Watershed Protection – Geomorphic and Benthic Macroinvertebrate Monitoring

# Stream Health in Surface Water Areas Served by WES

Client: Clackamas Water Environment Services
Date: June 2022

This report developed by:

WOLF WATER RESOURCES

CASM ENVIRONMENTAL, LLC

# Table of Contents



# List of Tables

## List of Figures

## List of Appendices

# 1. Introduction

## 1.1 Background and Purpose

As part of a broader effort to support stream health within its district, Clackamas Water Environment Services (WES) undertakes periodic monitoring and evaluation of stream health throughout its surface water districts. The monitoring occurs within nineteen small to medium sized tributaries of the Clackamas, Tualatin, and Willamette rivers. Overview maps of these monitored watersheds are presented in Appendix A and with more detail in Appendix B.

This report documents the findings of the recent monitoring effort and stream health assessment conducted on behalf of WES during fall and winter of 2021–2022. Wolf Water Resources (W2r) in collaboration with CASM Environmental (CASM), led the technical aspects of monitoring and stream health assessment reported herein. W2r conducted the geomorphic monitoring and CASM conducted the monitoring of macroinvertebrates, which are two major components of the stream health assessment. Hydrology and water quality aspects of health assessment were based on monitoring and analysis by WES staff.

The general outline of this document follows a logical progression to present the salient stream-level health findings in the main body of the report and the more detailed methods and findings in the appendices. This information progression is intended to increase usability of the overall document for decision making and easy reference, but also requires deeper inquiry into appendixes to understand detailed definitions and results.

The current geomorphic monitoring protocol incorporated several revisions to the data collection and analytical methods compared with those employed during previous WES monitoring campaigns that occurred in 2009, 2011, 2014, and 2017. The revisions were needed to provide more targeted and less labor-intensive monitoring and analysis approaches. For example, where the previous efforts conducted detailed geomorphic surveys at relatively few sites, the refined protocol emphasized rapid data collection at many more sites. This shift toward a more widespread and rapid protocol was intended to gain a broader geographic understanding of overall stream health in the county. The revised approach also entailed adjustments to specific physical indicators and indices. Details of these monitoring approaches are further described below and in greater detail in Appendices C and D.

## 1.2 Study Area Description

This assessment covers 19 tributaries of the Clackamas, Tualatin, and Willamette rivers within northwestern Clackamas County (see maps in Appendix A). The streams of interest include ten creeks east of the Willamette River ("east-side" streams) and nine creeks west of the Willamette River ("west-side" streams), as listed in Table 1. All the creeks are within or near the Portland metropolitan area and are therefore affected by various land uses that include agricultural/rural and urban developments. Most of the study watersheds support urban and semi-urban land uses.

The study area includes 55 miles of stream length and 53 square miles of contributing watershed area. The streams of interest vary in mainstem length from just over 0.5 mile to 7.5 miles. Their watershed areas range from 0.16 square miles to 15.5 square miles and range in impervious cover from 12.9% to 51.6% as compared to total watershed area. The watersheds drain relatively low elevation terrain (i.e., less than 1000-foot elevation) of the Boring Hills, Tualatin Mountains, and adjacent and less prominently named portions of the local terrain. The climate of the study area is Mediterranean with cool, wet winters and hot, dry summers. The average annual rainfall within the study area is 46.5 inches and the 2-year, 24-hour precipitation event is 1.89 inches (USGS StreamStats).

**Table 1: Summary of the streams monitored in this effort**

| Stream Name | Geography | Stream Length, miles | Streamflow Monitoring? | Water Quality Monitoring? | Physical Habitat? | Benthic Macroinvertebrate Monitoring? |
|---|---|---|---|---|---|---|
| Carli | East-side | 0.5 | | ✓ | ✓ | ✓ |
| Cedar | East-side | 0.9 | | | ✓ | ✓ |
| Cow | East-side | 3.0 | | ✓ | ✓ | ✓ |
| Kellogg | East-side | 5.4 | ✓ | ✓ | ✓ | ✓ |
| Mt Scott | East-side | 7.0 | ✓ | ✓ | ✓ | ✓ |
| Phillips | East-side | 2.2 | ✓ | ✓ | ✓ | ✓ |
| Richardson | East-side | 1.5 | | | ✓ | ✓ |
| Rock | East-side | 6.6 | ✓ | ✓ | ✓ | ✓ |
| Sieben | East-side | 2.4 | | ✓ | ✓ | ✓ |
| Trillium | East-side | 1.6 | | | ✓ | ✓ |
| Athey | West-side | 1.5 | | | ✓ | ✓ |
| Fields | West-side | 1.0 | | | ✓ | |
| Pecan | West-side | 0.8 | | ✓ | ✓ | ✓ |
| Saum | West-side | 1.7 | | | ✓ | ✓ |
| Shipley | West-side | 0.6 | | | ✓ | ✓ |
| Tate | West-side | 1.4 | | | ✓ | ✓ |
| Unnamed Trib. #2 | West-side | 1.3 | | | ✓ | ✓ |
| Unnamed Trib. #4 | West-side | 1.4 | | | ✓ | ✓ |
| Wilson | West-side | 1.3 | | | ✓ | ✓ |

## 1.3 Study Area Geology and Geomorphology

The west-side creeks originate upon steep, highly faulted basalt bluffs and flows towards the low gradient floodplain of the Tualatin River. Nearly every creek draining these bluffs follows the trace of a mapped fault (Figure 1A). The higher elevation and steeper areas with exposed or shallower basalt bedrock likely serve as sources of coarse sediment for many of the west-side streams as fine-grained Missoula Flood deposits cover the valley bottom of the Tualatin basin. These west-side creeks can be generalized as having lower gradient in the upper reaches, steeper gradient in the middle reaches as the streams transition through the basalt bluffs, and lower gradient in the Tualatin River floodplain.

The east-side creeks drain the Boring Volcanic Field and other sedimentary fill such as fine Missoula Flood deposits and Troutdale Formation (or similar sedimentary deposits of Cascade volcanic arc origin) (Figure 1B). Unlike the west-side creeks, the east-side creeks have cut canyons through the sedimentary deposits where they accumulate substantial gravel in the bed. The east-side creeks have low gradient, unconfined upper reaches where the Missoula Floods created broad valleys at elevation within the Boring Volcano Field. Compared to the west-side creeks, the east-side creeks are generally longer and lower gradient.

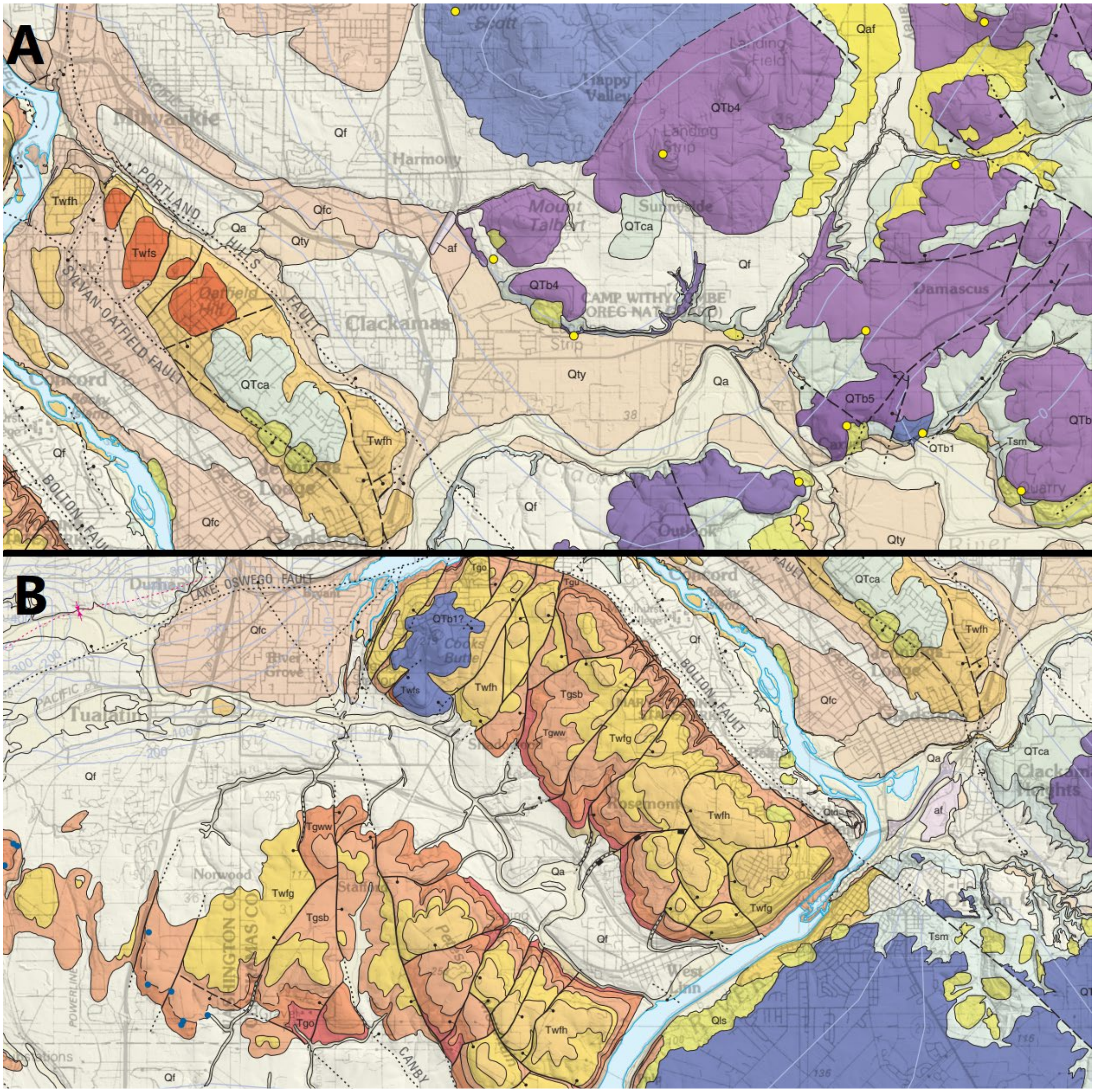



**Figure 1: Excerpts from a geologic map of the greater Portland region published by Wells et al. (2020), showing an overlay of the 9 creeks west of the Willamette River (A) and the 10 creeks east of the Willamette River (B).**

## 1.4 Development Patterns in the Study Streams

In urban and suburban areas, land development is a fundamental driver of stream health. Therefore, characterizing relative development intensity in the streams of interest provides important context in understanding stream health trends and patterns. The percent of each watershed covered by impervious area is the most direct way to characterize these patterns. The National Land Cover Database (NLCD) provides consistent and multi-temporal mapping of impervious surface on the landscape. Using NLCD as a basis, impervious area was measured as a percentage of stream's watershed area in both 2001 and 2019 (the earliest and most recent NLCD datasets available). These two measurements provide direct measures of:

- Present-day (2019) development intensity within each watershed; and,

- Recent development pressure (2001–2019) over the last two decades.

A secondary measure of development, road density, was measured for each watershed using Clackamas County's roads inventory.

Patterns of imperviousness and road density across the 19 streams of interest reveal varying patterns of total watershed development and more recent pressure. On the basis of total imperviousness, Figure 2 reveals a grouping of watersheds with relatively low imperviousness (i.e., less than about 30% imperviousness), and a second cluster of more developed watersheds (i.e., greater than about 30% imperviousness). The cut-off at 30% imperviousness is a convenient natural break that defines observed clusters in the data. There also appears to be a direct relationship between imperviousness and road density across the watersheds. In general, the west-side watersheds have lower total imperviousness, while the east side streams have higher total imperviousness, except for Rock, Trillium, and Richardson creeks.

The most rapidly developing watersheds from 2001–2019 are Sieben (+5%) and Rock (+2.5%) Creeks. Most watersheds experienced growing impervious area between 0–2% in the same period. The only watershed to lose impervious area is Phillips Creek, where the percent decrease (-0.07%) is minor and potentially within the margin of error in the NCLD source data.

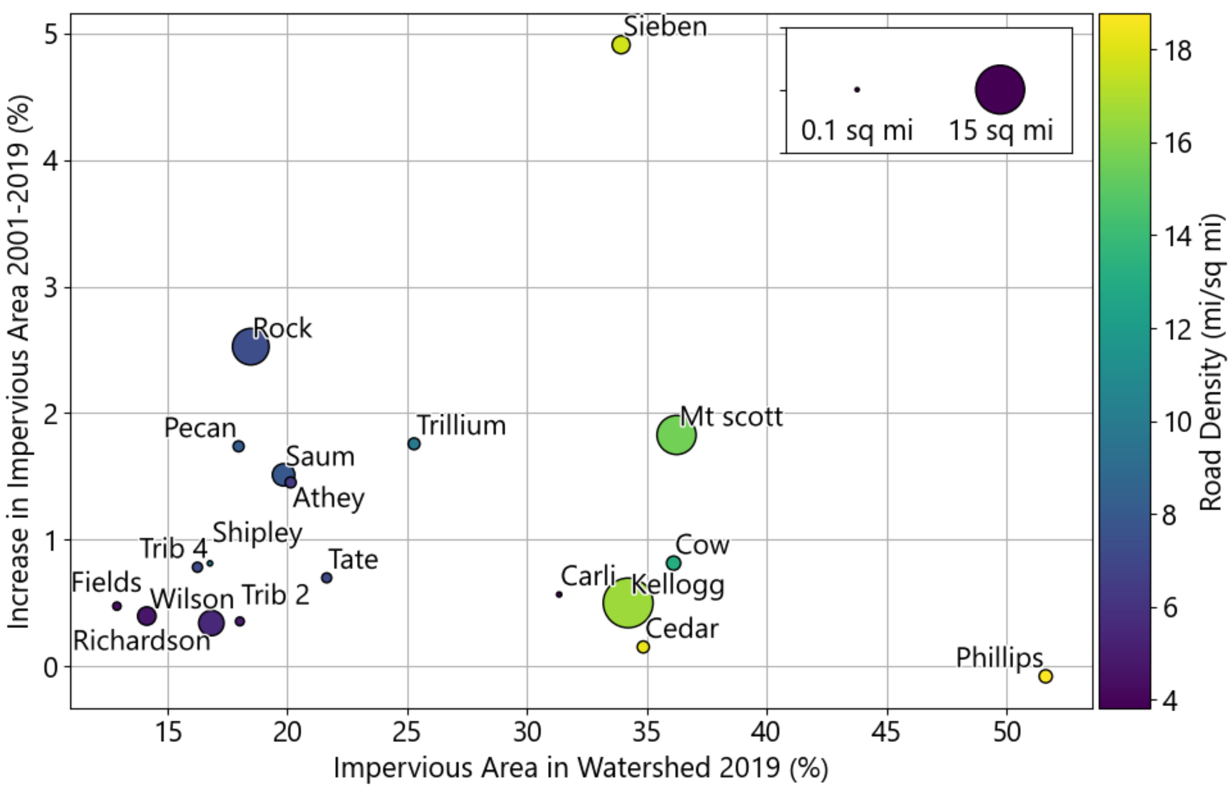



**Figure 2: Impervious areas and their changes, and road density in the study watersheds. Marker size corresponds to the size of the watershed and color corresponds to road density within the watershed.**

## 1.5 Summary of Past Monitoring Efforts

Macroinvertebrate monitoring has been conducted across the WES surface water districts since 2002, while geomorphology monitoring was initiated in 2009 (Table 2). The BMI monitoring protocol has remained consistent while the geomorphic monitoring protocol has evolved from previous efforts. During the most recent geomorphic monitoring phase in 2017 the protocol at each site included (Waterways Consulting 2018):

> "*…a topographic survey of three cross sections and the longitudinal profile of the channel, typically between 400 and 600 feet long. Sediment size is characterized using (a) a pebble count (Wolman, 1964) on a recent in-channel depositional feature within the reach, and (b) laboratory sieve analysis on a bulk sediment sample of the bed collected at a pool tail/riffle crest location using a McNeil sampler (McNeil and Ahnell, 1964). In addition, a geomorphic sampling event includes measurements of the number and depths of pools and a rapid inventory of active bank erosion in the survey reach. Starting in 2017, the geomorphic surveys are also tallying the number of large wood pieces (minimum 12 inches diameter and 20 feet long) within the active channel in each of the measurement reaches.*"

During the four monitoring campaigns, geomorphic data and macroinvertebrate data were collected from 31 and 26 sites, respectively, across the WES surface water districts with an effort to co-locate as many macroinvertebrate sites and geomorphology sites as possible. Most of the sites were revisited each time to repeat the same measurements. The main components of the previous geomorphic field measurements included surveyed channel longitudinal profiles and cross-sections, measured sediment texture via pebble counts and bulk sediment collection, inventoried pools, and estimated bank erosion activity.

**Table 2: General timeline (by year) of past geomorphic and benthic macroinvertebrate monitoring efforts.**

| | 2002 | 2007 | 2009 | 2011 | 2014 | 2017 |
|---|---|---|---|---|---|---|
| Geomorphic | | | ✓ | ✓ | ✓ | ✓ |
| Benthic Macroinvertebrate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

As introduced above in Section 1.1, the geomorphic monitoring protocol has since been revised cover broader stretches of stream via rapid assessment with less emphasis on topographic surveying. An overview of the updated monitoring protocol is presented in the next section and a detailed description of the protocol is presented in Appendix C.

# 2. General Description of Monitoring Approach and Definitions

## 2.1 Framework for Urban Stream Health and Monitoring

Health of urbanized watersheds like those covered in this study is influenced largely by the degree of development. The effects of urbanization on stream health are well known and documented in the literature (e.g., Booth and Jackson, 1997). Stream health can be broadly characterized into four sub-indices, or factors, identified in the initial Health Framework (WES, 2016):

- **Hydrology**—Development and associated increases in impervious area (e.g., buildings, parking lots, roadways) and stormwater conveyance together increase runoff and streamflow.
- **Water quality**—Runoff from urban areas, which typically lack the natural buffering effects from forests, commonly contains contaminants that flow to streams and impact stream biology.
- **Physical habitat (geomorphic and riparian)**—Accelerated and concentrated runoff and streamflow tend to increase erosion in streams and stream corridors. Additionally, encroachment of urban development commonly constricts stream corridors, exacerbating erosion rates, which can induce stream incision (i.e., vertical erosion) and reduced floodplain connectivity and habitat quality. Removal of riparian forests further impacts stream function through decreased riparian shading and large wood recruitment, and increased bank erosion.
- **Biological health**—The above factors combine to reduce the functional value of streams for biota. While the habitat quality and health vary by the species and their specific needs, benthic macroinvertebrate communities serve as a key indicator of a stream's biological health and are emphasized in this monitoring approach.

The hierarchy of drivers and watershed process connections is an important consideration with each of the factors above. Considered simply, development is the primary driver of reduced stream health. Development most directly impacts hydrology and water quality, although it can infringe upon and constrain the stream corridor. Watershed-scale changes in hydrology and water quality cascade down and directly impact the stream geomorphology and biology. Therefore, the monitoring emphasis on stream geomorphology and benthic macro-invertebrates measures the "response" or "outcome" of development. Furthermore, the response of stream conditions is not linear (even if the rate of development is), as is discussed in the context of geomorphic monitoring below.

## 2.2 Application of Monitoring Framework

The monitoring methods used to assess stream health per the four major factors (sub-indexes) introduced above were, generally:

- **Hydrology**—Monitoring via four continuous stream gages operated by WES. With relatively few gage sites available, impervious area was used as a surrogate for hydrologic impacts (as discussed further below).
- **Water quality**—Monitoring at nine water quality sampling locations by WES
- **Physical habitat (geomorphic and riparian)**—Monitoring via field geomorphic observation/survey, conducted on approximate triannual basis since 2008 (methodology is summarized briefly below and in greater detail in Appendices C and D)
- **Biological health**—Monitoring via field macroinvertebrate sampling, conducted on approximate triannual basis since 2008 (methodology is summarized briefly below and in greater detail in Appendix C)

Monitoring data are organized in a hierarchical manner to arrive ultimately at an overall health assessment per stream/watershed. The conversion from data to health is described as follows and was applied to the various categories of monitoring data considered in this report:

1. **Measurements**—Direct measurements (or observations) were made in the field or through GIS analysis
2. **Metrics**—Metrics were calculated from one or multiple measurements (e.g., width-to-depth ratio)
3. **Categorical conditions and scoring**—Classified conditions and scoring of specific health categories were necessary for some of the sub-indices. For instance, physical (geomorphic and riparian) health evaluation required assessment of conditions in multiple categories (e.g., entrenchment, floodplain connectivity) before an overall physical health sub-index was assigned. Condition classifications drew upon metrics to assign relative assessments of health and scoring.
4. **Stream health sub-index scoring**—Hydrology, water quality, physical, and biological health sub-index scores were either calculated directly from key metrics (e.g., hydrology and water quality) or relied on summation of categorical scores (e.g., physical and biological habitat). Depending on the nature of data, sub-index scoring was calculated on reach-scale and stream-levels.
5. **Stream health assess**—The collection of scoring from the four sub-indices provided an overall indication of stream health, although a single metric of stream health was not calculated directly.

# 3. Hydrologic Health Summary

Urbanization of watersheds commonly shifts hydrologic regimes via increased runoff and reduced infiltration and water retention on the landscape, a process generally referred to as hydromodification. The hydrological consequences of these processes can include increased flow volumes, increased peak flows, reduced summer stream flows, and shifts in flow timing (Konrad and Booth, 2002). The degree of hydromodification was initially determined by applying Konrad and Booth’s (2002) flow metric $Tq_{mean,}$ which is the proportion of annual flows exceeding the annual mean streamflow. In the four streams monitored for streamflow (e.g., Kellogg, Mt. Scott, Phillips, and Rock), however, this metric was found to be remarkably similar (26–27%) over the previous five years (Table

3). Considering that these four watersheds cover a wide range of development intensities (e.g., percent imperviousness values range from 17% to 53% as shown in Figure 2), the hydromodification indicator, $Tq_{mean}$ was determined not to be a reliable indicator of relative hydrologic impacts between the watersheds. In the absence of additional gages, impervious area percentage was therefore chosen as a surrogate for the hydromodification indicator.

**Table 3: Average flow statistics over the previous 5 years in the four streams with active streamflow monitoring by WES.**

| Stream | 7-day Low Flow (cfs) | Annual Mean Discharge (cfs) | Annual Maximum Discharge (cfs) | Hydromodification Indicator, $Tq_{mean}$ (%) |
|---|---|---|---|---|
| Kellogg | 3.2 | 23.3 | 511 | 27% |
| Mt. Scott | 1.2 | 16.9 | 453 | 26% |
| Phillips | 0.3 | 3.5 | 190 | 26% |
| Rock | 1.0 | 14.3 | 395 | 26% |

# 4. Water Quality Health Summary

Water quality scoring is based on the Oregon Water Quality Index (OWQI) developed by Cude (2001). The Oregon Water Quality Index (OWQI) is a statistical tool used to analyze a defined set of water quality variables and produce a score describing general water quality for a particular monitoring site. OWQI scores range from 10 (worst case) to 100 (ideal water quality). Variables included in the OWQI are temperature, dissolved oxygen (percent saturation and concentration), biochemical oxygen demand (BOD), pH, total solids, ammonia and nitrate nitrogen, total phosphorous and bacteria (Brown 2016). Table 4 presents the 5-year running seasonal averages of OWQI and the minimum of those seasonal averages, which together are the basis of water quality classifications. A majority of streams are classified in the "poor" range as defined by Oregon Department of Environmental Quality (ODEQ). The exceptions are Carli, Kellogg (above Mt. Scott), and Pecan creeks, which all score in the "very poor" category.

Statistical Mann-Kendall tests were also performed to evaluate trends in the last 10 years and on the basis of observed improvements in scores. These statistical tests revealed significant positive trends in all but two streams, although these positive trends are most prevalent in non-summer months. Only Kellogg (above Mt. Scott Creek) and Rock Creeks have positive trends in summer months. The lack of significant negative trends is a notable finding. The prevalence of improving water quality trends and the absence of worsening trends suggests that water quality conditions are improving overall across the district.

However, a change in monitoring methodology in 2017 may also impact these results. In 2017, WES changed from targeting sites during storm conditions (when streams would hypothetically have worse water quality and consequently lower OWQI scores) to a monthly, but randomly chosen day. Because streams generally experience "storm runoff conditions" only during high flow events following heavy rain and not for a majority of the year, the random monthly dates approach was used to more representatively depict the water quality in the streams year-round, not just when storms occurred.

**Table 4: Summary of OWQI water quality scores and trends in the watersheds with water quality sampling. Condition classifications include the following OWQI ranges: "very poor" (<59, displayed red), "poor" (60-79, displayed yellow), "fair" (80-84), "good" (85-89), "excellent" (>90). NS (grey) and "Sig. Positive" (green) indicate statistically non-significant trends and significantly positive trends, respectively (α=0.05).**

| Stream | 5-year (WY 2016–2021) OWQI Seasonal Averages | | Minimum of 5-year OWQI Seasonal Averages | 10-year (WY 2012-2021) Seasonal Mann-Kendall Trend test Trend and Direction | |
|---|---|---|---|---|---|
| | Summer | Fall-Winter-Spring | | Summer | Fall/Winter/Spring |
| Carli | 59 | 69 | 59 | N.S. | N.S. |
| Cow | 69 | 77 | 69 | N.S. | Sig Positive |
| Kellogg (ab. Mt. Scott) | 54 | 53 | 53 | Sig Positive | Sig Positive |
| Kellogg (bel. Mt. Scott) | 63 | 65 | 63 | N.S. | N.S. |
| Mt. Scott | 62 | 72 | 62 | N.S. | Sig Positive |
| Pecan | 49 | 73 | 49 | N.S. | Sig Positive |
| Phillips | 67 | 70 | 67 | N.S. | Sig Positive |
| Rock | 78 | 71 | 71 | Sig Positive | Sig Positive |
| Sieben | 71 | 63 | 63 | N.S. | Sig Positive |

# 5. Physical Habitat (Geomorphic and Riparian) Health Summary

## 5.1 Overview of Revised Monitoring Approach

The revised methods precipitated from the significant effort and cost needed for geomorphic surveys, the difficulty in measuring meaningful geomorphic change in complex stream environments, and the challenge of assessing broader stream health from a small number of sites. Thus, the revised methods developed and employed in 2021–2022 have an emphasis on capturing broader spatial coverage through application of rapid reconnaissance techniques at more sites. This revised approach is intended to gain a broader understanding of stream conditions and trajectories using simplified measurements and observations collected at several sites per stream (109 total sites with approximately 2 sites per mile of stream). In contrast, past efforts used detailed survey methods to measure change at fewer sites (1–2 sites per stream of interest, ~25-30 total in study area) with the idea that site-scale changes were reflective of broader stream health. Although detection of significant geomorphic change is possible, a targeted trend analysis of 2009–2021 data (documented in Appendix E) finds that relatively few statistically significant trends were detectable with the current data set. This points to the need for longer datasets to overcome the challenges with detecting meaningful trends that inform broader watershed understanding.

The reconnaissance-level methods developed for this monitoring effort emphasized collection of rapid stream measurements and observations to inform the degree of past and ongoing channel changes in response to stream disturbance. To increase efficiency, field data were also supplemented with targeted geospatial measurements where data availability allowed. All detailed data collected are provided in a tabular database in Appendix F. Corresponding shapefiles of monitoring data and site locations are also available along with this study.

In an effort to link past and revised methods, detailed geomorphic surveys were conducted at six of the previous survey sites (i.e., "status and trends sites") (Appendix G documents these detailed survey results).

The rationale for the revised methods is described briefly below and a more detailed description of the monitoring methods is presented in Appendix C.

## 5.2 Rationale and Basis for Physical Habitat Assessment

The physical habitat assessment addresses fundamental processes of stream response to disturbance and core physical elements that structure biological habitats along stream-floodplain corridors. Enhanced runoff from urban development typically increases the energy in streams and thus drives increased vertical erosion, or incision, in stream channels (e.g., Booth and Jackson, 1997). In response to this erosion and incision, streams undergo a common progression of physical changes that, in turn, impact the abundance and diversity of habitat along the stream (Cluer and Thorne, 2014). The Stream Evolution Model of Cluer and Thorne (2014; Figure 3) provides a conceptual model that charts this physical progression and the associated changes in habitat and river function through a sequence of stream evolution stages. The physical progression of geomorphic processes typically extends from stream incision to widening (i.e., lateral expansion via bank erosion) and followed by aggradation.

Two key diagrams outline the physical progress and habitat functions as a stream progresses along the Stream Evolution Model. The top diagram in Figure 3 shows the typical stages of stream evolution in response to some incision-causing disturbance. Specific stages correspond to varying combinations of stream incision, widening, and aggradation and associated stream conditions. The bottom diagram in Figure 3 displays both the quantity and relative composition of hydrogeomorphic and ecosystem benefits. In general, these functional attributes are greatest near early stages (before significant stream incision) and late stages (after a stream reestablishes an inset floodplain). The lowest ecosystem function occurs in middle stages when the stream is most entrenched.

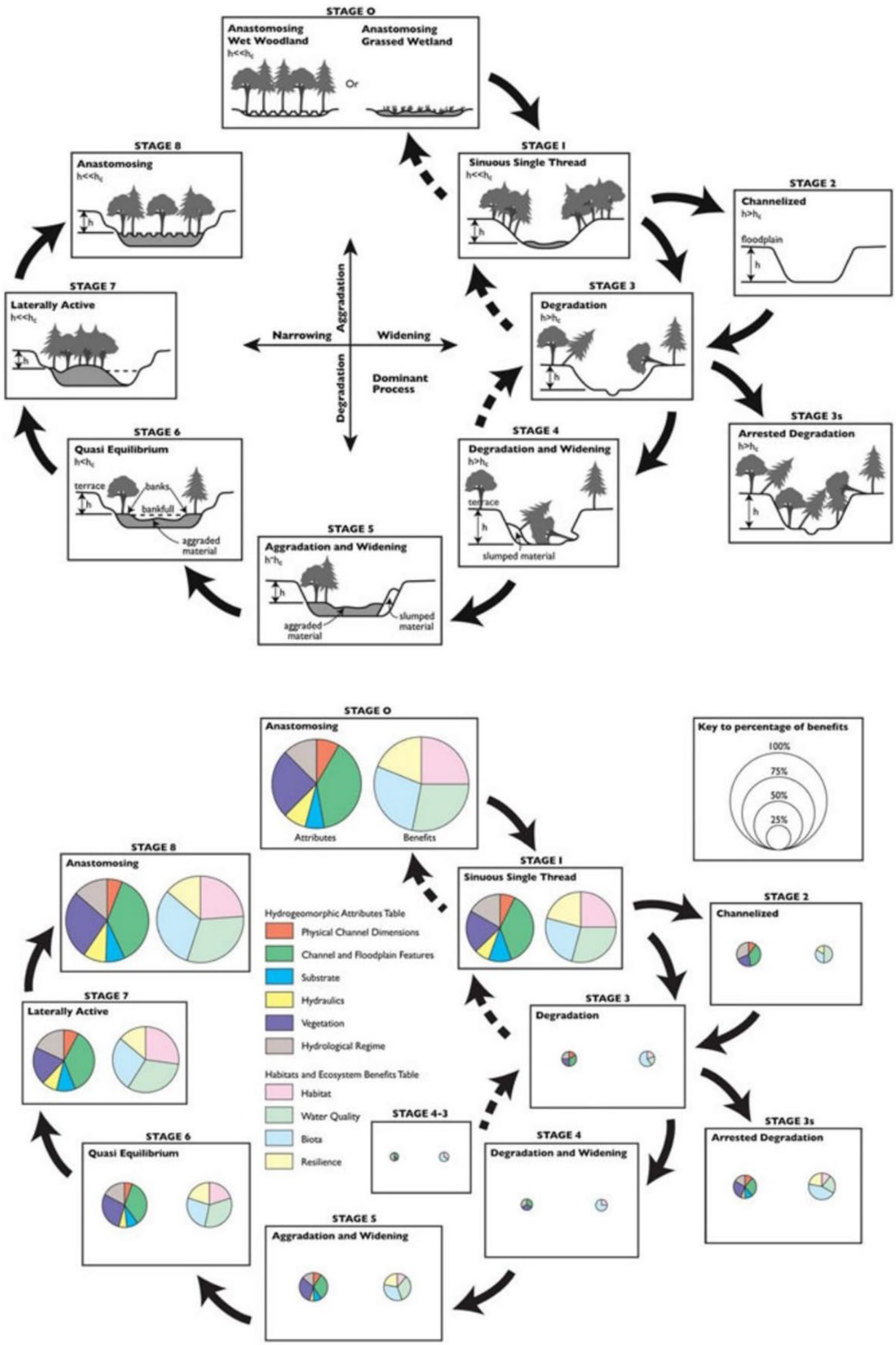



**Figure 3: Stream evolution model (SEM) of Cluer and Thorne (2014).**

The stream health assessment approach for physical habitat health addressed four core categorical elements of health in a stream, including:

- Stream entrenchment—Entrenchment is a direct reflection of the stage of stream evolution and degree of flow confinement. The applied measure of entrenchment incorporates field-derived measures of incision and widening. The combined degrees of incision and widening determine the degree to which the stream is entrenched, streamflows are confined, and stream power (energy) is elevated. Ultimately these aspects of channel entrenchment have direct effects upon habitat quantity and quality along a stream corridor.
- Complexity—Streams with greater diversity and complexity of physical features have higher quality habitat (Montgomery et al., 1996). The observed abundance of pools and large wood in the stream were used as indicators of relative habitat complexity.
- Floodplain connectivity—Streams with greater connectivity to their floodplains have higher quality and quantity of habitats (Wohl, 2017). Relative connectivity was evaluated through visual observation of stream and floodplain features at monitoring sites. In many cases, degraded floodplain connectivity is associated with stream entrenchment. However, visual assessment of connectivity indicators (e.g. high water marks, adjacent wetland vegetation, side channels) is intended to supplement that general association.
- Riparian Cover—The extent and quality of vegetation within riparian corridors relate to stream habitat conditions and functions. Extent and quality of riparian condition were informed through mapped canopy cover proportions (Metro, 2014) and relative abundances of invasive species observed in the riparian corridor.

For the four categories of physical habitat health, monitoring-based indicators were developed to inform the current stream *condition* and inferred *trajectory* of change (as described in Table 5, and in detail in Appendix D). Condition metrics inform the current state and/or form of the stream channel, but not necessarily its rate or direction of change. Trajectories were inferred through understanding of stream evolution and response mechanisms in the Stream Evolution Model (Cluer and Thorne, 2014), direct observations of change (e.g., active bank erosion), susceptibility to additional change (e.g., substrate erodibility and the potential for additional erosion), and measurements of change (e.g., riparian cover using multi-temporal datasets).

**Table 5: General description of the basis for classification and scoring. For each category, monitoring data were used to characterize and score the current condition and assess the future trajectory. Appendix D provides detailed descriptions of condition classification criteria and scoring criteria.**

| Geomorphic/Riparian Condition Category | Current Condition Classification and Scoring Basis | Trajectory Classification and Scoring Basis |
|---|---|---|
| Entrenchment | Based on combination of:<br>• *Degree of incision* as measured with the height of the floodplain above the channel bed (normalized to bankfull channel depth)<br>• *Degree of widening* as measured with the width-to-depth ratio as measured from the floodplain edge<br>Narrower and more incised streams are considered more entrenched and received lower condition scores | Based on assessed "incision potential" according to:<br>• Observed substrate size and erodibility<br>• Trajectory inferred from SEM stage characterized in the field<br>Streams with higher potential for incision received lower trajectory scores. |
| Complexity | Based on the abundance of pools and large wood observed. The presence of wood and pools were equally weighted and both resulted in higher scoring. | LWD recruitment from intact riparian corridors is fundamental to a stream's ability to build complexity through time. Complexity trajectory was accordingly rated based on canopy cover (measured from Metro [2014] mapping) |
| Floodplain Connectivity | Based on an observed rating of connectivity accounting for the presence of features like adjacent wetland vegetation, side channels, and high-water marks on floodplain.<br><br>More connected floodplains received higher scores than those with less connectivity. | Because floodplain connectivity is typically impacted negatively by stream incision, trajectories in floodplain connectivity are tied to "incision potential" (see above). Based on this redundancy, connectivity was not incorporated in trajectory scoring. |
| Riparian Cover | Based on the percent of canopy cover (measured from Metro [2014] mapping) and relative abundance of invasive plant species observed along the stream corridor. Higher canopy covers and less abundant invasive species received higher scores. | Trajectory in riparian condition was assessed based on change in canopy cover as measured from Metro's 2007 and 2014 datasets |

## 5.3 Physical Habitat Health Subindex Scoring Results

The results of physical habitat health as assessed through the 2021-2022 monitoring are presented in Table 6 and Table 7. The results in Table 6 provide the classified descriptions of stream condition and trajectory in the four geomorphic/riparian condition categories of stream entrenchment, floodplain connectivity, complexity, and riparian cover. Stream conditions were then translated to numerical stream scores (reported in Table 7), whereby habitat categories received a score of zero, one, or two depending on its condition category. These category-specific scores are summed to produce two overall scores for the creek informing its overall condition (maximum score of 8) and trajectory (maximum score of 6).

### 5.3.1 Physical Habitat Findings by Category

The general findings in in relation to the four major condition categories are discussed below. These findings are relative to the results presented in Table 6 and Appendix B.

*Entrenchment* is mixed throughout the study watershed, with six, five, and eight streams in the high, medium, and low entrenchment categories, respectively. The most entrenched streams are those that are highly incised (as measured by floodplain height scaled to bankfull depth) and narrowly confined within that incised trench. Highly incised streams can also reduce their entrenchment through time as they widen according to the SEM progression shown in Figure 3. Although current entrenchment is mixed across the study areas, most of the streams have a notably high incision potential based on their SEM stage and substrate erodibility, which means the general trajectory is likely worsening. Only four streams are classified as having low incision potential due to bedrock exposures in the streambed (although reach-scale variations in stream bed erodibility should also be considered, as reported in Appendix B). Entrenchment patterns and trajectories are an important guide for stream restoration/enhancement and preservation actions. General strategies should consider natural valley confinement and setting, and may include the following based on current entrenchment and stream trajectory:

- *Streams with relatively low entrenchment and high incision potential:* These streams and stream reaches represent high priority areas for preservation and/or restoration actions to prevent degradation of these higher functioning habitats. These restoration actions may address downstream headcuts that, through continued upstream migration, threaten less incised reaches upstream. Enhancement of stream reaches with relatively low entrenchment may also increase their resilience to further degradation.
- *Streams with relatively low entrenchment and low incision potential:* These streams and stream reaches should be assessed further to confirm their condition and degree of resilience to further degradation. These reaches represent possible targets for relatively low-cost measures (like placement of beaver dam analogues and large wood) to further increase resilience and/or create core habitats with high functional value.
- *Streams with relatively high entrenchment and high incision potential:* These streams and stream reaches are likely to have low habitat quality and possible erosion impacts to adjacent infrastructure. With high degrees of erosion (both present and future), relatively aggressive actions may be needed to address erosion issues and restore instream habitats. Restoration efforts should emphasize reductions in erosive energy through added connectivity and complexity, potentially through grading and or channel filling. In cases of extreme and active incision that threatens infrastructure, stabilization may be required.

- *Streams with relatively high entrenchment and low incision potential:* These streams and stream reaches probably incised to bedrock in the past and are now in a widening phase. Further assessment may evaluate the potential for additional widening to impact adjacent infrastructure. With widening trajectories (and corresponding trends toward less erosive energy), these streams are considered to be lower priorities for restoration in general. However, opportunities may exist to accelerate the widening process and achieve stream restoration goals through actions like grading or large wood placement.

*Stream complexity* scoring is almost entirely in low to moderate categories, with only two streams (Carli and Mt. Scott Creeks) having high complexity scores. These general patterns indicate that wood and pools are limited in the assessed streams. However, general trajectories were assessed to be positive based on relatively extensive canopy cover, which implies a relatively high potential for future wood recruitment and pool scour. Efforts to build complexity should generally be paired with stream entrenchment restoration efforts, as discussed above. Especially in smaller streams, complexity can be built in the short-term through low-cost beaver dam analog structures. Large wood placement in larger streams can also build complexity. Over the longer-term, maintaining and restoring riparian zones to build large wood recruitment potential and beaver habitats are critical to improving and sustaining stream complexity.

*Floodplain connectivity* scoring revealed that most streams were either in low to moderate categories, with only three (Carli, Richardson, and Wilson) falling in the high category. The field approach informing this score assessed indicators of connectivity adjacent to the stream, but not necessarily the extent or width of floodplain. Therefore, these ratings are a supplement to the stream entrenchment scoring, which also informs floodplain connectivity. In general, these findings suggest that connection to adjacent wetlands and side channels is limited and could be improved through restoration efforts. Actions discussed in categories above (e.g. grading, beaver dam analogue placement, LWD placement) offer potential solutions to adding connectivity.

*Riparian condition* throughout the assessed streams and stream reaches are generally low to moderate. Only Fields Creek and Unnamed Tributary 2 scored in the high condition category. The general prevalence of low to moderate scores reflects the broad presence of invasive plant species in the riparian zones of most (~80%) monitoring locations. In contrast, canopy coverage is relatively high along the study streams, with the exceptions being Cow, Phillips, and Trillium Creeks where canopy coverage is less than 40%. Riparian cover change from 2007-2014 was used as an indicator of trajectory – most streams show minimal change to growth in riparian cover, indicating that trajectories are likely more positive than negative (although analysis of more contemporary GIS layers, when they become available, would improve the confidence in this trend).

**Table 6: Ratings and characterization of the current condition and assessed trajectory related to stream incision, widening, and entrenchment.**

| | | Entrenchment | | Complexity | | Connectivity* | Riparian Cover | |
|---|---|---|---|---|---|---|---|---|
| Stream | Geog. | Condition | Incision Potential | Condition | LWD Recruitment Potential | Condition | Condition | Change in Riparian Canopy (2007-2014) |
| Athey | West | High | Low | Low | High | Low | Mod. | Stable |
| Carli | East | Low | Mod. | High | Mod. | High | Low | Increasing |
| Cedar | East | Low | High | Mod. | Mod. | Mod. | Low | Increasing |
| Cow | West | Mod. | Mod. | Low | Low | Mod. | Low | Stable |
| Fields | West | Low | High | Low | High | Mod. | High | Increasing |
| Kellogg | East | Low | High | Low | Mod. | Low | Low | Stable |
| Mt Scott | East | Mod. | High | High | High | Low | Mod. | Increasing |
| Pecan | West | Low | Low | Low | High | Mod. | Mod. | Stable |
| Phillips | East | Mod. | High | Mod. | Mod. | Low | Low | Increasing |
| Richardson | East | Low | High | Mod. | High | High | Mod. | Increasing |
| Rock | East | Low | Low | Mod. | High | Low | Mod. | Increasing |
| Saum | West | High | High | Mod. | High | Low | Mod. | Increasing |
| Shipley | West | High | High | Low | Mod. | Low | Low | Decreasing |
| Sieben | East | High | High | Low | High | Low | Mod. | Increasing |
| Tate | West | Mod. | Low | Low | High | Mod. | Mod. | Stable |
| Trib 2 | West | High | High | Low | High | Low | High | Increasing |
| Trib 4 | West | Low | High | Low | High | Mod. | Mod. | Stable |
| Trillium | East | High | High | Mod. | Mod. | Low | Low | Increasing |
| Wilson | West | Mod. | Mod. | Mod. | High | High | Mod. | Decreasing |

*** No trajectory score for connectivity was assigned based on the close linkage between floodplain connectivity and "Incision Potential."**

### 5.3.2 Overall Physical Health Scoring

As shown in Table 7, total condition scores range from the minimum possible score of zero in Shipley Creek to the highest score of six out of eight (75% of total possible) in Carli and Richardson creeks. Nine of the 19 creeks score in the lowest category of "likely impaired" with scores of two or less. Eight creeks score in the middle category of "probably impaired" with scores of three to five. Only two creeks score in the highest health category of "functioning" with scores exceeding six.

Calculated trajectory scoring ranges from one in Shipley Creek to the maximum possible of six in Rock Creek (Rock Creek's high score likely results from the prevalence of bedrock). Three, twelve, and four creeks respectively fall in the three trajectory categories of "likely degrading" (scores of 0–2), "potentially degrading" (scores of 3–4), and "likely improving" (scores of 5–6). The relative abundance of creeks in the middle category reflects offsetting effects of commonly low scores in the entrenchment category and relatively high scores in the large wood recruitment potential and riparian trajectory categories. High incision potential reflects the observation that streams are commonly within the incising stages of the Stream Evolution Model (Cluer and Thorne, 2014) and are largely composed of erodible substrates. More positive complexity riparian trajectories reflect the common finding that riparian zones are relatively extensive (thus leading to relatively high large wood recruitment potential) and have increased in canopy cover from 2007–2014 (based on our change analysis of Metro canopy layers).

### 5.3.3 Physical Health and Watershed Development (Impervious Area)

To explore the effects of watershed development, the bivariate plots in Figure 4 show the relationship of physical habitat conditions scores to the two key measures of impervious area. Plot A shows no obvious relationship between total impervious area (2019) and physical habitat condition. Plot B shows potentially more systematic data scatter relative to increased impervious area from 2001-2019 (a measure of more recent development pressure). Specifically, we observe a potential downward sloping upper envelope in the data. This envelope may imply that more intense and recent development pressure results in increasingly more degraded conditions, whereas lower development pressure allows for a wider range of stream conditions. Although the significance of this envelope is uncertain, it may also suggest that physical stream degradation occurs relatively rapidly in response to development. This further implies that stream recovery processes like those displayed in Figure 3 may complicate relationships between longer term development patterns (as reflected by total impervious area) and stream health.

**Table 7: Condition and trajectory scoring matrices for all creeks. Current condition has a maximum possible score of 8 and trajectory has a maximum possible score of 6.**

| Current Condition Scoring | | | | | | Trajectory Scoring | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stream Name | Entrench-ment (0-2) | Complexity (0-2) | Floodplain Connectivity (0-2) | Riparian Cover (0-2) | Total Score | Incision Potential (0-2) | Complexity - LWD Recruitment Potential (0-2) | Riparian Cover Change (0-2) | Total Score | Probable Management Approach (General Priority and Focus) |
| Athey | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 5 | Lower – Targeted Enhancement |
| Carli | 2 | 2 | 2 | 0 | 6 | 1 | 1 | 2 | 4 | Lower- Preserve/Prevent |
| Cedar | 2 | 1 | 1 | 0 | 4 | 0 | 1 | 2 | 3 | Higher – Integrated Strategy |
| Cow | 1 | 0 | 1 | 0 | 2 | 1 | 0 | 1 | 2 | Higher – Integrated Strategy |
| Fields | 2 | 0 | 1 | 2 | 5 | 0 | 2 | 2 | 4 | Lower – Preserve/Prevent |
| Kellogg | 2 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 2 | Higher – Integrated Strategy |
| Mt Scott | 1 | 2 | 0 | 1 | 4 | 0 | 2 | 2 | 4 | Lower – Targeted Enhancement |
| Pecan | 2 | 0 | 1 | 1 | 4 | 2 | 2 | 1 | 5 | Lower - Preserve/Prevent |
| Phillips | 1 | 1 | 0 | 0 | 2 | 0 | 1 | 2 | 3 | Higher – Integrated Strategy |
| Richardson | 2 | 1 | 2 | 1 | 6 | 0 | 2 | 2 | 4 | Lower – Preserve/Prevent |
| Rock | 2 | 1 | 0 | 1 | 4 | 2 | 2 | 2 | 6 | Higher – Integrated Strategy |
| Saum | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 2 | 4 | Lower – Targeted Enhancement |
| Shipley | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | Higher – Integrated Strategy |
| Sieben | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 2 | 4 | Lower – Targeted Enhancement |
| Tate | 1 | 0 | 1 | 1 | 3 | 2 | 2 | 1 | 5 | Lower – Targeted Enhancement |
| Trib 2 | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 4 | Lower – Targeted Enhancement |
| Trib 4 | 2 | 0 | 1 | 1 | 4 | 0 | 2 | 1 | 3 | Higher – Integrated Strategy |
| Trillium | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 3 | Higher – Integrated Strategy |
| Wilson | 1 | 1 | 2 | 1 | 5 | 1 | 2 | 0 | 3 | Higher- Preserve/Prevent |

Condition Classes

| | |
|---|---|
| 0–2: | Likely Impaired |
| 3–5: | Probably Impaired |
| 6–8: | Functioning |

Trajectory Classes

| | |
|---|---|
| 0–2: | Likely Degrading |
| 3–4: | Potentially Degrading |
| 5–6: | Likely Improving |

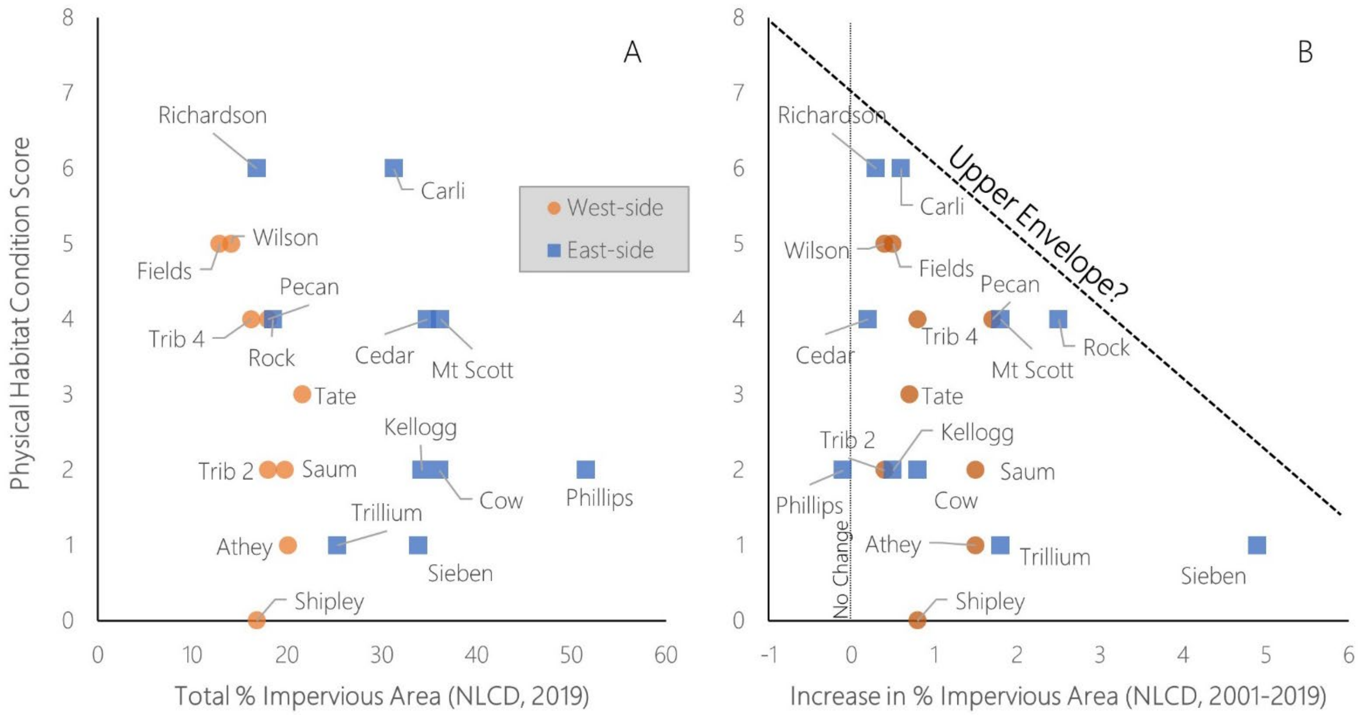



**Figure 4: Charts showing the relationship between calculated physical habitat condition scores and watershed development intensity, as measured by total percentage impervious area (A) and change in percentage impervious area from 2001-2019 (B). The potential upper envelope observed in chart B implies that more recent development intensity may be the more important driver of physical habitat health.**

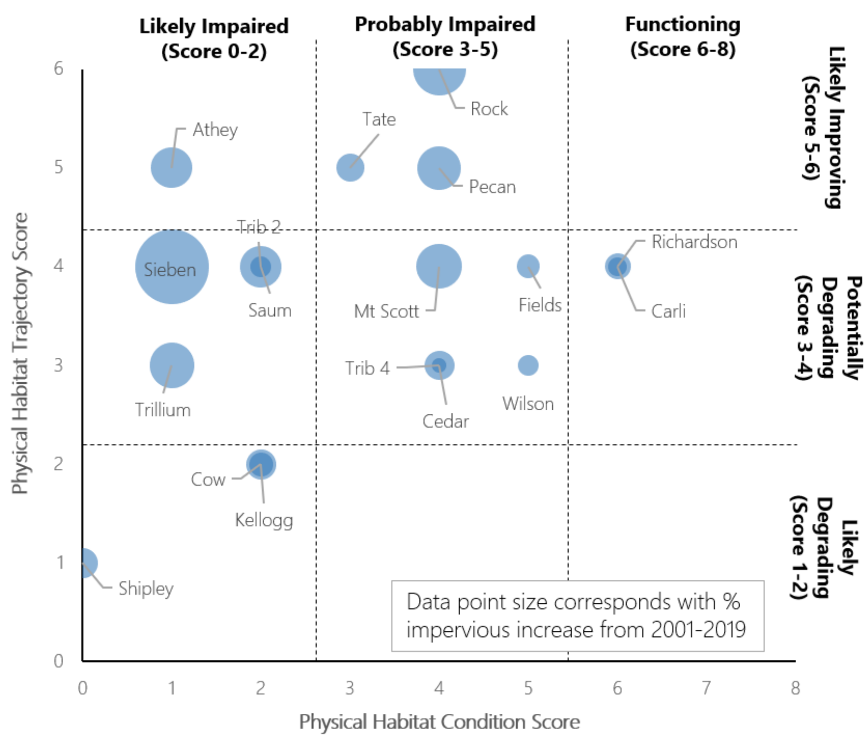



**Figure 5: Summary plot of physical habitat condition and trajectory scoring with 2001-2019 impervious percentages. Considering both current conditions and trajectories form the possible basis for prioritization of restoration and protection projects and programs.**

### 5.3.4 Potential Strategies to Manage and Improve Physical Habitat Health

Although this is not planning or prioritization study, the combination of current conditions, stream trajectories, and development pressures can support planning around stream protection and restoration actions. In general, building and managing stream corridor health requires integrated thinking and strategizing around land use, stormwater management, stream condition, and social/economic concerns. The information presented here provides an initial and incomplete first step in informing such a strategy.

Figure 5 helps to visualize the various combinations of current condition and trajectory scoring along with recent imperviousness increases (2001-2019) for the study streams. Importantly, this chart overlays current conditions with two aspects of each stream's potential future health trend. The trajectory scores inform likely future stream evolution by considering the stream's natural capacity to recover. And the measured changes in impervious percent from 2001-2019 inform the degree of added pressure from new development.

From a general strategy standpoint, the current condition of streams can inform the *type of actions* that may be necessary to address and build stream health, whereas the trajectory or trend of a stream's health can indicate the relative priority (or timeframe) of those actions. By this general framework, we used the physical habitat scoring and 2001-2019 imperviousness values to preliminarily place streams in four broad categories within Table 7:

- *Higher Priority Action – Preservation and Preventative Measures:* Streams in this category are those with generally better health (higher condition scores) and with trends that are more likely to be negative (higher degradation potential and/or more development pressure). Actions to preserve existing function and prevent further degradation are prudent and likely to save costs of avoiding more severe degradation over the long run.
- *Higher Priority Action – Integrated Strategy Needed:* Streams in this category are those with generally poor health (lower condition scores) and with trends that are more likely to be negative (higher degradation potential and/or more development pressure). These streams are especially likely to need integrated strategies to address system-scale issues from habitat, watershed, and infrastructure health perspectives.
- *Lower Priority Action – Preservation and Preventative Measures:* Streams in this category are those with generally better health (higher condition scores) and with trends that are more likely to be positive (improving trajectories and/or less development pressure). Actions to improve resilience of these stream corridors is an important long-term strategy.
- *Lower Priority Action – Targeted Stream Enhancement:* Streams in this category are those with generally poor health (lower condition scores) and with trends that are more likely to be positive (improving trajectories and/or less development pressure). Targeted actions to address degradation of these stream corridors is an important long-term strategy.

The broad categories defined above should also be considered in a reach-scale context, given longitudinal variability within streams. To support these planning considerations further, Appendix B in this document provides additional context on the geomorphology of streams as well as physical health scoring (both condition and trajectory) on a more focused reach scale.

# 6. Macroinvertebrate Health Summary

## 6.1 General Definitions and Approach

The composition and characteristics of aquatic benthic macroinvertebrate communities in urban streams is influenced by land use changes that alter hydrology and sediment provision and introduce contaminants into the water. Changes in flow, temperature, fine suspended sediment concentrations, percent impervious surface, stormwater delivery, and riparian corridor quality can all act as environmental variables influencing macroinvertebrate communities. Macroinvertebrate communities in urban streams may be slower to respond to habitat restoration or management actions at the reach scale compared to communities in streams with a more rural or agricultural setting (Miller et al., 2009; Tullos et al., 2009; Violin et al., 2011), and long-term monitoring is required to determine trends in community taxonomic and ecological metrics.

Macroinvertebrate monitoring has been done in selected stream reaches in the WES service district since 2002 to evaluate the biological health of representative streams and assess changes due to management actions. Riffles were targeted where available to preferentially sample habitat environments where more sensitive taxa reside and take advantage of generally cooler temperatures, higher oxygen contents, and higher velocities.

While macroinvertebrate sampling provides several indices and metrics with which to interpret stream health, two primary metrics were used in this study to inform biological health scoring. These include the multimetric invertebrate-based index of biotic integrity (M-IBI) and predictive PREDATOR O/E indices, which are standard metrics used by ODEQ to inform biotic condition of wadable streams. Both metrics provide a measure of overall habitat disturbance or impairment. The M-IBI score translates the raw value of 10 individual community metrics, which include both taxonomic (i.e., taxa richness) and ecological trait rates (i.e., % tolerant taxa), to a scaled value (5, 3, 1), yielding a summed multi-metric score that corresponds to severe, moderate, slight, or no impairment. In contrast, the PREDATOR O/E model score is based on the presence/absence of taxa. Both scores account for the similarity of sample sites to reference streams used to construct the model.

## 6.2 Overview of Key Results

Detailed results and discussion of the macroinvertebrate monitoring can be found in Appendix H.

It should be noted that hot dry weather conditions in summer of 2021, including an unprecedented "heat dome" that brought triple digit temperatures to the county, may have affected stream flows and macroinvertebrate communities. Thus, large changes in biological condition scores or community traits that vary substantially from prior sampling years should be interpreted with caution. Table 8 presents 2021 IBI and O/E model scores along with a summary of observed trends in selected metrics (total and EPT taxa richness, relative abundance of the dominant taxon, and M-IBI and O/E model scores). It can be seen that even at sites that received lower scores in 2021, overall trends towards increased taxa diversity and/or a more balanced community can be seen.

**Table 8: Current condition scores of the macroinvertebrate community in sample reaches and trends related to taxonomic metrics and ORDEQ model scores. Note that increases suggest improved conditions for all metrics except for % top taxon, which is expected to decrease in more stable/less impaired communities. See Appendix H for discussion of trends. * Indicates sites with extremely low flows, which may have skewed 2021 metric values and model scores. ^ Indicates site sampled within seven days of a rain event.**

| | | Trends in metrics | | | Trends in model scores | |
|---|---|---|---|---|---|---|
| Stream | 2021 condition (I-IBI / O/E) | # Total taxa | # EPT taxa | % top taxon | I-IBI | O/E |
| Athey * | Severely impaired/most disturbed | decrease | decrease | increase | decrease | decrease |
| Carli | Severely impaired/most disturbed | increase | stable | decrease | increase | increase |
| Cedar ^ | Severely impaired/most disturbed | increase | increase | increase | increase | decrease |
| Cow | Severely impaired/most disturbed | increase | stable | decrease | varies | increase |
| Lower Kellogg ^ | Moderately impaired/ most disturbed | increase | increase | decrease | increase | stable |
| Middle Kellogg ^ | Severely impaired/most disturbed | Increase | increase | increase | decrease | stable |
| Lower Mt. Scott ^ | Moderately impaired /most disturbed | Increase | increase | decrease | increase | increase |
| Middle Mt. Scott | Moderately impaired /most disturbed | increase | increase | decrease | Increase | increase |
| Upper Mt. Scott ^ | Moderately impaired /most disturbed | Increase | increase | decrease | Increase | increase |
| Saum ^ | Most disturbed | Increase | increase | decrease | N/A | increase |
| Pecan ^ | Slightly impaired/most disturbed | increase | increase | decrease | increase | Stable |
| Phillips ^ | Severely impaired/most disturbed | Increase | Increase | increase | stable | increase |
| Richardson ^ | Slightly impaired/most disturbed | Increase | stable | increase | increase | increase |
| Lower Rock | Slightly impaired/most disturbed | increase | increase | decrease | increase | Increase |
| Middle Rock | Moderately impaired /most disturbed | increase | increase | decrease | increase | varies |
| Upper Rock ^ | Slightly impaired/least disturbed | Increase | Increase | decrease | Increase | Increase |
| Shipley * | Moderately impaired/ most disturbed | increase | stable | decrease | Increase | increase |
| Sieben ^ | Moderately impaired/ most disturbed | Increase | Increase | decrease | Increase | increase |
| Tate | Moderately impaired /most disturbed | Increase | Increase | decrease | decrease | stable |
| Trillium | Slightly impaired/ moderately disturbed | increase | increase | increase | increase | increase |
| Unnamed Trib. 2 * ^ | Severely impaired/most disturbed | decrease | varies | decrease | increase | increase |
| Unnamed Trib. 4 * ^ | Severely impaired/most disturbed | increase | decrease | decrease | increase | increase |
| Wilson * ^ | Severely impaired/most disturbed | decrease | decrease | increase | increase | increase |

The M-IBI scores ranged from 14 to 38 among all sites (Figure 6), with nine sites scoring as severely impaired (<20), nine as moderately impaired (20-29), and five as slightly impaired (30-39) (see Figure 6). However, 12 sites attained an M-IBI score that was the same as or greater than the prior sampling year. In addition, 12 sites attained an M-IBI score greater than the mean of all available prior sampling years for that site (Table 9).

PREDATOR O/E scores reflected worse biological conditions overall, with 21 sites scoring as most disturbed, one as moderately disturbed, and one as least-disturbed (Figure 7). However, 11 sites attained an O/E score that was the same as or higher than the prior sampling year, and nine sites attained a score that was higher than the mean score for all prior years at the site (Table 9). The magnitude of change was quite small at many sites, with Pecan and upper Rock Creek showing the greatest increase in M-IBI over the average of previous years, and Trillium and Sieben Creeks showing the greatest increase in O/E over the average of previous years.

Despite differences in overall condition categories between the two models, there was a strong positive correlation between M-IBI and O/E scores (r = 0.86). It is not unusual for the same site to have a comparatively lower condition score based on the O/E model vs. the M-IBI, because this model is based on presence of expected taxa and loss of one or a few taxa can have a large impact on the overall score. In contrast, while the M-IBI does include taxonomic elements, there are also several metrics that relate more to ecological traits (e.g., tolerance, sensitivity), which may be shared by multiple different taxa in a sample. However, it should be noted that several sample reaches had extremely low flow at sampling time (i.e., Athey, Shipley, Unnamed Tributary 2, Unnamed Tributary 4, Wilson) due to severe summer weather conditions, resulting in unusual alterations to habitat that are likely to have disturbed benthic macroinvertebrate communities.

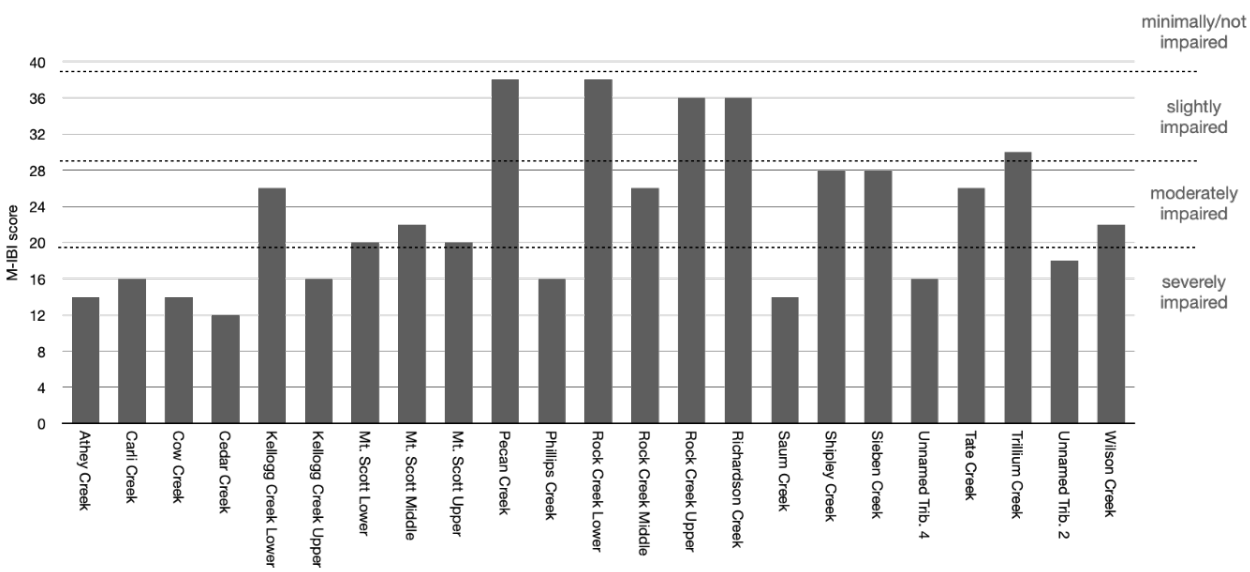



**Figure 6: M-IBI model scores among WES macroinvertebrate sampling sites. Dotted lines show cutoff values for site condition assignment.**

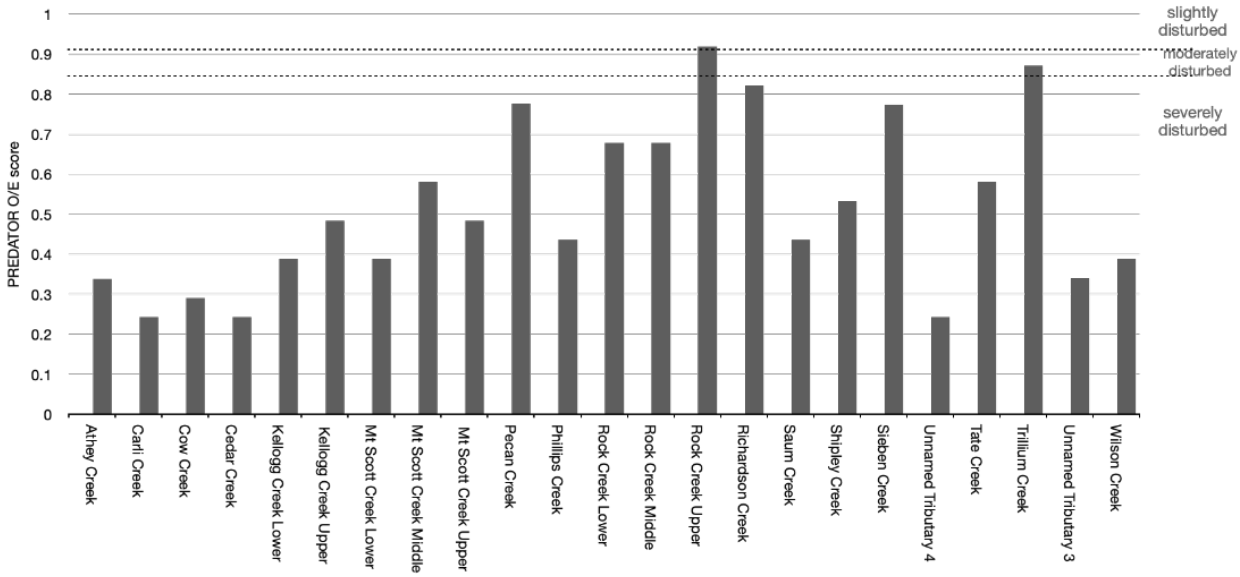



**Figure 7: PREDATOR predictive model O/E scores among WES macroinvertebrate sampling sites. Dotted lines show cutoff values for site condition assignment.**

**Table 9: Comparison of M-IBI and PREDATOR predictive model O/E scores in 2021 to mean scores from prior years. SD = standard deviation. Bold numbers indicate a 2021 model score higher than the mean of prior years. Note that not all differences correspond to a change in biological condition category. Highlighted scores for 2021 indicate severe (red), moderate (orange), or slight (green) impairment. * Indicates sites with extremely low flow at sampling time, which may have skewed 2021 metric values and model scores. ^ Indicates site sampled within seven days of a rain event**

| | M-IBI Scores | | | | O/E Scores | | | |
|---|---|---|---|---|---|---|---|---|
| | mean, 2002-2017 | SD | 2021 | change | mean, 2002-2017 | SD | 2021 | change |
| Athey Creek * | 28.3 | 6.4 | 14 | -14.3 | 0.81 | 0.08 | 0.34 | -0.47 |
| Saum Creek ^ | 24.0 | 0.0 | 14 | -10.0 | 0.42 | 0.19 | 0.44 | **0.02** |
| Pecan Creek ^ | 22.4 | 3.3 | 38 | **15.6** | 0.65 | 0.06 | 0.78 | **0.12** |
| Shipley Creek * | 26.0 | 3.3 | 28 | **2.0** | 0.47 | 0.13 | 0.53 | **0.07** |
| Unnamed Trib. 4 * ^ | 28.7 | 6.5 | 16 | -12.7 | 0.75 | 0.12 | 0.24 | -0.51 |
| Tate Creek ^ | 24.7 | 3.1 | 26 | **1.3** | 0.73 | 0.05 | 0.58 | -0.15 |
| Unnamed Trib. 2 * ^ | 25.7 | 5.3 | 18 | -7.7 | 0.64 | 0.15 | 0.34 | -0.30 |
| Wilson Creek ^ | 31.6 | 9.1 | 22 | -9.6 | 0.73 | 0.26 | 0.39 | -0.34 |
| Carli Creek | 13.2 | 3.0 | 16 | **2.8** | 0.25 | 0.11 | 0.24 | -0.01 |
| Sieben Creek ^ | 21.0 | 2.1 | 28 | **7.0** | 0.39 | 0.11 | 0.77 | **0.39** |
| Cow Creek | 14.8 | 4.1 | 14 | -0.8 | 0.32 | 0.08 | 0.29 | -0.02 |
| Kellogg Cr. Middle ^ | 20.7 | 2.3 | 16 | -4.7 | 0.57 | 0.03 | 0.48 | -0.09 |
| Kellogg Cr. Lower ^ | 20.5 | 3.0 | 26 | **5.5** | 0.42 | 0.16 | 0.39 | -0.03 |
| Mt Scott Lower ^ | 18.0 | 3.3 | 20 | **2.0** | 0.36 | 0.05 | 0.39 | **0.02** |
| Mt Scott Middle | 17.7 | 2.3 | 22 | **4.3** | 0.47 | 0.10 | 0.58 | **0.11** |
| Mt Scott Upper ^ | 21.3 | 4.8 | 20 | -1.3 | 0.52 | 0.07 | 0.48 | -0.03 |
| Phillips Creek ^ | 20.0 | 3.5 | 16 | -4.0 | 0.40 | 0.03 | 0.44 | **0.03** |
| Cedar Creek ^ | 14.4 | 3.3 | 12 | -2.4 | 0.46 | 0.07 | 0.24 | -0.21 |
| Rock Creek Lower | 30.3 | 4.3 | 38 | **7.7** | 0.76 | 0.14 | 0.68 | -0.08 |
| Rock Creek Middle | 27.0 | 4.1 | 26 | -1.0 | 0.77 | 0.13 | 0.68 | -0.10 |
| Rock Creek Upper ^ | 26.5 | 5.7 | 36 | **9.5** | 0.87 | 0.13 | 0.92 | **0.05** |
| Trillium Creek | 23.0 | 5.3 | 30 | **7.0** | 0.59 | 0.02 | 0.87 | **0.28** |
| Richardson Creek ^ | 34.0 | 3.3 | 36 | **2.0** | 0.85 | 0.07 | 0.82 | -0.03 |

Weighted-average inference models developed by ORDEQ (Huff et al., 2006) were also applied to macroinvertebrate community data to reveal whether fine sediment and/or elevated water temperature may be acting as a stressor on the macroinvertebrate community. Similar to the PREDATOR model, inferred values at the sample site, based on taxa temperature tolerances and sample abundance, are compared to conditions at appropriate regional reference sites. The 75th percentile of the distribution of inferred temperature and fine- sediment values from regional reference sites was used to determine whether a site is potentially stressed by these factors. These models were again developed specifically for riffle habitats, and thus glide or pool samples would score lower as slower flows are likely to have more fine sediment and warmer water. Based on reference sites in the Willamette Valley, ORDEQ threshold values, above which temperature and/or sediment may be a potential stressor, are 18.4ºC and 19% fine sediment, respectively.

Temperature and fine sediment are potential stressors at multiple sites. Only three samples received a temperature stressor model score that was below the threshold value of 18.4ºC (Pecan, Richardson, and Shipley), and 14 sites had a higher temperature stressor value in 2021 compared to 2017 (Table

10). Six sites received a sediment stressor score below the threshold value of 19% (Athey, Carli, Pecan, Lower Rock, Richardson, Trillium), and 13 sites had a higher sediment stressor score in 2021 compared to 2017 (Table 9).

**Table 10: Comparison of temperature and fine sediment stressor model scores in 2021 vs. 2017. Green highlight indicates score below the threshold value at which temperature or sediment is considered a potential stressor (18.4oC and 19% fine sediment, respectively). Grey highlight indicates a lower or unchanged score in 2021, although not necessarily resulting in a number below the threshold value. * Indicates sites with extremely low flow at sampling time, which may have skewed 2021 metric values and model scores. ^ Indicates site sampled within seven days of a rain event.**

| | Temperature stressor model score (ºC) | | | Sediment stressor model score (% fine sediment) | | |
|---|---|---|---|---|---|---|
| Stream | 2017 | 2021 | change | 2017 | 2021 | change |
| Athey Creek * | 18.5 | 18.5 | 0.0 | 19.9 | 17.4 | -2.5 |
| Carli Creek | 17.1 | 18.9 | 1.8 | 30.0 | 18.4 | -11.6 |
| Cow Creek | -- | 24.9 | — | — | 87.8 | — |
| Cedar Creek ^ | 22.4 | 21.3 | -1.1 | 39.9 | 39.1 | -0.8 |
| Kellogg Lower ^ | 22.2 | 23.5 | 1.3 | 21.8 | 36.6 | 14.8 |
| Kellogg Middle ^ | 21.5 | 22.2 | 0.7 | 35.9 | 32.4 | -3.5 |
| Mt Scott Lower ^ | 23.0 | 24.1 | 1.1 | 20.7 | 52.3 | 31.6 |
| Mt Scott Middle | 21.4 | 20.9 | -0.5 | 31.7 | 35.1 | 3.4 |
| Mt Scott Upper ^ | 20.8 | 22.4 | 1.6 | 26.2 | 32.0 | 5.8 |
| Pecan Creek ^ | — | 17.5 | — | — | 17.6 | — |
| Phillips Creek ^ | 18.0 | 19.0 | 1.0 | 22.3 | 29.8 | 7.5 |
| Rock Lower | 18.2 | 18.8 | 0.6 | 7.5 | 10.4 | 2.9 |
| Rock Middle | 21.6 | 22.4 | 0.8 | 21.9 | 31.0 | 9.1 |
| Rock Upper ^ | 19.8 | 20.2 | 0.4 | 20.6 | 25.1 | 4.5 |
| Richardson ^ | 18.5 | 17.9 | -0.6 | 12.3 | 11.0 | -1.3 |
| Saum ^ | — | 23.2 | — | — | 35.4 | — |
| Shipley * | 17.4 | 16.2 | -1.2 | 28.6 | 20.8 | -7.8 |
| Sieben ^ | 18.7 | 19.2 | 0.5 | 24.8 | 21.9 | -2.9 |
| Unnamed Trib 4 * ^ | 18.6 | 19.4 | 0.8 | 22.5 | 31.1 | 8.6 |
| Tate | 19.0 | 19.6 | 0.6 | 22.5 | 26.3 | 3.8 |
| Trillium | 19.4 | 19.3 | -0.1 | 12.7 | 17.3 | 4.6 |
| Unnamed Trib 2 * ^ | 17.7 | 22.0 | 4.3 | 18.3 | 53.1 | 34.8 |
| Wilson ^ | 18.1 | 19.2 | 1.1 | 25.5 | 36.3 | 10.8 |

Hydrologic conditions at the time of sampling are a consideration when interpreting these results. Some samples yielded lower than the target sample size of 500 organisms (i.e., Saum, Tate, Unnamed Tributary 2, Unnamed Tributary 4, Wilson); several of these were nearly dry at the time of sampling, although some (Saum, Tate) were not. Fifteen other samples were collected within seven days of an early fall rain event (Cedar, Lower Kellogg, Middle Kellogg, Lower Mt. Scott, Upper Mt. Scott, Pecan, Phillips, Upper Rock, Richardson, Saum, Sieben, Unnamed Tributary 4, Tate, Unnamed Tributary 2, Wilson), which could have altered macroinvertebrate communities via scouring or drift. Furthermore, these sites could have been nearly dry prior to the rain event. However, no consistent pattern of decreased abundance or diversity was observed in reaches sampled after a rainfall event. Further discussion of these and other site-scale factors are provided in Appendix H.

Despite uncertainty related to relative hydrologic conditions at the time of sampling, watershed impervious area has a significant influence on the relative macroinvertebrate communities (Figure 8). Impervious surface as a percentage of watershed area showed the strongest negative correlation with the number of Plecoptera (stonefly) taxa, the number of sensitive taxa, and M-IBI model score. Impervious surface also correlated strongly with the abundance of taxa tolerant to organic pollution (as indicated by the modified Hilsehoff Biotic index [MHBI]) as well as sediment stressors. Together these results suggest that macroinvertebrate communities are responding to watershed scale development and the associated cascade of hydrologic, water quality, and geomorphic impacts.

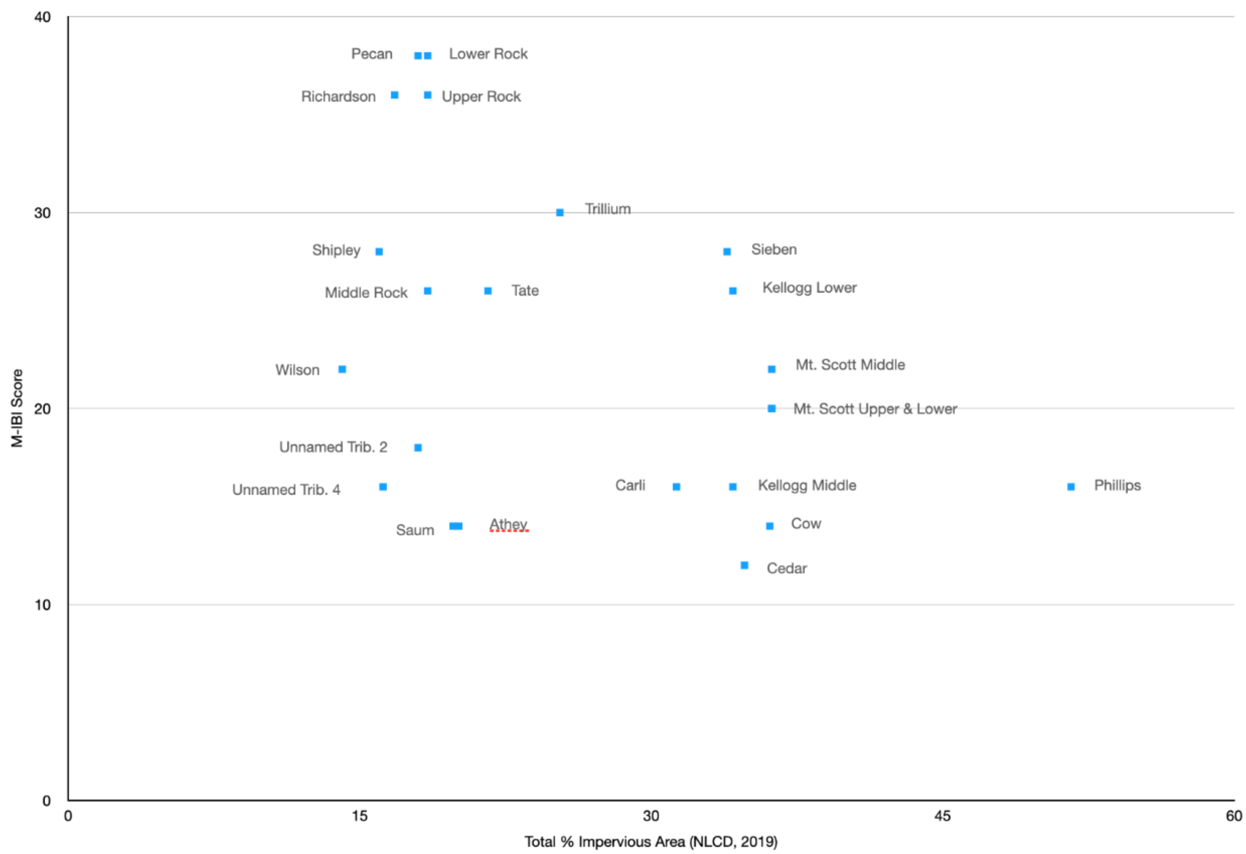



**Figure 8: Plot of total impervious area percentage (2019) versus M-IBI.**

# 7. Overall Stream Health Summary

As presented in Table 11, the WES streams exhibit varied health scores depending on their unique conditions sub-indices—hydrology, water quality, physical habitat, and biological health. Although a numerical score representing overall health was not developed, the steams with a greater number of positive scores are considered to be healthier overall, whereas streams with more commonly low sub-index scores are considered less healthy. Table 11 is organized accordingly to visualize the streams with higher health toward the top and visualized with blue-colored cells, and lower scores are placed toward the bottom and colored red. From this organization, the nineteen streams can be organized into three broad categories:

- Higher health streams include Richardson, Wilson, Rock, Fields, and Pecan creeks. In general, these creeks have relatively low impervious areas (<20%), mixed water quality scores, moderate to high physical habitat scores, and macroinvertebrate communities with slight to moderate disturbance.

- Mixed health streams include Tate, Mt. Scott, Unnamed Tributaries 2 and 4, Shipley, Trillium, Carli, Cedar, and Sieben creeks. These creeks have mixed scores in all categories (without consistently low or high scores).
- Low health streams include Saum, Athey, Cow, Kellogg, and Phillips creeks. These creeks have consistently low scores in all or most sub-indices.

Although complicated to generalize, these patterns of stream health should be considered in the context of the recent development pressures and trajectories in stream response (e.g. Figure 5). Watersheds with high and recent development pressure are most likely to experience hydromodification, water quality, and stream habitat impacts. Furthermore, stream evolution and response in the physical habitat realm informs the likely trends independent of development pressures. These factors are also presented in Table 11 to support that forward-look on the stream health findings presented in this report.  Discussion of potential stream corridor restoration and management strategies are also included in Section 5.

**Table 11: Summary of stream health condition scoring for the four sub-indexes with general organization from most (top) to least (bottom) healthy. Cell shading indicates relative scoring in the four categories considered, with darker blue indicating greater health in each sub-index.**

| | | | Stream Health Conditions Sub-Index | | | | Trajectory Indicators | |
|---|---|---|---|---|---|---|---|---|
| | Stream | Geog. | Hydrology (Impervious % in 2019) | Water Quality | Physical Habitat | Biological Communities (Macroinvertebrate) | Hydrology (Impervious change 2001-2019) | Physical Habitat Trajectory |
| Higher Health Grouping | Richardson | East | 16.8 | - | Functioning | Slightly/moderately disturbed | +0.3 | Potentially degrading |
| | Wilson | West | 14.1 | - | Probably impaired | Moderately/severely disturbed | +0.4 | Potentially degrading |
| | Rock | East | 18.5 | Poor | Probably impaired | Slightly/moderately disturbed | +2.5 | Likely improving |
| | Fields | West | 12.9 | - | Probably impaired | - | +0.5 | Potentially degrading |
| | Pecan | West | 18.0 | Very Poor | Probably impaired | Slightly/moderately disturbed | +1.7 | Likely improving |
| Mixed Health Grouping | Tate | West | 21.6 | - | Probably impaired | Moderately/severely disturbed | +0.7 | Likely improving |
| | Mt Scott | East | 36.2 | Poor | Probably impaired | Moderately/severely disturbed | +1.8 | Potentially degrading |
| | Trib 4 | West | 16.2 | - | Probably impaired | Severely disturbed | +0.8 | Potentially degrading |
| | Shipley | West | 16.8 | - | Likely impaired | Moderately/severely disturbed | +0.8 | Likely Degrading |
| | Trib 2 | West | 18.0 | - | Likely impaired | Severely disturbed | +0.4 | Potentially degrading |
| | Trillium | East | 25.3 | - | Likely impaired | Slightly/moderately disturbed | +1.8 | Potentially degrading |
| | Carli | East | 31.3 | Very Poor | Functioning | Severely disturbed | +0.6 | Potentially degrading |
| | Cedar | East | 34.8 | - | Probably impaired | Severely disturbed | +0.2 | Potentially degrading |
| | Sieben | East | 33.9 | Poor | Likely impaired | Moderately disturbed | +4.9 | Potentially degrading |
| Low Health Grouping | Saum | West | 19.8 | - | Likely impaired | Severely disturbed | +1.5 | Potentially degrading |
| | Athey | West | 20.1 | - | Likely impaired | Severely disturbed | +1.5 | Likely improving |
| | Cow | West | 36.1 | Poor | Likely impaired | Severely disturbed | +0.8 | Likely Degrading |
| | Kellogg | East | 34.2 | Poor/Very Poor | Likely impaired | Moderately/severely disturbed | +0.5 | Likely Degrading |
| | Phillips | East | 51.6 | Poor | Likely impaired | Severely disturbed | -0.1 | Potentially degrading |

# 8. Literature Cited


Booth, D. B., & Jackson, C. R. (1997). Urbanization of aquatic systems: degradation thresholds, stormwater detection, and the limits of mitigation 1. JAWRA Journal of the American Water Resources Association, 33(5), 1077-1090.

Brown, D. (2016). Oregon Water Quality Index: Background, Analysis, and Usage. Oregon Department of Environmental Quality, Laboratory and Environmental Assessment Program.

Cluer, B., & Thorne, C. (2014). A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications, 30(2), 135-154.

Cude, C. G. 2001. Oregon Water Quality Index: A Tool for Evaluating Water Quality Management Effectiveness. Journal of the American Water Resources Association 37: 125-137.

Miller, S.W., P. Budy, and J.C. Schmidt. 2009. Quantifying macroinvertebrate responses to in-stream habitat restoration: applications of meta-analysis to river restoration. Restoration Ecology 18: 8-19.

Montgomery, D. R., Buffington, J. M., Smith, R. D., Schmidt, K. M., & Pess, G. (1995). Pool spacing in forest channels. Water Resources Research, 31(4), 1097-1105.

