

**CLACKAMAS COUNTY NPDES MS4 CO-PERMITTEES
2018 COORDINATED MACROINVERTEBRATE ASSESSMENT**

Clackamas County, Oregon

FINAL REPORT

Prepared for

**City of Gladstone
City of Lake Oswego
City of Milwaukie
City of Oregon City
City of West Linn
City of Wilsonville
Oak Lodge Water Services**

By

**Michael B. Cole, Ph.D.
&
Christopher T. Burtch
Cole Ecological, Inc.**

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EXECUTIVE SUMMARY

In 2018, seven Clackamas County jurisdictions, including the cities of Gladstone, Lake Oswego, Milwaukie, Oregon City, West Linn, Wilsonville, and Oak Lodge participated in biological monitoring as required during the 2017-2022 NPDES MS4 permit period. Cole Ecological, Inc. sampled macroinvertebrate communities, stream physical habitat, and water chemistry from twenty-two stream reaches across these seven jurisdictions in the fall of 2018. The objectives of the study were to assess the current status of chemical, physical, and biological conditions in these waters, and as applicable, determine whether noticeable changes or trends in improvement or decline in biological conditions are occurring.

Multimetric Index (MMI) scores and PREDATOR Marine Western Coastal Forest (MWCF) O/E scores calculated from macroinvertebrate community data indicated that biological conditions are generally similar to those measured in 2013 across the ten City of Lake Oswego study reaches. MMI scores ranged among the ten Lake Oswego reaches from 14 to 22, and eight of the ten sites scored lower than 20, corresponding to “severely disturbed” biological conditions. Only the Nettle Creek reach (MMI score = 20) and the Tryon Creek reach (MMI score = 22) scored outside of the “severely disturbed” range, and only marginally. 2018 MMI scores were within 2 points of 2013 MMI scores at nine of ten the Lake Oswego reaches, suggesting no notable change in biological conditions. Lake Oswego MWCF O/E scores ranged from 0.243 to 0.583, occurring exclusively in the “most disturbed” condition class. Comparison of 2018 MMI scores with 2013 MMI scores also suggest very similar conditions between the two sampling years. Temperature stressor (TS) scores indicate that compositional shifts in macroinvertebrate communities have occurred in response to elevated water temperature in six of the ten Lake Oswego stream reaches. Only lower the Lost Dog Creek, East Lost Dog Creek, West Lost Dog, and Nettle Creek reaches appear to support macroinvertebrate communities likely unaffected by elevated water temperatures. Fine sediment stressor (FSS) scores from eight of nine Lake Oswego samples collected from riffle habitats (i.e., all reaches other than Carter and Tryon creeks) indicated likely sediment-induced stress on macroinvertebrate communities in these reaches.

MMI scores ranged from 10 to 38 among the twelve co-permittee reaches from the other six jurisdictions. Singer Creek received the highest MMI score of 38, corresponding to a slightly disturbed biological condition. Coffee Creek scored a 30, corresponding to slightly/moderately disturbed. The ten other co-permittee reaches received MMI scores ranging between 10 and 18, indicative of severely disturbed biological conditions. MWCF O/E scores ranged from 0.194 to 0.776 among the twelve co-permittee reaches, exclusively within the “most disturbed” condition class. MMI and O/E scores from Rinearson Creek, Boardman, Creek, and River Forest Creek were not assigned condition classes because only glides were sampled from these reaches. Temperature stressor (TS) scores indicate temperature-stress-induced shifts in macroinvertebrate communities have likely occurred in nine of the twelve co-permittee reaches. Only three reaches – Coffee, Singer, and Tanner – received temperature stress scores lower than the 90th percentile

threshold score of 18.4. Fine sediment stressor (FSS) scores indicate FS-induced stress in all seven of the eight co-permittee reaches from which riffle samples were collected. Only the Singer Creek benthic community received a fine sediment stressor score below the 90th percentile threshold score of 19%.

Recovery of biological communities in these MS4 co-permittee area streams is dependent on identifying and improving stream conditions and functions that are currently impaired. While additional water quality data would further elucidate likely cause-effect relationships, stressor model results, combined with the results of physical habitat assessments, are suggestive of multiple stressors co-occurring in most streams assessed in this study. This phenomenon, known as “urban stream syndrome” or “multiple stress syndrome” is well documented among urban streams (Walsh et al. 2005). Mechanisms driving the syndrome are complex and interacting, yet rapid and unabated stormwater delivery into highly physically altered (often channelized) receiving waters is largely the source of the various perturbations observed and measured in this and other regional studies of stream conditions. These highly modified hydrologic patterns destabilize streamflows and alter seasonal high and low flows, pollutant concentrations, temperature and dissolved oxygen extremes, sediment inputs, and channel morphology, all which cumulatively degrade biological communities.

Among pollutants entering streams through stormwater, pesticides have been receiving increased attention with respect to understanding their effects on the ecology of surface waters. Recent work in Clackamas County, Oregon found that several indicators of macroinvertebrate community condition were strongly negatively correlated with streambed sediment concentrations of the pyrethroid insecticide bifenthrin, now widely used in urban areas (Carpenter et al. 2016). Two streams from the 2018 co-permittees macroinvertebrate study, Lost Dog Creek and Tanner Creek, were implicated by the Carpenter et al. study as having bifenthrin concentrations in streambed sediments that were potentially deleterious to macroinvertebrates (Carpenter et al. 2016). Continued and expanded pesticides monitoring in Clackamas County and elsewhere could assist with further understanding this emerging issue as it relates to stormwater management and consequences to the biology in receiving waters.

While many proximate factors may contribute to the biological degradation measured in this study, ultimately, causation in most cases can likely be attributed to stormwater. Protection of area streams should focus on minimizing total effective impervious areas and improving stormwater retention and drainage patterns to minimize the hydrologic effects of storm events on stream channel conditions. Further development within Clackamas County will necessitate careful attention to these and other measures intended to preserve and enhance stream conditions and functions. As such measures and other restoration activities are undertaken, these biological data will assist with determining the success of these actions relative to their intended benefits to aquatic life.

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INTRODUCTION

As a condition of the Clackamas County National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, Clackamas County co-permittees updated their comprehensive NPDES MS4 stormwater monitoring program in 2017 (Brown and Caldwell 2017). This updated NPDES stormwater monitoring program requires biological monitoring throughout the Clackamas MS4 permit area at least once over the 2017-2022 permit period. The objectives of the biological monitoring component are as follows:

- Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges; and
- Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters

Specifically, the comprehensive monitoring plan states that monitoring activities will attempt to address the following questions (Brown and Caldwell 2017):

- What are the biological conditions of receiving waters?
- Based on historic macroinvertebrate sampling efforts (as applicable), are there noticeable trends of improvement or impairment in receiving waters?

The first coordinated biological monitoring effort by six of the Clackamas County NPDES MS4 co-permittees occurred in 2013 (Cole 2014). In 2018, seven Clackamas County jurisdictions, including the cities of Gladstone, Lake Oswego, Milwaukie, Oregon City, West Linn, Wilsonville, and Oak Lodge participated in biological monitoring as required at least once during the 2017-2022 NPDES MS4 permit period. Prior to implementation of coordinated biological monitoring under the 2012-2017 NPDES MS4 permit period, among these seven jurisdiction, only the City of Lake Oswego had historically performed regular biological monitoring of their receiving waters, having assessed macroinvertebrate communities in 2004, 2007, 2009, and 2013 (Lemke & Cole 2009). The City of Wilsonville performed a macroinvertebrate assessment in 2003 (Cole 2003), and Oak lodge performed a macroinvertebrate assessment in 2012 (Cole & Haxton 2013). The 2013 coordinated assessment represented the first biological assessment by the other jurisdictions of their receiving waters.

In the present study, Cole Ecological (CE), Inc. sampled macroinvertebrate communities, stream physical habitat, and water chemistry from twenty-two stream reaches across these seven jurisdictions in the fall of 2018. As stated above, the objectives of the study were to assess the current status of chemical, physical, and biological conditions in these waters, and as applicable, determine whether noticeable trends in improvement or decline in biological conditions are occurring. In order to meet

these objectives, results of the 2018 assessment were compared to those from previous years (2003-2013) in order to determine whether measurable changes or trends have occurred in any of the assessed waterbodies.

METHODS

SAMPLE SITE SELECTION

Biological sample sites under this program were selected for the cities of Lake Oswego, Wilsonville, and Oak Lodge to correspond with previously assessed locations in order to determine whether trends or changes in biological conditions have occurred as compared to prior sampling efforts (Table 1 and Figure 1). Sample sites within the City of Lake Oswego were originally selected in 2004 and 2007 (Cole & Harris 2004; Lemke & Cole 2007) to provide representative coverage of perennial streams within the city. Six reaches were initially selected and sampled in 2004 (Table 1). In 2007, an additional five reaches were added to the previously surveyed reaches, while the Blue Heron Creek reach was dropped from sampling. These same ten stream reaches were sampled for the City of Lake Oswego in 2009, 2013, and 2018.

The City of Wilsonville performed a comprehensive biological assessment of eleven reaches in Boeckman Creek, Coffee Lake Creek, and Mill Creek in 2003 (Cole 2004). One reach in Boeckman Creek, presently also used as a water quality monitoring station by the City, was re-assessed under the 2013 comprehensive monitoring program. In 2017, two additional previously-assessed reaches on Boeckman Creek were added to the 2018 biological monitoring effort (Table 1). Oak Lodge first sampled the Boardman and River Forest creek reaches included in this study back in 2012 (Cole & Haxton 2013).

The cities of Gladstone, Milwaukie, Oregon City, and West Linn each initiated macroinvertebrate sampling in 2013 as part of the coordinated monitoring effort. Macroinvertebrate sample sites within these jurisdictions were co-located with current water quality and pesticide monitoring sites in order to provide greater opportunity for examining relationships between water quality and biological conditions (Brown and Caldwell 2012). Among these six sample sites first assessed in 2013, only one was re-located in 2018: the Rinearson Creek sample site was relocated approximately 300 m downstream (Table 1, Figure 1).

FIELD DATA COLLECTION

Macroinvertebrate communities, physical habitat, and water chemistry were sampled at the 22 study reaches between 14 and 22 September, 2013. First, each study reach was marked and the reach length was measured. Each sample reach measured approximately 75 m, unless the sample reach was obstructed by a culvert, heavy vegetation, or other impediments.

Table 1. List of 2018 Clackamas County MS4 co-permittee macroinvertebrate sample sites.

Sample Site	Sample Site Location	Jurisdiction	Habitat	Lat	Long	Past
			Sampled			Assessments
Rinearson Creek	River Road	Gladstone	Glide	45.3804	-122.6076	13
Ball Creek	at Kruse Oaks Blvd	Lake Oswego	Riffle	45.4245	-122.7403	04, '07, '09, '13
Carter Creek	at Bangy	Lake Oswego	Glide	45.4170	-122.7406	07, '09, '13
Lost Dog Creek (lower)	at Lake Front Dr	Lake Oswego	Riffle	45.4006	-122.6891	04, '07, '09, '13
Lost Dog Crk (East Br.)	at Stafford Rd	Lake Oswego	Riffle	45.4026	-122.6806	07, '09, '13
Lost Dog Crk (West Br.)	Lake Oswego Golf Course	Lake Oswego	Riffle	45.4100	-122.6782	07, '09, '13
Nettle Creek	at Iron Mtn Blvd	Lake Oswego	Riffle	45.4246	-122.6814	04, '07, '09, '13
Oswego Creek	downstream of Hwy 43	Lake Oswego	Riffle	45.4107	-122.6625	07, '09, '13
Springbrook Crk (lower)	at Iron Mtn Park	Lake Oswego	Riffle	45.4142	-122.7078	04, '07, '09, '13
Springbrook Crk (rest.)	upstream of Boones Way	Lake Oswego	Riffle	45.4140	-122.7151	04, '07, '09, '13
Tryon Creek	Upstream of Hwy 43	Lake Oswego	Riffle	45.4243	-122.6613	07, '09, '13
Minthorn Creek	at SE Lake Road	Milwaukie	Riffle	45.4318	-122.5984	13
River Forest Creek	at Risley Park	Oak Lodge	Glide	45.4075	-122.6400	12
Boardman Creek (rest.)	at Stringfield Park	Oak Lodge	Glide	45.3988	-122.6253	12
Boardman Creek (upper)	at Boardman Ave	Oak Lodge	Glide	45.3945	-122.6175	12
Coffee Creek	at 5th Ave	Oregon City	Riffle	45.3461	-122.6182	13
Singer Creek	in Singer Creek Park	Oregon City	Riffle	45.3477	-122.6020	13
Tanner Creek	at Imperial Drive	West Linn	Riffle	45.3517	-122.6310	13
Trillium Creek	at Caloroga Rd	West Linn	Riffle	45.3957	-122.6378	13
Boeckman Creek (rest.)	Downstream of Rose Ln	Wilsonville	Riffle	45.2992	-122.7549	03, '13
Boeckman Creek (middle)	at Kolbe Lane Bridge	Wilsonville	Riffle	45.3012	-122.7568	03
Boeckman Creek (upper)	at Boeckman Cr trail bridge	Wilsonville	Riffle	45.3091	-122.7530	03

HABITAT ASSESSMENTS

Habitat surveys were performed in the reaches following modified Rapid Stream Assessment Technique (RSAT) protocols (adapted from Clean Water Services 2000) and consisted of data collection from surveys of channel habitat units, three channel cross sections, and the adjacent riparian zone (Table 2). First, the valley type within which each study reach occurred was broadly classified as U-type, V-type, ponded, or floodplain. A plan view of the reach was sketched as the survey was performed. The physical data were then collected using the following procedures:

HABITAT UNITS SURVEY

The number, length, width, maximum water depth, and gradient of pools, glides, riffles, and rapids were recorded from each reach. The following definitions were adapted

from ODFW's *Methods for Stream Habitat Surveys* (2002) and Armantrout (1998) and used for this study:

Pool: Water surface slope is usually zero. Pools are normally deeper and wider than aquatic habitats immediately above and below.

Glide: There is a general lack of consensus of the definition of glides (Hawkins et al. 1993). For the purposes of this study, a glide was defined as an area with generally uniform depth and flow with no surface turbulence. Glides have a low-gradient water surface profile of 0–1% slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Glides are generally deeper than riffles with few major flow obstructions and low habitat complexity.

Riffle: Fast, turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Riffles generally have a broad, uniform cross section and a low-to-moderate water surface gradient, usually 0.5–2.0% slope and rarely up to 6%.

Rapid: Swift, turbulent flow including chutes and some hydraulic jumps swirling around boulders. Rapids often contain exposed substrate features composed of individual bedrock or boulders, boulder clusters, and partial bars. Rapids are moderately high gradient habitat, usually 2.0–4.0% slope and occasionally 7.0–8.0%. Rapids also include swift, turbulent, “sheeting” flow over smooth bedrock.

Cascade: Fast, turbulent flow with many hydraulic jumps and strong chutes and eddies, 30–80% white water. Gradients approaching or exceeding 10.0%.

The following attributes were then measured or visually estimated in each channel unit. Dominant substrate was visually estimated in each unit using substrate size classes adapted from EPA's Environmental Monitoring & Assessment Program (EMAP) protocols for wadeable streams (USEPA 2000). Percent substrate embeddedness, percent actively eroding banks, and percent undercut banks (both banks, combined) were each visually estimated. Water surface slope of each unit was measured with a clinometer and the value of woody debris to fish in each unit was rated on a scale from one to five, with one representing little or no wood, and five representing large amounts of wood creating abundant cover and refuge. Additionally, all woody debris measuring at least 15 cm in diameter (at estimated diameter breast height) and 2 m in length was tallied for each unit and the configuration, type, location, and size of root wads and pieces of wood were noted. Overhead cover was measured with a spherical densiometer in four directions (upstream, downstream, right, left) from the center of the stream at evenly spaced intervals along the length of the reach (usually every 15 m). Habitat features such as beaver activity, culverts, and potential fish passage barriers were noted by habitat unit.

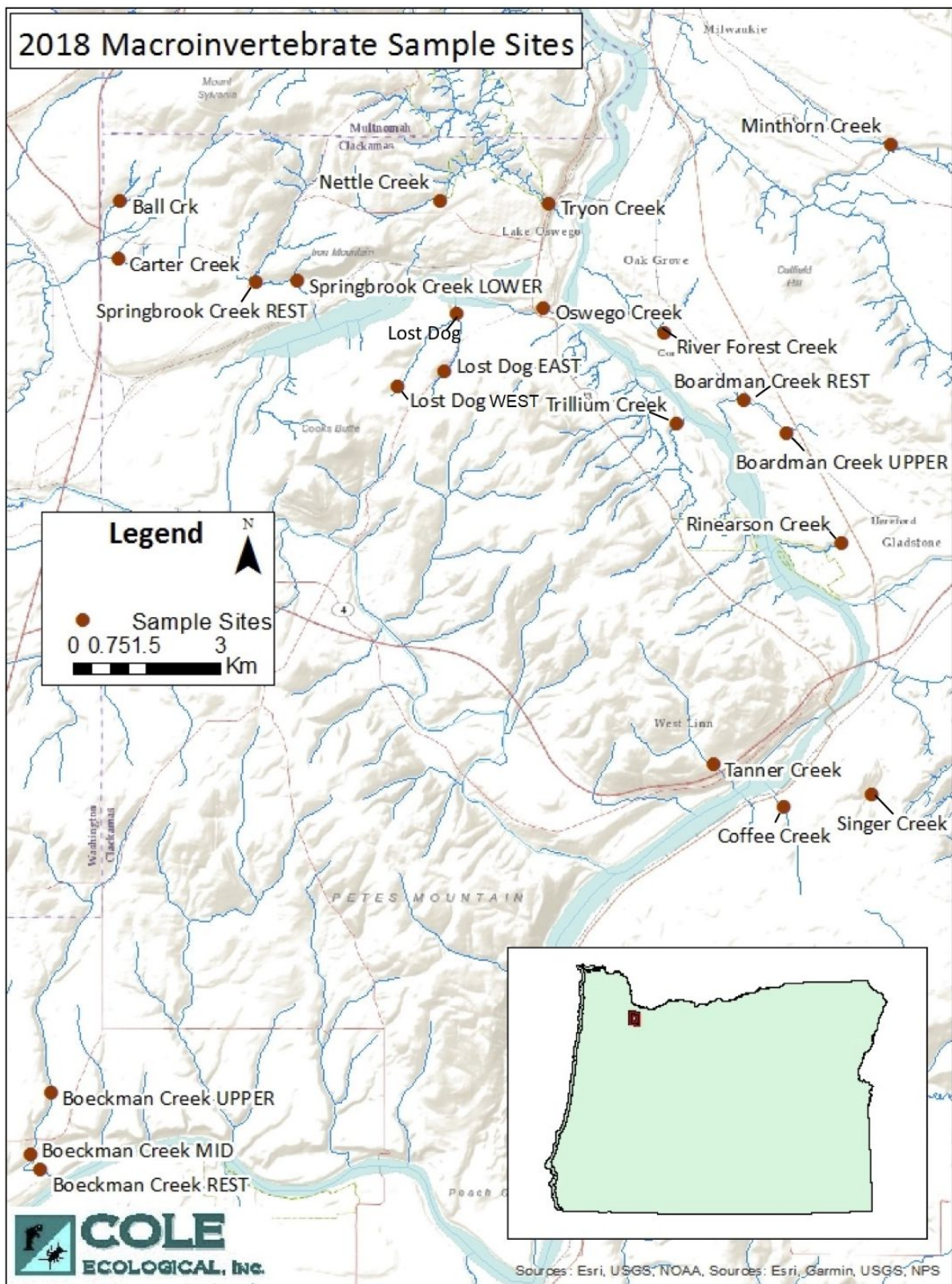


Figure 1. 2018 Clackamas County NPDES co-permittees macroinvertebrate sample sites.

