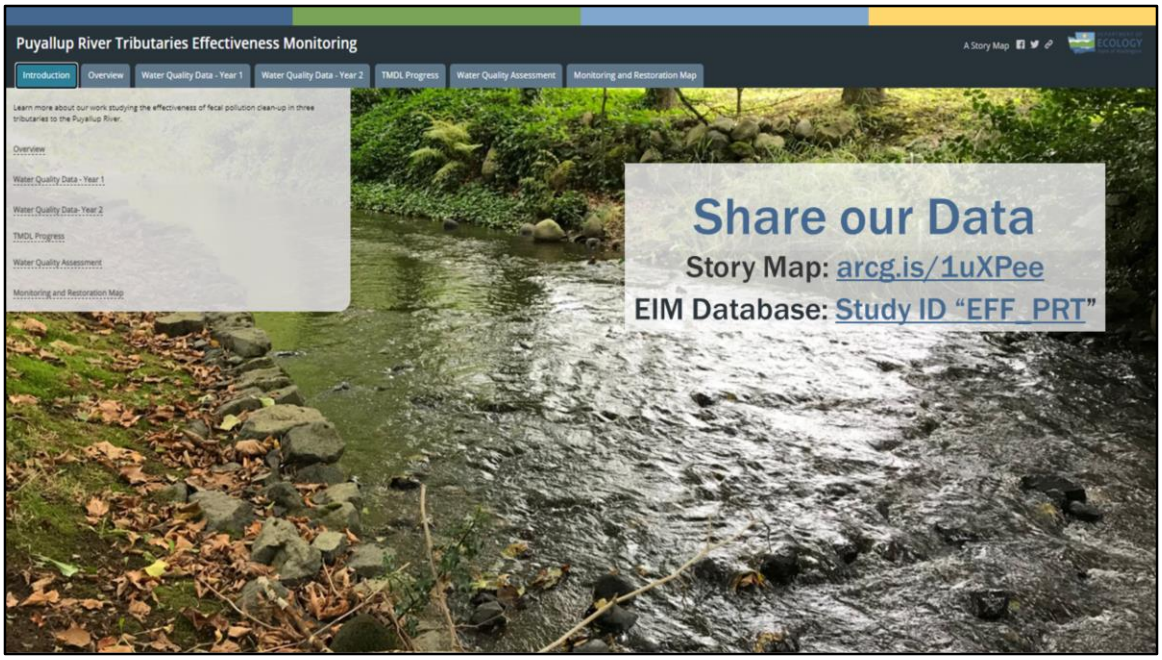
We're finding areas to focus our implementation work based on the data and observations. We hope to start making an impact on this watershed by continuing to nonpoint investigations and outreach to encourage changes.

Collaborate with Our Partners

- City of Enumclaw
- King County
- King Conservation District
- Muckleshoot Tribe
- Washington State Department of Agriculture
- Ecology- Cross-program



We are going to continue sharing results with our partners and From our combined efforts, we were able to find the critical areas to prioritize and focus source correction work.
It's important to continue communicating these results is essential to bring awareness to the health of this watershed and promote clean up efforts.



We will continue to do this by publishing our results on this **Storymap (**arcg.is/1uXPee),, and we will continue to update, share and communicate these results as we continue this effectiveness monitoring work.

Thank You!

Questions?

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