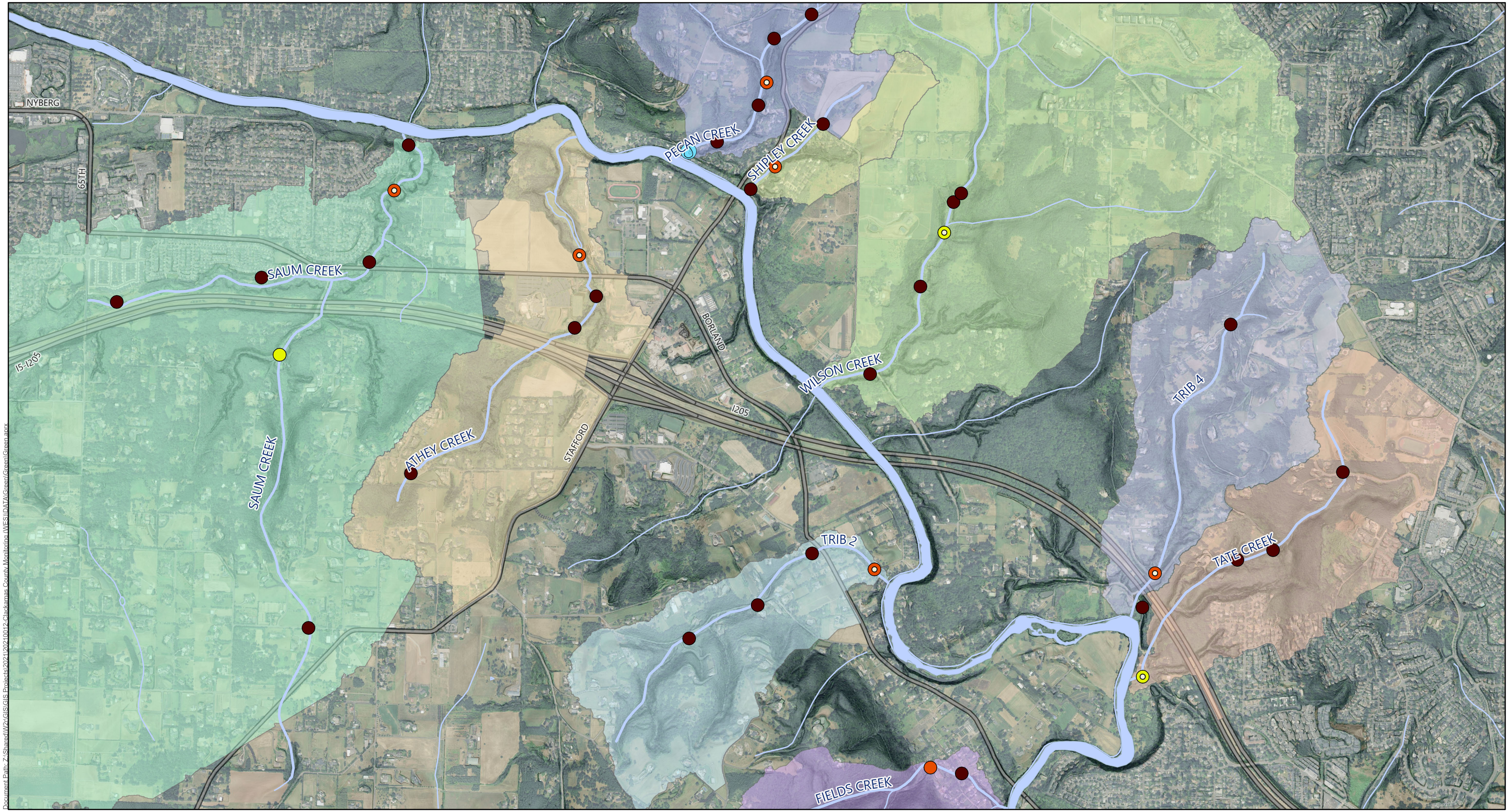
ODEQ (Oregon Department of Environmental Quality). 2009. Water Monitoring and Assessment Mode of Operations Manual. Version 3.2 DEQ03-LAB-0036-SOP.

Tullos, D.D., D.L. Penrose, and G.D. Jennings. 2009. Analysis of functional traits in reconfigured channels: implications for the bioassessment and disturbance of river restoration. Journal of the North American Benthological Society 28: 80-92.

Violin, C.R., P. Cada, E.B. Suddoth, B.A. Hassett, D.L. Penrose, and E.S. Bernhardt. 2011. Effects of urbanization and stream restoration on the physical and biological structure of stream communities. Ecological Applications 21(6): 1932-1949.

Wohl, E. (2017). Connectivity in rivers. Progress in Physical Geography, 41(3), 345-362.

# Appendix A – Overview Maps of Study Area




**Clackamas County Monitoring**

Western Sites

0 0.13 0.25 0.5 Miles

N

*Geomorphic Monitoring Sites*

- Level 1
- Level 2
- Level 3
- Macroinvertebrate Monitoring Sites

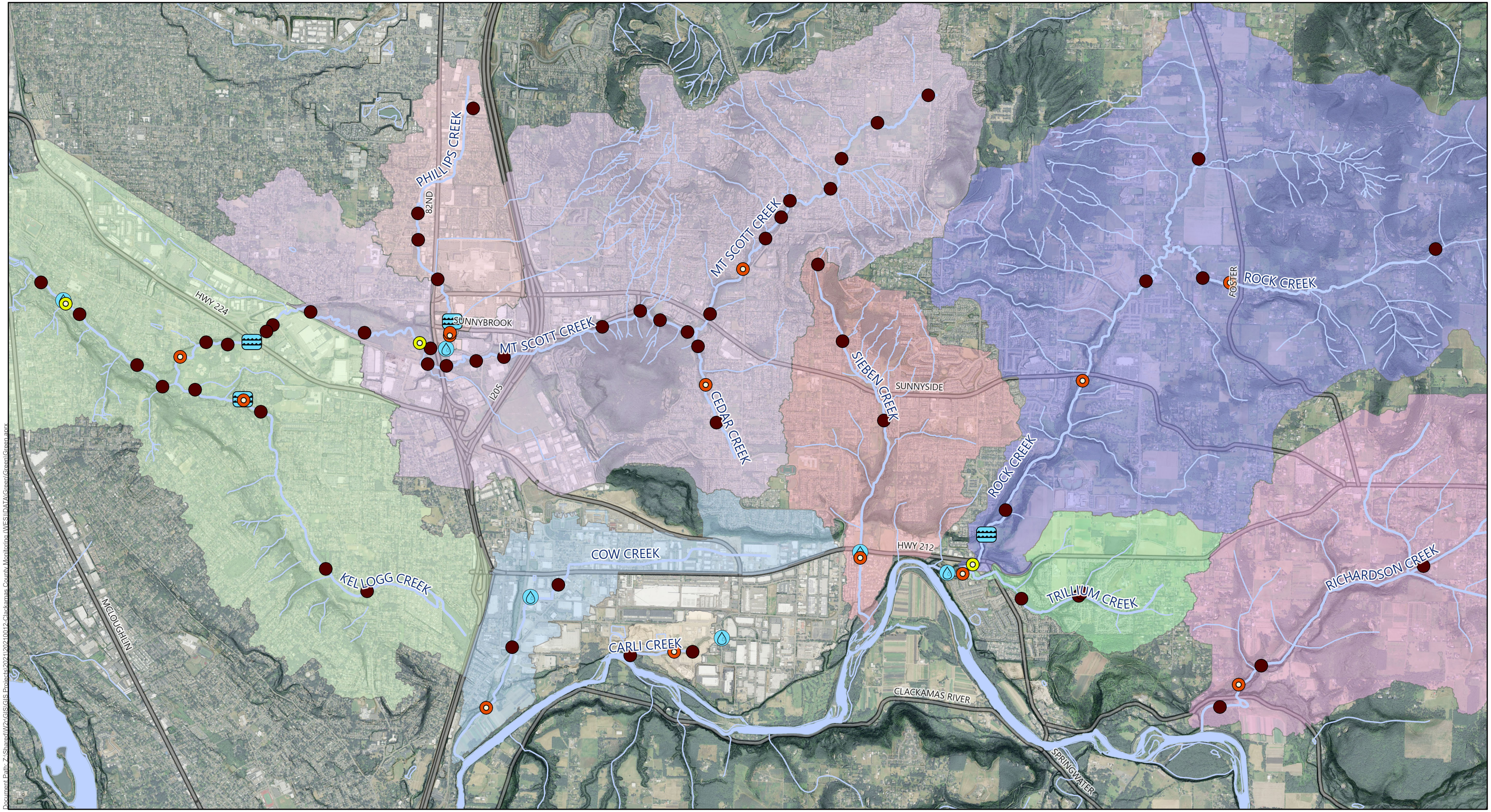
*Permit-required In-stream Monitoring Sites*

- Water Quality
- Streamflow

CLACKAMAS WATER ENVIRONMENT SERVICES

WOLF WATER RESOURCES

Esri, USDA Farm Service Agency




## Clackamas County Monitoring

Eastern Sites

0 0.25 0.5 1 Miles

N

### *Geomorphic Monitoring Sites*

- Level 1
- Level 2
- Level 3
- Macroinvertebrate Monitoring Sites

### *Permit-required In-stream Monitoring Sites*

- Water Quality
- Streamflow

CLACKAMAS WATER ENVIRONMENT SERVICES

WOLF WATER RESOURCES

Esri, USDA Farm Service Agency

# Appendix B – Stream Summary Sheets with Reach-Based Physical Health Scoring

## Appendix B- Stream Overview Sheets

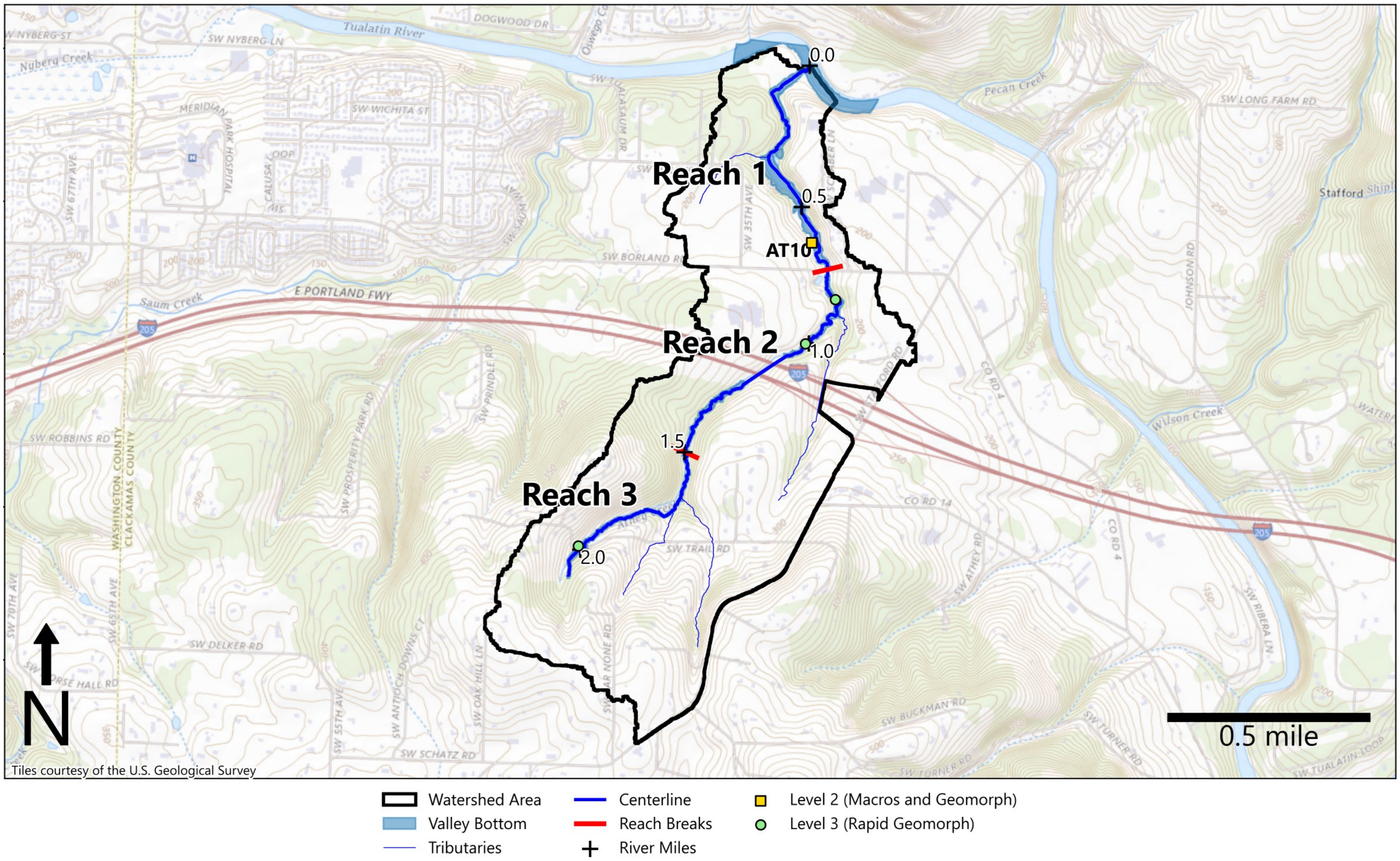
The purpose of this appendix is to summarize each stream's geomorphology and overall physical health. Each "Stream Overview Sheet" focuses on a single stream in the district and contains three sections:

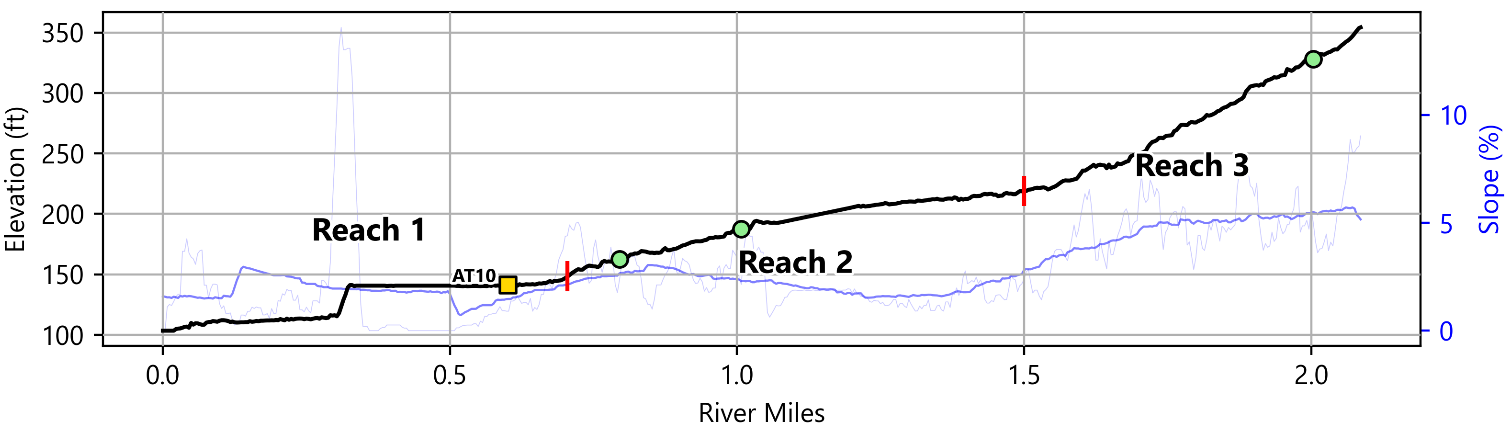
- **Context and Overview- Map and Profile**: This section contains a map of the stream divided into its geomorphic reaches and displays the site locations symbolized by the data level. The map also includes an outline of the stream's watershed. This section also includes a graph of the longitudinal profile of the stream overlaid with the stream's slope.
- **Reach-Based Summary – Geomorphology**: The table in this section of the sheet summarizes the geomorphic characteristics of each stream displayed per geomorphic reach. The "BF Width" measurement was collected in the field, while the remaining measurements were derived using GIS. Slope and valley confinement provide indicators of natural habitat potential – in particular, low gradient and wide floodplains (lower confinements) are likely to have higher habitat potential.
- **Reach and Stream Based Health Scoring**: This section contains several tables outlining both the measurements and metrics collected/calculated for each stream, as well as the categorical scoring of the stream's health. This section is divided into 4 subsections:
  - *Summary of Watershed Development Patterns/Stream Health Drivers:* This first table shows general watershed development measurements derived in GIS and then ranked as compared to the other streams in the district. The next table in this subsection displays the physical habitat measurements used to derive the stream's health scoring. The first row of the data is for the entire stream and the remaining rows are per reach. The table also includes the scoring category that each measurement was used in.
  - *Physical Habitat Current Condition Categories and Scoring:* The table in this subsection uses the measurements from the table above to score the stream's current health. The first row of the table is for the entire stream and the remaining rows are per reach. The scoring is shown with both a numerical number and a descriptor as described by the color-coded key at the bottom of the page.
  - *Physical Habitat Trajectory Categories and Scoring:* The table in this subsection reports health categories based on data table above. The first row of the table is for the entire stream and the remaining rows are per reach. The scoring is shown with both a numerical number and a descriptor as described by the color-coded key at the bottom of the page.
  - *Biological Habitat Scoring:* The table in this subsection categorizes the biological health of the stream based on its macroinvertebrate communities. It should both the M-IBI Score (including level of disturbance) and the O/E Score. The scoring is then categorized and color coded based on the key at the bottom of the page.

For additional information on the measurements and metrics used in these tables, see Appendix C. For additional information on the health scoring and categorization criteria, see Appendix D.

# Athey Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.7 | 3720 | 4.6 | 0.77 | 0.4 | Unconfined |
| 2 | 0.7 | 1.5 | 4200 | 5.65 | 0.59 | 2.43 | Partially Confined |
| 3 | 1.5 | 2.1 | 3100 | 3.8 | 0.3 | 4.8 | Unconfined |

We were unable to access Athey Creek below Schaber Reservoir (RM 0.3-0.5) and therefore conditions reported for Reach 1 may not be representative of stream conditions below the reservoir. Similarly, data collected in Reach 2 may not represent stream conditions in the lower gradient section (RM 1.25-1.5). Further data collection and private land access would be required to best capture the variety in stream conditions on Athey Creek.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 6.4 | 18.7 | 20.1 | 1.5 |
| Rank* | 16 | 10 | 10 | 7 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **2.2** | **Bedrock** | **Incised** | **4.1** | **32.5** | **14.3** | **28.6** | **55.5** | **1.25** | **85.7** | **-2.05** |
| Reach 1 | 1 | 2.4 | Fines | Widening | 2.9 | 90 | 0 | 25 | 43.4 | 2.0 | 100 | 0.3 |
| Reach 2 | 2 | 1.8 | Gravel | Incised | 6.3 | 13 | 50 | 50 | 64.9 | 1.0 | 100 | 1.5 |
| Reach 3 | 1 | 2.2 | Bedrock | Incised | 4.5 | 15 | 0 | 0 | 61.1 | 1.0 | 0 | -8.8 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Low** | **Low** | **Moderate** | **1** | **Likely Impaired** |
| Reach 1 | High | Low | Moderate | Low | 1 | Likely Impaired |
| Reach 2 | Moderate | Moderate | Low | Moderate | 3 | Probably Impaired |
| Reach 3 | High | Low | Low | High | 2 | Likely Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **Stable** | **5** | **Likely Improving** |
| Reach 1 | Moderate | Moderate | Stable | 3 | Potentially Degrading |
| Reach 2 | High | High | Stable | 3 | Potentially Degrading |
| Reach 3 | Low | High | Decreasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (Overall)** | 14.0 | Severe | 0.3 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

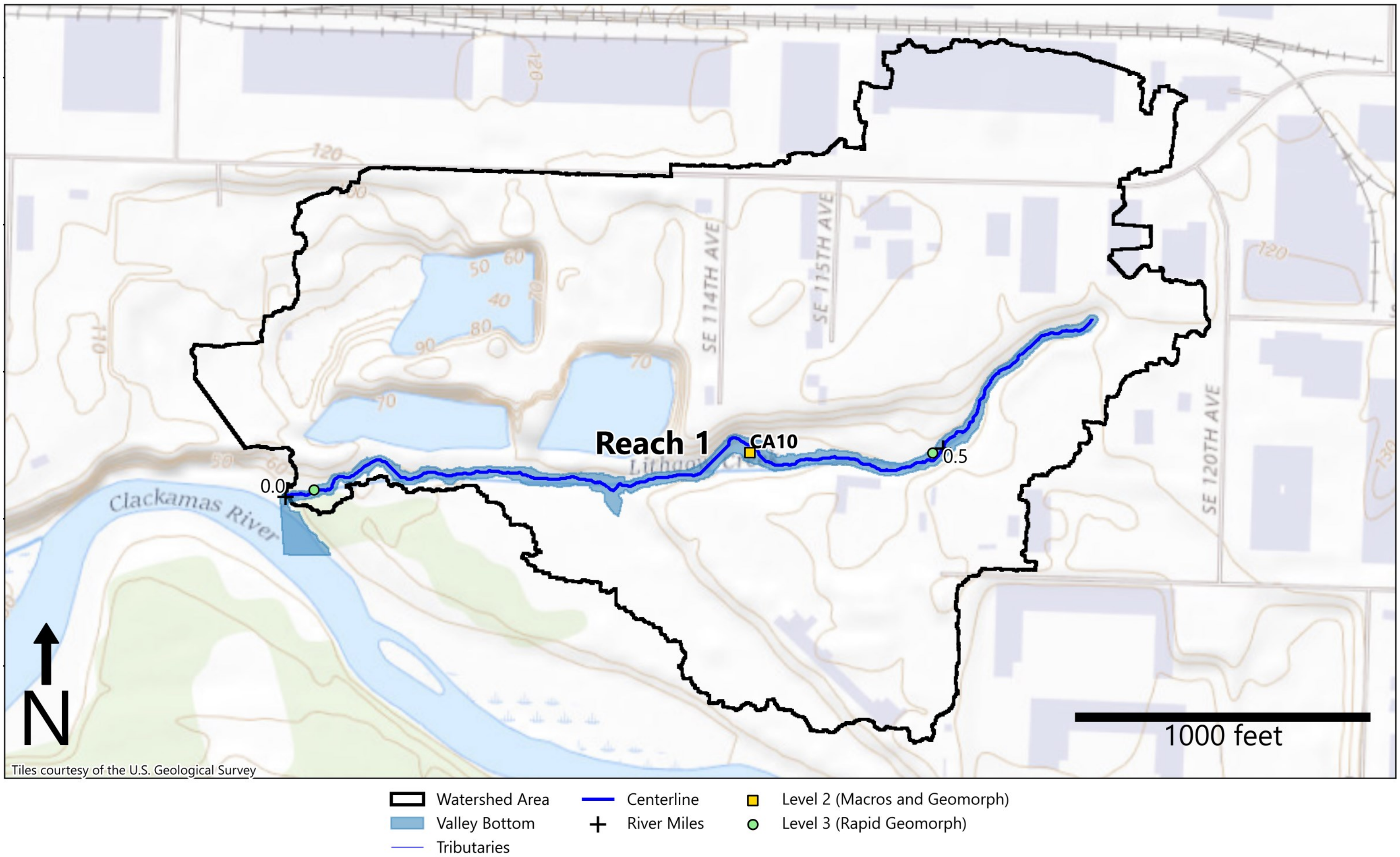
| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

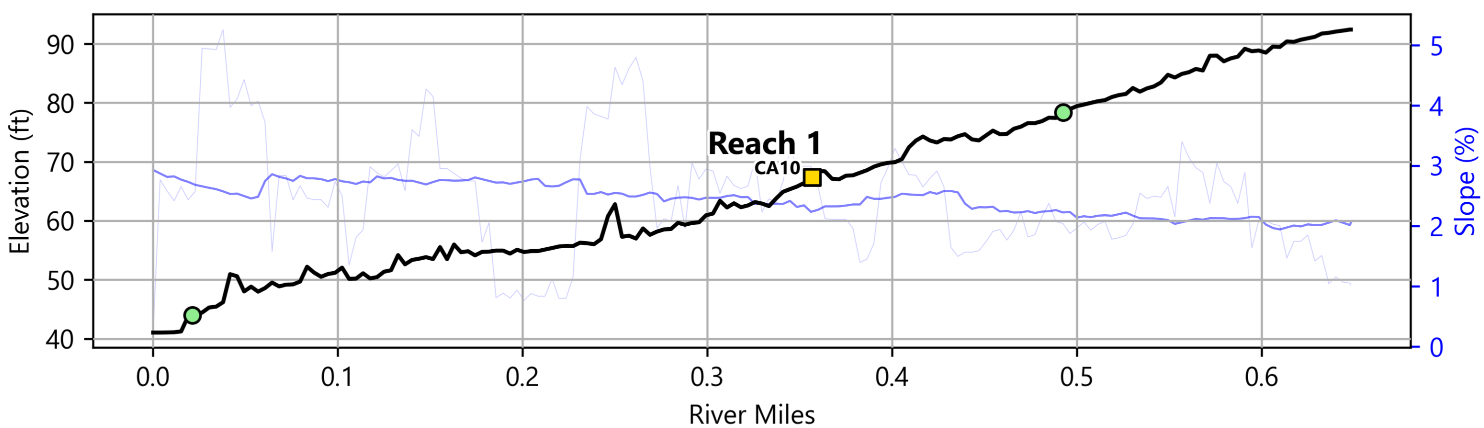
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Athey Creek flows northward off of steep bluffs into the Tualatin floodplain. Schaber Reservoir, located at RM 0.3-0.5, creates a low gradient reach upstream to RM 0.7 where the creek exhibits high entrenchment into fine-grained soil and low floodplain connectivity. The upstream reaches are more confined, gravel-bedded, well-canopied, and overall less impaired than Reach 1. The Athey Creek Watershed has both a low road density and minimal development pressure since 2001. Athey Creek has relatively low potential for incision in Reach 1 due to low slopes, presence of bedrock, and a widening trajectory. The upstream reaches also exhibit lower potential for incision due to coarse bed substrate (gravels and cobbles) and the presence of bedrock. Reach 1 above the reservoir has the space to widen and migrate within the valley bottom and has grade control provided by the reservoir. Therefore, the potential for further degradation in reach is relatively low.

# Carli Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.6 | 3420 | 16.37 | 0.05 | 2.22 | Partially Confined |

Carli Creek was recently restored as part of the Carli Creek Water Quality Project and therefore measurements taken on this stream may not represent natural conditions, but rather built conditions created during the restoration. Tracking geomorphic conditions at this site as the creek responds to the recent modifications may inform the relative success of the restoration efforts in creating habitat and facilitating natural geomorphic processes.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi² | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 6.2 | 30.8 | 31.3 | 0.6 |
| Rank* | 18 | 6 | 7 | 12 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **1.9** | **Gravel** | **Connected** | **11.5** | **8.33** | **100.0** | **57.1** | **43.0** | **3.0** | **85.7** | **18.0** |
| Reach 1 | 3 | 1.9 | Gravel | Connected | 11.5 | 8 | 100 | 57.1 | 43.0 | 3.0 | 86 | 18.0 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **High** | **Low** | **6** | **Functioning** |
| Reach 1 | Low | High | High | Low | 6 | Functioning |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Moderate** | **Increasing** | **4** | **Potentially Degrading** |
| Reach 1 | Moderate | Moderate | Increasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (Overall)** | 16.0 | Severe | 0.2 | Most |

**Scoring**
0
1
2

**Condition Classes**
0-2: Likely Impaired
3-5: Probably Impaired
6-8: Functioning

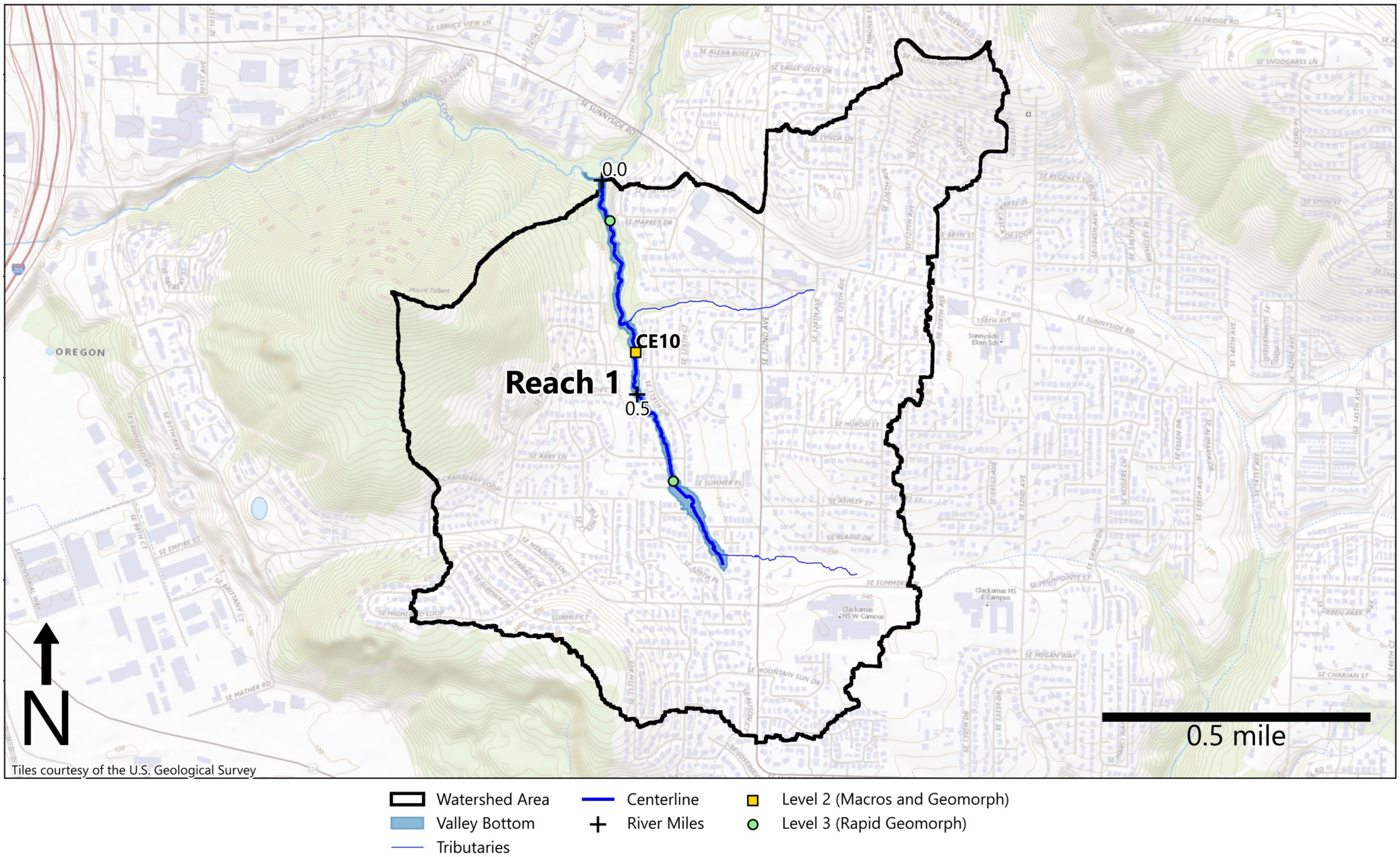
**Trajectory Classes**
0-2: Likely Degrading
3-4: Potentially Degrading
5-6: Likely improving

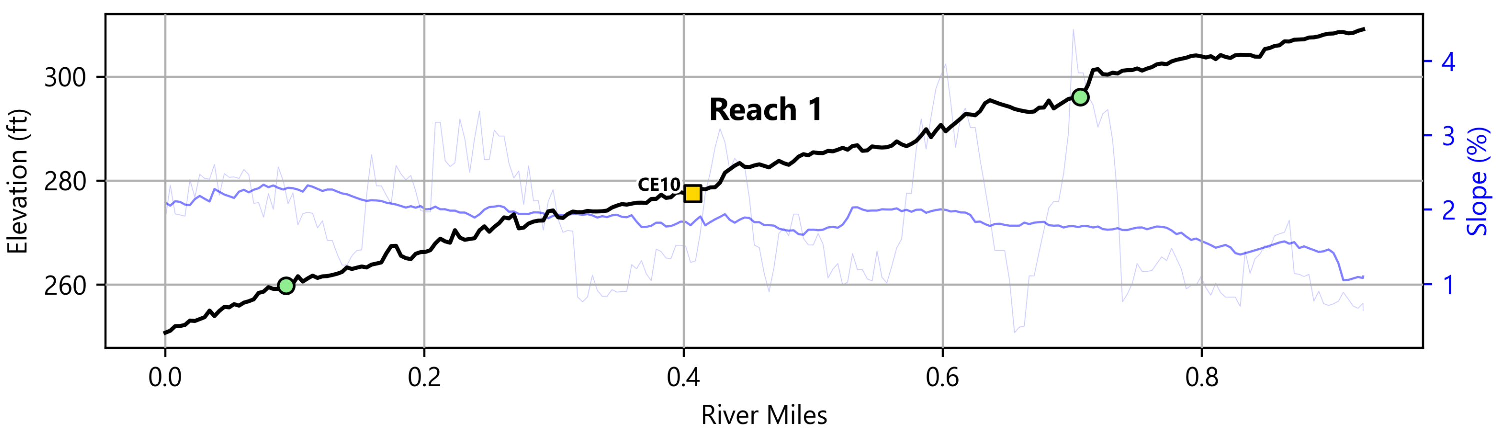
**Level of Disturbance**
Severe/Most
Moderate
Slight/Least

Carli Creek flows westward into the Clackamas River and drains industrial and commercial parks with extensive impervious areas. Conditions in the channel are fairly consistent along the entire stretch of creek, with the exception of the lowermost portion of the creek that can be backwatered by the Clackamas River. Overall, Carli Creek is gravel-bedded and well connected to its floodplain. However, these are built conditions from recent restoration activities. The potential for incision here is moderate, although the scoring does not account for the diversion of water into the nearby wetlands which reduces stream power in the channel. Conditions in Carli Creek are likely to evolve post-restoration and should be monitored closely.

# Cedar Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.9 | 4880 | 9.02 | 1.04 | 1.44 | Unconfined |

Stream conditions are relatively uniform on Cedar Creek and we were able to obtain data with a good distribution of sites. Therefore, data reported for Cedar Creek is representative of most, if not all, locations on the stream.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 20.4 | 34.7 | 34.8 | 0.2 |
| Rank* | 2 | 3 | 4 | 18 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **1.4** | **Fines** | **Incised** | **7.3** | **11.7** | **83.3** | **0.0** | **48.2** | **1.7** | **100** | **17.3** |
| Reach 1 | 3 | 1.4 | Fines | Incised | 7.3 | 11.7 | 83.3 | 0.0 | 48.2 | 1.7 | 100 | 17.3 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Moderate** | **Moderate** | **Low** | **4** | **Probably Impaired** |
| Reach 1 | Low | Moderate | Moderate | Low | 4 | Probably Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Increasing** | **3** | **Potentially Degrading** |
| Reach 1 | High | Moderate | Increasing | 3 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (Overall)** | 12.0 | Severe | 0.2 | Most |

| **Scoring** |
|---|
| 0 |
| 1 |
| 2 |

| **Condition Classes** | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

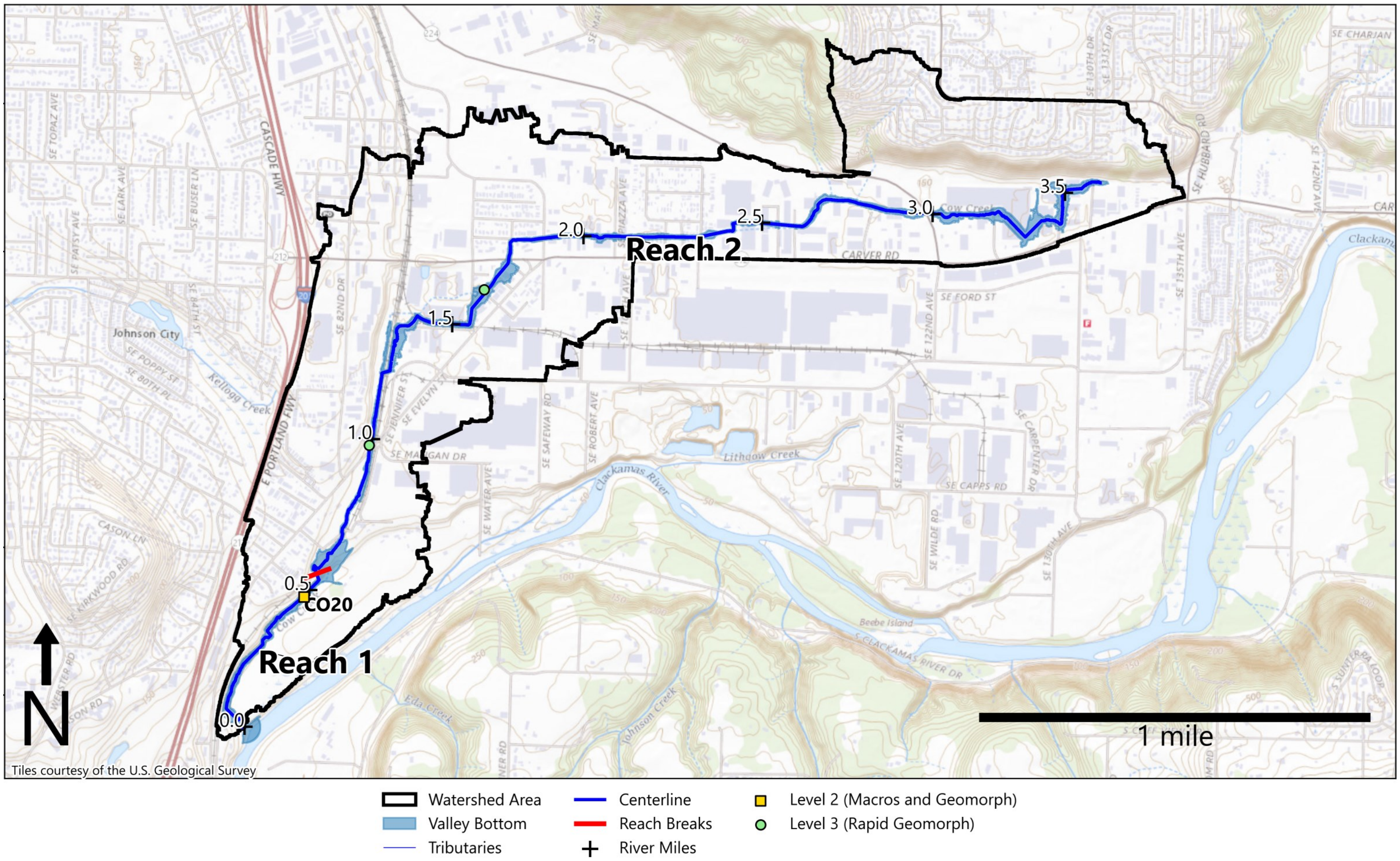
| **Trajectory Classes** | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

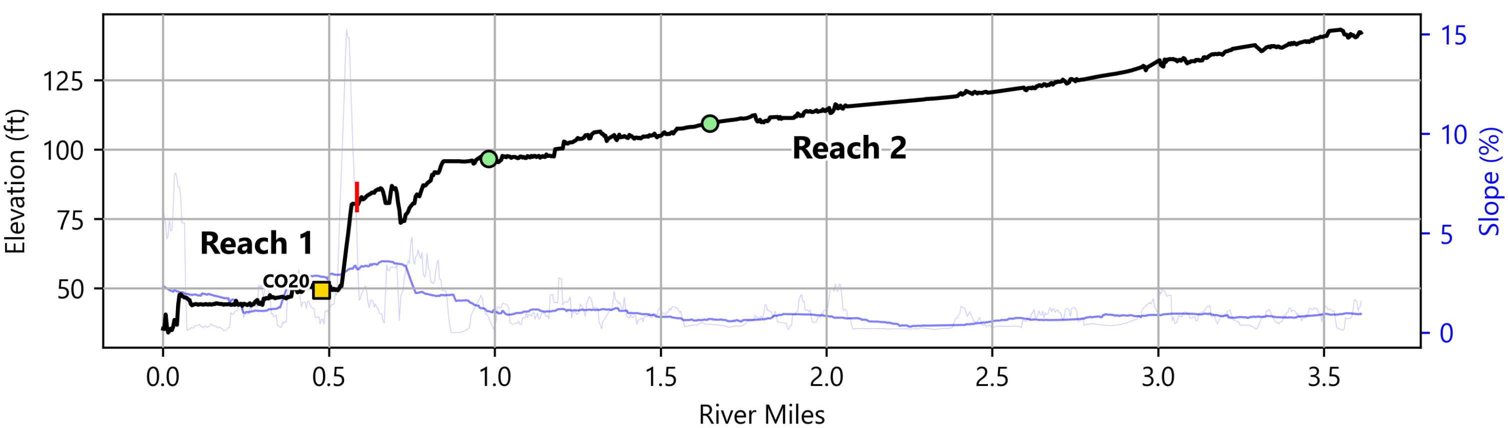
| **Level of Disturbance** |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Cedar Creek flows north to its confluence with Mt Scott Creek at the upstream end of the Mt Talbert Nature Park. Conditions on Cedar Creek are fairly consistent and development pressure since 2001 is relatively low, although the watershed was already developed by that time. Because Cedar Creek flows through fine-grained soils the potential for incision is high. Allowing for ongoing widening and LWD recruitment will support on-going natural recovery of Fields Creek.

# Cow Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.6 | 2930 | 43.33 | 1.27 | 3.87 | Confined |
| 2 | 0.6 | 3.6 | 15900 | 13.8 | 0.94 | 0.77 | Partially Confined |

Much of Cow Creek runs through stormwater pipes, which made access difficult. Stream conditions in the upper section of Reach 2 may not be fully represented in the data reported.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 16.7 | 35.3 | 36.1 | 0.8 |
| Rank* | 6 | 2 | 3 | 8 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **1.9** | **Fines** | **Connected** | **6.3** | **26.7** | **0.0** | **0.0** | **17.9** | **1.7** | **100** | **2.4** |
| Reach 1 | 1 | 1.9 | Fines | Connected | 8.1 | 0.0 | 0.0 | 0.0 | 35.8 | 3.0 | 100 | 0.7 |
| Reach 2 | 2 | 1.8 | Fines | Widening | 3.4 | 40.0 | 0.0 | 0.0 | 14.9 | 1.0 | 100 | 2.9 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Low** | **Moderate** | **Low** | **2** | **Likely Impaired** |
| Reach 1 | Moderate | Low | High | Low | 3 | Probably impaired |
| Reach 2 | High | Low | Low | Low | 0 | Likely Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Low** | **Stable** | **2** | **Likely Degrading** |
| Reach 1 | Moderate | Moderate | Stable | 3 | Potentially Degrading |
| Reach 2 | Moderate | Low | Stable | 2 | Likely Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (Overall)** | 14.0 | Severe | 0.3 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

| Condition Classes | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

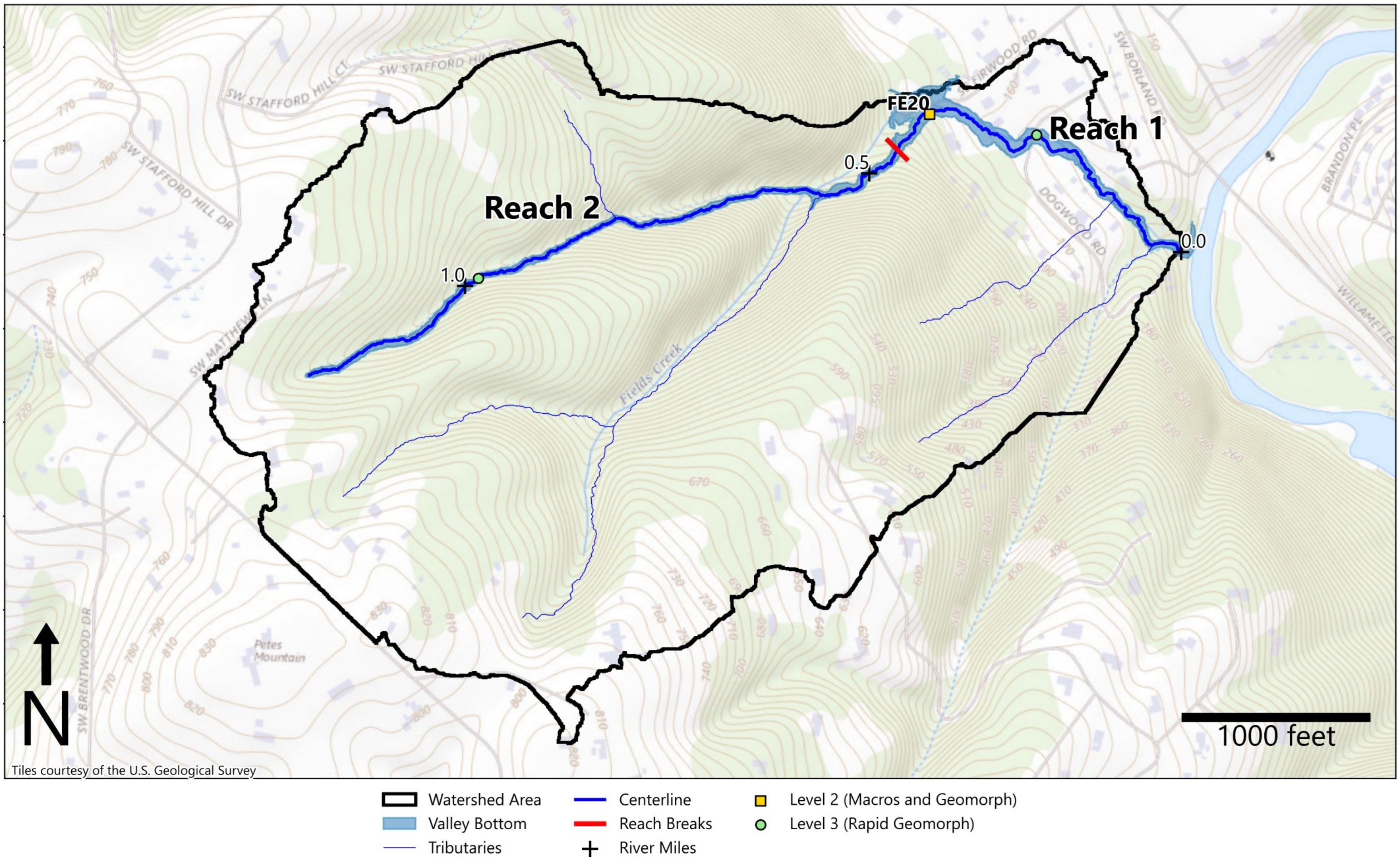
| Trajectory Classes | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

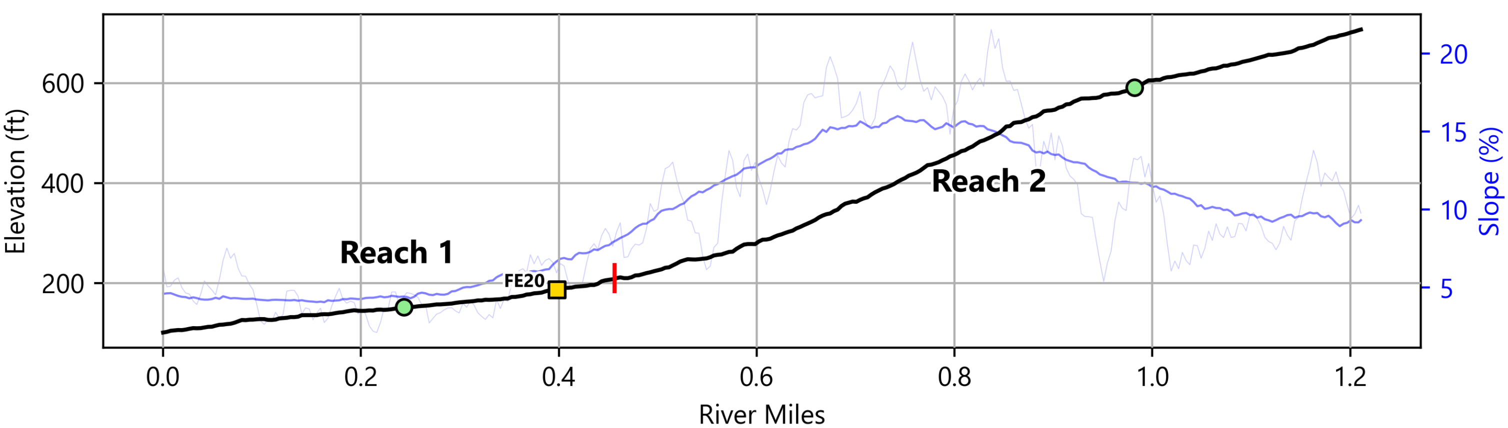
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Cow Creek flows west-southwest into the Clackamas River and drains commercial and industrial parks with extensive impervious areas. Reach 1 of Cow Creek is low-gradient and backwatered by the Clackamas River (or potentially from a private bridge crossing the creek near its confluence with the Clackamas). This reach is also closely confined by a railroad prism on the right bank and extensive rip-rap on the left bank protecting agricultural land in the Clackamas floodplain. Upstream of Reach 1, Cow Creek is narrowly confined, straightened, and often routed through stormwater pipes. Reach 1 is likely the only stretch of Cow Creek accessible to fish, and exhibits low complexity, low potential for natural recruitment of LWD, and moderate incision potential. Overall, conditions are poor and are unlikely to change without direct intervention.

# Fields Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.5 | 2410 | 6.83 | 0.43 | 5.24 | Unconfined |
| 2 | 0.5 | 1.2 | 3980 | 10.75 | 0.3 | 8.11 | Partially Confined |

Due to limited access, stream conditions within the steepest portions of the creek (RM 0.6-0.8) and the lowermost section of the creek (RM (0-0.1) were not captured. Site FE20 is on the Bosky Dell Natives property (a plant nursery) that is actively managed by the owner, who has planted thousands of riparian native plants (personal correspondence). Therefore, conditions at this site may not be representative of natural conditions.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 7.2 | 12.4 | 12.9 | 0.5 |
| Rank* | 15 | 19 | 19 | 14 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **1.4** | **Gravel** | **Incised** | **6.2** | **25.0** | **16.7** | **16.7** | **80.2** | **1.2** | **33** | **66.1** |
| Reach 1 | 2 | 1.3 | Gravel | Incised | 5.3 | 30.0 | 0.0 | 25.0 | 54.2 | 2.0 | 25 | 18.2 |
| Reach 2 | 1 | 1.6 | Gravel | Incised | 7.8 | 15.0 | 50.0 | 0.0 | 96.8 | 1.0 | 50 | 96.8 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Low** | **Moderate** | **High** | **5** | **Probably impaired** |
| Reach 1 | Low | Low | Moderate | High | 5 | Probably impaired |
| Reach 2 | Moderate | Low | Low | High | 3 | Probably impaired |

## Physical Habitat Trajectory Categories and Scoring

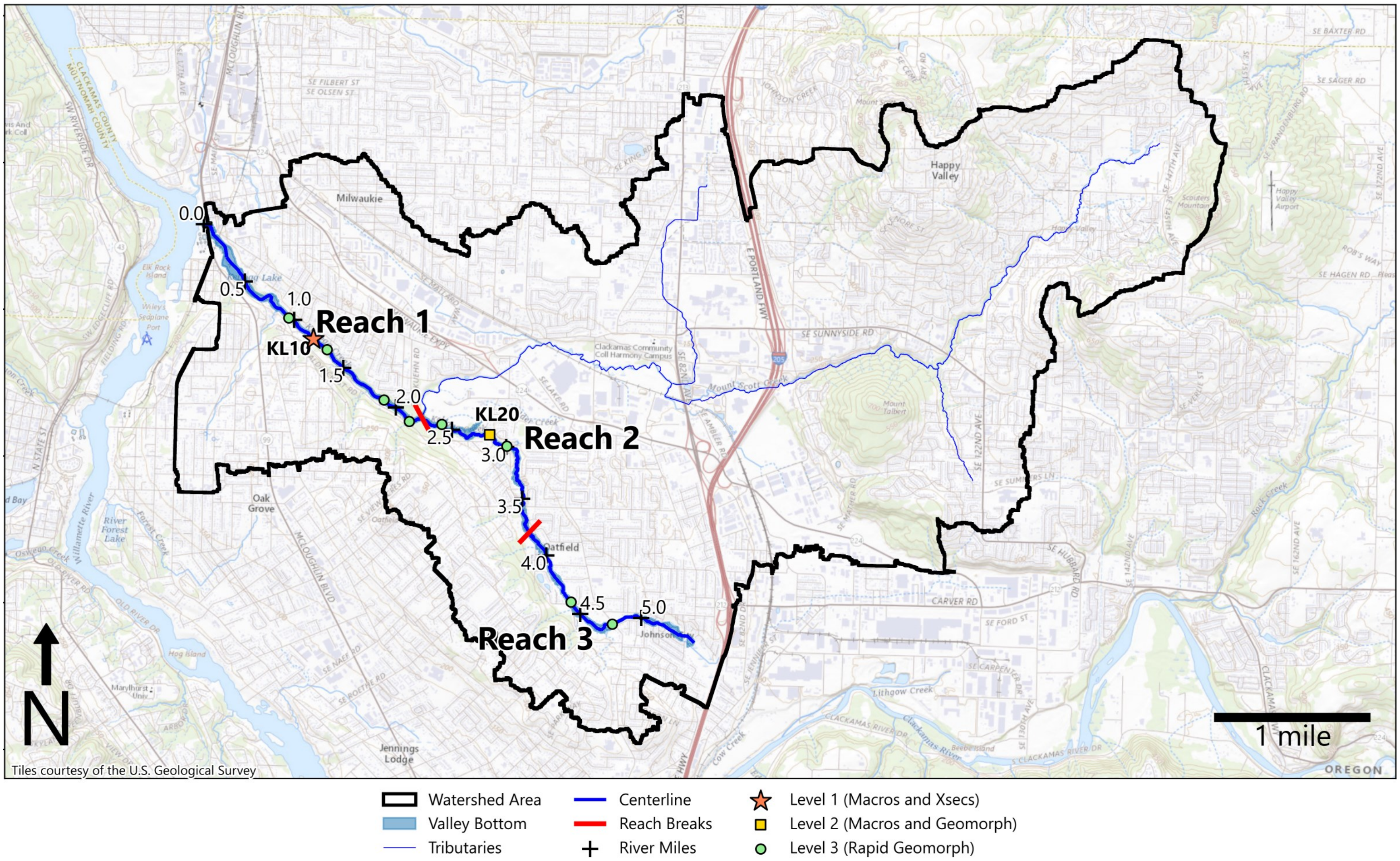
| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Increasing** | **4** | **Potentially Degrading** |
| Reach 1 | High | High | Increasing | 4 | Potentially Degrading |
| Reach 2 | High | High | Increasing | 4 | Potentially Degrading |

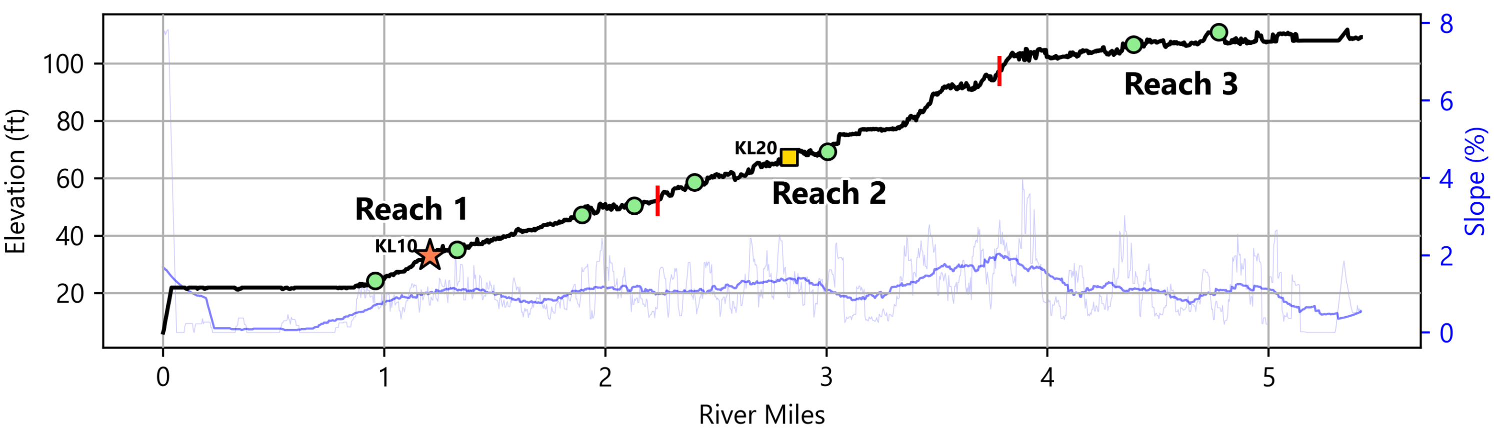
| Scoring | Condition Classes | | Trajectory Classes | |
|---|---|---|---|---|
| 0 | 0-2: | Likely Impaired | 0-2: | Likely Degrading |
| 1 | 3-5: | Probably Impaired | 3-4: | Potentially Degrading |
| 2 | 6-8: | Functioning | 5-6: | Likely improving |

Fields Creek flows northeast off steep bluffs into the Tualatin River. In Reach 1 the creek likely becomes increasingly entrenched as it enters the backwater zone of the Tualatin River. Incision potential is high in both Reach 1 and Reach 2 due to fine-grained soils in the Tualatin floodplain and steep slopes on the bluffs, respectively. Despite the potential for incision, Fields Creek has good riparian cover and potential for LWD recruitment. Without direct intervention and assuming ample space in the riparian corridor, further incision may drive LWD recruitment and channel widening leading to increased complexity. Allowing for ongoing widening will support on-going natural recovery of Fields Creek.

# Kellogg Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 2.2 | 11810 | 33.01 | 15.64 | 0.82 | Partially Confined |
| 2 | 2.2 | 3.8 | 8160 | 15.5 | 13.63 | 0.88 | Partially Confined |
| 3 | 3.8 | 5.4 | 8630 | 10.37 | 1.72 | 0.7 | Unconfined |

Site distribution on Kellogg Creek is sufficient that all defined reaches are properly represented.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 19.4 | 33.7 | 34.2 | 0.5 |
| Rank* | 4 | 5 | 5 | 13 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream (Overall)** | **10** | **1.2** | **Gravel** | **Incised** | **8.0** | **10.0** | **17.7** | **5.9** | **47.2** | **1.2** | **94** | **-3.6** |
| Reach 1 | 5 | 1.2 | Gravel | Incised | 9.8 | 7.0 | 12.5 | 0.0 | 54.7 | 1.2 | 88 | -5.5 |
| Reach 2 | 3 | 1.2 | Gravel | Incised | 7.4 | 3.3 | 16.7 | 16.7 | 54.2 | 1.3 | 100 | -3.6 |
| Reach 3 | 2 | 1.4 | Fines | Incised | 4.0 | 21.7 | 0.0 | 0.0 | 31.2 | 1.0 | 100 | -1.1 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Low** | **Low** | **Low** | **2** | **Likely Impaired** |
| Reach 1 | Low | Low | Low | Moderate | 3 | Probably Impaired |
| Reach 2 | Low | Low | Low | Moderate | 3 | Probably Impaired |
| Reach 3 | Moderate | Low | Low | Low | 1 | Likely Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Stable** | **2** | **Likely Degrading** |
| Reach 1 | High | High | Decreasing | 2 | Likely Degrading |
| Reach 2 | High | High | Stable | 3 | Potentially Degrading |
| Reach 3 | High | Moderate | Stable | 2 | Likely Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Kellogg Lower** | 26.0 | Moderate | 0.4 | Most |
| **Kellogg Upper** | 16.0 | Severe | 0.5 | Most |

**Scoring**

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

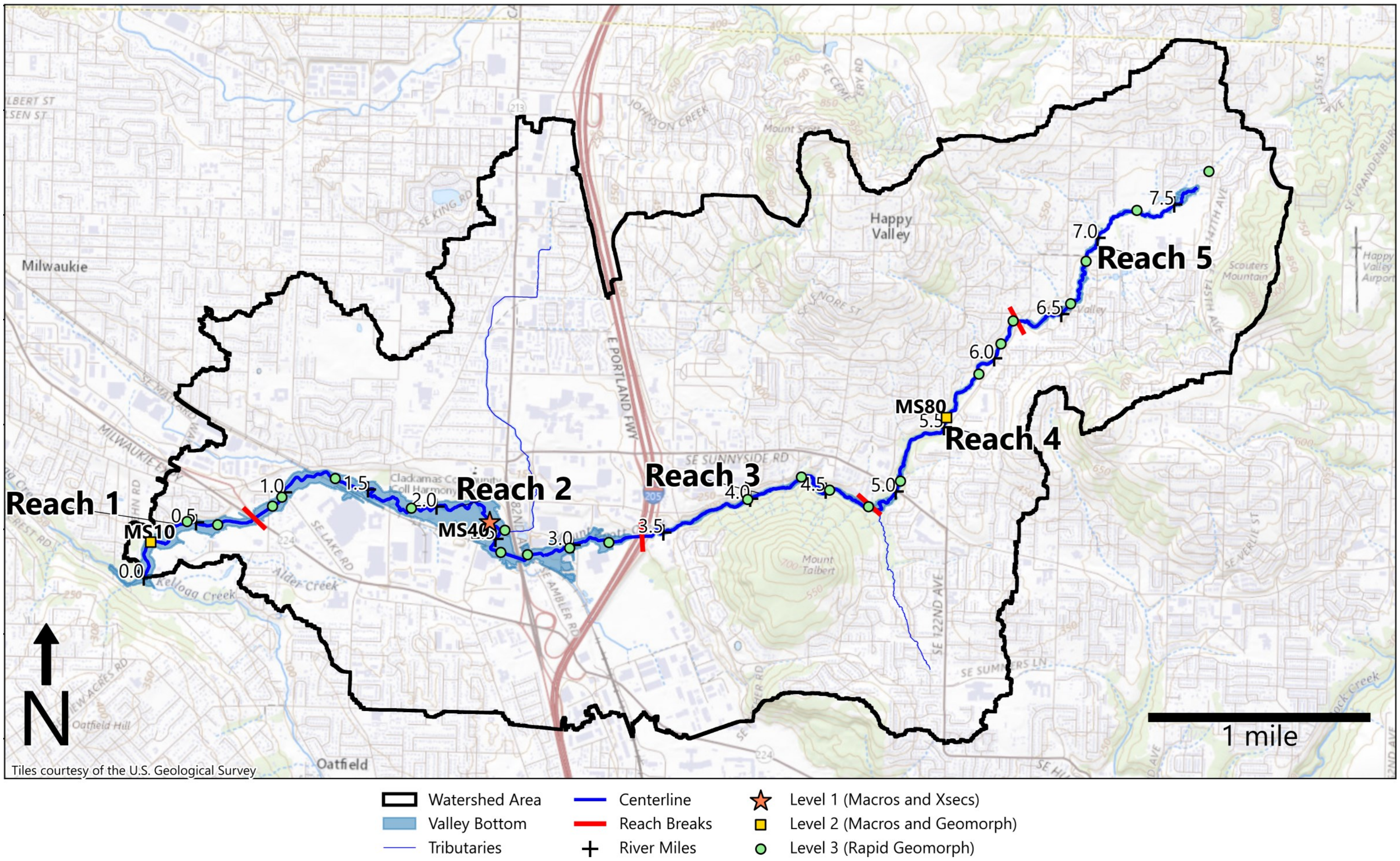
**Level of Disturbance**

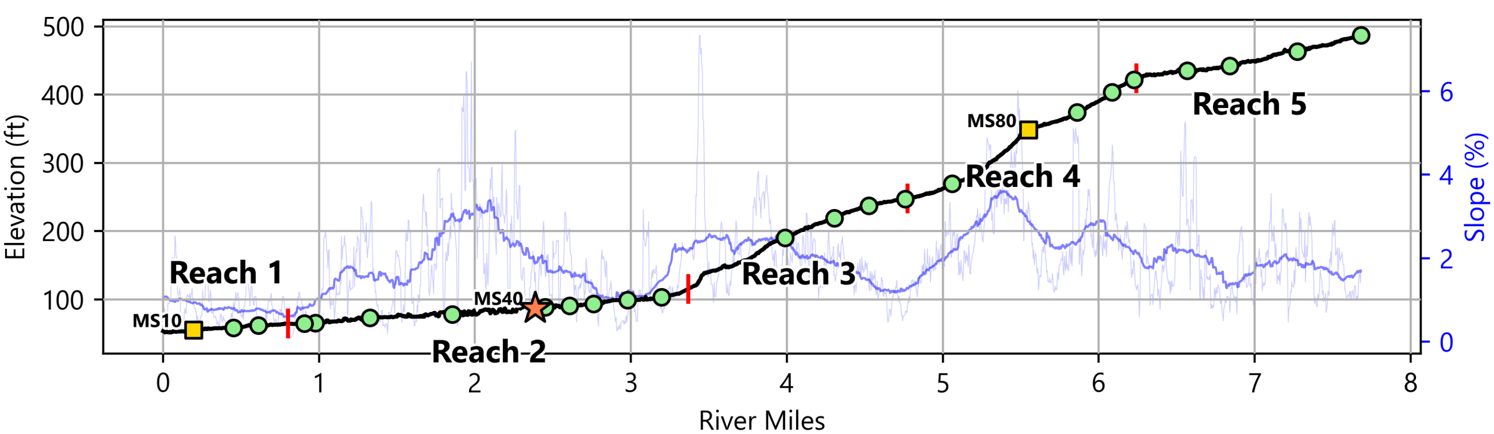
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Kellogg Creek flows northwest into the Willamette River and captures the Mt Scott stream network along the way. Below the confluence of Mt Scott Creek (not including Kellogg Lake), Reach 1 exhibits a straight, gravel-bedded channel often armored from rip-rap that has fallen into the bed. The streambed had a notable presence of rip-rap (placed) cobbles/boulders. Upstream of the confluence with Mt Scott Creek, flows in Reach 2 and Reach 3 are smaller and modulated by a series of small reservoirs, the largest being Johnson Lake at the headwaters. Potential for incision is high on Kellogg Creek, and the planned dam removal will exacerbate this issue. Incision would likely occur in Reach 1 where flows are much greater (from the contribution of Mt Scott Creek) and not modulated by reservoirs. Riparian cover and potential for LWD recruitment are moderate. However, the private residences on Kellogg Creek, particularly in Reach 1, often actively influence stream bank conditions with near continuous bank armoring, maintenance of lawns, and removal of large trees and other vegetation from the banks.

# Mount Scott Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.8 | 4240 | 28.47 | 10 | 1.21 | Unconfined |
| 2 | 0.8 | 3.4 | 13550 | 21.9 | 9.35 | 1.13 | Unconfined |
| 3 | 3.4 | 4.8 | 7420 | 29.83 | 5.32 | 1.66 | Partially Confined |
| 4 | 4.8 | 6.2 | 7740 | 22.52 | 3.6 | 2.63 | Partially Confined |
| 5 | 6.2 | 7.7 | 7610 | 15.6 | 1.83 | 1.51 | Unconfined |

Site distribution on Mt Scott Creek is sufficient that all defined reaches are properly represented.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 16.7 | 34.4 | 36.2 | 1.8 |
| Rank* | 7 | 4 | 2 | 3 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream (Overall)** | **26** | **1.6** | **Gravel** | **Incised** | **7.9** | **13.5** | **81.1** | **27.0** | **63.6** | **1.4** | **81.1** | **21.4** |
| Reach 1 | 3 | 1.6 | Gravel | Incised | 10.4 | 5.0 | 28.6 | 57.1 | 61.2 | 2.0 | 100 | 0.1 |
| Reach 2 | 10 | 1.8 | Gravel | Widening | 5.8 | 20.0 | 92.3 | 30.8 | 59.2 | 1.2 | 85 | 27.6 |
| Reach 3 | 4 | 1.7 | Gravel | Incised | 7.8 | 10.0 | 100.0 | 0.0 | 72.1 | 1.3 | 67 | 15.1 |
| Reach 4 | 5 | 1.3 | Gravel | Incised | 11.5 | 8.0 | 100.0 | 22.2 | 71.6 | 1.4 | 67 | 20.2 |
| Reach 5 | 4 | 1.3 | Gravel | Incised | 7.0 | 16.3 | 75.0 | 0.0 | 53.2 | 1.0 | 75 | 29.4 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **High** | **Low** | **Moderate** | **4** | **Probably Impaired** |
| Reach 1 | Low | High | Moderate | Moderate | 6 | Functioning |
| Reach 2 | Moderate | High | Low | Moderate | 4 | Probably impaired |
| Reach 3 | Moderate | Moderate | Low | Moderate | 3 | Probably impaired |
| Reach 4 | Low | Moderate | Low | Moderate | 4 | Probably impaired |
| Reach 5 | Low | Moderate | Low | Moderate | 4 | Probably impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **Stable** | **5** | **Likely Improving** |
| Reach 1 | High | High | Stable | 3 | Potentially Degrading |
| Reach 2 | Low | High | Increasing | 6 | Likely Improving |
| Reach 3 | High | High | Increasing | 4 | Potentially Degrading |
| Reach 4 | High | High | Increasing | 4 | Potentially Degrading |
| Reach 5 | High | High | Increasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Mt Scott Lower** | 20.0 | Moderate | 0.4 | Most |
| **Mt Scott Middle** | 22.0 | Moderate | 0.6 | Most |
| **Mt Scott Upper** | 20.0 | Moderate | 0.5 | Most |

**Scoring**
0
1
2

**Condition Classes**
0-2: Likely Impaired
3-5: Probably Impaired
6-8: Functioning

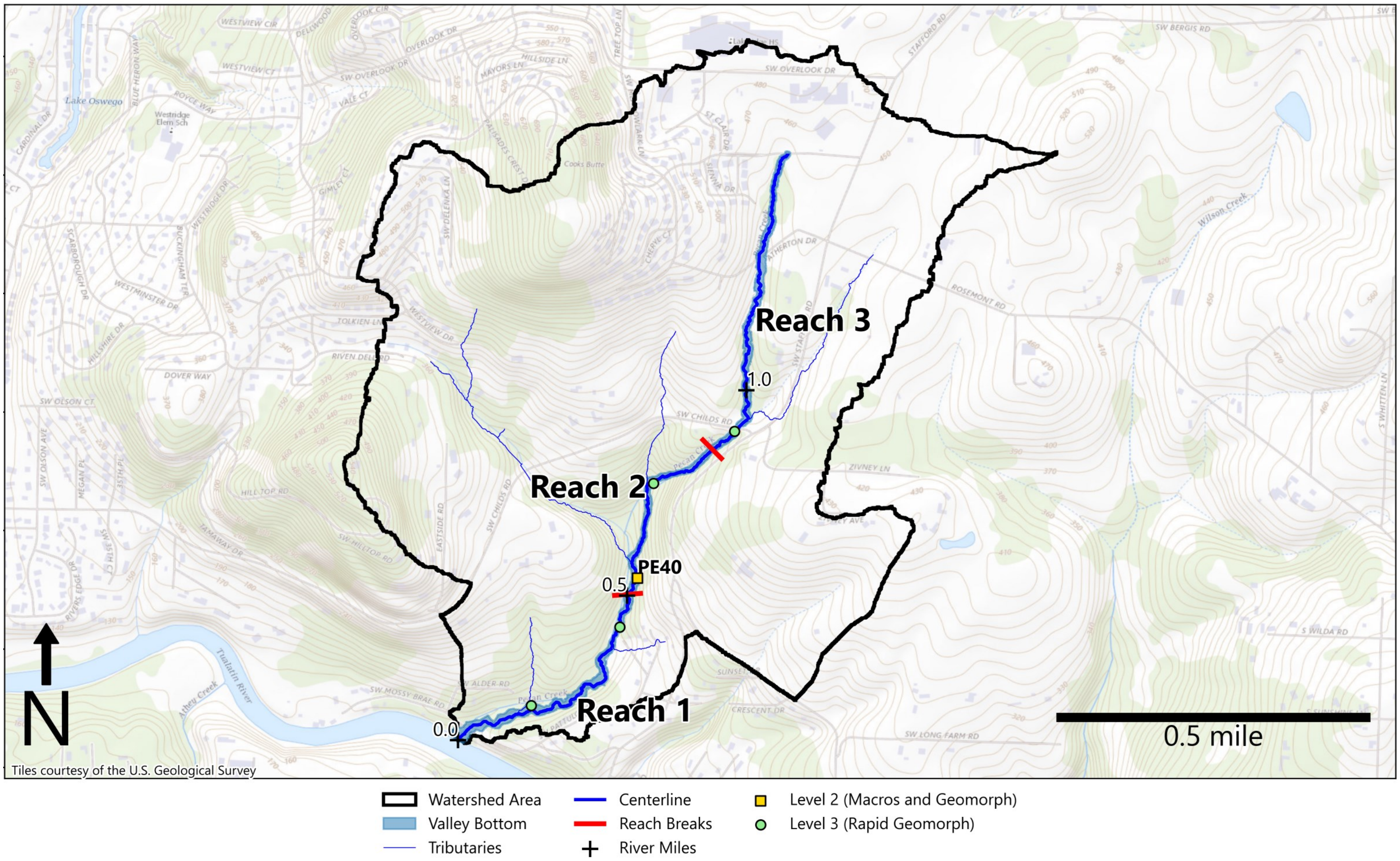
**Trajectory Classes**
0-2: Likely Degrading
3-4: Potentially Degrading
5-6: Likely improving

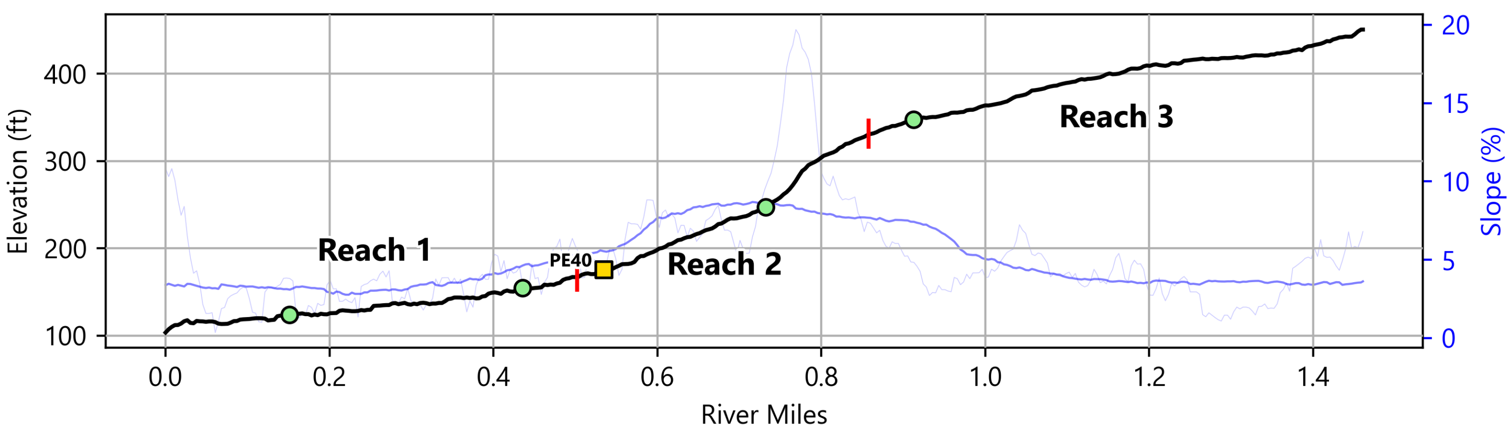
**Level of Disturbance**
Severe/Most
Moderate
Slight/Least

Mt Scott creek flows southeast to its confluence with Kellogg Creek and eventually the Willamette River. The first two reaches of Mt Scott Creek are low-gradient and have the widest floodplains of any creeks in this study. The uppermost reach is another low gradient reach where fine-grained Missoula Flood deposits created a wide valley within the Boring Hills. Reaches 3 and 4 are the steep, confined transition that connects the low-gradient headwaters to the lower reaches. Potential for incision is high for most of Mt Scott Creek and floodplain connectivity is low. In the low-gradient reaches fine-grained soils are easily eroded, while steep slopes in the transition reaches are naturally erosive. Within Reach 2 the stream is exhibiting signs of widening and natural LWD recruitment. Notable restoration opportunities exist within Reaches 1, 2, and 5, whereas Reaches 3 and 4 are more naturally confined and may be opportunities for more targeted restoration treatments.

# Pecan Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.5 | 2650 | 11.5 | 0.63 | 3.15 | Partially Confined |
| 2 | 0.5 | 0.9 | 1880 | 14.88 | 0.46 | 6.97 | Partially Confined |
| 3 | 0.9 | 1.5 | 3180 | 7.6 | 0.15 | 5.21 | Partially Confined |

Site distribution on Pecan Creek is sufficient that all defined reaches are properly represented, with the exception of the upper section of Reach 3.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 10.9 | 16.2 | 18.0 | 1.7 |
| Rank* | 11 | 14 | 14 | 5 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **5** | **1.2** | **Bedrock** | **Connected** | **5.8** | **13.0** | **25.0** | **0.0** | **66.4** | **2.0** | **87.5** | **-3.1** |
| Reach 1 | 2 | 1.2 | Gravel | Widening | 5.2 | 25.0 | 0.0 | 0.0 | 78.9 | 1.5 | 100.0 | -3.8 |
| Reach 2 | 2 | 1.2 | Gravel | Connected | 6.2 | 5.0 | 20.0 | 0.0 | 88.8 | 3.0 | 80.0 | -1.7 |
| Reach 3 | 1 | 1.5 | Bedrock | Incised | 4.8 | 5.0 | 100.0 | 0.0 | 43.8 | 1.0 | 100.0 | -2.9 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Low** | **Moderate** | **Moderate** | **4** | **Probably Impaired** |
| Reach 1 | Low | Low | Low | Moderate | 3 | Probably impaired |
| Reach 2 | Low | Low | High | Moderate | 5 | Probably impaired |
| Reach 3 | Moderate | Moderate | Low | Low | 2 | Likely Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **Stable** | **5** | **Likely Improving** |
| Reach 1 | Low | High | Stable | 5 | Likely Improving |
| Reach 2 | Moderate | High | Stable | 4 | Potentially Degrading |
| Reach 3 | Low | Moderate | Stable | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 38.0 | Slight | 0.8 | Most |

**Scoring**

| |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

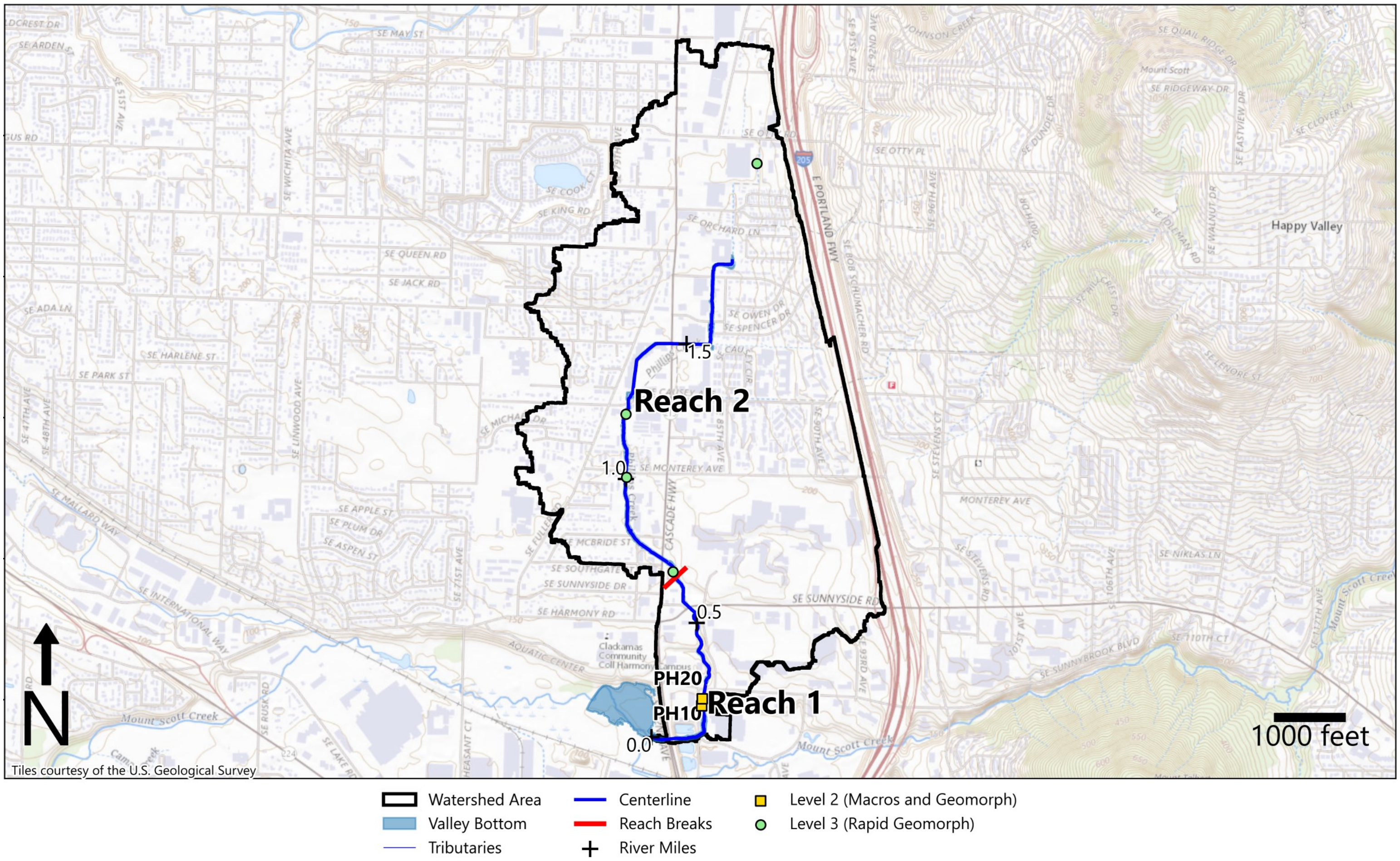
**Level of Disturbance**

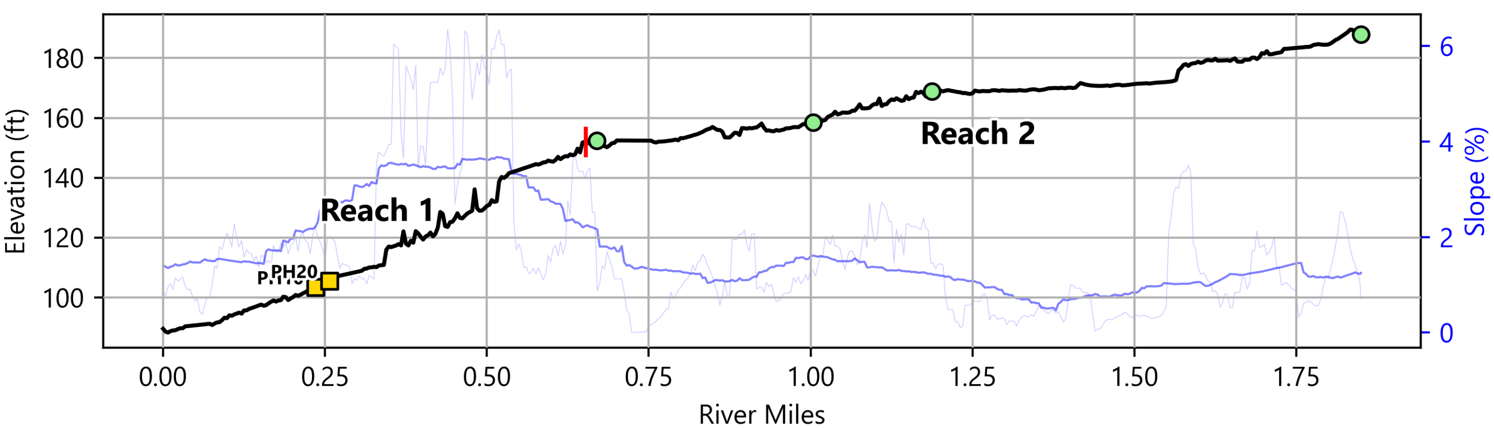
| |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Pecan Creeks flows south-southeast into the Tualatin River. Pecan Creek is gravel-bedded and well-canopied. It maintains 3-4% slopes with a steep step in the profile at the upper end of Reach 2. Development in the upper watershed may be causing Reach 3 to become entrenched, but overall, the development pressure is relatively low. The downstream reaches have more capacity, such as LWD recruitment and floodplain connectivity, to support natural recovery.

# Phillips Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.6 | 3450 | 8.93 | 0.91 | 1.59 | Unconfined |
| 2 | 0.6 | 1.8 | 6320 | 10.2 | 0.65 | 1.03 | Partially Confined |

Site distribution on Phillips Creek is sufficient to represent both defined reaches. However, Phillips Creek is heavily impacted by development and some structures and/or other factors influencing stream conditions may not be captured in the collected data. Particularly in the upper section of Reach 1 (RM 0.35-0.6) where major slope breaks are observed in the profile but we had no access to the creek.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 22.5 | 51.7 | 51.6 | -0.1 |
| Rank* | 1 | 1 | 1 | 19 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Floodplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **6** | **1.6** | **Gravel** | **Incised** | **7.1** | **10.0** | **50.0** | **37.5** | **29.3** | **1.0** | **100.0** | **15.6** |
| Reach 1 | 2 | 1.5 | Gravel | Incised | 9.9 | 0.0 | 0.0 | 25.0 | 39.6 | 1.0 | 100.0 | 23.9 |
| Reach 2 | 4 | 2.0 | Gravel | Incised | 4.7 | 11.7 | 100.0 | 33.3 | 24.0 | 1.0 | 100.0 | 10.9 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Moderate** | **Low** | **Low** | **2** | **Likely Impaired** |
| Reach 1 | Moderate | Low | Low | Low | 1 | Likely Impaired |
| Reach 2 | High | High | Low | Low | 2 | Likely Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Increasing** | **3** | **Potentially Degrading** |
| Reach 1 | High | Moderate | Increasing | 3 | Potentially Degrading |
| Reach 2 | High | Low | Increasing | 2 | Likely Degrading |

## Biological Habitat Scoring

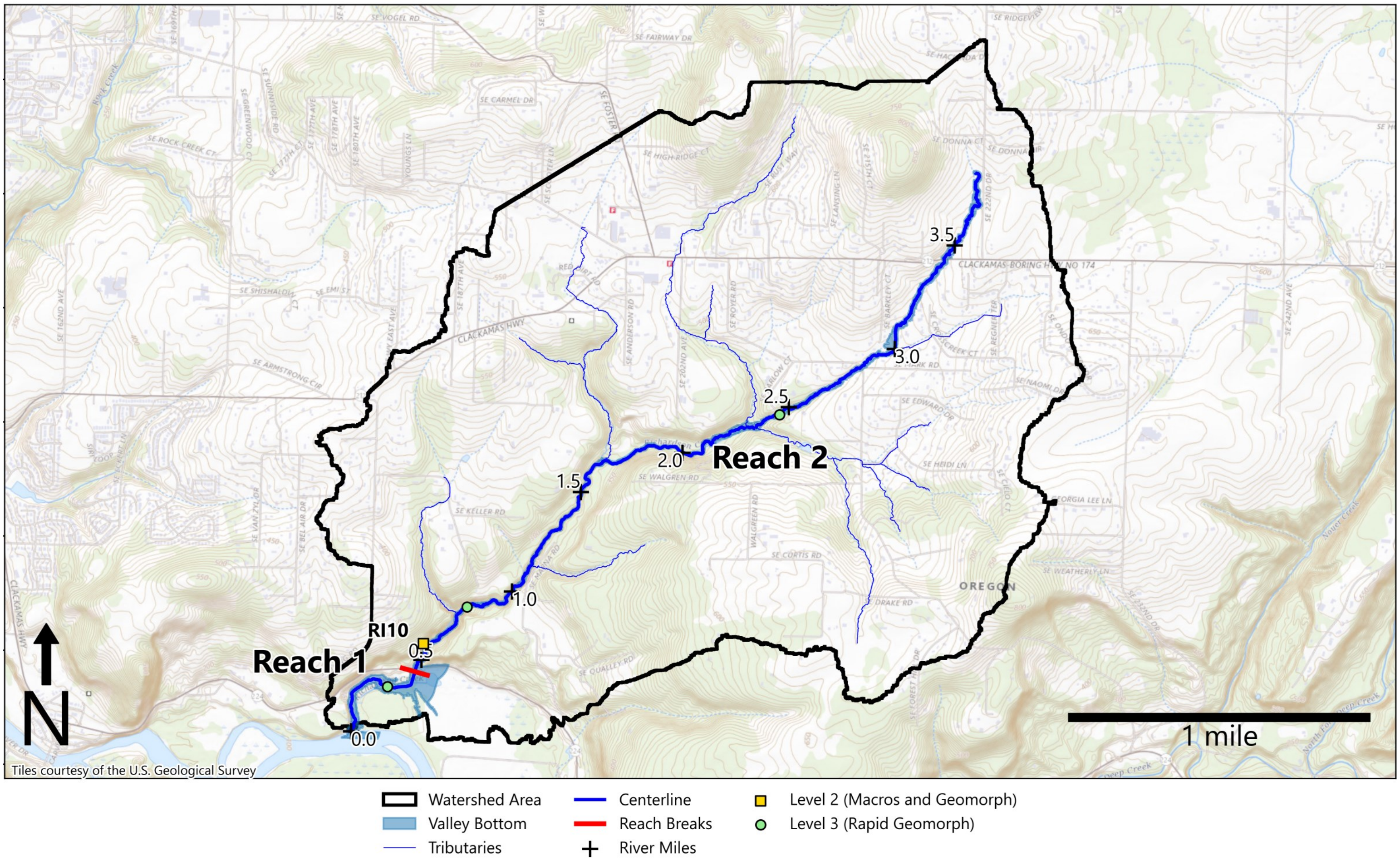
| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 16.0 | Severe | 0.4 | Most |

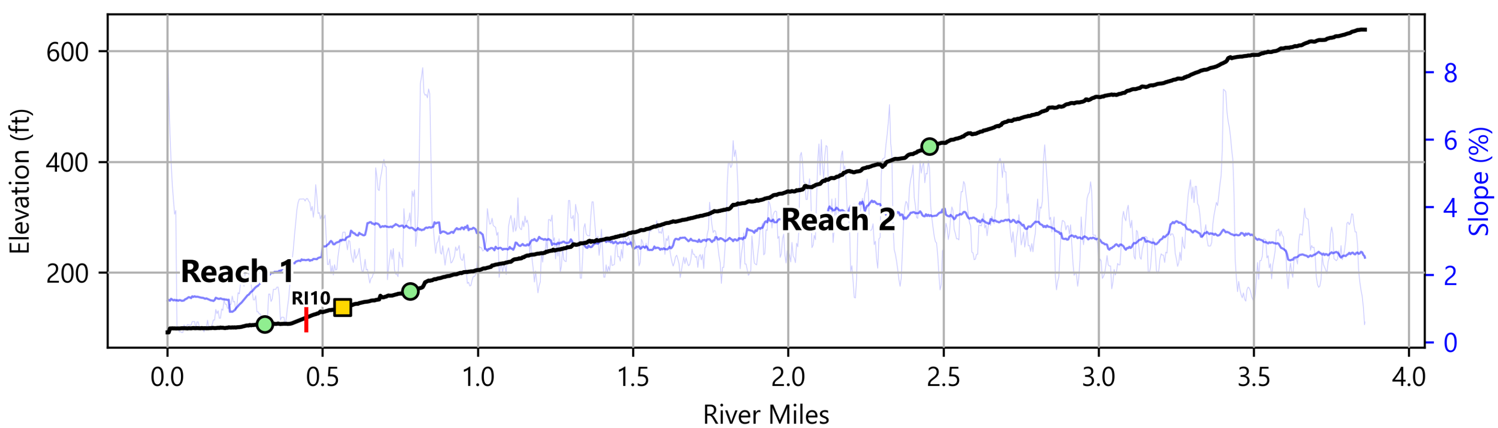
| Scoring | Condition Classes | | Trajectory Classes | | Level of Disturbance |
|---|---|---|---|---|---|
| 0 | 0-2: | Likely Impaired | 0-2: | Likely Degrading | Severe/Most |
| 1 | 3-5: | Probably Impaired | 3-4: | Potentially Degrading | Moderate |
| 2 | 6-8: | Functioning | 5-6: | Likely improving | Slight/Least |

Phillips Creek flows south to its confluence with Mt Scott Creek and is the single most impacted creek of any in this study. The creek is wholly confined and entrenched along its entire length with near continuous rip-rap in the bed and/or retaining walls along its banks. The creek now operates in a very straightened, narrow strip of floodplain deeply inset within the landscape and often is routed through stormwater pipes. Given the current level of entrenchment, confinement by infrastructure, and future trajectory of incision, the capacity for natural recovery is low.