Table 2. Environmental variables measured in the field for characterizing stream reaches sampled for macroinvertebrates in Clackamas County, fall 2018.

Variable	<u>Quantitative or</u> <u>Categorical</u>	<u>Visual Estimate or</u> <u>Measured Variable</u>
Wetted Width	Q	M
Bankfull Width	Q	M
Bankfull Height	Q	M
Mean Water Depth	Q	M
Pools (% of reach length)	Q	M
Glides (% of reach length)	Q	M
Riffles (% of reach length)	Q	M
Rapids (% of reach length)	Q	M
Cascades (% reach length)	Q	M
Reach Embeddedness (%)	Q	V
Eroding Banks (%)	Q	V
Undercut Banks (%)	Q	V
Substrate Composition	Q	M
Substrate Embeddedness (%)	Q	M
Large Wood Rating	Q	M
Overhead Canopy Cover (%)	Q	M
Riparian Buffer Width	Q	V
Riparian Zone Tree Cover (%)	Q	V
Non-native Riparian Veg. Cover (%)	Q	V
Dominant Adjacent Land Use	C	V
Water Temperature (°C)	Q	M
Specific Conductance (µS/cm)	Q	M
Dissolved Oxygen (mg/L)	Q	M

CROSS-SECTION SURVEYS

Channel dimensions were measured at three transects occurring within each sample reach. The three habitat units were selected according to the following guidelines:

1. Three separate riffles were sampled if three or more riffles occurred in the reach.
2. If two riffles occurred in the reach, both riffles and a representative glide or pool (least preferred) were sampled. If riffles were of sufficient length (10 m or longer)

then more than one set of cross-section measurements were made in the riffle to ensure that all measurements were taken from this habitat type.

3. If only one riffle occurred within the reach, two additional units that represented channel dimensions and substrate composition were sampled. If the riffle was longer than 20 m, then all three sets of measurements were taken from the riffle.
4. If no riffles occurred in the reach, three units that were representative of the channel dimensions and substrate composition occurring within the reach were sampled.

At each of the three channel cross sections, wetted width (WW), bankfull width (BFW), maximum bankfull height (BFH_{max}), the bankfull height at 25%, 50%, and 75% across the distance of the bankfull channel, and the flood-prone width (FPW) were measured with a tape measure and survey rod. From these channel dimension data, width-to-depth and channel-entrenchment ratios were later calculated. Water depths were recorded at 10%, 30%, 50%, 70%, and 90% across the width of the wetted channel. Maximum bank height (Left or Right) and bank angles were visually estimated. Pebble counts were performed in riffles when they represented an adequate amount of the stream channel area to allow measurement of at least 100 substrate particles along transects. If riffles occupied less than 10% of the total habitat area in the reach (e.g. if macroinvertebrate samples were collected from glides in reaches where benthic sampling occurs), then pebble counts occurred in glides. Pebble counts were performed using the “heel-to-toe” method, starting at the bankfull edge on one side of the channel and walking heel-to-toe to the other edge (USEPA 2000). With each step, the surveyor looked away and touched the streambed at the tip of their toe. The size class and embeddedness of each piece of streambed substrate was estimated until at least 100 particles were counted.

RIPARIAN SURVEYS

Adjacent riparian conditions were characterized beyond the left and right banks separately and according to a number of attributes. The dominant plant community type(s) (ash woodland, willow shrub-scrub, upland forest, etc.) occurring in the riparian zone to the edge of human-dominated activity was classified and recorded and the approximate width of each of these community types was visually estimated. The percent vegetative cover of the canopy layer (>5 m high), shrub layer (0.5 to 5 m high), and groundcover layer (<0.5 m high) was estimated, as well as the percent cover of invasive or non-native species as a single estimate across all three vegetative layers. The dominant adjacent land use outside of the vegetated riparian buffer was noted, and then a cross-sectional diagram of the riparian zone was sketched.

WATER QUALITY SAMPLING

Water quality was sampled from each sample reach prior to collecting macroinvertebrates and performing the reach habitat assessment. Measured water quality parameters included temperature (°C), dissolved oxygen (mg/L), oxygen saturation (%), conductivity (µS/cm), and specific conductance (µS/cm). Water temperature, dissolved oxygen, conductivity, and specific conductance were measured in situ with a YSI Model 556 water chemistry meter.

MACROINVERTEBRATE SAMPLE COLLECTION

Macroinvertebrates were collected using the Oregon Department of Environmental Quality's (DEQ) Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams (DEQ 2003). An 8-kick composite sample was collected from riffles in higher-gradient reaches that supported sufficient riffle habitat; glides were sampled from lower-gradient reaches that lacked riffle habitat. Instream sampling points were selected to apportion the eight kick samples among as many as four habitat units. Macroinvertebrates were collected with a D-frame kicknet (30 cm wide, 500 µm mesh opening) from a 30 x 30 cm (1 x 1 ft) area at each sampling point. Larger pieces of substrate, when encountered, were first hand-washed inside the net, and then placed outside of the sampled area. Then the area was thoroughly disturbed by hand (or by foot in deeper water) to a depth of ~10 cm.

The eight samples from the reach were composited and carefully washed through a 500 µm sieve to strain fine sediment and hand remove larger substrate and leaves after inspection for clinging macroinvertebrates. The composite sample then was placed into one or more 1-L polyethylene wide-mouth jars, labeled, and preserved with 80% denatured ethanol for later sorting and identification at the laboratory.

SAMPLE SORTING AND MACROINVERTEBRATE IDENTIFICATION

Samples were sorted to remove a 500-organism subsample from each preserved sample following the procedures described in the DEQ Level 3 protocols (Water Quality Interagency Workgroup [WQIW], 1999) and using a Caton gridded tray, as described by Caton (1991). Contents of the sample were first emptied onto the gridded tray and then floated with water to evenly distribute the sample material across the tray. Squares of material from the 30-square gridded tray were transferred to a Petri dish, which was examined under a dissecting microscope at 7–10X magnification to sort aquatic macroinvertebrates from the sample matrix. Macroinvertebrates were removed from each sample until at least 500 organisms were counted, or until the entire sample had been sorted. Following sample sorting, all macroinvertebrates were generally identified to the level of taxonomic resolution recommended for Level 2 macroinvertebrate assessments by the Pacific Northwest Aquatic Monitoring Partnership (2015).

DATA ANALYSIS

A number of standard analytical approaches exist for assessing the condition of macroinvertebrate communities in western Oregon. These approaches can be broadly classified as multimetric indexes and predictive models. Existing tools for analysis of macroinvertebrate data in western Oregon have been developed from, and therefore are only appropriate for, assessment of assemblages collected from coarse substrates (gravels and cobble) in riffle habitat. Consequently, the use of existing bioassessment tools and their attendant condition thresholds is inappropriate for assessing the condition of benthic communities from low-gradient (generally <1-1.5% slope) streams dominated by fine substrates and glide/pool habitat. Analysis of glide samples collected from these streams with existing bioassessment tools would result in artificially lower index scores and classification of condition. In the present study, five of the twenty-two sample sites supported only glide habitat and fine substrates, a condition likely naturally occurring in each system. Accordingly, these five sites were not assigned condition classifications following data analysis.

MULTIMETRIC INDEX ANALYSIS

Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that has been shown to be responsive to one or more types of pollution or habitat degradation. Each community metric is converted to a standardized score; standardized scores of all metrics are then summed to produce a single multimetric score that is an index of overall biological integrity. Metric sets and standardized metric scoring criteria are developed and calibrated for specific stream types and geographic locales. The DEQ has developed and currently employs a 10-metric set for use with riffle samples from higher-gradient streams in western Oregon (WQIW 1999). Owing to the lack of reference conditions for low-gradient, glide-dominated valley-floor streams, no multimetric index currently exists for such stream types in this region.

The DEQ 10-metric set includes six positive metrics that score higher with improved biological conditions, and four negative metrics that score lower with improved conditions (Table 3). Mayflies (order Ephemeroptera), stoneflies (order Plecoptera), and caddisflies (order Trichoptera) are widely regarded among the aquatic insect orders as the most sensitive to water pollution and habitat degradation; accordingly, three metrics in the index summarize taxonomic richness within these three insect orders. These three orders of insects are collectively referred to as the “EPT” taxa, derived from the first letter in each of the order names.

Table 3. Multi-metric set and scoring criteria (WQIW 1999) used to assess the condition of macroinvertebrate communities from Clackamas County streams in fall 2018.

Metric	Scoring Criteria		
	5	3	1
POSITIVE METRICS			
Taxa richness	>35	19–35	<19
Mayfly richness	>8	4–8	<4
Stonefly richness	>5	3–5	<3
Caddisfly richness	>8	4–8	<4
Number sensitive taxa	>4	2–4	<2
# Sediment sensitive taxa	≥2	1	0
NEGATIVE METRICS			
Modified HBI ¹	<4.0	4.0–5.0	>5.0
% Tolerant taxa	<15	15–45	>45
% Sediment tolerant taxa	<10	10–25	>25
% Dominant	<20	20–40	>40

¹ Modified HBI = Modified Hilsenhoff Biotic Index

The Modified Hilsenhoff Biotic Index (HBI), originally developed by Hilsenhoff (1982), computes an index to organic enrichment pollution based on the relative abundance of various taxa at a reach. Values of the index range from 1 to 10; higher scores are interpreted as an indication of a macroinvertebrate community more tolerant to fluctuations in water temperature, fine sediment inputs, and organic enrichment. Sensitive taxa are those that are intolerant of warm water temperatures, high sediment loads, and organic enrichment; tolerant taxa are adapted to persist under such adverse conditions. The DEQ taxa attribute coding system was used to assign these classifications to taxa in the data set (DEQ, unpublished information). Metric values first were calculated for each riffle sample and then were converted to standardized scores using DEQ scoring criteria for riffle samples from western Oregon streams (Table 3). The standardized scores were summed to produce a multimetric score ranging between 10 and 50. Reaches were then assigned a level of impairment based on these total scores (Table 4).

PREDATOR MWCF MODEL

PREDATOR is a predictive model that evaluates macroinvertebrate community conditions based on a comparison of observed (O) to expected (E) taxa (Hawkins et al. 2000, Hubler 2008). The observed taxa are those that occurred at the reach, whereas the expected taxa are those expected to occur (>50% probability of occurrence) in the reach in the absence of disturbance. Biological condition is determined by comparing the O/E score at the test site to the distribution of reference reach O/E scores in the model. One

major strength of PREDATOR over the multimetric approach is that a single predictive model can be constructed to assess biological conditions over a wide range of environmental gradients such as stream slope, longitude, or elevation, whereas separate multimetric tools would have to be developed to make accurately assess condition. PREDATOR is able to predict taxonomic composition across a range of naturally occurring environmental gradients with discriminant functions models (DFMs). Discriminant functions analysis is used during the model building phase to identify the environmental variables that are statistically related to natural gradients in macroinvertebrate community composition (Hawkins et al. 2000). These “predictor variables” are used in the resulting model to predict macroinvertebrate community composition in the absence of disturbance. The model assigns a probability of class membership of each test site to the different classes of test sites specified in the model based on the environmental predictor variables that are input into the model.

Table 4. Multimetric score ranges for assignment of macroinvertebrate community condition levels (WQIW 1999).

Level of Impairment	Score Range (scale of 10 - 50)
None	>39
Slight	30–39
Moderate	20–29
Severe	<20

Several geographically specific PREDATOR models are currently in use in Oregon. The Marine Western Coastal Forest (MWCF) model includes the Willamette Valley and lower western foothills of the Cascades. Accordingly, this model was used for the present study. Predictor variables and taxonomic data were input into the model, which calculated the probability of occurrence of each taxon at each study site (in the absence of disturbance). With this information, the model calculates the O/E score for each site. Using the MWCF biological condition thresholds (Hubler 2008), higher-gradient streams with O/E scores ≤ 0.85 (≤ 10 th percentile of reference site scores) were classified as “most disturbed,” 0.86 to 0.91 (>10 th to 25th percentile) as “moderately disturbed,” and 0.92 to 1.24 (25th to 95th percentile) as “least disturbed.”

STRESSOR MODELS

Weighted-average (WA) inference models were developed by DEQ (Huff et al. 2006) to reveal shifts in macroinvertebrate assemblage composition that implicate either substrate degradation (i.e. fine sediment pollution) or temperature pollution. These WA

inference models for temperature and sediment are to be used as screening tools to assist with detecting the source(s) of stress to biological communities in wadeable Oregon streams. Inferred values at a test site are compared to conditions observed at regional reference sites to determine if there is a difference in assemblage-level preferences for temperature or fine sediment (Huff et al. 2006). The 75th percentile of the distribution of inferred temperature and fine-sediment values from regional reference sites is used to determine whether a particular site is potentially stressed by one or both of these attributes.

In the analysis for this study, temperature stress and fine-sediment stress weighted-average inference models were first run to derive estimates of inferred water temperatures (temperature scores, or TS) and sediment levels (fine sediment scores, or FSS) in each study reach. Both temperature and fine-sediment models were applied to riffle data, while only the temperature model was applied to glide data. Glide data were not run through the fine-sediment model because fine sediment levels would be expected to differ significantly between the higher- and lower-gradient reach types. For riffle samples, DEQ's thresholds of 18.4°C for temperature and 19% of fine sediment (90th percentile of the distribution of DEQ Willamette Valley reference site scores) were used to determine whether each was a potential stressor in each sample reach (Huff et al. 2006). In lower-gradient reaches that supported only glide and pool habitats, only the temperature stress threshold was applied (DEQ, unpublished data).

RESULTS

ENVIRONMENTAL CONDITIONS

LAKE OSWEGO STREAM REACHES

Land use adjacent to the ten previously assessed Lake Oswego study reaches did not change significantly from 2013 to 2018. Study reaches primarily occurred in areas dominated by moderate density residential land use within Lake Oswego's city limits. Reaches represented a range of stream channel and riparian conditions (Table 5). Across most sites, stream habitat was co-dominated by riffle and pool habitats; riffle habitat averaged 40% across all study reaches, while pool habitat averaged 44% (Table 5). Carter (8% riffle habitat), Tryon (20%), and West Lost Dog (22% riffle habitat) creeks supported the lowest frequency of riffle habitat among the Lake Oswego sample reaches. In 2013 and 2018, riffle habitat in Carter Creek was limited to a short section in the middle of the reach that contained cobble-sized fill material used to bury a water or sewer line. Because no naturally occurring riffle habitat was identified in this section of Carter, only a glide sample was collected from this reach in both 2013 and 2018.

Streambed substrate within sampled habitat units in the Lake Oswego study reaches primarily comprised coarse materials, which represented an average of 93% of streambed material across all ten study reaches (Table 5 and Figure 2). Sand and fines represented an average of 5% of bed materials in sampled habitat units across the ten reaches. Substrate embeddedness derived from pebble counts averaged 27% and ranged from 15.6% to 58% across the Lake Oswego study reaches. Carter Creek again had the highest reach-wide substrate embeddedness of 58% in 2018.

Forested riparian zone widths are generally narrow across the Lake Oswego study reaches, as buffer widths ranged from 10 to 110 m and averaged 43 m. Mature forested riparian zones occurred along most Lake Oswego study reaches (excluding Carter Creek), providing overhead cover ranging from 69 to 97%. Carter Creek, where sampled, flows through a reed-canary-grass-dominated meadow which provided 31% overhead cover (28% in 2013, 38% in 2009 and 27% in 2007). Riparian conditions in the Springbrook Creek restoration reach continue to improve as a result of willow plantings in the early 2000s. Willows in the riparian area of the Springbrook Creek restoration reach have continued to provide excellent canopy cover. Overhead cover in 2018 was measured at 90%, as compared to 93% in 2013, 80% in 2009, 55% in 2007.

Table 5. Environmental conditions measured in 22 Clackamas County MS4 co-permittee stream reaches sampled for macroinvertebrates in fall 2018.