# Richardson Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.45 | 2363.7 | 15 | 4.03 | 0.94 | Unconfined |
| 2 | 0.45 | 3.86 | 18001.37 | 22.62 | 3.58 | 3.17 | Partially Confined |

Limited access to Richardson Creek made getting a good distribution of sites difficult. However, the slope of Richardson Creek is relatively constant, and therefore stream conditions likely do not vary wildly. More monitoring locations may reveal two distinct geomorphic reaches within Reach 2 as the creek transitions from its headwaters into the canyon (RM 2.5).

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 6.3 | 16.5 | 16.8 | 0.3 |
| Rank* | 17 | 13 | 15 | 17 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **1.3** | **Gravel** | **Incised** | **9.4** | **22.5** | **85.7** | **0.0** | **63.8** | **2.8** | **100.0** | **8.2** |
| Reach 1 | 1 | 1.3 | Fines | Incised | 3.9 | 20.0 | 100.0 | 0.0 | 68.8 | 3.0 | 100.0 | 6.3 |
| Reach 2 | 3 | 1.3 | Gravel | Incised | 11.4 | 23.3 | 83.3 | 0.0 | 63.0 | 2.7 | 100.0 | 8.4 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Moderate** | **High** | **Moderate** | **6** | **Functioning** |
| Reach 1 | Moderate | Moderate | High | Moderate | 5 | Probably Impaired |
| Reach 2 | Low | Moderate | High | Moderate | 6 | Functioning |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Increasing** | **4** | **Potentially Degrading** |
| Reach 1 | High | High | Increasing | 4 | Potentially Degrading |
| Reach 2 | High | High | Increasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 36.0 | Slight | 0.8 | Most |

**Scoring**

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely improving |

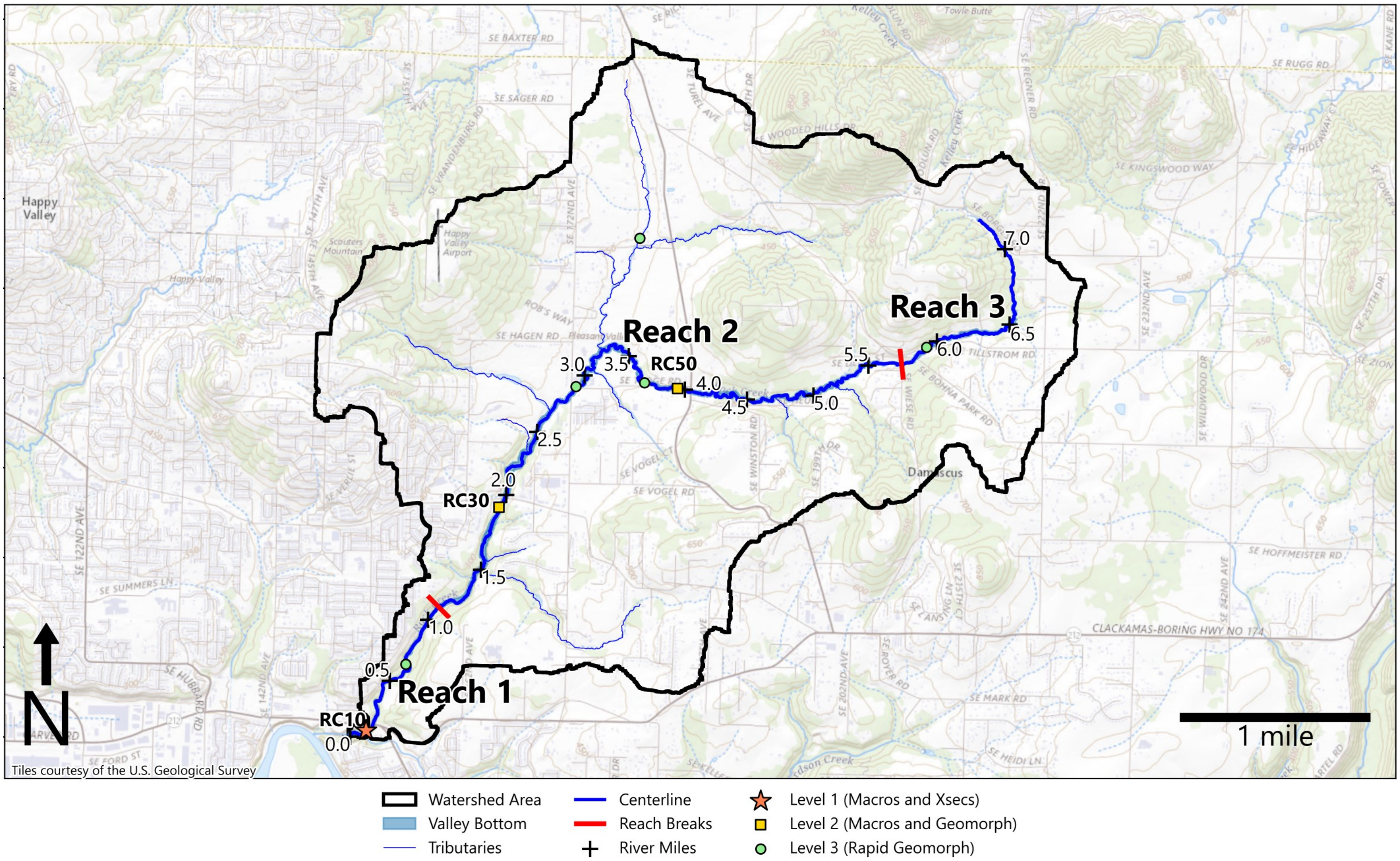
**Level of Disturbance**

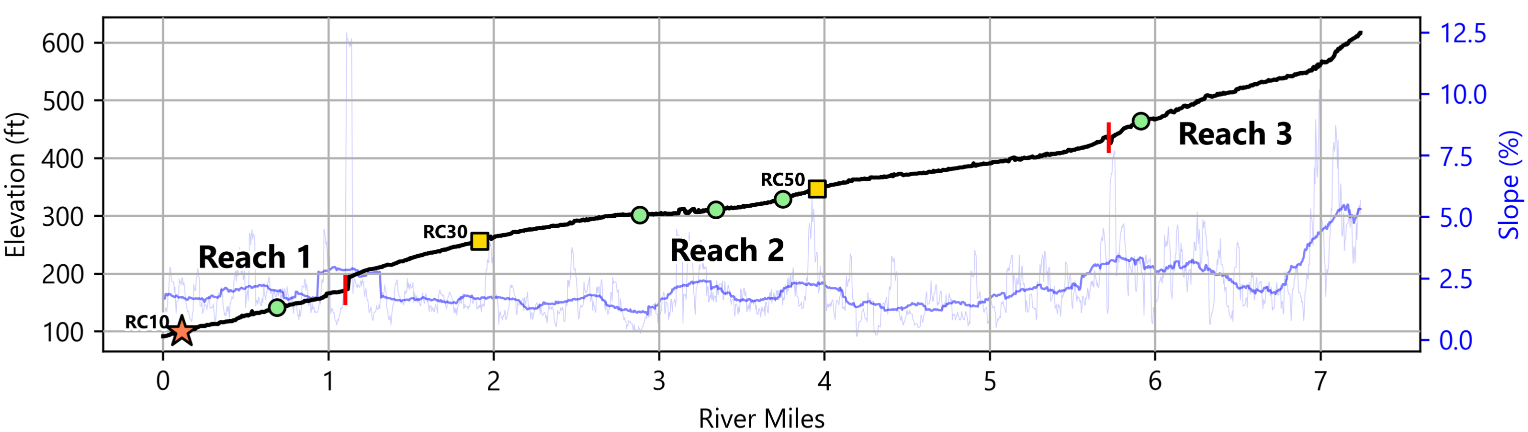
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Richardson Creek flows southwest into the Clackamas River. This Creek has a consistent slope as it has cut a deep canyon through gravel rich soils (such as the Troutdale Formation). The creek deposits much of this gravel at the bottom of Reach 2 near RI10, which makes that site a poor representation of conditions upstream. Entrenchment within the steep, confined canyon is expected along with significant LWD recruitment. The Highway 212 provides a major grade control in the lower creek.

# Rock Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 1.1 | 5820 | 37.98 | 8.46 | 1.72 | Confined |
| 2 | 1.1 | 5.7 | 24380 | 19.31 | 8.12 | 1.54 | Unconfined |
| 3 | 5.7 | 7.2 | 8030 | 16.7 | 1.16 | 1.87 | Unconfined |

Site distribution on Rock Creek is sufficient to represent all of the defined reaches. With more monitoring data, Reach 2 could be sub-divided into two geomorphically distinct reaches. Further monitoring of the tributaries can provide a more holistic view of conditions in the Rock Creek watershed.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 8.0 | 15.9 | 18.5 | 2.5 |
| Rank* | 14 | 16 | 12 | 2 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **7** | **1.5** | **Bedrock** | **Incised** | **6.4** | **16.7** | **55.6** | **5.6** | **59.5** | **1.4** | **94.4** | **8.5** |
| Reach 1 | 2 | 1.5 | Gravel | Incised | 9.6 | 17.5 | 20.0 | 20.0 | 76.0 | 3.0 | 80.0 | 16.7 |
| Reach 2 | 4 | 1.5 | Bedrock | Incised | 5.3 | 14.2 | 75.0 | 0.0 | 53.1 | 1.0 | 100.0 | 6.9 |
| Reach 3 | 1 | 1.5 | Bedrock | Incised | 6.7 | 30.0 | 0.0 | 0.0 | 66.3 | 1.0 | 100.0 | 7.3 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Moderate** | **Low** | **Moderate** | **4** | **Probably Impaired** |
| Reach 1 | Low | Low | High | Moderate | 5 | **Probably Impaired** |
| Reach 2 | Low | Moderate | Low | Moderate | 4 | **Probably Impaired** |
| Reach 3 | Low | Low | Low | Moderate | 3 | **Probably Impaired** |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **Increasing** | **6** | **Likely Improving** |
| Reach 1 | High | High | Increasing | 4 | Potentially Degrading |
| Reach 2 | Low | High | Increasing | 6 | Likely Improving |
| Reach 3 | Low | High | Increasing | 6 | Likely Improving |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Rock Lower** | 38.0 | Slight | 0.7 | Most |
| **Rock Middle** | 26.0 | Moderate | 0.7 | Most |
| **Rock Upper** | 36.0 | Slight | 0.9 | Least |

**Scoring**

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

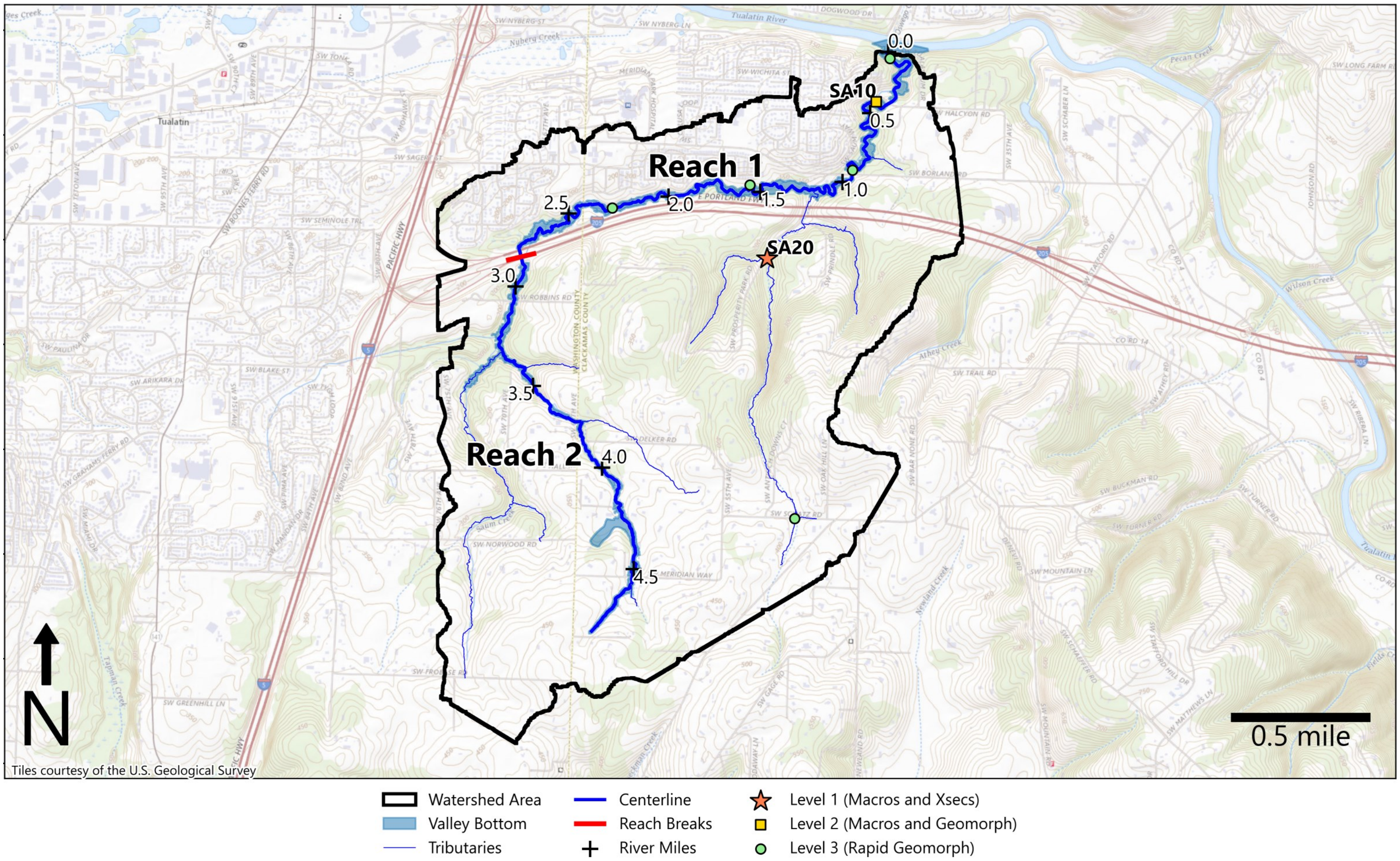
**Level of Disturbance**

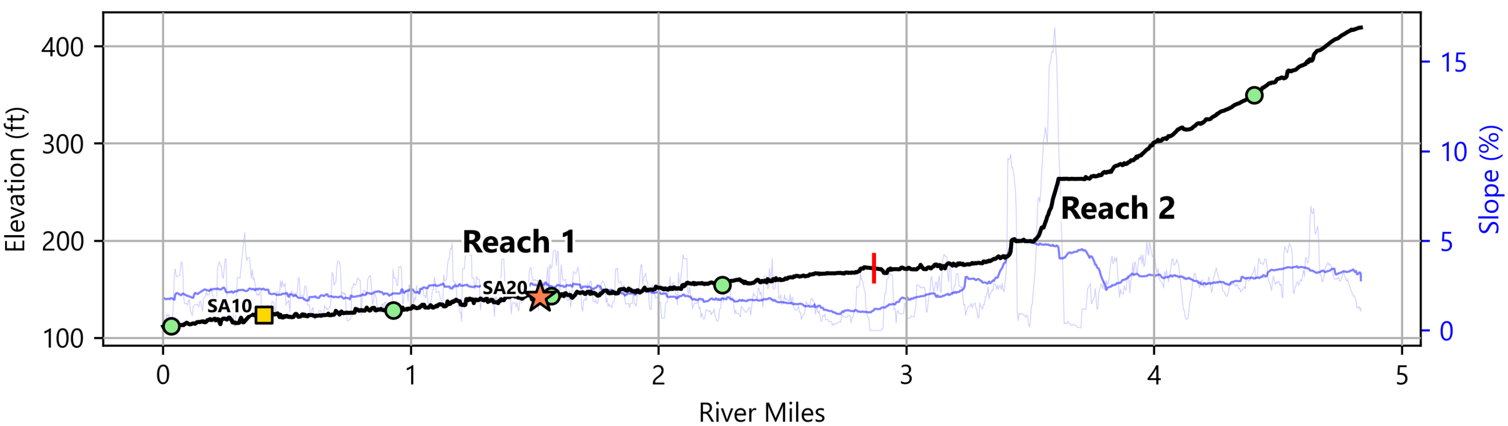
Severe/Most
Moderate
Slight/Least

Rock Creek flows southwest into the Clackamas River and is one of the fastest developing watersheds of those studied here. Similar to Mt Scott Creek, Rock Creek has relatively low-gradient reaches further up in the watershed where Missoula Flood deposits created wide valleys in the Boring Hills. Similar to other east-side creeks, Rock Creek has cut a deep narrow canyon through gravel-rich soils on its path out of the Boring Hills towards the Clackamas. Downstream of the falls, Reach 1 is confined and entrenched within the canyon walls where widening was observed through landsliding and mass wasting. In Reach 2, Rock Creek has meanders through fine-grained soils and has cut down to bedrock in many locations. Due to the Missoula Floods recently (in geologic time) resetting the landscape within Reach 2, Rock Creek has not had sufficient time to develop a natural floodplain. However, the process of channel migration has been limited by human intervention, which limits its ability to widen its floodplain. Overall, many parts of the Rock Creek watershed are still healthy and functioning and are targets for preservation given recent urban growth .

# Saum Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 2.9 | 15150 | 12.46 | 3.17 | 1.38 | Unconfined |
| 2 | 2.9 | 4.8 | 10370 | 7.55 | 1.41 | 1.92 | Unconfined |

While Reach 1 is very well characterized, access to the upper reaches and tributaries of Saum Creek was limited. Further monitoring in these reaches would provide a more holistic view of watershed conditions.

## Reach and Stream Based Health Scoring

### Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 9.1 | 18.3 | 19.8 | 1.5 |
| Rank* | 13 | 11 | 11 | 6 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **7** | **1.6** | **Fines** | **Incised** | **3.4** | **21.4** | **70.0** | **0.0** | **53.0** | **1.1** | **100.0** | **6.4** |
| Reach 1 | 5 | 1.7 | Fines | Incised | 3.1 | 27.0 | 87.5 | 0.0 | 66.1 | 1.0 | 100.0 | 0.0 |
| Reach 2 | 2 | 1.3 | Fines | Incised | 0.0 | 7.5 | 0.0 | 0.0 | 34.3 | 1.5 | 100.0 | 14.7 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

### Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Low** | **Moderate** | **2** | **Likely Impaired** |
| Reach 1 | High | Moderate | Low | Moderate | 2 | Likely Impaired |
| Reach 2 | Moderate | Low | Low | Low | 1 | Likely Impaired |

### Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Increasing** | **4** | **Potentially Degrading** |
| Reach 1 | High | High | Stable | 3 | Potentially Degrading |
| Reach 2 | High | Moderate | Increasing | 3 | Potentially Degrading |

### Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 14.0 | Severe | 0.4 | Most |

**Scoring**

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

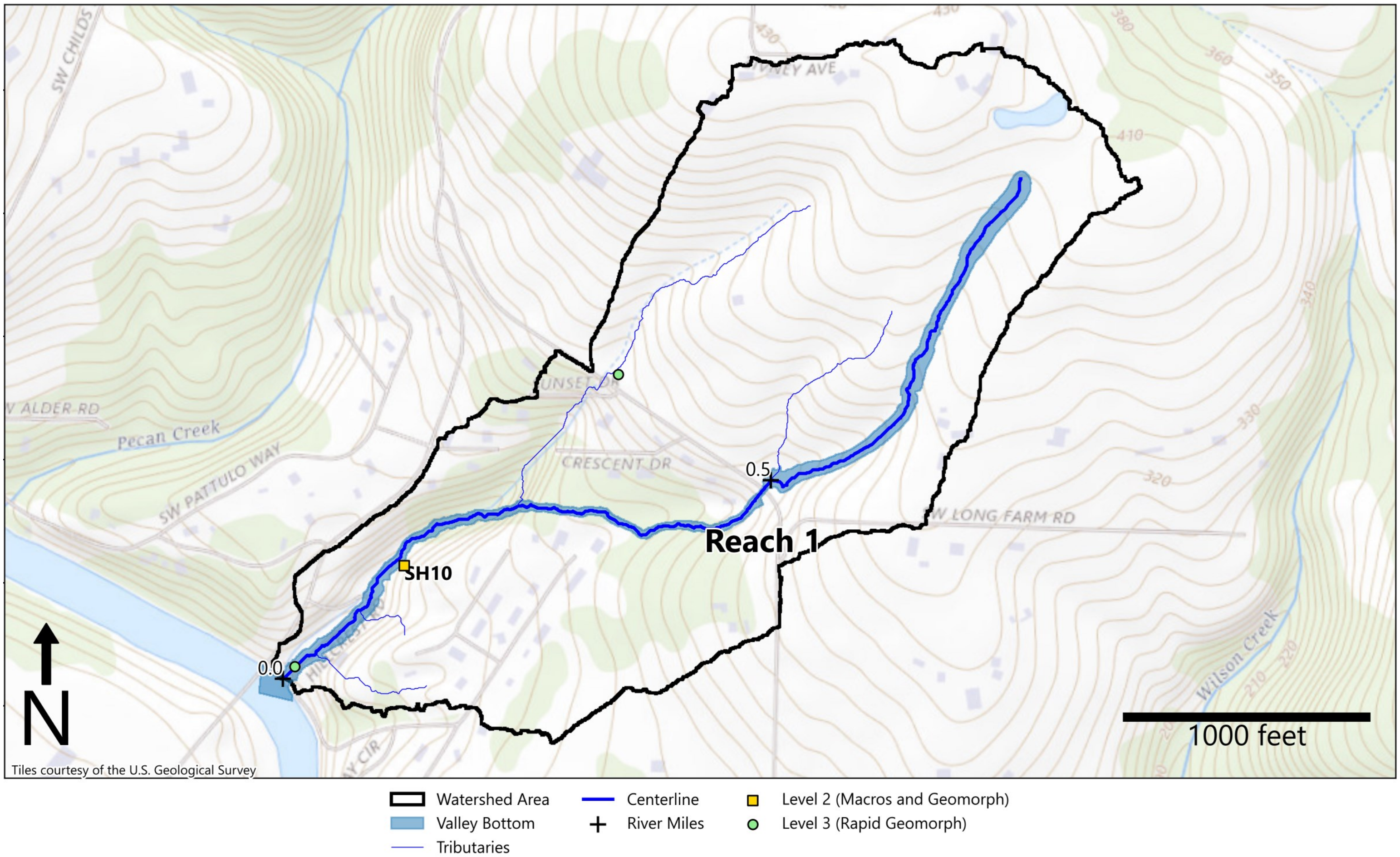
**Level of Disturbance**

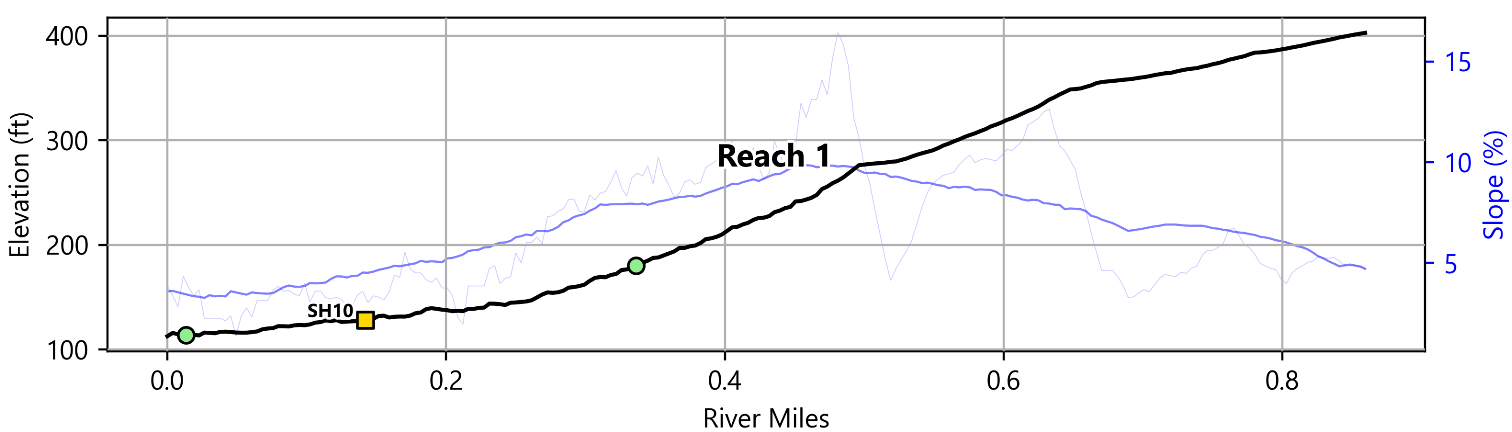
Severe/Most
Moderate
Slight/Least

Saum Creek flows north into the Tualatin River. Saum Creek is among the most developed of any of the west-side creeks. Unlike the other west-side creeks, Saum Creek has a long, unconfined, low-gradient reach that travels along I-205 after coming off the steep bluffs to the south. Overall, Saum Creek is entrenched and has low floodplain connectivity. Incision is expected to continue due to prevalence of fine-grained soils. Reach 1 represents a potential opportunity for restoration on the west-side due to its wide floodplain and low gradient.

# Shipley Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.86 | 4537.24 | 5.9 | 0.17 | 3.87 | Unconfined |

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 17.8 | 16.0 | 16.8 | 0.8 |
| Rank* | 5 | 15 | 16 | 9 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **2.0** | **Gravel** | **Incised** | **3.8** | **16.7** | **16.7** | **0.0** | **45.0** | **1.5** | **100.0** | **-6.2** |
| Reach 1 | 3 | 1.9 | Gravel | Incised | 4.2 | 20.0 | 20.0 | 0.0 | 45.0 | 1.5 | 100.0 | -6.2 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Low** | **Low** | **Low** | **0** | **Likely Imparied** |
| Reach 1 | High | Low | Low | Low | 0 | Likely Imparied |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Decreasing** | **1** | **Likely Degrading** |
| Reach 1 | High | Moderate | Decreasing | 1 | Likely Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 28.0 | Moderate | 0.5 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

| Condition Classes | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

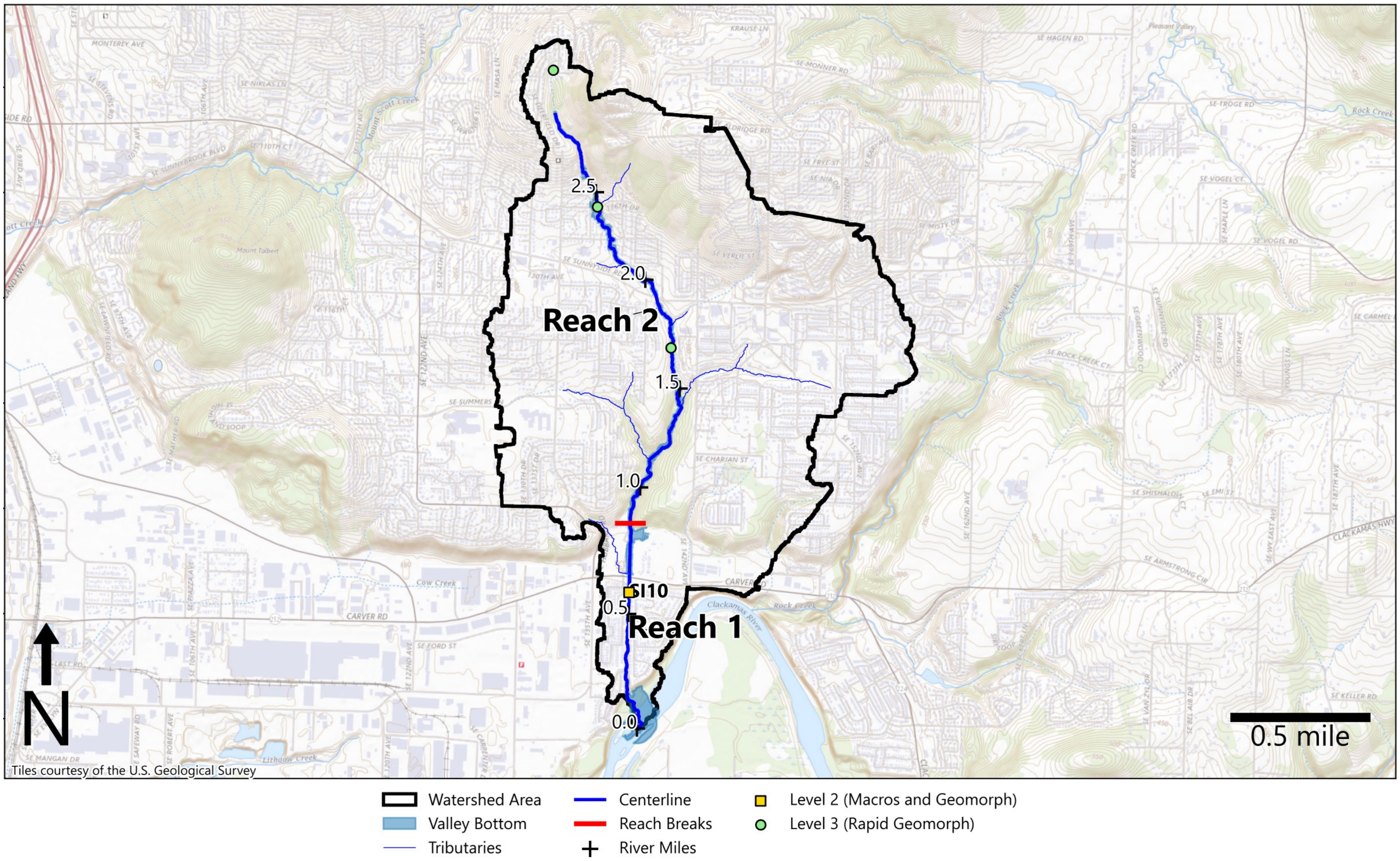
| Trajectory Classes | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

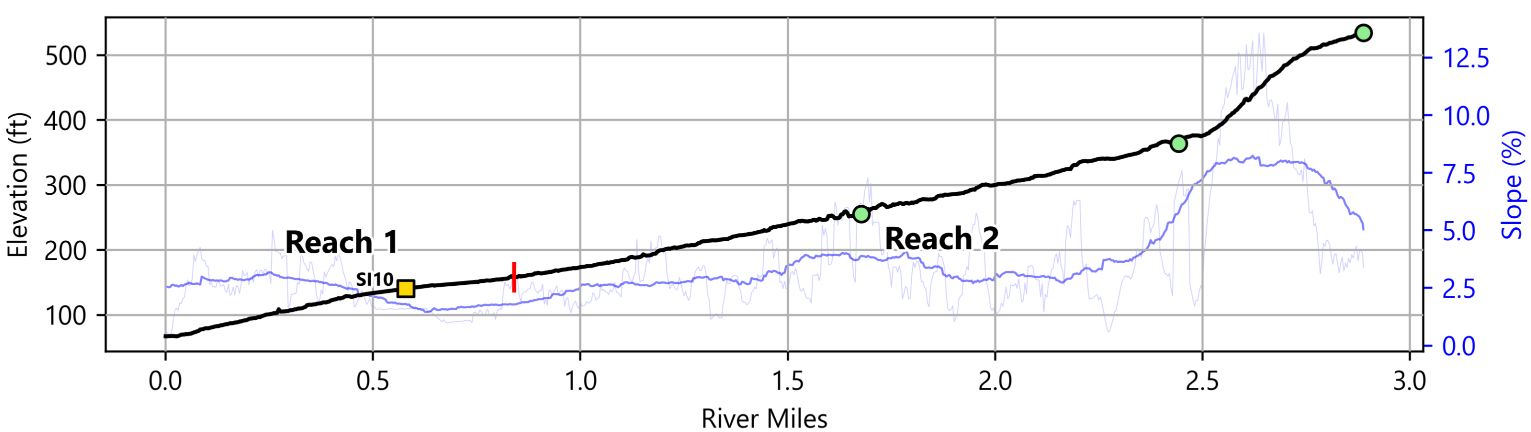
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Shipley Creek flows southwest into the Tualatin River. This creek is small and overrun with invasive plan species. The channel is often entrenched and confined. Development pressure is relatively low, but riparian canopy cover is decreasing according to canopy cover change from 2007-2014. Efforts to conserve the riparian canopy and invasive removal may help mitigate further degradation.

# Sieben Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.8 | 4430 | 12.6 | 2.03 | 1.38 | Partially Confined |
| 2 | 0.8 | 2.9 | 10810 | 8.45 | 1.49 | 4.36 | Unconfined |

Site distribution for Sieben Creek is sufficient to characterize the distinct geomorphic reaches. Given that Sieben Creek is the most rapidly developing watershed of any of the study streams, increased monitoring efforts in the future may be desired.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 19.5 | 29.0 | 33.9 | 4.9 |
| Rank* | 3 | 7 | 6 | 1 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **3.3** | **Gravel** | **Incised** | **1.9** | **12.5** | **28.6** | **0.0** | **54.9** | **1.5** | **85.7** | **17.8** |
| Reach 1 | 1 | 3.5 | Gravel | Incised | 1.6 | 10.0 | 0.0 | 0.0 | 38.7 | 1.0 | 100.0 | 12.8 |
| Reach 2 | 3 | 3.9 | Gravel | Incised | 1.8 | 20.0 | 50.0 | 0.0 | 62.2 | 1.0 | 50.0 | 19.8 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Low** | **Low** | **Moderate** | **1** | **Likely Imparied** |
| Reach 1 | High | Low | Low | Low | 0 | Likely Imparied |
| Reach 2 | High | Low | Low | High | 2 | Likely Imparied |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Increasing** | **4** | **Potentially Degrading** |
| Reach 1 | High | Moderate | Increasing | 3 | Potentially Degrading |
| Reach 2 | High | High | Increasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 28.0 | Moderate | 0.8 | Most |

**Scoring**

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

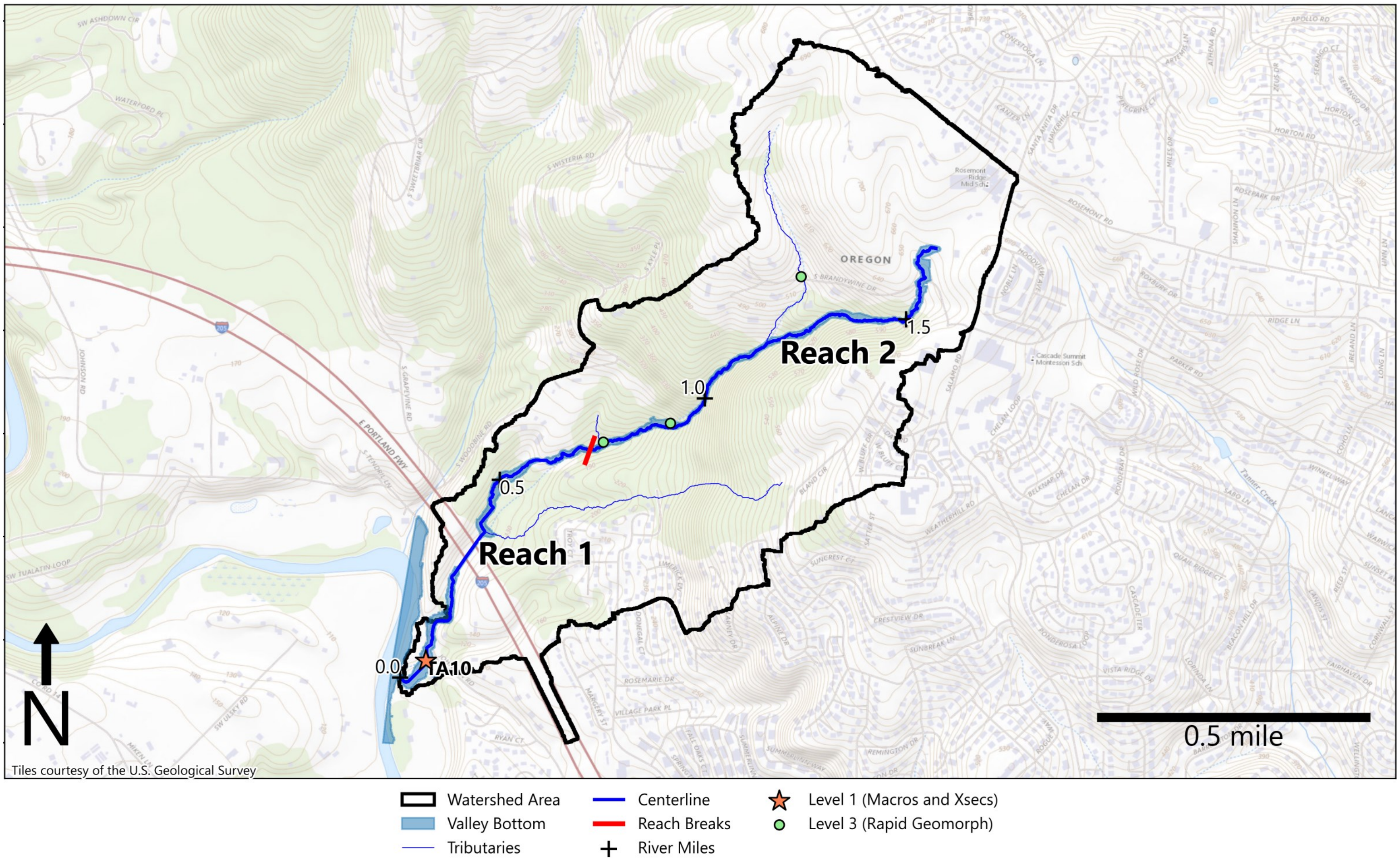
**Level of Disturbance**

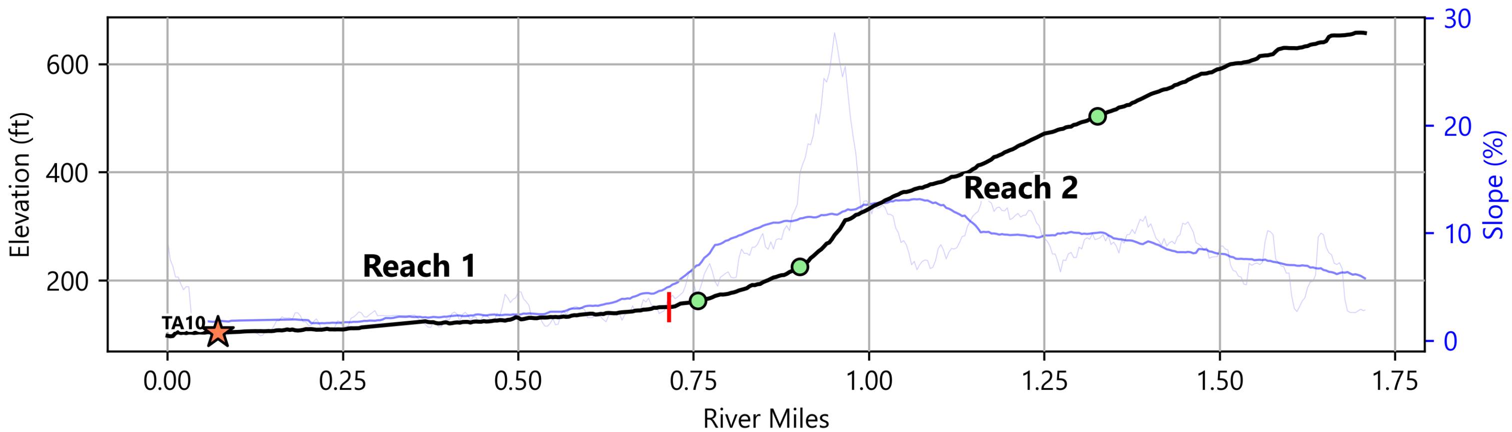
- Severe/Most
- Moderate
- Slight/Least

Sieben Creek flows south into the Clackamas River. Sieben Creek has experienced the most development in the last two decades than any other creek in this study. The creek is entrenched and no longer connected to its floodplain, with banks often exceeding 10 feet. At RM 1.7, the creek has cut a small canyon into gravel-rich soils (15+ ft banks) through backyards and a small natural area. At SI10 the creek is confined with 10+ foot banks and has incised down to bedrock. Given its current state, this creek is expected to begin experiencing bank failures and significant widening.

# Tate Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.7 | 3770 | 6.87 | 0.61 | 1.41 | Unconfined |
| 2 | 0.7 | 1.7 | 5240 | 9.2 | 0.35 | 10.35 | Partially Confined |

Site distribution at Tate Creek was sufficient to characterize all reaches. With more monitoring data particularly in the headwaters, Reach 2 may be further divided into two reaches.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 11.6 | 20.9 | 21.6 | 0.7 |
| Rank* | 10 | 9 | 9 | 11 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **1.5** | **Bedrock** | **Incised** | **3.9** | **23.8** | **28.6** | **14.3** | **75.1** | **1.8** | **100.0** | **-3.2** |
| Reach 1 | 1 | 1.8 | Fines | Widening | 3.1 | 80.0 | 0.0 | 25.0 | 65.9 | 1.0 | 100.0 | -7.2 |
| Reach 2 | 3 | 1.1 | Bedrock | Incised | 5.7 | 5.0 | 100.0 | 0.0 | 83.2 | 2.5 | 100.0 | -0.4 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Low** | **Moderate** | **Moderate** | **3** | **Probably Impaired** |
| Reach 1 | High | Low | Low | Moderate | 1 | Likely Impaired |
| Reach 2 | Low | Moderate | Moderate | Moderate | 5 | Probably Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **High** | **Stable** | **5** | **Likely Improving** |
| Reach 1 | Moderate | High | Decreasing | 3 | Potentially Degrading |
| Reach 2 | Low | High | Stable | 5 | Likely Improving |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 26.0 | Moderate | 0.6 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

| Condition Classes | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

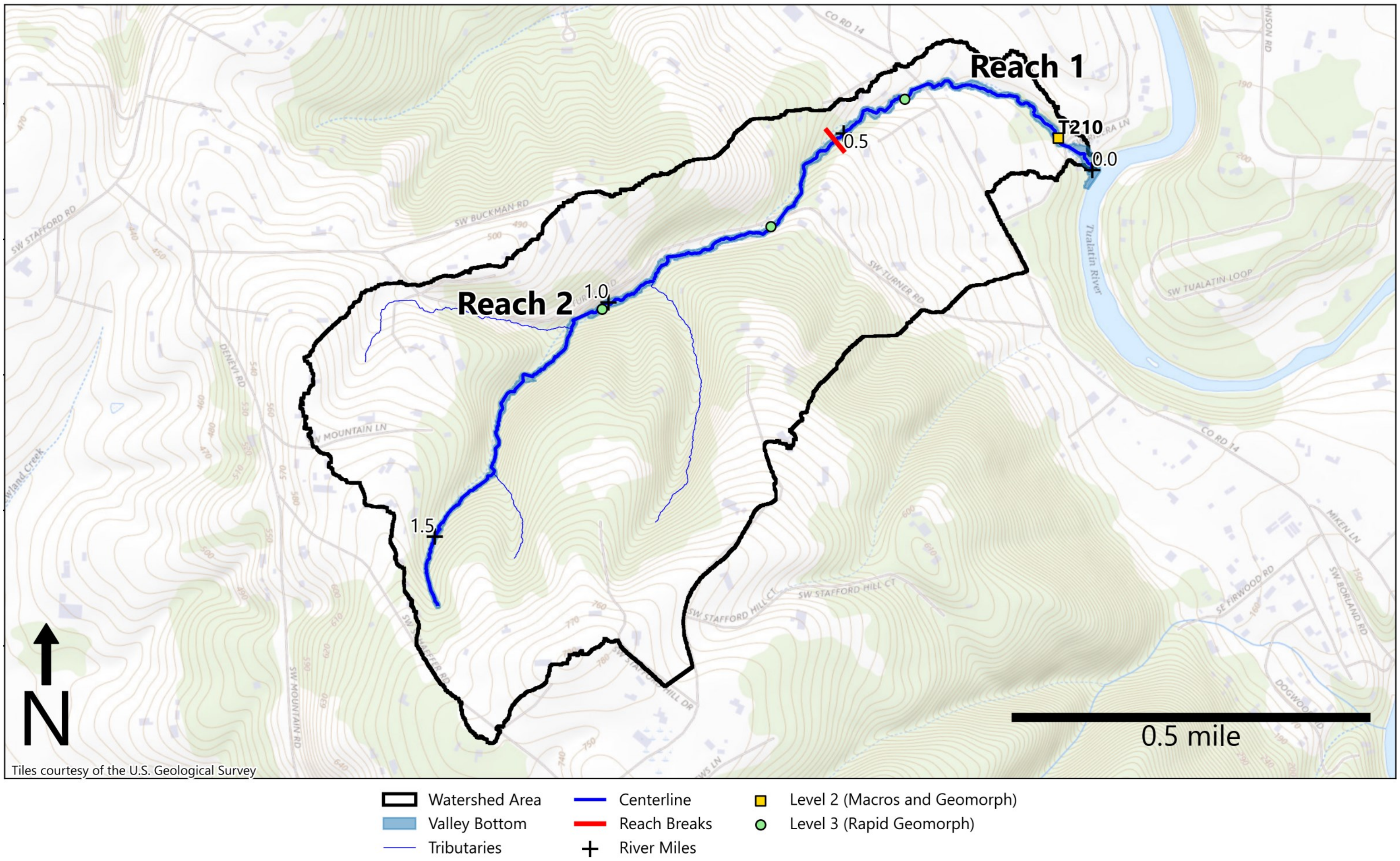
| Trajectory Classes | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

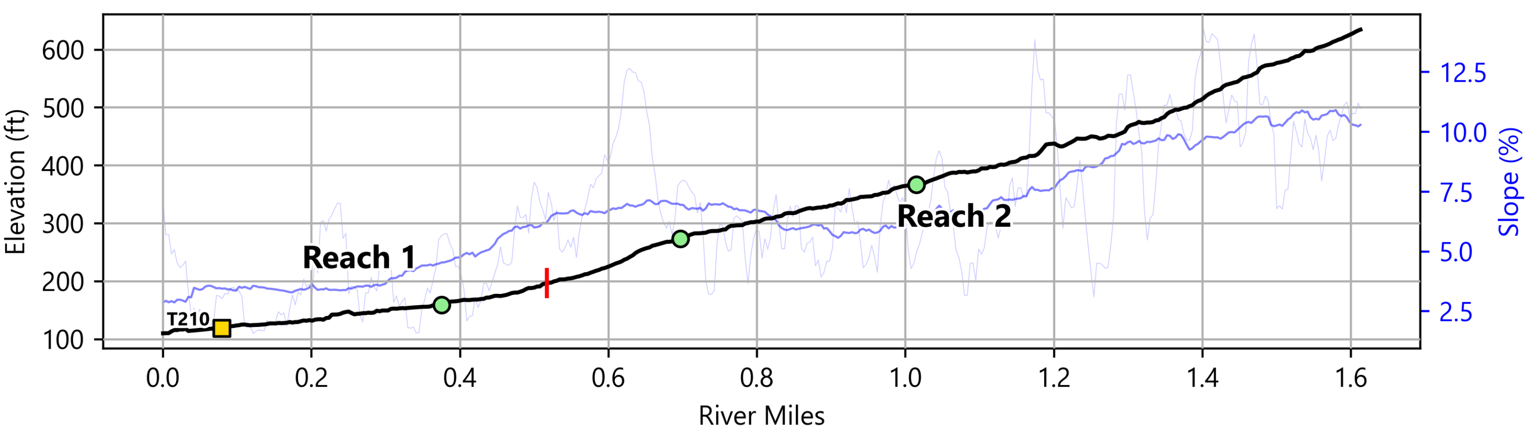
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Tate Creek flows south-southwest into the Tualatin River. Reach 1 is low-gradient and well entrenched, especially within the backwater influence of the Tualatin. Reach 2 is much steeper with exposed bedrock. Tate Creek experienced relatively low development pressure, but riparian canopy cover is decreasing. The potential for incision is greatest in the lower reach, although entrenchment is partially natural as the creek flows into the backwater influence of the Tualatin. Upstream, incision is less likely due to observed bedrock.

# Trib-2 Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.5 | 2730 | 6.32 | 0.49 | 3.11 | Partially Confined |
| 2 | 0.5 | 1.6 | 5790 | 8.45 | 0.36 | 6.52 | Partially Confined |

Site distribution on Unnamed Trib-2 is sufficient to characterize all reaches. The exact location of the reach break may be further refined with more monitoring data.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 9.5 | 17.7 | 18.0 | 0.4 |
| Rank* | 12 | 12 | 13 | 16 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **2.1** | **Gravel** | **Incised** | **6.9** | **15.0** | **42.9** | **0.0** | **71.2** | **1.3** | **42.9** | **60.0** |
| Reach 1 | 2 | 2.1 | Gravel | Widening | 5.8 | 12.5 | 20.0 | 0.0 | 47.1 | 1.0 | 20.0 | 11.7 |
| Reach 2 | 2 | 2.1 | Gravel | Incised | 10.4 | 17.5 | 100.0 | 0.0 | 83.9 | 1.5 | 100.0 | 81.3 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Low** | **Low** | **High** | **2** | **Likely Impaired** |
| Reach 1 | High | Low | Low | Moderate | 1 | Likely Impaired |
| Reach 2 | Moderate | Moderate | Low | Moderate | 3 | Probably Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Stable** | **3** | **Potentially Degrading** |
| Reach 1 | Low | Moderate | Increasing | 5 | Likely Improving |
| Reach 2 | High | High | Increasing | 4 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 18.0 | Severe | 0.3 | Most |

**Scoring**

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

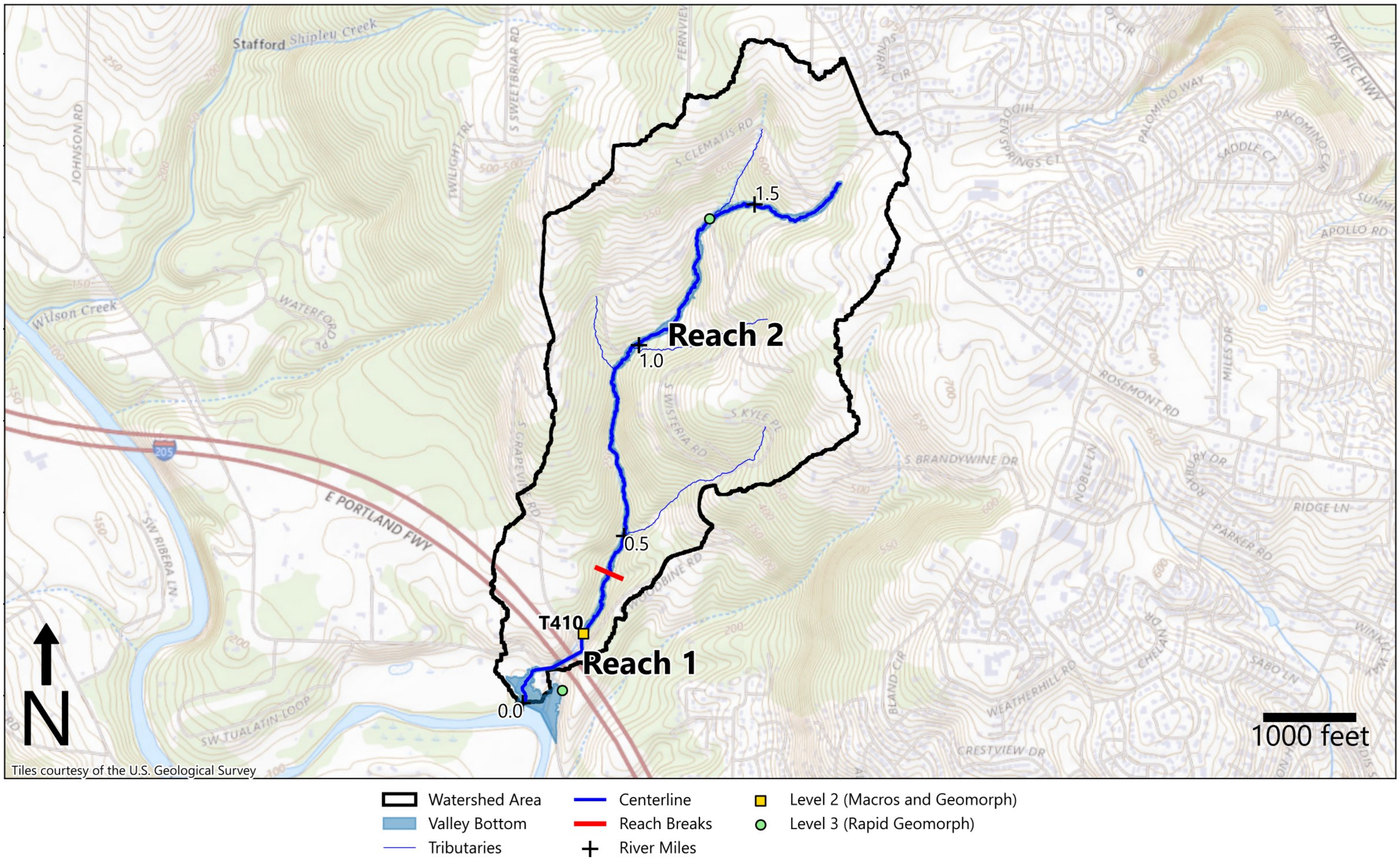
**Level of Disturbance**

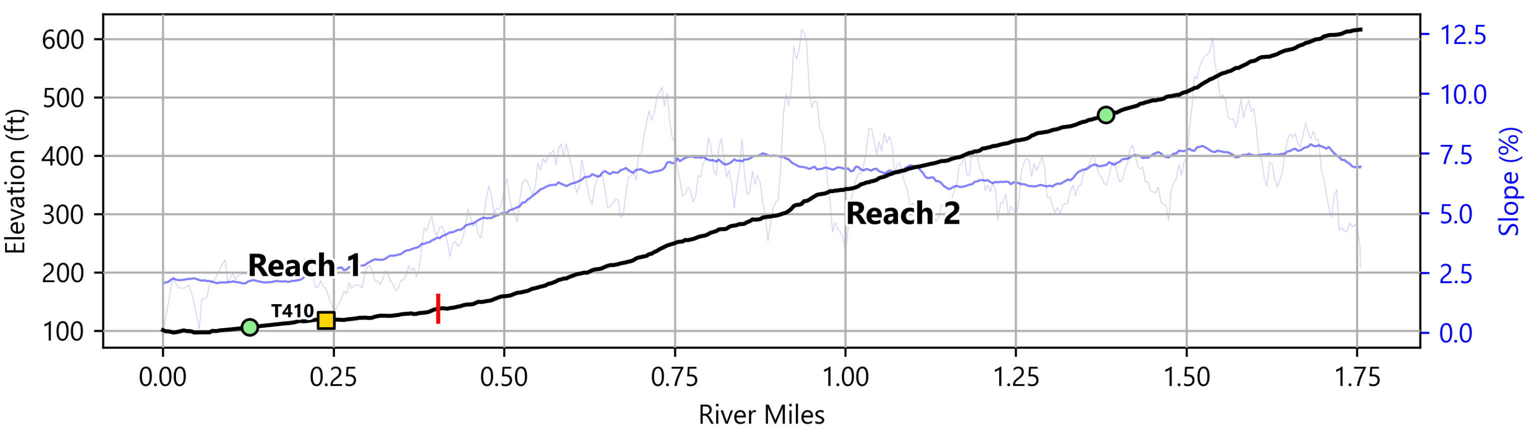
Severe/Most
Moderate
Slight/Least

Unnamed Tributary 2 flows northeast into the Tualatin River. Similar to many of the other west-side creeks, Trib-2 has a low-gradient and well-entrenched downstream reach, and a steeper upstream reach with a gravel bed. Trib-2 experienced relatively low development pressure. The potential for incision is greatest in the upper reach due to the lack of observed bedrock.

# Trib-4 Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.4 | 2130 | 13.3 | 0.63 | 4.45 | Partially Confined |
| 2 | 0.4 | 1.8 | 7140 | 4.5 | 0.54 | 6.26 | Unconfined |

Due to limited access, more monitoring data is likely required to fully represent stream conditions in Reach 2.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 13.3 | 15.5 | 16.2 | 0.8 |
| Rank* | 8 | 17 | 17 | 10 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **3** | **1.3** | **Gravel** | **Incised** | **7.1** | **21.7** | **33.3** | **16.7** | **73.9** | **1.7** | **100.0** | **0.6** |
| Reach 1 | 2 | 1.3 | Gravel | Incised | 10.2 | 25.0 | 0.0 | 0.0 | 68.6 | 3.0 | 100.0 | -0.8 |
| Reach 2 | 1 | 1.4 | Gravel | Incised | 4.6 | 0.0 | 100.0 | 100.0 | 76.6 | 1.0 | 100.0 | 0.8 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Low** | **Low** | **Moderate** | **Moderate** | **4** | **Probably Impaired** |
| Reach 1 | Low | Low | High | Moderate | 5 | Likely Imparied |
| Reach 2 | Moderate | High | Low | Moderate | 4 | Probably Impaired |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **High** | **Stable** | **3** | **Potentially Degrading** |
| Reach 1 | High | High | Stable | 3 | Potentially Degrading |
| Reach 2 | High | High | Stable | 3 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 16.0 | Severe | 0.2 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

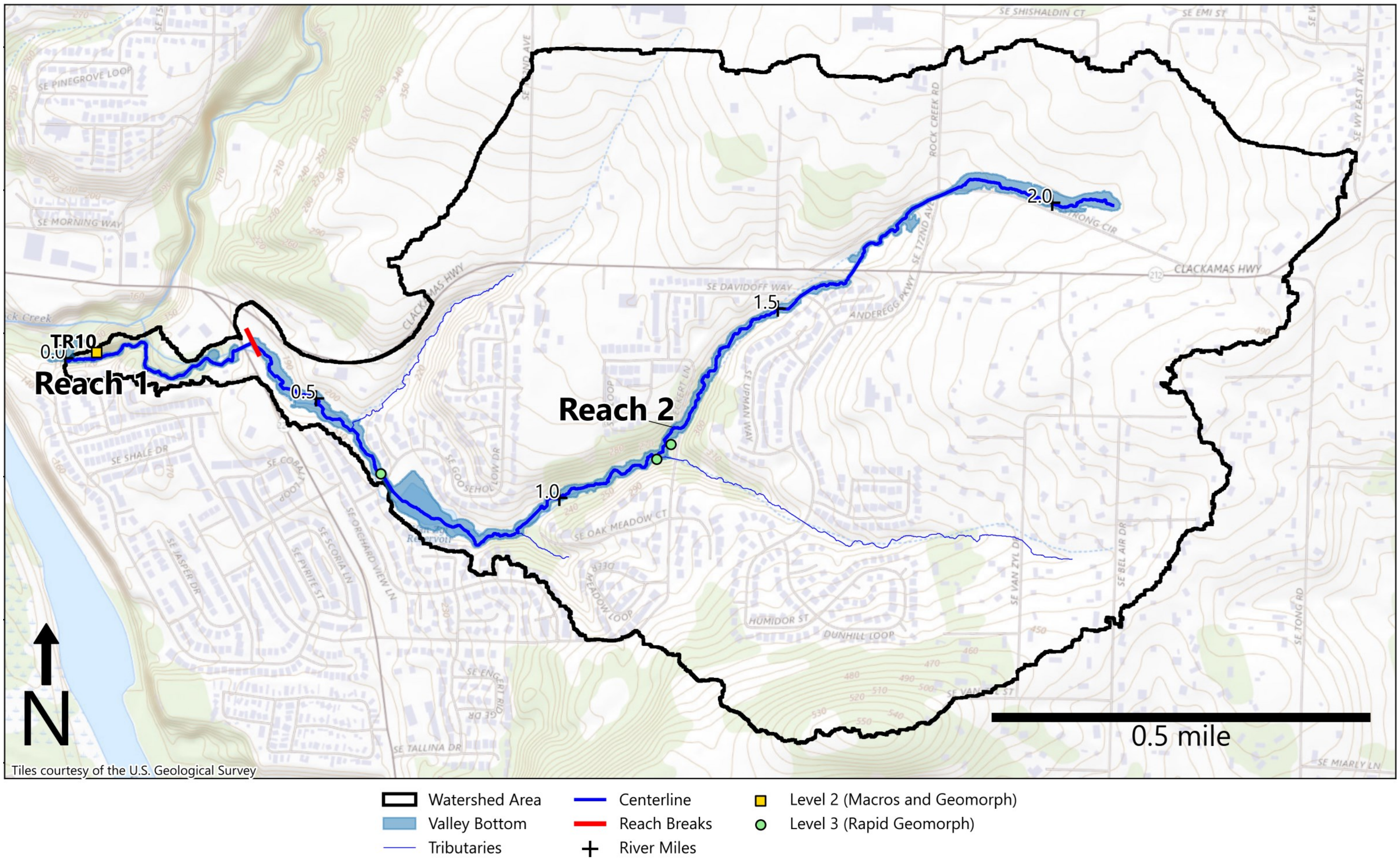
| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

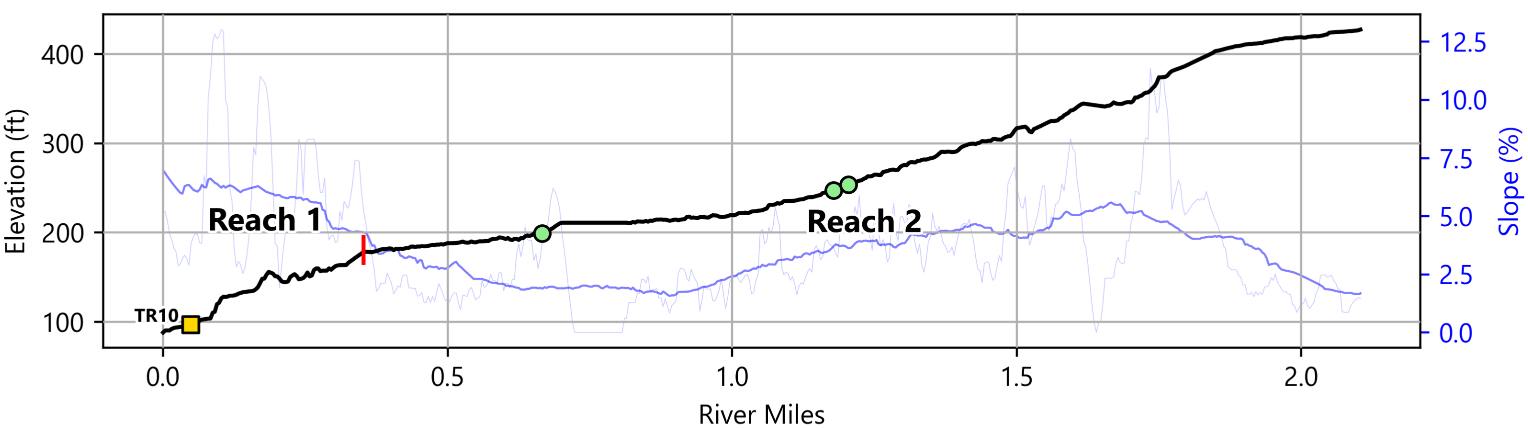
| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Unnamed Tributary 4 flows southwest into the Tualatin River. Similar to many of the other west-side creeks, Trib-4 has a low-gradient downstream reach, and a steeper upstream reach with a gravel bed. Trib-4 experienced relatively low development pressure. The potential for incision is greatest in the upper reach due to the lack of observed bedrock.

# Trillium Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.4 | 1860 | 17.9 | 0.41 | 4.23 | Partially Confined |
| 2 | 0.4 | 2.1 | 9250 | 12.5 | 0.18 | 3.28 | Partially Confined |

Due to limited access, more monitoring data may be required to fully represent stream conditions on Trillium Creek. Particularly in the low gradient headwaters and the transition between Reach 1 and Reach 2.

# Reach and Stream Based Health Scoring

## Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 11.6 | 23.5 | 25.3 | 1.8 |
| Rank* | 9 | 8 | 8 | 4 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **1.8** | **Gravel** | **Incised** | **4.3** | **12.5** | **100.0** | **0.0** | **39.2** | **1.3** | **87.5** | **10.7** |
| Reach 1 | 1 | 1.6 | Gravel | Incised | 5.3 | 25.0 | 100.0 | 0.0 | 50.0 | 2.0 | 80.0 | 10.6 |
| Reach 2 | 3 | 2.0 | Fines | Incised | 3.3 | 8.3 | 100.0 | 0.0 | 36.9 | 1.0 | 100.0 | 10.9 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

## Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Low** | **Low** | **1** | **Likely Imparied** |
| Reach 1 | Moderate | Moderate | Moderate | Low | 3 | Probably Impaired |
| Reach 2 | High | Moderate | Low | Low | 1 | Likely Imparied |

## Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **High** | **Moderate** | **Increasing** | **3** | **Potentially Degrading** |
| Reach 1 | High | Moderate | Increasing | 3 | Potentially Degrading |
| Reach 2 | High | Moderate | Increasing | 3 | Potentially Degrading |

## Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 30.0 | Slight | 0.9 | Moderate |

**Scoring**

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

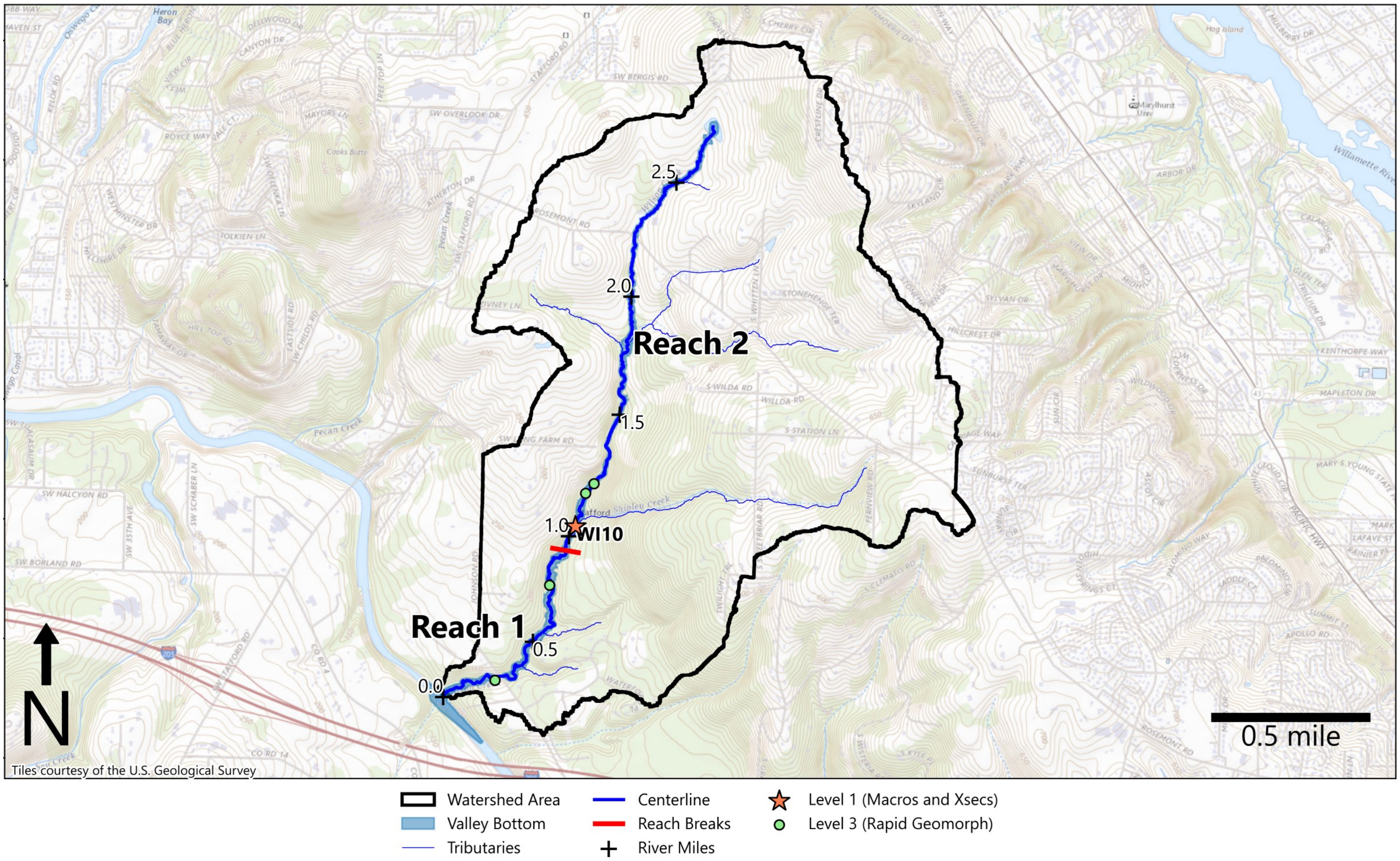
**Level of Disturbance**

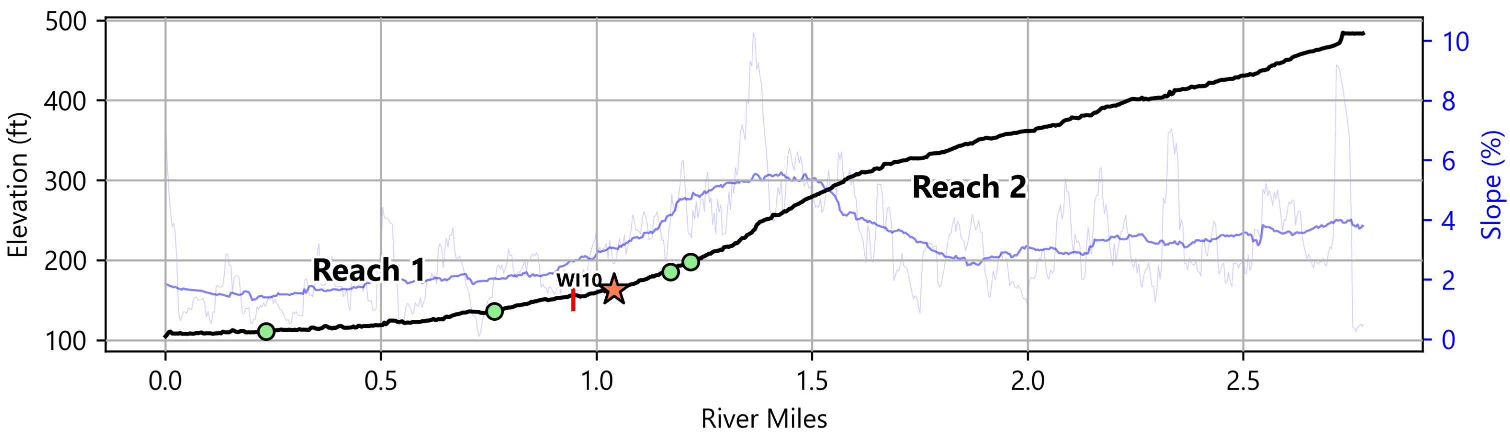
| |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Trillium flows west to its confluence with Rock Creek just upstream of the Clackamas River. Reach 1 is steep and confined with multiple waterfalls and overhanging canyon walls. Reach 2 brings water from the headwaters into a reservoir at RM 0.7. This reservoir has created a low-gradient partially unconfined reach upstream. Overall, stream health for Trillium Creek is low. Given the higher relative development pressure, this creek may be a priority for restoration/management efforts, particularly in the unconfined reach upstream of the reservoir where entrenchment potential is high due to fine-grained bed material.

# Wilson Creek

## Context and Overview—Map and Profile




## Reach-Based Summary—Geomorphology

| Reach | DS RM | US RM | Length (ft) | BF Width (ft) | Drainage Area (sq mi) | Slope (%) | Confinement |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 5000 | 15.6 | 2.15 | 1.45 | Partially Confined |
| 2 | 1 | 2.8 | 9670 | 14.9 | 1.7 | 2.92 | Partially Confined |

Due to limited access there is insufficient data to characterize all geomorphic reaches on Wilson Creek. With further monitoring efforts in the upper reaches, Reach 2 could be subdivided into two distinct reaches.

## Reach and Stream Based Health Scoring

### Summary of Watershed Development Patterns/Stream Health Drivers

| | Road Density mi/mi$^2$ | Impervious 2001 % | Impervious 2019 % | Change in Impervious 2001-2019 % |
|---|---|---|---|---|
| Value | 5.7 | 13.7 | 14.1 | 0.4 |
| Rank* | 19 | 18 | 18 | 15 |

*Ranking of the 19 creeks evaluated where 1 is the most and 19 is the least.

| | Number of Sites | Floodplain Height Ratio ft/ft | Substrate Erodobility | SEM Dominant Process | W/D Ratio of Inset Flooplain ft/ft | Eroding Bank Percentage % | LWD Presence % | Pool Presence % | Riparian Cover (2014) % | Floodplain Connectivity Rating | Invasives Presence % | Change in Riparian Cover (2007-2014) % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scoring Category | - | E-CC, C-CC | E-T | E-T | E-CC | E-T | CP-CC | CP-CC | R-CC, C-T | C-CC | R-CC | R-T |
| **Stream** | **4** | **1.6** | **Gravel** | **Connected** | **6.3** | **8.0** | **100.0** | **22.2** | **62.9** | **2.8** | **66.7** | **-6.9** |
| Reach 1 | 2 | 1.4 | Fines | Incised | 6.2 | 10.0 | 100.00 | 50.00 | 81.75 | 3.00 | 100.0 | -8.9 |
| Reach 2 | 3 | 1.6 | Gravel | Connected | 6.3 | 6.7 | 100.00 | 14.29 | 54.15 | 2.67 | 57.1 | -5.9 |

E-CC: Entrenchment Current Condition
E-T: Entrenchment Trajectory
C-CC: Connectivity Current Condition
CP-CC: Complexity Current Condition
R-CC: Riparian Current Condition
R:T: Riparian Trajectory
CP-T: Complexity Trajectory

### Physical Habitat Current Condition Categories and Scoring

| | Entrenchment | Complexity | Floodplain Connectivity | Riparian Condition | Overall Condition Score (max of 8) | Overall Condition |
|---|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **Moderate** | **High** | **Moderate** | **5** | **Probably Impaired** |
| Reach 1 | High | Low | High | Moderate | 1 | Likely Impaired |
| Reach 2 | Low | Moderate | High | Moderate | 4 | Probably Impaired |

### Physical Habitat Trajectory Categories and Scoring

| | Entrenchment-Incision Potential | Complexity - LWD Recruitment Potential | Riparian-Canopy Cover Change (2007-2014) | Overall Trajectory Score (max score of 6) | Overall Trajectory |
|---|---|---|---|---|---|
| **Stream (Overall)** | **Moderate** | **High** | **Decreasing** | **3** | **Potentially Degrading** |
| Reach 1 | High | High | Decreasing | 2 | Likely Degrading |
| Reach 2 | Moderate | High | Decreasing | 4 | Probably Impaired |

### Biological Habitat Scoring

| | M-IBI Score | M-IBI Level of Disturbance | O/E Score | O/E Level of Disturbance |
|---|---|---|---|---|
| **Stream (overall)** | 22.0 | Moderate | 0.4 | Most |

| Scoring |
|---|
| 0 |
| 1 |
| 2 |

**Condition Classes**

| | |
|---|---|
| 0-2: | Likely Impaired |
| 3-5: | Probably Impaired |
| 6-8: | Functioning |

**Trajectory Classes**

| | |
|---|---|
| 0-2: | Likely Degrading |
| 3-4: | Potentially Degrading |
| 5-6: | Likely Improving |

| Level of Disturbance |
|---|
| Severe/Most |
| Moderate |
| Slight/Least |

Wilson Creek flows south-southwest into the Tualatin River. Again, like many west-side creeks it has a low-gradient downstream reach and a steep upstream reach. The potential for incision is greatest in the downstream reach where the creek travels through fine-grained floodplain deposits, which is natural within the backwater influence of the Tualatin. Riparian canopy cover is decreasing. Given the overall low development pressure in this watershed and well-connected floodplain, Wilson Creek maintains some capacity for natural recovery.

# Appendix C – Monitoring Methods and Definitions

## Appendix C- Monitoring Methods and Definitions

This appendix is separated into two sections, C1 and C2. C1 explains the methods used for the geomorphic monitoring and assessment, and C2 explains the macroinvertebrate methodology.

### C1- Geomorphic Monitoring

This part of the appendix defines the measurements and derived metrics that were used in this assessment. Measurements (or observations) were made in the field or through GIS analysis. Derived metrics are calculated from multiple measurements.

Part of W2r's approach was to gather data at different levels of detail across the service area. Below is a brief description of the different data levels:

- Detailed status and trends sites (**Level 1**): Six (6) status and trends sites were monitored with this most detailed level of geomorphic monitoring. The methods employed at these sites most resemble previous monitoring methods and include detailed cross-section surveys and other measurements to compare with previous monitoring campaigns. All level 1 locations coincide with previous geomorphic monitoring stations and are a subset of sites planned for benthic macroinvertebrate sampling in 2021.
- Geomorphic measurements at macroinvertebrate sites (**Level 2**): Macro-invertebrate sampling (23 sites) requires associated geomorphic measurement characterization. These geomorphic measurements are of moderate-detail level.
- Distributed (Rapid) geomorphic characterization (**Level 3**): To gain a broader geographic understanding of stream conditions, rapid geomorphic approaches were applied at several sites and reaches along the streams of interest.

**Table C 1: Definitions of measured and derived metrics used in this study. Those with an "*" were measured/calculated in GIS rather than in the field. The final column of the table provides the shorthand for the metrics as referred to in the database (Appendix E).**

| | Measurement or Derived? | Data Level | Definition/Method | Database Shorthand |
|---|---|---|---|---|
| Bankfull Width | Meas. | 1, 2, 3 | Width of channel between banks at bankfull stage as indicated by vegetation and scour features (bare areas). | BF_width |
| Bankfull Depth | Meas. | 1, 2, 3 | Channel depth measured from stream thalweg to bankfull stage. | BF_depth |
| Bankfull Height | Meas. | 1, 2, 3 | Height from toe of bank to bankfull stage. | BF_height |
| Banktop Width | Meas. | 1, 2, 3 | Channel width measured from top of bank or edge of first terrace. | BT_width |

| | | | | |
|---|---|---|---|---|
| Banktop Height | Meas. | 1, 2, 3 | Height from toe of bank to top of bank or edge of first terrace. | BT_height |
| Flow Width | Meas. | 1, 2, 3 | Width of wetted channel at current flow, measured from water's edge to water's edge. | Flow_width |
| Riffle Depth | Meas. | 1, 2, 3 | Depth of water at deepest point on the riffle along the transect. | Riffle_depth |
| Pool Depth | Meas. | 1, 2, 3 | Depth of deepest pool found immediately upstream of measured riffle. | Pool_depth |
| Presence of Invasives | Meas. | 1, 2, 3 | Observed presence or absence of common invasive plant species (e.g. Himalayan Blackberry, Knotweed, English Ivy) in the riparian zone. | Invasives?_mean |
| Floodplain Connectivity | Meas. | 1, 2, 3 | Observed rating (ratings of 1, 2, and 3) of floodplain connectivity as indicated by the presence of adjacent wetland vegetation, side channels, or high water marks on the adjacent floodplain. Low (ratings of 1) were assigned to sites with none of the above features. Medium ratings (ratings of 2) were assigned to sites with one of the above features. High ratings (ratings of 3) were assigned to sites with at least two of the above features. | FP_connectivity |
| Vegetation Health | Meas. | 3 | Observed rating of overall vegetation health within the riparian zone. 1 signified that the riparian zone almost entirely composed of invasives. 2. Signified that there was an even mix of invasives and natives.3 signified that the riparian vegetation was mainly native and was in generally good health. | Veg_health |
| Presence of Bedrock | Meas. | 1, 2, 3 | Observed presence or absence of bedrock within the channel within 100 ft upstream and downstream of the transect location. | Bedrock? |
| Channel Type | Meas. | 1, 2 | Observed classification of the channel based utilizing Montgomery and Buffington (1997) classification (pool-riffle, plane-bed, etc.) | Channel_type |
| Bank Erosion | Meas. | 1, 2, 3 | Percentage of visible bank at each side that was exhibiting signs of active erosion. Observation incorporates both banks | Bank_erosion |
| Overhanging Bank | Meas. | 1, 2, 3 | Percent of bank length with overhang and/or active collapse | Bank_overhanging |
| SEM Stage | Meas. | 1, 2, 3 | Based on the stage of stream evolution (according to Cluer and Thorne, 2014), as identified in the field. | SEM_stage |
| Drainage Area | Meas.* | 1, 2, 3 | Measured in square miles using Metro (2014) LiDAR. Creek lelvel DA is measured as the whole watershed, reach level DA is measured from the downstream end of each reach, and site level DA is measured from their location on the centerline. | DA |

| | | | | |
|---|---|---|---|---|
| Floodplain Width | Meas.* | 1, 2, 3 | Width of valley bottom using line orthogonal to stream centerline. Valley bottom was delineated using a modified version of VBET (Gilbert et al 2016) from Metro (2014) terrain. | FP_width |
| Confinement Ratio | Meas.* | 1, 2, 3 | Floodplain width divided by the bankfull width. Further categorized into three categories: Confined where ratio <2, Partially Confined where ratio 2-6, and Unconfined where ratio >6. Modified categories from Legg & Olson 2015. | Confinement |
| Riparian Cover | Meas.* | 1, 2, 3 | Canopy cover percentage measured from Metro (2014) canopy mapping data. Canopy percentages were measured within a 180-foot riparian buffer width (measured on each side of stream centerline), which corresponds to a site potential tree height of Douglas Fir West of the Cascades. | Canopy%_2014 and Canopy%_2014 cl buff |
| Riparian Change | Derived | 1, 2, 3 | Canopy cover percentage changed measured from Metro mapping in 2007 and 2014. Canopy percentages were measured within a 180-foot riparian buffer width (measured on each side of stream centerline), which corresponds to a site potential tree height of Douglas Fir West of the Cascades | Canopy%_change and Canopy%_change cl buff |
| Embeddedness | Meas. | 2 | The degree to which fine sediments surround coarse substrates on the surface of a streambed. A percentage of embeddedness was observed during pebble counts by counting the number of pebbles that were more than 50% embedded. | embedded% |
| Bank Height Ratio | Derived | 1, 2, 3 | Ratio of measured banktop height to bankfull height | Bank_height_ratio |
| Floodplain Height | Derived | 1, 2, 3 | Measured as the vertical distance between the stream thalweg to the elevation defined by edge of the first terrace or abandoned floodplain | FP_height |
| Floodplain Height Ratio | Derived | 1, 2, 3 | Ratio of measured floodplain height to bankfull depth. Used as a measure of incision. | FP_height_BF_depth_ratio |
| Residual Depth | Derived | 1, 2, 3 | The difference between the pool depth and the riffle depth. | Residual_depth |
| Bankfull W/D Ratio | Derived | 1, 2, 3 | Ratio of bankfull width to bankfull depth. | BF_W/D_ratio |
| Dominant Substrate | Meas. | 1, 2, 3 | Visual observation of the substrate type (e.g. coarse gravel, fines, etc.) composing the greatest proportion of the channel bed. | Substrate |
| Presence of Large Woody Debris | Meas. | 1, 2, 3 | The observed presence or absence of large woody debris (<6" DBH) within the active (bankfull) channel at a given site. | LWD? |

| | | | | |
|---|---|---|---|---|
| Slope | Meas.* | Creek-based | Measured using Metro (2014) LiDAR. Measured in 100-foot reaches to reduce noise in the LiDAR surface. | Slope |
| Impervious Area % | Meas.* | Creek based | Measured using 2001 and 2019 NLCD impervious data. | Imp%_2001 and Imp%_2019 |
| Impervious Area Change | Derived | Creek Based | Difference between percent impervious are from 2001 to 2019. | Imp%_change |
| Road Density | Meas.* | Creek Based | Measured using Clackamas County's roads GIS layer by intersecting the layer with each watershed. | Road_density |
| Road Crossings | Meas.* | Creek Based | Measured using Clackamas County's roads GIS layer by intersecting the layer with each stream centerline and getting a count of intersection points. | road_crossings |

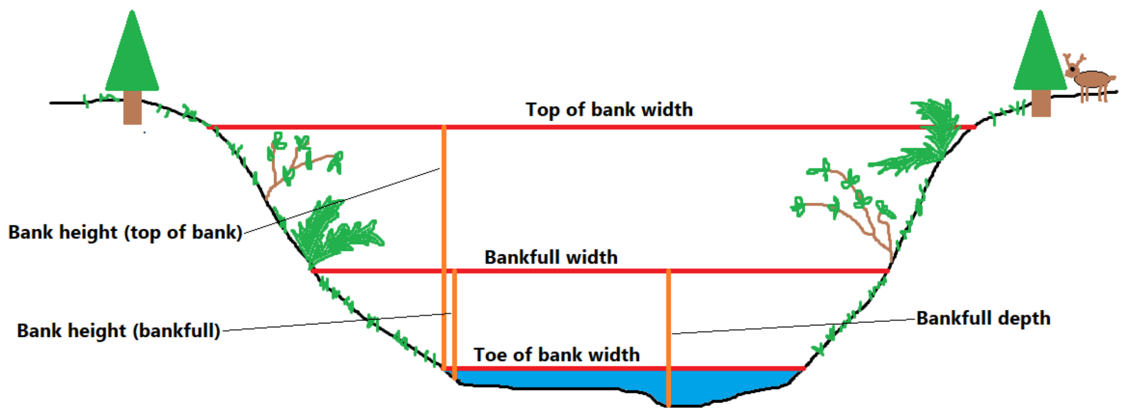



Figure C 1: Schematic of channel geometry measurements taken I the field.