Variable	Other Co-Permittees (n = 12)				Lake Oswego (n = 10)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Gradient	1.0	1.8	0.0	6.4	2.6	2.7	0.3	9.6
Wetted width (m)	1.7	1.1	0.5	4.9	2.1	1.3	0.8	5.0
Bankfull width (m)	3.5	2.0	1.9	9.1	4.3	3.4	1.6	12.3
% Pool	52.7	25.8	25.0	100.0	44.2	21.8	14.7	83.3
% Glide	19.7	27.1	0.0	75.0	14.4	11.4	0.0	32.0
% Riffle	25.8	26.1	0.0	72.2	39.7	19.6	7.7	70.3
% Rapid/Cascade	2.7	9.2	0.0	32.0	1.7	3.6	0.0	9.2
% Embeddedness (Reach Vis Est)	72.4	26.5	27.2	100.0	52.4	17.2	36.6	92.3
% Eroding Banks	64.1	35.5	0.0	100.0	62.1	34.5	0.0	100.0
% Undercut Banks	6.0	12.1	0.0	41.7	4.7	9.9	0.0	32.1
% Coarse substrate	64.8	42.5	0.0	99.1	93.1	13.1	60.0	100.0
% Sand and fines	32.4	40.5	0.0	95.0	5.2	12.6	0.0	40.0
% Hardpan	0.7	1.7	0.0	5.0	1.7	3.2	0.0	10.0
Embeddedness (Pebble Count)	48.3	38.0	12.5	99.5	26.9	12.0	15.6	58.0
LWD rating	5.4	6.4	0.0	19.6	7.5	7.2	0.0	15.8
Overhead Cover	73.3	27.9	21.1	98.5	83.6	20.1	30.9	97.4
Riparian Buffer Width (m)	29.2	25.7	1.0	70.0	42.8	33.1	10.0	110.0
% Tree Cover	44.0	26.6	5.0	85.0	64.1	20.7	12.5	85.0
% Non-Native Veg	29.9	19.9	0.0	60.0	34.1	23.1	3.8	80.0
Water Temperature (°C)	14.7	2.2	12.0	18.9	15.3	2.6	12.2	21.7
Dissolved Oxygen (% sat)	68.3	31.6	5.7	96.7	83.8	19.2	36.2	98.9
Dissolved Oxygen (mg/L)	7.0	3.4	0.5	10.2	8.4	2.0	3.6	10.6
Conductivity (µS/cm)	132.8	46.2	60.0	203.0	119.6	36.5	60.0	182.0
Specific Conductance (µS/cm)	164.1	51.6	76.0	230.0	147.1	44.0	72.0	218.0
pH	6.9	0.3	6.3	7.3	7.1	0.4	6.3	7.6

Limited water quality sampling during macroinvertebrate sampling in 2018 suggested potential low dissolved oxygen issues in several Lake Oswego stream reaches. While dissolved oxygen concentrations exceeded 8 mg/L in most reaches (measurements taken at various times of the day and not necessarily during peak stress early AM hours), Carter Creek dissolved oxygen was 3.6 mg/L (collected at 920), the lowest among Lake Oswego study reaches, suggesting likely periodic low-DO-induced stress in this reach. Morning dissolved oxygen in the West Branch of Lost Dog Creek was 6.4 mg/L at 930, also suggesting periodically low DO conditions in this reach.

CO-PERMITTEE STREAM REACHES

Land use adjacent to the twelve co-permittee reaches was variable, ranging from moderate density residential to commercial/industrial. All streams were smaller first or second-order tributaries; bankfull widths averaged 3.5 m and ranged from 1.9 to 9.1 m, while wetted channel widths averaged 1.7 m and ranged from 0.5 to 4.9 m (Table 5).

Riffle habitat ranged from 0 to 72%. Eight of twelve reaches supported sufficient riffle area to sample macroinvertebrates from this habitat type; among the twelve reaches, riffle habitat was absent from the Rinearson and both Boardman creek reaches, while the River Forest reach supported only 3% riffle habitat.

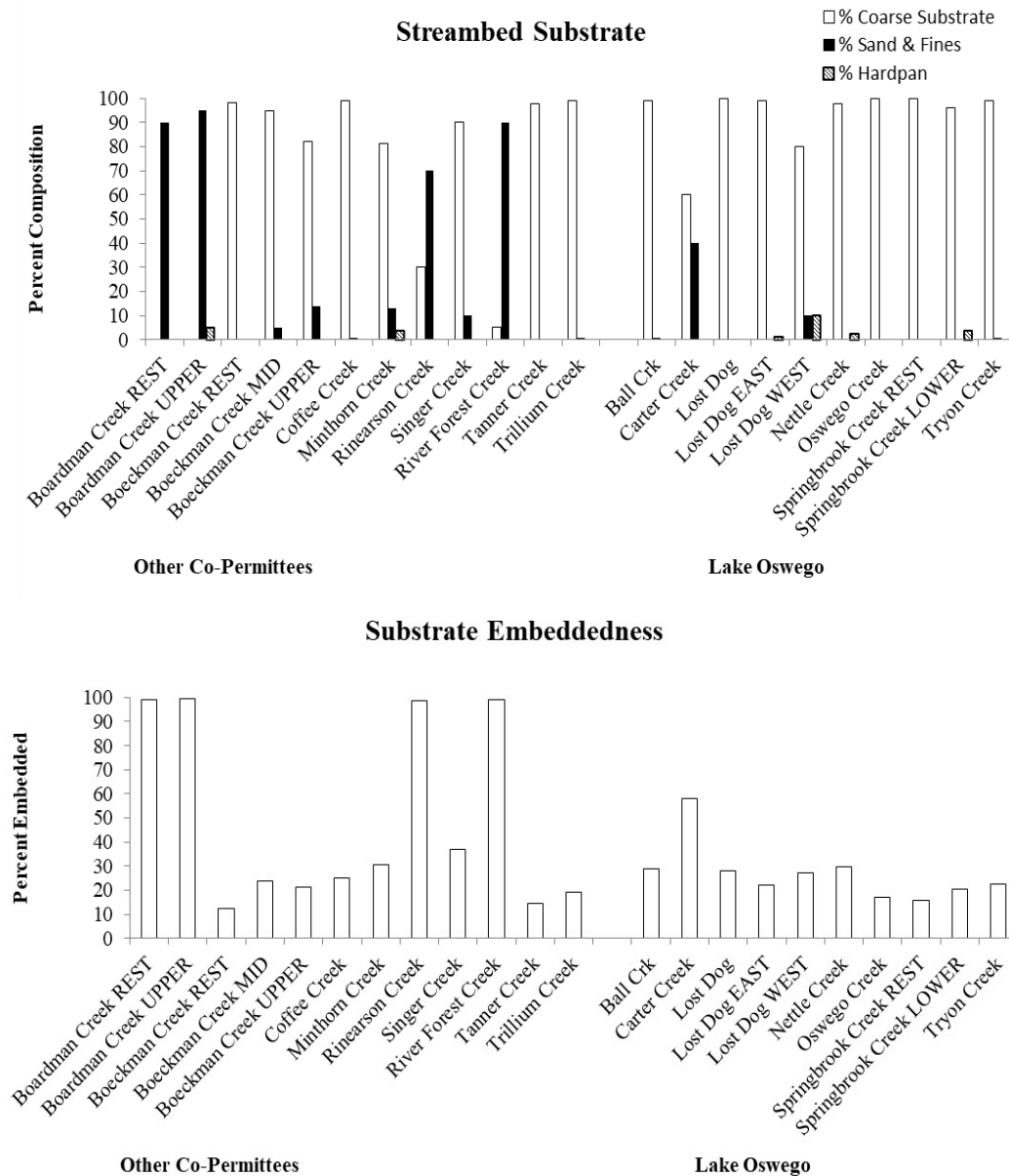


Figure 2. Substrate composition and embeddedness from pebble counts (or visual estimates where pebble counts were precluded) performed in 22 Clackamas County MS4 co-permittee streams sampled for determining conditions of macroinvertebrate communities in September 2018.

Riffles from the eight riffle-sampled reaches were dominated by coarse materials (Figure 2). In contrast, glides sampled in Rinearson, Boardman, and River Forest creeks lacked substrates larger than fine gravels and were heavily dominated by sand and fines (Figure 2). Reach-wide embeddedness varied among sites, but was generally high, ranging from 27% to 100% (Table 5). Substrate embeddedness in riffles sampled for macroinvertebrates (in 8 reaches) ranged from 13 to 37% (Figure 2).

Riparian buffer widths were generally narrow among the 12 co-permittee reaches, averaging 29 m and ranging from 1 to 70 m. Overhead canopy cover averaged 73% among the 12 co-permittee reaches, and ranged from 21% at the upper Boardman Creek reach to 99% at the River Forest Creek reach. Overhead cover improved from 6% to 46% along the Minthorn Creek; however, this improved shade condition results from the heavy growth Himalayan blackberry and canary reed grass along the reach. Riparian tree cover was again lacking along both the Minthorn Creek (5% tree cover) and Rinearson Creek reaches (25% tree cover). Each of the Boardman Creek reach also lacked riparian tree cover, averaging 20% and 8% cover in the restoration and upper Boardman Creek reaches, respectively.

Dissolved oxygen concentrations were sufficiently low to be a significant stress to macroinvertebrate communities in the River Forest Creek reach (2.2 mg/L) and in both Boardman Creek reaches (3.0 and 0.5 mg/L). Water quality sampling once again indicated potential low dissolved oxygen problems in Minthorn Creek (6.4 mg/L @ 1400), and DO in the middle Boeckman Creek and the Rinearson Creek reaches only slightly exceeded 7 mg/L in the early afternoon. The results suggest potentially low AM dissolved oxygen in these three reaches, as well. Dissolved oxygen concentrations from the other six reaches approached or exceeded 9 mg/L.

MACROINVERTEBRATE COMMUNITY CONDITIONS

LAKE OSWEGO STREAM REACHES

Multimetric Index (MMI) scores and PREDATOR MWCF O/E scores indicated that biological conditions are generally similar to those measured in 2013 (Table 6, Table 7, and Figure 3). MMI scores ranged among the ten Lake Oswego reaches from 14 to 22, and eight of the ten sites scored lower than 20, corresponding to “severely disturbed” biological conditions. Only the Nettle Creek reach (MMI score = 20) and the Tryon Creek reach (MMI score = 22) scored outside of the “severely disturbed” range, and only marginally. 2018 MMI scores were within 2 points of 2013 MMI scores at nine of ten the Lake Oswego reaches, suggesting no notable change in biological conditions. Lake Oswego PREDATOR O/E scores ranged from 0.243 to 0.583, occurring exclusively in the “most disturbed” condition class. Comparison of 2018 O/E scores with 2013 O/E scores also suggest very similar conditions between the two sampling years (Table 7).

Table 6. Summary of Multimetric Index (MMI) scores, PREDATOR MWCF model O/E scores, and temperature (TS) and fine sediment (FSS) stressor model scores calculated from macroinvertebrate samples collected from 22 Clackamas County MS4 co-permittee streams in September 2018. Highlighted TS and FSS scores indicate values that exceed DEQ inferred stressor thresholds of 18.4°C and 19% fine sediment. Asterisk (*) indicates Oak Lodge reach scores from 2012 (rather than 2013).

Waterbody	Habitat Sampled	2013 MMI Score	2018 MMI Score	2018 Dist. Class	2013 MWCF Score	2018 MWCF Score	2018 Dist. Class	2018 TS	2018 FSS		
Boardman Creek REST	Glide		16	NA	0.194*	0.194	NA	24.6	Poor	76.4	NA
Boardman Creek UPPER	Glide		10	NA	0.242*	0.194	NA	22.8	Poor	45.6	NA
Boeckman Creek REST	Riffle	20	18	Severe	0.388	0.437	Most	22.1	Poor	25.3	Poor
Boeckman Creek MID	Riffle		16	Severe		0.583	Most	23.4	Poor	42.4	Poor
Boeckman Creek UPPER	Riffle		14	Severe		0.583	Most	18.8	Poor	29.3	Poor
Coffee Creek	Riffle	36	30	Slight/Mod	0.63	0.485	Most	16.7	Good	28.8	Poor
Minthorn Creek	Riffle	16	12	Severe	0.388	0.194	Most	19.7	Poor	62.6	Poor
Rinearson Creek	Glide	14	12	NA	0.242	0.291	NA	20.5	Poor	55.4	NA
River Forest Creek	Glide		16	NA	0.145*	0.194	NA	20.7	Poor	68.2	NA
Singer Creek	Riffle	30	38	Slight	0.581	0.776	Most	16.5	Good	17.6	Fair
Tanner Creek	Riffle	18	16	Severe	0.242	0.388	Most	16.8	Good	22.3	Poor
Trillium Creek	Riffle	20	18	Severe	0.485	0.485	Most	22.1	Poor	30.3	Poor
Ball Creek	Riffle	18	18	Severe	0.437	0.389	Most	19.4	Poor	29.8	Poor
Carter Creek	Glide	16	18	NA	0.388	0.292	NA	20.8	Poor	42.4	NA
Lost Dog Creek	Riffle	16	14	Severe	0.291	0.243	Most	16.9	Good	25.7	Poor
Lost Dog Creek EAST	Riffle	18	18	Severe	0.436	0.340	Most	17.0	Good	36.8	Poor
Lost Dog Creek WEST	Riffle	10	18	Severe	0.242	0.291	Most	17.9	Good	29.9	Poor
Nettle Creek	Riffle	18	20	Severe/Mod	0.339	0.437	Most	17.3	Good	25.1	Poor
Oswego Creek	Riffle	14	16	Severe	0.194	0.291	Most	25.9	Poor	44.8	Poor
Springbrook Creek REST	Riffle	20	18	Severe	0.388	0.583	Most	21.7	Poor	35.8	Poor
Springbrook Creek LOWER	Riffle	16	18	Severe	0.437	0.486	Most	22.1	Poor	30.2	Poor
Tryon Creek	Riffle	24	22	Moderate	0.485	0.388	Most	23.0	Poor	18.6	Fair

Among the Lake Oswego streams reaches, EPT (mayfly, stonefly, and caddisfly) richness was highest in Nettle and Tryon creeks (8 EPT taxa each), followed closely by both Springbrook Creek reaches (6 EPT taxa each). A higher EPT richness generally suggests a less disturbed biological condition. The Nettle Creek sample included three mayfly taxa, two stonefly taxa, and three caddisfly taxa. Two of these eight taxa – the mayfly *Cinygma* sp. and the caddisfly *Parapsyche elsis* – are classified as “sensitive” to

disturbance. Both Springbrook Creek reaches also support the mayfly *Cinygma* sp.; no taxa classified as sensitive to disturbance were sampled from any of the other eight Lake Oswego sample reaches.

Temperature stressor (TS) scores indicate that compositional shifts in macroinvertebrate communities have occurred in response to elevated water temperature in six of the ten Lake Oswego stream reaches (Table 6). Only lower the Lost Dog Creek, East Lost Dog Creek, West Lost Dog, and Nettle Creek reaches appear to support macroinvertebrate communities likely unaffected by elevated water temperatures. Among those six reaches indicating temperature-induced stress, Oswego Creek's community showed the largest shifts in community composition likely induced by temperature, as the inferred temperature score was 25.9°C, almost 3°C higher than the second highest TSS score (Table 6).

Fine sediment stressor (FSS) scores from eight of nine Lake Oswego samples collected from riffle habitats (i.e., all reaches other than Carter Creek and Tryon Creek) indicated likely sediment-induced stress on macroinvertebrate communities in these reaches. All eight samples exceeded the threshold FSS score of 19. Tryon Creek's sediment stressor score of 18.6 received a "fair" condition classification, indicating potential, but not likely, sediment induced stress (Table 6).

Table 7. Multimetric Index scores and PREDATOR MWCF model O/E scores from stream reaches sampled in and adjacent to the City of Lake Oswego, Oregon, fall 2004, 2007, 2009, 2013, and 2018.

Sample Site	DEQ Multimetric Index Scores						PREDATOR O/E Scores					
	2004	2007	2009	2013	2018	13-18	2004	2007	2009	2013	2018	13-18
Ball Creek	20	12	12	18	18	0	0.243	0.339	0.243	0.437	0.389	-0.048
Carter Creek		16	14	16	18	2		0.388	0.388	0.388	0.292	-0.096
Lost Dog Creek	18	16	16	16	14	-2	0.242	0.291	0.339	0.291	0.243	-0.048
Lost Dog Creek East		16	18	18	18	0		0.291	0.436	0.436	0.340	-0.096
Lost Dog Creek West		14	10	10	18	8		0.242	0.194	0.232	0.291	0.059
Nettle Creek	18	14	12	18	20	2	0.436	0.533	0.388	0.339	0.437	0.098
Oswego Creek		18	12	14	16	2		0.436	0.194	0.194	0.291	0.097
Springbrook Crk Lower	14	12	10	16	18	2	0.242	0.388	0.339	0.388	0.583	0.195
Springbrook Crk Rest	16	14	12	20	18	-2	0.339	0.436	0.291	0.437	0.486	0.049
Tryon Creek		14	18	24	22	-2		0.532	0.388	0.485	0.388	-0.097

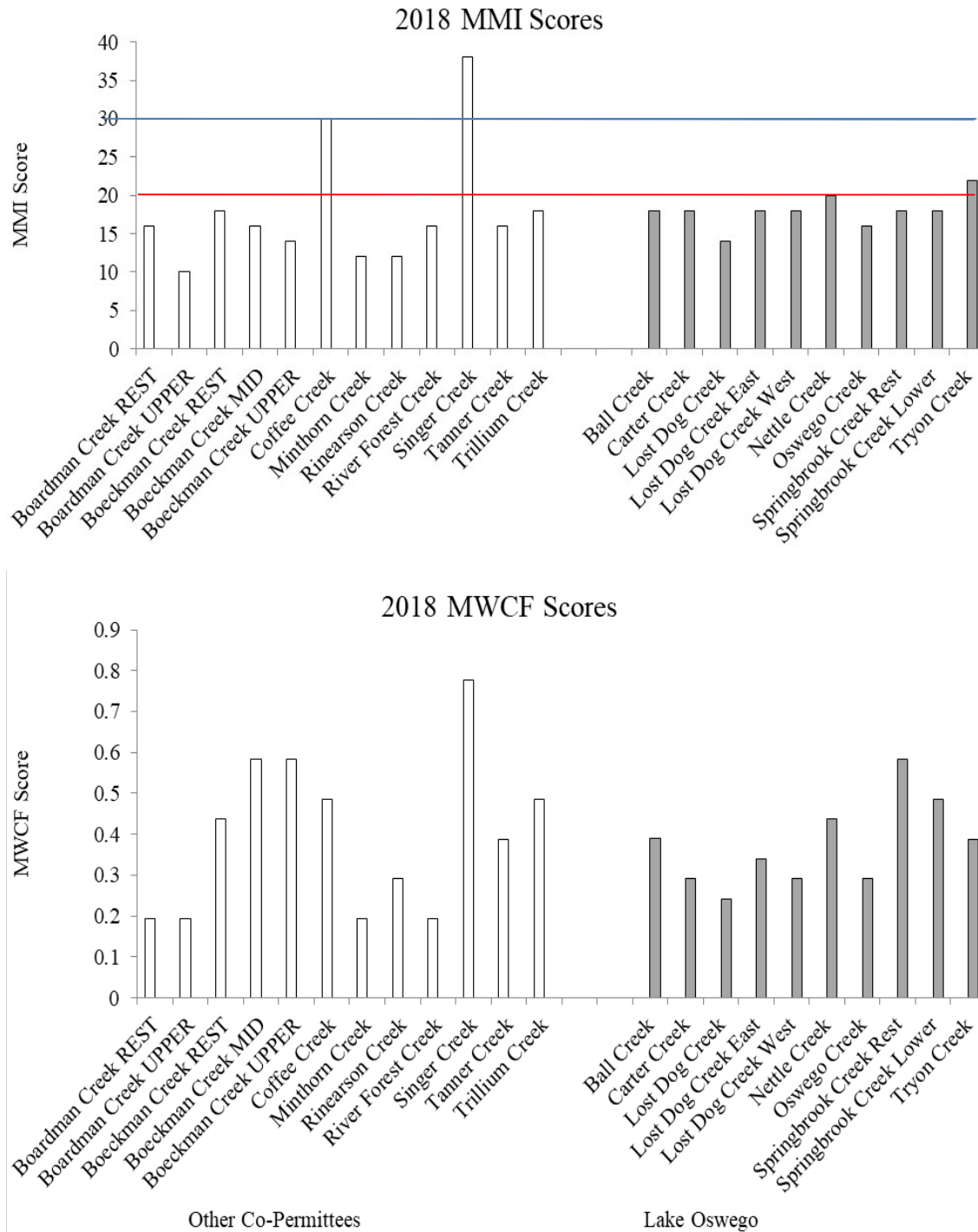


Figure 3. Multimetric index (MMI) and Marine Western Coastal Forest (MWCF) PREDATOR model scores calculated from 22 macroinvertebrate samples collected from Clackamas County MS4 co-permittee streams in September 2018.