**C2- Macroinvertebrate Monitoring**

*Sampling sites*

Reaches were located based on sampling done in prior monitoring years (Table 1). In a few instances, the reach was shifted due to difficulties in obtaining access permission from landowners, inability to access due to thick growths of Himalayan blackberry, or low/absent flow at sampling time. WES staff communicated with landowners to obtain access consent for all sites that were accessed. Sites were sampled between 16 September and 3 October 2021, between 7:15 am and 3:00 pm.

*Instream habitat and riparian assessments*

At each site, the downstream end of the reach was located using a Garmin handheld GPS unit datum WGS84) and the OnX mobile application, in conjunction with descriptions of site access from prior sampling years. The downstream end of each reach was flagged, and the average wetted width was calculated. Reach lengths were determined as the greater of 20X the average wetted with or 75 m (245 ft). The reach length was paced, the number and proportion of individual habitat units (riffle, glide, pool) was assessed, and upstream end was flagged and the coordinates were recorded. Relative proportions of different substrate types in the reach were assessed visually (sand/silt; cobble/gravel; boulder; bedrock; small woody debris; large woody debris; root wads; algae; and macrophytes).

The riparian zone of each bank of the sample reach was assessed separately, with vegetative cover ratings of absent (0%); sparse (10-40%); heavy (40-75%); or very heavy (>75%) assigned for each of the following: upper canopy; lower canopy; woody shrubs and saplings; herbs/grasses; bare soil/duff; and total non-native cover. The identity of the dominant non-native species was recorded, along with dominant adjacent land use. At each transect where a macroinvertebrate net set was taken (see Macroinvertebrate Sampling below), the wetted width and water depths at 25%, 50%, and 75% of the wetted width was measured. Canopy cover over the channel was estimated at each point using a convex spherical densiometer (Lemmon, 1957), standing in the center of the channel at each sampling transect and holding the densiometer at 0.3 m (1 ft) above the water surface. A measurement while facing downstream (DS), towards the right bank (R), upstream (US), and towards the left bank (L). Total shading was calculated as [DS+R+US+L]*1.5.

The degree of human influence was also recorded for each band separately, with ratings of absent; on bank; between bank and 30 ft; or >30 ft from bank for the following elements: wall/riprap/dam; buildings; pavement/cleared lot; road/railroad; pipes; landfill/trash; park/lawn; vegetation management; and bridge/abutment.

*Water chemistry*

Water chemistry measurements were taken during macroinvertebrate sampling in each reach. Water pH was measured using an EcoSense pH meter that was calibrated every other sampling day. Water temperature ($^{o}$C), dissolved oxygen (mg/L), dissolved oxygen saturation (%), conductivity (μS/cm), and specific conductance (μS/cm) were measured using a YSI Pro 2030 multi-meter that was calibrated daily for dissolved oxygen. Water color and odor were also noted.

*Macroinvertebrate sampling and identification*

Macroinvertebrate collection was done similar to prior years, according to the ORDEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams (ORDEQ 2009), to maintain a standardized technique across time.

Each site sample was a composite of eight individual net sets obtained using a D-frame kicknet (12in. [30 cm] mouth, 500 μm Nitex mesh) within a 1 ft2 (900 cm2) area. In accordance with ORDEQ protocols, duplicate samples were collected at 10% (two) of the sampling sites (M-MS-80, M-PH-10) as a quality control measure to assess within-reach sample variability. Net samples were taken from among four different habitat units along the reach; in reaches with sufficient riffle habitat, all samples were taken in riffles, and glides were sampled in reaches that lacked riffle habitat. In one case (Cow Creek), only pool habitat was available.

Flow type and substrate were recorded at each point where a net set was taken. For each net set, large cobble within the sampling area were rubbed and rinsed into the net to collect clinging organisms and set aside, and then the remaining substrate was disturbed thoroughly by foot to a depth of 2-4 in. (6-10 cm) for 1-2 minutes. All net sets were pooled in a bucket and large debris was rinsed and removed. Sample material was concentrated on sieve lined with 500 µm Nitex membrane and transferred to 1L Nalgene sample jars half-filled with 80% ethanol as a preservative. Jars were filled no more than 2/3 full; sample material was divided among multiple jars if needed. The preservative in all jars was replaced with fresh within 72 hours to ensure preservation.

Sample identification was done by Cole Ecological. Each composited sample was first randomly sub-sampled to 500 individuals using a gridded Caton tray (Caton, 1991); if samples lacked 500 organisms, the entire sample was sorted for identification. Sorted organisms were identified to the lowest practical taxonomic level recommended by the Pacific Northwest Aquatic Monitoring Partnership (PNAMP, 2015).

*Macroinvertebrate community analysis*

Biological conditions in sample communities were assessed using the ORDEQ multimetric macroinvertebrate-based index of biotic integrity (M-IBI) and the probability-based PREDATOR model (Predictive Assessment Tool for Oregon; Hubler, 2008). It was originally intended to apply the new Biological Condition Gradient (BCG) that is being regionally calibrated for Oregon (USEPA, 2016) to the macroinvertebrate community data. However, at the time of this report, ORDEQ had not released the BCG for use. Both the PREDATOR and M-IBI models were developed specifically for riffle communities and thus will artificially downgrade samples taken from glides or polls, which would not be expected to support the same diversity of sensitive taxa that are typically associated with colder, better-oxygenated riffle habitat, but raw values for individual metrics were calculated in all samples for reference.

In the M-IBI, raw values of 10 metrics are calculated and assigned scaled values that are then summed to give a number corresponding to a level of biological impairment (Table 2), for a possible minimum score of 10 and possible maximum score of 50. Six of the metrics are positive (i.e., receive a higher scaled score with better conditions) and four are negative (i.e., receive a higher scaled score with degraded conditions). Sites may be scored as severely impaired (M-IBI summed score <20), moderately impaired (20-29), slightly impaired (30-39); or not impaired (>39).

PREDATOR calculates the ratio of taxa observed at a site to taxa expected if the site is not impaired (O/E), based on comparison to established reference communities (taxa with >50% probability of occurrence in reference reaches); the model uses site elevation, slope, and longitude to select appropriate reference streams. The PREDATOR model that encompasses the

Coast Range and Willamette Valley was applied (Marine Western Coastal Forest; MWCF). Conditions were assigned based on O/E score ranges used in prior sampling years (Cole, 2018) for higher-gradient streams: most disturbed (O/E score <0.85); moderately disturbed (O/E 0.86-0.91); and least disturbed (O/E 0.92-1.24.

Weighted-average inference models developed by ORDEQ (Huff et al., 2006) are also applied to macroinvertebrate community data to reveal whether fine sediment and/or elevated water temperature may be acting as a stressor. Similar to the PREDATOR model, inferred values at the sample site, based on taxa temperature tolerances and sample abundance, are compared to conditions at appropriate regional reference sites. The 75th percentile of the distribution of inferred temperature and fine- sediment values from regional reference sites is used to determine whether a site is potentially stressed by these factors. These models were again developed specifically for riffle habitats, and thus glide or pool samples would score lower as slower flows are likely to have more fine sediment and warmer water. Based on reference sites in the Willamette Valley, ORDEQ threshold values, above which temperature and/or sediment may be a potential stressor, are 18.4oC and 19% fine sediment, respectively.

Selected functional traits (i.e., biological properties and ecological preferences) of the macroinvertebrate community were also assessed for each sample. Functional trait assessment can help infer habitat conditions that shape the community, diagnose stressors or environmental filters, and predict restoration-related changes (Poff et al., 2006; Tullos et al., 2009; Culp et al., 2011; Van den Brink et al., 2011; Lange et al., 2014; White et al., 2017). Ecological and life history traits were assigned to taxa where data were available but note that values for each trait are not known for every taxon. Trait data were drawn from sources specific to Oregon and/or the west (Vieira et al., 2006; Meyer & McCafferty, 2007; Huff et al., 2008; Richards & Rogers, 2011; Relyea et al., 2012; IDDEQ, 2015; SAFIT, 2016), and more general references (Pinder, 1986; Wiggins, 1996; Larson et al., 2000; Thorp & Covich, 2001; Stewart & Stark, 2002; Anderson et al., 2013; Merritt et al., 2019). Where multiple modalities existed for a trait, the primary one was used. Community measures that were calculated included:

- trophic guild (functional feeding group), i.e., relative abundances of predator (PR), scraper (SC), shredder (SH), collector-filterer (CF) and collector-gatherer (CG) organisms: Filterers are negatively impacted by sedimentation if their feeding structures become clogged (Rabení et al., 2005; Wilkes et al., 2017); predator abundance can increase as increasing habitat diversity and/or stability creates more abundant and diverse prey (Arce et al., 2014); scrapers can be more abundant on algae- and biofilm-coated mineral substrates; and shredders indicate more plant material and leaf litter input.

- habit (locomotion) i.e., relative abundances of swimmer, clinger, burrower, climber, and sprawler organisms: Swimmers can more rapidly escape disturbances such as sedimentation; burrowers are selected for in sedimented habitat, whereas sprawlers, clingers, and crawlers can be smothered and/or lose habitat as interstitial spaces are filled (Mathers et al., 2017; Murphy et al., 2017).

- voltinism (# generations per year) i.e., relative abundances of multivoltine (>1 generation/year), univoltine (1 generation/year), and semivoltine <1 generation/yr) organisms. Multivoltinism is associated with more tolerant organisms and/or greater resilience in disturbed habitats, while semivoltine taxa require more stable conditions to compete their longer egg to adult development.

- rheophily (flow preference), i.e, relative abundances of organisms associated with erosional (fast/lotic), depositional (slow/lentic), or mixed flows (i.e., found in both lotic and lentic habitats).

- temperature associations, i.e., relative abundances of organisms with cool/cold or warm water temperatures. Organisms may be stenothermic (narrow tolerance range) or eurythermic (wide tolerance range), and water temperature can act as an environmental filter on macroinvertebrate communities.

*Data analysis*
Statistical analyses and graphing were done using PRIMER-e v7 (Clarke et al., 2014) and PAST 4.0 (Hammer et al., 2001) statistical software. Non-metric multidimensional scaling (nMDS) ordinations were run on a Bray-Curtis similarity matrix of square-root transformed taxa abundances and overlaid with similarity levels from CLUSTER dendrograms. Principal Component Analysis (PCA) was done using a variance-covariance matrix. Means are presented with standard deviation (SD). Trait correlations were calculated using ordinary least-squares regression. A summary of all ecological trait values calculated for the macroinvertebrate community at each site is presented in Appendix H.

# Appendix D – Physical habitat Health Characterization and Scoring Definitions

## Appendix D- Physical Habitat Health Characterization and Scoring Definitions

This appendix details the definitions and scoring W2r used to evaluate the physical habitat health of the streams in the surface water areas served by WES. These definitions and scoring were used on the stream level (Table 2 in the report body) and the reach level (Appendix B).

Most of the metrics listed in Table D1 were assessed in the field at each individual site. The metrics involving riparian cover and riparian change were calculated at each individual site using GIS. Once metrics were determined on the individual site level, they were calculated at both the reach and the creek level using either average, modes, or percentages.

Table D2 shows the scoring matrices used to determine both reach and stream based health. The matrix is divided by "Condition" and "Trajectory" (as explained in Section 5.2 in report body). Some of the scoring classifications (those seen with the gray shading) were based on more than one metric, while others (those with no shading) were calculated from a single metric. The scoring shown in Table D2 used descriptive words to explain stream health for each category and these were then translated into numeric scores.

Table D 1: Metrics used to characterize and score physical stream health.

| Metric | Definition on Site Scale | Calculation for Reach- and Stream-Level Categorical Health Scoring (accounting for one or multiple sites) |
|---|---|---|
| Floodplain Height Ratio | Ratio of measured floodplain height to bankfull depth. Floodplain height is measured as the vertical distance between the stream thalweg to the elevation defined by edge of the first terrace or abandoned floodplain. Floodplain height measurements ignore inset floodplains created through lateral erosion since incision and abandonment of the original floodplain. | Scoring accounts for average value measured within a given reach or stream. |
| Substrate Erodibility | Observations of substrate size class into three general classifications with increasing erodibility. 1. Bedrock presence or boulder sizes dominant. 2. Cobble or gravel sizes dominant with no bedrock present. 3. Sand or silt substrate dominant with no bedrock present. | Scoring is based on the most common class in a reach or stream. |
| SEM Dominant Process | Based on the stage of stream evolution (according to Cluer and Thorne, 2014) identified in the field, sites were characterized as being "un-incised" (Stage 0), "incising" (Stages 1-3), and "widening" (Stages 4-5). | Scoring is based on the most common class in a reach or stream. |
| Width to Depth Ratio of Inset Floodplain | Ratio of the width of the inset floodplain (as measured from banktop to banktop) to the floodplain height. Floodplain height is measured as the vertical distance between the stream thalweg to the elevation defined by edge of the first terrace or abandoned floodplain. | Scoring accounts for average value measured within a given reach or stream. |
| Eroding Bank Percentage | Percentage of visible bank at each side that was exhibiting signs of active erosion. | Scoring accounts for average value observed within a given reach or stream. |
| LWD Presence | The observed presence or absence of large woody debris (<6" DBH) within the active channel at a given site. | Scoring accounts for percentage of sites with LWD present within a given reach or stream. |

| Metric | Definition on Site Scale | Calculation for Reach- and Stream-Level Categorical Health Scoring (accounting for one or multiple sites) |
|---|---|---|
| Pool Presence | The observed presence or absence of significant pools at a given site. Significant pools were those with residual depths exceeding half of a channel's bankfull depth. | Scoring accounts for percentage of sites with pools present within a given reach or stream. |
| Floodplain Connectivity Rating | Observed rating (ratings of 1, 2, and 3) of floodplain connectivity as indicated by the presence of adjacent wetland vegetation, side channels, or high water marks on the adjacent floodplain. Low (ratings of 1) were assigned to sites none of the above features. Medium ratings (ratings of 2) were assigned to sites with at least one of the above features. High ratings (ratings of 3) were assigned to sites with at least two of the above features. | Scoring accounts for average value observed within a given reach or stream. |
| Riparian Cover (2014) | Canopy cover percentage measured from Metro (2014) canopy mapping data. Canopy percentages were measured within a 180-foot riparian buffer width (measured on each side of stream centerline), which corresponds to a site potential tree height of Douglas Fir West of the Cascades. | Scoring accounts for average value measured along a given reach or stream. |
| Invasives Presence | Observed presence or absence of common invasive plant species (e.g. Himalayan Blackberry, Knotweed, English Ivy) in the riparian zone. | Scoring accounts for percentage of sites with at least one invasive plant species present within a given reach or stream. |
| Change in Riparian Cover (2007-2014) | Canopy cover percentage changed measured from Metro mapping in 2007 and 2014. Canopy percentages were measured within a 180-foot riparian buffer width (measured on each side of stream centerline), which corresponds to a site potential tree height of Douglas Fir West of the Cascades. | Scoring accounts for average value measured along a given reach or stream. |

# Appendix E – Trends Analysis of Past Geomorphic Monitoring Data

## Appendix E- Trends Analysis of Past Geomorphic Monitoring Data

W2r used previous geomorphic measurements to evaluate potential historic trends in the channel geometry. Trends analysis targeted bankfull channel dimensions to understand potential trajectories in stream widths (i.e. widening v. narrowing) and bed changes (incision v. aggrading) at monitoring sites measured in 2009, 2011, and 2014. The channel geometry data collected in 2017 were not used in this analysis since field monitoring methods targeted an alternate definition of the bankfull channel defined by the bank tops. In contrast, in 2009, 2011, 2014, and 2021 the bankfull channel was identified according to field-based indicators of scour and vegetation patterns. The channel geometry parameters analyzed here are bankfull width, bankfull depth, and width to depth ratio (see Appendix C for definitions).

For each parameter, trends were evaluated through least-squared regression analysis at each site. Regression analyses evaluated potential trends between time (year, x-axis) and the measurement (y-axis). The strength of correlation and statistical significance were evaluated via calculation of R-squared values and p-values, respectively. R-squared values provide a relative measure of correlation, whereas p-values indicate the statistical significance relative to a chosen probability. P-values below a chosen significance value indicate a statistically significant trend. In this case, we chose to evaluate statistical significance at the 10% (90% confidence) and 5% (95% confidence) levels, which are identified by yellow and green cell shading in tables 1, 2, and 3 below.

Generally, the analysis revealed relatively few sites with statistically significant trends from 2009-2021. However, there are a few sites that show some potential historic trends that are worth noting:

- **RC-30:** This site on Rock Creek is currently showing a statistically significant (95% confidence) widening trend (increasing bankfull width).
- **RC-60:** This site on Rock Creek is exhibiting a statistically significant (95% confidence) trend of increasing bankfull depth, which implies potentially active incision.
- **FE-20:** This site on Fields is experiencing a statistically significant (90% confidence) widening trend.
- **PH-10:** This site on Phillips Creek is currently showing a statistically significant (90%) trend towards narrowing, however, it should be noted that the 2021 measurement for bankfull width is much smaller than earlier years. PH-10 is also exhibiting a statistically significant (95%) trend of decreasing bankfull depth (which may imply aggradation).
- **SA-10:** This site on Saum Creek is experiencing a statistically significant (90%) narrowing trend.
- **T2-10:** This site on the unnamed Tributary 2 is showing a statistically significant (95% confidence) trend towards widening.
- **WI-10**: This site on Wilson Creek is currently showing a statistically significant (95% confidence) trend towards widening. This site is also showing a statistically significant (90% confidence) trend toward shallowing bankfull depth.

While the above trends in bankfull width and depth emerge, there were no statistically significant trends in width to depth ratio.

The presence of relatively few significant trends reflects a combination of complex river processes and relatively few data points with which to assess trends. Future measurements of bankfull dimensions should provide more data to allow for increased confidence in the presence or absence of trends and their significance.

**Table 1: Bankfull width trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.**

| | Bankfull Width (ft) by Year | | | | | | |
|---|---|---|---|---|---|---|---|
| Site ID | 2009 | 2011 | 2014 | 2021 | Rate of Change [regression m], ft/yr | R^2 | p-value |
| AT-10 | 8.8 | 7.0 | 8.5 | 4.6 | -0.31 | 0.72 | 0.17 |
| KL-10 | 39.9 | 41.2 | 37.7 | 37.2 | -0.29 | 0.65 | 0.21 |
| KL-30 | 10.3 | 12.6 | 8.0 | 22.1 | 0.95 | 0.65 | 0.21 |
| MS-40 | 21.2 | 24.2 | 22.6 | 21.8 | -0.05 | 0.03 | 0.93 |
| MS-70 | 23.1 | 26.3 | 23.2 | 32.4 | 0.71 | 0.73 | 0.16 |
| MS-80 | 18.8 | 14.1 | 12.8 | 17.6 | 0.03 | 0.00 | 0.99 |
| PH-10 | 23.1 | 24.4 | 21.6 | 8.7 | -1.31 | 0.90 | 0.05 |
| RC-10 | 37.7 | 36.6 | 37.5 | 39.1 | 0.16 | 0.65 | 0.21 |
| RC-30 | 21.7 | 23.1 | 23.1 | 26.1 | 0.34 | 0.94 | 0.03 |
| RC-50 | 12.2 | 13.0 | 11.5 | 13.1 | 0.05 | 0.13 | 0.76 |
| RC-60 | 9.1 | 11.0 | 11.6 | 12.5 | 0.24 | 0.78 | 0.12 |
| FE-20 | 6.2 | 6.1 | 6.1 | 9.8 | 0.32 | 0.83 | 0.09 |
| SA-10 | 18.8 | 17.8 | 14.1 | 12.7 | -0.51 | 0.86 | 0.08 |
| TA-10 | 7.2 | 8.5 | 7.2 | 6.9 | -0.07 | 0.28 | 0.57 |
| T2-10 | 4.8 | 5.3 | 5.2 | 6.3 | 0.12 | 0.91 | 0.05 |
| WI-10 | 7.2 | 9.6 | 11.8 | 14.2 | 0.55 | 0.92 | 0.04 |
| SI-10 | 10.7 | 11.6 | 8.8 | 12.0 | 0.08 | 0.08 | 0.85 |
| SA-20 | 8.4 | 6.9 | 5.4 | 9.5 | 0.14 | 0.16 | 0.72 |

**Table 2: Bankfull depth trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.**

| | Bankfull Depth (ft) by Year | | | | | | |
|---|---|---|---|---|---|---|---|
| Site ID | 2009 | 2011 | 2014 | 2021 | Rate of Change [regression m], ft/yr | R^2 | p-value |
| AT-10 | 0.90 | 0.60 | 0.60 | 1.2 | 0.04 | 0.44 | 0.39 |
| KL-10 | 2.30 | 2.54 | 2.00 | 3.3 | 0.08 | 0.55 | 0.29 |
| KL-30 | 2.20 | 2.00 | 1.40 | 3.1 | 0.08 | 0.38 | 0.45 |
| MS-40 | 2.30 | 3.60 | 1.40 | 1.7 | -0.10 | 0.28 | 0.56 |
| MS-70 | 1.70 | 2.40 | 1.70 | 2.5 | 0.05 | 0.32 | 0.52 |
| MS-80 | 2.20 | 1.60 | 2.00 | 2.1 | 0.01 | 0.04 | 0.91 |
| PH-10 | 1.70 | 1.70 | 1.60 | 1.4 | -0.03 | 0.97 | 0.01 |
| RC-10 | 3.0 | 2.6 | 2.4 | 2.9 | 0.00 | 0.00 | 1.00 |
| RC-30 | 1.50 | 1.40 | 1.40 | 2.7 | 0.11 | 0.80 | 0.11 |
| RC-50 | 1.70 | 1.90 | 1.30 | 2.9 | 0.10 | 0.56 | 0.28 |
| RC-60 | 2.10 | 2.30 | 2.30 | 2.8 | 0.06 | 0.95 | 0.03 |
| FE-20 | 1.10 | 1.20 | 0.80 | 1.5 | 0.03 | 0.31 | 0.52 |
| SA-10 | 3.50 | 3.30 | 2.70 | 3.0 | -0.04 | 0.31 | 0.52 |
| TA-10 | 2.10 | 2.70 | 1.80 | 2.2 | -0.01 | 0.02 | 0.97 |
| T2-10 | 0.80 | 1.30 | 1.20 | 1.3 | 0.03 | 0.39 | 0.44 |
| WI-10 | 1.20 | 1.70 | 1.60 | 2.3 | 0.08 | 0.86 | 0.07 |
| SI-10 | 2.50 | 3.50 | 1.20 | 3.5 | 0.05 | 0.06 | 0.89 |
| SA-20 | 2.2 | 1.9 | 1.1 | 2.7 | 0.05 | 0.16 | 0.73 |

**Table 3: Bankfull width to depth ratio trend analysis from measurements in 2009, 2011, 2014, and 2021. Yellow and green shading indicate statistical significance to 90% and 95% confidence, respectively.**

| | Width to Depth Ratio (ft/ft) by Year | | | | | | |
|---|---|---|---|---|---|---|---|
| Site ID | 2009 | 2011 | 2014 | 2021 | Rate of Change [regression m] | R^2 | p-value |
| AT-10 | 9.70 | 11.30 | 14.60 | 3.6 | -0.57 | 0.43 | 0.40 |
| KL-10 | 17.10 | 18.90 | 19.10 | 11.6 | -0.53 | 0.64 | 0.22 |
| KL-30 | 5.70 | 5.40 | 6.50 | 7.0 | 0.12 | 0.81 | 0.11 |
| MS-40 | 9.10 | 6.80 | 15.70 | 13.0 | 0.44 | 0.34 | 0.50 |
| MS-70 | 15.20 | 11.30 | 16.40 | 13.0 | -0.06 | 0.02 | 0.96 |
| MS-80 | 9.10 | 8.70 | 6.50 | 8.9 | -0.01 | 0.00 | 1.00 |
| PH-10 | 14.50 | 16.40 | 20.10 | 7.1 | -0.70 | 0.45 | 0.38 |
| RC-10 | 13.00 | 18.90 | 15.50 | 14.1 | -0.10 | 0.04 | 0.93 |
| RC-30 | 14.40 | 17.80 | 17.60 | 9.8 | -0.51 | 0.51 | 0.33 |
| RC-50 | 7.20 | 7.30 | 9.20 | 4.5 | -0.23 | 0.40 | 0.43 |
| RC-60 | 4.70 | 5.50 | 5.20 | 4.5 | -0.05 | 0.26 | 0.58 |
| FE-20 | 5.60 | 5.70 | 8.30 | 7.5 | 0.17 | 0.45 | 0.38 |
| SA-10 | 5.40 | 5.50 | 5.70 | 4.3 | -0.10 | 0.68 | 0.19 |
| T4-10 | | 13.3 | 11.0 | 9.1 | NA | 0.93 | NA |
| TA-10 | 3.40 | 3.20 | 4.30 | 3.1 | -0.02 | 0.02 | 0.96 |
| T2-10 | 5.90 | 4.30 | 4.80 | 5.2 | -0.01 | 0.01 | 0.98 |
| WI-10 | 6.30 | 5.80 | 7.40 | 6.3 | 0.02 | 0.02 | 0.96 |
| SI-10 | 4.60 | 3.40 | 7.80 | 3.9 | -0.01 | 0.00 | 1.00 |
| SA-20 | 3.7 | 7.3 | 5.8 | 3.5 | -0.13 | 0.14 | 0.75 |

# Appendix F – Tabular Monitoring Data

## Site Level Physical Data

| Stream | Site | Data_level | BF_width | BF_height | BF_depth | BT_width | BT_height | Flow_width | Riffle_depth | Pool_depth | Bedrock? | LWD% | LWD_count | Run% | Riffle% | Pool% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | CA10 | 2 | 15.95 | 0.88 | 1.18 | 22.48 | 1.60 | 7.95 | 0.30 | 0.85 | 0.00 | 20.00 | 6.00 | 30.00 | 50.00 | 20.00 |
| carli | CA20 | 3 | 19.40 | 0.60 | 1.30 | 30.30 | 3.00 | 6.20 | 0.30 | 1.50 | 0.00 | | | | | |
| carli | CA30 | 3 | 15.00 | 1.30 | 1.20 | 37.00 | 2.50 | 9.50 | 0.20 | 1.40 | 0.00 | | | | | |
| fields | FE20 | 2 | 9.77 | 1.33 | 1.50 | 11.63 | 2.03 | 5.13 | 0.33 | 0.77 | 1.00 | 20.00 | 1.00 | 40.00 | 20.00 | 20.00 |
| fields | FE30 | 3 | 8.50 | 1.30 | 1.40 | 14.20 | 1.80 | 3.00 | 0.20 | 0.30 | 0.00 | | | | | |
| fields | FE35 | 3 | 4.20 | 0.90 | 1.20 | 13.00 | 1.20 | 2.70 | 0.30 | 1.30 | 0.00 | | | | | |
| trillium | TR10 | 2 | 17.90 | 2.43 | 2.65 | 23.60 | 4.20 | 7.85 | 0.53 | 0.75 | 1.00 | 5.00 | 1.00 | 40.00 | 50.00 | 10.00 |
| trillium | TR30 | 3 | 18.10 | 1.50 | 2.60 | 28.00 | 6.00 | 6.00 | 0.60 | 1.00 | 0.00 | | | | | |
| trillium | TR50 | 3 | 12.60 | 2.30 | 2.90 | 17.70 | 3.70 | 8.90 | 0.50 | 1.20 | 0.00 | | | | | |
| trillium | TRT50 | 3 | 6.80 | 2.10 | 2.90 | 9.20 | 4.60 | 3.00 | 0.50 | 0.90 | 1.00 | | | | | |
| cow | CO20 | 2 | 43.33 | 2.17 | 3.17 | 48.33 | 5.00 | 38.33 | 2.10 | 2.50 | 0.00 | 10.00 | 3.00 | 90.00 | 0.00 | 10.00 |
| cow | CO30 | 3 | 13.60 | 2.60 | 3.40 | 18.00 | 5.50 | 9.20 | 1.60 | | 0.00 | | | | | |
| cow | CO60 | 3 | 14.00 | 2.40 | 2.70 | 19.00 | 4.40 | 10.00 | 0.90 | | 0.00 | | | | | |
| sieben | SI10 | 2 | 12.60 | 2.97 | 3.23 | 18.43 | 11.03 | 8.67 | 0.67 | 1.50 | 1.00 | 5.00 | 0.00 | 40.00 | 30.00 | 30.00 |
| sieben | SI45 | 3 | 11.50 | 1.00 | 1.40 | 14.00 | 9.00 | 10.20 | 0.50 | 1.00 | 1.00 | | | | | |
| sieben | SI70 | 3 | 5.40 | 1.00 | 1.20 | 5.40 | 1.00 | 1.30 | 0.20 | | 0.00 | | | | | |
| sieben | SI90 | 3 | 5.00 | 0.80 | 1.30 | 11.00 | 1.10 | 3.50 | 0.70 | | 0.00 | | | | | |
| cedar | CE10 | 2 | 9.37 | 1.27 | 1.37 | 17.70 | 1.87 | 6.07 | 0.70 | 0.97 | 0.00 | 20.00 | 2.00 | 70.00 | 10.00 | 20.00 |
| cedar | CE20 | 3 | 3.90 | 1.90 | 1.90 | 6.50 | 2.10 | 3.00 | 1.30 | | 0.00 | | | | | |
| cedar | CE5000 | 3 | 13.10 | 1.30 | 1.90 | 18.20 | 2.10 | 6.70 | 0.30 | 0.50 | 1.00 | | | | | |
| mt scott | MS10 | 2 | 29.13 | 1.15 | 1.75 | 33.70 | 2.20 | 28.30 | 1.13 | 2.43 | 0.00 | 5.00 | 1.00 | 20.00 | 40.00 | 40.00 |
| mt scott | MS120 | 3 | 25.50 | 2.30 | 2.70 | 45.00 | 5.00 | 16.00 | 1.00 | 1.00 | 0.00 | | | | | |
| mt scott | MS130 | 3 | 29.00 | 2.30 | 3.20 | 32.00 | 2.60 | 23.80 | 0.80 | 2.20 | 1.00 | | | | | |
| mt scott | MS150 | 3 | 24.60 | 2.00 | 2.20 | 25.00 | 2.50 | 10.30 | 0.40 | 2.40 | 1.00 | | | | | |
| mt scott | MS170 | 3 | 24.60 | 1.50 | 1.70 | 27.50 | 2.30 | 18.50 | 0.40 | 0.70 | 1.00 | | | | | |
| mt scott | MS180 | 3 | 28.30 | 2.00 | 2.70 | 28.30 | 2.00 | 16.60 | 0.30 | 0.90 | 0.00 | | | | | |
| mt scott | MS190 | 3 | 22.30 | 2.30 | 2.50 | 27.60 | 3.00 | 12.10 | 0.00 | | 1.00 | | | | | |
| mt scott | MS210 | 3 | 15.00 | 2.20 | 2.60 | 21.00 | 2.80 | 9.00 | 1.40 | 1.40 | 1.00 | | | | | |
| mt scott | MS230 | 3 | 10.60 | 1.40 | 2.00 | 16.20 | 1.90 | 6.90 | 1.10 | 1.60 | 0.00 | | | | | |
| mt scott | MS240 | 3 | 14.50 | 1.30 | 2.30 | 20.00 | 2.30 | 8.30 | 0.70 | 1.10 | 0.00 | | | | | |
| mt scott | MS250 | 3 | 5.50 | 0.90 | 0.90 | 9.00 | 1.40 | 2.30 | 0.20 | | 0.00 | | | | | |
| mt scott | MS260 | 3 | 35.00 | 2.90 | 3.10 | 41.00 | 6.00 | 15.00 | 0.50 | 2.00 | 0.00 | | | | | |
| mt scott | MS280 | 3 | 17.50 | 2.60 | 3.30 | 22.00 | 4.40 | 8.80 | 0.60 | 3.20 | 1.00 | | | | | |
| mt scott | MS290 | 3 | 41.80 | 3.30 | 3.70 | 53.00 | 3.80 | 16.00 | 2.50 | 2.50 | 0.00 | | | | | |
| mt scott | MS300 | 3 | 17.30 | 1.50 | 1.50 | 21.30 | 2.00 | 12.80 | 0.50 | 2.60 | 0.00 | | | | | |
| mt scott | MS310 | 3 | 11.30 | 1.80 | 2.60 | 16.90 | 3.20 | 8.00 | 0.90 | 1.50 | 1.00 | | | | | |
| mt scott | MS320 | 3 | 18.50 | 1.80 | 2.30 | 26.00 | 2.80 | 9.70 | 0.40 | 0.70 | 0.00 | | | | | |
| mt scott | MS330 | 3 | 22.40 | 3.00 | 3.70 | 25.40 | 6.00 | 15.00 | 2.10 | | 1.00 | | | | | |
| mt scott | MS340 | 3 | 19.00 | 2.70 | 3.90 | 27.00 | 6.00 | 16.70 | 2.60 | 3.00 | 1.00 | | | | | |
| mt scott | MS350 | 3 | 25.00 | 1.50 | 2.60 | 27.00 | 3.00 | 23.00 | 1.20 | 3.70 | 0.00 | | | | | |
| mt scott | MS360 | 3 | 24.70 | 3.30 | 4.00 | 28.70 | 5.50 | 18.70 | 0.90 | 2.00 | 0.00 | | | | | |
| mt scott | MS365 | 3 | 28.50 | 1.40 | 3.30 | 31.00 | 2.50 | 28.00 | 2.30 | | 0.00 | | | | | |
| mt scott | MS380 | 3 | 25.80 | 1.40 | 2.00 | 31.70 | 2.80 | 23.00 | 0.90 | 2.50 | 0.00 | | | | | |
| mt scott | MS40 | 1 | 21.77 | 1.40 | 1.70 | 27.10 | 4.23 | 18.27 | 0.57 | 1.30 | 0.00 | 25.00 | 3.00 | 30.00 | 40.00 | 30.00 |
| mt scott | MS70 | 3 | 32.40 | 1.70 | 2.50 | 38.40 | 2.50 | 22.80 | 0.80 | 1.50 | 1.00 | | | | | |
| mt scott | MS80 | 2 | 17.58 | 1.98 | 2.05 | 33.53 | 2.63 | 11.98 | 1.03 | 1.80 | 0.00 | 5.00 | 2.00 | 50.00 | 20.00 | 30.00 |
| shipley | SH10 | 2 | 5.67 | 1.23 | 1.23 | 13.07 | 2.40 | 3.33 | 0.53 | 0.53 | 0.00 | 0.00 | 0.00 | 50.00 | 40.00 | 5.00 |
| shipley | SH20 | 3 | 6.00 | 1.40 | 1.90 | 12.60 | 4.10 | 2.70 | 0.30 | 0.00 | 0.00 | | | | | |
| shipley | SH50 | 3 | 6.50 | 2.40 | 2.60 | 11.20 | 4.60 | 3.50 | 0.50 | 0.50 | 0.00 | | | | | |
| richardson | RI10 | 2 | 25.63 | 1.87 | 2.13 | 34.77 | 2.37 | 11.97 | 0.57 | 0.70 | 0.00 | 15.00 | 1.00 | 10.00 | 10.00 | 80.00 |
| richardson | RI20 | 3 | 15.00 | 2.00 | 3.60 | 18.00 | 3.00 | 14.00 | 2.50 | 3.00 | 0.00 | | | | | |
| richardson | RI30 | 3 | 25.20 | 1.60 | 2.40 | 29.00 | 2.70 | 15.80 | 0.70 | 1.40 | 0.00 | | | | | |
| richardson | RI40 | 3 | 11.00 | 1.00 | 1.50 | 14.50 | 1.10 | 6.30 | 0.50 | | 0.00 | | | | | |
| pecan | PE10 | 3 | 11.30 | 2.60 | 2.90 | 15.60 | 3.00 | 5.90 | 1.00 | | 1.00 | | | | | |
| pecan | PE40 | 2 | 16.17 | 2.43 | 2.83 | 21.63 | 2.93 | 6.83 | 0.47 | 1.03 | 1.00 | 15.00 | 2.00 | 20.00 | 40.00 | 40.00 |
| pecan | PE60 | 3 | 11.70 | 2.10 | 2.60 | 17.00 | 2.50 | 5.20 | 0.50 | | 0.00 | | | | | |
| pecan | PE70 | 3 | 11.00 | 1.20 | 2.10 | 15.50 | 2.00 | 4.80 | 0.40 | 0.50 | 1.00 | | | | | |
| pecan | PE80 | 3 | 7.60 | 1.00 | 1.40 | 10.10 | 1.70 | 5.40 | 0.30 | 0.70 | 1.00 | | | | | |
| kellogg | KL10 | 1 | 37.17 | 2.40 | 3.27 | 43.50 | 2.73 | 36.00 | 1.97 | 2.30 | 0.00 | 10.00 | 1.00 | 80.00 | 0.00 | 20.00 |
| kellogg | KL100 | 3 | 32.50 | 2.30 | 3.00 | 37.50 | 2.90 | 21.50 | 0.80 | 1.40 | 0.00 | | | | | |
| kellogg | KL110 | 3 | 15.50 | 3.30 | 4.20 | 17.50 | 3.80 | 10.50 | 1.70 | 2.30 | 0.00 | | | | | |
| kellogg | KL150 | 3 | 10.00 | 1.90 | 2.50 | 16.00 | 3.00 | 5.70 | 1.10 | 1.10 | 0.00 | | | | | |
| kellogg | KL160 | 3 | 9.10 | 1.60 | 2.30 | 13.30 | 2.80 | 7.90 | 0.90 | 1.10 | 0.00 | | | | | |
| kellogg | KL20 | 2 | 13.67 | 1.37 | 1.63 | 18.93 | 1.60 | 10.43 | 0.90 | 1.27 | 0.00 | 0.00 | 0.00 | 20.00 | 40.00 | 40.00 |
| kellogg | KL30 | 3 | 22.10 | 2.10 | 3.05 | 24.35 | 2.85 | 20.85 | 1.55 | 2.05 | 0.00 | | | | | |
| kellogg | KL60 | 3 | 30.40 | 2.30 | 2.90 | 31.00 | 3.20 | 30.00 | 1.10 | 1.30 | 0.00 | | | | | |
| kellogg | KL80 | 3 | 24.50 | 3.10 | 3.50 | 30.50 | 4.00 | 18.00 | 1.30 | 1.90 | 0.00 | | | | | |
| kellogg | KL90 | 3 | 21.00 | 1.80 | 2.30 | 26.00 | 2.70 | 16.50 | 0.50 | 2.00 | 0.00 | | | | | |
| phillips | PH10 | 2 | 8.65 | 1.00 | 1.35 | 20.80 | 1.85 | 8.55 | 0.90 | 1.85 | | | | | | |
| phillips | PH120 | 3 | 6.00 | 1.60 | 1.10 | 9.80 | 1.00 | 6.00 | 1.10 | 1.80 | 0.00 | | | | | |
| phillips | PH20 | 2 | 9.50 | 1.10 | 1.50 | 20.00 | 1.40 | 8.80 | 1.10 | 1.10 | 0.00 | 0.00 | 0.00 | 40.00 | 50.00 | 10.00 |
| phillips | PH40 | 3 | 10.20 | 1.30 | 1.50 | 12.10 | 2.20 | 7.90 | 0.40 | 1.70 | 0.00 | | | | | |
| phillips | PH60 | 3 | 11.70 | 1.30 | 1.80 | 22.30 | 4.10 | 10.00 | 0.60 | 0.90 | 0.00 | | | | | |
| phillips | PH70 | 3 | 8.70 | 1.20 | 1.70 | 12.50 | 2.40 | 8.30 | 1.00 | 1.40 | 0.00 | | | | | |
| saum | SA10 | 2 | 12.73 | 1.93 | 3.03 | 17.17 | 3.23 | 12.73 | 1.67 | 2.47 | 1.00 | 15.00 | 1.00 | 0.00 | 10.00 | 90.00 |
| saum | SA100 | 3 | 14.00 | 2.30 | 2.40 | 20.00 | 5.30 | 10.10 | 1.10 | 1.10 | 0.00 | | | | | |
| saum | SA110 | 3 | 12.20 | 1.50 | 2.40 | 14.00 | 3.90 | 7.70 | 1.40 | 1.40 | 0.00 | | | | | |
| saum | SA20 | 1 | 9.50 | 2.30 | 2.70 | 15.50 | 3.30 | 5.40 | 0.50 | 0.90 | 0.00 | | | | | |

## Site Level Physical Data

| Stream | Site | Data_level | BF_width | BF_height | BF_depth | BT_width | BT_height | Flow_width | Riffle_depth | Pool_depth | Bedrock? | LWD% | LWD_count | Run% | Riffle% | Pool% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| saum | SA40 | 3 | 5.60 | 0.90 | 1.10 | 9.00 | 1.10 | 4.60 | 0.30 | 0.60 | 0.00 | | | | | |
| saum | SA80 | 3 | 11.60 | 2.40 | 3.40 | 16.60 | 3.90 | 10.90 | 2.00 | 2.40 | 0.00 | | | | | |
| saum | SA90 | 3 | 11.20 | 2.70 | 2.90 | 1.00 | 4.70 | 10.70 | 1.30 | | 0.00 | | | | | |
| tate | TA10 | 1 | 6.87 | 2.10 | 2.23 | 12.43 | 3.90 | 4.83 | 0.60 | 1.27 | 1.00 | 5.00 | 0.00 | 80.00 | 0.00 | 20.00 |
| tate | TA30 | 3 | 11.70 | 2.10 | 2.10 | 12.00 | 2.10 | 8.80 | 0.00 | | 0.00 | | | | | |
| tate | TA40 | 3 | 6.00 | 1.10 | 1.50 | 8.50 | 1.30 | 1.50 | 0.20 | | 0.00 | | | | | |
| tate | TA50 | 3 | 6.70 | 1.50 | 1.70 | 12.00 | 1.90 | 3.60 | 0.80 | 0.80 | 0.00 | | | | | |
| trib 2 | T210 | 2 | 6.33 | 1.10 | 1.30 | 15.87 | 1.83 | 3.90 | 0.33 | 0.70 | 0.00 | 0.00 | 0.00 | 30.00 | 30.00 | 30.00 |
| trib 2 | T220 | 3 | 6.30 | 1.20 | 1.40 | 14.00 | 4.40 | 2.50 | 0.30 | 0.80 | 0.00 | | | | | |
| trib 2 | T230 | 3 | 8.30 | 1.20 | 1.30 | 17.50 | 2.40 | 5.50 | 0.40 | 0.60 | 0.00 | | | | | |
| trib 2 | T240 | 3 | 8.60 | 0.40 | 0.50 | 20.00 | 1.00 | 4.50 | 0.20 | 0.40 | 0.00 | | | | | |
| trib 4 | T410 | 2 | 13.30 | 1.40 | 1.60 | 20.30 | 1.80 | 8.63 | 0.40 | 0.73 | 1.00 | 10.00 | 1.00 | 80.00 | 10.00 | 10.00 |
| trib 4 | T420 | 3 | 14.80 | 2.50 | 3.10 | 17.40 | 3.90 | 6.00 | 0.80 | 1.20 | 0.00 | | | | | |
| trib 4 | T440 | 3 | 4.50 | 0.80 | 1.00 | 6.50 | 1.20 | 3.50 | 0.20 | 1.80 | 0.00 | | | | | |
| athey | AT10 | 2 | 4.60 | 1.00 | 1.23 | 8.50 | 2.70 | 2.83 | 0.57 | 0.97 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.00 |
| athey | AT20 | 3 | 4.80 | 0.80 | 1.30 | 14.20 | 1.50 | 4.30 | 0.60 | 0.70 | 0.00 | | | | | |
| athey | AT40 | 3 | 3.80 | 0.70 | 1.00 | 10.00 | 1.90 | 2.70 | 0.10 | | 0.00 | | | | | |
| athey | AT60 | 3 | 6.50 | 0.70 | 1.00 | 11.10 | 1.70 | 5.30 | 0.40 | 1.00 | 1.00 | | | | | |
| wilson | WI10 | 1 | 14.18 | 1.95 | 2.25 | 26.78 | 3.90 | 6.03 | 0.45 | 2.85 | 1.00 | 25.00 | 2.00 | 40.00 | 40.00 | 20.00 |
| wilson | WI20 | 3 | 14.50 | 1.50 | 2.70 | 23.50 | 3.40 | 10.70 | 1.30 | 2.30 | 0.00 | | | | | |
| wilson | WI35 | 3 | 17.20 | 2.60 | 3.20 | 24.20 | 3.60 | 10.30 | 0.50 | 1.30 | 0.00 | | | | | |
| wilson | WI40 | 3 | 15.50 | 1.30 | 2.30 | 15.50 | 1.30 | 12.60 | 0.70 | 1.40 | 0.00 | | | | | |
| wilson | WI50 | 3 | 16.70 | 2.30 | 2.30 | 20.70 | 2.50 | 8.80 | 0.40 | 1.70 | 0.00 | | | | | |
| rock | RC10 | 1 | 39.13 | 2.43 | 2.87 | 42.33 | 4.00 | 25.50 | 0.90 | 1.60 | 1.00 | 5.00 | 1.00 | 40.00 | 50.00 | 10.00 |
| rock | RC110 | 3 | 24.00 | 2.90 | 6.00 | 28.50 | 5.00 | 22.00 | 4.40 | | 1.00 | | | | | |
| rock | RC150 | 3 | 14.90 | 1.90 | 1.90 | 21.60 | 1.60 | 12.20 | 0.70 | 1.50 | 1.00 | | | | | |
| rock | RC180 | 3 | 16.70 | 2.00 | 2.30 | 22.70 | 3.10 | 8.50 | 0.80 | 1.20 | 1.00 | | | | | |
| rock | RC30 | 2 | 26.10 | 1.80 | 2.73 | 29.83 | 2.63 | 19.77 | 1.13 | 1.47 | 1.00 | 5.00 | 0.00 | 50.00 | 10.00 | 40.00 |
| rock | RC50 | 2 | 13.13 | 2.60 | 2.90 | 21.70 | 4.27 | 8.07 | 0.63 | 1.00 | 1.00 | 25.00 | 3.00 | 70.00 | 10.00 | 20.00 |
| rock | RC60 | 3 | 12.50 | 2.00 | 2.80 | 24.50 | 6.00 | 11.00 | 0.70 | 1.60 | 1.00 | | | | | |
| rock | RC70 | 3 | 34.50 | 1.90 | 3.20 | 39.50 | 2.80 | 31.00 | 1.00 | 3.00 | 0.00 | | | | | |

| Stream | FP_connectivity | Bank_erosion | Bank_overhanging | SEM_stage | DA | Slope | FP_width | Confinement | Canopy%_2014 | Canopy%_2007 | Canopy%_change | D16 | D50 | D84 | sort_coeff | embedded% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 3.00 | 5.00 | 15.00 | 0.00 | 0.04 | 2.25 | 103.62 | 4.71 | 68.37 | 48.41 | 19.96 | 14.72 | 37.24 | 77.77 | 33.84 | 7.00 |
| carli | 3.00 | 5.00 | 10.00 | 0.00 | 0.05 | 2.30 | 31.50 | 1.62 | 73.06 | 49.17 | 23.89 | | | | | |
| carli | 3.00 | 15.00 | 50.00 | 4.00 | 0.02 | 1.99 | 46.70 | 3.11 | 53.60 | 32.92 | 20.68 | | | | | |
| fields | 2.00 | 40.00 | 40.00 | 2.00 | 0.30 | 6.09 | 98.69 | 10.73 | 63.39 | 0.00 | 63.39 | 12.41 | 33.11 | 86.29 | 32.73 | 17.48 |
| fields | 1.00 | 15.00 | 30.00 | 3.00 | 0.05 | 9.58 | 27.39 | 3.22 | 96.29 | 0.00 | 96.29 | | | | | |
| fields | 2.00 | 20.00 | 30.00 | 3.00 | 0.32 | 3.21 | 76.44 | 18.20 | 36.27 | 44.91 | -8.63 | | | | | |
| trillium | 2.00 | 25.00 | 50.00 | 2.00 | 0.46 | 4.23 | 46.44 | 2.64 | 74.29 | 58.56 | 15.72 | 16.50 | 35.73 | 78.53 | 35.99 | 10.48 |
| trillium | 1.00 | 10.00 | 0.00 | 3.00 | 0.68 | 2.23 | 59.61 | 3.29 | 27.55 | 5.17 | 22.38 | | | | | |
| trillium | 1.00 | 5.00 | 10.00 | 2.00 | 0.57 | 3.65 | 21.06 | 1.67 | 82.59 | 75.28 | 7.32 | | | | | |
| trillium | 1.00 | 10.00 | 30.00 | 3.00 | 0.57 | 3.96 | 37.90 | 5.57 | 81.95 | 74.98 | 6.98 | | | | | |
| cow | 3.00 | 0.00 | 5.00 | 0.00 | 1.04 | 3.87 | 59.33 | 1.38 | 47.50 | 46.39 | 1.11 | | | | | |
| cow | 1.00 | 40.00 | 60.00 | 3.00 | 0.92 | 0.57 | 35.87 | 2.64 | 5.46 | 21.73 | -16.27 | | | | | |
| cow | 1.00 | 40.00 | 5.00 | 4.00 | 0.53 | 0.98 | 83.94 | 6.00 | 12.59 | 2.98 | 9.62 | | | | | |
| sieben | 1.00 | 10.00 | 70.00 | 3.00 | 1.92 | 1.38 | 58.66 | 4.91 | 20.59 | 11.15 | 9.44 | 9.60 | 24.23 | 45.00 | 20.78 | 5.00 |
| sieben | 1.00 | 40.00 | 70.00 | 3.00 | 0.73 | 4.02 | 37.09 | 3.23 | 48.35 | 21.00 | 27.35 | | | | | |
| sieben | 1.00 | 0.00 | 10.00 | 2.00 | 0.18 | 4.70 | 96.78 | 17.92 | 18.57 | 2.69 | 15.88 | | | | | |
| sieben | 3.00 | 0.00 | 0.00 | 0.00 | 0.01 | 1.78 | 1636.47 | 327.29 | 42.55 | 12.23 | 30.32 | | | | | |
| cedar | 2.00 | 5.00 | 10.00 | 2.00 | 0.57 | 1.34 | 62.50 | 7.06 | 61.53 | 30.80 | 30.74 | | 5.60 | 11.71 | | 3.92 |
| cedar | 1.00 | 0.00 | 70.00 | 3.00 | 0.35 | 1.63 | 61.76 | 15.84 | 12.45 | 4.86 | 7.59 | | | | | |
| cedar | 2.00 | 30.00 | 50.00 | 2.00 | 0.89 | 1.61 | 65.35 | 4.99 | 69.11 | 58.06 | 11.05 | | | | | |
| mt scott | 3.00 | 5.00 | 30.00 | 0.00 | 5.35 | 1.25 | 175.07 | 5.64 | 65.00 | 44.06 | 20.94 | | | | | |
| mt scott | 1.00 | 10.00 | 10.00 | 3.00 | 3.76 | 1.70 | 87.61 | 3.44 | 84.70 | 67.00 | 17.70 | | | | | |
| mt scott | 1.00 | 5.00 | 15.00 | 2.00 | 3.66 | 1.31 | 60.92 | 2.10 | 97.49 | 82.81 | 14.68 | | | | | |
| mt scott | 2.00 | 5.00 | 10.00 | 4.00 | 2.64 | 1.99 | 97.07 | 3.95 | 74.17 | 58.44 | 15.73 | | | | | |
| mt scott | 1.00 | 0.00 | 5.00 | 2.00 | 2.07 | 2.78 | 101.00 | 4.11 | 84.19 | 63.60 | 20.59 | | | | | |
| mt scott | 2.00 | 20.00 | 15.00 | 4.00 | 1.85 | 2.78 | 75.83 | 2.68 | 87.54 | 70.44 | 17.10 | | | | | |
| mt scott | 1.00 | 15.00 | 20.00 | 3.00 | 1.83 | 1.84 | 74.36 | 3.33 | 56.44 | 19.04 | 37.40 | | | | | |
| mt scott | 1.00 | 30.00 | 20.00 | 3.00 | 1.52 | 1.51 | 100.84 | 6.72 | 88.40 | 59.73 | 28.67 | | | | | |
| mt scott | 1.00 | 5.00 | 40.00 | 2.00 | 1.01 | 1.29 | 68.62 | 6.47 | 52.64 | 21.68 | 30.96 | | | | | |
| mt scott | 1.00 | 15.00 | 5.00 | 3.00 | 0.64 | 1.42 | 116.43 | 8.03 | 71.05 | 42.97 | 28.08 | | | | | |
| mt scott | 3.00 | 0.00 | 0.00 | 1.00 | 0.09 | 0.65 | 910.07 | 165.47 | 33.35 | 8.46 | 24.89 | | | | | |
| mt scott | 2.00 | 15.00 | 15.00 | 2.00 | 3.96 | 1.98 | 91.72 | 2.62 | 69.03 | 51.83 | 17.21 | | | | | |
| mt scott | 1.00 | 5.00 | 50.00 | 4.00 | 5.33 | 1.03 | 227.69 | 13.01 | 83.48 | 54.08 | 29.39 | | | | | |
| mt scott | 2.00 | 5.00 | 0.00 | 5.00 | 5.44 | 0.67 | 242.80 | 5.81 | 55.06 | 19.69 | 35.37 | | | | | |
| mt scott | 2.00 | 50.00 | 0.00 | 2.00 | 7.28 | 1.09 | 246.13 | 14.23 | 48.71 | 16.21 | 32.50 | | | | | |
| mt scott | 1.00 | 40.00 | 15.00 | 3.00 | 7.34 | 1.03 | 312.48 | 27.65 | 56.12 | 26.28 | 29.85 | | | | | |
| mt scott | 1.00 | 20.00 | 5.00 | 4.00 | 7.35 | 1.25 | 448.19 | 24.23 | 83.10 | 34.16 | 48.94 | | | | | |
| mt scott | 1.00 | 30.00 | 20.00 | 3.00 | 7.45 | 2.35 | 364.36 | 16.27 | 95.49 | 77.01 | 18.47 | | | | | |
| mt scott | 1.00 | 10.00 | 40.00 | 3.00 | 9.39 | 0.58 | 216.10 | 11.37 | 43.28 | 36.26 | 7.02 | | | | | |
| mt scott | 1.00 | 10.00 | 70.00 | 4.00 | 9.22 | 0.59 | 181.43 | 7.26 | 36.94 | 17.46 | 19.48 | | | | | |
| mt scott | 1.00 | 5.00 | 50.00 | 3.00 | 9.27 | 0.43 | 247.12 | 10.00 | 59.84 | 52.13 | 7.71 | | | | | |
| mt scott | 2.00 | 5.00 | 50.00 | 2.00 | 7.40 | 1.75 | 741.64 | 26.02 | 90.61 | 38.43 | 52.18 | | | | | |
| mt scott | 1.00 | 5.00 | 60.00 | 3.00 | 9.39 | 0.47 | 130.93 | 5.07 | 54.25 | 45.64 | 8.61 | | | | | |
| mt scott | 1.00 | 25.00 | 80.00 | 4.00 | 7.90 | 1.43 | 583.74 | 23.93 | 80.59 | 39.07 | 41.52 | | | | | |
| mt scott | 1.00 | 10.00 | 30.00 | 2.00 | 3.60 | 0.91 | 99.06 | 3.06 | 90.67 | 78.85 | 11.82 | | | | | |
| mt scott | 1.00 | 5.00 | 5.00 | 3.00 | 2.32 | 3.04 | 71.27 | 4.41 | 74.16 | 28.58 | 45.58 | 13.17 | 87.25 | 165.06 | 46.62 | 18.18 |
| shipley | 2.00 | 20.00 | 50.00 | 3.00 | 0.14 | 2.92 | 47.16 | 10.25 | 82.83 | 91.17 | -8.34 | 2.10 | 6.38 | 16.24 | 5.84 | 8.74 |
| shipley | 1.00 | 10.00 | 80.00 | 3.00 | 0.04 | 8.45 | 1119.64 | 186.61 | 51.06 | 41.10 | 9.95 | | | | | |
| shipley | | 20.00 | 50.00 | 3.00 | 0.17 | 3.08 | 52.23 | 8.03 | 57.69 | 71.42 | -13.74 | | | | | |
| richardson | 3.00 | 30.00 | 10.00 | 2.00 | 3.58 | 2.92 | 37.73 | 1.63 | 94.27 | 89.09 | 5.18 | | | | | |
| richardson | 3.00 | 20.00 | 20.00 | 1.00 | 3.97 | 0.94 | 161.41 | 10.76 | 91.83 | 76.98 | 14.85 | | | | | |
| richardson | 3.00 | 40.00 | 5.00 | 0.00 | 3.17 | 3.55 | 52.44 | 2.08 | 88.28 | 79.32 | 8.96 | | | | | |
| richardson | 2.00 | 0.00 | 30.00 | 2.00 | 0.64 | 3.76 | 65.76 | 5.98 | 80.56 | 77.12 | 3.45 | | | | | |
| pecan | 1.00 | 40.00 | 20.00 | 4.00 | 0.62 | 2.22 | 78.98 | 6.99 | 80.63 | 90.83 | -10.20 | | | | | |
| pecan | 3.00 | 10.00 | 10.00 | 0.00 | 0.45 | 6.07 | 40.42 | 3.37 | 99.24 | 100.03 | -0.79 | 12.68 | 51.20 | 117.73 | 38.64 | 13.73 |
| pecan | 2.00 | 10.00 | 25.00 | 2.00 | 0.47 | 4.08 | 51.67 | 4.42 | 81.15 | 86.45 | -5.30 | | | | | |
| pecan | 3.00 | 0.00 | 5.00 | 0.00 | 0.23 | 10.57 | 43.88 | 3.99 | 99.46 | 100.04 | -0.58 | | | | | |
| pecan | 1.00 | 5.00 | 60.00 | 2.00 | 0.15 | 5.21 | 24.27 | 3.19 | 60.18 | 60.87 | -0.69 | | | | | |
| kellogg | 2.00 | 15.00 | 15.00 | 2.00 | 14.38 | 0.87 | 121.75 | 3.53 | 54.64 | 51.02 | 3.61 | | | | | |
| kellogg | 1.00 | 10.00 | 0.00 | 4.00 | 14.54 | 0.70 | 137.59 | 4.23 | 72.30 | 81.05 | -8.75 | | | | | |
| kellogg | 1.00 | 0.00 | 0.00 | 2.00 | 2.26 | 1.01 | 31.79 | 2.05 | 53.38 | 57.85 | -4.46 | | | | | |
| kellogg | 1.00 | 25.00 | 0.00 | 2.00 | 1.20 | 0.86 | 82.31 | 8.23 | 39.90 | 48.37 | -8.48 | | | | | |
| kellogg | 1.00 | 15.00 | 0.00 | 3.00 | 0.70 | 0.70 | 87.38 | 9.60 | 38.54 | 35.25 | 3.29 | | | | | |
| kellogg | 1.00 | 5.00 | 25.00 | 2.00 | 2.28 | 0.89 | 72.77 | 5.81 | 63.01 | 63.25 | -0.24 | 12.95 | 45.61 | 117.27 | 38.97 | 13.59 |
| kellogg | 1.00 | 15.00 | 27.50 | 6.00 | 7.80 | 0.69 | 107.64 | 6.04 | 39.92 | 34.92 | 5.00 | | | | | |
| kellogg | 1.00 | 0.00 | 0.00 | 2.00 | 13.81 | 0.93 | 128.38 | 4.22 | 54.39 | 66.39 | -12.01 | | | | | |
| kellogg | 1.00 | 5.00 | 5.00 | 2.00 | 13.73 | 0.59 | 62.95 | 2.57 | 80.34 | 96.41 | -16.07 | | | | | |
| kellogg | 2.00 | 5.00 | 20.00 | 2.00 | 2.46 | 0.70 | 115.54 | 5.50 | 81.75 | 86.52 | -4.76 | | | | | |
| phillips | | | | | 0.88 | 1.42 | 38.55 | 12.24 | 25.82 | 6.82 | 19.00 | 11.90 | 25.19 | 59.97 | 26.72 | 8.82 |
| phillips | 1.00 | 15.00 | 30.00 | 3.00 | 0.01 | 0.58 | 2801.61 | 466.94 | 37.16 | 12.63 | 24.53 | | | | | |
| phillips | 1.00 | 0.00 | 0.00 | 3.00 | 0.88 | 1.76 | 39.54 | 3.79 | 26.78 | 5.99 | 20.79 | | | | | |
| phillips | 1.00 | 10.00 | 30.00 | 2.00 | 0.65 | 1.20 | 51.10 | 5.01 | 39.24 | 24.27 | 14.97 | | | | | |
| phillips | 1.00 | 10.00 | 70.00 | 3.00 | 0.42 | 1.04 | 33.00 | 2.82 | 36.72 | 16.50 | 20.22 | | | | | |
| phillips | 1.00 | 15.00 | 70.00 | 3.00 | 0.25 | 0.85 | 40.24 | 4.63 | 29.33 | 13.29 | 16.04 | | | | | |
| saum | 1.00 | 10.00 | 80.00 | 3.00 | 3.12 | 1.47 | 183.82 | 14.12 | 81.80 | 85.42 | -3.62 | | | | | |
| saum | 1.00 | 40.00 | 20.00 | 4.00 | 3.17 | 1.62 | 94.10 | 6.72 | 76.39 | 86.10 | -9.71 | | | | | |
| saum | 1.00 | 40.00 | 30.00 | 3.00 | 1.80 | 0.76 | 106.92 | 8.76 | 31.53 | 14.21 | 17.32 | | | | | |
| saum | 1.00 | 5.00 | 20.00 | 2.00 | 0.63 | 0.88 | 2374.28 | 249.92 | 87.30 | 90.63 | -3.34 | | | | | |

| Stream | FP_connectivity | Bank_erosion | Bank_overhanging | SEM_stage | DA | Slope | FP_width | Confinement | Canopy%_2014 | Canopy%_2007 | Canopy%_change | D16 | D50 | D84 | sort_coeff | embedded% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| saum | 2.00 | 10.00 | 0.00 | 2.00 | 0.10 | 2.96 | 6077.24 | 1085.22 | 19.58 | 0.00 | 19.58 | | | | | |
| saum | 1.00 | 30.00 | 50.00 | 4.00 | 1.98 | 1.01 | 33.54 | 2.89 | 61.00 | 66.57 | -5.57 | | | | | |
| saum | 1.00 | 15.00 | 70.00 | 2.00 | 2.97 | 1.74 | 138.24 | 12.34 | 60.97 | 86.22 | -25.25 | | | | | |
| tate | 1.00 | 80.00 | 80.00 | 4.00 | 0.61 | 1.41 | 119.43 | 17.39 | 69.01 | 72.17 | -3.16 | | | | | |
| tate | 2.00 | 5.00 | 15.00 | 2.00 | 0.29 | 15.18 | 74.32 | 6.35 | 98.45 | 100.04 | -1.59 | | | | | |
| tate | 1.00 | 5.00 | 0.00 | 3.00 | 0.09 | 9.33 | 928.24 | 154.71 | 58.94 | 54.80 | 4.14 | | | | | |
| tate | 3.00 | 5.00 | 15.00 | 3.00 | 0.35 | 5.51 | 24.53 | 3.66 | 99.49 | 99.86 | -0.37 | | | | | |
| trib 2 | 1.00 | 10.00 | 10.00 | 2.00 | 0.48 | 3.03 | 29.96 | 5.80 | 61.20 | 41.55 | 19.65 | 7.89 | 14.70 | 25.39 | 14.15 | 3.85 |
| trib 2 | 1.00 | 15.00 | 60.00 | 4.00 | 0.37 | 3.43 | 30.55 | 4.85 | 49.90 | 60.12 | -10.21 | | | | | |
| trib 2 | 2.00 | 25.00 | 5.00 | 2.00 | 0.34 | 7.56 | 33.90 | 4.08 | 64.79 | 0.00 | 64.79 | | | | | |
| trib 2 | 1.00 | 10.00 | 10.00 | 3.00 | 0.20 | 5.48 | 47.38 | 5.51 | 93.48 | 0.00 | 93.48 | | | | | |
| trib 4 | 3.00 | 25.00 | 30.00 | 3.00 | 0.57 | 4.45 | 54.14 | 4.68 | 81.49 | 87.64 | -6.15 | 3.44 | 15.13 | 35.69 | 11.07 | 3.96 |
| trib 4 | 1.00 | 40.00 | 40.00 | 4.00 | 0.00 | 12.82 | 293.40 | 19.82 | 75.30 | 83.35 | -8.05 | | | | | |
| trib 4 | 1.00 | 0.00 | 20.00 | 2.00 | 0.16 | 6.26 | 72.59 | 16.13 | 73.51 | 68.79 | 4.72 | | | | | |
| athey | 2.00 | 90.00 | 90.00 | 4.00 | 0.61 | 0.40 | 80.55 | 23.52 | 41.82 | 44.05 | -2.23 | | 2.88 | 7.41 | | 0.00 |
| athey | 1.00 | 5.00 | 10.00 | 2.00 | 0.41 | 2.17 | 15.53 | 3.23 | 61.77 | 52.80 | 8.97 | | | | | |
| athey | 1.00 | 15.00 | 0.00 | 3.00 | 0.06 | 4.80 | 90.52 | 23.82 | 19.23 | 39.10 | -19.87 | | | | | |
| athey | 1.00 | 20.00 | 10.00 | 2.00 | 0.55 | 2.69 | 52.42 | 8.06 | 84.45 | 81.57 | 2.89 | | | | | |
| wilson | 3.00 | 5.00 | 5.00 | 0.00 | 1.55 | 2.49 | 60.36 | 4.02 | 86.44 | 97.10 | -10.66 | 17.28 | 54.22 | 105.63 | 42.72 | 16.00 |
| wilson | 3.00 | 0.00 | 60.00 | 2.00 | 2.13 | 0.98 | 41.63 | 2.87 | 77.99 | 87.75 | -9.76 | | | | | |
| wilson | 2.00 | 15.00 | 5.00 | 3.00 | 1.32 | 4.04 | 77.67 | 4.52 | 93.31 | 85.90 | 7.41 | | | | | |
| wilson | 3.00 | 0.00 | 0.00 | 0.00 | 1.28 | 3.99 | 27.47 | 1.77 | 91.51 | 90.73 | 0.78 | | | | | |
| wilson | 3.00 | 20.00 | 20.00 | 0.00 | 1.73 | 1.93 | 89.20 | 5.34 | 90.63 | 100.03 | -9.41 | | | | | |
| rock | 3.00 | 5.00 | 5.00 | 2.00 | 8.45 | 1.82 | 61.69 | 1.60 | 88.69 | 76.97 | 11.72 | 22.84 | 56.31 | 152.60 | 59.03 | 8.70 |
| rock | 1.00 | 10.00 | 50.00 | 3.00 | 5.39 | 0.77 | 90.66 | 3.78 | 13.95 | 16.80 | -2.85 | | | | | |
| rock | 1.00 | 15.00 | 10.00 | 3.00 | 2.51 | 1.73 | 74.09 | 4.97 | 59.98 | 50.78 | 9.20 | | | | | |
| rock | 1.00 | 30.00 | 30.00 | 3.00 | 1.04 | 1.87 | 116.81 | 6.99 | 61.90 | 48.75 | 13.14 | | | | | |
| rock | 1.00 | 5.00 | 5.00 | 2.00 | 7.02 | 1.63 | 89.55 | 3.20 | 70.75 | 60.25 | 10.51 | 13.98 | 57.58 | 123.94 | 41.63 | 20.69 |
| rock | 1.00 | 15.00 | 20.00 | 4.00 | 2.42 | 1.75 | 93.59 | 6.30 | 44.75 | 29.34 | 15.41 | 7.73 | 21.90 | 98.46 | 27.60 | 7.69 |
| rock | 1.00 | 30.00 | 25.00 | 3.00 | 0.76 | 1.73 | 6138.78 | 491.10 | 34.04 | 25.05 | 9.00 | | | | | |
| rock | 3.00 | 30.00 | 40.00 | 0.00 | 8.29 | 1.31 | 61.53 | 1.78 | 95.54 | 66.44 | 29.10 | | | | | |

| Stream | bank_height_ratio | bank_height_diff | FP_height | FP_height_BF_depth_ratio | Residual_depth | BF_W/D_ratio | Channel spanning wood within active channel | Large wood within active channel (>~6" DBH) | Small wood within active channel (~<6" DBH) | Substrate | SEM_classified | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 1.83 | 0.73 | 1.90 | 1.63 | 0.55 | 16.03 | | | | c_gravel | Connected | -122.5462185 | 45.40054813 |
| carli | 5.00 | 2.40 | 3.70 | 2.85 | 1.20 | 14.92 | 1.00 | 1.00 | 1.00 | m_gravel | Connected | -122.5519785 | 45.40009996 |
| carli | 1.92 | 1.20 | 2.40 | 2.00 | 1.20 | 12.50 | 0.00 | 1.00 | 0.00 | c_gravel | Widening | -122.5438002 | 45.40058594 |
| fields | 1.61 | 0.70 | 2.20 | 1.53 | 0.43 | 7.51 | | | | m_gravel | Incised | -122.683315 | 45.35118851 |
| fields | 1.38 | 0.50 | 1.90 | 1.36 | 0.10 | 6.07 | 1.00 | 1.00 | 1.00 | f_gravel | Incised | -122.6925914 | 45.34861473 |
| fields | 1.33 | 0.30 | 1.50 | 1.25 | 1.00 | 3.50 | 0.00 | 0.00 | 0.00 | f_gravel | Incised | -122.6810836 | 45.35092879 |
| trillium | 1.65 | 1.78 | 4.43 | 1.62 | 0.23 | 7.23 | | | | c_gravel | Incised | -122.5084973 | 45.40845024 |
| trillium | 4.00 | 4.50 | 7.10 | 2.73 | 0.40 | 6.96 | 1.00 | 1.00 | 1.00 | silt/clay | Incised | -122.5006788 | 45.40626083 |
| trillium | 1.61 | 1.40 | 4.30 | 1.48 | 0.70 | 4.34 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.4931734 | 45.40666695 |
| trillium | 2.19 | 2.50 | 5.40 | 1.86 | 0.40 | 2.34 | 1.00 | 1.00 | 0.00 | | Incised | -122.492797 | 45.40695717 |
| cow | 2.30 | 2.83 | 6.00 | 1.89 | 0.40 | 14.22 | | | | silt/clay | Connected | -122.5707779 | 45.39490415 |
| cow | 2.12 | 2.90 | 6.30 | 1.85 | | 4.00 | 0.00 | 0.00 | 0.00 | f_gravel | Incised | -122.5675508 | 45.40058812 |
| cow | 1.83 | 2.00 | 4.70 | 1.74 | | 5.19 | 0.00 | 0.00 | 1.00 | silt/clay | Widening | -122.5616924 | 45.40646693 |
| sieben | 3.77 | 8.07 | 11.30 | 3.53 | 0.83 | 3.94 | | | | c_gravel | Incised | -122.5220236 | 45.40967795 |
| sieben | 9.00 | 8.00 | 9.40 | 6.71 | 0.50 | 8.21 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.5193766 | 45.42247445 |
| sieben | 1.00 | 0.00 | 1.20 | 1.00 | | 4.50 | 0.00 | 0.00 | 0.00 | f_cobble | Incised | -122.5250813 | 45.42972737 |
| sieben | 1.38 | 0.30 | 1.60 | 1.23 | | 3.85 | 1.00 | 1.00 | 1.00 | silt/clay | Connected | -122.5285832 | 45.43679874 |
| cedar | 1.54 | 0.60 | 1.97 | 1.53 | 0.27 | 7.26 | | | | f_gravel | Incised | -122.5429575 | 45.42536618 |
| cedar | 1.11 | 0.20 | 2.10 | 1.11 | | 2.05 | 0.00 | 0.00 | 0.00 | silt/clay | Incised | -122.5413963 | 45.42189772 |
| cedar | 1.62 | 0.80 | 2.70 | 1.42 | 0.20 | 6.89 | 1.00 | 1.00 | 1.00 | f_gravel | Incised | -122.5440843 | 45.42891478 |
| mt scott | 2.03 | 1.05 | 2.80 | 1.61 | 1.30 | 17.83 | | | | f_cobble | Connected | -122.6122323 | 45.42671119 |
| mt scott | 2.17 | 2.70 | 5.40 | 2.00 | 0.00 | 9.44 | 1.00 | 1.00 | 0.00 | f_cobble | Incised | -122.5518237 | 45.4320591 |
| mt scott | 1.13 | 0.30 | 3.50 | 1.09 | 1.40 | 9.06 | 1.00 | 1.00 | 0.00 | c_gravel | Incised | -122.5491792 | 45.43125439 |
| mt scott | 1.25 | 0.50 | 2.70 | 1.23 | 2.00 | 11.18 | 1.00 | 1.00 | 0.00 | c_gravel | Widening | -122.5426145 | 45.43194653 |
| mt scott | 1.53 | 0.80 | 2.50 | 1.47 | 0.30 | 14.47 | 0.00 | 1.00 | 0.00 | c_gravel | Incised | -122.5355521 | 45.43907672 |
| mt scott | 1.00 | 0.00 | 2.70 | 1.00 | 0.60 | 10.48 | 0.00 | 1.00 | 1.00 | m_gravel | Widening | -122.5335719 | 45.44109172 |
| mt scott | 1.30 | 0.70 | 3.20 | 1.28 | | 8.92 | 1.00 | 1.00 | 0.00 | | Incised | -122.5324832 | 45.44262057 |
| mt scott | 1.27 | 0.60 | 3.20 | 1.23 | 0.00 | 5.77 | 0.00 | 0.00 | 0.00 | silt/clay | Incised | -122.5271745 | 45.44383434 |
| mt scott | 1.36 | 0.50 | 2.50 | 1.25 | 0.50 | 5.30 | 1.00 | 1.00 | 1.00 | m_gravel | Incised | -122.5258267 | 45.44664199 |
| mt scott | 1.77 | 1.00 | 3.30 | 1.43 | 0.40 | 6.30 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.5212176 | 45.45006722 |
| mt scott | 1.56 | 0.50 | 1.40 | 1.56 | | 6.11 | 0.00 | 1.00 | 1.00 | f_gravel | Incised | -122.5146128 | 45.45272864 |
| mt scott | 2.07 | 3.10 | 6.20 | 2.00 | 1.50 | 11.29 | 1.00 | 1.00 | 0.00 | m_gravel | Incised | -122.5567796 | 45.43049554 |
| mt scott | 1.69 | 1.80 | 5.10 | 1.55 | 2.60 | 5.30 | 0.00 | 1.00 | 0.00 | c_gravel | Widening | -122.5696121 | 45.42745987 |
| mt scott | 1.15 | 0.50 | 4.20 | 1.14 | 0.00 | 11.30 | 0.00 | 1.00 | 0.00 | f_gravel | Widening | -122.5732422 | 45.42703545 |
| mt scott | 1.33 | 0.50 | 2.00 | 1.33 | 2.10 | 11.53 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.5771566 | 45.42652416 |
| mt scott | 1.78 | 1.40 | 4.00 | 1.54 | 0.60 | 4.35 | 0.00 | 1.00 | 0.00 | c_gravel | Incised | -122.579631 | 45.42663598 |
| mt scott | 1.56 | 1.00 | 3.30 | 1.43 | 0.30 | 8.04 | 1.00 | 1.00 | 1.00 | m_gravel | Widening | -122.5793019 | 45.42809072 |
| mt scott | 2.00 | 3.00 | 6.70 | 1.81 | | 6.05 | 1.00 | 1.00 | 1.00 | silt/clay | Incised | -122.5880576 | 45.429382 |
| mt scott | 2.22 | 3.30 | 7.20 | 1.85 | 0.40 | 4.87 | 1.00 | 1.00 | 0.00 | silt/clay | Incised | -122.5952334 | 45.43118317 |
| mt scott | 2.00 | 1.50 | 4.10 | 1.58 | 2.50 | 9.62 | 0.00 | 0.00 | 0.00 | m_gravel | Widening | -122.6001395 | 45.42989184 |
| mt scott | 1.67 | 2.20 | 6.20 | 1.55 | 1.10 | 6.18 | 0.00 | 1.00 | 0.00 | c_cobble | Incised | -122.6009853 | 45.42926927 |
| mt scott | 1.79 | 1.10 | 4.40 | 1.33 | | 8.64 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.6060465 | 45.42797195 |
| mt scott | 2.00 | 1.40 | 3.40 | 1.70 | 1.60 | 12.90 | 1.00 | 1.00 | 1.00 | f_cobble | Incised | -122.6088931 | 45.42811874 |
| mt scott | 3.02 | 2.83 | 4.53 | 2.75 | 0.73 | 13.01 | | | | c_gravel | Widening | -122.5807436 | 45.4285668 |
| mt scott | 1.47 | 0.80 | 3.30 | 1.32 | 0.70 | 12.96 | 0.00 | 1.00 | 0.00 | m_gravel | Incised | -122.5455313 | 45.43022515 |
| mt scott | 1.32 | 0.65 | 2.70 | 1.32 | 0.78 | 8.92 | | | | f_cobble | Incised | -122.5384565 | 45.43617944 |
| shipley | 1.90 | 1.17 | 2.40 | 1.94 | 0.00 | 4.54 | | | | f_gravel | Incised | -122.6954418 | 45.38094168 |
| shipley | 2.93 | 2.70 | 4.60 | 2.42 | -0.30 | 3.16 | 0.00 | 0.00 | 0.00 | silt/clay | Incised | -122.6921367 | 45.38313456 |
| shipley | 1.92 | 2.20 | 4.80 | 1.85 | 0.00 | 2.50 | 0.00 | 1.00 | 1.00 | c_cobble | Incised | -122.6971291 | 45.37978496 |
| richardson | 1.28 | 0.50 | 2.63 | 1.24 | 0.13 | 12.17 | | | | c_cobblec_gravelf_cobbl | Incised | -122.4718267 | 45.39878117 |
| richardson | 1.50 | 1.00 | 4.60 | 1.28 | 0.50 | 4.17 | 1.00 | 1.00 | 1.00 | silt/clay | Incised | -122.4742247 | 45.39667118 |
| richardson | 1.69 | 1.10 | 3.50 | 1.46 | 0.70 | 10.50 | 1.00 | 1.00 | 1.00 | m_gravel | Connected | -122.4689061 | 45.40059929 |
| richardson | 1.10 | 0.10 | 1.60 | 1.07 | | 7.33 | 0.00 | 0.00 | 1.00 | c_gravel | Incised | -122.4478824 | 45.4101974 |
| pecan | 1.15 | 0.40 | 3.30 | 1.14 | | 3.90 | 0.00 | 0.00 | 0.00 | f_gravel | Widening | -122.6995968 | 45.38210685 |
| pecan | 1.21 | 0.50 | 3.33 | 1.18 | 0.57 | 5.83 | | | | m_gravel | Connected | -122.6962106 | 45.38512473 |
| pecan | 1.19 | 0.40 | 3.00 | 1.15 | | 4.50 | 0.00 | 0.00 | 0.00 | m_gravel | Incised | -122.6967493 | 45.38397821 |
| pecan | 1.67 | 0.80 | 2.90 | 1.38 | 0.10 | 5.24 | 1.00 | 1.00 | 1.00 | boudler | Connected | -122.6957662 | 45.38732858 |
| pecan | 1.70 | 0.70 | 2.10 | 1.50 | 0.40 | 5.43 | 1.00 | 1.00 | 1.00 | f_cobble | Incised | -122.6931548 | 45.38858143 |
| kellogg | 1.16 | 0.33 | 3.60 | 1.12 | 0.33 | 11.64 | | | | c_cobble | Incised | -122.6274924 | 45.43135621 |
| kellogg | 1.26 | 0.60 | 3.60 | 1.20 | 0.60 | 10.83 | 0.00 | 0.00 | 0.00 | c_gravel | Widening | -122.6308198 | 45.43326351 |
| kellogg | 1.15 | 0.50 | 4.70 | 1.12 | 0.60 | 3.69 | 0.00 | 0.00 | 1.00 | silt/clay | Incised | -122.6014246 | 45.42181029 |
| kellogg | 1.58 | 1.10 | 3.60 | 1.44 | 0.00 | 4.00 | 0.00 | 0.00 | 1.00 | silt/clay | Incised | -122.5923582 | 45.40739614 |
| kellogg | 1.75 | 1.20 | 3.50 | 1.52 | 0.20 | 3.96 | 0.00 | 1.00 | 1.00 | silt/clay | Incised | -122.5868243 | 45.40543743 |
| kellogg | 1.22 | 0.23 | 1.87 | 1.16 | 0.37 | 8.42 | | | | c_gravel | Incised | -122.6037337 | 45.42282911 |
| kellogg | 1.34 | 0.75 | 3.80 | 1.24 | 0.50 | 6.96 | 0.00 | 0.00 | 1.00 | c_gravelsilt/clay | IncisedWidening | -122.6256468 | 45.43040509 |
| kellogg | 1.39 | 0.90 | 3.80 | 1.31 | 0.20 | 10.48 | 0.00 | 0.00 | 0.00 | f_cobble | Incised | -122.6178927 | 45.42584701 |
| kellogg | 1.29 | 0.90 | 4.40 | 1.26 | 0.60 | 7.00 | 1.00 | 1.00 | 0.00 | c_gravel | Incised | -122.614475 | 45.42390391 |
| kellogg | 1.50 | 0.90 | 3.20 | 1.39 | 1.50 | 9.13 | 1.00 | 1.00 | 0.00 | m_gravel | Incised | -122.6101518 | 45.4236882 |
| phillips | 1.85 | 0.85 | 2.20 | 1.69 | 0.95 | 7.07 | | | | c_gravel | | -122.5768138 | 45.42932776 |
| phillips | 0.63 | -0.60 | 0.50 | 0.45 | 0.70 | 5.45 | 0.00 | 1.00 | 1.00 | silt/clay | Incised | -122.5745295 | 45.45045919 |
| phillips | 1.27 | 0.30 | 1.80 | 1.20 | 0.00 | 6.33 | | | | m_gravel | Incised | -122.5767967 | 45.42959604 |
| phillips | 1.69 | 0.90 | 2.40 | 1.60 | 1.30 | 6.80 | 1.00 | 1.00 | 1.00 | c_gravel | Incised | -122.5785965 | 45.43450701 |
| phillips | 3.15 | 2.80 | 4.60 | 2.56 | 0.30 | 6.50 | 0.00 | 1.00 | 1.00 | f_gravel | Incised | -122.5813034 | 45.43813516 |
| phillips | 2.00 | 1.20 | 2.90 | 1.71 | 0.40 | 5.12 | 0.00 | 1.00 | 1.00 | silt/clay | Incised | -122.5814266 | 45.44058945 |
| saum | 1.72 | 1.30 | 4.33 | 1.45 | 0.80 | 4.29 | | | | silt/clay | Incised | -122.7223554 | 45.37923718 |
| saum | 2.30 | 3.00 | 5.40 | 2.25 | 0.00 | 5.83 | 0.00 | 1.00 | 1.00 | silt/clay | Widening | -122.7214299 | 45.38151749 |
| saum | 2.60 | 2.40 | 4.80 | 2.00 | 0.00 | 5.08 | 0.00 | 0.00 | 1.00 | silt/clay | Incised | -122.7417809 | 45.37329708 |
| saum | 1.43 | 1.00 | 3.70 | 1.37 | 0.40 | 3.52 | 0.00 | 0.00 | 1.00 | m_gravel | Incised | -122.7301553 | 45.37087835 |

| Stream | bank_height_ratio | bank_height_diff | FP_height | FP_height_BF_depth_ratio | Residual_depth | BF_W/D_ratio | Channel spanning wood within active channel | Large wood within active channel (>~6" DBH) | Small wood within active channel (~<6" DBH) | Substrate | SEM_classified | Longitude | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| saum | 1.22 | 0.20 | 1.30 | 1.18 | 0.30 | 5.09 | 0.00 | 0.00 | 0.00 | sand | Incised | -122.7275768 | 45.35729704 |
| saum | 1.63 | 1.50 | 4.90 | 1.44 | 0.40 | 3.41 | 1.00 | 1.00 | 0.00 | silt/clay | Widening | -122.7315853 | 45.37470427 |
| saum | 1.74 | 2.00 | 4.90 | 1.69 | | 3.86 | 0.00 | 1.00 | 0.00 | silt/clay | Incised | -122.7239882 | 45.37562697 |
| tate | 1.93 | 1.80 | 4.03 | 1.85 | 0.67 | 3.13 | | | | silt/clay | Widening | -122.668476 | 45.35600642 |
| tate | 1.00 | 0.00 | 2.10 | 1.00 | | 5.57 | 1.00 | 1.00 | 1.00 | boudler | Incised | -122.6594785 | 45.3624911 |
| tate | 1.18 | 0.20 | 1.70 | 1.13 | | 4.00 | 0.00 | 0.00 | 0.00 | boudler | Incised | -122.6546871 | 45.36647787 |
| tate | 1.27 | 0.40 | 2.10 | 1.24 | 0.00 | 3.94 | 1.00 | 1.00 | 1.00 | f_cobble | Incised | -122.6619936 | 45.36194725 |
| trib 2 | 1.92 | 0.73 | 2.03 | 1.71 | 0.37 | 5.17 | | | | f_gravel | Incised | -122.6876519 | 45.36099499 |
| trib 2 | 3.67 | 3.20 | 4.60 | 3.29 | 0.50 | 4.50 | 0.00 | 1.00 | 0.00 | f_gravel | Widening | -122.692096 | 45.36170092 |
| trib 2 | 2.00 | 1.20 | 2.50 | 1.92 | 0.20 | 6.38 | 1.00 | 1.00 | 1.00 | f_gravel | Incised | -122.6958443 | 45.35905213 |
| trib 2 | 2.50 | 0.60 | 1.10 | 2.20 | 0.20 | 17.20 | 1.00 | 1.00 | 1.00 | f_gravel | Incised | -122.7006211 | 45.35729273 |
| trib 4 | 1.30 | 0.40 | 2.00 | 1.26 | 0.33 | 9.05 | | | | m_gravel | Incised | -122.6677866 | 45.36117427 |
| trib 4 | 1.56 | 1.40 | 4.50 | 1.45 | 0.40 | 4.77 | 1.00 | 1.00 | 0.00 | f_gravel | Widening | -122.6686266 | 45.35946132 |
| trib 4 | 1.50 | 0.40 | 1.40 | 1.40 | 1.60 | 4.50 | 1.00 | 1.00 | 1.00 | f_gravel | Incised | -122.6629031 | 45.37368344 |
| athey | 2.71 | 1.70 | 2.93 | 2.42 | 0.40 | 3.60 | | | | silt/clay | Widening | -122.7091423 | 45.37625618 |
| athey | 1.88 | 0.70 | 2.00 | 1.54 | 0.10 | 3.69 | 0.00 | 0.00 | 1.00 | f_gravel | Incised | -122.7093212 | 45.37263077 |
| athey | 2.71 | 1.20 | 2.20 | 2.20 | | 3.80 | 0.00 | 0.00 | 0.00 | boudler | Incised | -122.7206196 | 45.36515474 |
| athey | 2.43 | 1.00 | 2.00 | 2.00 | 0.60 | 6.50 | 0.00 | 1.00 | 1.00 | boudler | Incised | -122.7078607 | 45.37423906 |
| wilson | 2.03 | 1.95 | 4.20 | 1.89 | 2.40 | 6.29 | | | | f_cobble | Connected | -122.6833564 | 45.37787625 |
| wilson | 2.27 | 1.90 | 4.60 | 1.70 | 1.00 | 5.37 | 0.00 | 1.00 | 0.00 | silt/clay | Incised | -122.6883368 | 45.37072752 |
| wilson | 1.38 | 1.00 | 4.20 | 1.31 | 0.80 | 5.38 | 1.00 | 1.00 | 1.00 | f_cobble | Incised | -122.6827491 | 45.37941111 |
| wilson | 1.00 | 0.00 | 2.30 | 1.00 | 0.70 | 6.74 | 1.00 | 1.00 | 1.00 | f_cobble | Connected | -122.6822233 | 45.37986246 |
| wilson | 1.09 | 0.20 | 2.50 | 1.09 | 1.30 | 7.26 | 1.00 | 1.00 | 1.00 | c_gravel | Connected | -122.6849354 | 45.375159 |
| rock | 1.60 | 1.57 | 4.43 | 1.52 | 0.70 | 14.07 | | | | f_cobble | Incised | -122.5072233 | 45.4093182 |
| rock | 1.72 | 2.10 | 8.10 | 1.35 | | 4.00 | | | | boudler | Incised | -122.4853185 | 45.43599978 |
| rock | 0.84 | -0.30 | 1.60 | 0.84 | 0.80 | 7.84 | 0.00 | 0.00 | 0.00 | m_gravel | Incised | -122.4778674 | 45.43640785 |
| rock | 1.55 | 1.10 | 3.40 | 1.48 | 0.40 | 7.26 | | | | c_gravel | Incised | -122.4473083 | 45.43963156 |
| rock | 1.47 | 0.83 | 3.57 | 1.32 | 0.33 | 9.78 | | | | boudler | Incised | -122.4933483 | 45.426628 |
| rock | 1.65 | 1.67 | 4.57 | 1.58 | 0.37 | 4.52 | | | | c_gravelf_cobblem_grav | Widening | -122.474252 | 45.43603918 |
| rock | 3.00 | 4.00 | 6.80 | 2.43 | 0.90 | 4.46 | 1.00 | 1.00 | 1.00 | m_gravel | Incised | -122.4787728 | 45.44745001 |
| rock | 1.47 | 0.90 | 4.10 | 1.28 | 2.00 | 10.78 | 1.00 | 1.00 | 1.00 | c_gravel | Connected | -122.5030677 | 45.41445245 |

## Reach Level Physical Data

| Stream | Reach | BF_width | BF_height | BF_depth | BT_width | BT_height | Flow_width | Riffle_depth | Pool_depth | LWD% | LWD_count | Run% | Riffle% | Pool% | FP_connectivity | Bank_erosion |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 1 | 16.36666667 | 0.90 | 1.20 | 26.20 | 1.98 | 7.92 | 0.28 | 1.05 | 20.00 | 6.00 | 30.00 | 50.00 | 20.00 | 3.00 | 8.33 |
| fields | 1 | 6.833333333 | 1.33 | 1.57 | 11.07 | 1.87 | 3.23 | 0.33 | 1.07 | 20.00 | 1.00 | 40.00 | 20.00 | 20.00 | 2.00 | 30.00 |
| fields | 2 | 10.75 | 1.10 | 1.20 | 14.45 | 1.75 | 5.70 | 0.25 | 0.35 | | | | | | 1.00 | 15.00 |
| trillium | 1 | 17.9 | 2.43 | 2.65 | 23.60 | 4.20 | 7.85 | 0.53 | 0.75 | 5.00 | 1.00 | 40.00 | 50.00 | 10.00 | 2.00 | 25.00 |
| trillium | 2 | 12.5 | 1.97 | 2.80 | 18.30 | 4.77 | 5.97 | 0.53 | 1.03 | | | | | | 1.00 | 8.33 |
| cow | 1 | 43.33333333 | 2.17 | 3.17 | 48.33 | 5.00 | 38.33 | 2.10 | 2.50 | 10.00 | 3.00 | 90.00 | 0.00 | 10.00 | 3.00 | 0.00 |
| cow | 2 | 13.8 | 2.50 | 3.05 | 18.50 | 4.95 | 9.60 | 1.25 | | | | | | | 1.00 | 40.00 |
| sieben | 1 | 12.6 | 2.97 | 3.23 | 18.43 | 11.03 | 8.67 | 0.67 | 1.50 | 5.00 | 0.00 | 40.00 | 30.00 | 30.00 | 1.00 | 10.00 |
| sieben | 2 | 8.45 | 1.00 | 1.30 | 9.70 | 5.00 | 5.75 | 0.35 | 1.00 | | | | | | 1.00 | 20.00 |
| cedar | 1 | 9.02 | 1.40 | 1.58 | 15.56 | 1.96 | 5.58 | 0.74 | 0.85 | 20.00 | 2.00 | 70.00 | 10.00 | 20.00 | 1.67 | 11.67 |
| mt scott | 1 | 28.46666667 | 1.23 | 2.05 | 32.92 | 2.35 | 27.37 | 1.28 | 2.44 | 5.00 | 1.00 | 20.00 | 40.00 | 40.00 | 2.00 | 5.00 |
| mt scott | 2 | 21.9 | 2.14 | 2.73 | 27.38 | 4.12 | 15.29 | 1.12 | 2.10 | 25.00 | 3.00 | 30.00 | 40.00 | 30.00 | 1.20 | 20.00 |
| mt scott | 3 | 29.83333333 | 2.50 | 3.00 | 39.33 | 4.53 | 18.27 | 0.77 | 1.73 | | | | | | 1.33 | 10.00 |
| mt scott | 4 | 22.525 | 1.89 | 2.16 | 31.66 | 2.48 | 14.51 | 0.75 | 1.59 | 5.00 | 2.00 | 50.00 | 20.00 | 30.00 | 1.40 | 8.00 |
| mt scott | 5 | 15.6 | 1.80 | 2.35 | 21.20 | 2.50 | 9.08 | 0.80 | 1.37 | | | | | | 1.00 | 16.25 |
| shipley | 1 | 5.9 | 1.50 | 1.64 | 12.60 | 3.18 | 3.24 | 0.48 | 0.42 | 0.00 | 0.00 | 50.00 | 40.00 | 5.00 | 1.50 | 16.67 |
| richardson | 1 | 15 | 2.00 | 3.60 | 18.00 | 3.00 | 14.00 | 2.50 | 3.00 | | | | | | 3.00 | 20.00 |
| richardson | 2 | 22.62 | 1.64 | 2.06 | 29.56 | 2.18 | 11.60 | 0.58 | 0.88 | 15.00 | 1.00 | 10.00 | 10.00 | 80.00 | 2.67 | 23.33 |
| pecan | 1 | 11.5 | 2.35 | 2.75 | 16.30 | 2.75 | 5.55 | 0.75 | | | | | | | 1.50 | 25.00 |
| pecan | 2 | 14.875 | 2.13 | 2.65 | 20.10 | 2.70 | 6.33 | 0.45 | 0.90 | 15.00 | 2.00 | 20.00 | 40.00 | 40.00 | 3.00 | 5.00 |
| pecan | 3 | 7.6 | 1.00 | 1.40 | 10.10 | 1.70 | 5.40 | 0.30 | 0.70 | | | | | | 1.00 | 5.00 |
| kellogg | 1 | 33.01428571 | 2.54 | 3.23 | 38.10 | 3.19 | 29.96 | 1.51 | 1.99 | 10.00 | 1.00 | 80.00 | 0.00 | 20.00 | 1.20 | 7.00 |
| kellogg | 2 | 15.5 | 1.84 | 2.28 | 20.06 | 2.26 | 11.66 | 0.98 | 1.62 | 0.00 | 0.00 | 20.00 | 40.00 | 40.00 | 1.33 | 3.33 |
| kellogg | 3 | 10.36666667 | 1.60 | 2.50 | 13.60 | 2.50 | 7.70 | 1.20 | 1.30 | | | | | | 1.00 | 21.67 |
| phillips | 1 | 8.933333333 | 1.03 | 1.40 | 20.53 | 1.70 | 8.63 | 0.97 | 1.60 | 0.00 | 0.00 | 40.00 | 50.00 | 10.00 | 1.00 | 0.00 |
| phillips | 2 | 10.2 | 1.27 | 1.67 | 15.63 | 2.90 | 8.73 | 0.67 | 1.33 | | | | | | 1.00 | 11.67 |
| saum | 1 | 12.45714286 | 2.10 | 2.89 | 14.73 | 3.93 | 11.09 | 1.54 | 2.05 | 15.00 | 1.00 | 0.00 | 10.00 | 90.00 | 1.00 | 27.00 |
| saum | 2 | 7.55 | 1.60 | 1.90 | 12.25 | 2.20 | 5.00 | 0.40 | 0.75 | | | | | | 1.50 | 7.50 |
| tate | 1 | 6.866666667 | 2.10 | 2.23 | 12.43 | 3.90 | 4.83 | 0.60 | 1.27 | 5.00 | 0.00 | 80.00 | 0.00 | 20.00 | 1.00 | 80.00 |
| tate | 2 | 9.2 | 1.80 | 1.90 | 12.00 | 2.00 | 6.20 | 0.40 | 0.80 | | | | | | 2.50 | 5.00 |
| trib 2 | 1 | 6.325 | 1.13 | 1.33 | 15.40 | 2.48 | 3.55 | 0.33 | 0.73 | 0.00 | 0.00 | 30.00 | 30.00 | 30.00 | 1.00 | 12.50 |
| trib 2 | 2 | 8.45 | 0.80 | 0.90 | 18.75 | 1.70 | 5.00 | 0.30 | 0.50 | | | | | | 1.50 | 17.50 |
| trib 4 | 1 | 13.3 | 1.40 | 1.60 | 20.30 | 1.80 | 8.63 | 0.40 | 0.73 | 10.00 | 1.00 | 80.00 | 10.00 | 10.00 | 3.00 | 25.00 |
| trib 4 | 2 | 4.5 | 0.80 | 1.00 | 6.50 | 1.20 | 3.50 | 0.20 | 1.80 | | | | | | 1.00 | 0.00 |
| athey | 1 | 4.6 | 1.00 | 1.23 | 8.50 | 2.70 | 2.83 | 0.57 | 0.97 | 0.00 | 0.00 | 0.00 | 0.00 | 30.00 | 2.00 | 90.00 |
| athey | 2 | 5.65 | 0.75 | 1.15 | 12.65 | 1.60 | 4.80 | 0.50 | 0.85 | | | | | | 1.00 | 12.50 |
| athey | 3 | 3.8 | 0.70 | 1.00 | 10.00 | 1.90 | 2.70 | 0.10 | | | | | | | 1.00 | 15.00 |
| wilson | 1 | 15.6 | 1.90 | 2.50 | 22.10 | 2.95 | 9.75 | 0.85 | 2.00 | | | | | | 3.00 | 10.00 |
| wilson | 2 | 14.9 | 1.95 | 2.42 | 24.47 | 3.42 | 7.83 | 0.50 | 2.35 | 25.00 | 2.00 | 40.00 | 40.00 | 20.00 | 2.67 | 6.67 |
| rock | 1 | 37.975 | 2.30 | 2.95 | 41.63 | 3.70 | 26.88 | 0.93 | 1.95 | 5.00 | 1.00 | 40.00 | 50.00 | 10.00 | 3.00 | 17.50 |
| rock | 2 | 19.31 | 2.29 | 3.36 | 25.77 | 3.83 | 15.07 | 1.55 | 1.31 | 15.00 | 1.50 | 60.00 | 10.00 | 30.00 | 1.00 | 14.17 |
| rock | 3 | 16.7 | 2.00 | 2.30 | 22.70 | 3.10 | 8.50 | 0.80 | 1.20 | | | | | | 1.00 | 30.00 |

| Stream | Bank_overhanging | SEM_stage | Substrate_numeric | DA | Slope | FP_width | Confinement | Canopy%_2014 | Canopy%_2007 | Canopy%_change | D16 | D50 | D84 | sort_coeff | embedded% | bank_height_ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 25.00 | 0.00 | 3.67 | 0.05 | 2.22 | 85.19 | 3.93 | 43.03 | 25.08 | 17.95 | 14.72 | 37.24 | 77.77 | 33.84 | 7.00 | 2.37 |
| fields | 35.00 | 5.00 | 3.67 | 0.43 | 5.24 | 101.17 | 15.09 | 54.19 | 35.98 | 18.21 | 12.41 | 33.11 | 86.29 | 32.73 | 17.48 | 1.42 |
| fields | 30.00 | 3.00 | 2.50 | 0.30 | 8.11 | 46.97 | 4.17 | 96.76 | 0.00 | 96.76 | 12.41 | 33.11 | 86.29 | 32.73 | 17.48 | 1.64 |
| trillium | 50.00 | 2.00 | 4.00 | 0.41 | 4.23 | 46.44 | 2.64 | 49.97 | 39.39 | 10.58 | 16.50 | 35.73 | 78.53 | 35.99 | 10.48 | 1.65 |
| trillium | 13.33 | 3.00 | 2.00 | 0.18 | 3.28 | 39.53 | 3.51 | 36.87 | 25.94 | 10.94 | | | | | | 2.60 |
| cow | 5.00 | 0.00 | 0.00 | 1.27 | 3.87 | 59.33 | 1.38 | 35.84 | 35.18 | 0.66 | | | | | | 2.30 |
| cow | 32.50 | 7.00 | 1.00 | 0.94 | 0.77 | 59.91 | 4.32 | 14.91 | 12.06 | 2.85 | | | | | | 1.97 |
| sieben | 70.00 | 3.00 | 3.67 | 2.03 | 1.38 | 58.66 | 4.91 | 38.73 | 25.97 | 12.76 | 9.60 | 24.23 | 45.00 | 20.78 | 5.00 | 3.77 |
| sieben | 40.00 | 5.00 | 4.50 | 1.49 | 4.36 | 66.94 | 10.57 | 62.21 | 42.45 | 19.76 | | | | | | 5.00 |
| cedar | 43.33 | 2.00 | 1.40 | 1.04 | 1.44 | 62.85 | 8.40 | 48.16 | 30.82 | 17.34 | | 5.60 | 11.71 | | 3.92 | 1.47 |
| mt scott | 46.67 | 5.00 | 4.67 | 10.00 | 1.21 | 249.71 | 8.94 | 61.22 | 61.08 | 0.15 | | | | | | 1.98 |
| mt scott | 33.00 | 7.00 | 3.08 | 9.35 | 1.13 | 370.86 | 16.80 | 59.20 | 31.60 | 27.60 | | | | | | 2.04 |
| mt scott | 13.33 | 2.00 | 4.00 | 5.32 | 1.66 | 80.08 | 2.72 | 72.12 | 57.07 | 15.05 | | | | | | 1.79 |
| mt scott | 13.00 | 6.00 | 4.63 | 3.60 | 2.63 | 81.03 | 3.93 | 71.57 | 51.32 | 20.25 | 13.17 | 87.25 | 165.06 | 46.62 | 18.18 | 1.32 |
| mt scott | 21.25 | 3.00 | 2.33 | 1.83 | 1.51 | 90.06 | 6.14 | 53.16 | 23.77 | 29.39 | | | | | | 1.43 |
| shipley | 60.00 | 3.00 | 2.20 | 0.17 | 3.87 | 226.75 | 45.08 | 45.02 | 51.19 | -6.16 | 2.10 | 6.38 | 16.24 | 5.84 | 8.74 | 2.11 |
| richardson | 20.00 | 1.00 | 0.00 | 4.03 | 0.94 | 161.41 | 10.76 | 68.77 | 62.48 | 6.30 | | | | | | 1.50 |
| richardson | 15.00 | 2.00 | 4.40 | 3.58 | 3.17 | 44.85 | 2.59 | 62.97 | 54.53 | 8.44 | | | | | | 1.32 |
| pecan | 22.50 | 6.00 | 2.50 | 0.63 | 3.15 | 65.33 | 5.70 | 78.89 | 82.68 | -3.79 | | | | | | 1.17 |
| pecan | 7.50 | 0.00 | 4.25 | 0.46 | 6.97 | 41.11 | 3.53 | 88.79 | 90.50 | -1.71 | 12.68 | 51.20 | 117.73 | 38.64 | 13.73 | 1.32 |
| pecan | 60.00 | 2.00 | 5.00 | 0.15 | 5.21 | 24.27 | 3.19 | 43.83 | 46.71 | -2.88 | | | | | | 1.70 |
| kellogg | 14.00 | 2.00 | 4.86 | 15.64 | 0.82 | 115.98 | 3.58 | 54.70 | 60.20 | -5.50 | | | | | | 1.26 |
| kellogg | 15.00 | 2.00 | 2.80 | 13.63 | 0.88 | 73.07 | 5.00 | 54.15 | 57.71 | -3.56 | 12.95 | 45.61 | 117.27 | 38.97 | 13.59 | 1.26 |
| kellogg | 1.67 | 9.00 | 0.00 | 1.72 | 0.70 | 91.02 | 8.82 | 31.20 | 32.32 | -1.13 | | | | | | 1.55 |
| phillips | 0.00 | 3.00 | 3.67 | 0.91 | 1.59 | 39.04 | 9.43 | 39.64 | 15.79 | 23.85 | 11.90 | 25.19 | 59.97 | 26.72 | 8.82 | 1.66 |
| phillips | 56.67 | 3.00 | 2.00 | 0.65 | 1.03 | 41.44 | 4.15 | 23.99 | 13.08 | 10.91 | | | | | | 2.28 |
| saum | 50.00 | 7.00 | 0.71 | 3.17 | 1.38 | 138.51 | 10.44 | 66.10 | 66.10 | 0.00 | | | | | | 1.92 |
| saum | 10.00 | 2.00 | 2.00 | 1.41 | 1.92 | 4225.76 | 667.57 | 34.25 | 19.51 | 14.74 | | | | | | 1.33 |
| tate | 80.00 | 4.00 | 0.00 | 0.61 | 1.41 | 119.43 | 17.39 | 65.91 | 73.06 | -7.16 | | | | | | 1.93 |
| tate | 15.00 | 5.00 | 6.00 | 0.35 | 10.35 | 49.42 | 5.01 | 83.20 | 83.55 | -0.35 | | | | | | 1.13 |
| trib 2 | 35.00 | 6.00 | 2.00 | 0.49 | 3.11 | 30.08 | 5.56 | 47.14 | 35.41 | 11.73 | 7.89 | 14.70 | 25.39 | 14.15 | 3.85 | 2.35 |
| trib 2 | 7.50 | 5.00 | 2.00 | 0.36 | 6.52 | 40.64 | 4.80 | 83.86 | 2.54 | 81.32 | | | | | | 2.25 |
| trib 4 | 30.00 | 3.00 | 2.67 | 0.63 | 4.45 | 54.14 | 4.68 | 68.62 | 69.42 | -0.80 | 3.44 | 15.13 | 35.69 | 11.07 | 3.96 | 1.30 |
| trib 4 | 20.00 | 2.00 | 2.00 | 0.54 | 6.26 | 72.59 | 16.13 | 76.61 | 75.77 | 0.84 | | | | | | 1.50 |
| athey | 90.00 | 4.00 | 0.67 | 0.77 | 0.40 | 80.55 | 23.52 | 43.36 | 43.09 | 0.27 | | 2.88 | 7.41 | | 0.00 | 2.71 |
| athey | 10.00 | 2.00 | 4.50 | 0.59 | 2.43 | 33.97 | 5.65 | 64.89 | 63.36 | 1.53 | | | | | | 2.15 |
| athey | 0.00 | 3.00 | 7.00 | 0.30 | 4.80 | 90.52 | 23.82 | 61.11 | 69.90 | -8.79 | | | | | | 2.71 |
| wilson | 40.00 | 2.00 | 2.00 | 2.15 | 1.45 | 65.42 | 4.11 | 81.75 | 90.64 | -8.88 | | | | | | 1.68 |
| wilson | 3.33 | 0.00 | 5.00 | 1.70 | 2.92 | 58.13 | 3.73 | 54.15 | 60.03 | -5.88 | 17.28 | 54.22 | 105.63 | 42.72 | 16.00 | 1.75 |
| rock | 22.50 | 2.00 | 4.50 | 8.46 | 1.72 | 61.66 | 1.64 | 75.96 | 59.24 | 16.72 | 22.84 | 56.31 | 152.60 | 59.03 | 8.70 | 1.57 |
| rock | 26.67 | 3.00 | 5.30 | 8.12 | 1.54 | 593.90 | 53.21 | 53.08 | 46.13 | 6.94 | 10.86 | 39.74 | 111.20 | 34.61 | 14.19 | 1.66 |
| rock | 30.00 | 3.00 | 4.00 | 1.16 | 1.87 | 116.81 | 6.99 | 66.33 | 59.01 | 7.32 | | | | | | 1.55 |

| Stream | bank_height_diff | FP_height | FP_height_BF_depth_ratio | Residual_depth | BF_W/D_ratio | Channel spanning wood within active channel | Large wood within active channel (>~6" DBH) | Small wood within active channel (~<6" DBH) | LWD? | SWD? | Substrate | Substrate_classified | SEM_classified | Length (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 1.08 | 2.28 | 1.90 | 0.77 | 15.26 | 0.50 | 1.00 | 0.50 | 1.00 | 1.00 | c_gravel | Gravel | Connected | 3422.81 |
| fields | 0.53 | 2.10 | 1.34 | 0.73 | 4.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | _cobblef_gravelm_grav | Gravel | Incised | 2408.32 |
| fields | 0.65 | 1.85 | 1.58 | 0.10 | 9.54 | 1.00 | 1.00 | 1.00 | 0.50 | 0.50 | f_gravelm_gravel | Gravel | Incised | 3984.09 |
| trillium | 1.78 | 4.43 | 1.62 | 0.23 | 7.23 | | | | 1.00 | 1.00 | c_gravel | Gravel | Incised | 1858.79 |
| trillium | 2.80 | 5.60 | 2.03 | 0.50 | 4.55 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | c_gravelsilt/clay | BedrockFinesGravel | Incised | 9250.31 |
| cow | 2.83 | 6.00 | 1.89 | 0.40 | 14.22 | | | | 0.00 | 0.00 | silt/clay | Fines | Connected | 2927.93 |
| cow | 2.45 | 5.50 | 1.80 | | 4.59 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 | f_gravelsilt/clay | FinesGravel | IncisedWidening | 15900.30 |
| sieben | 8.07 | 11.30 | 3.53 | 0.83 | 3.94 | | | | 0.00 | 0.00 | c_gravel | Gravel | Incised | 4434.81 |
| sieben | 4.00 | 5.30 | 3.86 | 0.50 | 6.36 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | c_gravelf_cobble | BedrockGravel | Incised | 10812.72 |
| cedar | 0.56 | 2.14 | 1.42 | 0.25 | 6.14 | 0.50 | 0.50 | 0.50 | 0.83 | 0.83 | f_gravel | FinesGravel | Incised | 4880.35 |
| mt scott | 1.12 | 3.17 | 1.58 | 1.36 | 15.48 | 1.00 | 1.00 | 1.00 | 0.29 | 0.29 | f_cobble | Gravel | Incised | 4236.02 |
| mt scott | 1.98 | 4.70 | 1.84 | 1.07 | 8.85 | 0.44 | 0.89 | 0.33 | 0.92 | 0.92 | c_gravel | Gravel | IncisedWidening | 13549.77 |
| mt scott | 2.03 | 5.03 | 1.70 | 0.97 | 9.93 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | _gravelf_cobblem_grav | Gravel | Incised | 7423.02 |
| mt scott | 0.59 | 2.75 | 1.29 | 0.84 | 10.60 | 0.25 | 1.00 | 0.25 | 1.00 | 1.00 | _gravelf_cobblem_grav | BedrockGravel | Incised | 7737.84 |
| mt scott | 0.70 | 3.05 | 1.30 | 0.30 | 6.57 | 0.75 | 0.75 | 0.50 | 0.75 | 0.75 | c_gravelm_gravelsilt/cla | BedrockGravel | Incised | 7608.15 |
| shipley | 1.68 | 3.32 | 2.02 | -0.06 | 3.86 | 0.00 | 0.50 | 0.50 | 0.17 | 0.17 | f_gravel | Gravel | Incised | 4537.24 |
| richardson | 1.00 | 4.60 | 1.28 | 0.50 | 4.17 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | silt/clay | Fines | Incised | 2363.70 |
| richardson | 0.54 | 2.60 | 1.25 | 0.28 | 10.87 | 0.50 | 0.50 | 1.00 | 0.83 | 0.83 | c_gravel | Gravel | Incised | 18001.37 |
| pecan | 0.40 | 3.15 | 1.15 | | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | f_gravelm_gravel | BedrockGravel | IncisedWidening | 2651.45 |
| pecan | 0.58 | 3.23 | 1.23 | 0.45 | 5.68 | 1.00 | 1.00 | 1.00 | 0.20 | 0.20 | m_gravel | Gravel | Connected | 1875.90 |
| pecan | 0.70 | 2.10 | 1.50 | 0.40 | 5.43 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | f_cobble | Bedrock | Incised | 3184.46 |
| kellogg | 0.64 | 3.87 | 1.21 | 0.47 | 10.39 | 0.25 | 0.25 | 0.25 | 0.13 | 0.13 | c_gravel | Gravel | Incised | 11807.36 |
| kellogg | 0.42 | 2.70 | 1.20 | 0.64 | 7.61 | 0.50 | 0.50 | 0.50 | 0.17 | 0.17 | c_gravelm_gravel | Gravel | Incised | 8158.54 |
| kellogg | 0.90 | 3.40 | 1.37 | 0.10 | 4.13 | 0.00 | 0.33 | 1.00 | 0.33 | 0.33 | silt/clay | Fines | Incised | 8634.02 |
| phillips | 0.67 | 2.07 | 1.53 | 0.63 | 6.82 | | | | 0.00 | 0.00 | c_gravel | Gravel | Incised | 3446.16 |
| phillips | 1.63 | 3.30 | 1.95 | 0.67 | 6.14 | 0.33 | 1.00 | 1.00 | 1.00 | 1.00 | c_gravelf_gravelsilt/clay | Gravel | Incised | 6320.18 |
| saum | 1.83 | 4.71 | 1.68 | 0.47 | 4.44 | 0.25 | 0.75 | 0.50 | 0.88 | 0.88 | silt/clay | Fines | Incised | 15150.95 |
| saum | 0.60 | 2.50 | 1.28 | 0.35 | 4.30 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 | m_gravelsand | FinesGravel | Incised | 10370.05 |
| tate | 1.80 | 4.03 | 1.85 | 0.67 | 3.13 | | | | 0.00 | 0.00 | silt/clay | Fines | Widening | 3774.31 |
| tate | 0.20 | 2.10 | 1.12 | 0.00 | 4.76 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | boudlerf_cobble | BedrockGravel | Incised | 5236.68 |
| trib 2 | 1.35 | 2.68 | 2.11 | 0.40 | 5.01 | 0.00 | 1.00 | 0.00 | 0.20 | 0.20 | f_gravel | Gravel | IncisedWidening | 2727.64 |
| trib 2 | 0.90 | 1.80 | 2.06 | 0.20 | 11.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | f_gravel | Gravel | Incised | 5787.42 |
| trib 4 | 0.40 | 2.00 | 1.26 | 0.33 | 9.05 | | | | 0.00 | 0.00 | m_gravel | Gravel | Incised | 2127.98 |
| trib 4 | 0.40 | 1.40 | 1.40 | 1.60 | 4.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | f_gravel | Gravel | Incised | 7135.53 |
| athey | 1.70 | 2.93 | 2.42 | 0.40 | 3.60 | | | | 0.00 | 0.00 | silt/clay | Fines | Widening | 3720.14 |
| athey | 0.85 | 2.00 | 1.77 | 0.35 | 5.10 | 0.00 | 0.50 | 1.00 | 0.50 | 0.50 | boudlerf_gravel | BedrockGravel | Incised | 4198.23 |
| athey | 1.20 | 2.20 | 2.20 | | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | boudler | Bedrock | Incised | 3096.25 |
| wilson | 1.05 | 3.55 | 1.40 | 1.15 | 6.32 | 0.50 | 1.00 | 0.50 | 1.00 | 1.00 | c_gravelsilt/clay | FinesGravel | ConnectedIncised | 4995.85 |
| wilson | 1.47 | 3.88 | 1.65 | 1.85 | 6.21 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | f_cobble | Gravel | Connected | 9668.70 |
| rock | 1.40 | 4.35 | 1.46 | 1.03 | 13.24 | 1.00 | 1.00 | 1.00 | 0.20 | 0.20 | c_gravelf_cobble | Gravel | ConnectedIncised | 5818.35 |
| rock | 1.54 | 4.90 | 1.47 | 0.48 | 6.32 | 0.50 | 0.50 | 0.50 | 0.75 | 0.75 | boudler | Bedrock | Incised | 24376.28 |
| rock | 1.10 | 3.40 | 1.48 | 0.40 | 7.26 | | | | 0.00 | 0.00 | c_gravel | Bedrock | Incised | 8034.14 |

## Watershed Level Physical Data

| Stream | Reach | BF_width | BF_height | BF_depth | BT_width | BT_height | Flow_width | Riffle_depth | Pool_depth | Bedrock? | Pools? | LWD% | LWD_count | Run% | Riffle% | Pool% | FP_connectivity | Bank_erosion | Bank_overhanging | DA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 1 | 16.36666667 | 0.90 | 1.20 | 26.20 | 1.98 | 7.92 | 0.28 | 1.05 | 0.00 | 0.57 | 20.00 | 6.00 | 30.00 | 50.00 | 20.00 | 3.00 | 8.33 | 25.00 | 0.17 |
| fields | 1.333333333 | 8.4 | 1.24 | 1.42 | 12.42 | 1.82 | 4.22 | 0.30 | 0.78 | 0.33 | 0.17 | 20.00 | 1.00 | 40.00 | 20.00 | 20.00 | 1.67 | 25.00 | 33.33 | 0.43 |
| trillium | 1.375 | 15.58571429 | 2.23 | 2.71 | 21.33 | 4.44 | 7.04 | 0.53 | 0.87 | 0.50 | 0.00 | 5.00 | 1.00 | 40.00 | 50.00 | 10.00 | 1.25 | 12.50 | 22.50 | 0.88 |
| cow | 1.333333333 | 31.52 | 2.30 | 3.12 | 36.40 | 4.98 | 26.84 | 1.76 | 2.50 | 0.00 | 0.00 | 10.00 | 3.00 | 90.00 | 0.00 | 10.00 | 1.67 | 26.67 | 23.33 | 1.27 |
| sieben | 1.333333333 | 9.95 | 1.95 | 2.27 | 14.28 | 7.37 | 6.83 | 0.57 | 1.38 | 0.50 | 0.00 | 5.00 | 0.00 | 40.00 | 30.00 | 30.00 | 1.50 | 12.50 | 37.50 | 2.03 |
| cedar | 1 | 9.02 | 1.40 | 1.58 | 15.56 | 1.96 | 5.58 | 0.74 | 0.85 | 0.33 | 0.00 | 20.00 | 2.00 | 70.00 | 10.00 | 20.00 | 1.67 | 11.67 | 43.33 | 0.91 |
| mt scott | 2.722222222 | 22.68235294 | 1.88 | 2.40 | 29.15 | 3.19 | 16.39 | 0.96 | 1.91 | 0.38 | 0.27 | 11.67 | 2.00 | 33.33 | 33.33 | 33.33 | 1.38 | 13.46 | 25.38 | 9.65 |
| shipley | 1 | 5.9 | 1.50 | 1.64 | 12.60 | 3.18 | 3.24 | 0.48 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 50.00 | 40.00 | 5.00 | 1.50 | 16.67 | 60.00 | 0.17 |
| richardson | 1.857142857 | 21.35 | 1.70 | 2.32 | 27.63 | 2.32 | 12.00 | 0.90 | 1.30 | 0.00 | 0.00 | 15.00 | 1.00 | 10.00 | 10.00 | 80.00 | 2.75 | 22.50 | 16.25 | 4.03 |
| pecan | 1.875 | 12.87142857 | 2.03 | 2.50 | 17.59 | 2.57 | 5.97 | 0.51 | 0.86 | 0.80 | 0.00 | 15.00 | 2.00 | 20.00 | 40.00 | 40.00 | 2.00 | 13.00 | 24.00 | 0.75 |
| kellogg | 1.705882353 | 22.64666667 | 2.12 | 2.77 | 27.19 | 2.74 | 19.41 | 1.27 | 1.73 | 0.00 | 0.06 | 5.00 | 0.50 | 50.00 | 20.00 | 30.00 | 1.18 | 10.00 | 10.91 | 15.64 |
| phillips | 1.428571429 | 9.057142857 | 1.21 | 1.47 | 16.90 | 2.11 | 8.30 | 0.86 | 1.51 | 0.00 | 0.38 | 0.00 | 0.00 | 40.00 | 50.00 | 10.00 | 1.00 | 10.00 | 40.00 | 1.09 |
| saum | 1.2 | 11.36666667 | 1.99 | 2.67 | 14.18 | 3.54 | 9.73 | 1.29 | 1.73 | 0.14 | 0.00 | 15.00 | 1.00 | 0.00 | 10.00 | 90.00 | 1.14 | 21.43 | 38.57 | 3.17 |
| tate | 1.333333333 | 7.5 | 1.83 | 2.00 | 11.63 | 2.83 | 4.73 | 0.47 | 1.15 | 0.25 | 0.14 | 5.00 | 0.00 | 80.00 | 0.00 | 20.00 | 1.75 | 23.75 | 27.50 | 0.61 |
| trib 2 | 1.285714286 | 7.033333333 | 1.02 | 1.18 | 16.52 | 2.22 | 4.03 | 0.32 | 0.65 | 0.00 | 0.00 | 0.00 | 0.00 | 30.00 | 30.00 | 30.00 | 1.25 | 15.00 | 21.25 | 0.48 |
| trib 4 | 1.2 | 11.84 | 1.50 | 1.78 | 16.96 | 2.10 | 7.08 | 0.44 | 1.04 | 0.33 | 0.17 | 10.00 | 1.00 | 80.00 | 10.00 | 10.00 | 1.67 | 21.67 | 30.00 | 0.63 |
| athey | 1.571428571 | 4.816666667 | 0.87 | 1.17 | 10.13 | 2.20 | 3.47 | 0.47 | 0.92 | 0.50 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 30.00 | 1.25 | 32.50 | 27.50 | 0.76 |
| wilson | 1.777777778 | 15.075 | 1.94 | 2.44 | 23.88 | 3.30 | 8.31 | 0.59 | 2.26 | 0.20 | 0.22 | 25.00 | 2.00 | 40.00 | 40.00 | 20.00 | 2.80 | 8.00 | 18.00 | 2.15 |
| rock | 1.777777778 | 24.11333333 | 2.27 | 3.18 | 29.79 | 3.75 | 17.78 | 1.33 | 1.50 | 0.89 | 0.06 | 11.67 | 1.33 | 53.33 | 23.33 | 23.33 | 1.44 | 16.67 | 26.11 | 8.46 |

| Stream | Slope | FP_width | Confinement | Canopy%_2014 | Canopy%_2007 | Canopy%_change | D16 | D50 | D84 | sort_coeff | embedded% | riprap? | bank_height_ratio | bank_height_diff | FP_height | FP_height_BF_depth_ratio | Residual_depth | BF_W/D_ratio | Channel spanning wood within active channel | Large wood within active channel (>~6" DBH) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 2.22 | 85.19 | 3.93 | 15.38 | 7.93 | 7.45 | 14.72 | 37.24 | 77.77 | 33.84 | 7.00 | 0.00 | 2.37 | 1.08 | 2.28 | 1.90 | 0.77 | 15.26 | 0.50 | 1.00 |
| fields | 6.20 | 83.10 | 10.72 | 72.65 | 7.08 | 65.58 | 12.41 | 33.11 | 86.29 | 32.73 | 17.48 | 0.00 | 1.51 | 0.58 | 2.00 | 1.44 | 0.48 | 6.42 | 0.50 | 0.50 |
| trillium | 3.88 | 43.85 | 3.02 | 22.03 | 18.31 | 3.71 | 16.50 | 35.73 | 78.53 | 35.99 | 10.48 | 0.13 | 2.05 | 2.21 | 4.93 | 1.79 | 0.34 | 6.08 | 1.00 | 1.00 |
| cow | 2.84 | 59.52 | 2.55 | 16.88 | 13.02 | 3.86 | | | | | | 0.33 | 2.17 | 2.68 | 5.80 | 1.85 | 0.40 | 10.37 | 0.00 | 0.00 |
| sieben | 2.29 | 286.43 | 60.53 | 28.89 | 16.54 | 12.35 | 9.60 | 24.23 | 45.00 | 20.78 | 5.00 | 0.14 | 3.78 | 5.42 | 7.68 | 3.25 | 0.75 | 4.73 | 0.67 | 0.67 |
| cedar | 1.44 | 62.85 | 8.40 | 32.78 | 18.85 | 13.93 | | 5.60 | 11.71 | | 3.92 | 0.00 | 1.47 | 0.56 | 2.14 | 1.42 | 0.25 | 6.14 | 0.50 | 0.50 |
| mt scott | 1.58 | 238.08 | 14.26 | 29.78 | 17.40 | 12.37 | 13.17 | 87.25 | 165.06 | 46.62 | 18.18 | 0.11 | 1.75 | 1.31 | 3.71 | 1.58 | 0.97 | 10.18 | 0.57 | 0.91 |
| shipley | 3.87 | 226.75 | 45.08 | 29.11 | 33.61 | -4.50 | 2.10 | 6.38 | 16.24 | 5.84 | 8.74 | 0.17 | 2.11 | 1.68 | 3.32 | 2.02 | -0.06 | 3.86 | 0.00 | 0.50 |
| richardson | 2.85 | 61.50 | 3.95 | 37.51 | 30.97 | 6.53 | | | | | | 0.00 | 1.35 | 0.62 | 2.93 | 1.26 | 0.32 | 9.75 | 0.67 | 0.67 |
| pecan | 5.80 | 45.06 | 4.10 | 42.91 | 42.53 | 0.38 | 12.68 | 51.20 | 117.73 | 38.64 | 13.73 | 0.00 | 1.33 | 0.54 | 3.04 | 1.24 | 0.44 | 5.22 | 0.50 | 0.50 |
| kellogg | 0.82 | 96.43 | 5.10 | 30.56 | 22.97 | 7.59 | 12.95 | 45.61 | 117.27 | 38.97 | 13.59 | 0.41 | 1.32 | 0.62 | 3.39 | 1.24 | 0.45 | 8.21 | 0.22 | 0.33 |
| phillips | 1.25 | 385.27 | 72.52 | 14.99 | 7.16 | 7.84 | 11.90 | 25.19 | 59.97 | 26.72 | 8.82 | 0.13 | 1.78 | 0.90 | 2.37 | 1.56 | 0.66 | 6.33 | 0.25 | 1.00 |
| saum | 1.48 | 955.96 | 156.47 | 39.17 | 31.16 | 8.01 | | | | | | 0.10 | 1.79 | 1.56 | 4.22 | 1.59 | 0.44 | 4.41 | 0.17 | 0.50 |
| tate | 5.10 | 214.97 | 36.15 | 54.24 | 55.74 | -1.49 | | | | | | 0.29 | 1.54 | 1.00 | 3.00 | 1.49 | 0.50 | 3.82 | 0.67 | 0.67 |
| trib 2 | 4.09 | 33.10 | 5.31 | 50.13 | 3.05 | 47.09 | 7.89 | 14.70 | 25.39 | 14.15 | 3.85 | 0.14 | 2.32 | 1.20 | 2.38 | 2.09 | 0.33 | 7.27 | 0.67 | 1.00 |
| trib 4 | 6.15 | 97.09 | 10.00 | 54.60 | 52.64 | 1.96 | 3.44 | 15.13 | 35.69 | 11.07 | 3.96 | 0.17 | 1.39 | 0.60 | 2.38 | 1.32 | 0.60 | 7.29 | 1.00 | 1.00 |
| athey | 1.61 | 68.66 | 17.61 | 32.62 | 31.83 | 0.79 | | 2.88 | 7.41 | | 0.00 | 0.14 | 2.53 | 1.33 | 2.50 | 2.16 | 0.38 | 4.13 | 0.00 | 0.33 |
| wilson | 2.60 | 59.75 | 3.82 | 40.68 | 41.86 | -1.19 | 17.28 | 54.22 | 105.63 | 42.72 | 16.00 | 0.00 | 1.73 | 1.36 | 3.80 | 1.58 | 1.68 | 6.24 | 0.75 | 1.00 |
| rock | 1.61 | 419.55 | 36.38 | 40.25 | 33.79 | 6.46 | 14.85 | 45.26 | 125.00 | 42.75 | 12.36 | 0.06 | 1.63 | 1.47 | 4.65 | 1.47 | 0.64 | 8.23 | 0.67 | 0.67 |

| Stream | Small wood within active channel (~<6" DBH) | LWD? | SWD? | num_points | Substrate | Substrate_classified | SEM_classified | Invasives?_mode | Imp%_2001 | Imp%_2019 | Imp%_change | Length (ft) | Canopy%_2014 cl buff | Canopy%_2007 cl buff | Canopy%_change cl buff | Road_density | Num_road_crossings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| carli | 0.50 | 1.00 | 1.00 | 7 | c_gravel | Gravel | Connected | 1.00 | 30.77 | 31.33444444 | 0.568888889 | 3422.812092 | 43.03 | 25.08 | 17.95 | 20199.85 | 0.00 |
| fields | 0.50 | 0.17 | 0.17 | 6 | f_gravel | Gravel | Incised | 0.00 | 12.41 | 12.88425926 | 0.476851852 | 6392.408576 | 80.21 | 14.10 | 66.11 | 23137.81 | 3.00 |
| trillium | 0.67 | 1.00 | 1.00 | 8 | c_gravel | Gravel | Incised | 1.00 | 23.52 | 25.28104575 | 1.758591609 | 11113.34228 | 39.21 | 28.54 | 10.67 | 52236.60 | 7.00 |
| cow | 0.50 | 0.00 | 0.00 | 6 | silt/clay | Fines | Connected | 1.00 | 35.29 | 36.1104016 | 0.816396255 | 19061.84802 | 17.92 | 15.51 | 2.42 | 69116.87 | 19.00 |
| sieben | 0.67 | 0.29 | 0.29 | 7 | c_gravel | Gravel | Incised | 1.00 | 29.01 | 33.92010536 | 4.908428446 | 15247.53644 | 54.90 | 37.14 | 17.76 | 93650.03 | 5.00 |
| cedar | 0.50 | 0.83 | 0.83 | 6 | f_gravel | Fines | Incised | 1.00 | 34.69 | 34.84417617 | 0.154581812 | 4880.352704 | 48.16 | 30.82 | 17.34 | 96776.04 | 5.00 |
| mt scott | 0.39 | 0.81 | 0.81 | 37 | c_gravel | Gravel | Incised | 1.00 | 34.40 | 36.2317431 | 1.82807113 | 40566.79865 | 63.62 | 42.18 | 21.44 | 82316.21 | 23.00 |
| shipley | 0.50 | 0.17 | 0.17 | 6 | f_gravel | Gravel | Incised | 1.00 | 15.95 | 16.76666667 | 0.814814815 | 4537.24386 | 45.02 | 51.19 | -6.16 | 51475.70 | 5.00 |
| richardson | 1.00 | 0.86 | 0.86 | 7 | c_gravel | Gravel | Incised | 1.00 | 16.48 | 16.82470669 | 0.343340235 | 20365.06764 | 63.81 | 55.59 | 8.22 | 28937.50 | 4.00 |
| pecan | 0.50 | 0.25 | 0.25 | 8 | m_gravel | Bedrock | Connected | 1.00 | 16.22 | 17.96200885 | 1.738582089 | 7711.813607 | 66.35 | 69.40 | -3.05 | 42830.50 | 3.00 |
| kellogg | 0.56 | 0.18 | 0.18 | 17 | c_gravel | Gravel | Incised | 1.00 | 33.71 | 34.21288719 | 0.502363582 | 28599.92006 | 47.19 | 50.75 | -3.57 | 87700.24 | 18.00 |
| phillips | 1.00 | 0.50 | 0.50 | 8 | c_gravel | Gravel | Incised | 1.00 | 51.71 | 51.63318623 | -0.07705342 | 9769.344251 | 29.31 | 13.75 | 15.57 | 99157.09 | 14.00 |
| saum | 0.50 | 0.70 | 0.70 | 10 | silt/clay | Fines | Incised | 1.00 | 18.32 | 19.83739316 | 1.513649587 | 25520.99497 | 52.97 | 46.61 | 6.36 | 41619.24 | 12.00 |
| tate | 0.67 | 0.29 | 0.29 | 7 | silt/clay | Bedrock | Incised | 1.00 | 20.94 | 21.63675602 | 0.70035049 | 9015.232873 | 75.09 | 78.30 | -3.22 | 37616.56 | 5.00 |
| trib 2 | 0.67 | 0.43 | 0.43 | 7 | f_gravel | Gravel | Incised | 0.00 | 17.66 | 18.01450617 | 0.356603296 | 8519.304875 | 71.20 | 12.21 | 58.98 | 26497.86 | 3.00 |
| trib 4 | 0.50 | 0.33 | 0.33 | 6 | f_gravel | Gravel | Incised | 1.00 | 15.46 | 16.24436937 | 0.784227525 | 9263.509499 | 73.88 | 73.30 | 0.58 | 37831.19 | 7.00 |
| athey | 0.67 | 0.14 | 0.14 | 7 | boudler | Bedrock | Incised | 1.00 | 18.68 | 20.13449973 | 1.453648663 | 11014.62024 | 55.48 | 57.53 | -2.05 | 33853.13 | 5.00 |
| wilson | 0.75 | 1.00 | 1.00 | 9 | f_cobble | Gravel | Connected | 1.00 | 13.73 | 14.13107417 | 0.3987943 | 14667.54817 | 62.87 | 69.78 | -6.91 | 24807.39 | 2.00 |
| rock | 0.67 | 0.56 | 0.56 | 18 | boudler | Bedrock | Incised | 1.00 | 15.94 | 18.4692673 | 2.525358209 | 38228.76991 | 59.47 | 50.99 | 8.49 | 38759.98 | 13.00 |

# Site Level Macro Invertabrate Data

| | SITE INFORMATION | | | | | | | | | | | | | WATER CHEMISTRY | | | | | | | | | HABITAT UNITS | | | | | | | | | | | | RIPARIAN ASSESSMENT (0=absent; 1= sparse ( | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Stream name** | **Date** | **City** | **# sample jars** | **Duplicate collected** | **Avg WW (ft)** | **Reach length (ft)** | **Start time** | **End time** | **D/s end** | **U/s end** | **Weather** | **Heavy rain in last 7 days?** | **Time measured** | **O2 sat (%)** | **DO (mg/L)** | **Cond. (uS/cm)** | **Spec Cond (uS/cm)** | **pH** | **Temp (C)** | **Water odor** | **Water color** | **Sand/silt (%)** | **Cobble/gravel (%)** | **Boulder (%)** | **bedrock (%)** | **Small woody debris (%)** | **Large woody debris (%)** | **Root wads (%)** | **algae (%)** | **Macrophytes (%)** | **Other** | **Flow types in reach (#)** | **Flow types in reach (%)** | **Upper canopy** | **Lower canopy** | **Woody shrubs & saplings** |
| **M-AT-10** | Atheny Creek | 10/3/2021 | West Linn | 1 | N | 0.75 | 50 | 7:30 | 8:45 | 45.376304, -122.709122 | 45.376185, -122.70917 | Calm, cloudy, 54F | N | 8:20 | 87 | 9.43 | 162.8 | 218.1 | 7.53 | 11.7 | None | Clear | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 glide | 100% glide | L bank 0 | L bank 0 | L bank 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 2 | R bank 1 | R bank 1 |
| **M-CA-10** | Carli Creek | 9/17/2021 | Gladstone | 1 | N | 5.1 | 250 | 9:30 | 12:00 | 45.40055, -122.54627 | 45.40041, -122.54694 | Cloudy, calm, 62F | N | 11:45 | 104.5 | 10.8 | 186.8 | 238.3 | 7.82 | 12.5 | None | Clear | 10 | 77 | 1 | 0 | 2 | 4 | 0 | 10 | 0 | 0 | 1 pool, 5 glide, 2 riffle | 10% pool, 75% glide, 15% riffle | L bank 2 | L bank 3 | L bank 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 2 | R bank 3 | R bank 2 |
| **M-CO-20** | Cow Creek | 9/17/2021 | Clackamas | 1 | N | 3.3 | 250 | 7:30 | 8:40 | 45.42624, -122.49349 | 45.39521, -122.57057 | Cloudy, calm, 55F | N | 8:10 | 7 | 0.73 | 149.6 | 192.7 | 7.25 | 13.3 | organic | Clear | 73 | 0 | 0 | 0 | 2 | 0 | 0 | 25 | 0 | 0 | 1 pool | 100% pool | L bank 1 | L bank 2 | L bank 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 2 | R bank 1 |
| **M-CE-10** | Cedar Creek | 9/21/2021 | Happy Valley | 1 | N | 4.3 | 250 | 10:00 | 11:15 | 45.42570, -122.54313 | 45.42534, -122.54292 | Sun, breezy | Y | 11:00 | 78 | 7.96 | 48 | 59.6 | 7.121 | 14.6 | None | Clear | 74 | 4 | 0 | 0 | 20 | 1 | 0 | 0 | 1 | 0 | 4 pool, 4 glide | 35% pool, 65% glide | L bank 3 | L bank 3 | L bank 3 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 4 | R bank 3 | R bank 3 |
| **M-KL-10** | Kellogg Creek | 9/22/2021 | Milwaukie | 1 | N | 15 | 250 | 11:35 | 13:00 | 45.4314, -122.628 | 45.4317, -122.62813 | Sun, calm, 65F | Y | 12:43 | 97.7 | 9.6 | 162.8 | 196.2 | 7.68 | 16.1 | None | Clear | 3 | 85 | 5 | 5 | 2 | 0 | 0 | 0 | 0 | 2 (pipe at u/s & d/s end) | 2 glide, 3 riffle | 55% glide, 45% riffle | L bank 2 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 2 | R bank 1 |
| **M-KL-20** | Kellogg Creek | 9/22/2021 | Milwaukie | 2 | N | 6.4 | 250 | 7:15 | 8:50 | 45.42295, -122.60388 | 45.4425, -122.60348 | Calm, cloudy, 56F | Y | 8:25 | 66.5 | 6.79 | 163.5 | 205 | 6.95 | 14.4 | None | Clear | 25 | 74 | 0 | 0 | 1 | 0 | 0 | 0 | 10 | 1 (concrete chunks SW drains L bank) | 1 pool, 3 glide, 3 riffle | 10% pool, 60% glide, 30% pool | L bank 1 | L bank 2 | L bank 3 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 2 | R bank 2 |
| **M-MS-10** | Mt Scott Creek | 9/22/2021 | Milwaukie | 2 | N | 13.3 | 250 | 9:30 | 10:40 | 45.42617, -122.61272 | 45.42662, -122.61237 | Cloudy, light breeze, 60F | Y | 10:15 | 66.4 | 6.62 | 156 | 190.1 | 7.18 | 15.6 | None | Clear | 0 | 73 | 0 | 0 | 2 | 0 | 0 | 5 | 10 | Beaver dam above u/s end | 3 glide, 4 riffle | 50% glide, 50% riffle | L bank 3 | L bank 3 | L bank 3 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 1 | R bank 0 |
| **M-MS-40** | Mt Scott Creek | 9/17/2021 | Happy Valley | 1 | N | 13 | 280 | 13:00 | 14:30 | 45.430, -122.582 | 45.42929, -122.58163 | Cloudy, breezy, 73F | N | 14:10 | 92.2 | 9.16 | 148.1 | 180.4 | 7.74 | 15.5 | None | Clear | 5 | 80 | 1 | 0 | 10 | 4 | 0 | 0 | 0 | 0 | 2 pool, 3 glide, 4 riffle | 15% pool, 45% glide, 40% riffle | L bank 3 | L bank 3 | L bank 2 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 4 | R bank 3 | R bank 2 |
| **M-MS-80** | Mt Scott Creek | 9/21/2021 | Happy Valley | 1 | Y (1 jar) | 6.6 | 250 | 7:20 | 9:40 | 45.43563, -122.53853 | 45.43574, -122.53853 | Cloudy, calm, 55F | Y | 9:00 | 90.6 | 9.38 | 113.5 | 144.5 | 7.5 | 13.8 | None | Clear | 15 | 70 | 4 | 1 | 5 | 5 | 0 | 0 | 0 | 0 | 2 pool, 2 glide, 4 riffle | 15% pool, 35% glide, 50% riffle | L bank 3 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 2 | R bank 2 | R bank 1 |
| **M-PE-40** | Pecan Creek | 9/29/2021 | Stafford | 2 | N | 2.1 | 250 | 7:45 | 9:45 | 45.38501, -122.69264 | 45.38506, -122.69635 | Cloudy, calm, 47F | Y | 9:35 | 92.3 | 10 | 36.3 | 48.7 | 7.75 | 11.8 | None | Clear | 5 | 89 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | | 2 pool, 4 glide, 5 ruffle | 5% pool, 40% glide, 55% riffle, | L bank 4 | L bank 3 | L bank 4 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 4 | R bank 3 | R bank 4 |
| **M-PH-10** | Philips Creek | 9/30/2021 | Happy Valley | 1 | Y (1 jar) | 5.1 | 250 | 12:00 | 14:00 | 45.42912, -122.57661 | 45.42459, -122.57672 | cloudy, lt breeze, 63F | Y | 13:15 | 91.7 | 9.05 | 129.8 | 157.1 | 7.5 | 15.9 | None | Clear | 15 | 81 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 (culvert at u/s and d/s end) | 2 pool, 3 glide, 4 riffle | 10% pool, 40% glide, 50% riffle | L bank 2 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 2 | R bank 2 | R bank 1 |
| **M-RC-10** | Rock Creek | 9/16/2021 | Happy Valley | 2 | N | 6.5 | 250 | 10:00 | 11:20 | 45.40913, -122.50791 | 45.40915, -122.50697 | Sun, calm, 46F | N | 11:00 | 99.6 | 10.89 | 71 | 95.5 | 7.93 | 11.5 | None | Clear | 10 | 76 | 8 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 2 glide, 3 riffle | 35% glide, 65% riffle | L bank 3 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 2 | R bank 2 | R bank 2 |
| **M-RC-30** | Rock Creek | 9/16/2021 | Happy Valley | 1 | N | 9 | 300 | 12:30 | 14:00 | 45.42602, -122.49368 | 45.42664, -122.49326 | Sun, breezy, 65F | N | 13:40 | 104.3 | 10.82 | 146.5 | 187.7 | 7.93 | 13.5 | None | Clear | 14 | 30 | 5 | 30 | 4 | 2 | 0 | 13 | 0 | 2 (big dam or logjam below d/s end) | 3 pool, 2 glide, 2 riffle | 40% pool, 30% glide, 30% riffle | L bank 1 | L bank 4 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 4 | R bank 1 |
| **M-RC-50** | Rock Creek | 9/27/2021 | Damascus | 1 | N | 3.5 | 250 | 7:20 | 8:30 | 45.43607, -122.47424 | 45.43590, -122.47537 | Raining | Y | 8:15 | 85.5 | 8.56 | 108 | 132.8 | 7.6 | 13.2 | None | Clear | 16 | 75 | 0 | 5 | 2 | 2 | 0 | 0 | 0 | 15 (old pavement?) | 2 pool, 2 glide, 2 riffle | 10% pool, 45% glide, 45% riffle | L bank 1 | L bank 1 | L bank 1 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | R bank 1 | R bank 1 | R bank 1 |

| | SITE INFORMATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Stream name** | **Date** | **City** | **# sample jars** | **Duplicate collected** | **Avg WW (ft)** | **Reach length (ft)** | **Start time** | **End time** | **D/s end** | **U/s end** | **Weather** | **Heavy rain in last 7 days?** |
| **M-RI-10** | Richardson Creek | 9/30/2021 | Damascus | 2 | N | 7.3 | 250 | 7:45 | 9:30 | 45.39778, -122.47231 | 45.39857, -122.47182 | Cloudy, calm, 57F | Y |
| **M-SA-10** | Saum Creek | 9/23/2021 | Tualatin | 1 | N | 8.1 | 250 | 8:30 | 10:00 | 45.37938, -122.72239 | 45.37926, -122.72219 | Cloudy, calm, 57F | N |
| **M-SH-10** | Shipley Creek | 10/3/2021 | Lake Oswego | 1 | N | 0.6 | 50 | 9:00 | 10:15 | 45.38083, -122.69596 | 45.38091, -122.69590 | Cloudy, calm, 55F | N |
| **M-SI-10** | Sieben Creek | 9/31/21 | Happy Valley | 1 | N | 7.1 | 250 | 10:20 | 11:30 | 45.39857, -122.47188 | 45.41015, -122.52198 | Overcast, 66F | Y |
| **M-T4-10** | Unnamed Tributary 4 | 9/24/2021 | Stafford | 1 | N | N/A | N/A | 7:20 | 8:00 | 45.36121, -122.66777 | N/A | Cloudy, calm, 55F | Y |
| **M-TA-10** | Tate Creek | 9/24/2021 | Stafford | 1 | N | 2.9 | 250 | 8:40 | 10:00 | 45.37495, -122.71002 | 45.35610, -122.66831 | Sun, calm, 59F | Y |
| **M-TR-10** | Trillium Creek | 9/16/2021 | Gladstone | 1 | N | 2.8 | 250 | 8:00 | 9:30 | 45.40830, -122.50910 | 45.40827, -122.50906 | Sun, calm, 46F | N |
| **M-UK3_10** | Unnamed Tributary 3 | 9/23/2021 | West Linn | 1 | N | 1 | 140 | 7:20 | 8:20 | 45.36092, -122.6758 | 45.36107, -122.68774 | Sun, calm, 56F | Y |
| **M-WI-10** | Wilson Creek | 9/29/2021 | West Linn | 1 | N | 2.4 | 250 | 11:15 | 12:30 | 45.37704, -122.68383 | 45.37777, -122.68332 | Sun, calm, 59F | Y |

| | WATER CHEMISTRY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Time measured** | **O2 sat (%)** | **DO (mg/L)** | **Cond. (uS/cm)** | **Spec Cond (uS/cm)** | **pH** | **Temp (C)** | **Water odor** | **Water color** |
| **M-RI-10** | 9:15 | 96.2 | 10.08 | 44.8 | 57.8 | 7.56 | 12.2 | None | Clear |
| **M-SA-10** | 9:35 | 73 | 7.47 | 164.3 | 207.2 | 7.26 | 14.2 | None | Clear |
| **M-SH-10** | 9:35 | 82.6 | 8.93 | 67.2 | 89.5 | 7.42 | 12 | None | Clear |
| **M-SI-10** | 11:15 | 90.4 | 9.2 | 115.5 | 143.6 | 7.7 | 14.4 | Nasty, like BO | Clear |
| **M-T4-10** | 7:50 | 60.4 | 6.26 | 139.1 | 177.5 | 7.37 | 13.7 | None | Clear |
| **M-TA-10** | 9:30 | 88.2 | 9.16 | 169.8 | 217.5 | 7.53 | 13.7 | None | Clear |
| **M-TR-10** | 9:15 | 92.7 | 9.97 | 139.4 | 184.9 | 8.23 | 12.1 | None | Clear |
| **M-UK3_10** | 7:55 | 78.5 | 8.08 | 72.1 | 91.6 | 7.43 | 14 | None | Clear |
| **M-WI-10** | 12:10 | 70.3 | 7.22 | 121.8 | 153.5 | 6.97 | 14.2 | None | Clear |

| | HABITAT UNITS | | | | | | | | | | | | RIPARIAN ASSESSMENT (0=absent; 1= sparse ( | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Sand/silt (%)** | **Cobble/gravel (%)** | **Boulder (%)** | **bedrock (%)** | **Small woody debris (%)** | **Large woody debris (%)** | **Root wads (%)** | **algae (%)** | **Macrophytes (%)** | **Other** | **Flow types in reach (#)** | **Flow types in reach (%)** | **Upper canopy** | **Lower canopy** | **Woody shrubs & saplings** |
| **M-RI-10** | 10 | 81 | 1 | 0 | 5 | 2 | 1 | 0 | 0 | 0 | 2 pool, 8 glide, 8 riffle | 2% pool, 49% glide, 49% riffle | L bank 2 | L bank 3 | L bank 1 |
| | | | | | | | | | | | | | R bank 1 | R bank 3 | R bank 1 |
| **M-SA-10** | 65 | 30 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 1 (tires in channel) | 2 pool, 1 glide | 85% pool, 15% glide | L bank 2 | L bank 1 | L bank 0 |
| | | | | | | | | | | | | | R bank 1 | R bank 1 | R bank 0 |
| **M-SH-10** | 50 | 40 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | glide | 100% glide | L bank 1 | L bank 1 | L bank 1 |
| | | | | | | | | | | | | | R bank 2 | R bank 2 | R bank 2 |
| **M-SI-10** | 15 | 70 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 2 pool, 2 glide, 3 riffle | 20% pool, 40% glide, 40% riffle | L bank 0 | L bank 1 | L bank 0 |
| | | | | | | | | | | | | | R bank 1 | R bank 1 | R bank 0 |
| **M-T4-10** | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1 pool (almost dry) | 100% pool | L bank 1 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | R bank 1 | R bank 2 | R bank 1 |
| **M-TA-10** | 60 | 32 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 2 pool, 3 glide, 1 riffle | 15% pool, 65% glide, 20% riffle | L bank 1 | L bank 0 | L bank 0 |
| | | | | | | | | | | | | | R bank 2 | R bank 1 | R bank 1 |
| **M-TR-10** | 20 | 75 | 2 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 pool, 1 long glide, 2 shirt riffle | 2% pool, 93% glide, 5% riffle | L bank 2 | L bank 2 | L bank 1 |
| | | | | | | | | | | | | | R bank 2 | R bank 2 | R bank 1 |
| **M-UK3_10** | 32 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 (culvert at d/s end at road, fence across u/s end) | 1 pool, 2 glide | 40% pool, 60% glide | L bank 1 | L bank 0 | L bank 0 |
| | | | | | | | | | | | | | R bank 1 | R bank 1 | R bank 1 |
| **M-WI-10** | 5 | 85 | 1 | 0 | 2 | 2 | 0 | 0 | 5 | 0 | 4 pool, 4 glide | 60% pool, 40% glide | L bank 3 | L bank 4 | L bank 2 |
| | | | | | | | | | | | | | R bank 3 | R bank 4 | R bank 2 |

## Site Leve

| | 10-40%); 3=heavy (40-75%); 4=very heavy (>75%) | | | | | HUMAN INFLUENCE (A =. Absent; B = on bank; C = btwn bank -30 ft; D = >30 ft from bank | | | | | | | | | MACROINVERTEBRATE SAMPLING TRANSECTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site name | Herbs/grasses | Bare soil/duff | Total cover non-native | Dom adj land use | Nonnative spp. | Wall/riprap/dam | buildings | Pavement/cleared lot | Road/railroad | Pipes | Landfill/trash | Park/lawn | Veg mgmt | Bridge/abutment | Lat/long | Flow type | Substrate | Wetted width (ft) | H2O depth at 25% WW | H2O depth at 50% WW | H2O depth at 75% WW | Canopy cover (densiometer) | Total shading %([DS+R+US+L]*1.5) | COMMENTS |
| **M-AT-10** | L bank 4 | L bank 0 | L bank 4 | Residential & light ag. | Ivy, HB, RCG, holly | L bank A | L bank D | L bank D | L bank D | L bank D | L bank A | L bank A | L bank A | L bank A | 45.3763, -122.709122 | Glide | clay/silt | 0.8 | 0.3 | 0.3 | 0.25 | DS 14 R 17 US 16 L 13 | 90 | Narrow incised channel; huge swath of RCG on L bank; substrate is pure clay, hard to walk; could only sample ~50 ft at d/s end due to v heavy HB growth; very low flow, may have been dry prior to rains; reach moved to N side of Borland as impossible to access from Rolling Hills Church (very steep slope covered |
| | R bank 4 | R bank 0 | R bank 4 | Residential & light ag. | | R bank A | R bank D | R bank D | R bank D | R bank D | R bank A | R bank A | R bank A | R bank A | | | | | | | | | | |
| **M-CA-10** | L bank 3 | L bank 0 | L bank 3 | Pepsi facility w/natural area | HB, RCG | L bank A | L bank D | L bank A | L bank A | L bank A | L bank B | L bank A | L bank A | L bank A | 45.40041, -122.54694 | Riffle | Cobble/gravel | 3 | 0.1 | 0.1 | 0.25 | DS 13 R 15 US 12 L 15 | 82.5 | Low flow, lots of algae clumps on rocks; reach shifted d/s due to impenetrable blackberry around and over creek |
| | R bank 3 | R bank 0 | R bank 3 | Business w/natural area buffer | | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | 45.40047, -122.54684 | Riffle | Cobble/gravel | 3 | 0.1 | 0.1 | 0.2 | DS 14 R 16 US 14 L 16 | 90 | |
| | | | | | | | | | | | Channel Yes | | | | 45.40067, -122.54642 | Riffle | Cobble/gravel | 4 | 0.25 | 0.4 | 0.4 | DS 16 R 15 US 11 L 13 | 82.5 | |
| | | | | | | | | | | | | | | | 45.40055, -122.54627 | Glide | Cobble/gravel | 4 | 0.1 | 0.2 | 0.25 | DS 16 R 8 US 7 L 17 | 72 | |
| **M-CO-20** | L bank 4 | L bank 0 | L bank 4 | Farm | RCG | L bank A | L bank D | L bank A | L bank D | L bank B | L bank B | L bank A | L bank A | L bank A | 45.42624, -122.49349 | Pool | Muck | 6 | 0.25 | 0.3 | 0.5 | DS 11 R 17 US 6 L 0 | 51 | H20 barely moving so DO measurements are likely skewed; murky thickly sedimented channel; covered in long filamentous algae & duckweed & surrounded by RCG; very narrow buffer before ag field on L bank, R bank below a more vegetated berm; water withdrawal pipe at road crossing; width measurements estimates as sunk mid-thigh in sediment in channel |
| | R bank 4 | R bank 0 | R bank 4 | Road/residential | | R bank A | R bank A | R bank A | R bank D | R bank B | R bank B | R bank A | R bank A | R bank A | 45.39519, -122.57052 | Pool | Muck | 5.75 | 0.75 | 0.8 | 0.8 | DS 7 R 17 US 6 L 10 | 60 | |
| | | | | | | | | | | Channel Yes | Channel Yes | | | | 45.39521, -122.57057 | Pool | Muck | 7.2 | 0.5 | Not done | Not done | DS 9 R 9 US 6 L 8 | 48 | |
| **M-CE-10** | L bank 3 | L bank 1 | L bank 2 | Residential & road | HB, Ivy | L bank A | L bank D | L bank D | L bank D | L bank A | L bank C | L bank D | L bank A | L bank A | 45.42532, -122.54286 | Glide | Sand/silt | 3 | 0.2 | 0.4 | 0.25 | DS 12 R 15 US 17 L 16 | 90 | Narrow channel choked w/small wood and HB; shallow, low flow; sandy bottom, eroding banks |
| | R bank 3 | R bank 1 | R bank 2 | Residential & road | | R bank A | R bank C | R bank C | R bank D | R bank A | R bank B | R bank C | R bank A | R bank A | 45.42561, -122.54301 | Glide | Gravel/sand | 1 | 0.1 | 0.2 | 0.2 | DS 13 R 16 US 17 L 17 | 94.5 | |
| | | | | | | | | | | | Channel Yes | | | | 45.42570, -122.54313 | Glide | Gravel/sand | 3 | 0.05 | 0.05 | 0.1 | DS 16 R 16 US 17 L 17 | 97.5 | |
| **M-KL-10** | L bank 3 | L bank 0 | L bank 1 | residential | Ivy, HB | L bank B | L bank D | L bank A | L bank A | L bank B | L bank A | L bank C | L bank A | L bank A | 45.43142, -122.62765 | Riffle | Cobble/gravel | 9.5 | 0.4 | 0.4 | 0.25 | DS 17 R 13 US 15 L 17 | 93 | Family of otters (mom and 4 grown offspring?) playing and eating crayfish as we put sample in jars |
| | R bank 4 | R bank 1 | R bank 1 | School & residential | | R bank B | R bank D | R bank A | R bank A | R bank B | R bank A | R bank D | R bank A | R bank A | 45.43159, -122.62794 | Riffle | Boulder/cobble | 16.5 | 0.75 | 0.3 | 0.4 | DS 3 R 14 US 16 L 10 | 64.5 | |
| | | | | | | Channel Yes | | | | | | | | | 45.43158, -122.62772 | Riffle | Cobble | 22.5 | 0.5 | 0.3 | 0.66 | DS 15 R 8 US 11 L 16 | 75 | |
| | | | | | | | | | | | | | | | 45.43141, -122.62759 | Riffle | Cobble | 21 | 0.6 | 0.2 | 0.33 | DS 16 R 15 US 6 L 5 | 63 | |
| **M-KL-20** | L bank 3 | L bank 1 | L bank 2 | Road | RCG | L bank A | L bank A | L bank C | L bank C | L bank A | L bank A | L bank A | L bank A | L bank B | 45.44295, -122.60388 | Riffle | Cobble/gravel | 9.5 | 0.2 | 0.5 | 0.25 | DS 12 R 15 US 17 L 12 | 84 | Bridge abutment immediately below d/s end; very narrow riparian buffer, road on L bank, houses on R bank; bare soil included barrier cloth in adjacent yard on R bank |
| | R bank 2 | R bank 2 | R bank 2 | residential | | R bank B | R bank D | R bank A | R bank D | R bank B | R bank A | R bank C | R bank A | R bank B | 45.42302, -122.60397 | Riffle/glide | Cobble/gravel | 8.8 | 0.4 | 0.4 | 0.25 | DS 13 R 15 US 17 L 15 | 90 | |
| | | | | | | Channel Yes | | | | | | | | | 45.42290, -122.60378 | Riffle | Cobble/gravel | 9.2 | 0.75 | 0.75 | 0.33 | DS 17 R 2 US13 L 17 | 73.5 | |
| **M-MS-10** | L bank 2 | L bank 0 | L bank 1 | Park | HB, ivy | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | 45.42617, -122.61272 | Riffle | Cobble | 14 | Not done | Not done | Not done | Not done | Not done | Slid reach due to big beaver dam; R bank all lawn to bank; L bank is park w/dense native plantings; pump assembly in yard of house on R bank? |
| | R bank 4 | R bank 0 | R bank 4 | residential | | R bank A | R bank D | R bank A | R bank A | R bank C | R bank A | R bank B | R bank A | R bank A | 45.42632, -122.61259 | Riffle | Cobble | 18.5 | Not done | Not done | Not done | Not done | Not done | |
| | | | | | | | | | | | | | | | 45.42676, -122.61240 | Riffle | Cobble | 15.5 | Not done | Not done | Not done | Not done | Not done | |
| | | | | | | | | | | | | | | | 45.42662, -122.61237 | Riffle | Cobble | Not done | Not done | Not done | Not done | Not done | Not done | |
| **M-MS-40** | L bank 1 | L bank 2 | L bank 2 | Natural area (RR above) | HB | L bank A | L bank A | L bank A | L bank C | L bank D | L bank B | L bank A | L bank A | L bank C | 45.42914, -122.58136 | Riffle | Cobble/gravel | 8 | 0.1 | 0.2 | 0.2 | DS 9 R 16 US 10 L 17 | 78 | Several small sculpin; shallow but good flow; much human use in buffer & on banks |
| | R bank 1 | R bank 1 | R bank 2 | Natural area (aquatic ctr above) | | R bank A | R bank A | R bank A | R bank C | R bank D | R bank B | R bank A | R bank A | R bank C | 45.42933, -122.58152 | Riffle | Cobble/gravel | 3.25 | 0.2 | 0.2 | 0.2 | DS 14 R 14 US 17 L 17 | 93 | |
| | | | | | | | | | | | Channel Yes | | | | 45.42917, -122.58154 | Riffle | Gravel/cobble | 12 | 0.05 | 0.4 | 0.66 | DS 8 R 17 US 15 L 17 | 85.5 | |
| **M-MS-80** | L bank 3 | L bank 1 | L bank 2 | Residential & road | HB, Ivy | L bank A | L bank D | L bank D | L bank D | L bank D | L bank A | L bank A | L bank A | L bank A | 45.43573, -122.53860 | Riffle | Cobble/gravel | 7 | 0.5 | 0.33 | 0.05 | DS 14 R 16 US 12 L 16 | 87 | Good flow, lots of large cobble; surprisingly little trash for a recreational use space; footpath runs above R bank; narrow buffer w/steep slope on each side; sculpin in net |
| | R bank 3 | R bank 1 | R bank 2 | Park | | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank D | R bank A | R bank A | 45.43575, -122.53856 | Riffle | Cobble/gravel | 8 | 0.2 | 0.25 | 0.05 | DS 12 R 17 US 15 L 16 | 90 | |
| | | | | | | | | | | | | | | | 45.43610, -122.53842 | Riffle | Cobble/gravel | 4 | 0.25 | 0.33 | 0.6 | DS 15 R 17 US 15 L 17 | 96 | |
| | | | | | | | | | | | | | | | 45.43574, -122.53863 | Riffle | Cobble/gravel | 6 | 0.33 | 0.25 | 0.33 | DS 14 R 17 US 16 L 16 | 94.5 | |
| **M-PE-40** | L bank 4 | L bank 1 | L bank 2 | Natural area | HB, Ivy | L bank A | L bank A | L bank A | L bank D | L bank A | L bank A | L bank A | L bank A | L bank A | 45.38501, -122.69624 | Riffle | Cobble/gravel | 3.75 | 0.2 | 0.05 | 0.05 | DS 14 R 14 US 16 L 12 | 84 | Large metal pipe at d/s end but appears defunct, not carrying water; Northwestern salamander in net; Stafford Rd >60 ft from L bank |
| | R bank 4 | R bank 1 | R bank 2 | Natural area | | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | 45.38509, -122.69644 | Riffle | Cobble/gravel | 4.4 | 0.25 | 0.4 | 0.33 | DS 16 R 17 US 16 L 17 | 99 | |
| | | | | | | | | | | Channel Yes | | | | | 45.38566, -122.69667 | Riffle | Cobble/gravel | 0.9 | 0.2 | 0.05 | 0.25 | DS 16 R 16 US 15 L 16 | 94.5 | |
| **M-PH-10** | L bank 4 | L bank 1 | L bank 4 | Business | Ivy, HB | L bank B | L bank D | L bank C | L bank C | L bank A | L bank C | L bank D | L bank A | L bank A | 45.42912, -122.57661 | Riffle | Cobble/gravel | 6 | 0.25 | 0.25 | 0.2 | DS 16 R 17 US 14 L 15 | 93 | At edge of CostCo lot; road crossing at u/s and d/s end; both banks armored with wire fence packed with rocks & riprap; part of shading was overhanging riprap wall on R bank; rocks felt slimy |
| | R bank 4 | R bank 1 | R bank 4 | Business | | R bank B | R bank D | R bank C | R bank C | R bank A | R bank A | R bank D | R bank A | R bank A | 45.42934, -122.57677 | Riffle | Cobble/gravel | 8 | 0.25 | 0.4 | 0.33 | DS 16 R 9 US 13 L 12 | 75 | |
| | | | | | | Channel Yes | | | | | Channel Yes | | | | 45.42959, -122.57672 | Riffle | Cobble/gravel | 8.5 | 0.7 | 0.4 | 0.33 | DS 5 R 8 US 15 L 16 | 66 | |
| **M-RC-10** | L bank 3 | L bank 1 | L bank 2 | Natural area w/road above | Ivy, bindweed | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | 45.40913, -122.50791 | Riffle | Cobble/gravel | 10 | 0.2 | 0.25 | 0.5 | DS10 R 13 US 14 L 14 | 76.5 | D/s end has gravel beach w/evidence of camping & trash but not an active camp now; highway above R bank; some ledges of bedrock; high bluff on both sides; several sculpin in net |
| | R bank 3 | R bank 1 | R bank 2 | Natural area | | R bank A | R bank D | R bank A | R bank D | R bank A | R bank B | R bank D | R bank A | R bank A | 45.40911, -122.50728 | Riffle | Cobble/gravel | 7.5 | 0.5 | 0.5 | 0.25 | DS 15 R 16 US 7 L 15 | 79.5 | |
| | | | | | | | | | | | | | | | 45.40915, -122.50697 | Riffle | Cobble/gravel | 6.5 | 0.25 | 0.33 | 0.25 | DS 15 R 17 US 13 L 14 | 88.5 | |
| **M-RC-30** | L bank 4 | L bank 0 | L bank 4 | Urban residential | HB, ivy, RCG | L bank A | L bank D | L bank D | L bank D | L bank A | L bank A | L bank A | L bank A | L bank A | 45.42596, -122.49352 | Glide | Cobble/boulder | 9 | 1.5 | 0.75 | 0.8 | DS 13 R 15 US 15 L 12 | 82.5 | Creek cut down to bedrock; big beaver dam/wood jam below d/s end; Sunnyside Rd crosses u/s end; rocks coated in fluffy layer of algae & sediment; several sculpin in net |
| | R bank 4 | R bank 0 | R bank 4 | Urban residential & business | | R bank A | R bank D | R bank D | R bank D | R bank A | R bank A | R bank A | R bank A | R bank A | 45.42615, -122.49327 | Riffle | Bedrock/boulder | 5.5 | 0.5 | 0.5 | 0.25 | DS 12 R 17 US 13 L 15 | 85.5 | |
| | | | | | | Channel Yes | | | | | Channel Yes | | | | 45.42664, -122.49326 | Riffle/glide | Bedrock/boulder | 6.5 | 0.5 | 0.3 | 0.3 | DS 10 R 7 US 11 L 16 | 66 | |
| **M-RC-50** | L bank 4 | L bank 0 | L bank 4 | Rural residential | HB, RCG, ivy | L bank A | L bank D | L bank C | L bank D | L bank B | L bank A | L bank D | L bank A | L bank A | 45.43607, -122.47383 | Glide | Cobble | 4 | 0.4 | 0.4 | 0.4 | DS 12 R 0 US 7 L 16 | 52.5 | Drainage pipe on L bank; some garbage in creek; concrete sections in creek bed |
| | R bank 4 | R bank 0 | R bank 4 | Rural residential | | R bank A | R bank D | R bank D | R bank C | R bank A | R bank A | R bank D | R bank A | R bank A | 45.43611, -122.47395 | Riffle | Cobble | 6 | 0.2 | 0.2 | 0.25 | DS 17 R 9 US 16 L 15 | 85.5 | |
| | | | | | | Channel Yes | | | | Channel Yes | Channel Yes | | | | 45.43607, -122.47424 | Riffle | Riprap/cobble | 5.5 | 0.33 | 0.33 | 0.05 | DS 17 R 14 US 10 L 10 | 61.5 | |

| | 10-40%); 3=heavy (40-75%); 4=very heavy (>75%) | | | | | HUMAN INFLUENCE (A =. Absent; B = on bank; C = btwn bank -30 ft; D = >30 ft from bank | | | | | | | | | MACROINVERTEBRATE SAMPLING TRANSECTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Herbs/grasses** | **Bare soil/duff** | **Total cover non-native** | **Dom adj land use** | **Nonnative spp.** | **Wall/riprap/dam** | **buildings** | **Pavement/cleared lot** | **Road/railroad** | **Pipes** | **Landfill/trash** | **Park/lawn** | **Veg mgmt** | **Bridge/abutment** | **Lat/long** | **Flow type** | **Substrate** | **Wetted width (ft)** | **H2O depth at 25% WW** | **H2O depth at 50% WW** | **H2O depth at 75% WW** | **Canopy cover (densiometer)** | **Total shading %([DS+R+US+L]*1.5)** | **COMMENTS** |
| **M-RI-10** | L bank 4 | L bank 0 | L bank 1 | Rural residential | HB | L bank A | L bank D | L bank A | L bank C | L bank A | L bank A | L bank D | L bank A | L bank A | 45.39778, -122.47231 | Riffle | Cobble | 7.5 | 0.25 | 0.33 | 0.25 | DS 16 R 16 US 15 L 16 | 94.5 | Braided rocky channel at base of steep slope; channel with several woody debris piles from 2020 ice storm |
| | R bank 4 | R bank 0 | R bank 2 | Rural residential | | R bank A | R bank D | R bank A | R bank C | R bank A | R bank A | R bank D | R bank A | R bank A | 45.39808, -122.47189 | Riffle | Cobble | 6.25 | 0.33 | 0.4 | 0.2 | DS 16 R 13 US 8 L 15 | 78 | |
| | | | | | | | | | Channel Y (d/s end) | | | | | | 45.39816, -122.47169 | Riffle | Cobble | 0.75 | 0.05 | 0.05 | 0.33 | DS 15 R 13 US 8 L 16 | 78 | |
| | | | | | | | | | | | | | | | 45.39857, -122.47182 | Riffle | Cobble | 0.7 | 0.25 | 0.25 | 0.25 | DS 16 R 15 US 9 L 16 | 84 | |
| **M-SA-10** | L bank 4 | L bank 0 | L bank 4 | residential | RCG, HB, ivy | L bank A | L bank D | L bank A | L bank D | L bank A | L bank A | L bank C | L bank A | L bank A | 45.37923, -122.72215 | Glide | Cobble/sand | 9.5 | 0.2 | 0.2 | 0.25 | DS 15 R 17 US 12 L 12 | 84 | Deeply incised, steep banks, slow flow (mainly 2 long pools separated by a slow glide); very mucky & sedimented; took 3 of 8 net sets at T1, at the only glide, then divided remaining at ~regular intervals along |
| | R bank 4 | R bank 0 | R bank 4 | residential | | R bank A | R bank D | R bank A | R bank C | R bank A | R bank A | R bank D | R bank A | R bank A | | | | | | | | | | |
| | | | | | | | | | | | Channel Yes | | | | | | | | | | | | | |
| **M-SH-10** | L bank 4 | L bank 0 | L bank 4 | residential | HB, ivy | L bank A | L bank D | L bank A | L bank D | L bank A | L bank A | L bank D | L bank C | L bank A | 45.38083, -122.69596 | glide | Sand/gravel | 0.6 | 0.05 | 0.05 | 0.05 | DS 8 R 11 US 15 L 5 | 58.5 | Very narrow incised channel cooled w/HB, jewelweed, horsetail; just a trickle of flow, likely dry before rains; so shallow that hacking HB to get at channel choked the flow with debris; had to process sample offsite due to insufficient water in creek |
| | R bank 4 | R bank 0 | R bank 4 | residential | | R bank A | R bank A | R bank A | R bank C | R bank A | R bank A | R bank A | R bank A | R bank A | | | | | | | | | | |
| | | | | | | | | | Channel Y (d/s | | | | | | | | | | | | | | | |
| **M-SI-10** | L bank 4 | L bank 0 | L bank 4 | residential | Ivy, HB | L bank A | L bank D | L bank D | L bank C | L bank A | L bank A | L bank B | L bank A | L bank A | 45.39857, -122.47188 | Riffle | Cobble/gravel | 7.25 | 0.33 | 0.33 | 0.25 | DS 11 R 13 US 4L 10 | 57 | Narrow, incised, flows highly variable with stormwater (too fast at highway culvert to even enter prior week); rocks felt quite slimy; channel scoured to bedrock, banks ~8-10 ft above; small fish in pools |
| | R bank 4 | R bank 0 | R bank 4 | residential | | R bank A | R bank D | R bank D | R bank C | R bank B | R bank A | R bank B | R bank A | R bank A | 45.41003, -122.52193 | Riffle | Cobble/gravel | 6 | 0.4 | 0.33 | 0.2 | DS 15 R 17 US 13 L 7 | 78 | |
| | | | | | | Channel Yes (u/s end at hwy crossing) | | | | Channel Yes | Channel Yes | | | | 45.41015, -122.52198 | Glide | Gravel | 4.5 | 0.7 | 0.25 | 0.2 | DS 10 R 15 US 17 L 13 | 82.5 | |
| **M-T4-10** | L bank 4 | L bank 0 | L bank 4 | Rural residential | HB, ivy | L bank A | L bank A | L bank D | L bank D | L bank B | L bank A | L bank D | L bank A | L bank A | 45.36121, -122.66777 | Pool | Gravel / small woody debris | N/A | 0.05 | 0.1 | 0.05 | DS 14 R 4 US 9 L 14 | 61.5 | Extremely steep slope; found somewhat gentler slope in from SW Woodbine Rd to d/s end; channel narrow, largely dry, extremely overgrown, too little flow and way too much HB to sample a reach; collected entire sample from pool at coordinates |
| | R bank 4 | R bank 0 | R bank 4 | Rural residential | | R bank A | R bank A | R bank D | R bank D | R bank B | R bank A | R bank D | R bank A | R bank A | | | | | | | | | | |
| | | | | | | | | | | Channel Yes | Channel Yes | | | | | | | | | | | | | |
| **M-TA-10** | L bank 4 | L bank 0 | L bank 4 | Road/residential | Ivy, HB, holly | L bank A | L bank D | L bank D | L bank C | L bank A | L bank A | L bank D | L bank A | L bank A | 45.37495, -122.71002 | Glide | Deeply compacted clay | 3.33 | 0.1 | 0.2 | 0.05 | DS 17 R 16 US 16 L 17 | 99 | Deeply incised, runs along Johnson Rd.;m reports of Anodonta in reach (but owners may have meant in the Tualatin, where they are known?); raccoon tracks in clay; much heavily compacted clay substrate; Native blackberry also present |
| | R bank 4 | R bank 0 | R bank 4 | residential | | R bank A | R bank D | R bank A | R bank D | R bank A | R bank A | R bank C | R bank A | R bank A | 45.35584, -122.66853 | Glide | Clay/silt & small wood | 4.25 | 0.25 | 0.05 | 0.1 | DS 17 R 17 US 17 L 17 | 100 | |
| | | | | | | | | | | | | | | | 45.35581, -122.66843 | Riffle | Cobble | 3 | 0.25 | 0.33 | 0.2 | DS 17 R 17 US 17 L 16 | 100 | |
| **M-TR-10** | L bank 3 | L bank 3 | L bank 1 | Natural area | RCG | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | 45.40830, -122.50910 | Glide | Cobble/gravel | 2.75 | 0.05 | 0.1 | 0.05 | DS 16 R 17 US 14 L 17 | 96 | Rocky narrow creek, very low flow, almost all glide; much of R bank along sandy bluff; u/s end shelves of bedrock |
| | R bank 3 | R bank 3 | R bank 1 | Natural area | | R bank A | R bank A | R bank A | R bank A | R bank A | R bank B | R bank A | R bank A | R bank A | 45.40834, -122.50835 | Glide | Cobble/gravel | 4 | 0.05 | 0.05 | 0.1 | DS 16 R 15 US 15 L 16 | 93 | |
| | | | | | | | | | | | | | | | 45.40838, -122.50854 | Glide | Cobble/gravel | 3 | 0.2 | 0.2 | 0.25 | DS 16 R 17 US 17 L 16 | 99 | |
| | | | | | | | | | | | | | | | 454.40837, -122.50843 | Glide | Cobble/gravel | 3.25 | 0.1 | 0.1 | 0.1 | DS 14 R 17 US 16 L 14 | 91.5 | |
| **M-UK3_10** | L bank 4 | L bank 0 | L bank 0 | residential | Ivy, woodbine | L bank A | L bank D | L bank B | L bank C | L bank B | L bank A | L bank B | L bank B | L bank A | 45.36092, -122.6758 | Glide | Gravel | 1.1 | 0.33 | 0.25 | 0.05 | DS 8 R 14 US 14 L 16 | 78 | Narrow ditched channel at edge of yard; very shallow; likely dry or nearly so before weekend rains; reach shortened due to fence across u/s end and stream then becoming an icy-walled ditch; some attempt at L bank stabilization by piling raked-up pine needles on bank |
| | R bank 4 | R bank 1 | R bank 3 | residential | | R bank A | R bank D | R bank B | R bank C | R bank B | R bank A | R bank B | R bank C | R bank A | 45.36101, -122.68768 | Pool | Muck | 0.33 | 0.25 | 0.6 | 0.4 | DS 11 R 15 US 16 L 14 | 84 | |
| | | | | | | | | | | Channel Yes | | | | | 45.36103, -122.68768 | Glide | Gravel/silt | 0.75 | 0.05 | 0.05 | 0.05 | DS 17 R 15 US 17 L 16 | 97.5 | |
| **M-WI-10** | L bank 4 | L bank 2 | L bank 1 | Natural area | Very small amount of RCG in stagnant areas; surprisingly little blackberry | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | L bank A | 45.37777, -122.68332 | Glide | Cobble/gravel | 2.5 | 0.2 | 0.2 | 0.2 | DS 14 R 16 US 10 L 10 | 75 | Limnephilid caddisfly cases on rocks at T3; where confluence with Shipley is mapped, stream bed was dry; had to shift d/s to find surface water |
| | R bank 4 | R bank 2 | R bank 1 | Natural area | | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | R bank A | 45.37767, -122.68341 | Glide | Gravel/cobble | 3.5 | 0.2 | 0.1 | 0.25 | DS 12 R 17 US 6 L 6 | 61.5 | |
| | | | | | | | | | | | | | | | 45.37748, -122.68363 | Glide | Cobble/gravel | 3.2 | 0.1 | 0.05 | 0.1 | DS 17 R 17 US 16 L 17 | 100 | |
| | | | | | | | | | | | | | | | 45.37704, -122.68383 | Glide | Cobble/gravel | 2.8 | 0.2 | 0.2 | 0.1 | DS 17 R 17 US 16 L 14 | 96 | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

# Appendix G – Detailed Geomorphic Surveys at Six Status and Trends Sites

## Appendix G- Detailed Geomorphic Survey at Six Status and Trend Sites

This appendix displays the data collected at the six Level 1 sites. As described in Appendix C, the Level 1 sites are considered detailed status and trends sites and involved the most in-depth level of geomorphic monitoring. All six of these sites coincide with previous geomorphic monitoring locations. Data collected at each of these sites include three surveyed cross sections in addition to the same geomorphic measurements taken for Level 2 sites. The Level 1 sites are a subset of the macroinvertebrate sampling sites. The sheets for each site in this Appendix were designed to resemble the stream sheets of past reports most closely.