CO-PERMITTEE STREAM REACHES

MMI scores ranged from 10 to 38 among the twelve co-permittee reaches (Table 6). Singer Creek received the highest MMI score of 38, corresponding to a slightly disturbed biological condition. Coffee Creek scored a 30, corresponding to slightly/moderately disturbed. The ten other co-permittee reaches received MMI scores ranging only between 10 and 18, indicative of severely disturbed biological conditions (Table 6). PREDATOR MWCF O/E scores ranged from 0.194 to 0.776, exclusively within the “most disturbed” condition class among the twelve co-permittee reaches (Table 6). MMI and O/E scores from Rinearson Creek, Boardman Creek, and River Forest Creek were not assigned condition classes because only glides were sampled from these reaches.

Among the twelve co-permittee reaches, macroinvertebrate total taxa richness was highest in Singer Creek, where 35 taxa were sampled (Figure 4). This richness included 12 EPT taxa (mayfly, stonefly, and caddisfly), the highest EPT richness among all 22 reaches sampled in this study. Singer Creek’s EPT richness included four taxa classified as sensitive to disturbance and water pollution, including the mayfly *Cinygma* sp., the stonefly *Despaxia augusta*, the caddisfly *Rhyacophila grandis* Gr., and dipteran *Glutops* sp. Furthermore, Singer Creek’s modified HBI score and percent tolerant individuals were the lowest among all 22 study sites (Figure 4), indicating the most disturbance-sensitive macroinvertebrate community among all reaches sampled. Across the 22 study reaches, Singer Creek presently supports the most sensitive and diverse macroinvertebrate community.

Coffee Creek, the only other reach to receive an MMI score corresponding to only slightly disturbed, supported 25 total macroinvertebrate taxa. Nine EPT taxa were sampled from the Coffee Creek reach, including two taxa classified as sensitive to disturbance: the mayfly *Cinygma* sp. and the caddisfly *Rhyacophila grandis* Gr. (Figure 4). Among the 22 sampled study reaches, Coffee Creek macroinvertebrate community scored better than 20 other reaches.

Across the co-permittee reaches from which riffles were sampled, Minthorn Creek received the lowest MMI score and MWCF O/E score (Table 6). Only one EPT taxon was sampled in this reach, the generally tolerant *Baetis tricaudatus* complex, and only one individual was sampled. Minthorn Creek also received the highest HBI score (Figure 5) among all study reaches within which riffles were sampled, indicative of a benthic community that is generally tolerant to organic enrichment pollution.

Riffles were nearly absent from the Rinearson reach, both Boardman reaches, and the River Forest reach, necessitating sampling macroinvertebrates from sand-dominated glide habitat. As such, biological condition classes were not assigned from the community scores calculated for these reaches. However, the very low MMI and O/E scores derived from these samples suggest degraded conditions in these reaches, and as

further evidenced by the paucity of EPT taxa. Among these four reaches, only two EPT taxa were sampled: one caddisfly taxon from Rinearson Creek and one mayfly taxon from the Boardman Creek restoration reach (Figure 4). The upper Boardman Creek sample supported the lowest total taxa richness among all 22 study reaches (Figure 4).

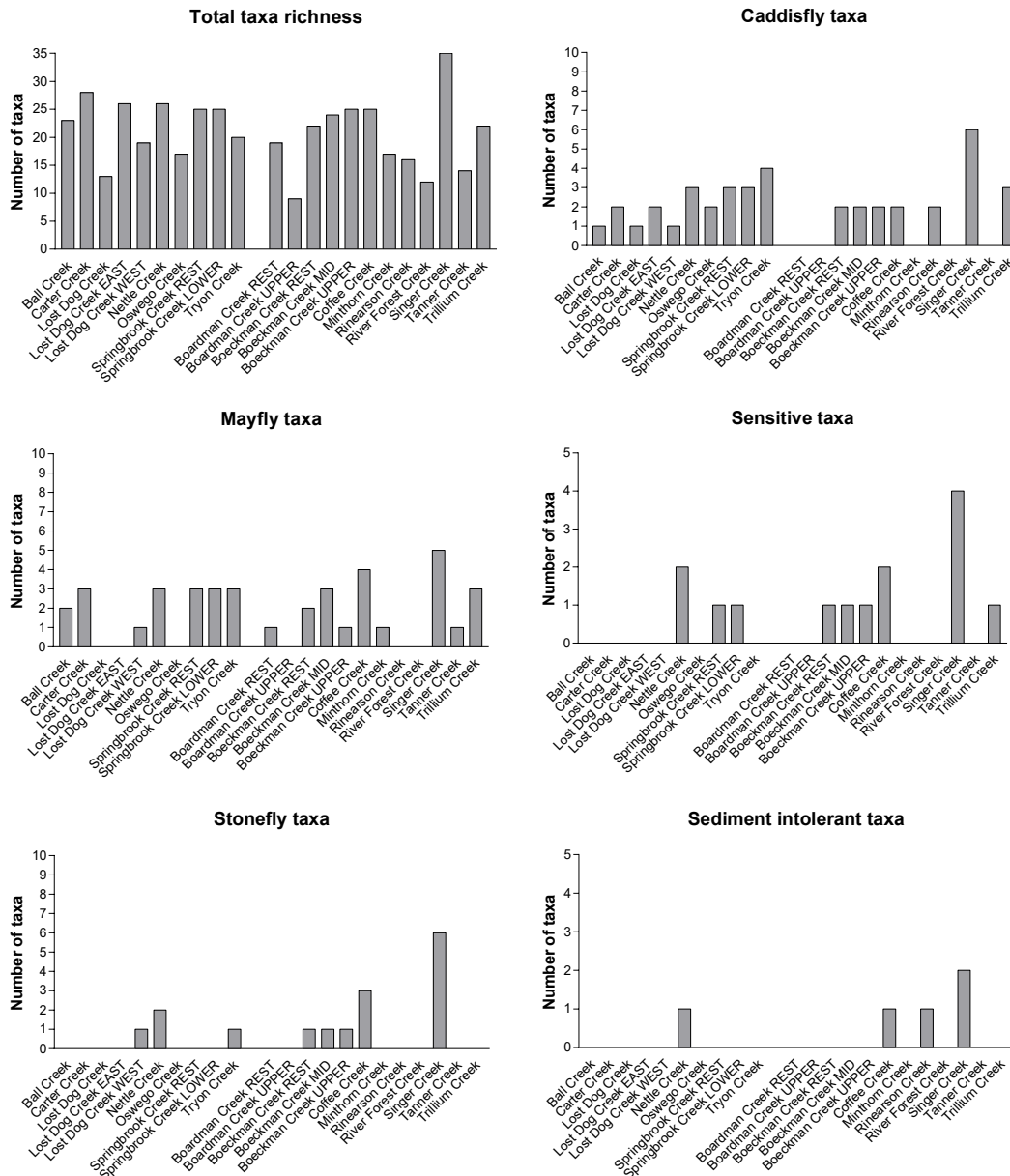


Figure 4. Panel 1 of individual community metric values calculated from macroinvertebrate samples collected from 22 Clackamas County MS4 co-permittee streams in September 2018.

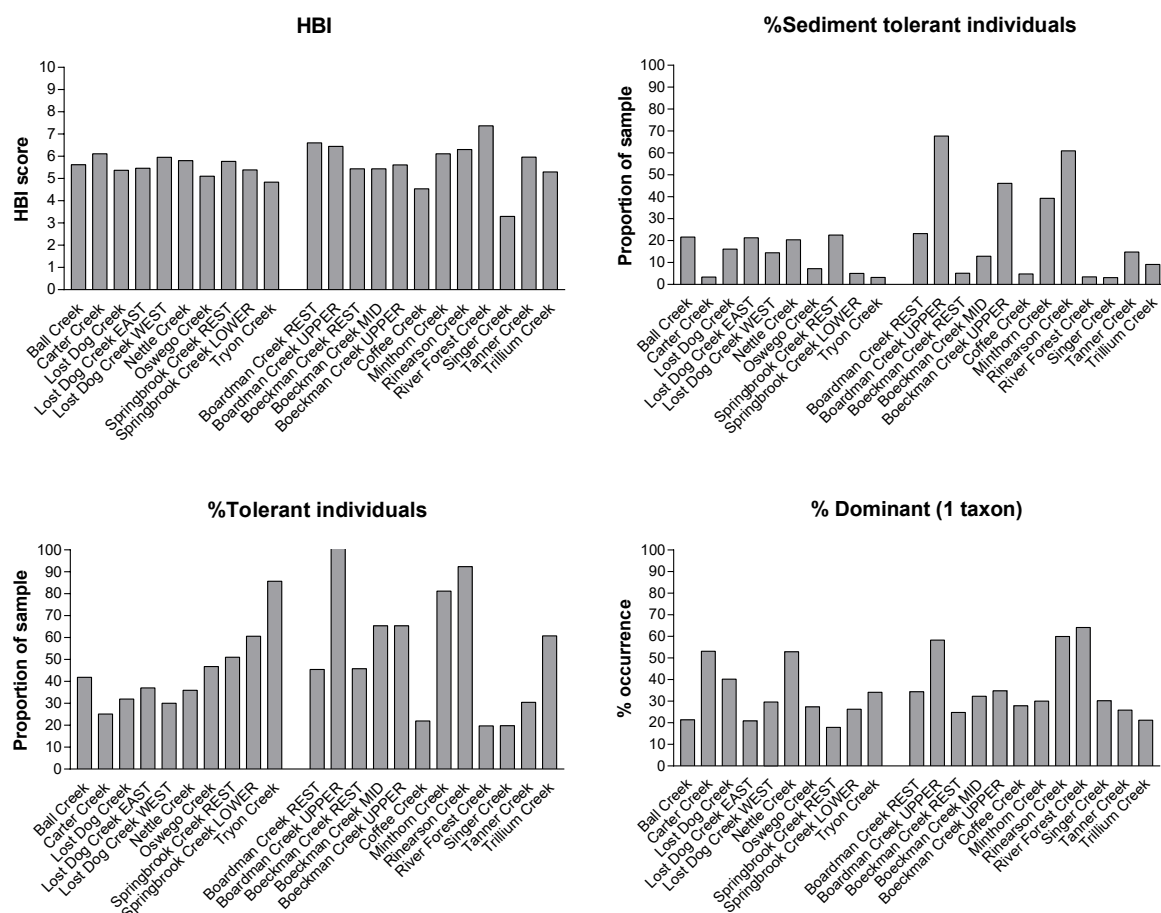


Figure 5. Panel 2 of individual community metric values calculated from macroinvertebrate samples collected from 22 Clackamas County MS4 co-permittee streams in September 2018.

Across the 12 co-permittee reaches, macroinvertebrate community conditions were generally very similar to what they were when last sampled. 2018 MMI scores were within 2 points of 2013 MMI scores in four of seven co-permittee reaches previously sampled in 2013 (Table 6). Singer Creek's MMI score increased from 30 in 2013 to 38 in 2018, while Coffee Creek's score decreased from 36 to 30 from 2013 to 2018. Neither of these score changes resulted in a change in disturbance class. PREDATOR MWCF O/E scores continued to occur exclusively in the "most" disturbed" class across all co-permittee sites.

The lower Boeckman Creek restoration reach's 2018 MMI score of 18 was similar to the 2013 score of 20, suggesting similar benthic community conditions. Conditions measured in both 2013 and 2018 are similar to those measured in 2003 in the reach, when the benthic community received an MMI score of 16. Individual community metrics have also been similar across these three sampling years (Table 8). Two

Boeckman Creek sites – both located upstream of the lower Boeckman Creek restoration site at Rose Lane – were sampled in 2018 for the first time since 2003. Both of these reaches – Boeckman Creek below Kolbe Lane (MID) and Boeckman Creek at the Boeckman Creek Trail footbridge (UPPER) – also received MMI scores corresponding to severely disturbed conditions in 2018. MMI scores from riffle samples from the upper Boeckman Creek site were similar between 2003 (MMI = 16) and 2018 (MMI = 14), suggesting similarly disturbed conditions in 2003 and 2018. The Boeckman Creek MID site below Kolbe Lane (also known as the *upper restoration* site) received an MMI score of 18 in 2003 (sampled from a glide) and 16 in 2018 (sampled from a riffle). While different habitat types were sampled in the different years, these results demonstrate generally similar benthic community conditions between 2003 and 2018 in this section of Boeckman Creek. Collectively, these data suggest that benthic biological conditions throughout Boeckman Creek have remained largely unchanged between 2003 and 2018.

Table 8. Macroinvertebrate community metrics calculated from samples collected from Boeckman Creek below Rose Lane, Wilsonville, Oregon in 2003, 2013 and again in 2018.

Metric	2003	2013	2018
Taxa Richness	17	19	21
Mayfly Richness	2	1	2
Stonefly Richness	0	0	1
Caddisfly Richness	1	2	2
# Sensitive Taxa	1	0	1
# Sediment Sensitive Taxa	0	0	0
Modified HBI	5.5	5.3	5.4
% Tolerant Taxa	25	37	46
% Sediment Tolerant	4	6	5
% Dominant (1 taxon)	40	31	25
MMI Score	16	20	18

The three Boardman and River Forest creek reaches included in the 2018 co-permittees study were last assessed 2012 (Cole and Haxton 2013). Biological conditions, as indicated by MWCF O/E scores and a number of community metrics, appear largely unchanged across these three sites between 2012 and 2018 (Table 9). 2018 MWCF O/E scores are identical or very similar to 2013 scores, total taxa richness is similar, EPT richness is almost identical, and HBI scores are similar (Table 9). While only glides have been sampled from these low-gradient reaches, the poorly performing community metrics, considered together with the low dissolved oxygen concentrations, suggest highly disturbed biological conditions in each of these three reaches.

Table 9. Comparison of 2012 versus 2018 PREDATOR MWCF O/E scores and select community metrics calculated from macroinvertebrate samples collected from Boardman and River Forest creeks.

Reach	Habitat Sampled	MWCF O/E Score		Total Richness		EPT Richness		HBI	
		2012	2018	2012	2018	2012	2018	2012	2018
Boardman Creek REST	Glide	0.194	0.194	14	19	0	1	7.2	6.7
Boardman Creek UPPER	Glide	0.242	0.194	8	9	0	0	6.7	6.4
River Forest Creek	Glide	0.145	0.194	9	12	0	0	7.0	7.4
Mean		0.194	0.194	10.3	13.3	0.0	0.3	7.0	6.8

Temperature stressor (TS) scores indicate temperature-stress-induced shifts in macroinvertebrate communities have likely occurred in nine of the twelve co-permittee reaches (Table 6). Only three reaches – Coffee, Singer, and Tanner – received temperature stress scores lower than the 90th percentile threshold score of 18.4 (Table 6). Fine sediment stressor (FSS) scores indicate FS-induced stress in all seven of the eight co-permittee reaches from which riffle samples were collected (Table 6). Only the Singer Creek benthic community received a fine sediment stressor score below the 90th percentile threshold score of 19%.

DISCUSSION

Owing to the extent of urban development within the study area, results indicating that biological conditions are severely disturbed in most local streams (Figure 6) are not unexpected. The results of this study are consistent with those of other studies of macroinvertebrate communities in Clackamas County urban/suburban settings. Clackamas Water Environment Services most recently sampled macroinvertebrates in the Mt. Scott and Kellogg Creek drainages in 2017; MMI scores of six riffle samples collected from these two drainages in the 2017 study all received “moderately disturbed” scores ranging from 20 to 28 (Waterways & Cole 2018).

In the present study, PREDATOR O/E scores did not correspond as well with MMI scores ($r^2 = 0.300$) as they did in the 2013 coordinated assessment. In both years, condition classes have not aligned well between the two sets of scores (Figure 7). Importantly, DEQ currently uses the PREDATOR models to evaluate biological condition of Oregon’s streams; by that measure, all reaches evaluated in this study are

deemed to be in a “most disturbed” condition relative to regional reference conditions (Figure 7). However, the MMI scores and corresponding condition classes better and more tangibly reflect and represent the range of conditions that currently exist among these small streams sampled in this study. Higher MMI scores result directly from higher taxonomic richness, including that of generally more sensitive groups such as mayflies, stoneflies, and caddisflies.

Recognizing this range of biological conditions across these study reaches is instructive to understanding and setting potential biological recovery targets; the highest quality reaches such as Coffee and Singer Creeks represent locally realistic least-disturbed and therefore potentially best attainable conditions for these small streams in local urban and suburban settings. A closer examination of the drainages supporting these reaches may reveal what physical and chemical conditions are necessary to support these locally least-disturbed biological conditions as measured in Coffee and Singer creeks. Further quantification of potential stressors in these and the other systems, including water temperature regime and diel patterns of dissolved oxygen concentrations during peak-stress periods may further reveal potentially causative agents producing the observed biological conditions. Temperature and fine sediment stressor modelling results suggested nearly ubiquitous fine sediment stress across study reaches, and potential temperature-induced stress in most reaches. Coffee and Singer creeks were once again among the few reaches supporting macroinvertebrate communities not exhibiting temperature-induced compositional shifts.