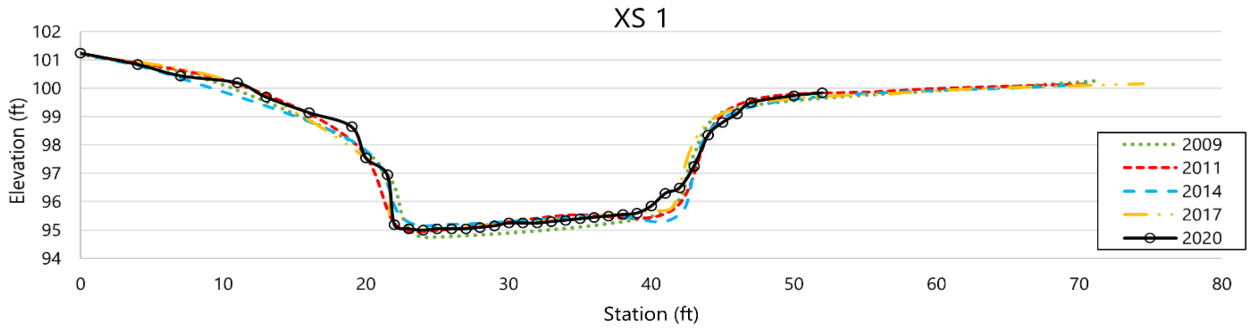
The purpose of the surveyed cross-sections at these six sites was to examine how the protocols from the previous geomorphic monitoring compared the protocols from this current study and to identify any potential trends in the geomorphic condition of the sites. In order to survey the same locations W2r had to locate the rebar monuments that were used previously to mark the cross-sections surveyed in 2009, 2011, 2014, and 2017. This proved an onerous task due to minimal notes, vegetation growth, and a lack of flagging or marking. W2r was able to locate a majority of the monuments at six sites, and for sites where monuments were not located notes were used to find the approximate location. These cross-sections are noted in the sheets below.

In general, W2r's cross-sections aligned well with those previously measured. There are a few cross-sections (KL-10 XS 1, SA-20 XS 3, and WI-10 XS 1) where there appears to be some discrepancy in the elevations collected, but the general geometry of the stream still aligns. The tables for each sheet display average channel geometry data for all three cross-sections across the 5 years of data collection. The trends of these measurements are outline in Appendix E.

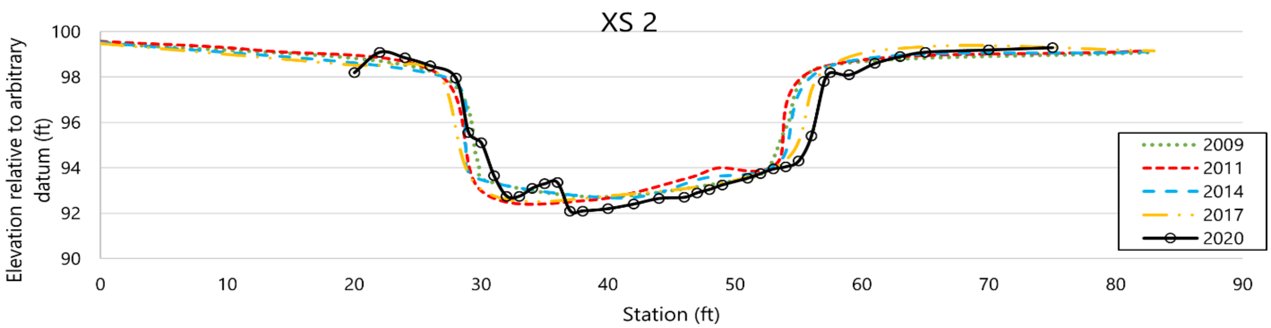
## Mt. Scott Creek (MS-40)

Lat: 649220.617, Long: 7667982.560

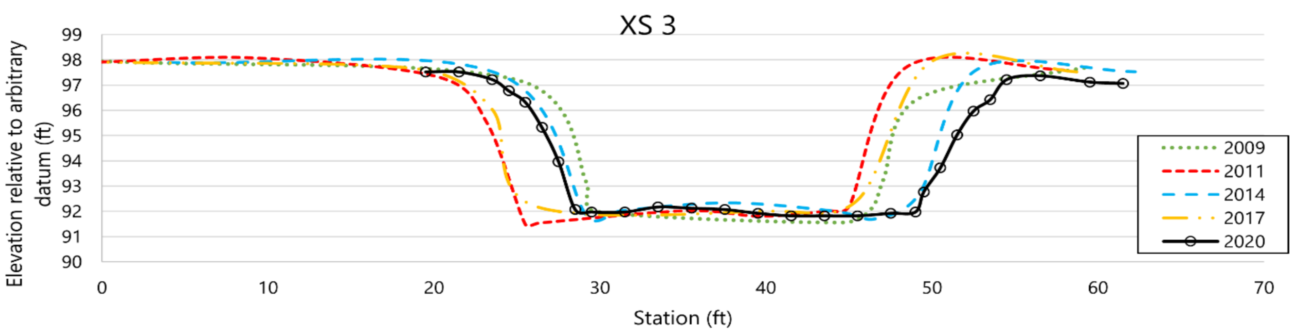
Surveyed January 24, 2022




*Right bank monument was not located. Cross-section ends 0.5 feet past top of right bank.




*Left and right bank monuments were not located. Cross-section location was estimated using WES notes. Stationing adjusted by 20 feet to align both sets of survey notes.




*Left and right bank monuments were not located. Cross-section location was estimated using WES notes. Stationing adjusted to align top of left bank.

### Average Bankfull Width, Depth and Width/Depth Ratio

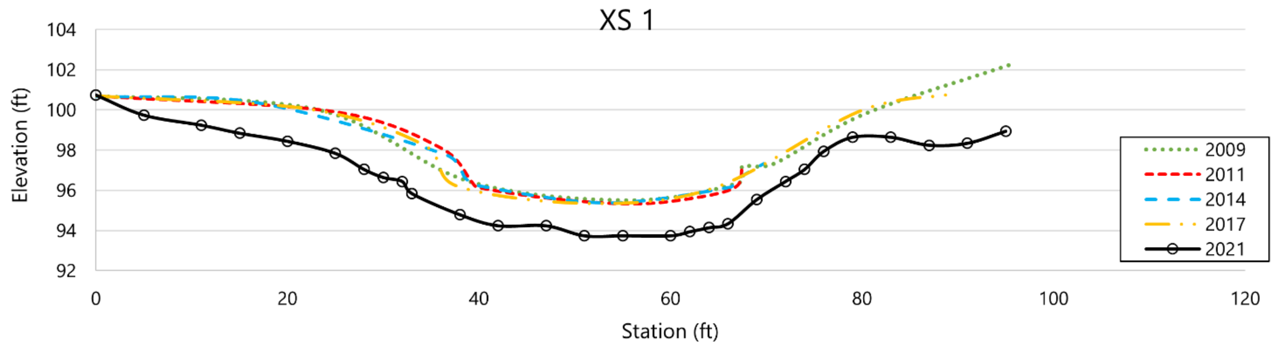
| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 21.20 | 2.30 | 9.10 |
| 2011 | 24.20 | 3.60 | 6.80 |
| 2014 | 22.60 | 1.40 | 15.70 |
| 2017 | 27.00 | 4.10 | 6.80 |
| 2021 | 21.77 | 1.70 | 12.80 |

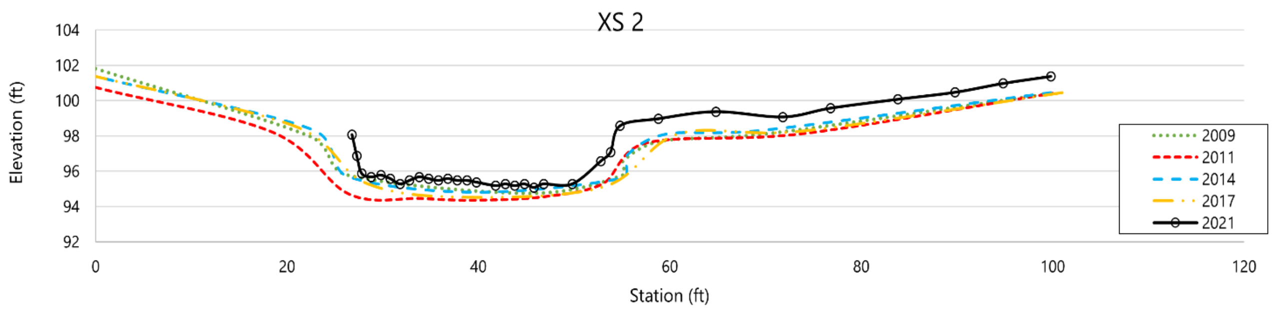
*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

## Kellogg Creek (KL-10)

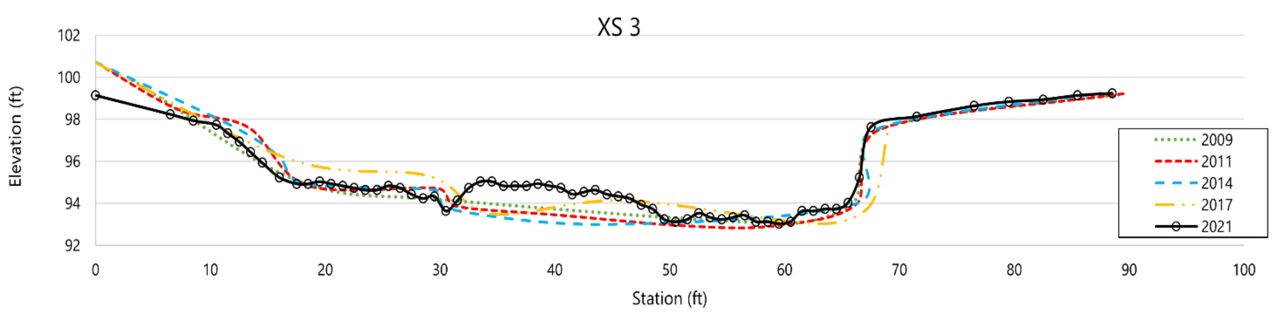
Lat: 650549.811, Long: 7656011.883

Surveyed January 24, 2022




* Left bank monument was on private property. The survey starts at top of left bank.




### Average Bankfull Width, Depth and Width/Depth Ratio

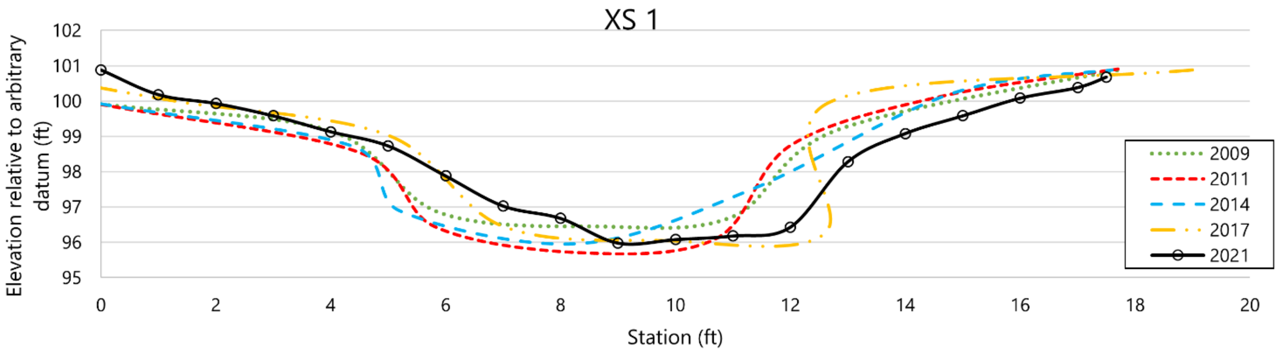
| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 39.90 | 2.30 | 17.10 |
| 2011 | 41.20 | 2.54 | 18.90 |
| 2014 | 37.70 | 2.00 | 19.10 |
| 2017 | 41.80 | 3.10 | 13.60 |
| 2021 | 37.20 | 3.30 | 11.40 |

*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

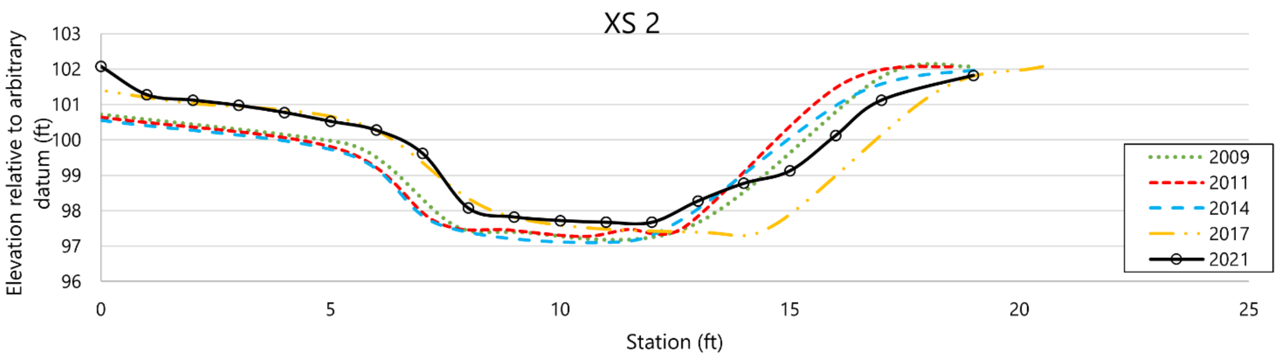
# Saum Creek (SA-20)

Lat: 629218.899, Long: 7629058.171

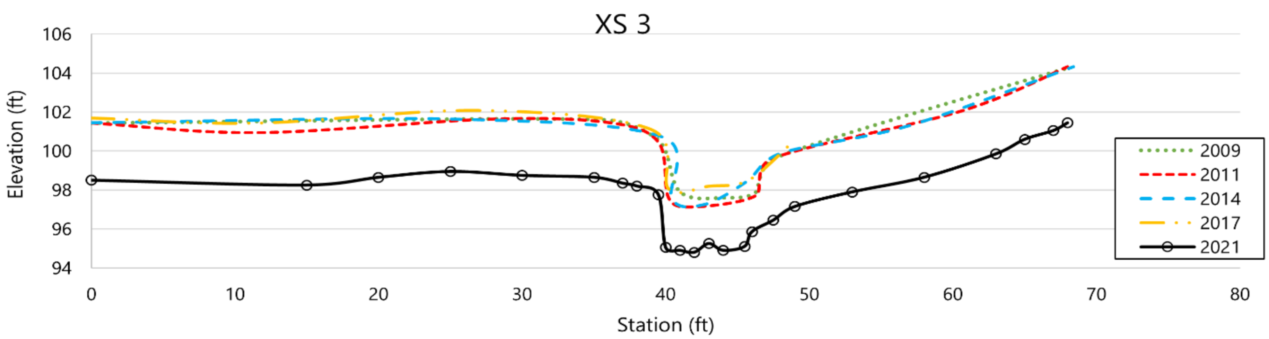
Surveyed February 11, 2022




* Left and right bank monuments were not located. Cross-section location estimated by WES notes and begins and ends at top of bank.




* Left bank monument was not located. Cross-section begins at edge of road to the right bank monument.




### Average Bankfull Width, Depth and Width/Depth Ratio

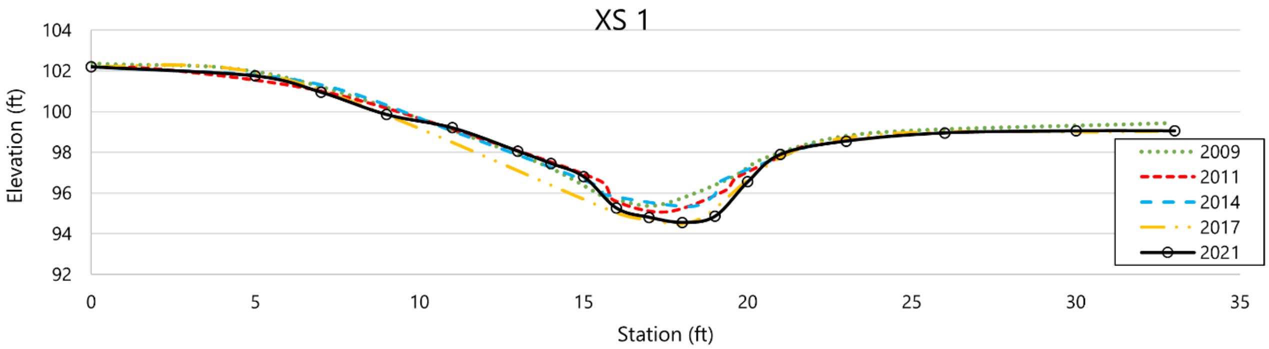
| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 8.40 | 2.20 | 3.70 |
| 2011 | 6.90 | 1.90 | 7.30 |
| 2014 | 5.40 | 1.10 | 5.80 |
| 2017 | 10.07 | 3.03 | 3.36 |
| 2021 | 9.50 | 2.70 | 3.52 |

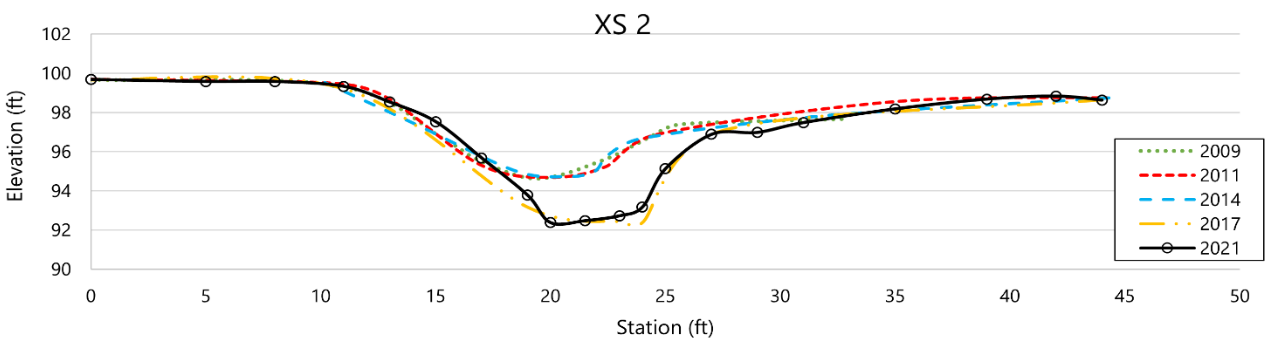
*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

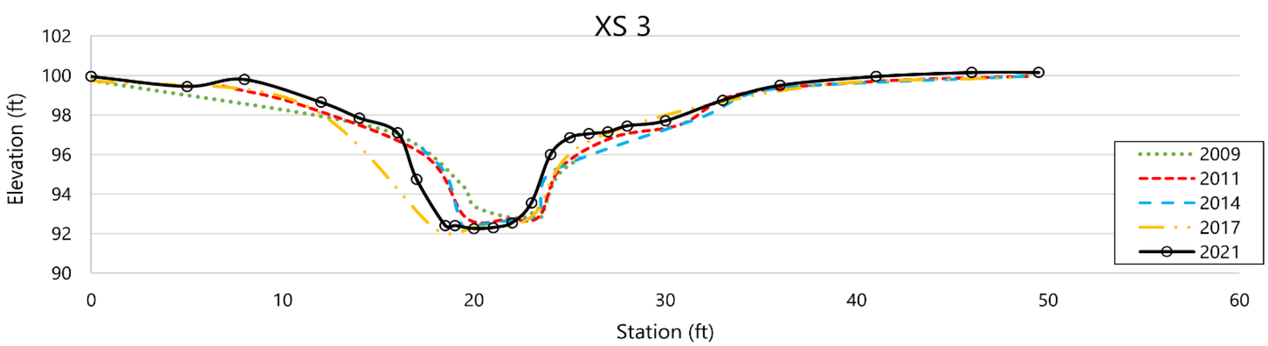
## Tate Creek (TA-10)

Lat: 623367.221, Long: 7644757.387

Surveyed February 11, 2022




### Average Bankfull Width, Depth and Width/Depth Ratio

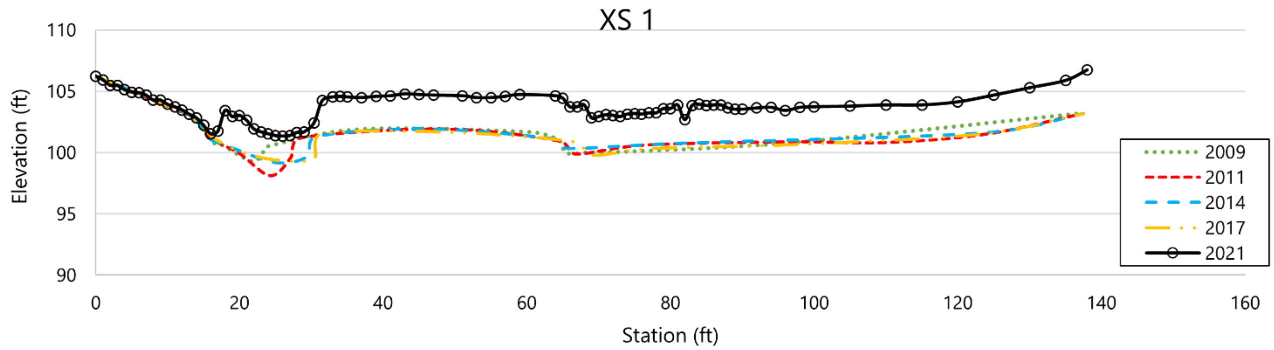
| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 7.20 | 2.10 | 3.40 |
| 2011 | 8.50 | 2.70 | 3.20 |
| 2014 | 7.20 | 1.80 | 4.30 |
| 2017 | 16.00 | 5.30 | 3.00 |
| 2021 | 6.87 | 2.23 | 3.07 |

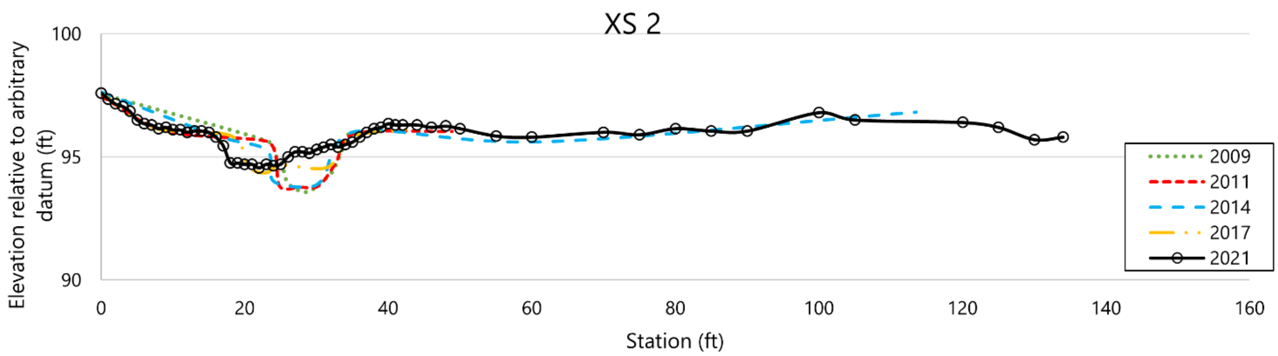
*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

# Wilson Creek (WI-10)

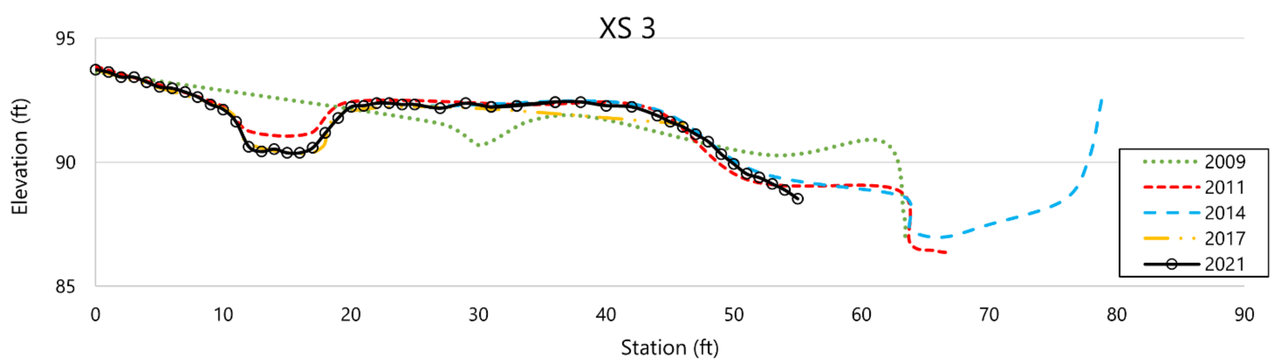
Lat: 631440.899, Long: 7641149.204

Surveyed January 25, 2022




* Right bank monument was not located. Cross-section ends at the toe of slope on the right bank.




### Average Bankfull Width, Depth and Width/Depth Ratio

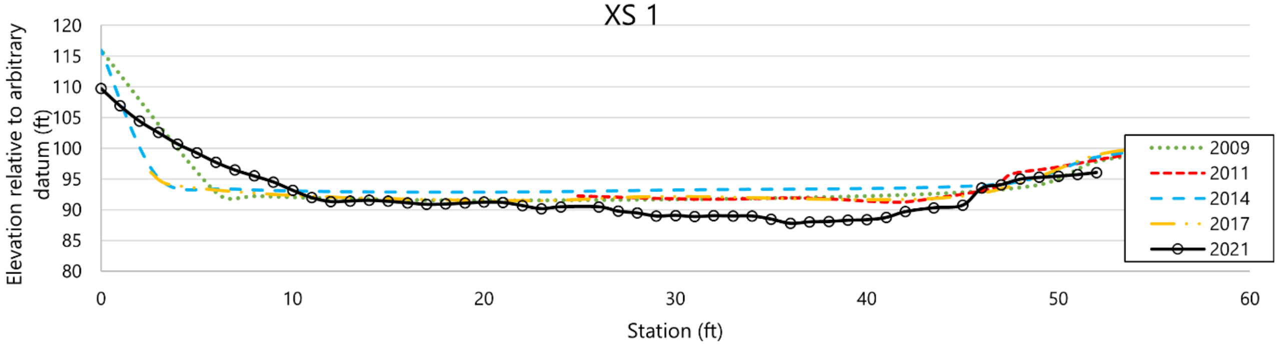
| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 7.20 | 1.20 | 6.30 |
| 2011 | 29.60 | 1.70 | 5.80 |
| 2014 | 22.60 | 1.40 | 15.70 |
| 2017 | 27.00 | 4.10 | 6.80 |
| 2021 | 21.77 | 1.70 | 12.80 |

*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

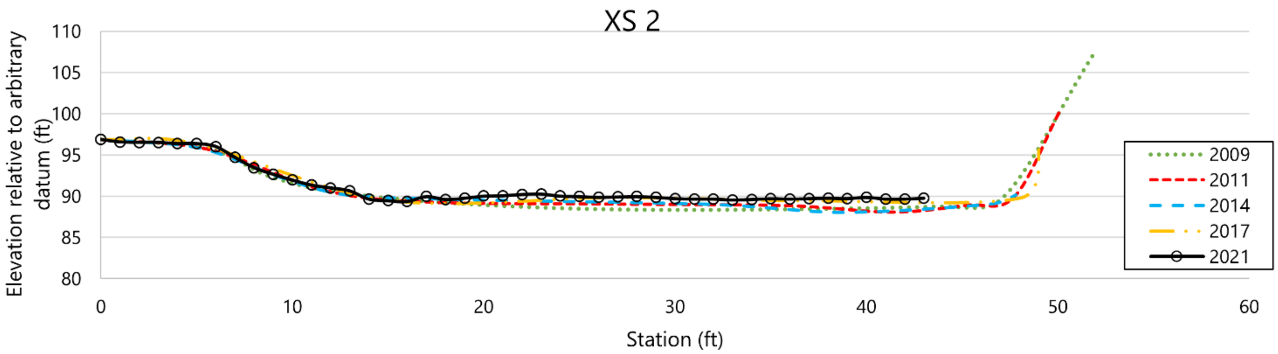
## Rock Creek (RC-10)

Lat: 641727.326, Long: 7686676.593

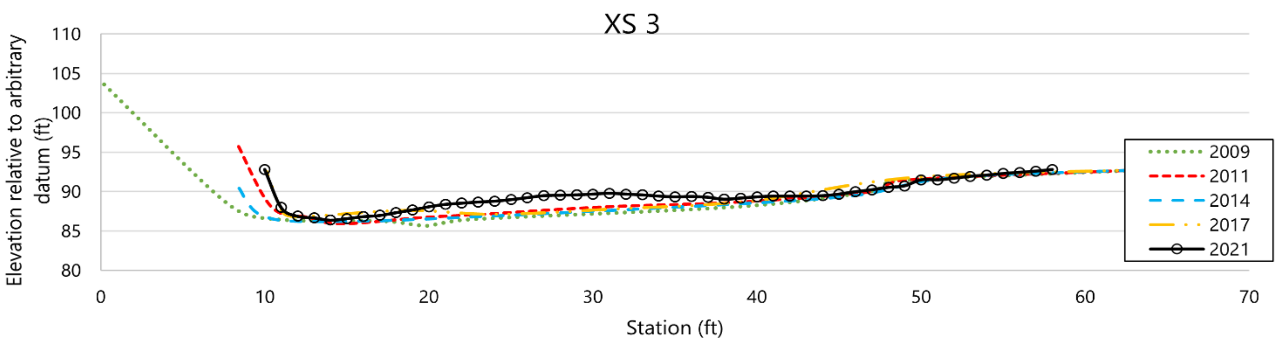
Surveyed January 25, 2022




*No monument on left bank due to wall of bedrock.




*No monument on right bank due to wall of bedrock.




*No monument on left bank due to wall of bedrock.

### Average Bankfull Width, Depth and Width/Depth Ratio

| Year | Average $W_{BF}$ | Average $D_{BF}$ | Average W/D |
|---|---|---|---|
| 2009 | 37.70 | 3.00 | 13.00 |
| 2011 | 36.60 | 2.60 | 18.90 |
| 2014 | 37.50 | 2.40 | 15.50 |
| 2017 | 44.30 | 5.30 | 8.40 |
| 2021 | 39.13 | 2.87 | 13.65 |

*In 2017, bankfull dimensions were measured according to topographic slope breaks at bank tops. Bankfull dimensions in 2009-2014 and 2021 were measured according to observed vegetation and scour indicators.

# Appendix H – Benthic Macroinvertebrate Monitoring Results

## Appendix H. Macroinvertebrate Health

*M-IBI metric values among all 2021 samples*

When considering model scores and corresponding biological conditions, it should be noted that the M-IBI often reflects better conditions than the O/E score for the same site. This is influenced by the fact that the O/E model relies on presence/absence of taxa expected based on reference sites, and changes in a few taxa can have a large influence on model outcome. In contrast, the M-IBI includes both taxonomic and ecological trait metrics, and thus some functions may be maintained even when community composition shifts. Scores for individual metrics ranged widely between samples (Figure 1), and although only five sites attained summed scores that corresponded to slight impairment (Pecan, Lower and Upper Rock, Richardson, and Trillium Creeks), individual metric values that corresponded to the highest scaled score in the IBI were attained at the following sites (threshold for top scaled score shown in parentheses; note that some metrics receive a higher scaled score at a lower raw trait value, i.e., % tolerant and % sediment-tolerant taxa; % dominance of top taxon; and community MHBI):

- taxa richness (>35 taxa): 7 sites (Lower Kellogg, Pecan, Lower, Middle, and Upper Rock, Sieben, and Trillium)
- Mayfly (Ephemeroptera) richness (>8 taxa): 0 sites; the most mayfly taxa in any sample was 8 (Upper Rock)
- stonefly (Plecoptera) richness (>5 taxa): 1 site (Richardson)
- caddisfly(Trichoptera) richness (>8 taxa): 0 sites; the most mayfly taxa in any sample was 8 (Middle Rock)
- # sensitive taxa (>4): 0 sites; the greatest number of sensitive taxa taken in any sample was 4 (Richardson)
- # sediment-sensitive taxa (≥2 taxa): 2 sites (Pecan and Richardson)
- MHBI (measure of tolerance to organic enrichment; <4.0): 2 sites (Pecan and Upper Rock)
- % tolerant taxa (<15%): 7 sites (Athey, Pecan, Richardson, Shipley, Sieben, Tate, and Trillium)
- % sediment-tolerant taxa (<10%): 8 sites (Carli, Lower Mt. Scott, Phillips, Lower Rock, Richardson, Shipley, Sieben, and Trillium)
- % dominant taxon (most abundant taxon in sample; <20%): 8 sites (Lower Kellogg; Lower and Upper Mt. Scott; Lower, Middle, and Upper Rock; Tate; and Unnamed Tributary 2)

Ranges for M-IBI metrics and additional calculated community metrics are shown in Table 1.

**Table 1. Summary of calculated metrics among 2021 samples. SD = standard deviation.**

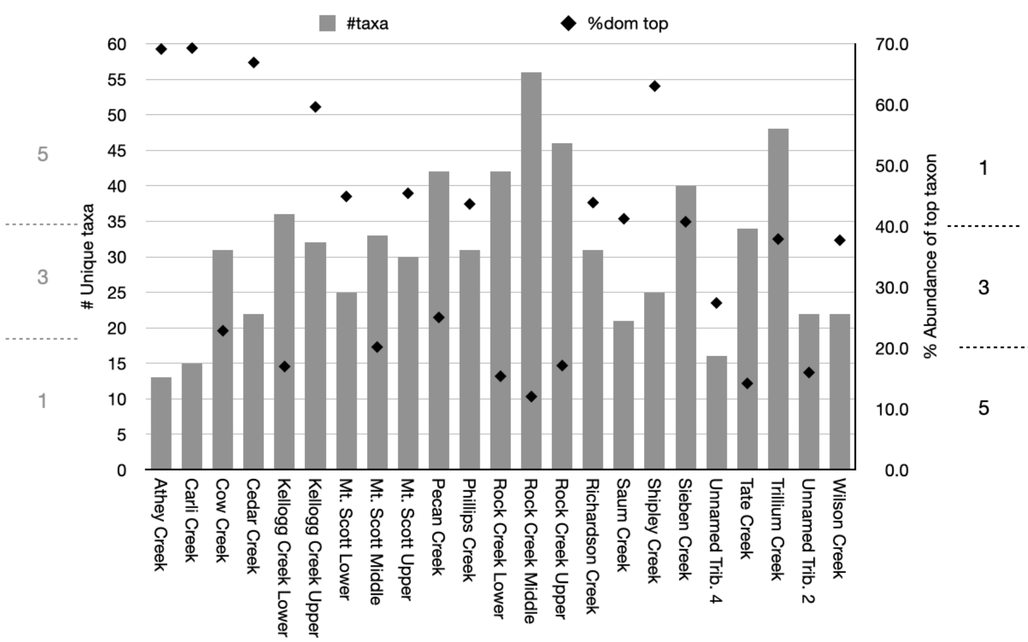
| Community trait | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| **M-IBI METRICS** | | | | |
| **total # taxa** | 13.0 | 56.0 | 31.0 | 10.7 |
| **# Ephemeroptera taxa** | 0.0 | 8.0 | 3.0 | 2.2 |

| Community trait | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| **# Plecoptera taxa** | 0.0 | 7.0 | 1.5 | 1.9 |
| **# Trichoptera taxa** | 0.0 | 8.0 | 3.1 | 2.3 |
| **# sensitive taxa** | 0.0 | 4.0 | 1.0 | 1.1 |
| **# sediment-sensitive taxa** | 0.0 | 3.0 | 0.7 | 0.8 |
| **% abundance of top (dominant) taxon** | 12.0 | 69.3 | 36.8 | 18.2 |
| **% abundance tolerant taxa** | 0.3 | 83.9 | 41.3 | 25.7 |
| **% abundance sediment tolerant taxa** | 0.5 | 76.0 | 21.2 | 22.4 |
| **MHBI (modified Hilsenhoff Biotic Index)** | 3.1 | 7.1 | 5.4 | 1.1 |
| **ADDITIONAL COMMUNITY METRICS** | | | | |
| **# organisms sorted in sample** | 62.0 | 572.0 | 424.3 | 181.0 |
| **# EPT taxa** | 0.0 | 17.0 | 7.6 | 5.1 |
| **% abundance non-insect taxa** | 1.6 | 87.4 | 33.0 | 27.6 |
| **FEEDING GUILDS** | | | | |
| **% abundance predator** | 1.1 | 30.6 | 6.4 | 6.0 |
| **% abundance scraper** | 0.0 | 38.3 | 8.4 | 10.9 |
| **% abundance shredder** | 0.0 | 40.7 | 6.4 | 10.6 |
| **% abundance collector-filterer** | 0.0 | 66.7 | 16.0 | 18.8 |
| **% abundance collector-gatherer** | 15.6 | 91.8 | 59.2 | 21.6 |
| **VOLTINISM** | | | | |
| **% abundance multivoltine** | 2.4 | 76.6 | 33.6 | 19.8 |
| **% abundance univoltine** | 23.4 | 85.9 | 60.5 | 18.8 |
| **% abundance semivoltine** | 0.0 | 27.4 | 3.9 | 6.4 |
| **TEMPERATURE ASSOCIATION** | | | | |
| **% abundance cool/cold-associated** | 1.6 | 77.9 | 28.4 | 21.3 |
| **% abundance warm-associated** | 0.0 | 60.4 | 9.6 | 15.4 |
| **% abundance cool_warm associated** | 8.8 | 92.3 | 49.1 | 24.9 |
| **FLOW ASSOCIATION** | | | | |
| **% abundance depositional-associated** | 0.7 | 89.4 | 21.5 | 25.0 |
| **%a abundance erosional-associated** | 0.4 | 81.8 | 39.6 | 26.0 |
| **% abundance mixed flow association** | 4.7 | 65.0 | 26.4 | 15.5 |

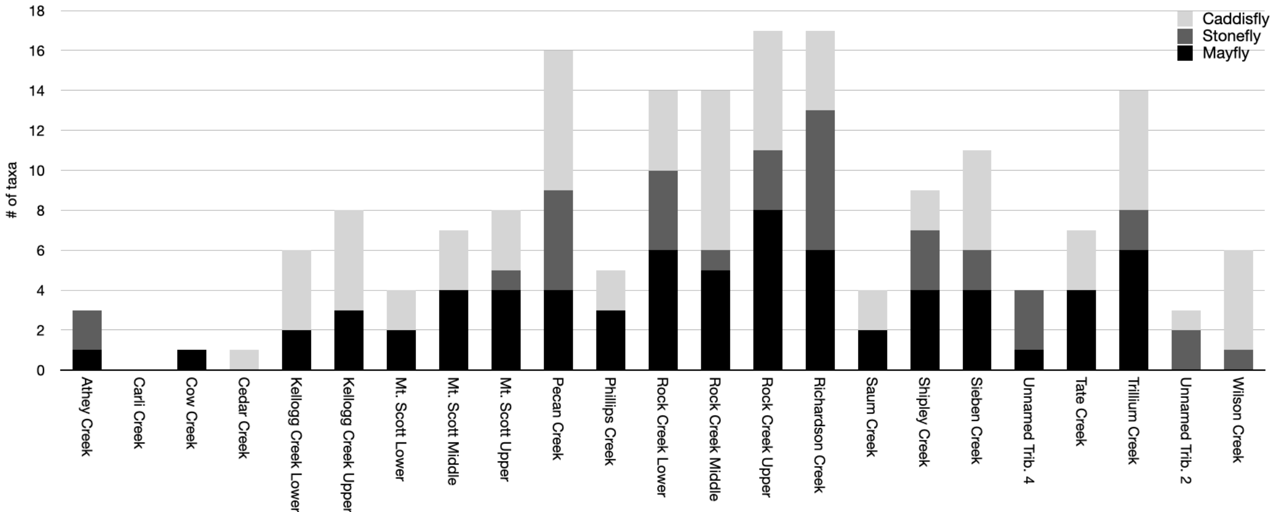
| Community trait | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| **HABIT** | | | | |
| **% abundance burrower** | 0.7 | 73.7 | 13.5 | 19.9 |
| **% abundance climber** | 0.0 | 16.3 | 3.3 | 4.3 |
| **% abundance crawler** | 0.0 | 6.6 | 1.4 | 1.5 |
| **% abundance clinger** | 3.2 | 76.0 | 34.8 | 21.3 |
| **% abundance sprawler** | 1.5 | 32.7 | 12.4 | 8.7 |
| **% abundance swimmer** | 0.0 | 57.8 | 22.1 | 17.2 |

**Figure 1. Raw values of individual M-IBI metrics among 2021 samples. Where present, dotted lines indicate cutoff values for scoring ranges in the IBI. Note that some metrics are positive (a higher raw value receives a higher scaled score) and some are negative (a higher raw value receives a lower scaled score).**

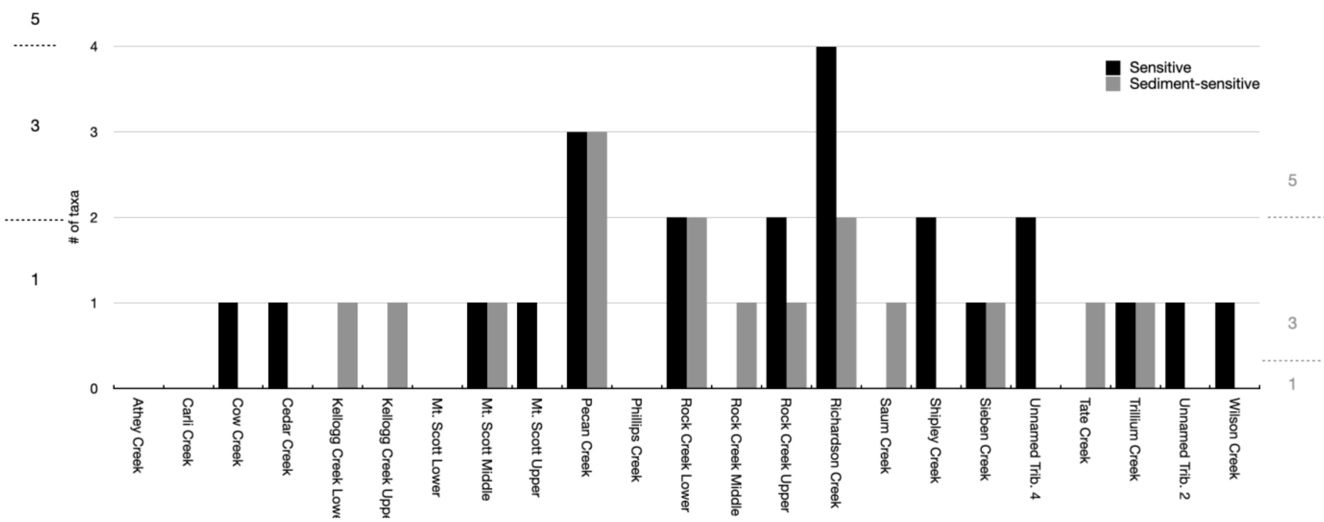
**A. Taxa richness and top taxon dominance (relative abundance)**



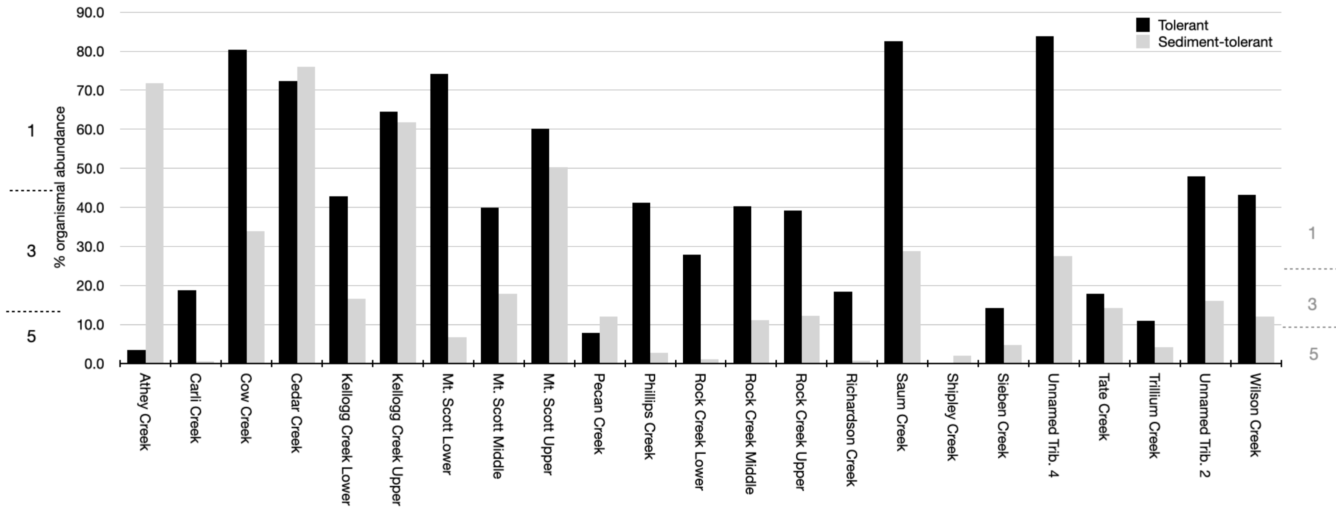
**B. Number of caddisfly, stonefly, and mayfly taxa. These metrics are scored separately in the M-IBI, with the highest scaled score attained at >8 mayfly, >5 stonefly, and >8 caddisfly taxa.**



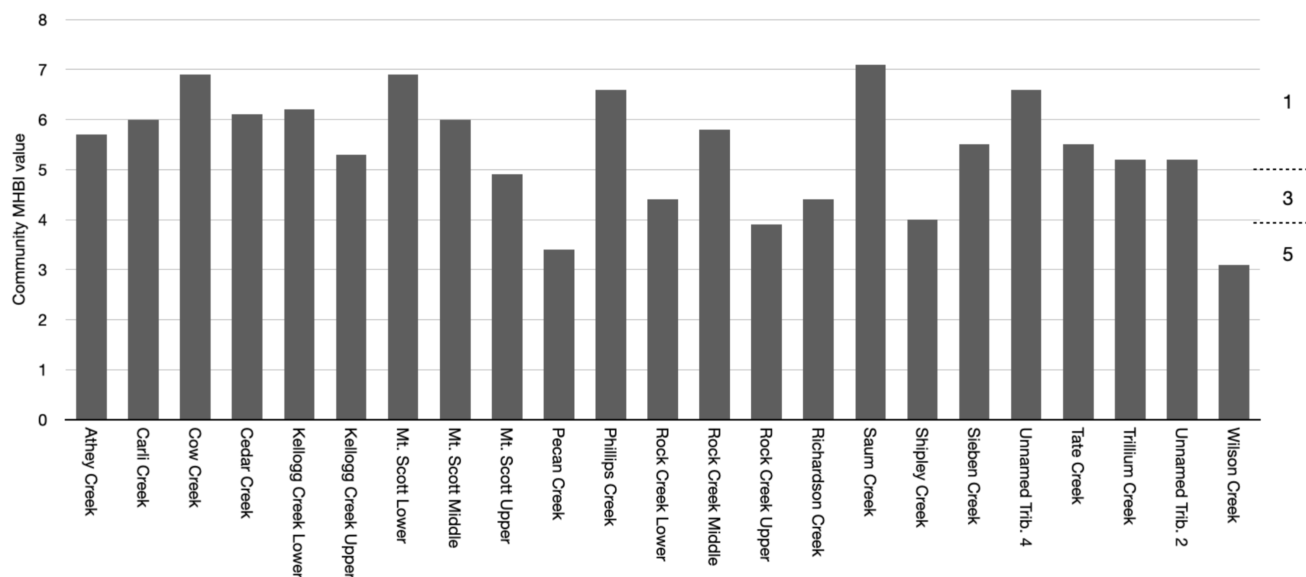

**C. Number of sensitive and sediment-sensitive taxa (assigned from ORDEQ unpublished data).**



**D. Relative abundance of tolerant and sediment-tolerant taxa (assigned from unpublished ORDEQ data tables)E. Community MHBI. Values for individual taxa range from 1 to 10, with higher values indicating**




**greater tolerance to organic pollution. Community score is calculated as a weighted average.**



*Trends in metrics and community composition among 2021 sampling sites*

<u>Athey Creek (M-AT-10)</u>

Athey Creek is consistently dominated by common, tolerant taxa such as midges, snails, and scuds (Figure 2). However, the community was much more unbalanced in 2021, with nearly three-quarters of organismal abundance comprised of lumbriculid worms, and this anomalous super-abundance of the top taxon largely accounts for the increasing trend in this metric. Similarly, while both total and EPT richness have been higher in prior years, especially in 2017 (Figure 3), the 2021 sample community was depauperate, and both values were lower in 2021 compared to any other year. M-IBI and O/E scores reflected these changes, as both were much lower in 2021 compared to any prior year (Figure 10). O/E scores have been relatively stable over time and have been at the upper end of the most disturbed range prior to 2021, while increases in M-IBI scores, especially after 2011, reflected changes from severe to slight impairment, but the 2021 score fell again into the severely impaired range. Composition of the 2021 community differed substantially from all other sampling years (~30% overall similarity; Figure 11), due primarily to the overwhelming abundance of worms; community similarity between more recent years was much greater (i.e., ~70%). Flow in the reach was very low at sampling time, and the reach was also shifted to the other side of Borland Road due to difficulties with access, and community changes reflect this.

Despite this, the temperature stressor score was identical to that in 2017 (18.5$^{o}$C) and just slightly above the threshold value, while the sediment model stressor score was lower in 2021 than in 2017 and slightly below the threshold value (17.4%), suggesting that neither of these may be significant stressors. Dominant community traits in 2021 included high relative abundances of sediment-tolerant; non-insect; burrower; collector-gatherer; and univoltine organisms; a high community MHBI (6.1), which reflects a community adapted to organic inputs; and more organisms associated with slower flows and cooler temperatures.

**Figure 2. Dominant (most abundant) taxon at Athey Creek over time. Linear trendline is shown.**

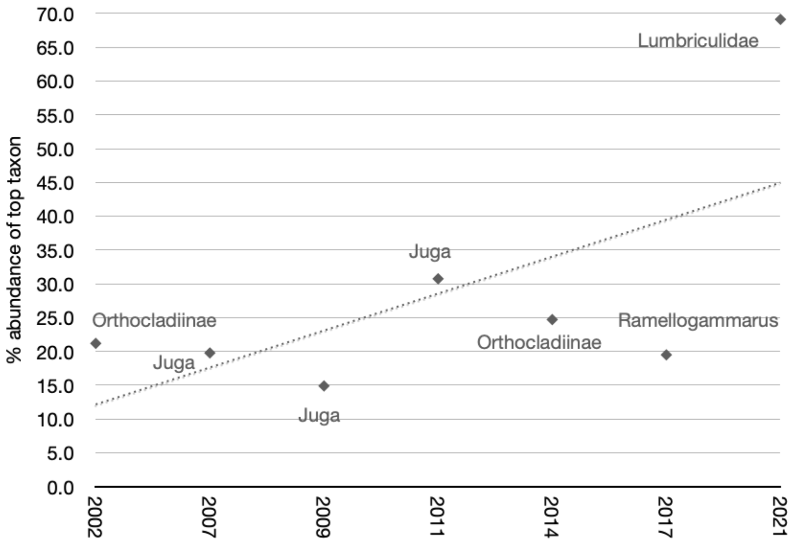



**Figure 3. Total and EPT richness at Athey Creek. Linear trendlines are shown.**

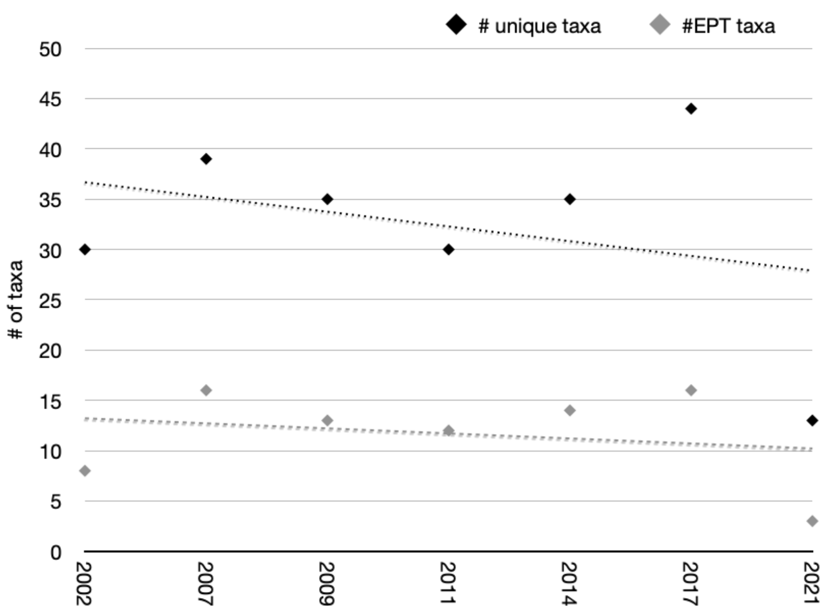


**Figure 4. M-IBI and O/E scores for Athey Creek. Linear trendlines and thresholds for condition assignments are shown.**

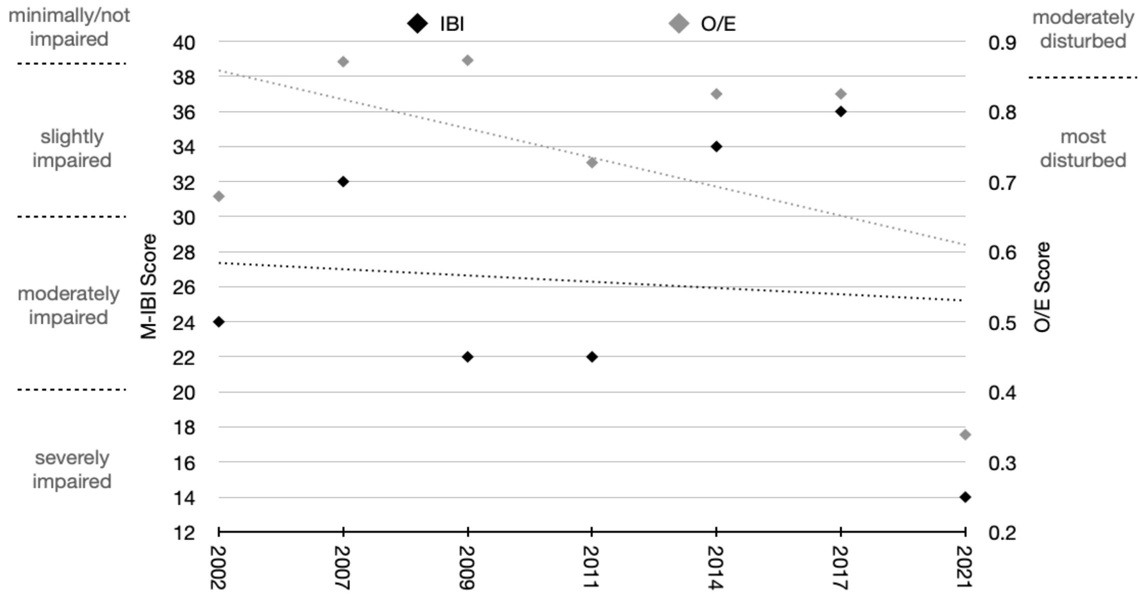
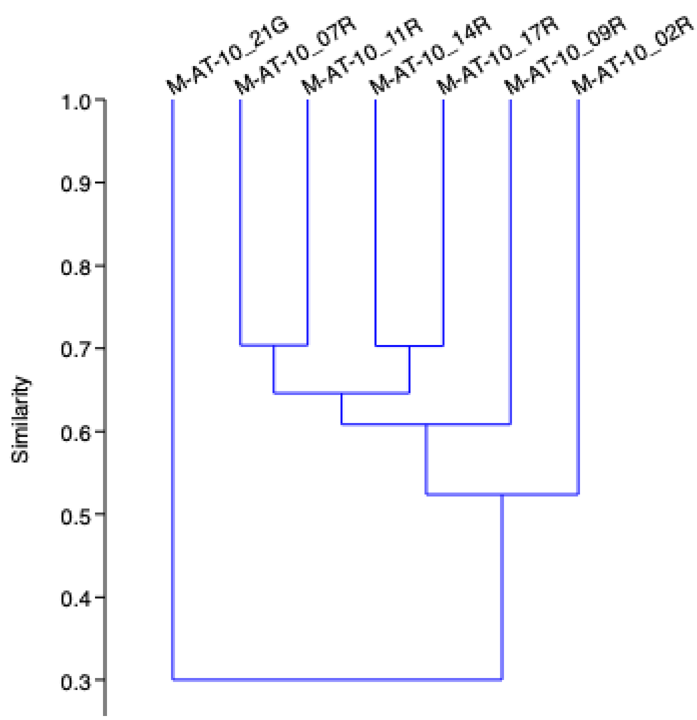



**Figure 5. CLUSTER dendrogram representing similarity of macroinvertebrate communities at Athey Creek. Analysis was run on a Bray-Curtis Similarity Index of square root-transformed taxa abundances. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Carli Creek (M-CA-10)

Although the number of total taxa taken at Carli Creek (15) was at the lower end of the 2021 range, it differed little from the last three sampling years, and taxa richness has been trending upwards here (Figure 6). Similarly, although no EPT were taken in 2021, no more than two EPT taxa have ever been taken in the reach, and both were relatively tolerant small minnow mayflies (Figure 6). M-IBI and O/E scores consistently indicate severely disturbed conditions; however, the 2021 O/E score was the same as in 2017 while the IBI score was higher, and both appear to be trending upwards (Figure 7). The temperature stressor score (18.9°C) was slightly higher than in 2017 and was just above the threshold value. The sediment stressor score was almost two-fold lower in 2021 (18.4%) compared to 2017 and was just below the threshold value. Dominant community traits in 2021 included high relative abundances of rapidly-developing (multivoltine) organisms, burrowers, tolerant organisms, and collector-gatherers; more organisms associated with slower flows and a broad range of temperatures. The community MHBI score, although slightly lower in 2021 (6.0) compared to 2017 (6.2), indicates a community tolerant of organic enrichment. The unbalanced community composition and dominance of multivoltine taxa in 2021 suggest higher levels of disturbance in this reach.

This site has been consistently dominated at very high abundance (40-70%) by common, tolerant taxa especially crustaceans (amphipods and isopods) and *Baetis tricaudatus* mayflies (Figure 8), although the relative abundance in each year prior to 2021 has been decreasing, suggesting improved habitat stability. However, in 2021 the majority of the sample (~70%) consisted of a tolerant non-biting midge (*Apedilum*). The 2021 community was most similar to that in 2014, and this pair differed more from all other sampling years (25% overall similarity; Figure 9), with fewer crustacea and more non-biting midge taxa. It remains to be seen whether the difference in metric values at this site in 2021 were due to an unusually hot dry summer, or if the community is experiencing new or increased disturbance such as hydrologic changes, pollution, or riparian zone degradation.

**Figure 6. Total and EPT richness at Carli Creek. Linear trendlines are shown.**

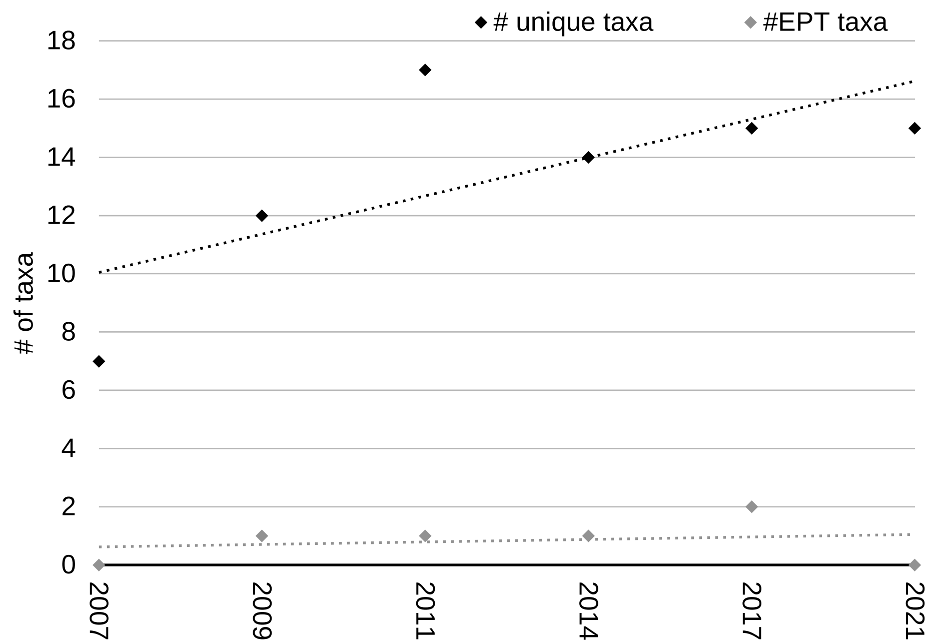



**Figure 7. M-IBI and O/E scores for Carli Creek. Linear trendlines and thresholds for condition assignments are shown.**

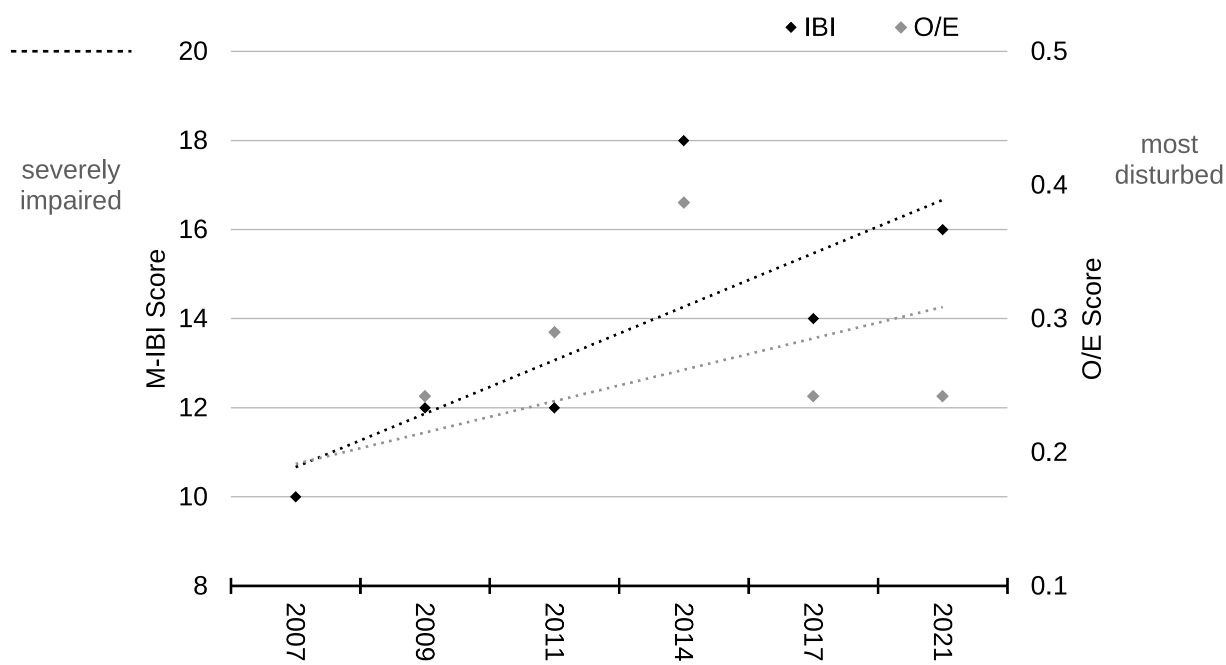


**Figure 8. Dominant (most abundant) taxon at Carli Creek. Linear trendline is shown.**

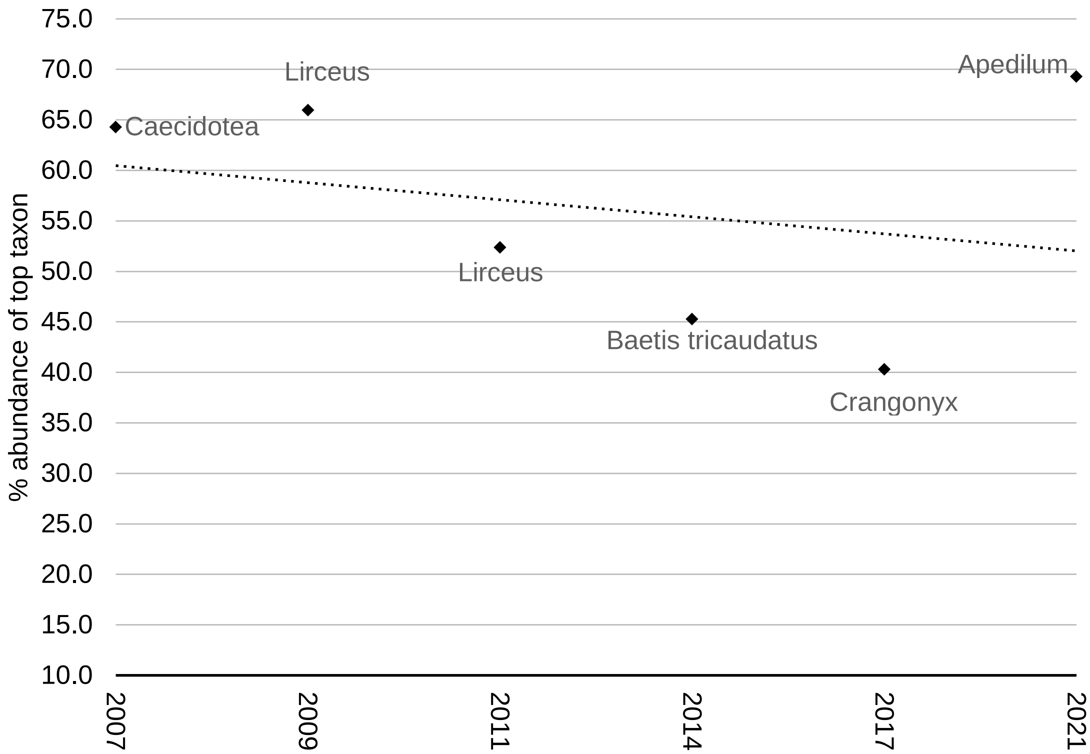
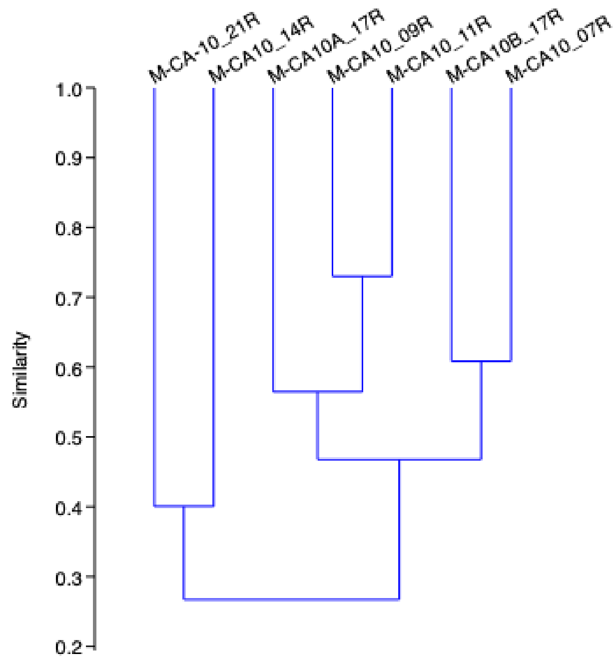


**Figure 9. CLUSTER dendrogram of macroinvertebrate community similarity at Carli Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Cedar Creek (M-CE-10)

Taxa richness at Cedar Creek has been trending upwards (Figure 10), but in 2021 this number decreased substantially, and only one EPT taxon was seen (the tolerant net-spinning caddisfly *Cheumatopsyche*), which is also fewer than in recent years (Figure 10). M-IBI and O/E scores have consistently indicated severely disturbed conditions, and although the M-IBI scores increased in recent years, scores for both models were lower in 2021 (Figure 11). The temperature model stressor score was slightly lower in 2021 (21.3ºC) compared to 2017 (22.4ºC), but both are above the threshold value. Sediment stressor model scores were almost identical in 2021 and 2017 (39.1 and 39.9, respectively), and well above the threshold value. Dominant community traits in 2021 included high abundances of both tolerant and sediment-tolerant organisms, univoltine taxa, and collector-gatherers; and a high community MHBI. (6.1).

This site is consistently dominated at high abundances (29-67%) by tolerant taxa (Figure 12), and while in recent years the dominant taxon has been a caddisfly taxon, the 2021 community was comprised largely of naidid worms. These differences were likely influenced by the fact that only glide habitat was available for sampling in 2021, and the community composition was more similar to glide samples taken in other years (2002, 2007), with more worms and tolerant Chironomini non-biting midges, and with glide vs. riffle samples having relatively low overall similarity (~46%;  Figure 13).

**Figure 10. Total and EPT richness at Cedar Creek. Linear trendlines are shown.**

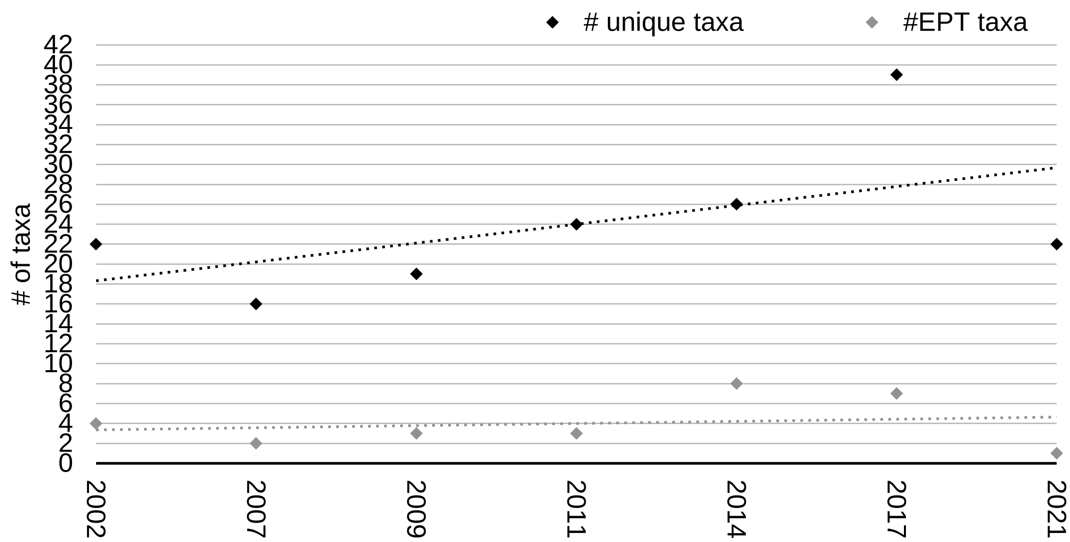



**Figure 11. M-IBI and O/E scores for Cedar Creek. Linear trendlines and thresholds for condition assignments are shown.**

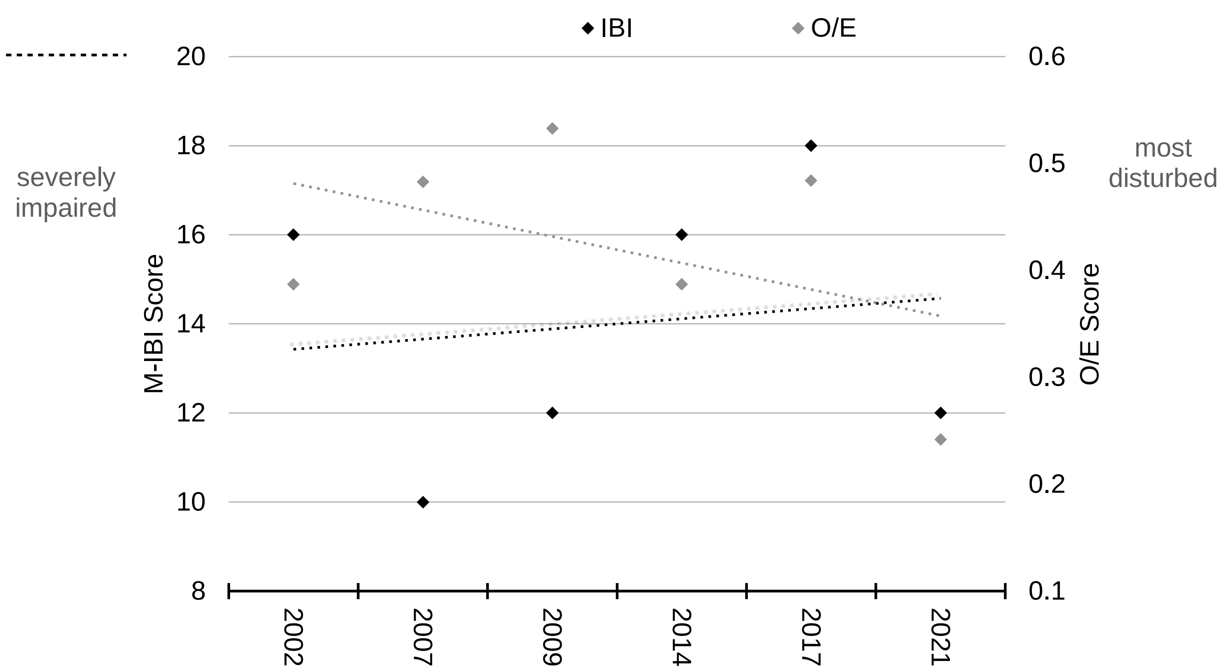


**Figure 12. Dominant (most abundant) taxon at Cedar Creek. Linear trendline is shown.**

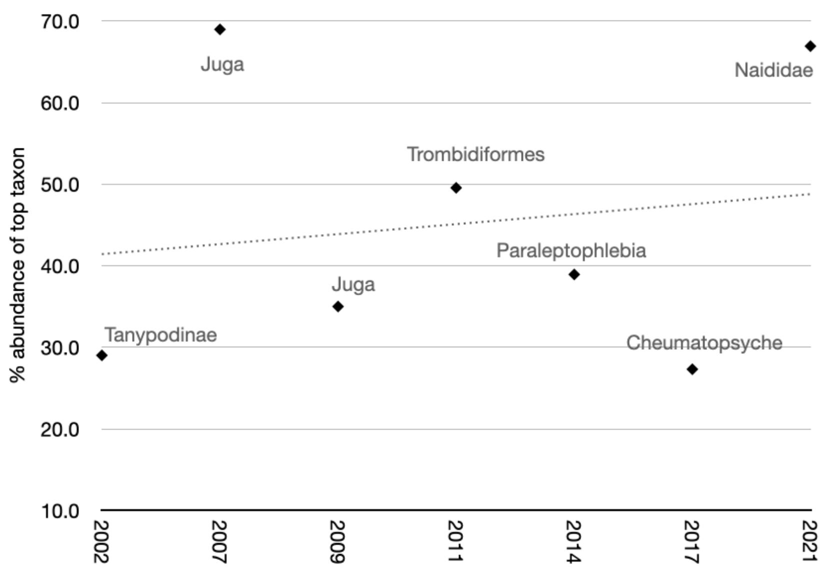
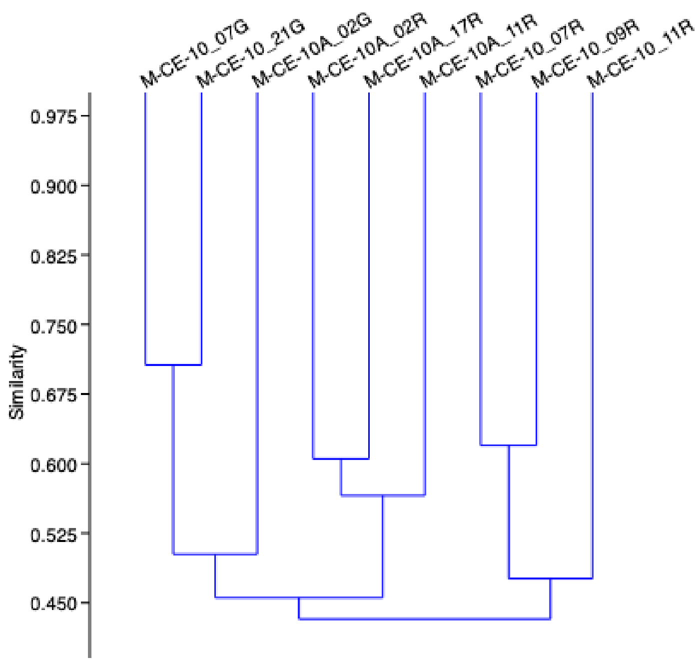



**Figure 13. CLUSTER dendrogram of macroinvertebrate community similarity at Cedar Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Cow Creek (M-CO-10)

Cow Creek resembled a wetland more than a stream at sampling time, and many community metrics related to flow and temperature associations and sediment tolerance reflected this. However, sampling conditions notwithstanding, more taxa were taken in 2021 (31) than in any prior year (Figure 14), and this metric is trending upwards. Only a single member of the more sensitive EPT was taken in 2021 (Figure 14), but no more than two EPT taxa have ever been seen here, and these are more relatively tolerant types (*Callibaetis* small minnow mayfly, *Hydropsyche* net-spinning addisfly). M-IBI and O/E scores vary across time (Figure 15), and while both were lower in 2021, this site has always scored as severely impaired/most disturbed. Temperature and sediment stressor model scores were not calculated in prior years, as this is a low-gradient stream that lacks riffles, but both (24.9ºC and 87.8% sediment) were well above the threshold values in 2021. Dominant community traits in 2021 included high abundances of tolerant organisms; organisms adapted to a variety of flow types; collector-gatherers; and a high community MHBI (6.9) indicative of a community adapted to organic inputs.

The community is routinely dominated by tolerant and sediment-tolerant taxa such as worms and pea clams, but in recent years relative abundance of the top taxon has been at or near the cutoff value for the highest scaled score in the M-IBI (Figure 16), and values for this metric decreased after reaching a high in 2011. No strong patterns in between-year community similarity are evident (Figure 17), and the 2021 community more similar to earlier years (2007, 2009).

**Figure 14. Total and EPT richness at Cow Creek. Linear trendlines are shown.**

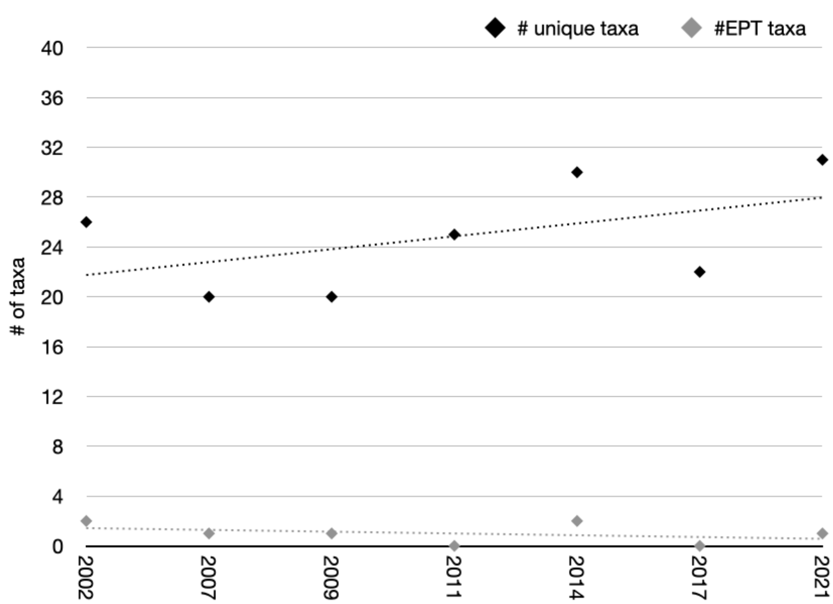


**Figure 15. M-IBI and O/E scores for Cow Creek. Linear trendlines and thresholds for condition assignments are shown.**

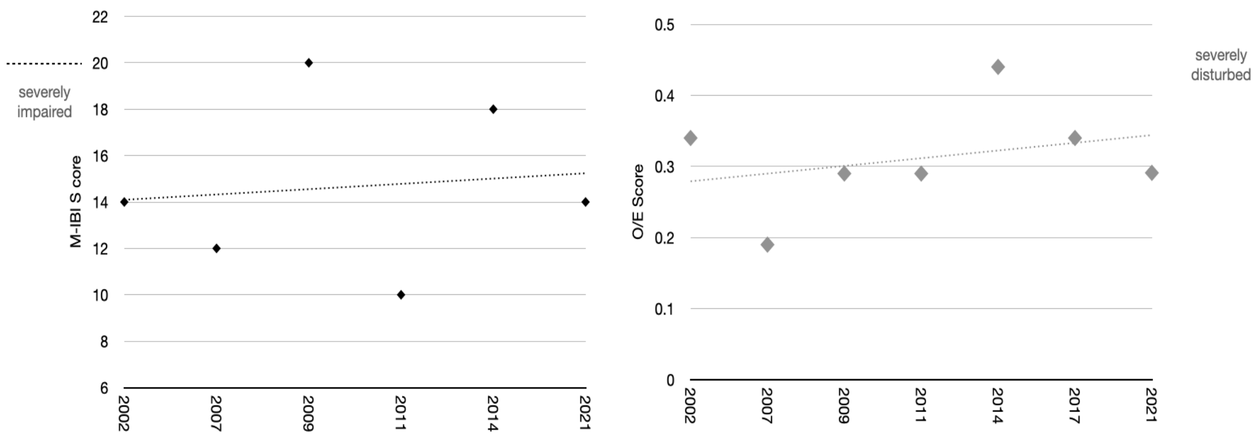



**Figure 16. Dominant (most abundant) taxon at Cow Creek. Linear trendline is shown.**

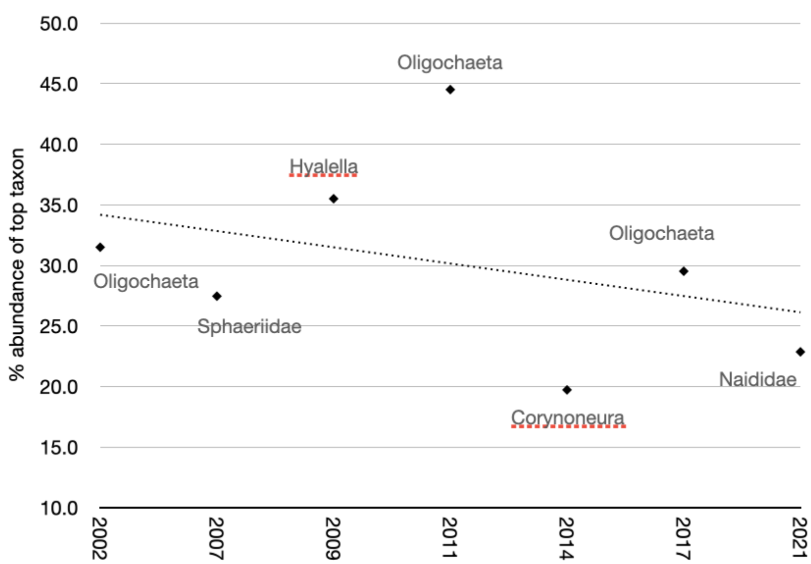
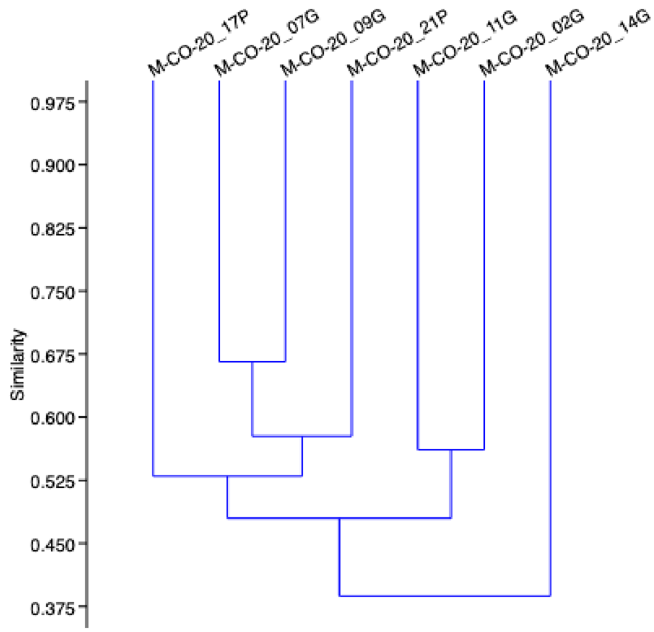


**Figure 17. CLUSTER dendrogram of macroinvertebrate community similarity at Cow Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Lower Kellogg Creek (M-KL-10)

Taxa richness has been increasing over time at Lower Kellogg Creek (Figure 18), and there were more taxa in 2017 and 2021 (36 and 35, respectively) than in any prior year. There are also more EPT in recent sampling years (Figure 18), although EPT richness seems to have plateaued (Figure 18) and may have stabilized with current flow and substrate conditions. The M-IBI score was higher in 2021 (25) than in any prior year, (Figure 19); this score has increased overall and 2009 was the only year in which it was low enough to score as severely impaired. O/E scores consistently reflect severely disturbed conditions, and the 2017 and 2021 scores were low and identical (0.39; Figure 25). The temperature model stressor score was slightly higher in 2021 (23.5°C) than in 2017 (22.2°C), and both are above the threshold value. There was a greater increase in the sediment stressor model score in 2021 (36.6%) compared to 2017 (21.8%), and these are also well above the threshold value. Dominant community traits in 2021 included high abundances of tolerant and univoltine organisms; collector-gatherers; organisms that tolerate a range of water temperatures and flow types; clingers; and a high community MHBI (6.2). Metric and model values suggest a community that is stressed by temperature and sediment input, but with habitat that is relatively stable.

The community is consistently dominated by tolerant taxa (Figure 20), but has become much more balanced (i.e., lower relative abundance of top taxon), which suggests more stable/less impaired habitat. In addition, the dominant taxon in three sampling years was a member of the EPT, albeit a relatively tolerant type *(Baetis tricaudatus* mayfly, *Cheumatopsyche* caddisfly). The 2021 community was dominated by a tolerant taxon (the isopod *Caecidotea)*, but it represented only 17% of total sample organismal abundance, the lowest in any sampling year. Between-year community similarity was relatively high among most years (Figure 21), but samples taken in the most recent monitoring years had the highest overall similarity (~65%).