While the dissolved oxygen data collected for this study are of limited use for relating observed biological conditions to environmental gradients, the data nonetheless suggest potential dissolved oxygen issues in several systems, most notably in 2018 in Boardman, Carter, and River Forest creeks. Importantly, dissolved oxygen data were collected at the time of macroinvertebrate sampling from each reach, so times varied across reaches and occurred only in the early AM hours from a handful of reaches. Continuous or synoptic temperature and dissolved oxygen monitoring is recommended from these reaches to produce more robust water quality data sets that would better implicate causes of the measured biological disturbance.

Since the first Boeckman Creek macroinvertebrate survey was conducted in 2003, only the restored reach below Rose Lane had been surveyed prior to 2018. Three years following the 2003 assessment, restoration work occurred at both the Rose lane and Kolbe Lane road crossings, where culverts were removed and replaced with bridges. More extensive channel restoration work was performed downstream of the Rose Lane crossing than at the Kolbe Lane crossing. The 2013 sampling in the Rose Lane restoration reach revealed that macroinvertebrate community conditions were similar between the 2003 and 2013 sampling events, suggesting recovery of the community following any short-term disturbance that may have resulted from the culvert replacement

work. Results of the 2018 assessment below Rose Lane were also similar to those obtained in 2003 and 2013, suggesting unchanging and consistently degraded macroinvertebrate community conditions. The Boeckman Creek reaches below Kolbe Lane and below the Boeckman Creek trail footbridge were each sampled in 2018 for the first time since 2003. Macroinvertebrate community conditions were found to be similar to those in 2003 in both of these reaches, as well. These results suggest similarly significant and chronically disturbed ecological conditions throughout Boeckman Creek, even in the upstream reaches. Temperature and sediment stressor scores implicate both as likely stressors to macroinvertebrate communities throughout Boeckman Creek.

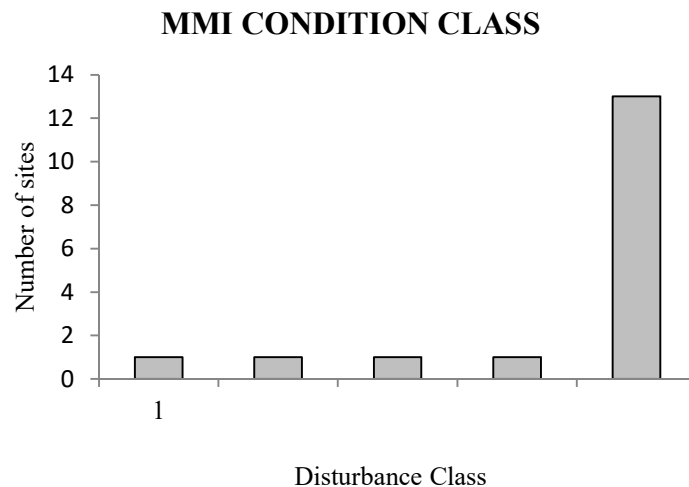


Figure 6. Distribution of macroinvertebrate community condition classes from 17 Clackamas County MS4 co-permittee streams sampled in September 2018, as determined from multimetric index (MMI) scores. Rinearson, Carter, Boardman, and River Forest creeks are not included in these results, as glides were sampled from each of these reaches, thereby precluding the assignment of condition classes.

Recovery of biological communities in these MS4 co-permittee area streams is dependent on identifying and improving stream conditions and functions that are currently impaired. While additional water quality data would further elucidate likely cause-effect relationships, stressor model results, combined with the results of physical habitat assessments, are suggestive of multiple stressors co-occurring in most streams assessed in this study. Urban development results in large impervious surface areas that modify hydrologic patterns, resulting in destabilized streamflows, altered seasonal high and low flows, increased sediment inputs, and modified channel morphology and habitat. Urban stormwater also carries numerous pollutants, some of which can attain toxic concentrations during first-flush storm events. This phenomenon, known as “urban

stream syndrome” or “multiple stress syndrome” is well documented among urban streams (Walsh et al. 2005). Mechanisms driving the syndrome are complex and interacting, yet rapid and unabated stormwater delivery into highly physically altered (often channelized) receiving waters is largely the source of the various perturbations observed and measured in this and other regional studies of stream condition. These highly modified hydrologic patterns destabilize streamflows and alter seasonal high and low flows, pollutant concentrations, temperature and dissolved oxygen extremes, sediment inputs, and channel morphology, all which cumulatively degrade biological communities.

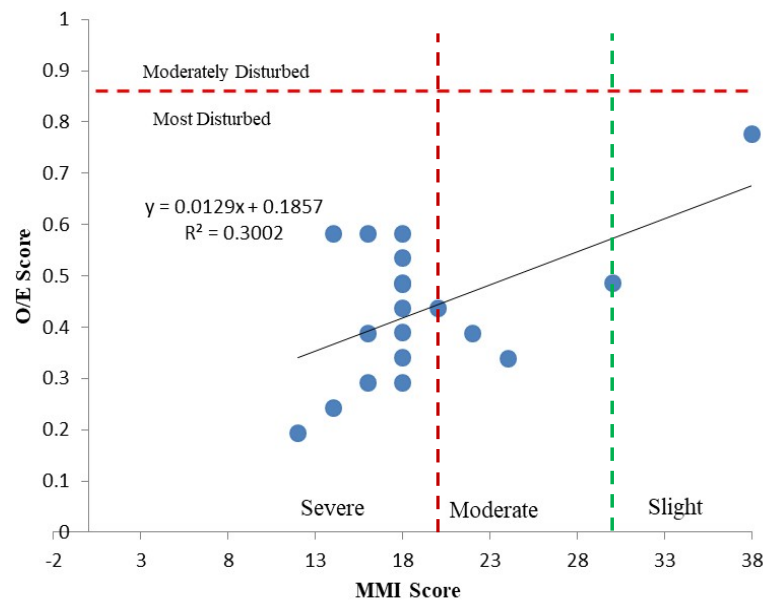


Figure 7. Relationship between MMI and O/E scores.

Among pollutants entering streams through stormwater, pesticides are only starting to receive their deserved attention with respect to understanding effects on the ecology of surface waters. Recent work in Clackamas County, Oregon found that several indicators of macroinvertebrate community condition were strongly negatively correlated with streambed sediment concentrations of the pyrethroid insecticide bifenthrin, now widely used in urban areas (Carpenter et al. 2016). Two streams from the 2018 co-permittees macroinvertebrate study, Lost Dog Creek and Tanner Creek, were implicated by the Carpenter study as having bifenthrin concentrations in streambed sediments that were potentially deleterious to macroinvertebrates (Carpenter et al. 2016). Both Lost Dog Creek and Tanner Creek support an abundance of riffle habitat and coarse substrate, and neither was implicated by the temperature stressor model as potentially suffering from thermal stress. The relatively intact habitat conditions in these reaches further implicate

bifenthrin as potentially deleteriously affecting the benthic communities in lower Lost Dog Creek and Tanner Creek. Carpenter et al.'s work suggests that pesticides carried by stormwater may play an important role in the degradation of aquatic communities in some area streams, but more work is necessary on this front. Continued and expanded pesticides monitoring in Clackamas County and elsewhere could assist with further understanding this emerging issue as it relates to stormwater management and consequences to the biology in receiving waters.

While many proximate factors may contribute to the biological disturbances measured in this study, ultimately, causation in most cases can likely be attributed to stormwater. Protection of area streams should focus on minimizing total effective impervious areas and improving stormwater retention and drainage patterns to minimize the hydrologic effects of storm events on stream channel conditions. Certain stormwater mitigation strategies such as artificial wetlands and retention facilities also serve to remove pollutants through physical, chemical, or biological processes. Further development within Clackamas County will necessitate careful attention to these and other measures intended to preserve and enhance stream conditions and functions. As such measures and other restoration activities are undertaken, these data will assist with determining the success of these actions relative to their intended benefits to aquatic life.

RECOMMENDATIONS

- Continue periodic biological monitoring to produce robust data sets of biological condition status and trends
- Establish continuous temperature monitoring (and potentially regular DO monitoring) at water quality/biological monitoring stations. These data will offer better opportunities for identifying potential causative agents in producing observed biological conditions
- Further characterize and quantify physical, chemical, and hydrologic conditions in study area drainages to understand potential causes of differences in biological conditions area among streams
- Continue and expand local and regional pesticides monitoring through the Clackamas Basin Pesticide Stewardship Partnership and other partnerships to further elucidate the effects of pesticides on aquatic life in area streams.

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Appendix 1. Environmental conditions measured from 22 Clackamas County NPDES MS4 co-permittee stream reaches, fall 2018.

Variable	Ball Creek	Carter Creek	Lost Dog @ Lake Front	Lost Dog EAST	Lost Dog WEST	Nettle Creek	Oswego Creek	Springbrook Creek REST	Springbrook Creek LOWER	Tryon Creek	Boardman Creek REST	Boardman Creek UPPER	Bockman Creek REST	Bockman Creek MID	Bockman Creek UPPER	Coffee Creek	Minthorn Creek	Rinearson Creek	River Forest Creek	Singer Creek	Tanner Creek	Trillium Creek
Reach length (m)	76	78	76	37	63	79	68	84	75	86	75	60	102	101	81	36	39	65	75	63	50	74
Wetted width (m)	1.9	1.0	1.1	1.1	0.8	1.8	3.6	2.2	2.1	5.0	4.9	1.2	2.3	1.5	1.7	1.2	0.5	1.3	1.3	1.4	1.6	2.0
Bankfull width (m)	3.9	2.3	3.3	1.6	1.6	3.3	12.3	3.1	3.4	8.7	9.1	3.1	4.0	2.3	4.4	2.4	2.0	1.9	2.2	2.9	3.1	4.3
% Pool	21	83	63	30	68	37	37	38	15	50	100	25	58	92	75	28	59	29	60	32	32	42
% Glide	17	9	0	0	10	8	15	24	32	30	0	75	20	0	10	0	0	71	37	3	10	11
% Riffle	53	8	29	70	22	56	49	38	53	20	0	0	23	8	15	72	41	0	3	65	36	47
% Rapid/Cascade	9	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0
% Embeddedness (Reach Est)	37	92	51	47	72	48	40	54	41	42	100	100	67	94	80	60	48	100	100	48	27	46
% Eroding Banks	88	21	42	100	88	80	0	85	82	35	50	0	88	100	100	55	55	100	100	70	7	45
% Undercut Banks	0	32	0	3	1	3	0	7	0	0	0	0	11	42	11	0	0	0	0	1	6	0
% Coarse substrate	99	60	100	99	80	98	100	100	96	99	0	0	98	95	82	99	90	30	5	81	98	99
% Sand and fines	1	40	0	0	10	0	0	0	0	1	90	95	0	5	14	1	10	70	90	13	0	1
% Hardpan	0	0	0	1	10	2	0	0	4	0	0	5	0	0	0	0	0	0	0	4	0	0
Embeddedness (Pebble Count)	29	58	28	22	27	30	17	16	21	22	99	100	13	24	21	25	37	99	99	30	14	19
LWD Pieces/100 m	11	0	16	0	2	15	1	15	1	14	9	0	20	3	14	0	0	0	0	5	8	7
Canopy Cover	97	31	90	93	96	92	69	90	91	87	34	21	95	51	97	84	46	74	99	97	97	85
Riparian Buffer Width (m)	65	23	110	18	13	63	63	13	10	53	15	5	58	25	70	60	1	3	7	60	28	20
% Tree Cover	75	13	70	63	80	85	70	55	55	76	20	8	68	28	63	48	5	25	85	45	63	73
% Non-Native Veg	18	80	30	50	38	13	4	15	45	50	3	25	34	58	30	60	45	0	8	45	30	23
WQ Time	740	920	1128	745	930	1435	1345	1240	1045	1005	1410	1510	845	1130	1230	1115	1400	1305	1300	800	1000	800
Water Temperature (oC)	14.4	16.3	14.7	12.2	16.1	14.6	21.7	15.5	14.9	12.4	16.9	18.9	12.8	13.3	13.1	14.0	17.5	16.6	15.0	12.0	13.5	12.8
Dissolved Oxygen (% sat)	93.0	36.2	88.7	84.3	64.7	90.9	93.1	92.9	95.4	98.9	30.7	5.7	85.5	71.3	84.4	96.7	66.5	73.5	21.7	91.4	95.5	96.2
Dissolved Oxygen (mg/L)	9.5	3.6	9.0	9.1	6.4	9.2	8.2	9.3	9.6	10.6	3.0	0.5	9.0	7.5	8.9	10.0	6.4	7.2	2.2	9.8	9.9	10.2
Conductivity (µS/cm)	141	182	107	114	60	104	151	94	90	153	156	203	159	153	138	60	192	152	131	68	95	87
Specific Conductance (µS/cm)	177	218	133	151	72	130	162	115	112	201	186	230	207	197	179	76	224	181	162	90	124	113
pH	7.6	6.8	7.2	6.9	6.3		7.2	7.1	7.3	7.5	6.6	6.6	7.1	6.9	7.2	6.8	7.2	6.3	6.7	7.3	7.1	7.0

Appendix 2. Western Oregon multimetric index individual metric scores calculated from macroinvertebrate communities sampled from 22 Clackamas County NPDES MS4 co-permittee stream reaches in fall 2018.

Metric	Ball Creek	Carter Creek	Lost Dog Creek	Lost Dog Creek EAST	Lost Dog Creek WEST	Nettle Creek	Oswego Creek	Springbrook Creek REST	Springbrook Creek LOWER	Springbrook Creek LOWER DUP	Tryon Creek	Tryon Creek DUP	Boardman Creek REST	Boardman Creek UPPER	Boeckman Creek REST	Boeckman Creek MID	Boeckman Creek UPPER	Coffee Creek	Minthorn Creek	Rinearson Creek	River Forest Creek	Singer Creek	Tanner Creek	Trillium Creek
Richness	23	28	13	26	19	26	17	25	25	21	20	20	19	9	21	24	25	25	17	16	12	35	14	22
Mayfly Richness	2	3	0	0	1	3	0	3	3	2	3	1	1	0	2	3	1	4	1	0	0	5	1	3
Stonefly Richness	0	0	0	0	1	2	0	0	0	0	1	1	0	0	1	1	1	3	0	0	0	6	0	0
Caddisfly Richness	1	2	1	2	1	3	2	3	3	3	4	4	0	0	2	2	2	2	0	2	0	6	0	3
Number Sensitive Taxa	0	0	0	0	0	2	0	1	1	0	0	0	0	0	1	1	1	2	0	0	0	4	0	1
# Sediment Sensitive Taxa	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	2	0	0
Modified HBI1	5.6	6.1	5.4	5.5	6.0	5.8	5.1	5.8	5.4	5.5	4.8	4.8	6.6	6.4	5.4	5.4	5.6	4.5	6.1	6.3	7.4	3.3	6.0	5.3
% Tolerant Taxa	42	25	32	37	30	36	47	51	61	52	86	82	45	161	46	65	65	22	81	92	20	20	30	61
% Sediment Tolerant Taxa	22	3	16	21	14	20	7	23	5	2	3	2	23	68	5	13	46	5	39	61	3	3	15	9
% Dominant	21	53	40	21	30	53	27	18	26	22	34	37	34	58	25	32	35	28	30	60	64	30	26	21

Appendix 3. Reach Assessment Summary Sheets

Reach Assessment Summary



Stream Name: **Ball Creek**
 Location: at Kruse Oaks Blvd
 County, State: Clackamas, Oregon
 Date sampled: 9/12/2018
 Personnel: M. Cole & C. Burtch

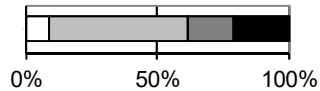
Latitude: 45.42452
 Longitude: -122.74031
 Reach Length: 76 m

Physical and Chemical Conditions Summary

Site Location

Instream Physical Characteristics

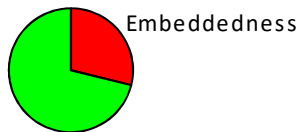
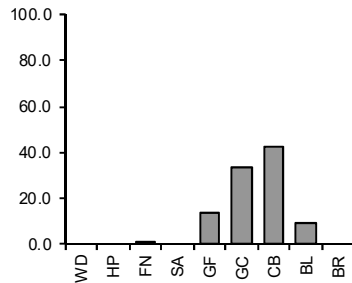
Wetted Width (m)	1.9
Bankfull Width (m)	3.9
% Rapids/Casc.	9.2
% Riffles	52.6
% Glides/Runs	17.1
% Pools	21.1



□ % Rapids/Casc. □ % Riffles
 ■ % Glides/Runs ■ % Pools

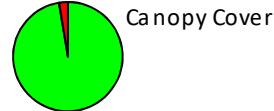
Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.8
% Sand	SA	0.0
% Fine Gravel	GF	13.4
% Crse Gravel	GC	33.6
% Cobble	CB	42.9
% Boulder	BL	9.2
% Bedrock	BR	0.0
% Embeddedness		28.8
LWD (pieces/100 m)		11
Eroding Banks (%)		88
Undercut Banks (%)		0



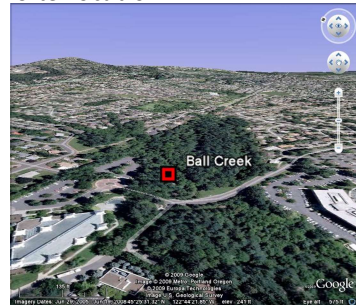
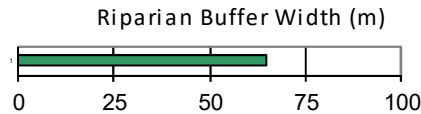
Riparian Zone Characteristics

Canopy Cover (%)	97
Riparian Buffer Width (m)	65
Rip Zone Tree Cover (%)	75
Rip Non-Native Cover (%)	18

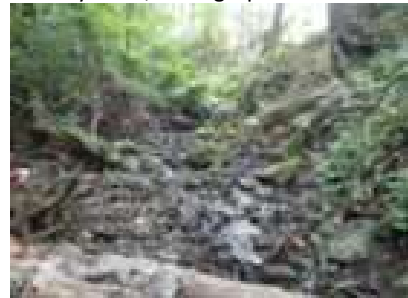


Chemical Characteristics

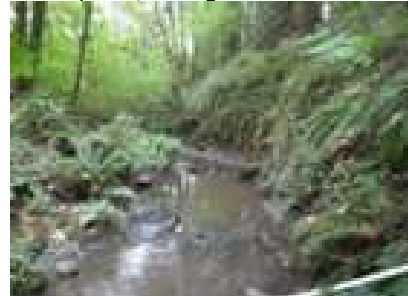
Water Temperature (°C)	14.37
Specific Cond (µS/cm)	177
Dissolved Oxygen (mg/L)	9.5
pH	7.63
Time of Measurement	740



Survey start, facing upstream



Survey end, facing downstream

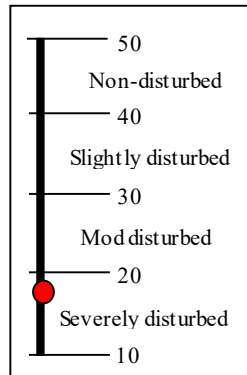


Biological Conditions Summary

CE Sample ID: 18-122-01
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ Metric Scores

	Raw	Stand.
Richness	23	3
Mayfly	2	1
Stonefly	0	1
Caddisfly	1	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	5.6	1
% Tolerant Taxa	41.9	3
% Sed Tol Taxa	21.6	3
% Dominant (1)	21.4	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.437	Most
2018	0.389	Most

2018 Stressor Scores

Temperature Stress:	19.4
Fine Sediment Stress:	29.8

Reach Assessment Summary

Stream Name: **Carter Creek**
 Location: at Bangy
 County, State: Clackamas, Oregon
 Date sampled: 9/12/2018
 Personnel: M. Cole & C. Burtch

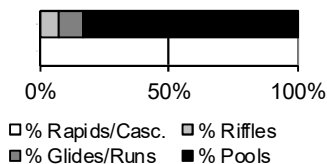
Latitude: 45.41703
 Longitude: -122.74064
 Reach Length: 78 m



Instream Physical Characteristics

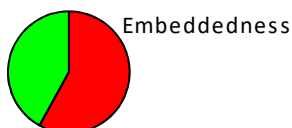
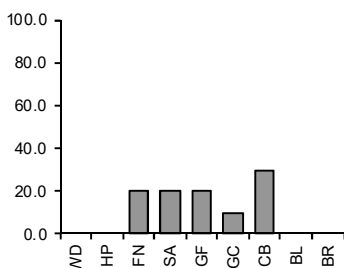
Wetted Width (m)	1.0
Bankfull Width (m)	2.3
% Rapids/Casc.	0.0
% Riffles	7.7
% Glides/Runs	9.0
% Pools	83.3

Physical and Chemical Conditions Summary



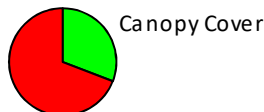
Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	20.0
% Sand	SA	20.0
% Fine Gravel	GF	20.0
% Crse Gravel	GC	10.0
% Cobble	CB	30.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		58.0
LWD (pieces/100 m)		0
Eroding Banks (%)		21
Undercut Banks (%)		32



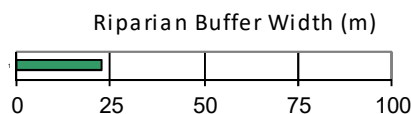
Riparian Zone Characteristics

Canopy Cover (%)	31
Riparian Buffer Width (m)	23
Rip Zone Tree Cover (%)	13
Rip Non-Native Cover (%)	80

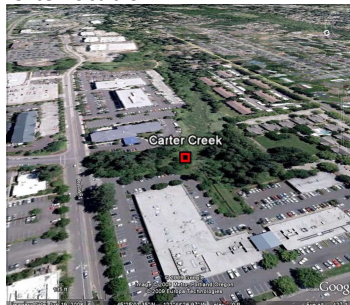


Chemical Characteristics

Water Temperature (°C)	16.28
Specific Cond (µS/cm)	218
Dissolved Oxygen (mg/L)	3.55
pH	6.78
Time of Measurement	920



Site Location



Survey start, facing upstream



Survey end, facing downstream

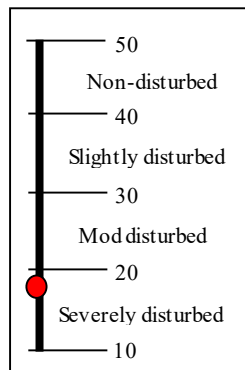


Biological Conditions Summary

CE Sample ID: 18-122-02
 Sample Method: OR 8-kick
 Target Habitat: Glide

DEQ METRIC SCORES

	Raw	Stand
Richness	28	3
Mayfly	3	1
Stonefly	0	1
Caddisfly	2	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.1	1
% Tolerant Taxa	25.1	3
% Sed Tol Taxa	3.4	5
% Dominant (1)	53.1	1
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.388	NA
2018	0.292	NA

Stressor Scores

Temperature Stress:	20.8
Fine Sediment Stress:	NA

Reach Assessment Summary



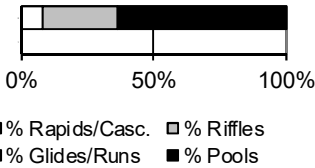
Stream Name: **Lost Dog Creek**
 Location: at end of Lake Front Dr
 County, State: Clackamas, Oregon
 Date sampled: 9/13/2018
 Personnel: M. Cole & C. Burtch

Latitude: 45.40064
 Longitude: -122.6891
 Reach Length: 76 m

Physical and Chemical Conditions Summary

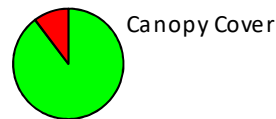
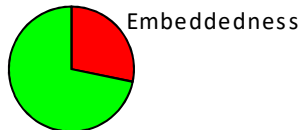
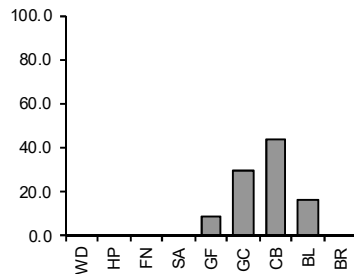
Instream Physical Characteristics

Wetted Width (m)	1.1
Bankfull Width (m)	3.3
% Rapids/Casc.	7.9
% Riffles	28.9
% Glides/Runs	0.0
% Pools	63.2



Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	8.8
% Crse Gravel	GC	30.1
% Cobble	CB	44.2
% Boulder	BL	16.8
% Bedrock	BR	0.0
% Embeddedness		28.2
LWD (pieces/100 m)		16
Eroding Banks (%)		42
Undercut Banks (%)		0

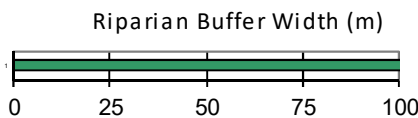


Riparian Zone Characteristics

Canopy Cover (%)	90
Riparian Buffer Width (m)	110
Rip Zone Tree Cover (%)	70
Rip Non-Native Cover (%)	30

Chemical Characteristics

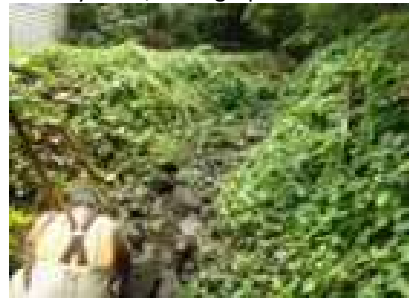
Water Temperature (°C)	14.7
Specific Cond (µS/cm)	133
Dissolved Oxygen (mg/L)	8.99
pH	7.24
Time of Measurement	1128



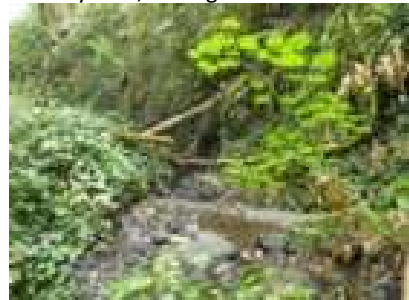
Site Location



Survey start, facing upstream



Survey end, facing downstream

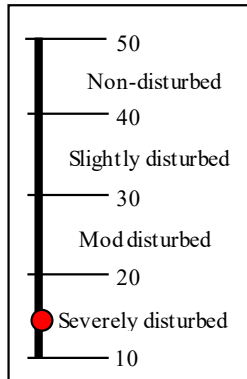


Biological Conditions Summary

CE Sample ID: 18-122-03
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand
Richness	13	1
Mavfly	0	1
Stonefly	0	1
Caddisfly	1	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	5.4	1
% Tolerant Taxa	32.0	3
% Sed Tol Taxa	16.1	3
% Dominant (1)	40.2	1
TOTAL MMI SCORE		14



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.291	Most
2018	0.243	Most

Stressor Scores

Temperature Stress:	16.9
Fine Sediment Stress:	25.7

Reach Assessment Summary



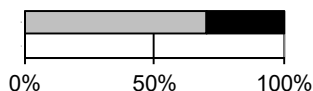
Stream Name: **Lost Dog Creek EAST**
 Location: at Stafford Rd (EAST)
 County, State: Clackamas, Oregon
 Date sampled: 9/13/2018
 Personnel: M. Cole & C. Burtch

Latitude: 45.4026
 Longitude: -122.68057
 Reach Length: 37 m

Physical and Chemical Conditions Summary

Instream Physical Characteristics

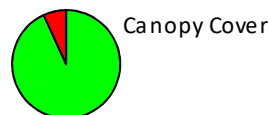
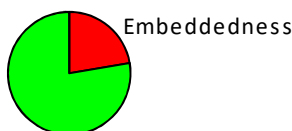
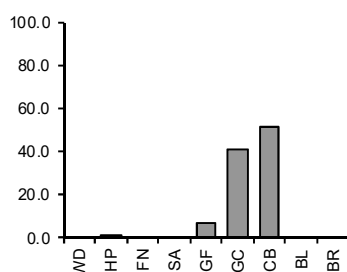
Wetted Width (m)	1.1
Bankfull Width (m)	1.6
% Rapids/Casc.	0.0
% Riffles	70.3
% Glides/Runs	0.0
% Pools	29.7



□ % Rapids/Casc. □ % Riffles
 ■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	1.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	6.7
% Crse Gravel	GC	41.3
% Cobble	CB	51.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		22.3
LWD (pieces/100 m)		0
Eroding Banks (%)		100
Undercut Banks (%)		3

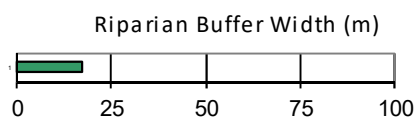


Riparian Zone Characteristics

Canopy Cover (%)	93
Riparian Buffer Width (m)	18
Rip Zone Tree Cover (%)	63
Rip Non-Native Cover (%)	50

Chemical Characteristics

Water Temperature (°C)	12.15
Specific Cond (µS/cm)	151
Dissolved Oxygen (mg/L)	9.05
pH	6.92
Time of Measurement	745



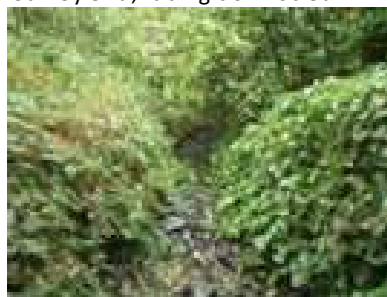
Site Location



Survey start, facing upstream



Survey end, facing downstream

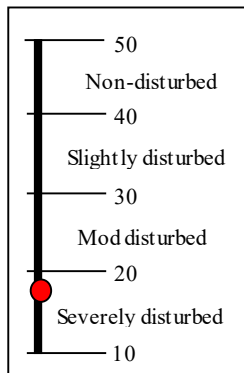


Biological Conditions Summary

CE Sample ID: 18-122-04
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	26	3
Mavfly	0	1
Stonefly	0	1
Caddisfly	2	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	5.5	1
% Tolerant Taxa	37.1	3
% Sed Tol Taxa	21.3	3
% Dominant (1)	20.9	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.436	Most
2018	0.340	Most

Stressor Scores

Temperature Stress:	17.0
Fine Sediment Stress:	36.8

Reach Assessment Summary

Stream Name: **Lost Dog Creek WEST**

Location: at Lake Oswego Golf Course (WEST)

County, State: Clackamas, Oregon

Date sampled: 9/13/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.40999

Longitude: -122.67819

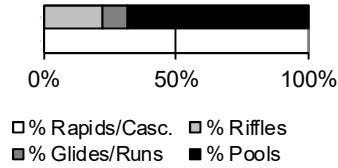
Reach Length: 63 m



Physical and Chemical Conditions Summary

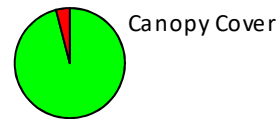
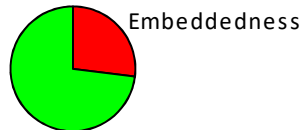
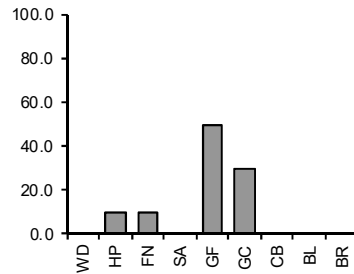
Instream Physical Characteristics

Wetted Width (m)	0.8
Bankfull Width (m)	1.6
% Rapids/Casc.	0.0
% Riffles	22.2
% Glides/Runs	9.5
% Pools	68.3



Substrate

% Wood	WD	0.0
% Hardpan	HP	10.0
% Fines	FN	10.0
% Sand	SA	0.0
% Fine Gravel	GF	50.0
% Crse Gravel	GC	30.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		27.0
LWD (pieces/100 m)		2
Eroding Banks (%)		88
Undercut Banks (%)		1

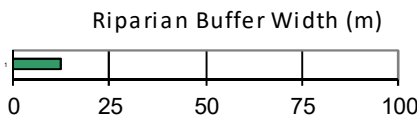


Riparian Zone Characteristics

Canopy Cover (%)	96
Riparian Buffer Width (m)	13
Rip Zone Tree Cover (%)	80
Rip Non-Native Cover (%)	38

Chemical Characteristics

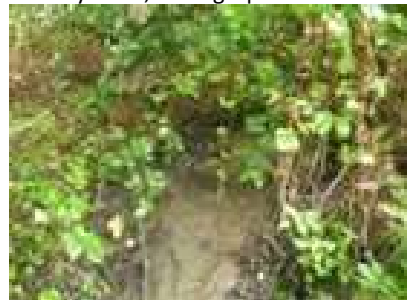
Water Temperature (°C)	16.05
Specific Cond (µS/cm)	72
Dissolved Oxygen (mg/L)	6.38
pH	6.25
Time of Measurement	930



Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

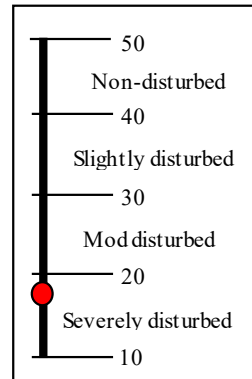
CE Sample ID: 18-122-05

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	19	3
Mayfly	1	1
Stonefly	1	1
Caddisfly	1	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.0	1
% Tolerant Taxa	30.0	3
% Sed Tol Taxa	14.4	3
% Dominant (1)	29.6	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.242	Most
2018	0.291	Most

Stressor Scores

Temperature Stress:	17.9
Fine Sediment Stress:	29.9

Reach Assessment Summary



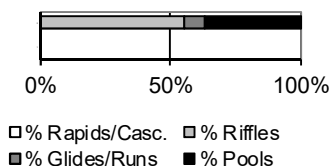
Stream Name: **Nettle Creek**
 Location: at Atwater Rd
 County, State: Clackamas, Oregon
 Date sampled: 9/12/2018
 Personnel: M. Cole & C. Burtch

Latitude: 45.42461
 Longitude: -122.68137
 Reach Length: 79 m

Physical and Chemical Conditions Summary

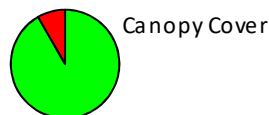
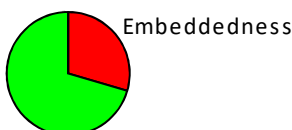
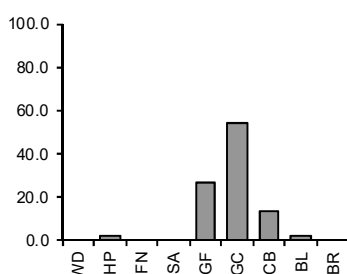
Instream Physical Characteristics

Wetted Width (m)	1.8
Bankfull Width (m)	3.3
% Rapids/Casc.	0.0
% Riffles	55.7
% Glides/Runs	7.6
% Pools	36.7



Substrate

% Wood	WD	0.0
% Hardpan	HP	2.3
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	27.3
% Crse Gravel	GC	54.5
% Cobble	CB	13.6
% Boulder	BL	2.3
% Bedrock	BR	0.0
% Embeddedness		29.5
LWD (pieces/100 m)		15
Eroding Banks (%)		80
Undercut Banks (%)		3

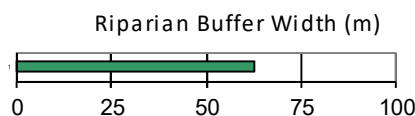


Riparian Zone Characteristics

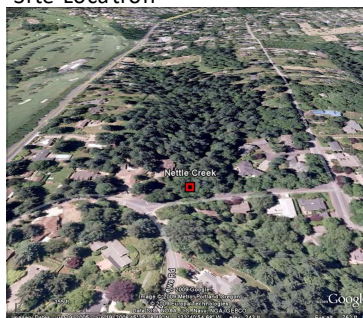
Canopy Cover (%)	92
Riparian Buffer Width (m)	63
Rip Zone Tree Cover (%)	85
Rip Non-Native Cover (%)	13

Chemical Characteristics

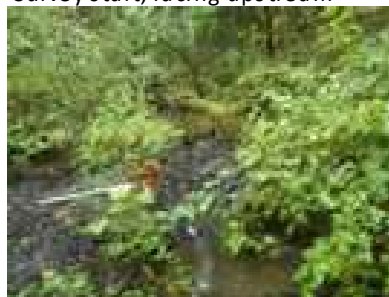
Water Temperature (°C)	14.6
Specific Cond (µS/cm)	130
Dissolved Oxygen (mg/L)	9.24
pH	
Time of Measurement	1435