**Figure 18. Total and EPT richness at Lower Kellogg Creek. Linear trendlines are shown.**

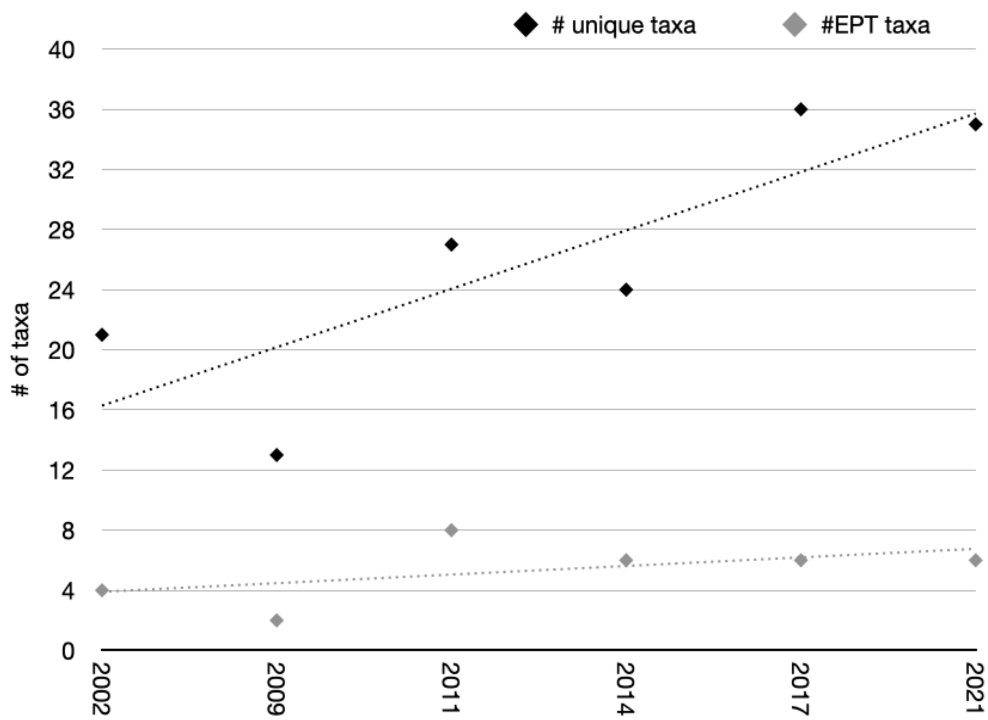


**Figure 19. M-IBI and O/E scores for Lower Kellogg Creek. Linear trendlines and thresholds for condition assignments are shown.**

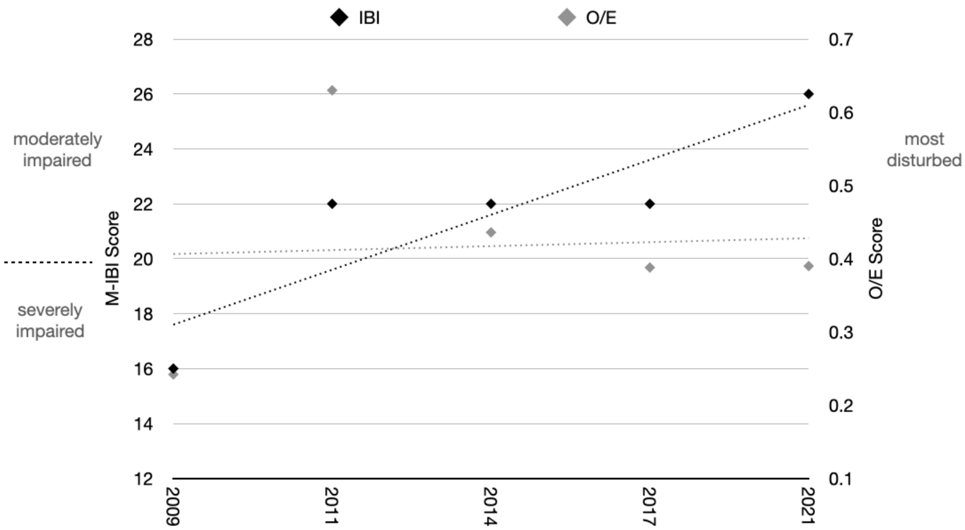



**Figure 20. Dominant (most abundant) taxon at Lower Kellogg Creek. Linear trendline is shown.**

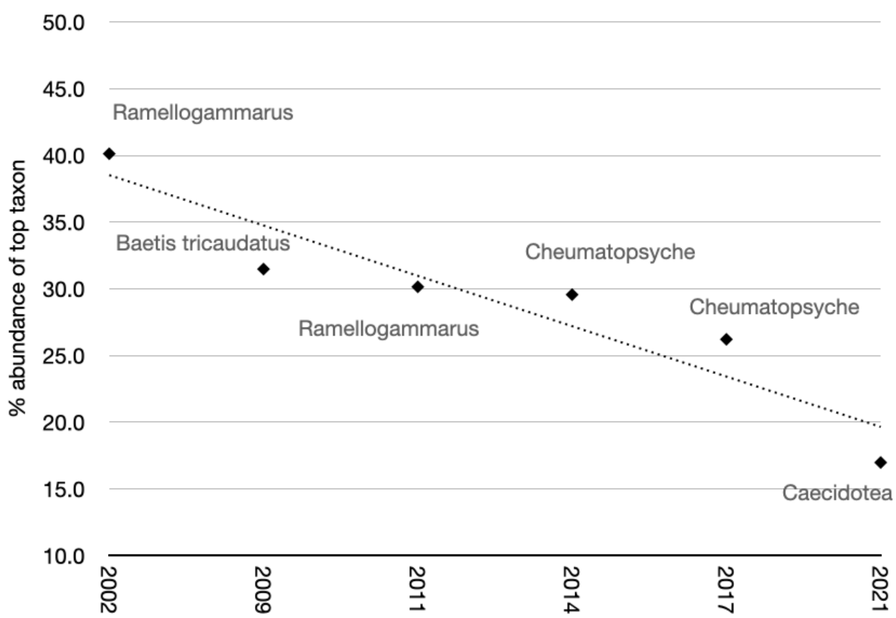
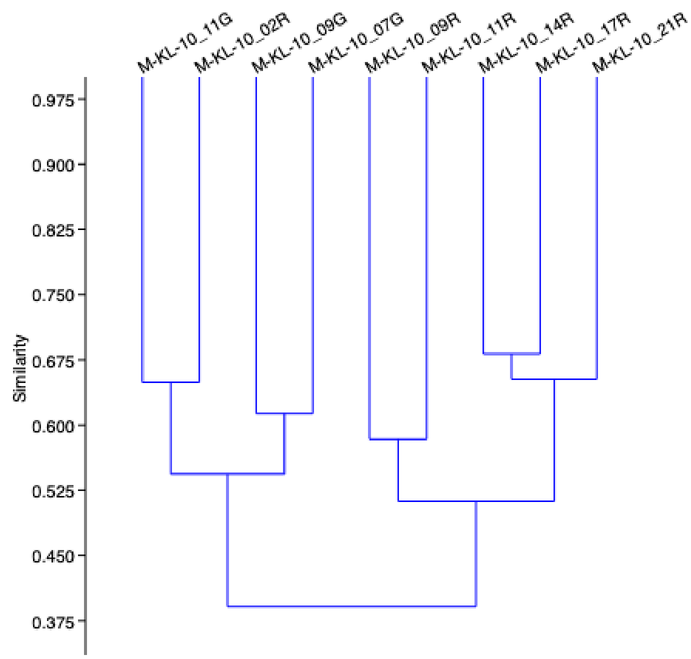


**Figure 21. CLUSTER dendrogram of macroinvertebrate community similarity at Lower Kellogg Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Middle Kellogg Creek (M-KL-20)

Fewer taxa were taken at Middle Kellogg Creek in 2021 (32) compared to the prior sampling year, (38) but richness was still greater than in the earliest sampling years and this metric has increased over time (Figure 22). The number of EPT taxa taken in 2021 (8) was almost the same as the prior year (9), and both are greater than in earlier sampling years (Figure 22). However, M-IBI and O/E scores were lower in 2021 than in any other sampling year (Figure 23), reflecting severely degraded conditions. Both scores were relatively stable between 2014 and 2017, with the M-IBI corresponding to moderate disturbance, although this site has always scored as severely disturbed based on O/E scores. Temperature model stressor scores were similar in 2021 (22.2ºC) and 2017 (21.5ºC), and both were above the threshold value. The sediment model stressor score was lower in 2021 (32.4%) compared to 2017 (35.9%), but both are well above the threshold value. Dominant community traits in 2021 included high abundances of tolerant and sediment-tolerant organisms; collector-filterers; univoltine organisms; organisms that move with a clinging habit; and organisms associated with faster flows and warmer water temperatures. The MHBI was lower than some other sites (5.3) but still of a magnitude to indicate a community that is fairly tolerant of organic enrichment. These traits suggest a community impacted by temperature, sediment, and organic pollution as stressors.

The community is consistently dominated by tolerant taxa including snails and non-biting midges (Figure 24), but in the two most recent sampling years the relatively tolerant caddisfly *Cheumatopsyche* has dominated the community at increasing relative abundance (Figure 24), which may reflect increasing habitat disturbance and potentially greater organic enrichment. Between-year community similarity is remarkably high (Figure 25); although the two most recent sample year communities were most similar to each other (~78% average similarity), due largely to high abundance of the dominant *Cheumatopsyche* taxon, the communities in all four years of sampling had an overall average similarity close to 65%.

**Figure 22. Total and EPT richness at Middle Kellogg Creek. Linear trendlines are shown.**

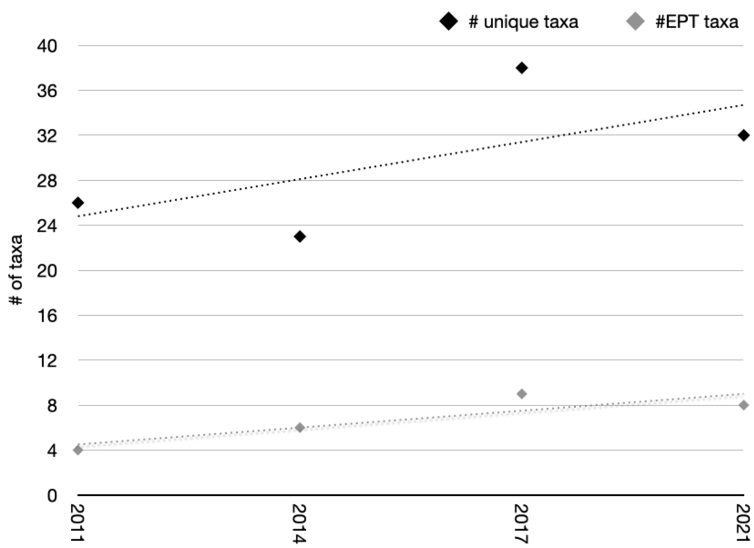



**Figure 23. M-IBI and O/E scores for Middle Kellogg Creek. Linear trendlines and thresholds for condition assignments are shown.**

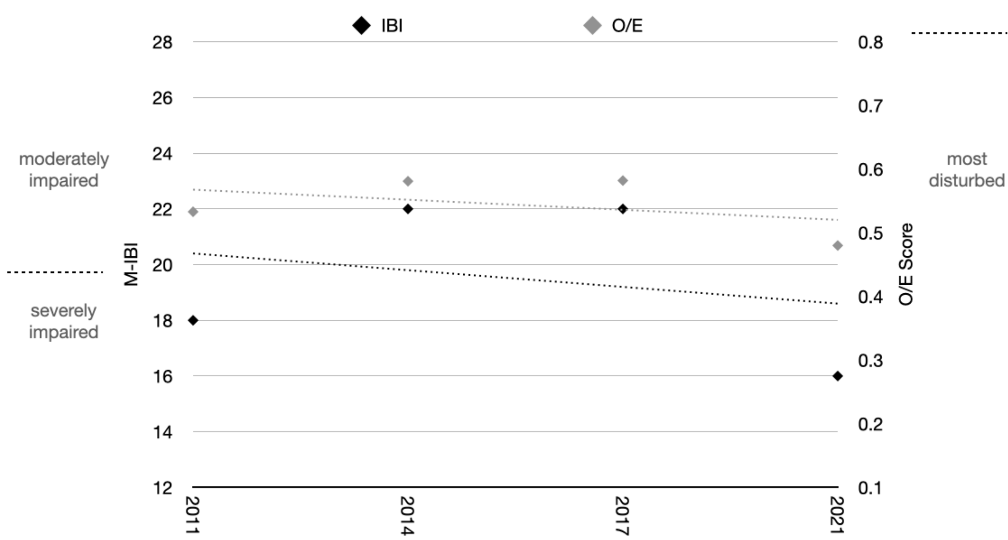


**Figure 24. Dominant (most abundant) taxon at Middle Kellogg Creek. Linear trendline is shown.**

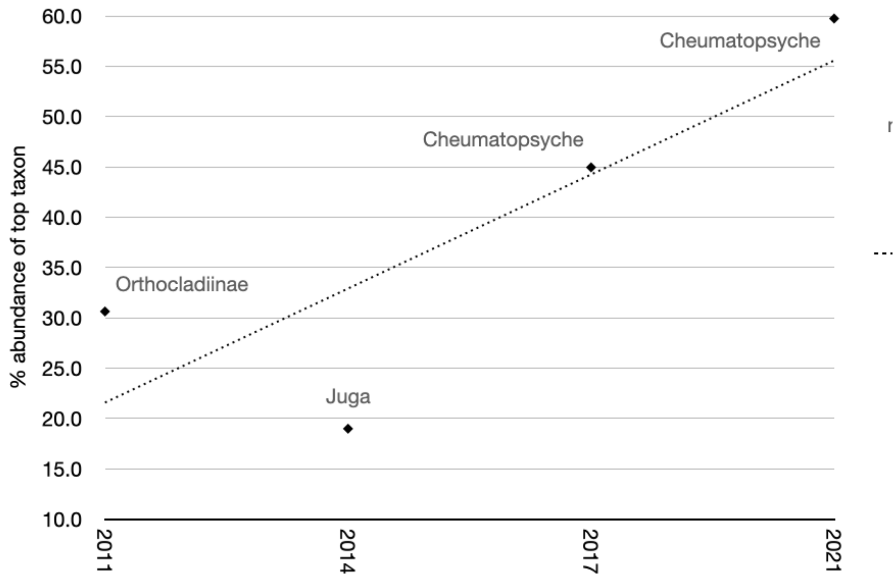
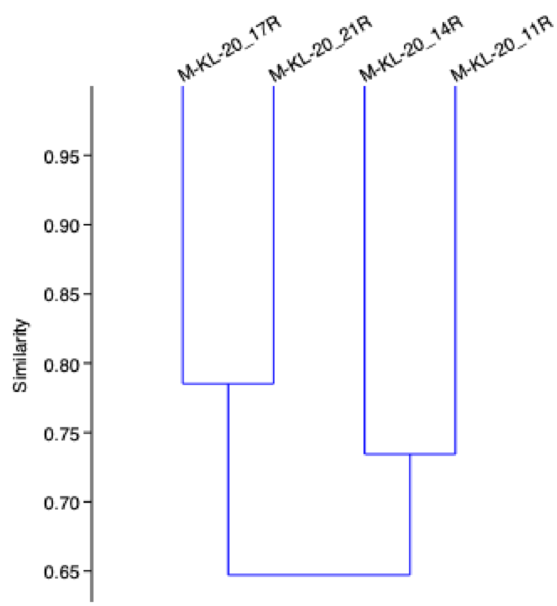



**Figure 25. CLUSTER dendrogram of macroinvertebrate community similarity at Middle Kellogg Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Lower Mt. Scott Creek (M-MS-10)

Fewer taxa were taken at Lower Mt. Scott in 2021 (25) compared to 2017 (35), but this metric is trending upwards overall (Figure 26). The number of EPT taxa increased overall and has been relatively stable since 2011 (Figure 26) but was also lower in 2021 (4) than in the three prior sampling years (6-7 EPT in 2011-2017). This site has never received an O/E score greater than 0.5, which correlates with most disturbed conditions (Figure 27), and scores in 2017 and 2021 were identical (0.39). M-IBI scores increased since 2007, reflecting a change from severely to moderately impaired (Figure 27); the reach scored as severely impaired in 2021, but was on the border of severe/moderate impairment, and the scores in the last two sampling years have been just above that transition point (22). Temperature model stressor scores were similar in 2021 and 2017 (24.1°C and 23.0°C, respectively), but the sediment stressor score was much higher (52.3%) than the prior sampling year (20.7%). All scores are well above the threshold values. Dominant community traits in 2021 included high abundances of tolerant, non-insect, univoltine, and collector-gatherer organisms associated slower flows and tolerant of a range of water temperatures. The high community MHBI (6.9) indicates a community tolerant of organic enrichment. These traits suggest a community impacted by temperature, sediment, and organic pollution as stressors.

The community is consistently dominated by tolerant taxa (Figure 28). However, while samples in early years were dominated by worms (Oligochaeta), there was a shift in 2014 to greater numbers of the tolerant caddisfly *Cheumatopsyche*. This metric is trending downwards, indicating a more balanced community, although in 2021 the community was dominated at higher abundance (45%) by a tolerant isopod (*Caecidotea*).

Sample communities differ more between the most recent sampling years (2014-2021) vs. earlier sampling years (2002-2011; Figure 29); this is likely due in part to the fact that most earlier samples were taken in glide habitat, and had more tolerant taxa such as worms, scuds (*Ramellogammarus*), and Chironomini (tolerant non-biting midges), while the riffles sampled in later years contained more taxa associated with flowing water. However, the community in the 2002 sample differs more from those in all other years, even though it was taken in riffle habitat, which indicates a greater community shift from earlier years.

**Figure 26. Total and EPT richness at Lower Mt. Scott Creek. Linear trendlines are shown.**

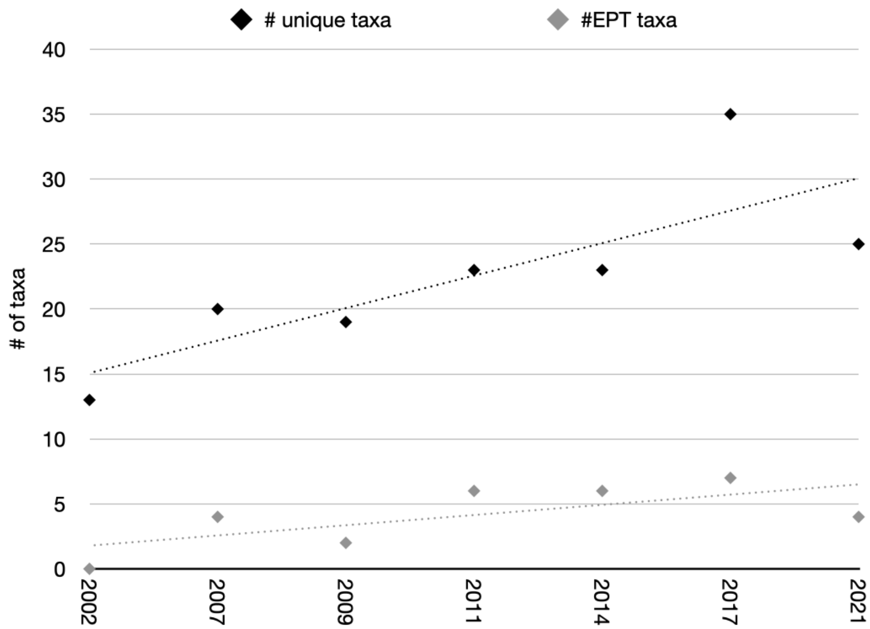



**Figure 27. M-IBI and O/E scores for Lower Mt. Scott Creek. Linear trendlines and thresholds for condition assignments are shown.**

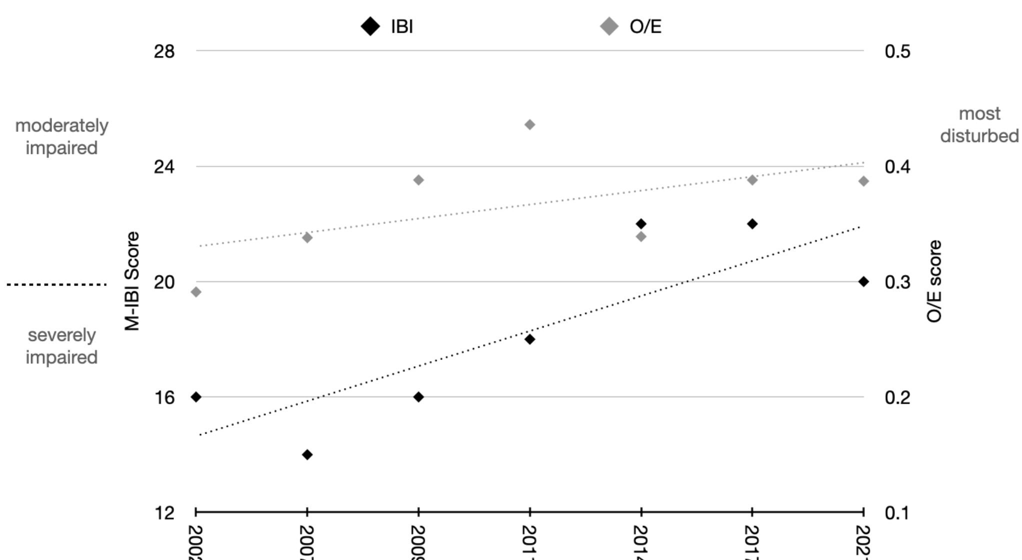


**Figure 28. Dominant (most abundant) taxon at Lower Mt. Scott Creek. Linear trendline is shown.**

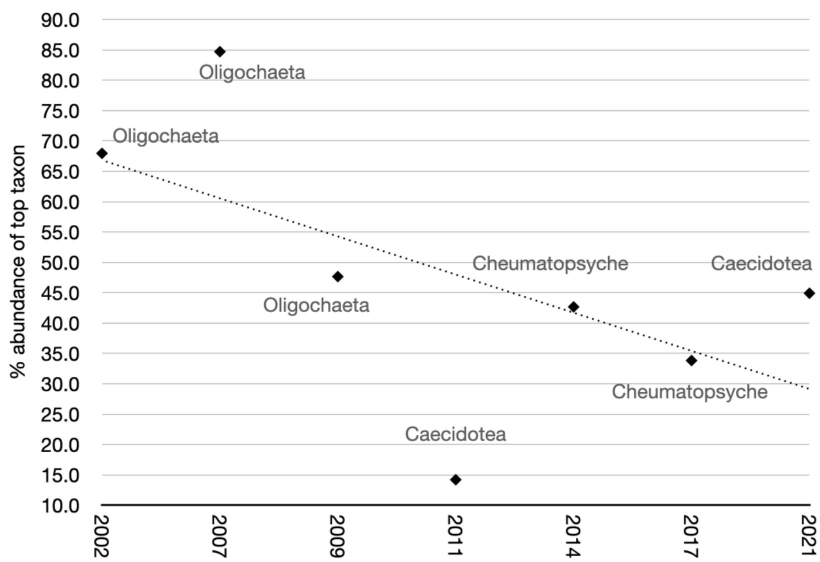
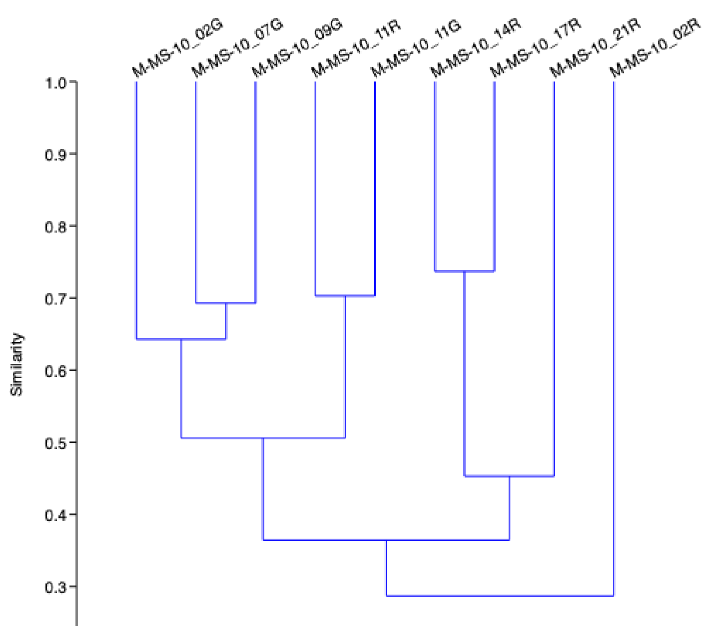



**Figure 29. CLUSTER dendrogram of macroinvertebrate community similarity at Lower Mt. Scott Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Middle Mt Scott Creek (M-MS-40)

More total taxa were taken at Middle Mt. Scott in 2021 (33) than in any other sampling year at this site, and this metric has trended steadily upwards over time (Figure 30). The number of EPT taxa (7) was slightly lower than in 2017 (Figure 30), but this metric increased almost three-fold since 2002 and has been relatively stable over the last four sampling years. M-IBI and O/E scores also increased over time (Figure 31); the M-IBI score was higher in 2021 than in any other sampling year and indicated moderately impaired conditions, which is an improvement over conditions from 2002-2011. The O/E score was also higher in 2021 compared to 2017 and scores for this model have been increasing, but the condition correlates to most disturbed in each year. Temperature model stressor scores were similar in 2017 and 2021, although the temperature stressor was slightly lower in 2021 (20.9ºC vs. 21.4ºC) and the sediment stressor score was higher (35.1% vs. 31.7% in 2017), but both were above the respective threshold values. Dominant community traits in 2021 included high abundances of univoltine organisms and collector-gatherers; and organisms associated with a faster flows and tolerant of a range of water temperatures. The high community MHBI (6.0) indicates tolerance to organic enrichment. Metrics indicate a community that may be impacted more by temperature than by fine sediment, whose composition has shifted over time to reflect improvement in habitat conditions.

The top taxon in the sample community was a member of the EPT in five of the seven monitoring years, although they are relatively more tolerant members of this group (*Baetis tricaudatus*, *Cheumatopsyche;* Figure 32). The dominant taxon in 2021 was a tolerant isopod (*Caecidotea*), but it occurred at a much lower relative abundance (21%) compared to the dominant taxon in 2017 (*Cheumatopsyche*, 51%), suggesting improved habitat stability. Values for this metric has been fairly stable over time, with the exception of 2017, which suggests some additional disturbance in that year. Like Lower Mt Scott, sample communities differed more based on the type of habitat samples (glide vs. riffle; Figure 33), with glide samples having more taxa associated with slower and/or more sedimented conditions, such as snails, worms, pea clams. However, riffle communities from more recent sample years (2014-2017) differ more from riffle samples in earlier years, indicating an overall community shift.

**Figure 30. Total and EPT richness at Middle Mt. Scott Creek. Linear trendlines are shown.**

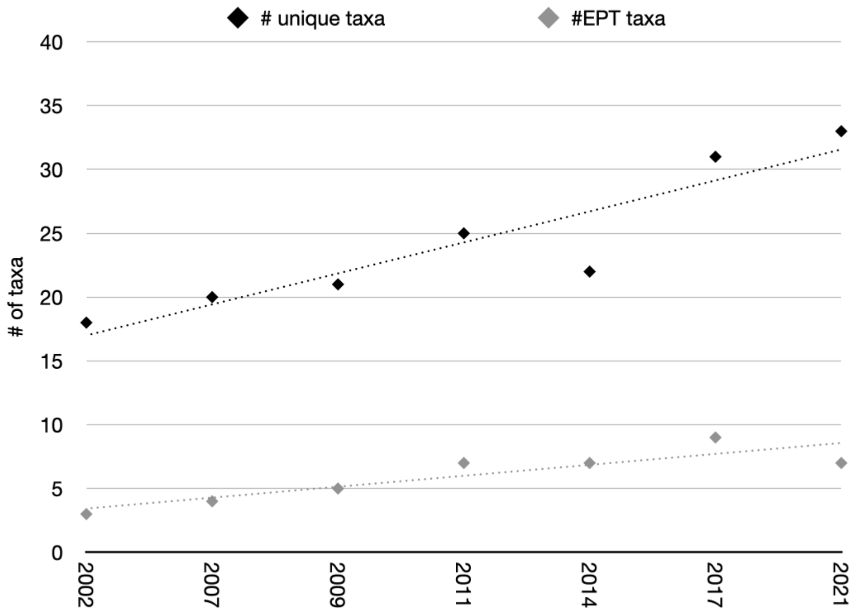



**Figure 31. M-IBI and O/E scores for Middle Mt. Scott Creek. Linear trendlines and thresholds for condition assignments are shown.**

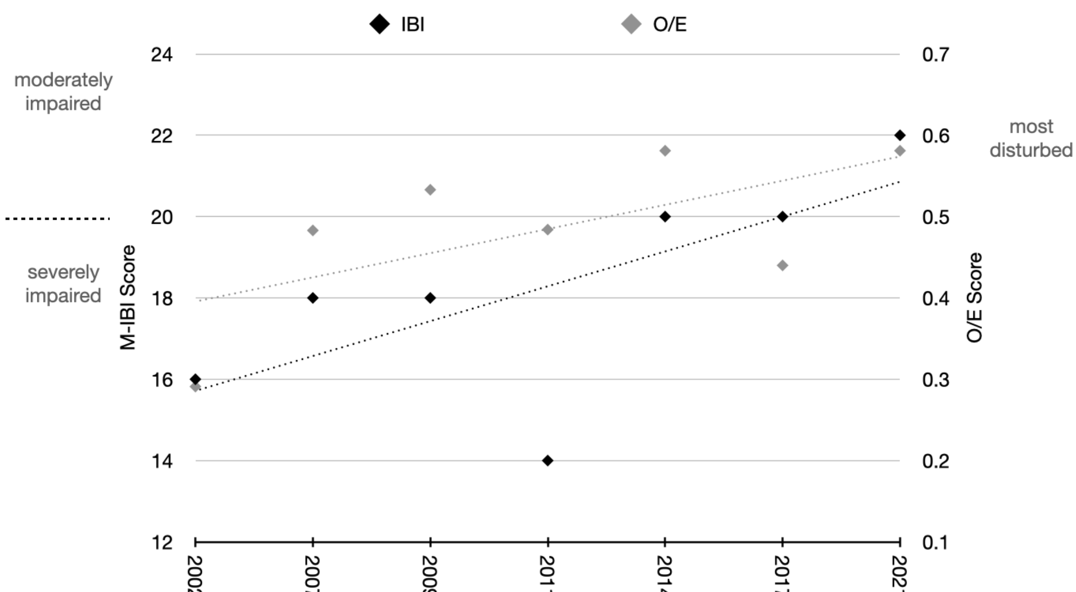


**Figure 32. Dominant (most abundant) taxon at Middle Mt. Scott Creek. Linear trendline is shown.**

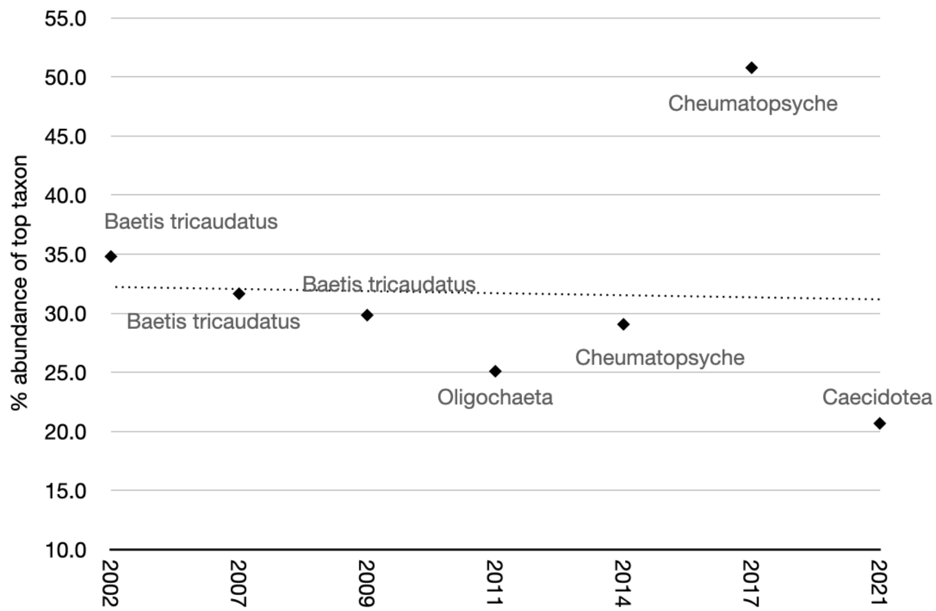
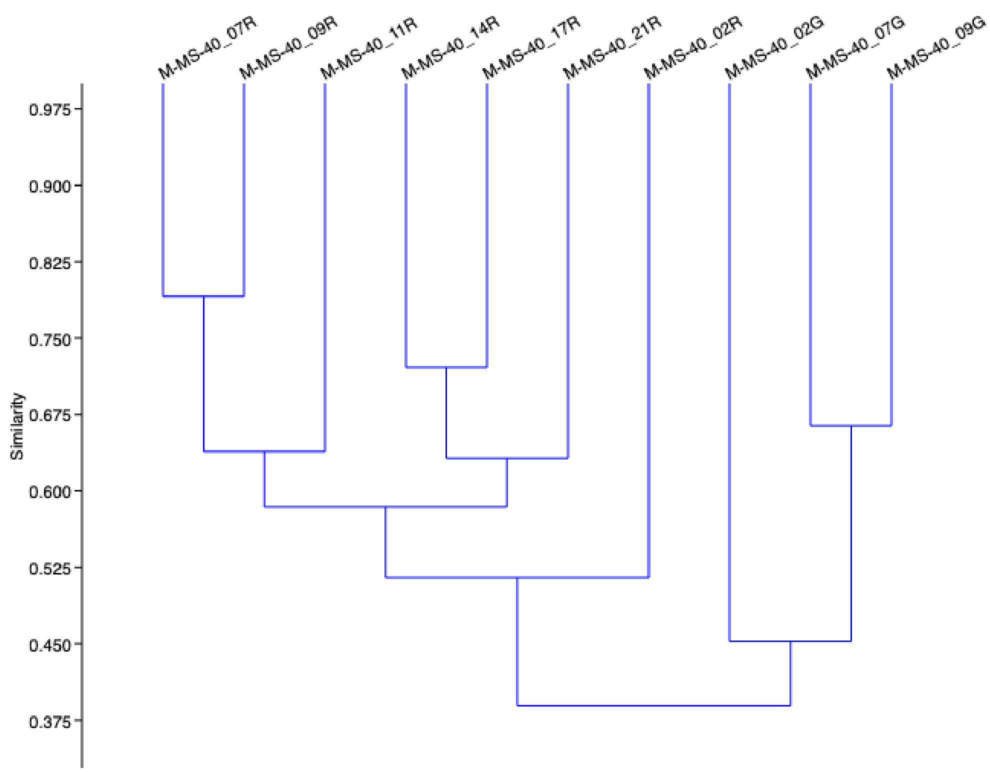



**Figure 33. CLUSTER dendrogram of macroinvertebrate community similarity at Middle Mt. Scott Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Upper Mt Scott Creek (M-MS-80)

The number of total taxa (30) and of EPT taxa (8) taken at Upper Mt. Scott in 2021 were similar to but slightly lower than in 2017 (35 taxa, 12 EPT; Figure 34); however, values of both metrics are trending upwards. The lower richness in 2021 may have been influenced by the rainfall that occurred within a week of sampling, as this can scour out taxa, especially in flashy urban streams. M-IBI scores have increased more over time than O/E scores (Figure 35), with M-IBI scores rising to the moderately impaired range by 2009 while O/E scores consistently indicate severe impairment. Both scores were lower in 2021 than in 2017 (Figure 35), but the M-IBI score still reflected moderate impairment, although it was at the lower limit of this range. . The temperature model stressor score was slightly greater in 2021 (22.4$^{o}$C) than in 2017 (20.8$^{o}$C), while the sediment stressor score increased more (26.2% in 2017, 32% in 2021), and both were above the respective threshold values. Dominant community traits in 2021 included high abundances of tolerant and sediment-tolerant organisms, and organisms associated with faster flows and tolerant of warmer water temperatures. The community MHBI was lower than at many other sites (4.9), though high enough to suggest some level of organic enrichment. Metrics indicate a community that is still impacted by temperature and sediment as stressors, whose composition has nonetheless shifted over time to reflect some improved habitat conditions.

Since 2007, the community has been dominated by relatively tolerant members of the EPT (*Baetis tricaudatus*, *Cheumatopsyche;* Figure 36). Sample communities in 2017 and 2021 were dominated by the same taxon (*Cheumatopsyche*) although at much greater relative abundance in 2021 (45% vs. 20%), which may reflect more disturbed conditions or increased organic enrichment. The value of this metric varies more annually but was lower in more recent sampling years (2011-2017). Sample community similarity has been increasing over time (Figure 37), which suggests greater habitat stability, although overall community similarity is fairly high from 2007-2021 (~60% overall similarity). Recent sample year communities had more of the tolerant caddisflies *Cheumatopsyche* and *Hydropsyche*, while earlier years (2007-2011) had more taxa suggestive of recent disturbance, such as *Simulium* black flies and *Baetis tricaudatus* mayflies.

**Figure 34. Total and EPT richness at Upper Mt. Scott Creek. Linear trendlines are shown.**

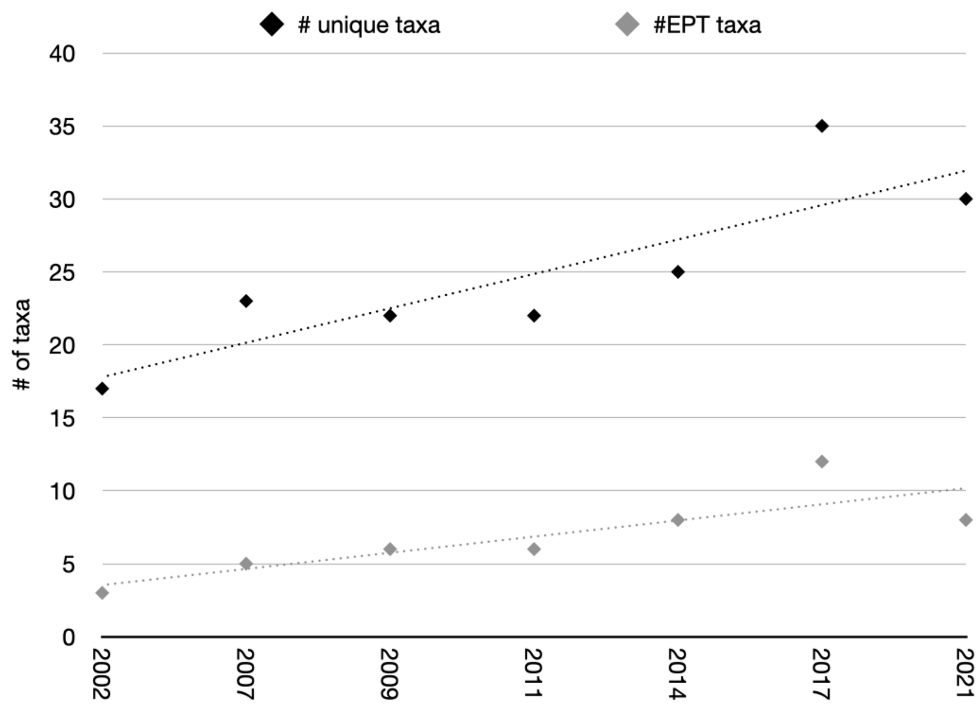



**Figure 35. M-IBI and O/E scores for Upper Mt. Scott Creek. Linear trendlines and thresholds for condition assignments are shown.**

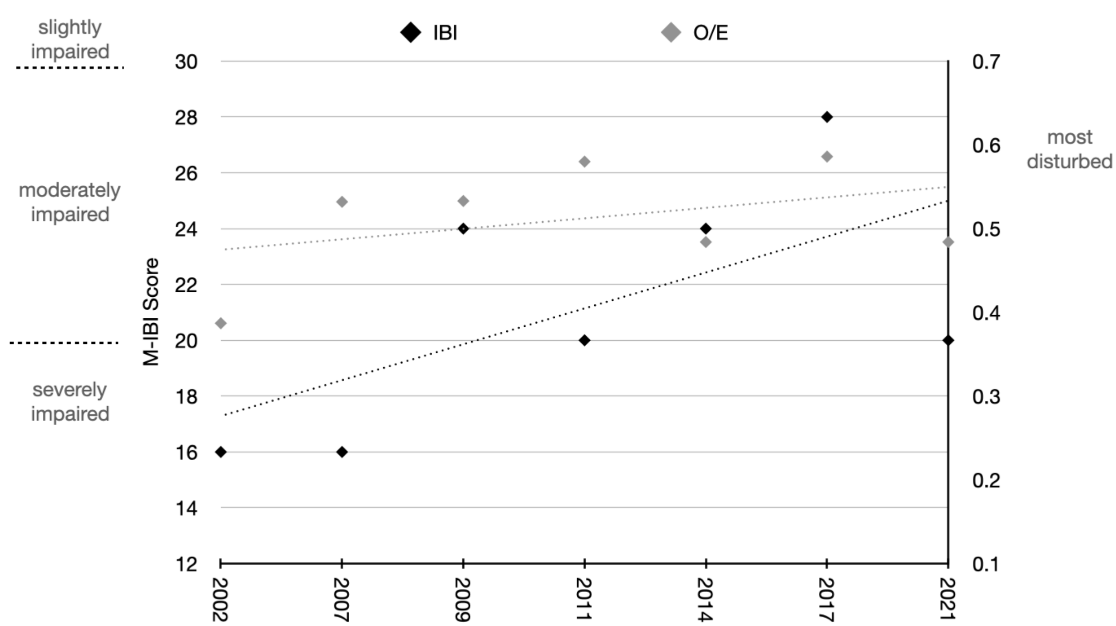


**Figure 36. Dominant (most abundant) taxon at Upper Mt. Scott Creek. Linear trendline is shown.**

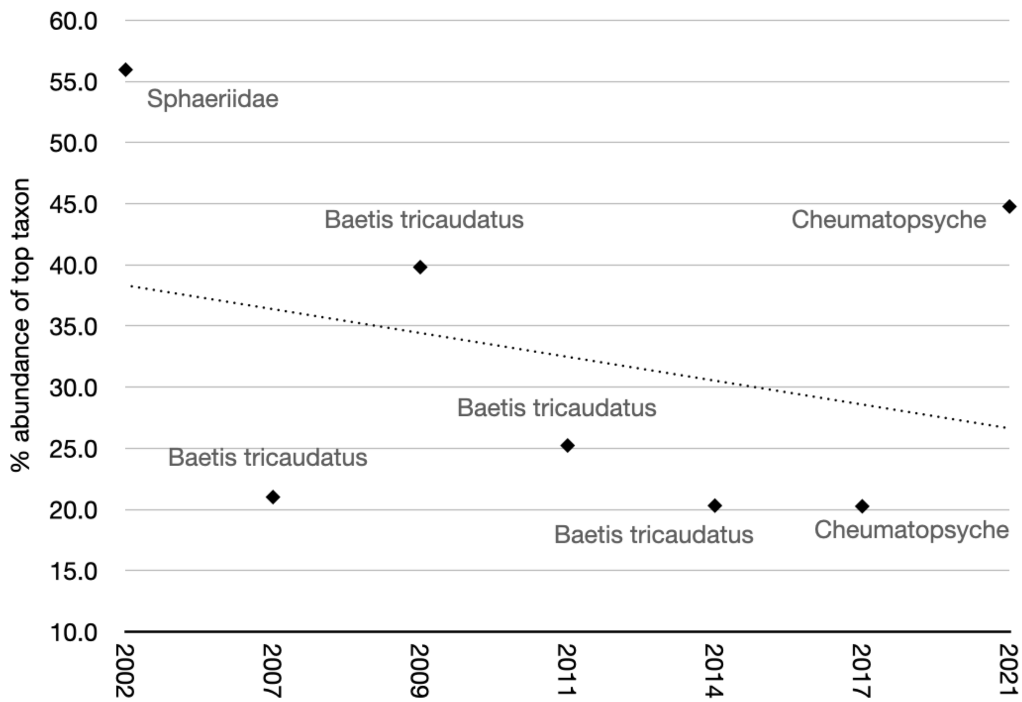
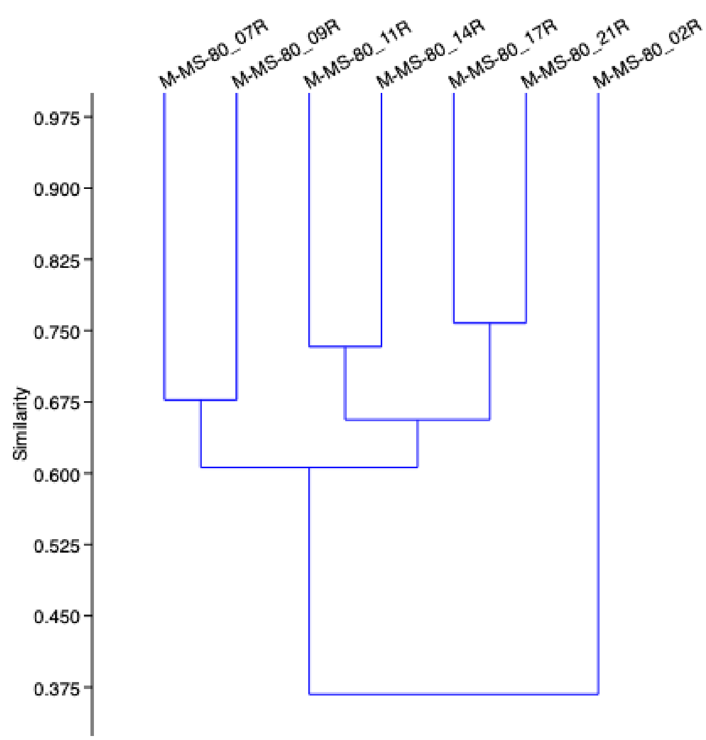



**Figure 37. CLUSTER dendrogram of macroinvertebrate community similarity at Upper Mt. Scott Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Saum Creek (M-SA-10)

The sample taken in 2021 at Saum Creek had extremely low organismal abundance (80 individuals total in sample) and only half as many total taxa (21) and EPT taxa (4) compared to 2017 (Figure 38). Prior to this, both metrics were trending upwards, due mainly to a large increase in total and EPT richness in 2017. M-IBI scores were not calculated in earlier years; O/E scores increased overall through 2017 (Figure 39) but the score was again much lower in 2021. This site has consistently scored as most disturbed, but this is likely due at least in part to the fact that slower flows seem to be the norm; samples in all prior years were taken in glide habitat, and 2021 samples were taken in glide and pool habitat. Slower flows are expected to support taxa more tolerant of sediment and lower dissolved oxygen levels and model scores will be accordingly lower, as the model references are based on riffle communities. Temperature and sediment stressor model scores were not calculated in prior years, as glide habitat would be expected to have warmer and more sedimented conditions, and scores in 2021 were above the threshold values. Dominant community traits in 2021 were driven largely by the top taxon and included high relative abundances of tolerant and multivoltine organisms, and organisms associated with a range of flows and water temperatures. The high community MHBI (7.1) indicates tolerance of organic enrichment. These metrics suggest a community impacted by temperature, sediment, and organic pollution, with some changes in community composition reflecting improved conditions in recent sampling years.

The community is consistently dominated by tolerant taxa, including snails, worms, and non-biting midges (Figure 40); the value of this metric varies annually but was higher in 2021, when the community was dominated by a non-biting midge (*Stictochironomus*) tolerant of warmer, slower, sedimented waters at 37% of total organismal abundance. The sample community in 2021 was most similar to the 2007 sample community (Figure 41) and differed more from the most recent sampling years, due largely to the high number of tolerant non-biting midges (Chironomini, a tribe to which the dominant taxon in 2021 belongs). The changes in many trait values in a low abundance, depauperate 2021 community may reflect a recent change in habitat conditions in this incised, sedimented creek or the effects of an unusually hot dry summer that reduced and heated flows early in the season.

**Figure 38. Total and EPT richness at Saum Creek. Linear trendlines are shown.**

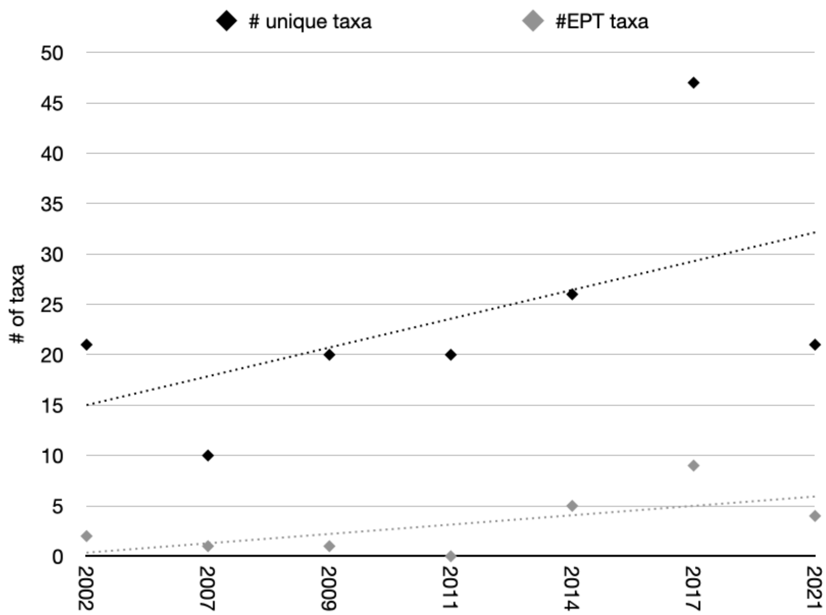



**Figure 39. O/E scores for Saum Creek. Linear trendline and threshold for condition assignment is shown. Note that M-IBi scores were not calculated in earlier years.**

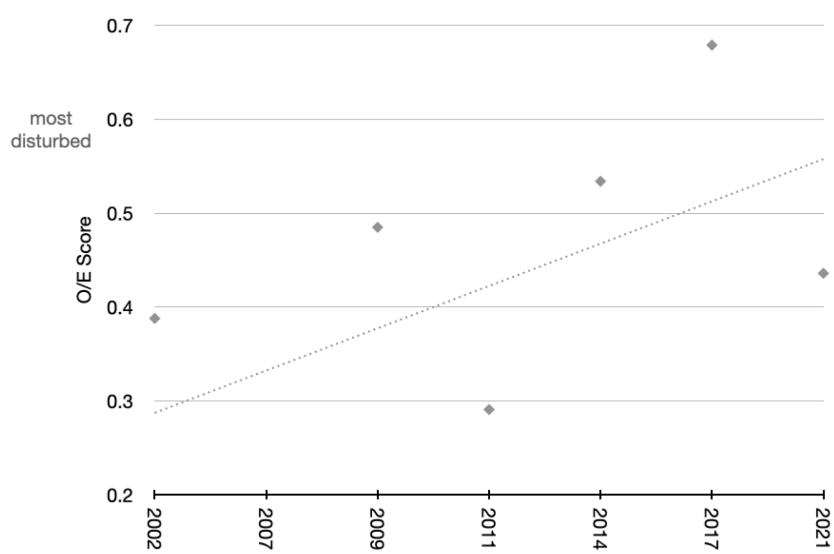


**Figure 40. Dominant (most abundant) taxon at Saum Creek. Linear trendline is shown.**

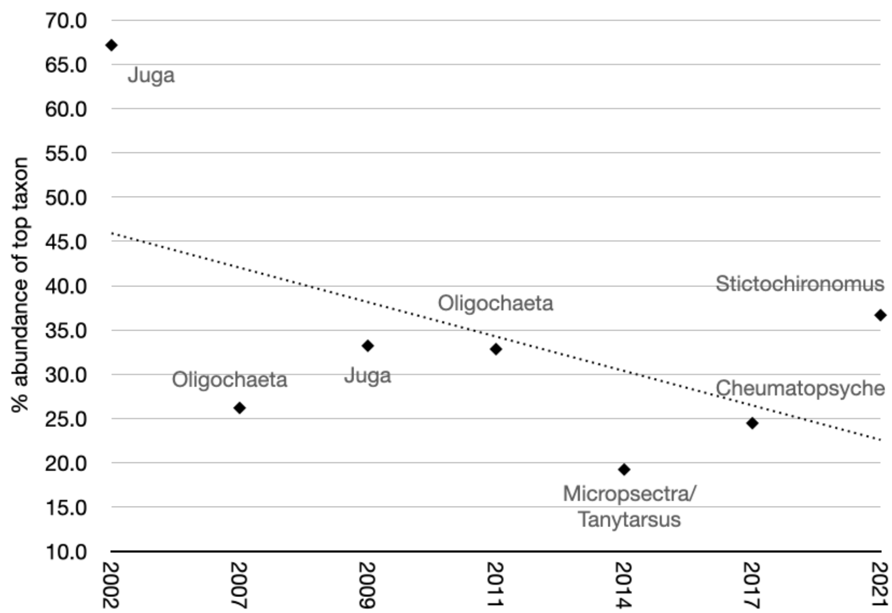
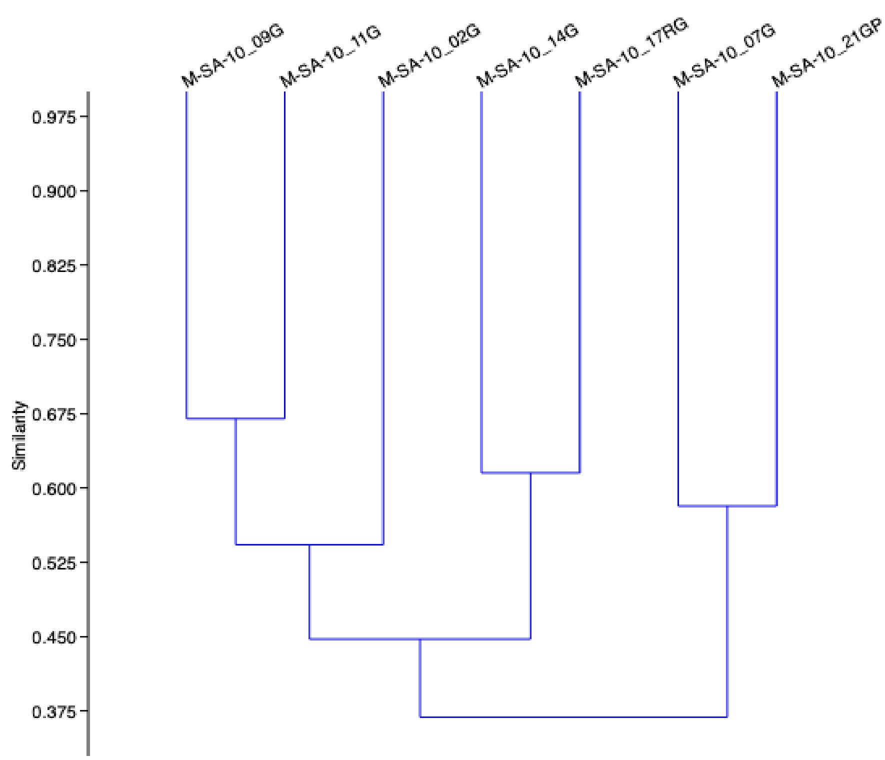



**Figure 41. CLUSTER dendrogram of macroinvertebrate community similarity at Saum Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Pecan Creek

The number of total taxa (42) and EPT taxa (16) taken at Pecan Creek in 2021 were greater than in any prior sampling year and both metrics are trending upwards (Figure 42). These values were also at the upper end of the range seen among all 2021 samples. M-IBI and O/E scores were higher in 2021 than in any prior sampling year (Figure 43), and the M-IBI score was higher than at any site sampled in 2021 except for Lower Rock Creek, while the O/E score was at the upper end of the range among all 2021 samples. M-IBI score has been trending upwards; the 2021 score indicated slight impairment and was close to the threshold for minimal impairment, while the O/E score was near the transition point from most disturbed to moderately disturbed conditions. Temperature and sediment stressor model scores were not available for 2017, but both were below the threshold values (17.5°C, 17.6% fine sediment) and at the lower end of the range among all 2021 samples. Dominant community traits in 2021 included high abundances of univoltine taxa and organisms associated with faster, colder flows. The community MHBI score (3.4) was lower than any other in the 2021 dataset except for Wilson Creek, indicating that organic enrichment is unlikely to be a stressor. Metrics reflect a relatively healthier, more diverse community in more stable habitat that is less impacted by temperature and fine sediment.

Although the community was dominated in past years by tolerant taxa such as snails, scuds, and worms (Figure 44), 2021 was the first year in which the top taxon was a stonefly (*Zapada cinctipes*), and it was the only sample in 2021 to be dominated by a member of this more sensitive order. *Zapada cinctipes* can be found in a wide range of habitats and is more tolerant than other species in this genus, but because it feeds as a shredder, its presence indicates ongoing contributions from the riparian zone to the instream food base. Sample community similarity between years has been relatively high (~52%; Figure 45), with the 2021 sample differing from prior years due to the greater abundance of several stonefly taxa (i.e., *Zapada cinctipes*, *Soyedina*) and a sensitive flatheaded mayfly (*Cinygma*) lower abundance of worms and non-biting midges. Note that in 2017 the sample site was moved upstream from the previous location, although the macroinvertebrate community in that year was still quite similar (~65% overall similarity) to the 2014 sample community.

**Figure 42. Total and EPT richness at Pecan Creek. Linear trendlines are shown.**

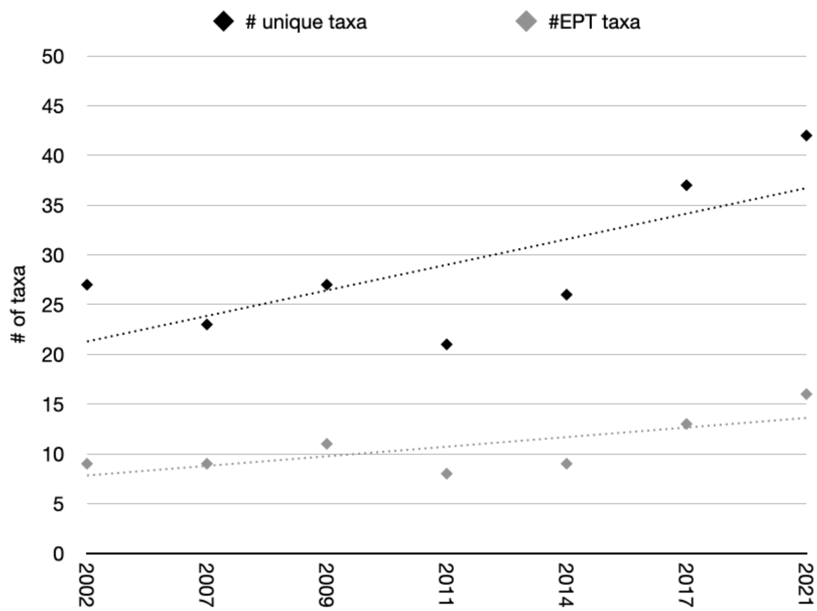



**Figure 43. M-IBI and O/E scores for Pecan Creek. Linear trendlines and thresholds for condition assignments are shown.**

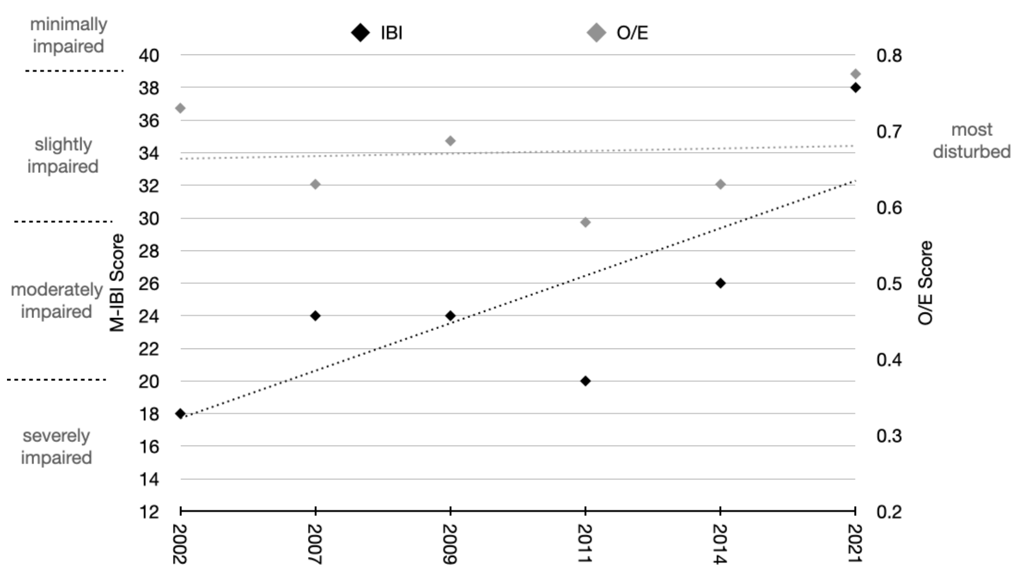


**Figure 44. Dominant (most abundant) taxon at Pecan Creek. Linear trendline is shown.**

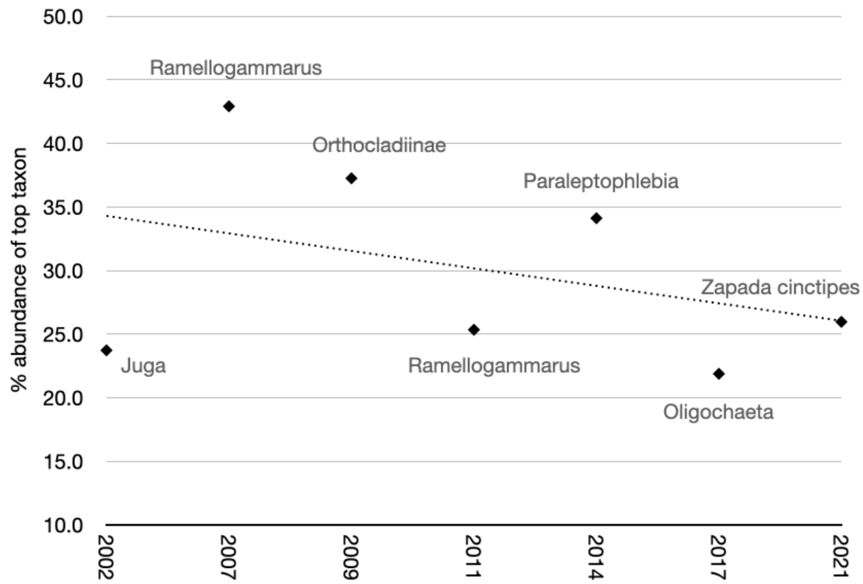
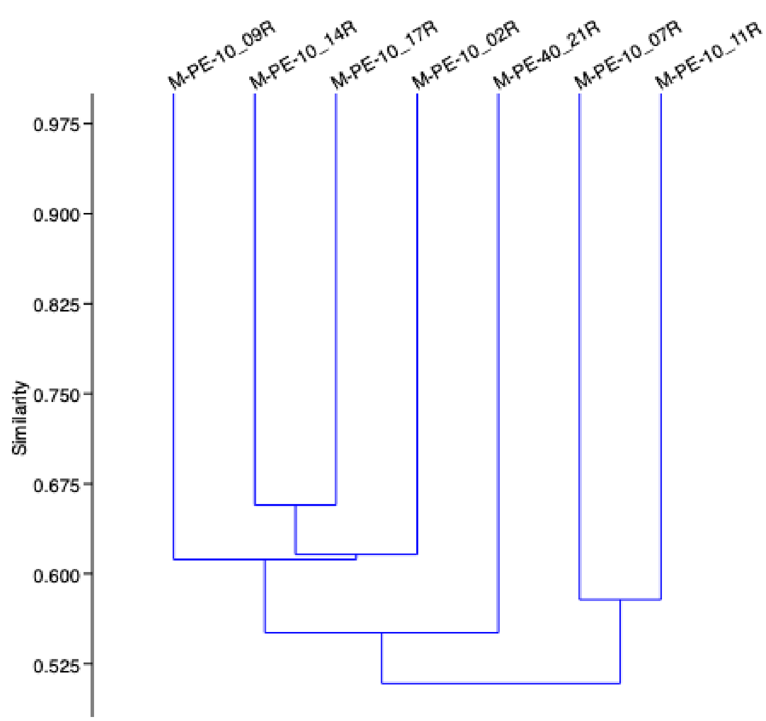



**Figure 45. CLUSTER dendrogram of macroinvertebrate community similarity at Pecan Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Phillips Creek (M-PH-10)

The sample taken at Phillips Creek in 2021 had more total taxa (32) than any prior year at this site, and richness has increased overall across time (Figure 46). There were more EPT taxa (6) than in any prior year except 2014, when six EPT were also taken, and values for this metric are also increasing (Figure 46). M-IBI scores in recent years were just above the transition between moderately and severely impaired, but in 2021 the score fell into the severely impaired range (Figure 47). O/E scores are consistently low, corresponding to severely disturbed conditions, and have not changed much over time (Figure 47). The temperature stressor model score was slightly higher in 2021 (19.0ºC) compared to 2017 (18.0ºC), and just above the threshold value for this model. Temperature stressor model scores were above the threshold in both 2017 and 2021 (22.3% and 29.8% fine sediment, respectively). Dominant community traits in 2021 included high abundances of tolerant organisms; non-insect taxa; collector-gatherers; and organisms that tolerate a wider range of water temperatures. The high community MHBI (6.6) indicates a community tolerant of organic enrichment. Metric values suggest a disturbed community stressed by fine sediment levels and organic enrichment, and one in which temperature may be becoming more of a stressor.

The community has been dominated by the relatively tolerant mayfly *Baetis tricaudatus* in most years, including 2021, and relative abundance of the top taxon increased over time, indicating a less balanced, more disturbed community (Figure 48). Sample community similarity between years is relatively low and shows few patterns, although glide samples taken in the reach are more similar to each other than the riffle samples taken in the same year (Figure 49), and riffle samples taken in recent years show greater community similarity.

**Figure 46. Total and EPT richness at Phillips Creek. Linear trendlines are shown.**

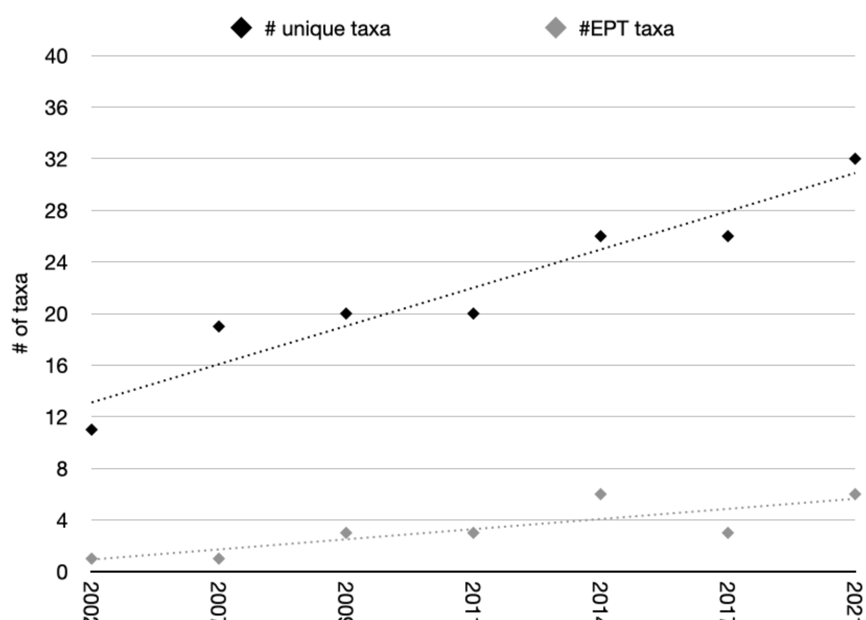


**Figure 47. M-IBI and O/E scores for Phillips Creek. Linear trendlines and thresholds for condition assignments are shown.**

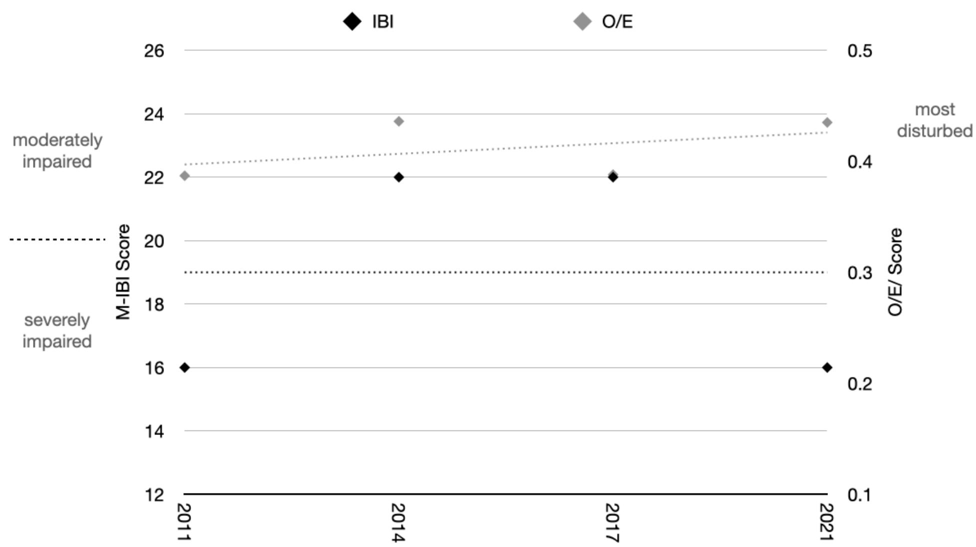



**Figure 48. Dominant (most abundant) taxon at Phillips Creek. Linear trendline is shown.**

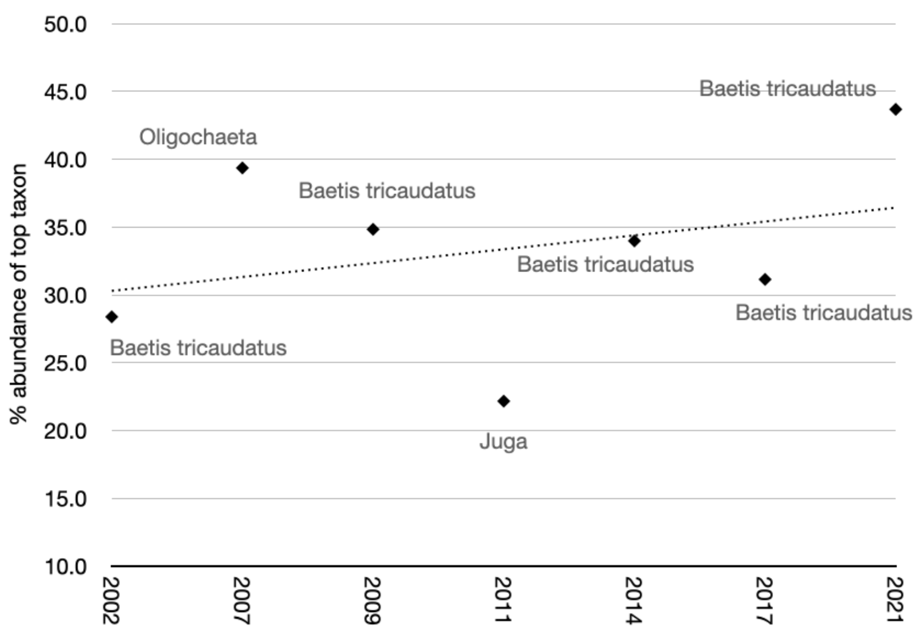
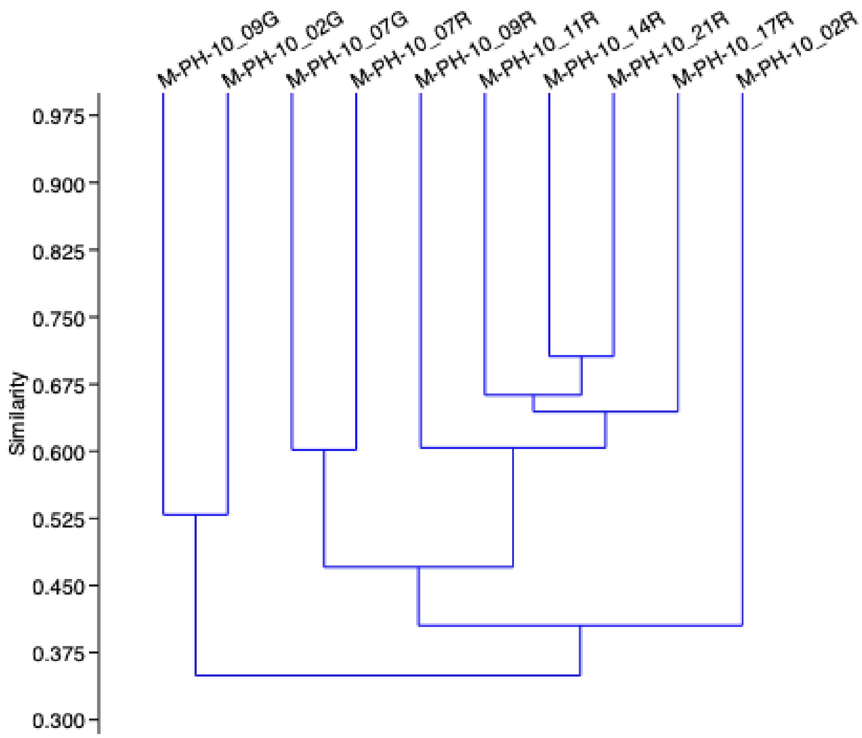


**Figure 49. CLUSTER dendrogram of macroinvertebrate community similarity at Phillips Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Richardson Creek (M-RI-10)

Richardson Creek had fewer total taxa (31) in 2021 compared to most prior sampling years, including 2017 (Figure 50); sample richness has varied across time, with a slight trend towards increased values. The number of EPT (17) was similar to past years and has also varied little over time, but was more than any other site sampled in 2021 except for Upper Rock Creek. This reach also had more taxa in the sensitive Plecoptera (stonefly) order than any other site sampled in 2021. M-IBI scores indicated slightly impaired conditions in every sampling year, including in 2021, which scored higher than the prior sampling year (Figure 51). O/E scores varied more, ranging from severely to slightly disturbed in different years (Figure 52), and were just below the threshold for moderately disturbed (0.822) in 2021. Values for both models have trended upwards across time. Temperature and sediment stressor model scores (17.9ºC, 11.0% fine sediment) were both lower in 2021 than in 2017 (18.5ºC, 12.3%), with the temperature score slightly below the threshold value and the sediment score well below the threshold. Dominant community traits in 2021 included higher numbers of both sensitive and sediment-sensitive taxa compared to other 2021 samples as well as greater abundance of organisms associated with faster flows and tolerant of a range of temperatures. The community MHBI was relatively low (4.4), suggesting less impact from organic enrichment. These metrics indicate a fairly stable, diverse community reflecting better quality habitat and less likely to be experiencing temperature- or sediment-related stress.

The community has been dominated consistently by EPT taxa, albeit more relatively tolerant members of this group (i.e., *Baetis tricaudatus, Hydropsyche*), but in recent years the value of this metric has been increasing (Figure 52), suggesting increased habitat disturbance. Sample community similarity between years is relatively high (~54% overall average similarity; Figure 53), and the 2021 sample had greater abundance of sensitive mayflies, *Zapada cinctipes* stoneflies, and fewer tolerant *Hydropsyche* caddisflies compared to the most recent sampling years.

Richardson Creek has been used as a reference site throughout sampling. While the macroinvertebrate community reflects changes over time that are likely due to both climate and land use, macroinvertebrate community traits indicate that it remains a higher-quality site in the sampling set with habitat conditions that support more sensitive types of taxa.

**Figure 50. Total and EPT richness at Richardson Creek. Linear trendlines are shown.**

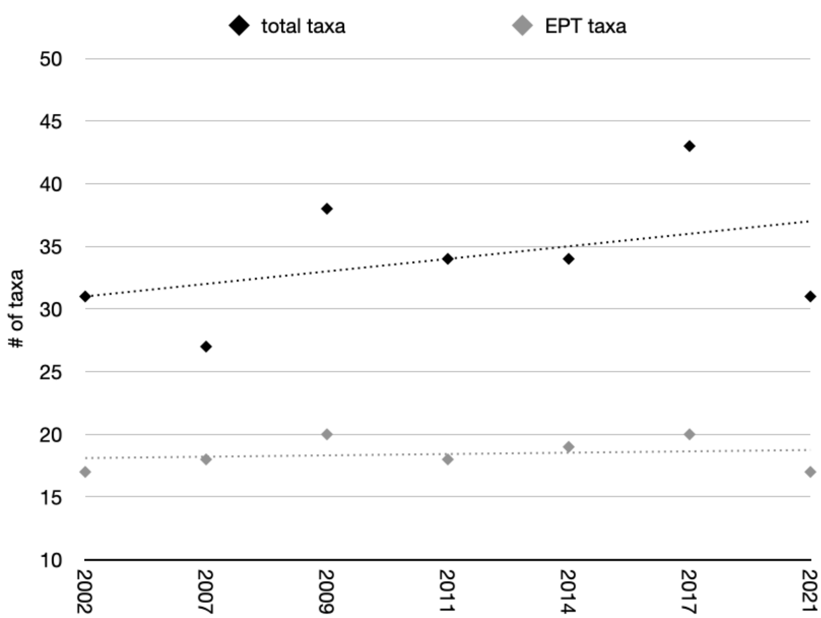


**Figure 51. M-IBI and O/E scores for Richardson Creek. Linear trendlines and thresholds for condition assignments are shown.**

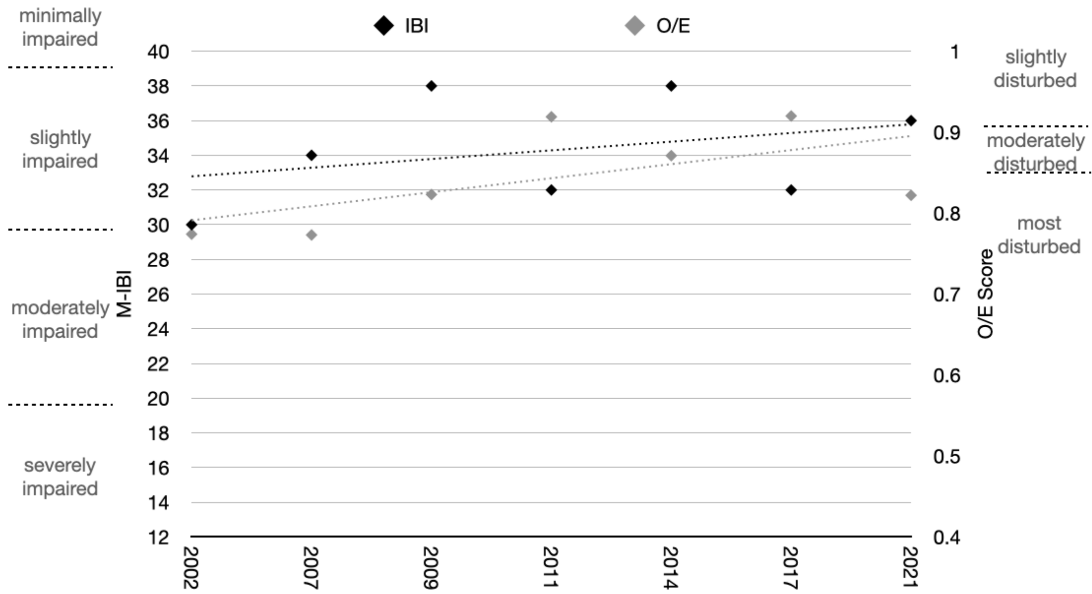



**Figure 52. Dominant (most abundant) taxon at Richardson Creek. Linear trendline is shown.**

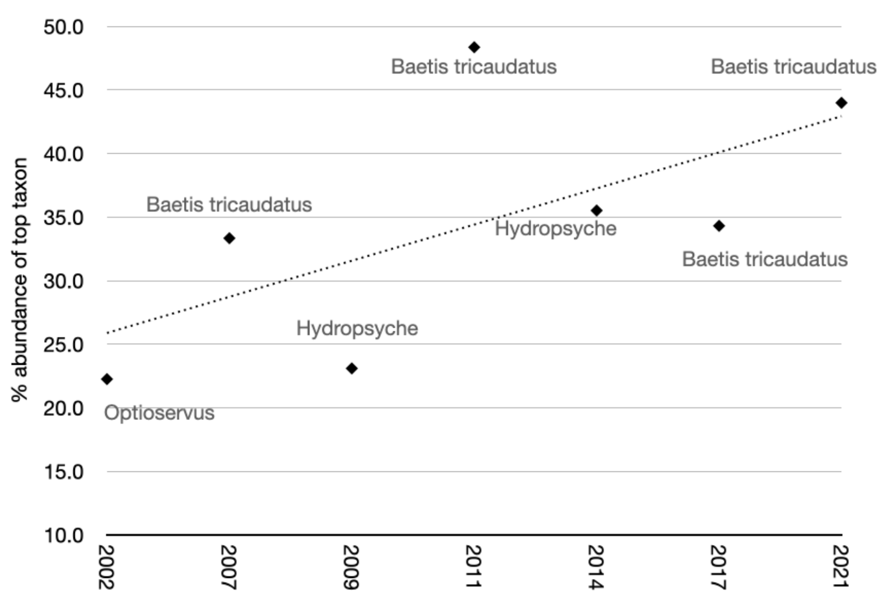
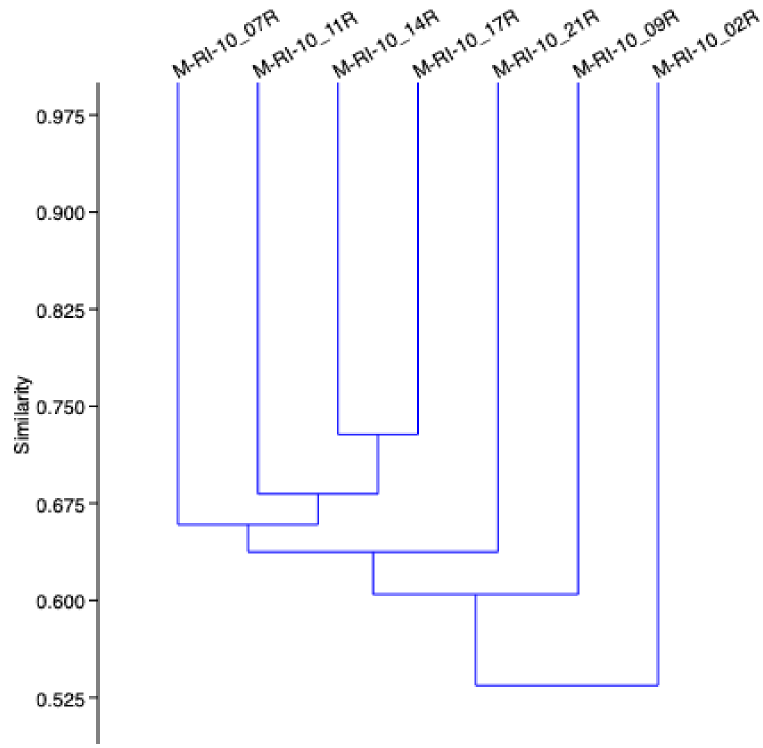


**Figure 53. CLUSTER dendrogram of macroinvertebrate community similarity at Richardson Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




<u>Lower Rock Creek (M-RC-10)</u>

Lower Rock Creek had slightly fewer total and EPT taxa in 2021 (42 and 15, respectively) compared to 2017 (50 total and 17 EPT taxa; Figure 54), but both were at the upper end of the range among all 2021 samples. Taxa richness rose more than two-fold over time at this site, with a sharp increase between 2014, when a restoration project was installed, and 2017. The number of EPT taxa tripled overall across time, though with no great differences between the 2014 and 2017 samples. M-IBI scores reflected slightly impaired conditions between 2007 and 2021 (Figure 55) but have also trended upwards with time; the score in 2021 (38) was the highest of any year at this site and close to the transition from slight to no impairment. O/E scores ranged from severely to slightly disturbed but were lower and similar in the last two years and in the range of severe disturbance (Figure 55). The temperature and sediment stressor model scores (18.8°C, 10.4%) were both higher than in 2017 (18.2°C, 7.5%), with the temperature stressor score slightly above the threshold value and the sediment score well below the threshold. Dominant community traits in 2021 included high relative abundance of univoltine organisms and organisms associated with cooler, faster flows, while the community MHBI was relatively low (4.4). Community metrics indicate a fairly stable, diverse community reflecting better quality habitat with less impact from temperature- or sediment-related stress or organic enrichment.

The community was dominated by the relatively tolerant mayfly *Baetis tricaudatus* in almost every sampling year (Figure 56), but at much lower relative abundance in recent sampling years. The lower abundance of this taxon in 2021 (16%) reflects a much more balanced community compared to 2011 and 2014, when this taxon comprised 35-40% of total organismal abundance. Sample community similarity between years is relatively high (~64% overall average similarity; Figure 57), except for 2002, which was an outlier, although still relatively similar to the community in other years (~50% overall similarity). The community in 2021 was most similar to the 2017 community and had a lower abundance of worms and tolerant *Hydropsyche* caddisflies and more *Zapada cinctipes* stoneflies compared to most earlier years.

**Figure 54. Total and EPT richness at Lower Rock Creek. Linear trendlines are shown.**

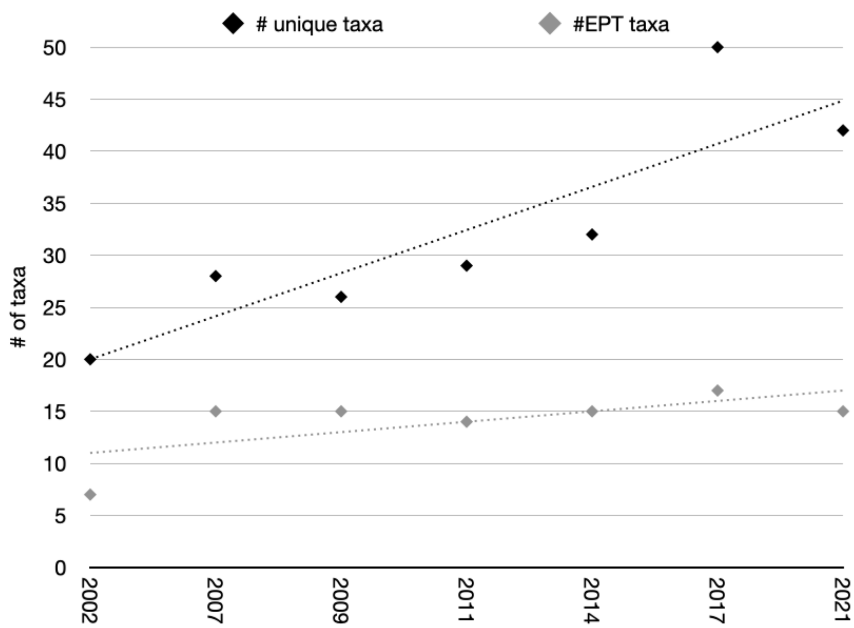


**Figure 55. M-IBI and O/E scores for Lower Rock Creek. Linear trendlines and thresholds for condition assignments are shown.**

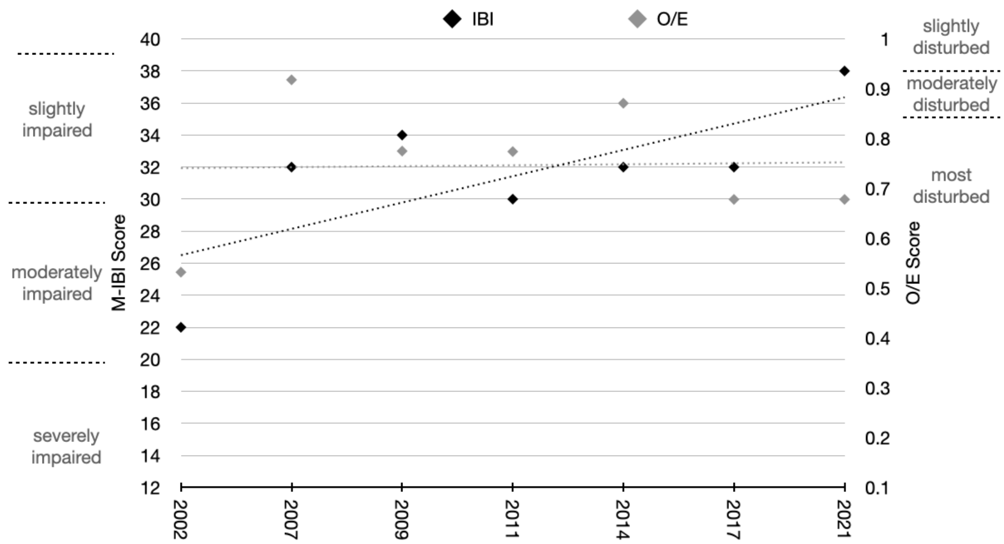



**Figure 56. Dominant (most abundant) taxon at Lower Rock Creek. Linear trendline is shown.**

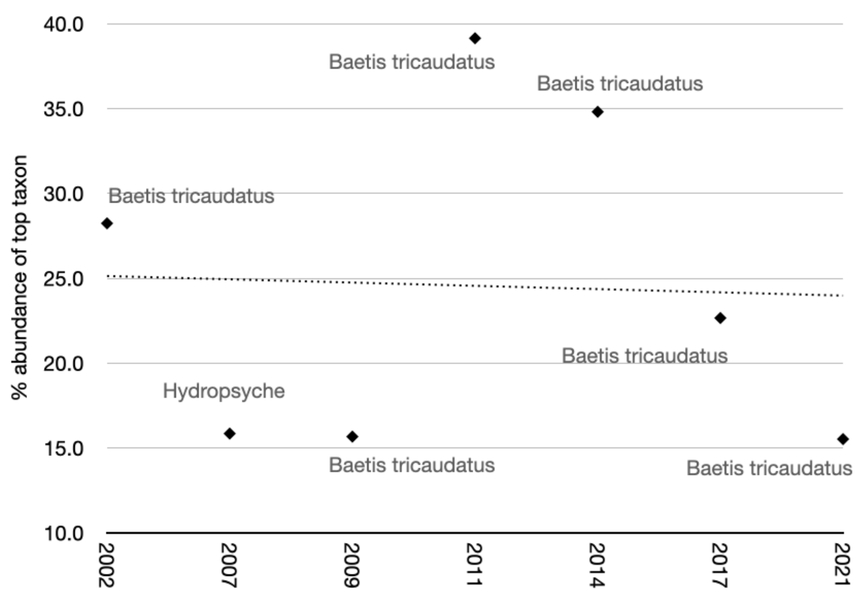
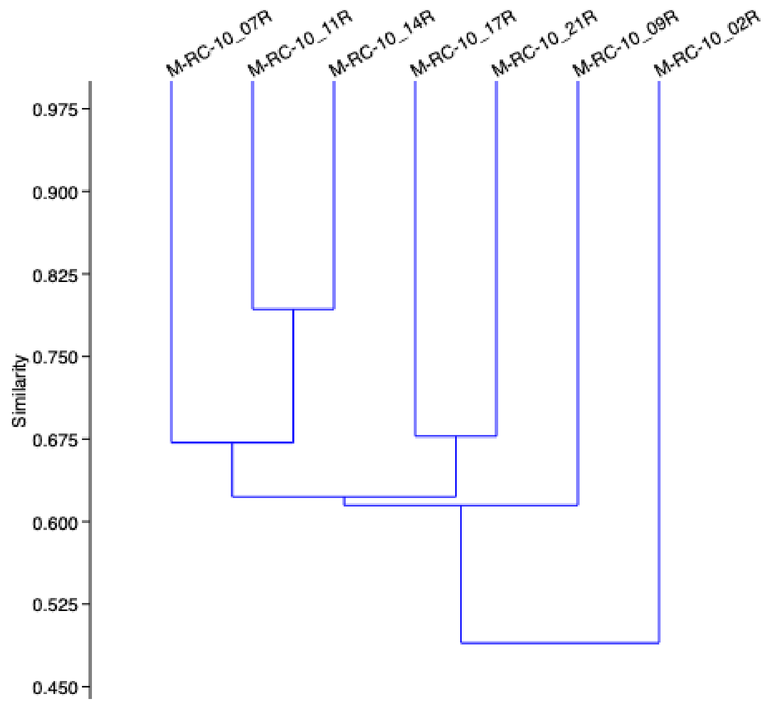


**Figure 57. CLUSTER dendrogram of macroinvertebrate community similarity at Lower Rock Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Middle Rock Creek (M-RC-30)

Taxa richness at Middle Rock Creek was higher in 2021 (56) than in any prior year (Figure 58); this was also the most taxa taken in any 2021 sample. This metric increased over time, with two-fold greater richness overall in 2021 compared to 2002. EPT richness increased about two-fold overall since sampling began in 2002 but has varied less since 2007. The number of EPT taxa in 2021 (14) was similar to other sampling years (Figure 58), but the value of this metric was near the upper end of the range among all 2021 samples. M-IBI scores increased between 2002 and 2014, rising overall from moderately to slightly impaired (Figure 59), but this score decreased sharply in 2017 and was again low in 2021 (M-IBI 24 and 26, respectively), with both years scoring as moderately impaired. The same pattern is seen in O/E scores, which increased steadily through 2014 to a high of 0.967 (slight disturbance) before falling to 0.68 in both 2017 and 2021 (Figure 59). The fact that these lower scores were seen for both models across two sampling events makes them less likely to be an anomaly and more likely to reflect changed habitat conditions in the reach, although it is somewhat inconsistent with the continued increase in overall richness, community balance (see below), and the sustained number of EPT. Temperature and stressor model scores were both greater in 2021 (22.4°C, 31.0%) compared to 2017 (21.6°C, 21.9%) and were above the threshold values in both years. Dominant community traits in 2021 included greater relative abundance of multivoltine organisms, which can reflect disturbance or unstable habitat, as well as more organisms that feed as collector-gatherers and tolerate a variety of temperatures and flow types, and the community MHBI was relatively high (5.8). Community metrics suggest a fairly diverse community that includes moderate numbers of EPT but is experiencing stress related to temperature, sediment, and organic enrichment, and that may be either experiencing or recovering from recent disturbance.

The community was dominated by members of the EPT group in all but the earliest sampling year (Figure 60). The most abundant taxon in 2021, the relatively tolerant mayfly *Baetis tricaudatus*, occurred at the lowest relative abundance (12%) of any sampling year; given that the community was much less balanced in 2017, when the dominant taxon *Hydropsyche* was present at 41% of relative abundance, it may be that recovery from some earlier disturbance is occurring. Despite differences in the top taxon, sample communities in 2017 and 2021 were more similar to each other and differed more from all prior sampling years except for 2002, which was an outlier (Figure 61), which again suggests a community shift in response to some more recent perturbation.

**Figure 58. Total and EPT richness at Middle Rock Creek. Linear trendlines are shown.**

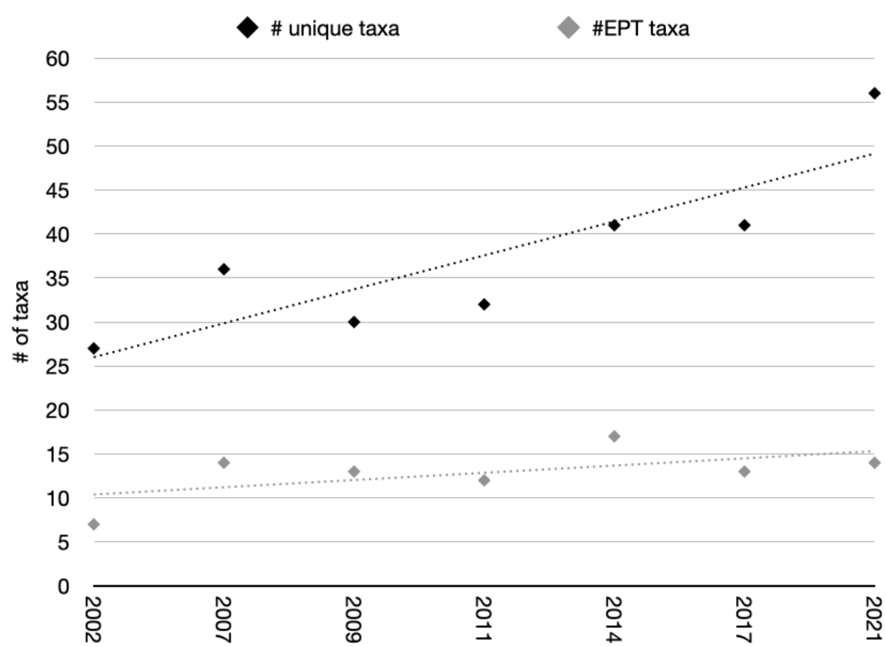


**Figure 59. M-IBI and O/E scores for Middle Rock Creek. Linear trendlines and thresholds for condition assignments are shown.**

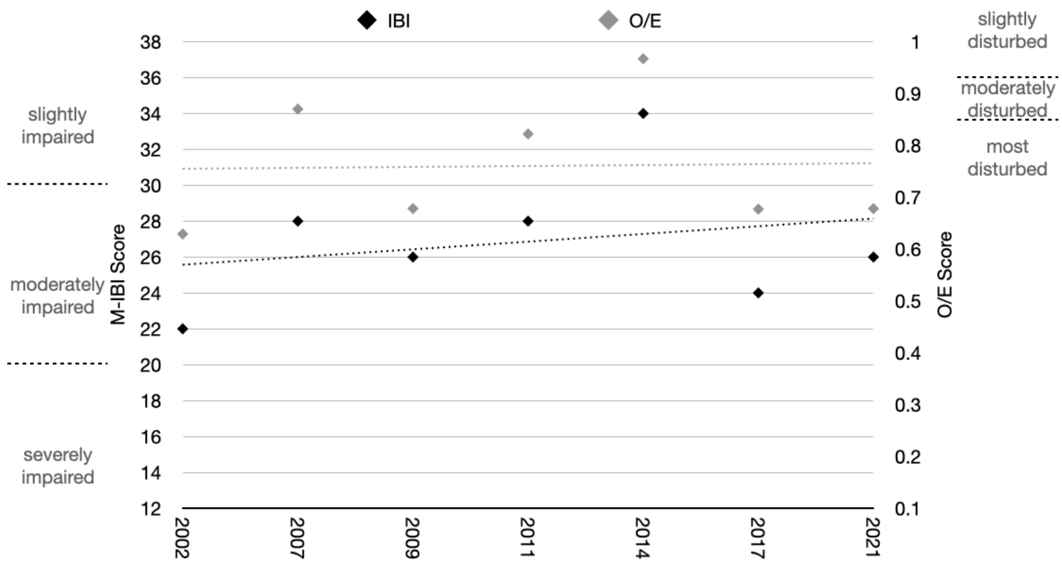



**Figure 60. Dominant (most abundant) taxon at Middle Rock Creek. Linear trendline is shown.**

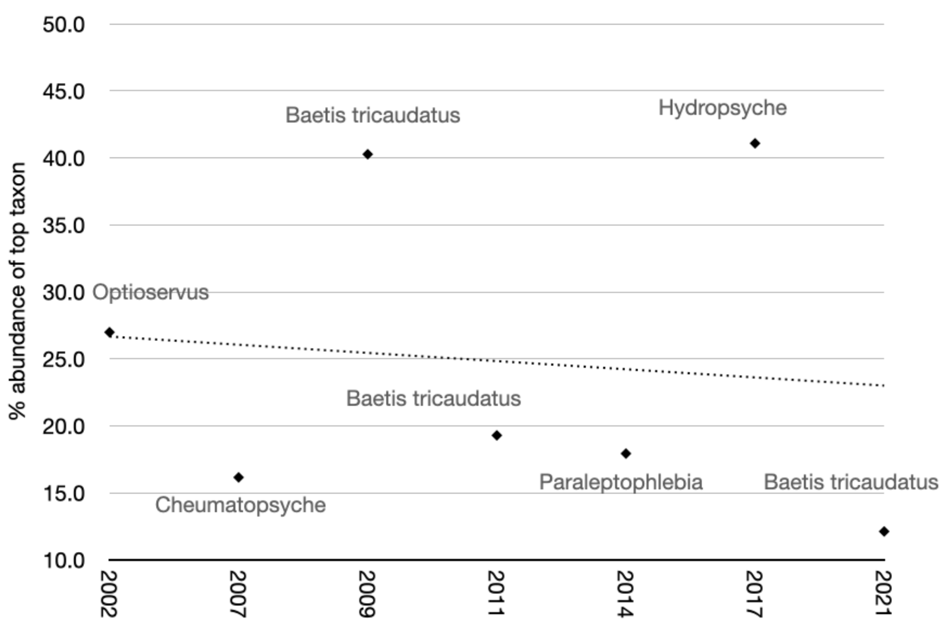
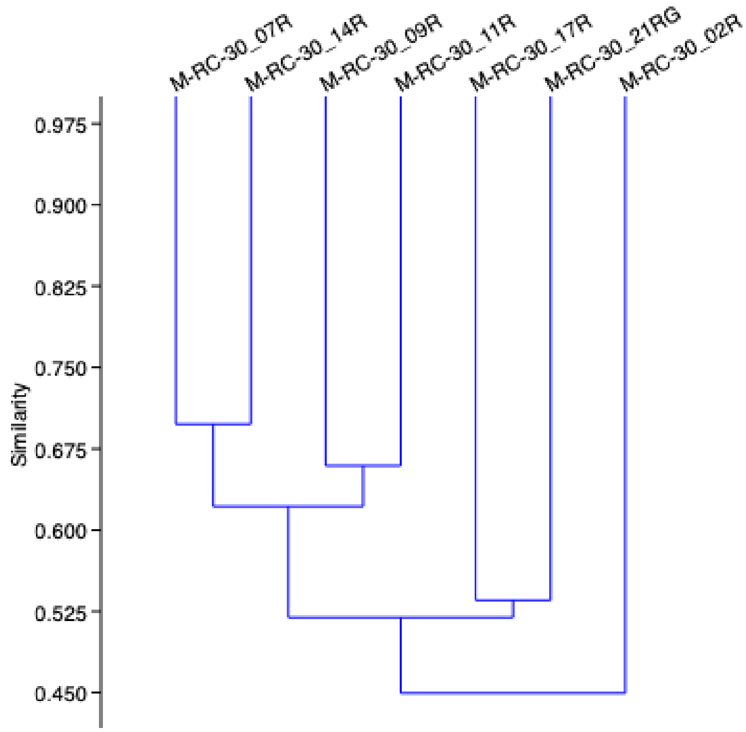


**Figure 61. CLUSTER dendrogram of macroinvertebrate community similarity at Middle Rock Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




<u>Upper Rock Creek (M-RC-50)</u>

Upper Rock Creek consistently has higher numbers of total and EPT taxa compared to other sites in the sample set, and values for these metrics were similar in the 2017 and 2021 samples (Figure 62). Both metrics trended upwards across time and are about 1.6 times higher overall than they were when sampling began in 2009, although values apparently plateaued between 2017 and 2021 following a period of sustained increase. M-IBI and O/E scores also increased in recent years (Figure 63). The 2021 M-IBI score (36), which corresponds to slightly impaired conditions, was the highest ever attained at this site, although this reach also scored as slightly impaired in 2017 (M-IBI = 34). O/E scores are higher overall at this site compared to other streams in the monitoring plan and although this score was slightly lower in 2021 (0.919) compared to 2017 (1.06), both years reflected least disturbed conditions. Temperature and sediment stressor model scores were higher in 2021 (20.2°C, 25.1%) compared to 2017 (19.8°C, 20.6%) and above the respective threshold values in both years. Dominant community traits in 2021 included a high relative abundance of organisms associated with cooler and faster flows, as well as a better balance among feeding guilds and a lower community MHBI (3.9). Metrics suggest a fairly diverse, stable community that is less tolerant of organic inputs although still likely to be experiencing stress from temperature and fine sediment.

In earlier sampling years the community was dominated by *Paraleptophlebia*, a prong-gilled mayfly associated with detritus and sediments in faster flows (Figure 64); in recent years the top taxon has been *Optioservus*, a tolerant riffle beetle, at lower relative abundances (17% in 2021). This beetle is long-lived, requiring more than one year to complete its development, and its presence is indicative of more stable/less disturbed habitat that allows it to complete its longer life cycle. Between-year sample community similarity is relatively high (~66% overall similarity), but later sampling years are more similar to each other than to the earliest sampling years (Figure 65), indicating that some changes in community composition have occurred.

**Figure 62. Total and EPT richness at Upper Rock Creek. Linear trendlines are shown.**

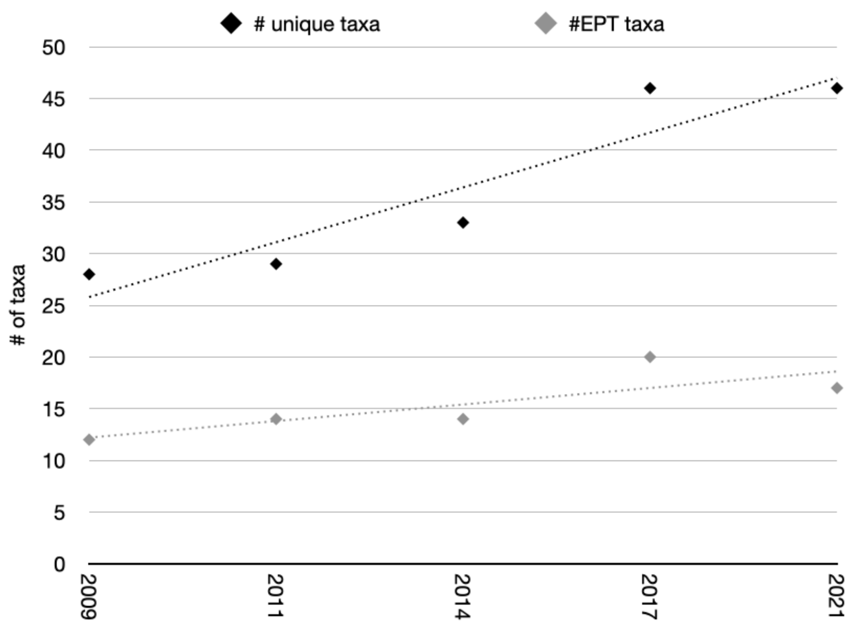


**Figure 63. M-IBI and O/E scores for Upper Rock Creek. Linear trendlines and thresholds for condition assignments are shown.**

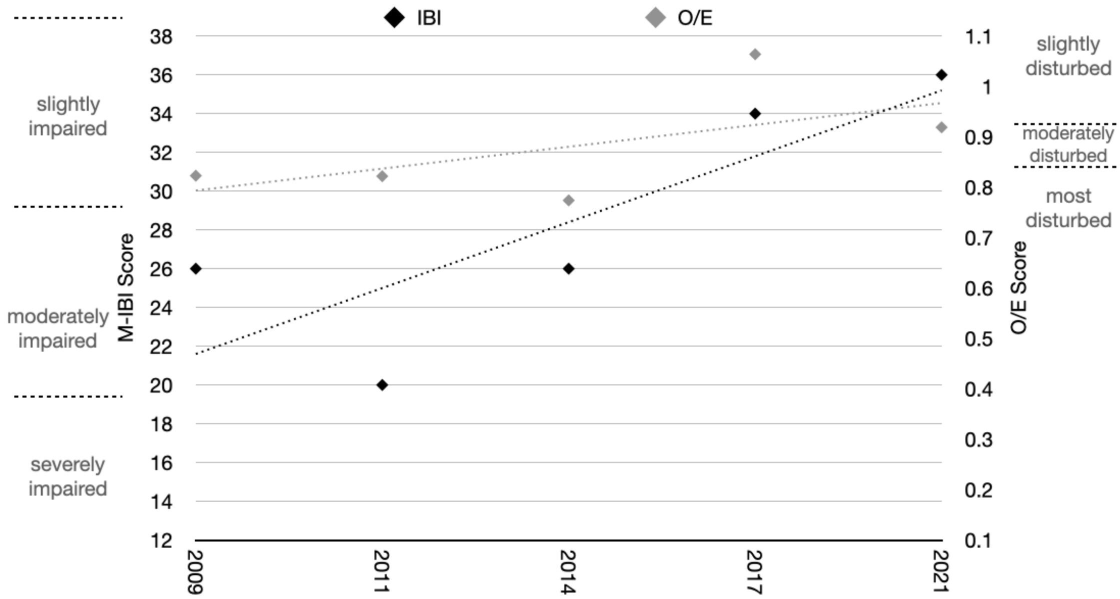



**Figure 64. Dominant (most abundant) taxon at Upper Rock Creek. Linear trendline is shown.**

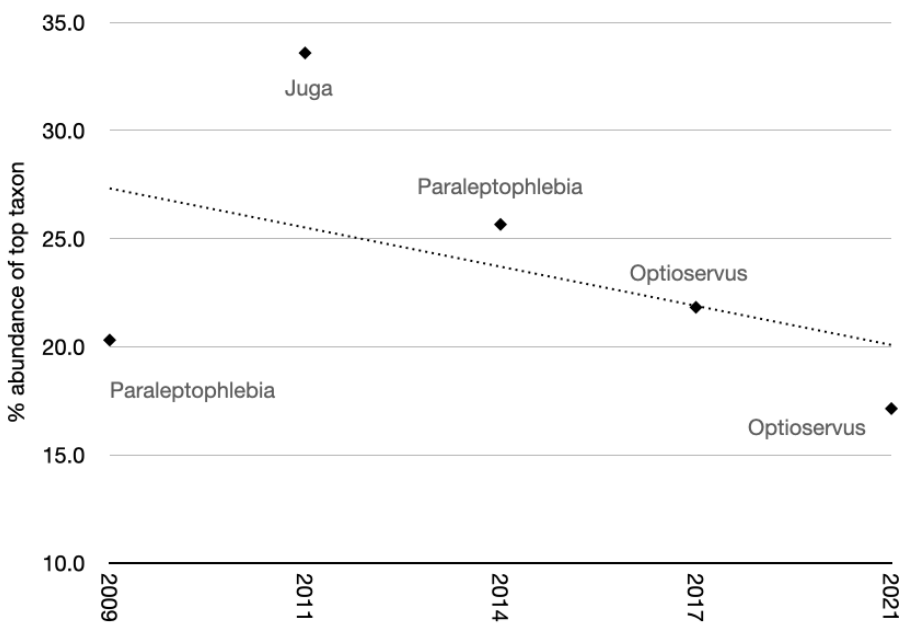
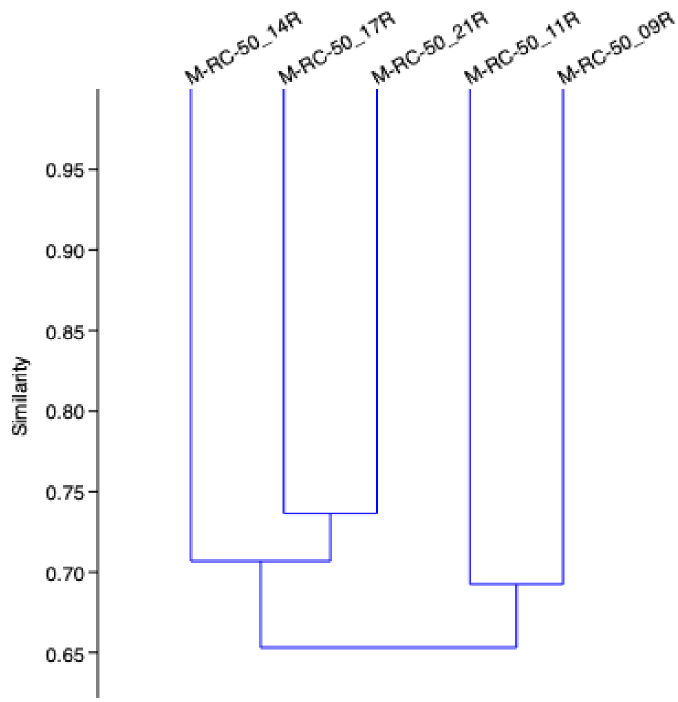


**Figure 65. CLUSTER dendrogram of macroinvertebrate community similarity at Upper Rock Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Shipley Creek (M-SH-10)

At the time of sampling in 2021, flow in Shipley Creek was reduced to a tiny trickle in the deeply incised channel. Samples in prior years have been taken in riffle or glide habitats, suggesting that flow in the reach may normally vary annually. The number of taxa taken here has been moderate and relatively stable (23-25 between 2011 and 2021; Figure 66) though with a slight increasing trend overall. EPT richness followed a similar pattern, with 8-11 taxa present in the same time span (Figure 66). Even though richness varies less over time compared to other sites, M-IBI and O/E scores have increased overall (Figure 67), although M-IBI scores correspond to moderate impairment in every year except 2014 (slight impairment) while O/E scores consistently reflect severe disturbance. Scores for both models were identical in the 2017 and 2021 samples, and it remains to be seen whether further habitat changes will support a continued increase or if maximum possible values have been attained. Temperature and sediment stressor model scores were both lower in 2021 (16.2ºC, 20.8%) compared to 2017 (17.4ºC, 28.6%), with the 2021 temperature score below the threshold value and the sediment score slightly above. Dominant community traits in 2021 reflect the characteristics of the super-abundant dominant taxon (see below) and include a high abundance of univoltine organisms, collector-gatherers, and organisms that tolerate a range of water temperatures, with a relatively low community MHBI (4.0). Metrics suggest an unbalanced community that may be more stressed by habitat disturbance and fine sediment input than by temperature or organic enrichments.

This site was dominated by the amphipod *Ramellogammarus* in every sampling year at high relative abundances (45-78% of total organismal abundance; Figure 68); this imbalance suggests suggesting a community experiencing more regularly habitat disturbance. Community composition between years is overall fairly high (~56% average similarity; Figure 69), with most glide sample communities differing more from all riffle communities. However, the glide community in 2021 was more similar overall to the riffle communities in past years.

**Figure 66. Total and EPT richness at Shipley Creek. Linear trendlines are shown.**

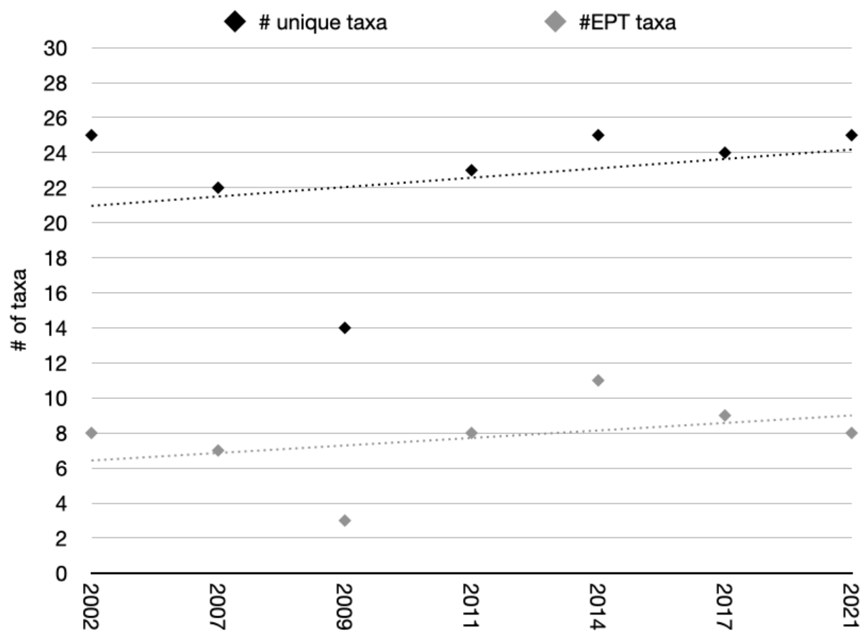


**Figure 67. M-IBI and O/E scores for Shipley Creek. Linear trendlines and thresholds for condition assignments are shown.**

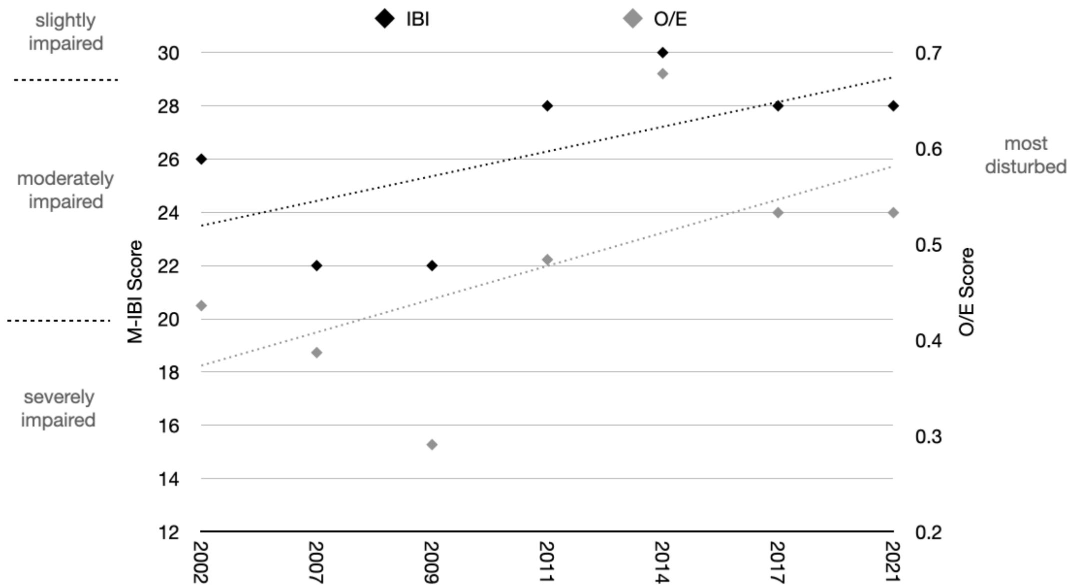



**Figure 68. Dominant (most abundant) taxon at Shipley Creek. Linear trendline is shown.**

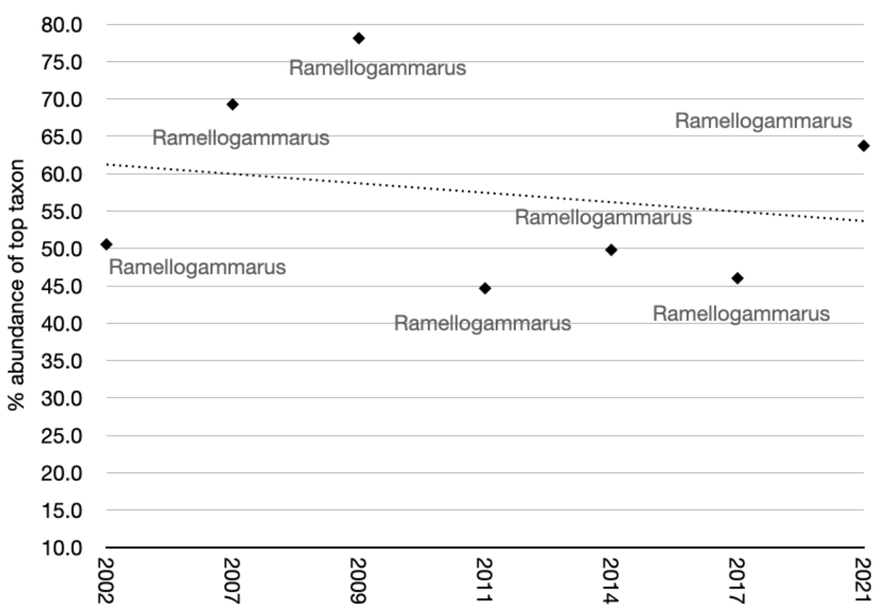
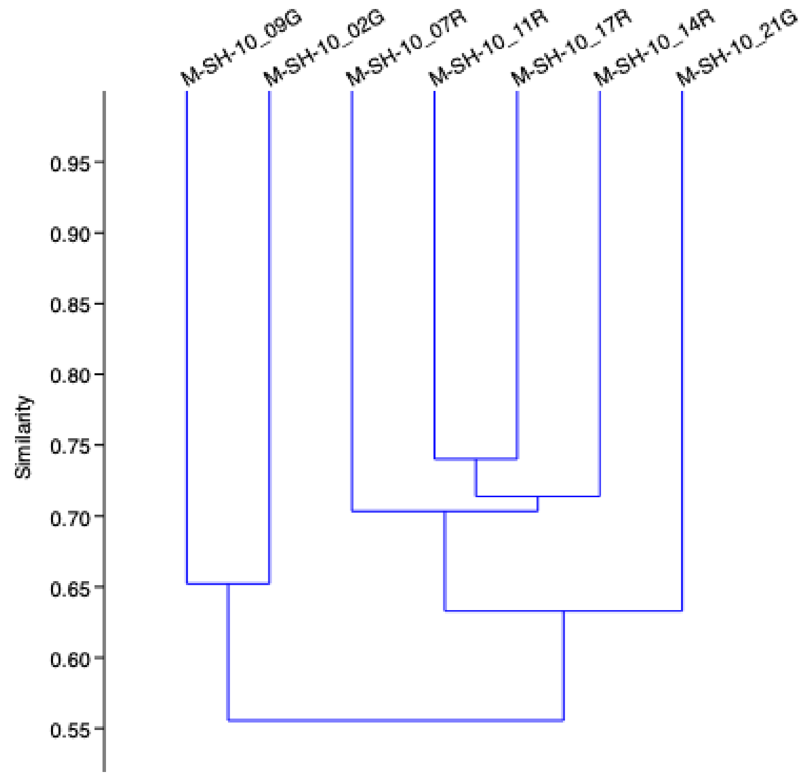


**Figure 69. CLUSTER dendrogram of macroinvertebrate community similarity at Shipley Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Sieben Creek (M-SI-10)

Reach conditions at Sieben Creek do not appear conducive to supporting a diversity of invertebrate taxa; the creek was deeply incised and narrow, surrounded by blackberry and residential grass lawn, and at the time of sampling in 2021 the mineral substrate felt slimy and the water had an unpleasant odor. Despite this, sample richness was relatively high (40 taxa) and similar to though slightly lower than the prior year (Figure 70). Values for this metric were consistent and low in early years but increased sharply between 2014 (19 taxa) and 2017 (44 taxa). The number of EPT taxa has also trended upwards (Figure 70), and the 12 EPT taken in 2021 were the most ever seen in this reach. M-IBI and O/E scores are trending upwards (Figure 71), and the highest score at this site for both models was attained in 2021. O/E scores continue to reflect most disturbed conditions, although the score in 2021 (0.774) was higher than any prior year and approaching the lower limit for moderately disturbed. M-IBI scores indicated moderate impairment for the last five sampling events and the 2021 score of 28, which was the highest attained at this site in an y year, was also close to the lower boundary between moderate and slight impairment. Temperature stressor model scores were similar in 2017 and 2021 (18.7°C and 19.2°C, respectively) and both were slightly above the threshold value. The sediment model stressor score was lower in 2021 (21.9%) than in 2017 (24.8%); both are above the threshold value. Dominant community traits in 2021 include high relative abundances of organisms that feed as collectors (filterers and gatherers), organisms associated with faster flows and cooler temperatures, and a relatively high community MHBI (5.5). Metrics suggest a community that s fairly tolerant to organic enrichment but also able to support more sensitive taxa, and that may be experiencing regular disturbance but is potentially less stressed by temperature or fine sediment.

This site has been dominated by a variety of relatively tolerant taxa including the mayfly *Baetis tricaudatus* and the cosmopolitan Orthocladiinae subfamily of non-biting midges (Figure 72). In 2017 and 2021, the community was dominated by *Simulium* black flies; this taxon can be an early colonizer following a disturbance, but its relative abundance was lower in both 2017 and 2021 (26-29%) compared to abundance of the top taxa in earlier years (36-56%). Macroinvertebrate community composition in the reach has shifted over time, and the 2021 sample community was something of an outlier compared to more recent sampling years (Figure 73), although the 2002 riffle community differed most from all other sampling years. In more recent sampling years, the number of *Simulium* black flies and mites has increased; greater abundances of these groups can indicate more disturbed conditions. However, the 2021 sample also had more Capniidae stoneflies, a sensitive group, than any prior year; increased numbers of these shredders is interesting considering that there is little riparian vegetation along this reach.

**Figure 70. Total and EPT richness at Sieben Creek. Linear trendlines are shown.**

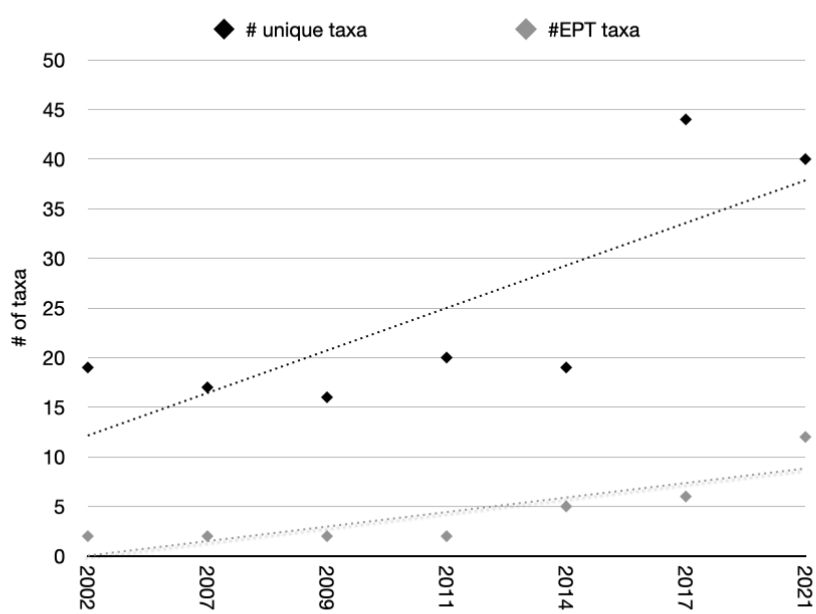


**Figure 71. M-IBI and O/E scores for Sieben Creek. Linear trendlines and thresholds for condition assignments are shown.**

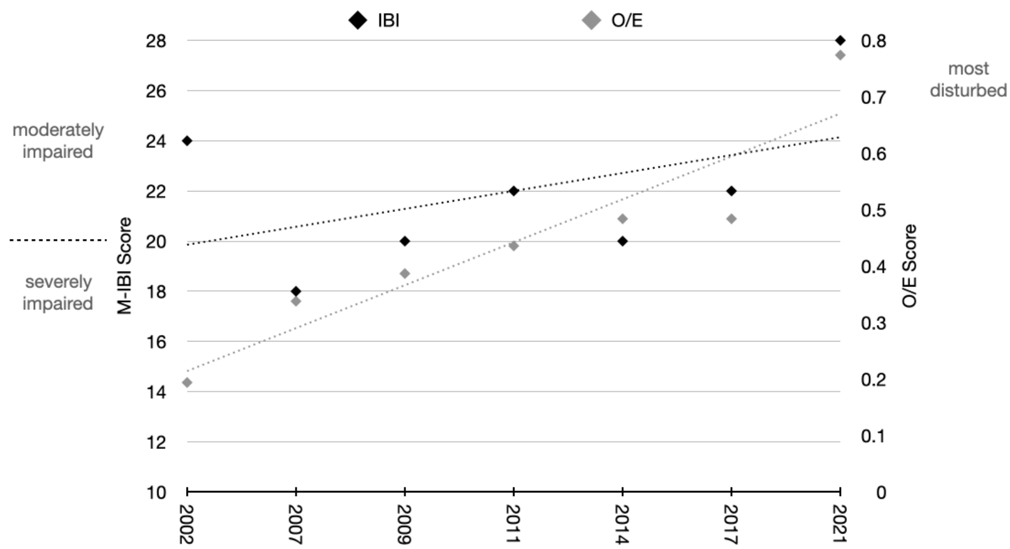



**Figure 72. Dominant (most abundant) taxon at Sieben Creek. Linear trendline is shown.**

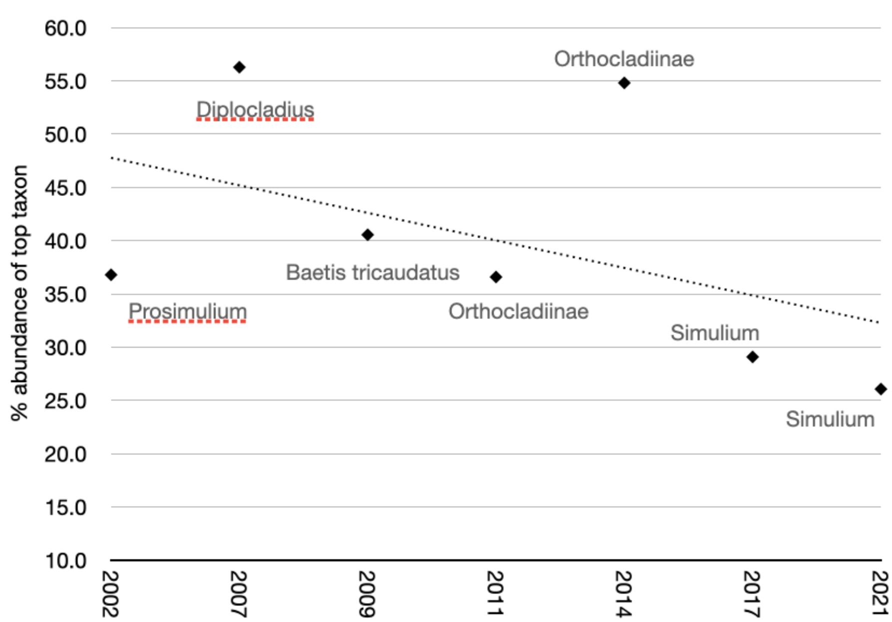
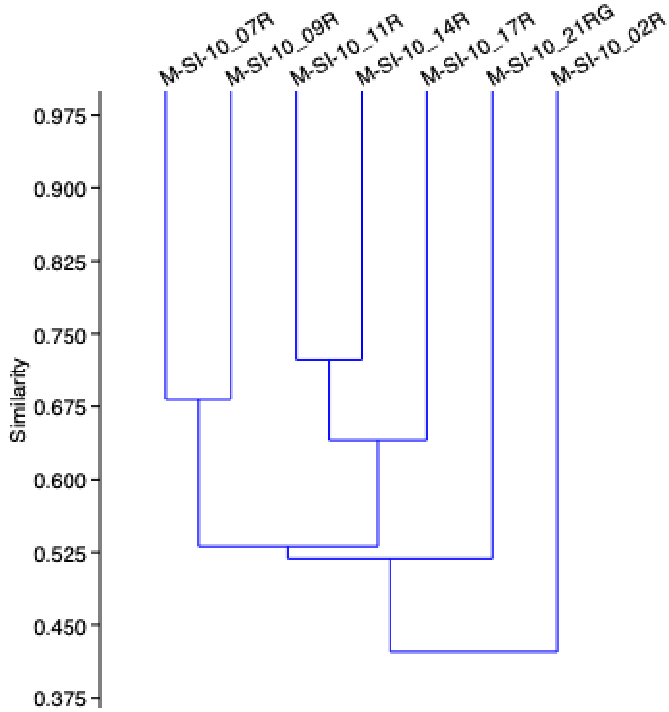


**Figure 73. CLUSTER dendrogram of macroinvertebrate community similarity at Sieben Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Tate Creek (M-TA-10)

Although organismal abundance in the 2021 Tate Creek sample was very low (190 individuals total), the number of total taxa (34) was still greater than in the 2009-2014 samples (Figure 74), although less than the previous sampling year (42). Fewer EPT taxa were taken in 2021 (7) compared to the prior sampling year (11 EPT; Figure 74), but values for this metric were fairly stable in recent years (7-13 between 2011 and 2021) and both total and EPT taxa numbers increased overall since sampling began. O/E scores consistently indicate severely disturbed conditions (Figure 75), and this value was lower in 2021 (0.581) than in any prior year. M-IBI scores consistently indicate moderately impaired conditions, but in contrast to the O/E model, the IBI score was higher in 2021 (26) than in 2017 (22). Temperature stressor model scores in 2021 and 2017 were almost identical (19.6°C  and 19.0°C, respectively) and slightly above the 18.4°C threshold value; the sediment stressor score was greater in 2021 (26.3%) than in 2017 (22.5%) and both were above the 19% threshold value. Dominant community traits in 2021 include high relative abundances of organisms that are multivoltine, which can reflect disturbed or unstable habitat; organisms that feed as collector-gatherers; and organisms tolerant of a range of water temperatures. The community MHBI value was somewhat high (5.5). Metric values indicate a community that may be more stressed by fine sediment and organic enrichment than by temperature.

The community was dominated by the relatively tolerant mayfly *Baetis tricaudatus* for the last three sampling years (Figure 76); relative abundance of the top taxon was fairly low in those three years but was lower in 2021 (14% of total abundance) than in any prior year, indicating a more balanced community overall. The communities in glide samples taken in earlier years (2002-2009) differ more from the riffle communities sampled in recent years (Figure 77). The 2021 riffle/glide sample was more similar to riffle samples taken in the three most recent sampling years although it contained fewer tolerant organisms such as amphipods, worms, non-biting midges, *Cheumatopsyche* caddisflies, and rock snails.

**Figure 74. Total and EPT richness at Tate Creek. Linear trendlines are shown.**

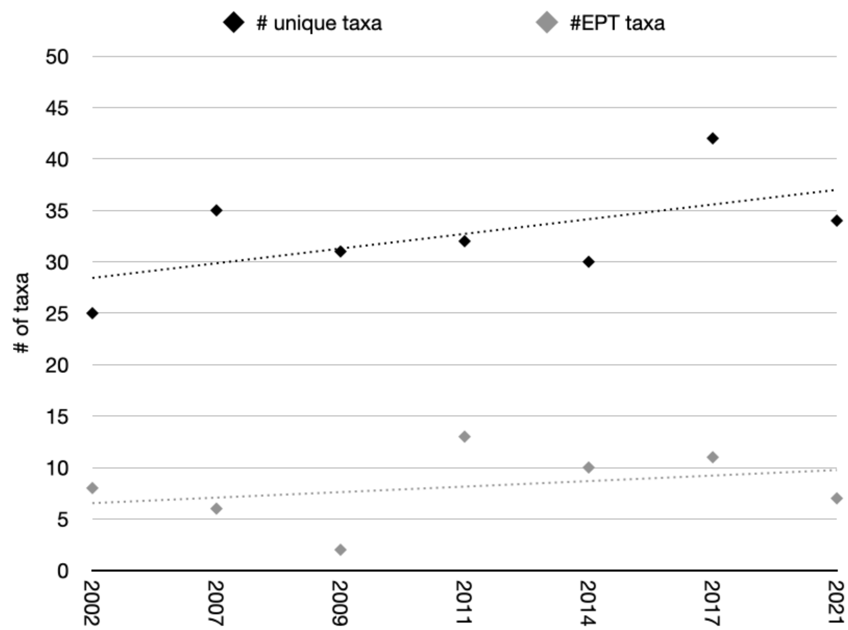


**Figure 75. M-IBI and O/E scores for Tate Creek. Linear trendlines and thresholds for condition assignments are shown.**

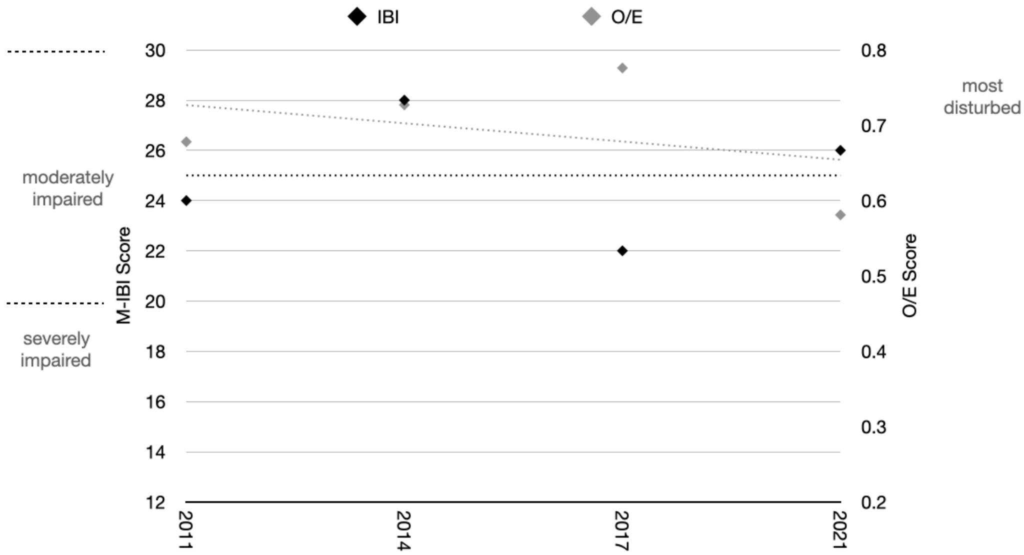



**Figure 76. Dominant (most abundant) taxon at Tate Creek. Linear trendline is shown.**

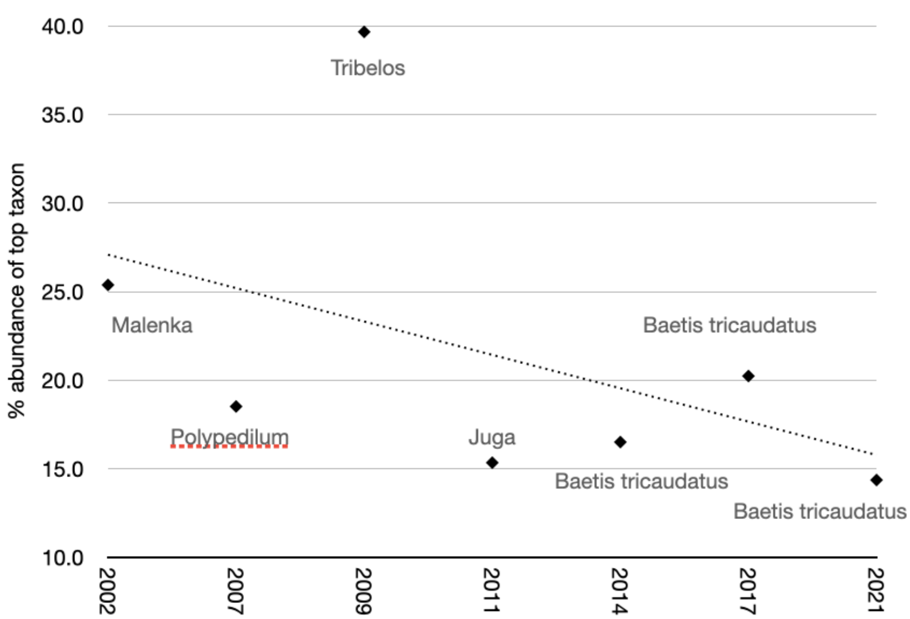
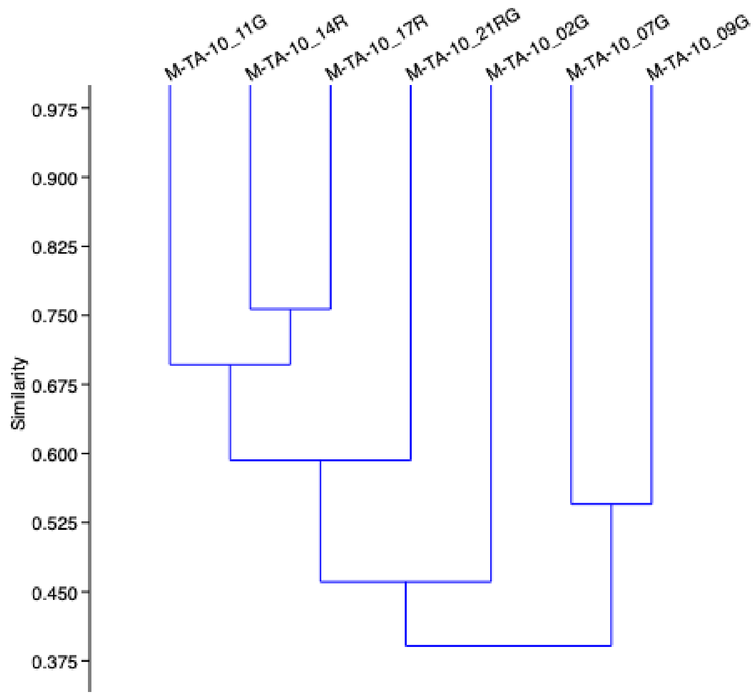


**Figure 77. CLUSTER dendrogram of macroinvertebrate community similarity at Tate Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




<u>Trillium Creek (M-TR-10)</u>

Fewer taxa were taken at Trillium Creek in 2021 (45) than in 2017 (51 taxa; Figure 78), but richness in both years was much higher compared to all earlier sampling years (25-30 taxa between 2002 and 2014). This site also has higher richness overall compared to other sites in the monitoring plan. One more EPT taxon was taken in 2021 (15) compared to 2017 (14; Figure 78), and values for this metric also show a pattern of being lower and more stable from 2002 to 2014 (6-11 EPT) and then increasing to an apparently sustained new high. M-IBI scores show the same pattern of substantial increase between 2014 and 2017 (Figure 79); in earlier sampling years, M-IBI scores reflected severe to moderate impairment (10-24), but samples in 2017 and 2021 both received a score of 30, which is the lower boundary to score as slightly impaired. O/E scores were consistently lower from 2002 through 2017 (Figure 79), corresponding to severely disturbed conditions, but the 2021 score was much higher (0.871) and rose to the first time into the moderate disturbance range. Temperature stressor model scores were virtually the same in 2021 and 2017 (19.3ºC and 19.4ºC, respectively) and slightly above the 18.4ºC threshold. The sediment stressor score increased from 2017 (12.7%) to 2021 (17.3%), although both are below the 19% threshold value. Dominant community traits in 2021 include high relative abundances of organisms associated with faster flows and tolerant of a variety of water temperatures, and the community MHBI value was somewhat high (5.5). Metric values indicate a diverse community that experienced the greatest change between 2014 and 2017.

Temperature is more likely to be a potential stressor than fine sediment, although based on the increase in sediment stressor score from 2017 and 2021, sediment could be becoming an issue.

The community was dominated by the relatively tolerant mayfly *Baetis tricaudatus* in all but the earliest sampling year (Figure 80), at moderate to high abundances (17-43% of total organismal abundance). Even though 2021 was the only year in which riffle habitat was not available to be sampled, the 2021 glide sample community was most similar to the riffle sample taken in 2017 (Figure 81). Between-year similarity for samples taken from 2009 through 2021 was fairly high (~55% overall similarity) but greatest between the two most recent sampling years, which further suggests that a substantial change reflecting improved conditions occurred between 2014 and 2017.

**Figure 78. Total and EPT richness at Trillium Creek. Linear trendlines are shown.**

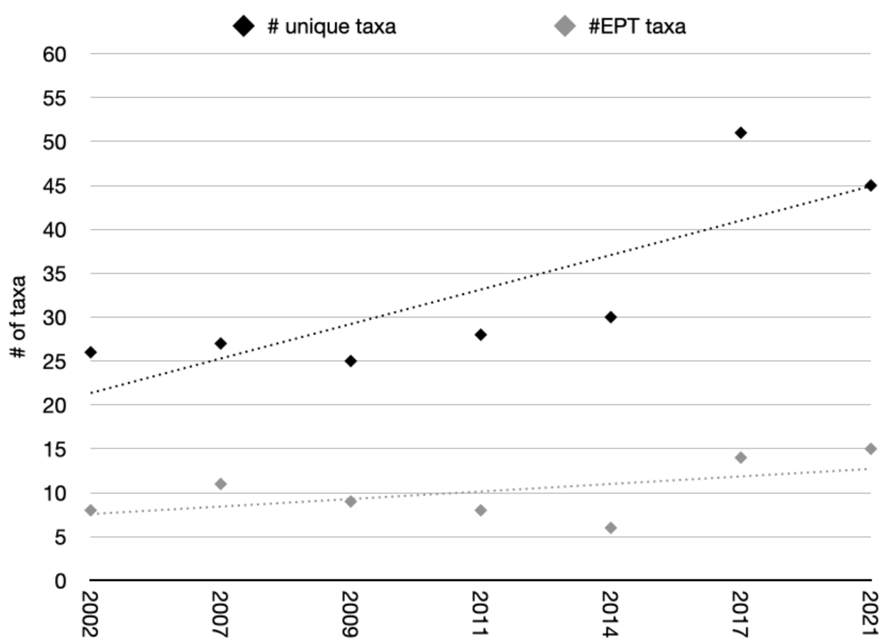


**Figure 79. M-IBI and O/E scores for Trillium Creek. Linear trendlines and thresholds for condition assignments are shown.**

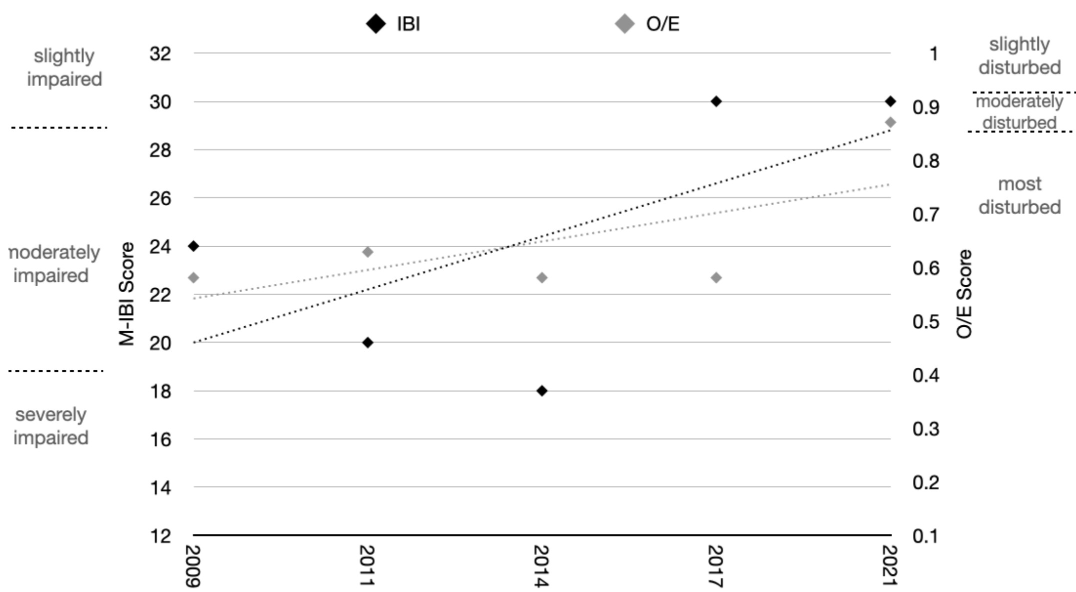



**Figure 80. Dominant (most abundant) taxon at Trillium Creek. Linear trendline is shown.**

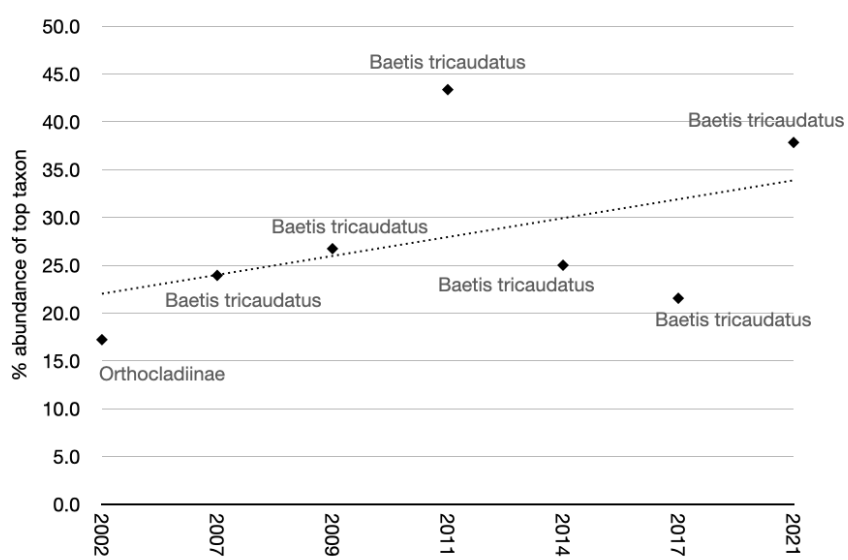
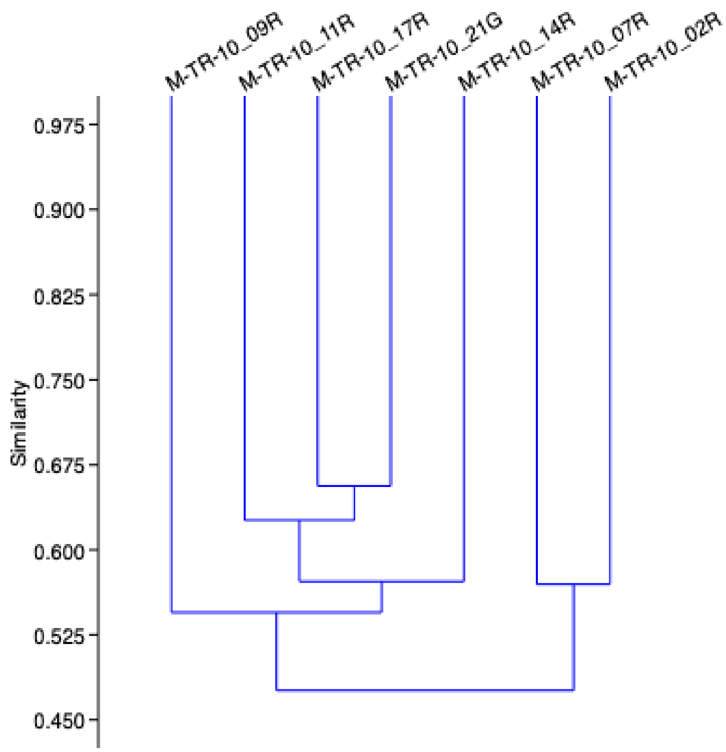


**Figure 81. CLUSTER dendrogram of macroinvertebrate community similarity at Trillium Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Unnamed Tributary 2 (M-T2-10)

Water levels in the Unnamed Tributary 2 reach were very shallow at sampling time, with flow reduced to a narrow trickle, and organismal abundance in the sample was extremely low (only 75 individuals). Not surprisingly with this small number of organisms, the community had fewer total taxa (22) and EPT (3 taxa) compared to previous sampling years (Figure 82). However, taxa richness has trended downwards over time, while EPT richness varied with less discernible pattern, so the 2021 values may not be entirely anomalous. M-IBI and O/E model scores trended upwards from 2002 to 2017, but both were much lower in 2021 than in any prior year (Figure 83), reflecting severely impaired/most disturbed conditions. O/E scores have always been in the lowest condition range of the model, but M-IBI scores that reflected severe impairment in 2002 rose fairly steadily to values corresponding to moderate and then slight impairment by 2011, after which they dropped into the moderate/slight impairment transition zone. The score in 2021 was the lowest since 2002, and these changes may be due more to conditions at sampling time than to actual changes in the stream, unless hydrologic alterations occurred since the last sampling year. Temperature and sediment stressor model scores were both higher in 2021 (22.0ºC, 53.1%) than in 2017 (17.7ºC, 18.3%) and well above the respective threshold values. Dominant community traits in 2021 included high relative abundance of tolerant organisms, collector-gatherers, and organisms associated with a range of flow types and water temperatures, and a somewhat high community MHBI (5.2). Metric values indicate a less diverse and more disturbed community in habitat that is still stable enough to support development of longer-lived taxa. The potential role of temperature and sediment as stressors is unclear; both values were likely influenced by the extremely low flows in the reach at sampling time, but they were also close to the threshold values in 2017, so both may be implicated as stressors.

The community was dominated by the amphipod *Ramellogammarus* in 2011-2017 (Figure 84). However, despite the very shallow water at sampling time, the 2021 community was dominated by *Optioservus*, a riffle beetle that requires more stable habitat to sustain its longer egg to adult development, and the 2nd most abundant taxon was another long-lived riffle beetle (*Zaitzevia*). Differences in community composition in previous sampling years were related to both year and habitat sampled, as glide samples taken in earlier years were more similar to each other overall compared to the riffle samples taken in more recent years (Figure 85). The relatively low overall similarity between the two groups (~35%) suggests that the differences are not entirely due to habitat type and that a shift in macroinvertebrate community composition occurred. However, the 2021 glide community was an outlier compared to all other sampling years, reflecting the low organismal abundance and reduced taxon diversity in the sample.

**Figure 82. Total and EPT richness at Unnamed Tributary 2. Linear trendlines are shown.**

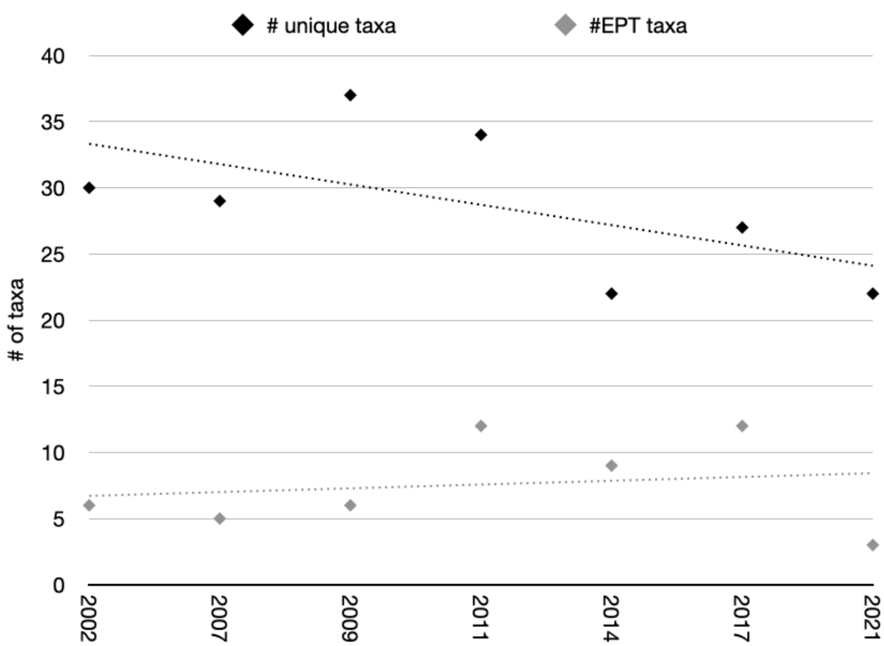


**Figure 83. M-IBI and O/E scores for Unnamed Tributary 2. Linear trendlines and thresholds for condition assignments are shown.**

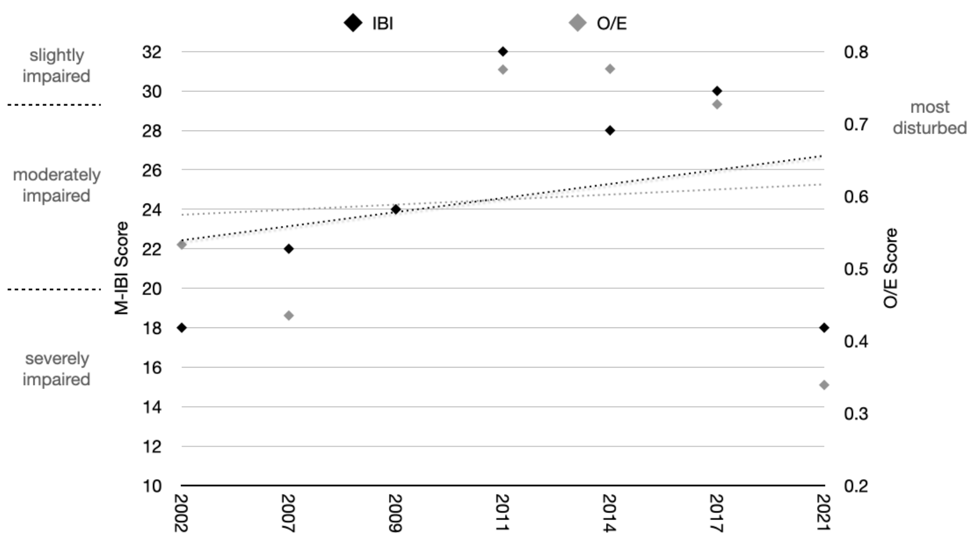



**Figure 84. Dominant (most abundant) taxon at Unnamed Tributary 2. Linear trendline is shown.**

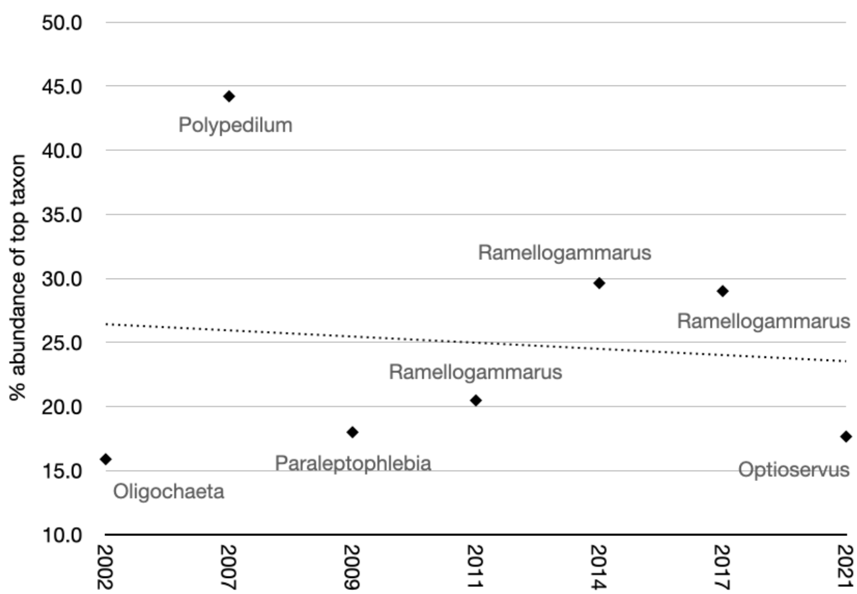
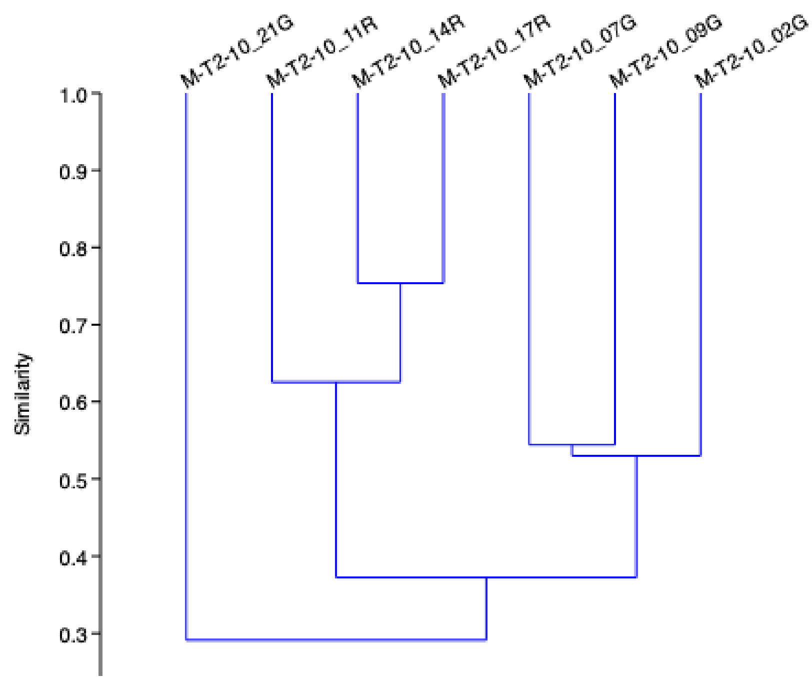


**Figure 85. CLUSTER dendrogram of macroinvertebrate community similarity at Unnamed Tributary 2. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**




Unnamed Tributary 4 (M-T4-10)

At the time of sampling in 2021 the reach at Unnamed Tributary 4 was almost dry, despite a rainfall event that occurred within the previous seven days, and the only open water in the reach was a small remnant pool in which all net sets were taken. As would be expected, organismal abundance was extremely low (62 individuals total) and metric values decreased across the board in response. Total richness, which had been increasing (22 to 47 taxa from 2002 to 2017; Figure 86), fell to a new low in 2021 (16 taxa). Similarly, only a single EPT taxon, the mayfly *Neoleptophlebia,* was taken in 2021 (Figure 86); values of this metric varied more across time than total richness, and while they had decreased slightly overall between 2011 (17 EPT) and 2017 (12 EPT), even the earliest sampling year had more EPT taxa than the 2021 sample.

The O/E and M-IBI models were applied to this sample but the results are not representative, due to dry conditions at sampling time (M-IBI score 14, severely impaired; O/E score 0.242, most disturbed), and thus were omitted from the historical trend analysis (Figure 87). The greatest difference in scores for both models occurred between 2002 and 2007, when the M-IBI increased from 16 (severely impaired) to 32 (slightly impaired). The O/E score rose from 0.533 to 0.725 in that same span, and while both correspond to most disturbed conditions, scores between 2009 and 2017 were around the threshold between most and moderately disturbed. Temperature and sediment stressor model scores did not differ as much from the previous year as would be expected based on the difference in reach conditions. Both scores were higher in 2021 (19.4ºC, 31.1%) compared to 2017 (18.6ºC, 22.5%) but although all were above the respective model threshold values, temperature scores in both years exceeded the threshold by no more than 1ºC. Dominant community traits in 2021 included high relative abundance of tolerant organisms; non-insect taxa; collector-gatherer feeders; organisms that tolerate a range of water temperatures and flow types; and a high community MHBI (6.6). While conditions suggested by 2021 metric values, which include a depauperate community experiencing high levels of disturbance and stressed by organic enrichment, fine sediment, and potentially temperature, may be anomalous due to a hot dry summer creating lower than usual flows, it is worth noting that this near-dry condition was observed within one week of a rainfall event, and that some metrics, such as characteristics of the dominant taxon, temperature and sediment stressor model scores, and M-IBI score, were also indicative of more impaired conditions in 2017, and this may be a trend reflecting a more recent change in habitat conditions and/or hydrology at the site.

The 2021 sample community was dominated by *Procladius* (Figure 88), a tolerant non-biting midge generally associated with sediment in slower-moving waters. This is again not unexpected considering the habitat available at sampling time, but it is notable that while the dominant taxon in both 2011 and 2014 was a stonefly (*Zapada cinctipes*), the dominant taxon in the 2017 riffle sample was another non-biting midge, *Micropsectra*, which is also associated with muddy sediments in slower-moving water. Both glide and riffle samples were taken in several earlier sampling years, and in general between-year community similarity is driven more by the type of habitat sampled (Figure 89). The 2021 pool sample community is an outlier but is overall more similar to glide samples taken in this reach than to riffle samples. However, future years will reveal whether the depleted, depauperate sample in 2021 was an anomaly brought about by an unusually hot dry summer, or indicative of new disturbance in the reach.

**Figure 86. Total and EPT richness at Unnamed Tributary 4. Linear trendlines are shown.**

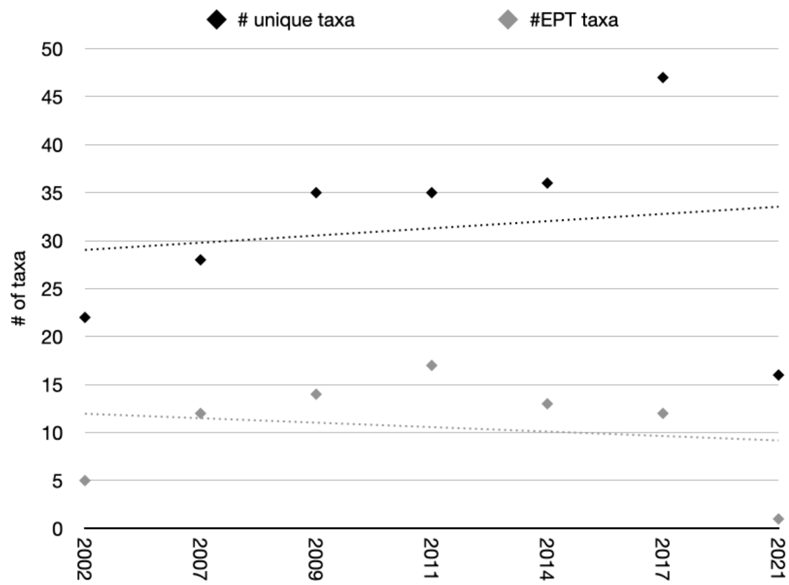



**Figure 87. M-IBI and O/E scores for Unnamed Tributary 4. Linear trendlines and thresholds for condition assignments are shown.**

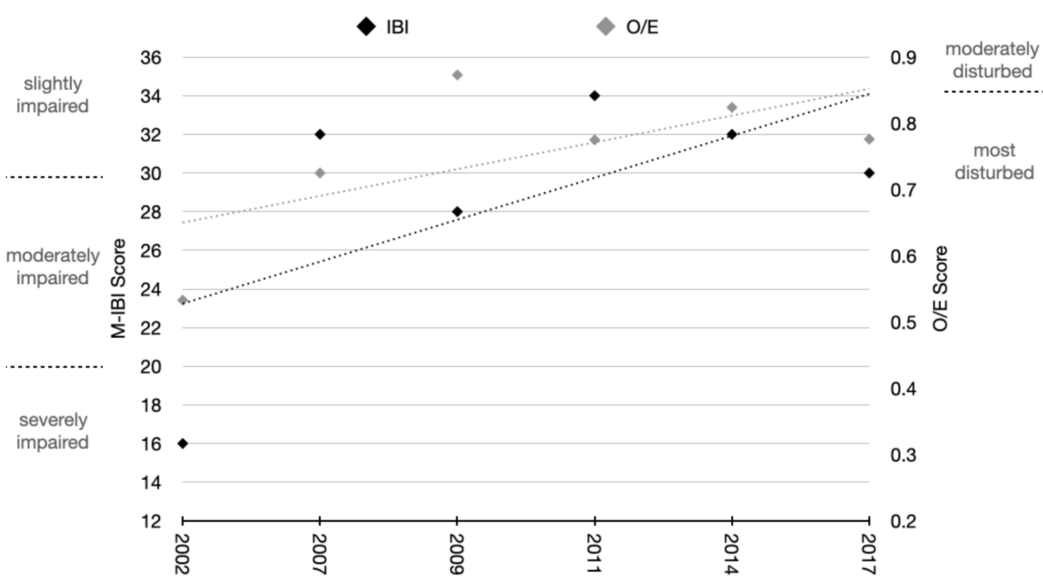


**Figure 88. Dominant (most abundant) taxon at Unnamed Tributary 4. Linear trendline is shown.**

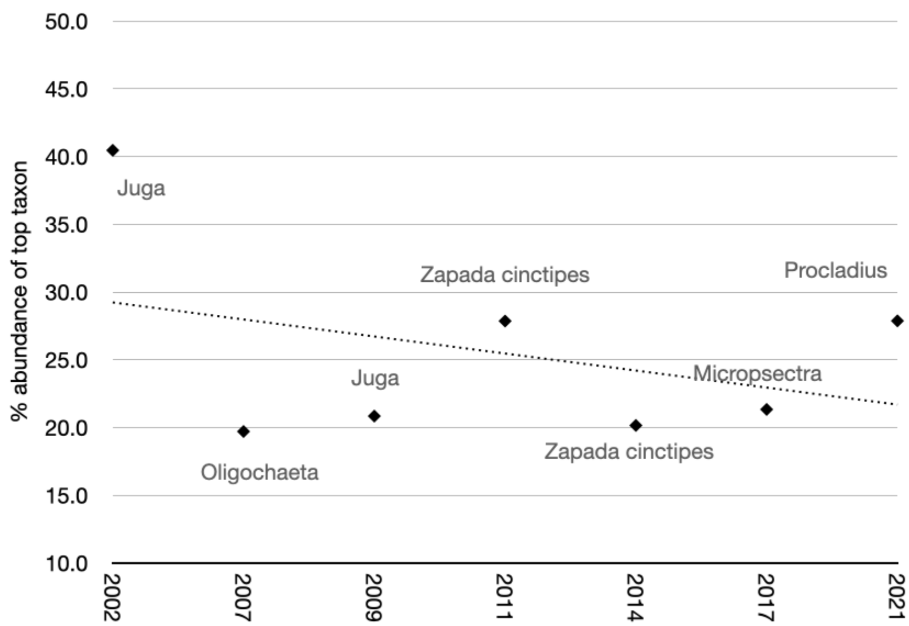
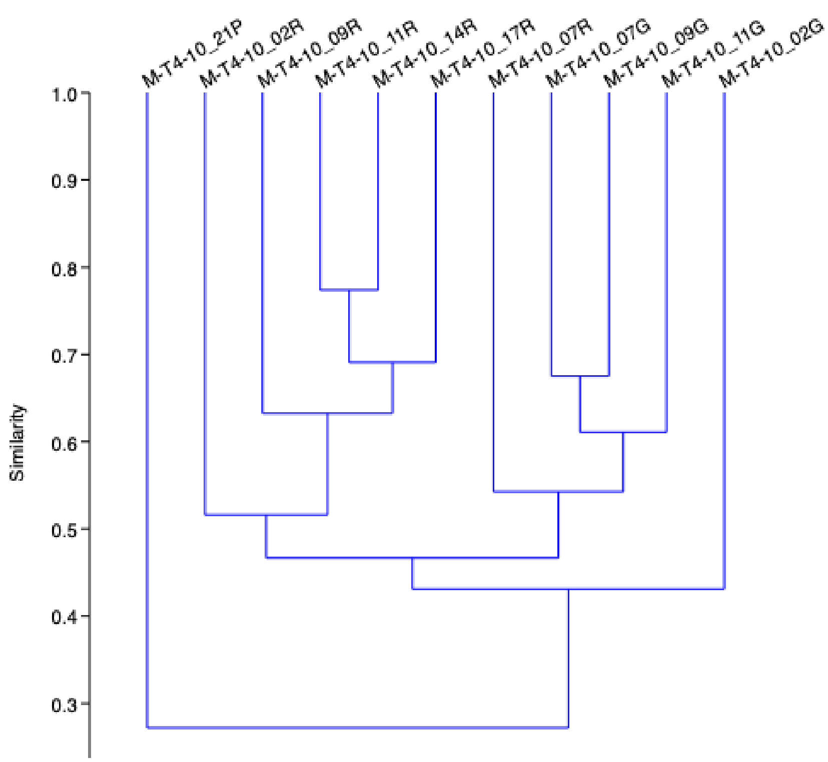



**Figure 89. CLUSTER dendrogram of macroinvertebrate community similarity at Unnamed Tributary 4. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**



Wilson Creek (M-WI-10)

The Wilson Creek reach was very shallow at sampling time and the sample was correspondingly of low abundance, with only 167 individuals total. As would be expected, this resulted in lower total and EPT taxa richness (Figure 90); less than half as many total taxa (22) and EPT taxa (6) were taken compared to previous monitoring years, but these metrics have also varied more between sampling years and a clear trend is not evident. However, M-IBI and O/E model scores both increased substantially overall between 2002 and 2017, with the greatest change in both scores occurring between 2002 and 2007 (Figure 91). The O/E score reflected minimal impairment in 2017 (40), and severe impairment in 2021 (22). The highest O/E score at this site was attained in 2014 (0.969, minimal disturbance), but the 2017 score dropped into the moderately disturbed range (0.873) and the 2021 score was lower than any sampling year except 2002. The 2021 temperature stressor model score (19.2$^{o}$C) was slightly higher compared to 2017 (18.1$^{o}$C) and just above the 18.4$^{o}$C threshold value for this metric. The sediment stressor model score was also higher in 2021 (36.3% vs. 25.5% in 2017), and both were well above the 19% threshold value. Dominant community traits in 2021 included high relative abundance of tolerant organisms, shredders and scrapers, and organisms associated with cooler water and faster flows. The community MHBI (3.1) was the lowest in the 2021 dataset. While conditions suggested by 2021 metric values include a depauperate, unbalanced, severely impaired/disturbed community, many of these values may be outliers resulting from the impacts of an unusually hot dry summer. However, based on stressor model scores form the past two years and the current community MHBI, sediment is a likely stressor, temperature a potential stressor, and organic enrichment does not appear to be a factor impacting the community.

Despite the differences described above, the dominant taxon in the 2021 sample was a more sensitive type (the caddisfly *Micrasema),* but it occurred at much higher abundance (38%) than the top taxon in the prior sampling year *(Sweltsa* stonefly; 13% of total abundance), indicating a less balanced, more disturbed community (Figure 92). The 2021 community differed more from communities in other years except for 2007, which was an outlier (Figure 93). These differences are influenced in part by the fact that both the 2007 and 2021 samples were taken in glides while other years sampled riffle habitat, but the depauperate nature of the sample in 2021 makes larger differences in overall community composition expected. This reach had very low flow despite being sampled within a week of a rain event, and so it remains to be seen whether the 2021 habitat conditions and altered community are a weather-related anomaly or the result of some greater hydrologic disturbance.

**Figure 90. Total and EPT richness at Wilson Creek. Linear trendlines are shown.**

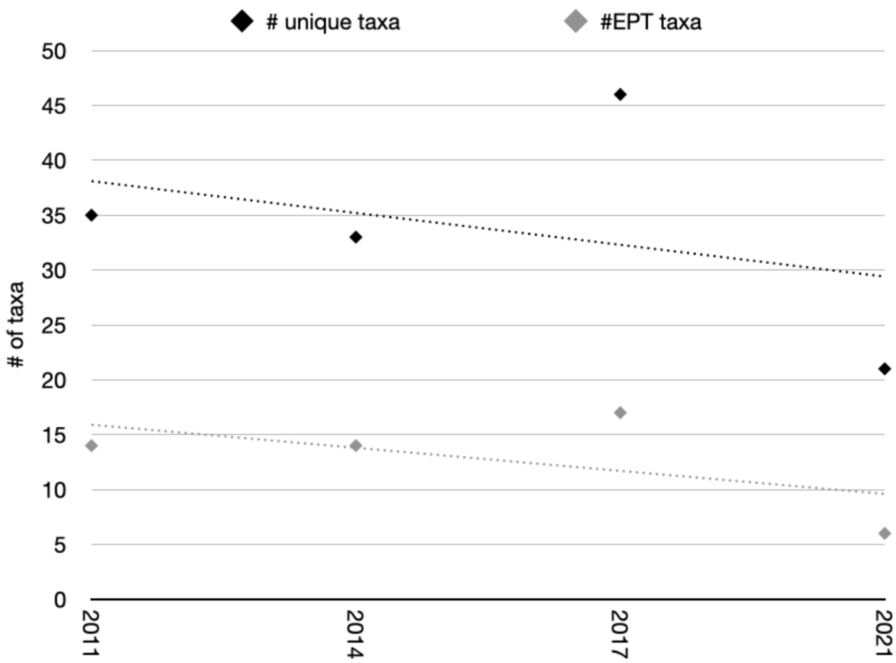



**Figure 91. M-IBI and O/E scores for Wilson Creek. Linear trendlines and thresholds for condition assignments are shown.**

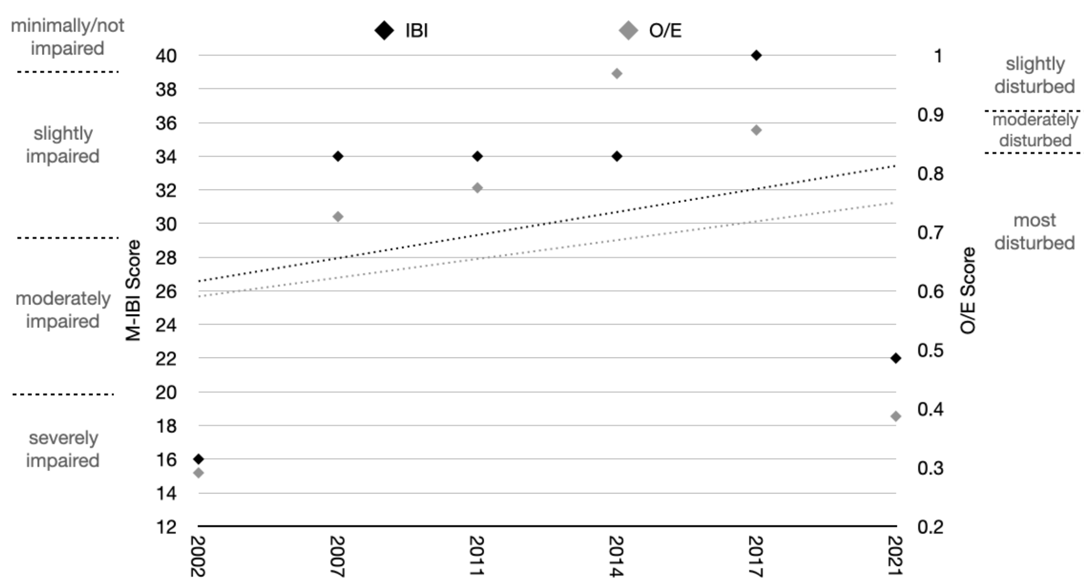


**Figure 92. Dominant (most abundant) taxon at Wilson Creek. Linear trendline is shown.**

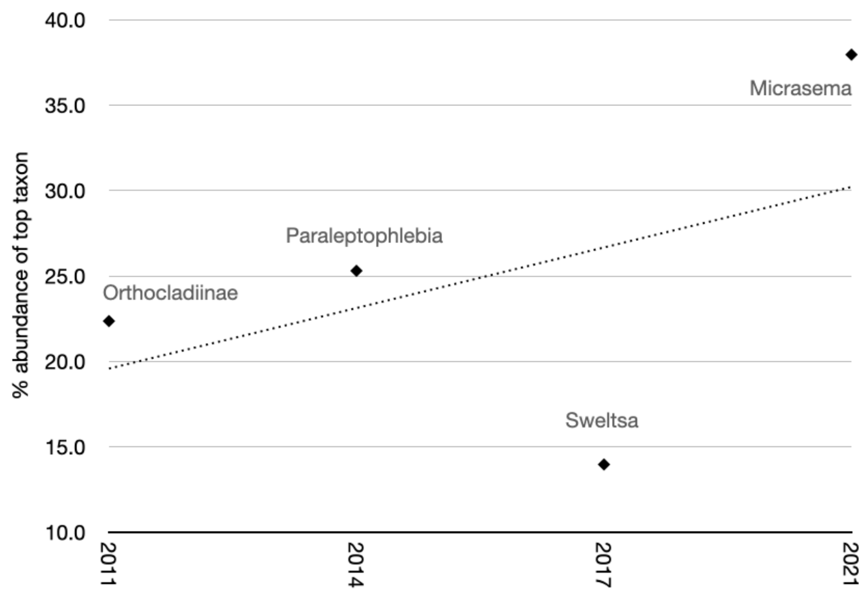



**Figure 93. CLUSTER dendrogram of macroinvertebrate community similarity at Wilson Creek. The number and letter at the end of each site label indicate sampling year and whether a riffle (R), glide (G), or pool (P) was sampled.**