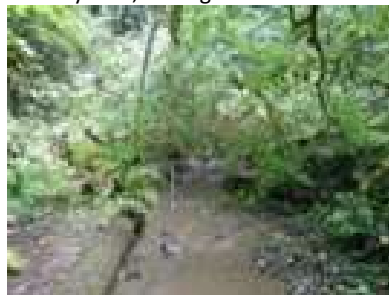
Site Location



Survey start, facing upstream



Survey end, facing downstream

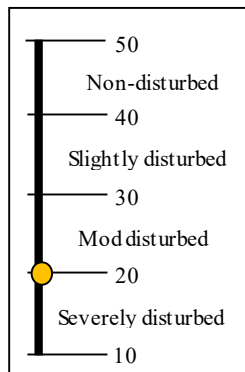


Biological Conditions Summary

CE Sample ID: 18-122-06
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	26	3
Mayfly	3	1
Stonefly	2	1
Caddisfly	3	1
# Sensitive Taxa	2	3
# Sed Sens Taxa	1	3
Modified HBI	5.8	1
% Tolerant Taxa	36.0	3
% Sed Tol Taxa	20.4	3
% Dominant (1)	52.8	1
TOTAL MMI SCORE		20



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.339	Most
2018	0.437	Most

Stressor Scores

Temperature Stress:	17.3
Fine Sediment Stress:	25.1

Reach Assessment Summary

Stream Name: **Oswego Creek**

Location: George Rogers Park (ds Hwy 43)

County, State: Clackamas, Oregon

Date sampled: 9/13/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.41073

Longitude: -122.66248

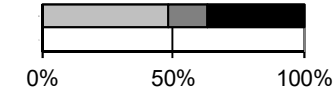
Reach Length: 68 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

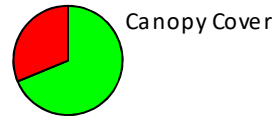
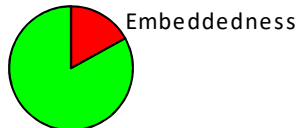
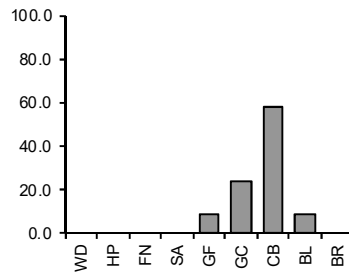
Wetted Width (m)	3.6
Bankfull Width (m)	12.3
% Rapids/Casc.	0.0
% Riffles	48.5
% Glides/Runs	14.7
% Pools	36.8



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	9.1
% Crse Gravel	GC	23.6
% Cobble	CB	58.2
% Boulder	BL	9.1
% Bedrock	BR	0.0
% Embeddedness		17.0
LWD (pieces/100 m)		1
Eroding Banks (%)		0
Undercut Banks (%)		0

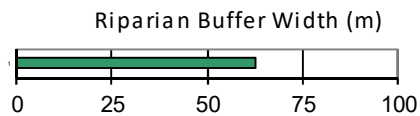


Riparian Zone Characteristics

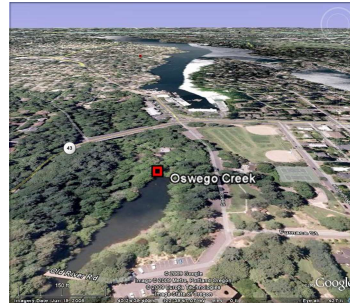
Canopy Cover (%)	69
Riparian Buffer Width (m)	63
Rip Zone Tree Cover (%)	70
Rip Non-Native Cover (%)	4

Chemical Characteristics

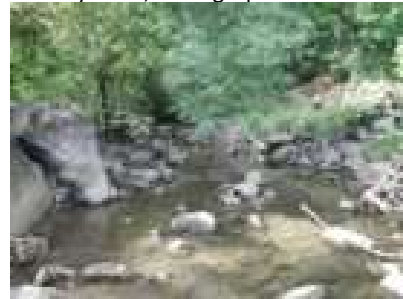
Water Temperature (°C)	21.71
Specific Cond (µS/cm)	162
Dissolved Oxygen (mg/L)	8.19
pH	7.19
Time of Measurement	1345



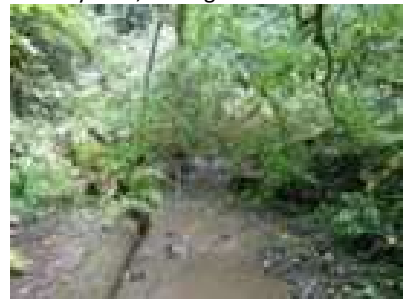
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

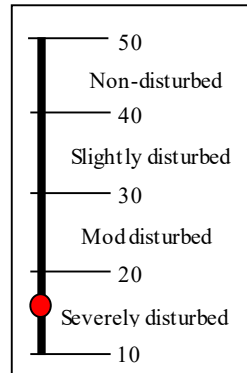
CE Sample ID: 18-122-07

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	17	1
Mavflv	0	1
Stonefly	0	1
Caddisfly	2	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	5.1	1
% Tolerant Taxa	46.8	1
% Sed Tol Taxa	7.2	5
% Dominant (1)	27.3	3
TOTAL MMI SCORE		16



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.194	Most
2018	0.291	Most

Stressor Scores

Temperature Stress:	25.9
Fine Sediment Stress:	44.8

Reach Assessment Summary

Stream Name: **Springbrook Creek REST**
 Location: at Boones Way
 County, State: Clackamas, Oregon
 Date sampled: 9/12/2018
 Personnel: M. Cole & C. Burtch

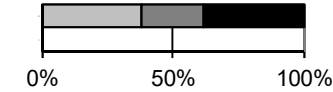
Latitude: 45.41403
 Longitude: -122.71512
 Reach Length: 84 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

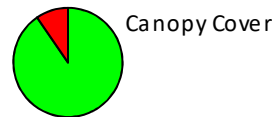
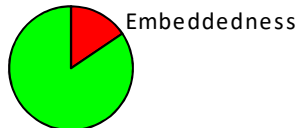
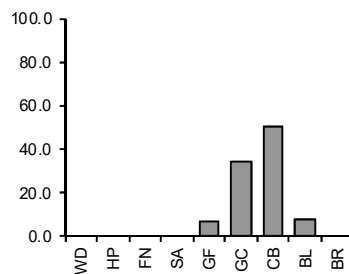
Wetted Width (m)	2.2
Bankfull Width (m)	3.1
% Rapids/Casc.	0.0
% Riffles	38.1
% Glides/Runs	23.8
% Pools	38.1



□ % Rapids/Casc. □ % Riffles
 ■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	6.5
% Crse Gravel	GC	34.6
% Cobble	CB	50.5
% Boulder	BL	8.4
% Bedrock	BR	0.0
% Embeddedness		15.6
LWD (pieces/100 m)		15
Eroding Banks (%)		85
Undercut Banks (%)		7

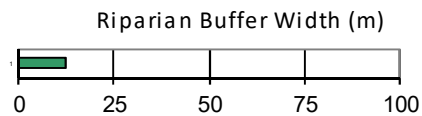


Riparian Zone Characteristics

Canopy Cover (%)	90
Riparian Buffer Width (m)	13
Rip Zone Tree Cover (%)	55
Rip Non-Native Cover (%)	15

Chemical Characteristics

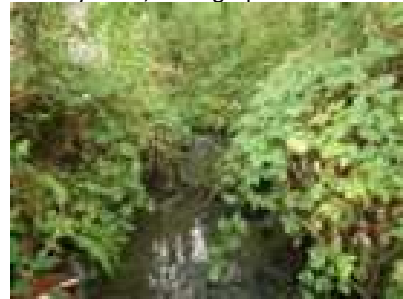
Water Temperature (°C)	15.47
Specific Cond (µS/cm)	115
Dissolved Oxygen (mg/L)	9.27
pH	7.11
Time of Measurement	1240



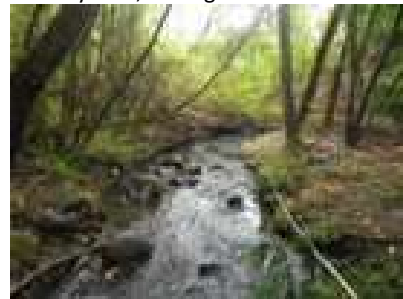
Site Location



Survey start, facing upstream



Survey end, facing downstream

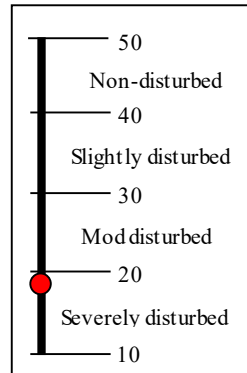


Biological Conditions Summary

CE Sample ID: 18-122-08
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	25	3
Mavflv	3	1
Stonefly	0	1
Caddisfly	3	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.8	1
% Tolerant Taxa	51.0	1
% Sed Tol Taxa	22.5	3
% Dominant (1)	17.9	5
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.388	Most
2018	0.583	Most

Stressor Scores

Temperature Stress:	21.7
Fine Sediment Stress:	35.8

Reach Assessment Summary

Stream Name: **Springbrook Creek LOWER**

Location: at Iron Mtn Park

County, State: Clackamas, Oregon

Date sampled: 9/12/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.41421

Longitude: -122.70775

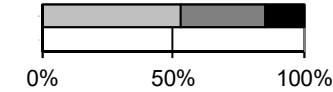
Reach Length: 75 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

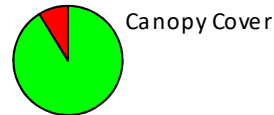
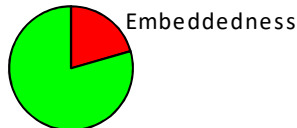
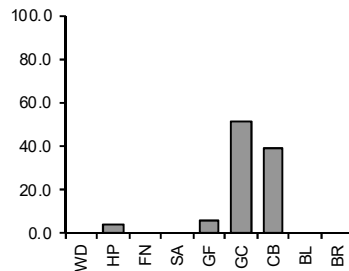
Wetted Width (m)	2.1
Bankfull Width (m)	3.4
% Rapids/Casc.	0.0
% Riffles	53.3
% Glides/Runs	32.0
% Pools	14.7



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	3.8
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	5.7
% Crse Gravel	GC	51.9
% Cobble	CB	38.7
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		20.6
LWD (pieces/100 m)		1
Eroding Banks (%)		82
Undercut Banks (%)		0

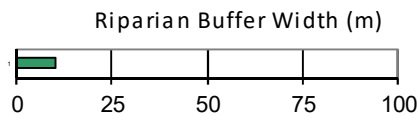


Riparian Zone Characteristics

Canopy Cover (%)	91
Riparian Buffer Width (m)	10
Rip Zone Tree Cover (%)	55
Rip Non-Native Cover (%)	45

Chemical Characteristics

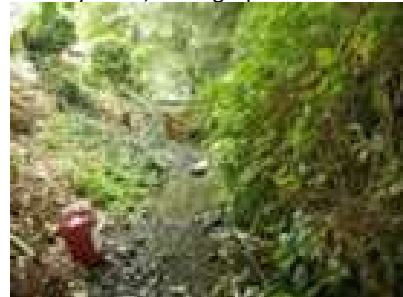
Water Temperature (°C)	14.94
Specific Cond (µS/cm)	112
Dissolved Oxygen (mg/L)	9.63
pH	7.32
Time of Measurement	1045



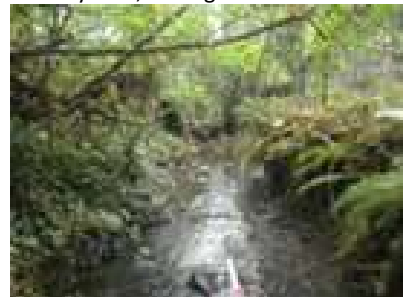
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

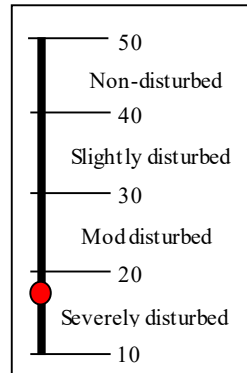
CE Sample ID: 18-122-09

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	25	3
Mavflv	3	1
Stonefly	0	1
Caddisfly	3	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.4	1
% Tolerant Taxa	60.6	1
% Sed Tol Taxa	5.1	5
% Dominant (1)	26.3	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.437	Most
2018	0.486	Most

Stressor Scores

Temperature Stress:	22.1
Fine Sediment Stress:	30.2

Reach Assessment Summary



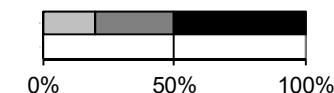
Stream Name: **Tryon Creek**
 Location: at Hwy 43
 County, State: Clackamas, Oregon
 Date sampled: 9/17/2018
 Personnel: M. Cole & C. Burtch

Latitude: 45.42427
 Longitude: -122.66125
 Reach Length: 86 m

Physical and Chemical Conditions Summary

Instream Physical Characteristics

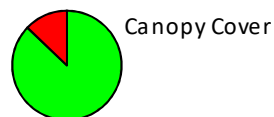
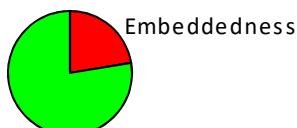
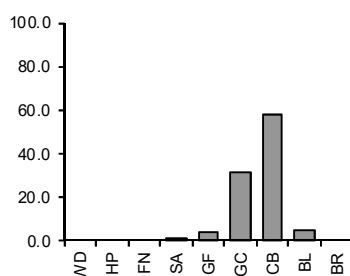
Wetted Width (m)	5.0
Bankfull Width (m)	8.7
% Rapids/Casc.	0.0
% Riffles	19.8
% Glides/Runs	30.2
% Pools	50.0



□ % Rapids/Casc. □ % Riffles
 ■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.9
% Fine Gravel	GF	4.5
% Crse Gravel	GC	31.3
% Cobble	CB	58.0
% Boulder	BL	5.4
% Bedrock	BR	0.0
% Embeddedness		22.4
LWD (pieces/100 m)		14
Eroding Banks (%)		35
Undercut Banks (%)		0

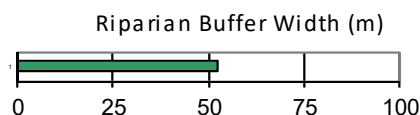


Riparian Zone Characteristics

Canopy Cover (%)	87
Riparian Buffer Width (m)	53
Rip Zone Tree Cover (%)	76
Rip Non-Native Cover (%)	50

Chemical Characteristics

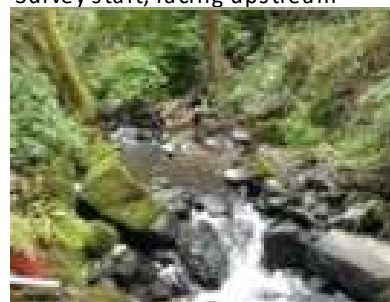
Water Temperature (°C)	12.41
Specific Cond (µS/cm)	201
Dissolved Oxygen (mg/L)	10.56
pH	7.45
Time of Measurement	1005



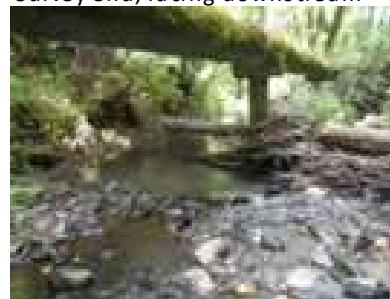
Site Location



Survey start, facing upstream



Survey end, facing downstream

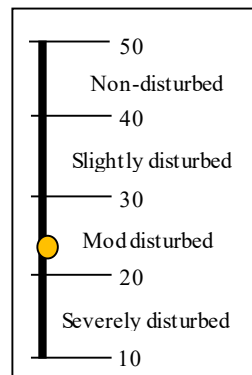


Biological Conditions Summary

CE Sample ID: 18-122-11
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	20	3
Mavflv	3	1
Stoneflv	1	1
Caddisflv	4	3
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	4.8	3
% Tolerant Taxa	85.7	1
% Sed Tol Taxa	3.2	5
% Dominant (1)	34.1	3
TOTAL MMI SCORE		22



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.485	Most
2018	0.388	Most

Stressor Scores

Temperature Stress:	23.0
Fine Sediment Stress:	18.6

Reach Assessment Summary

Stream Name: **Boeckman Creek REST**

Location: Restoration reach at Rose Lane (LOWER)

County, State: Clackamas, Oregon

Date sampled: 9/15/2018

Personnel: M. Cole & C. Burtch

Latitude:

45.29917142

Longitude:

-122.754864

Reach Length:

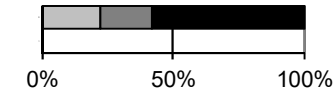
102 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

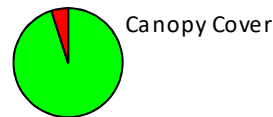
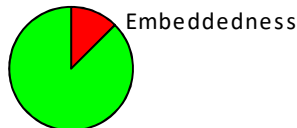
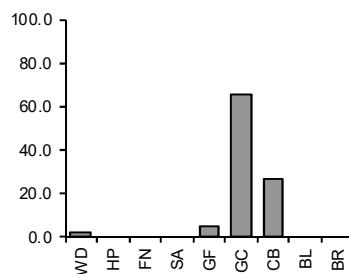
Wetted Width (m)	2.3
Bankfull Width (m)	4.0
% Rapids/Casc.	0.0
% Riffles	22.5
% Glides/Runs	19.6
% Pools	57.8



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	1.8
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	5.5
% Crse Gravel	GC	65.5
% Cobble	CB	27.3
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		12.5
LWD (pieces/100 m)		20
Eroding Banks (%)		88
Undercut Banks (%)		11

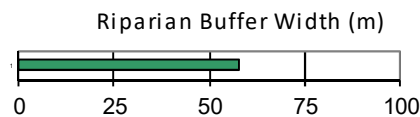


Riparian Zone Characteristics

Canopy Cover (%)	95
Riparian Buffer Width (m)	58
Rip Zone Tree Cover (%)	68
Rip Non-Native Cover (%)	34

Chemical Characteristics

Water Temperature (°C)	12.77
Specific Cond (µS/cm)	207
Dissolved Oxygen (mg/L)	9.03
pH	7.11
Time of Measurement	845



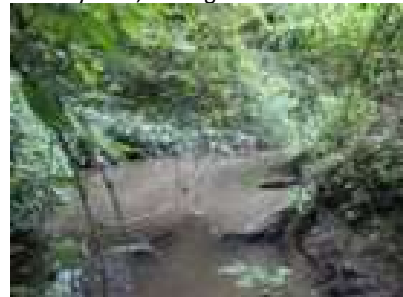
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

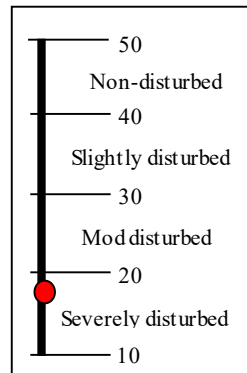
CE Sample ID: 18-122-13

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	21	3
Mavflv	2	1
Stoneflv	1	1
Caddisflv	2	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.4	1
% Tolerant Taxa	45.8	1
% Sed Tol Taxa	5.1	5
% Dominant (1)	24.8	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.388	Most
2018	0.437	Most

Stressor Scores

Temperature Stress:	22.1
Fine Sediment Stress:	25.3

Reach Assessment Summary

Stream Name: **Boeckman Creek MID**

Location: at Kolbe/Schroder Lane Bridge (MID)

County, State: Clackamas, Oregon

Date sampled: 9/15/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.301207

Longitude: -122.756831

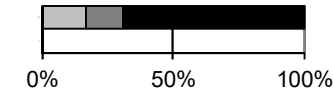
Reach Length: 101 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

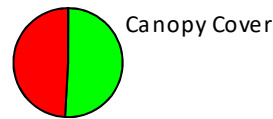
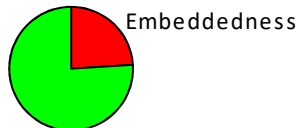
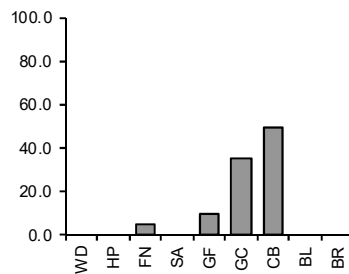
Wetted Width (m)	1.5
Bankfull Width (m)	2.3
% Rapids/Casc.	0.0
% Riffles	7.9
% Glides/Runs	0.0
% Pools	92.1



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	5.0
% Sand	SA	0.0
% Fine Gravel	GF	10.0
% Crse Gravel	GC	35.0
% Cobble	CB	50.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		24.0
LWD (pieces/100 m)		3
Eroding Banks (%)		100
Undercut Banks (%)		42

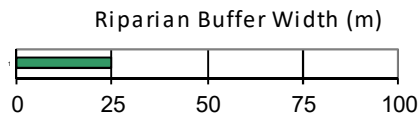


Riparian Zone Characteristics

Canopy Cover (%)	51
Riparian Buffer Width (m)	25
Rip Zone Tree Cover (%)	28
Rip Non-Native Cover (%)	58

Chemical Characteristics

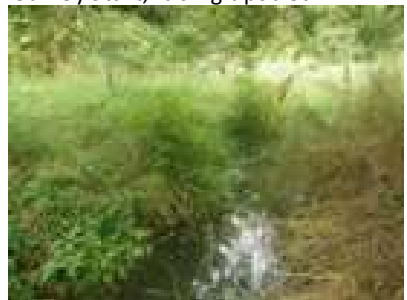
Water Temperature (°C)	13.29
Specific Cond (µS/cm)	197
Dissolved Oxygen (mg/L)	7.46
pH	6.91
Time of Measurement	1130



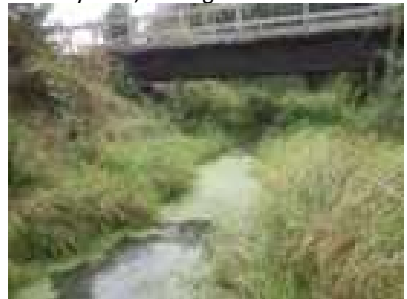
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

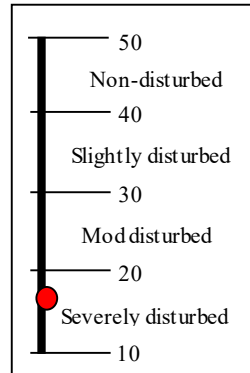
CE Sample ID: 18-122-14

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	24	3
Mavflv	3	1
Stoneflv	1	1
Caddisflv	2	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.4	1
% Tolerant Taxa	65.3	1
% Sed Tol Taxa	12.9	3
% Dominant (1)	32.3	3
TOTAL MMI SCORE		16



PREDATOR O/E Score

Year	Score	Disturbance Level
2018	0.583	Most

Stressor Scores

Temperature Stress:	23.4
Fine Sediment Stress:	42.4

Reach Assessment Summary

Stream Name: **Boeckman Creek UPPER**

Location: at Boeckman Trail footbridge UPPER

County, State: Clackamas, Oregon

Date sampled: 9/15/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.309137

Longitude: -122.753047

Reach Length: 81 m

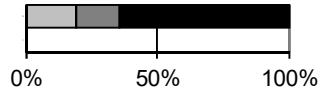


Physical and Chemical Conditions Summary

Site Location

Instream Physical Characteristics

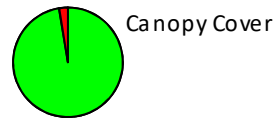
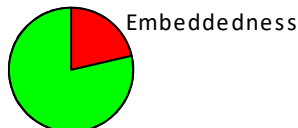
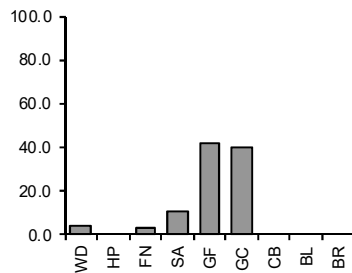
Wetted Width (m)	1.7
Bankfull Width (m)	4.4
% Rapids/Casc.	0.0
% Riffles	14.8
% Glides/Runs	9.9
% Pools	75.3



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	4.0
% Hardpan	HP	0.0
% Fines	FN	3.0
% Sand	SA	11.0
% Fine Gravel	GF	42.0
% Crse Gravel	GC	40.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		21.4
LWD (pieces/100 m)		14
Eroding Banks (%)		100
Undercut Banks (%)		11

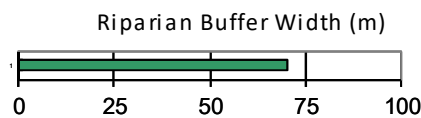


Riparian Zone Characteristics

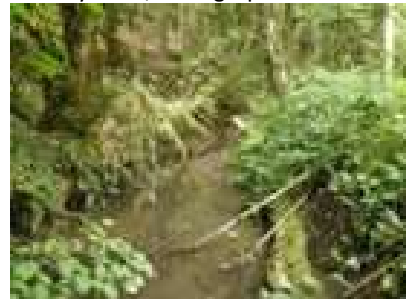
Canopy Cover (%)	97
Riparian Buffer Width (m)	70
Rip Zone Tree Cover (%)	63
Rip Non-Native Cover (%)	30

Chemical Characteristics

Water Temperature (°C)	13.11
Specific Cond (µS/cm)	179
Dissolved Oxygen (mg/L)	8.87
pH	7.18
Time of Measurement	1230



Survey start, facing upstream



Survey end, facing downstream

Biological Conditions Summary

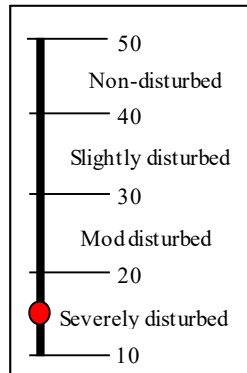
CE Sample ID: 18-122-15

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	25	3
Mayfly	1	1
Stonefly	1	1
Caddisfly	2	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.6	1
% Tolerant Taxa	65.4	1
% Sed Tol Taxa	46.1	1
% Dominant (1)	34.8	3
TOTAL MMI SCORE		14



PREDATOR O/E Score

Year	Score	Disturbance Level
2018	0.583	Most

Stressor Scores

Temperature Stress:	18.8
Fine Sediment Stress:	29.3

Reach Assessment Summary



Stream Name: **Coffee Creek**
 Location: at 5th Ave
 County, State: Clackamas, Oregon
 Date sampled: 9/14/2018
 Personnel: M. Cole & C. Burtch

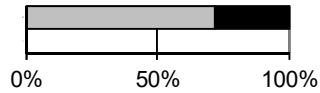
Latitude: 45.34613529
 Longitude: -122.618168
 Reach Length: 36 m

Physical and Chemical Conditions Summary

Site Location

Instream Physical Characteristics

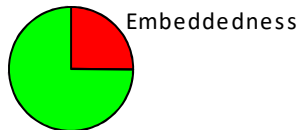
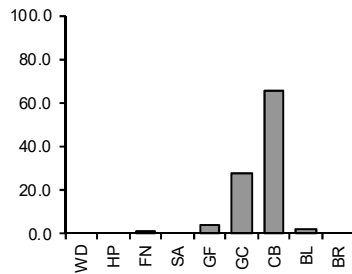
Wetted Width (m)	1.2
Bankfull Width (m)	2.4
% Rapids/Casc.	0.0
% Riffles	72.2
% Glides/Runs	0.0
% Pools	27.8



□ % Rapids/Casc. □ % Riffles
 ■ % Glides/Runs ■ % Pools

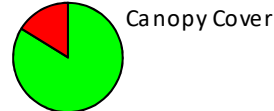
Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.9
% Sand	SA	0.0
% Fine Gravel	GF	3.7
% Crse Gravel	GC	28.0
% Cobble	CB	65.4
% Boulder	BL	1.9
% Bedrock	BR	0.0
% Embeddedness		25.1
LWD (pieces/100 m)		0
Eroding Banks (%)		55
Undercut Banks (%)		0



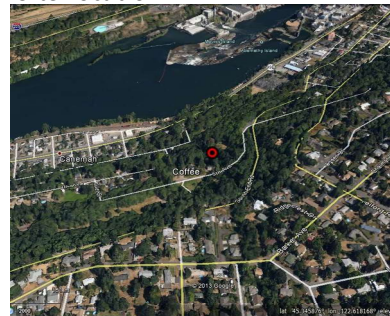
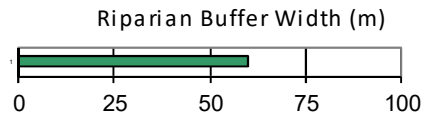
Riparian Zone Characteristics

Canopy Cover (%)	84
Riparian Buffer Width (m)	60
Rip Zone Tree Cover (%)	48
Rip Non-Native Cover (%)	60



Chemical Characteristics

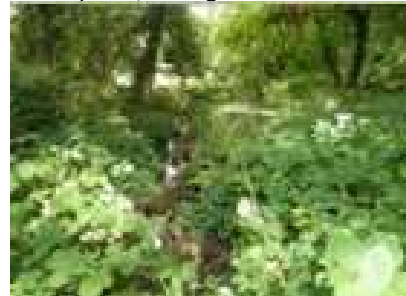
Water Temperature (°C)	13.97
Specific Cond (µS/cm)	76
Dissolved Oxygen (mg/L)	9.95
pH	6.8
Time of Measurement	1115



Survey start, facing upstream



Survey end, facing downstream

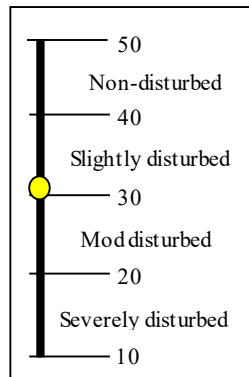


Biological Conditions Summary

CE Sample ID: 18-122-16
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	25	3
Mayfly	4	3
Stonefly	3	3
Caddisfly	2	1
# Sensitive Taxa	2	3
# Sed Sens Taxa	1	3
Modified HBI	4.5	3
% Tolerant Taxa	21.9	3
% Sed Tol Taxa	4.8	5
% Dominant (1)	27.9	3
TOTAL MMI SCORE		30



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.63	Most
2018	0.485	Most

Stressor Scores

Temperature Stress:	16.7
Fine Sediment Stress:	28.8

Reach Assessment Summary



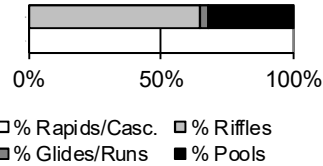
Stream Name: **Singer Creek**
 Location: at Singer Creek Park
 County, State: Clackamas, Oregon
 Date sampled: 9/14/2018
 Personnel: M. Cole & C. Burtch

Latitude: 45.34771701
 Longitude: -122.601959
 Reach Length: 63 m

Physical and Chemical Conditions Summary

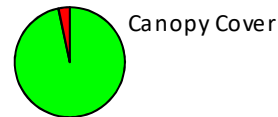
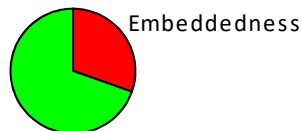
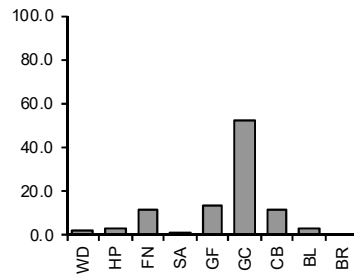
Instream Physical Characteristics

Wetted Width (m)	1.4
Bankfull Width (m)	2.9
% Rapids/Casc.	0.0
% Riffles	65.1
% Glides/Runs	3.2
% Pools	31.7



Substrate

% Wood	WD	1.9
% Hardpan	HP	3.7
% Fines	FN	12.0
% Sand	SA	0.9
% Fine Gravel	GF	13.9
% Crse Gravel	GC	52.8
% Cobble	CB	12.0
% Bulder	BL	2.8
% Bedrock	BR	0.0
% Embeddedness		30.4
Large Wood Rating		4.7619
Eroding Banks (%)		70.1587
Undercut Banks (%)		1.42857

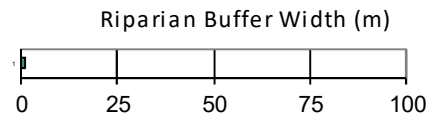


Riparian Zone Characteristics

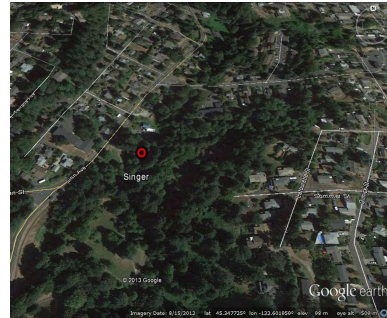
Canopy Cover (%)	97
Riparian Buffer Width (m)	60
Rip Zone Tree Cover (%)	45
Rip Non-Native Cover (%)	45

Chemical Characteristics

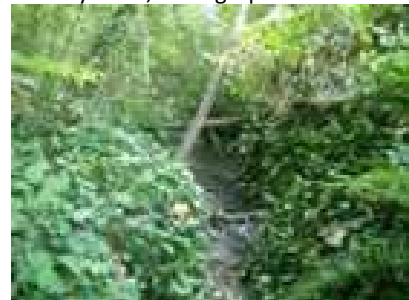
Water Temperature (°C)	12.04
Specific Cond (µS/cm)	90
Dissolved Oxygen (mg/L)	9.82
pH	7.25
Time of Measurement	800



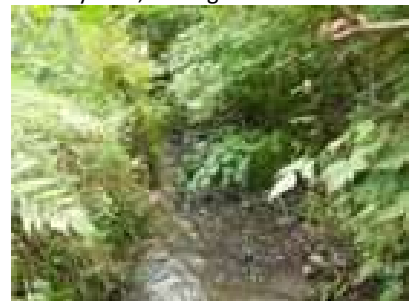
Site Location



Survey start, facing upstream



Survey end, facing downstream

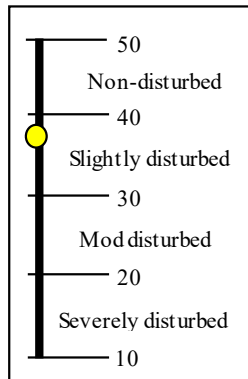


Biological Conditions Summary

CE Sample ID: 18-122-17
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	35	3
Mayfly	5	3
Stonefly	6	5
Caddisfly	6	3
# Sensitive Taxa	4	3
# Sed Sens Taxa	2	5
Modified HBI	3.3	5
% Tolerant Taxa	19.8	3
% Sed Tol Taxa	3.1	5
% Dominant (1)	30.2	3
TOTAL MMI SCORE		38



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.582	Most
2018	0.776	Most

Stressor Scores

Temperature Stress:	16.5
Fine Sediment Stress:	17.6

Reach Assessment Summary



Stream Name: **Rinearson Creek**

Location: River Road (Brookside Village Apartments)

Latitude: 45.380363

County, State: Clackamas, Oregon

Longitude: -122.607596

Date sampled: 9/14/2018

Reach Length: 65 m

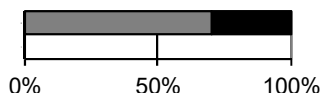
Personnel: M. Cole & C. Burtch

Physical and Chemical Conditions Summary

Site Location

Instream Physical Characteristics

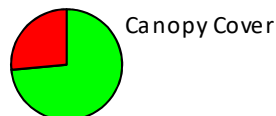
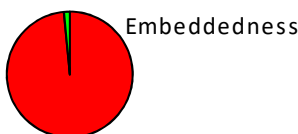
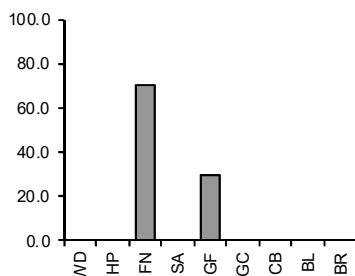
Wetted Width (m)	1.3
Bankfull Width (m)	1.9
% Rapids/Casc.	0.0
% Riffles	0.0
% Glides/Runs	70.8
% Pools	29.2



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	70.0
% Sand	SA	0.0
% Fine Gravel	GF	30.0
% Crse Gravel	GC	0.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		98.5
Large Wood Rating		0
Eroding Banks (%)		100
Undercut Banks (%)		0

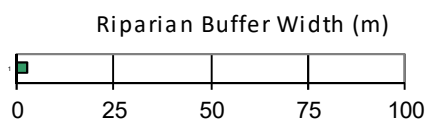


Riparian Zone Characteristics

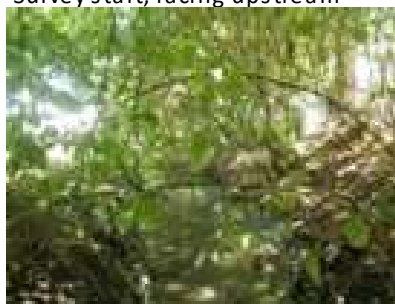
Canopy Cover (%)	74
Riparian Buffer Width (m)	3
Rip Zone Tree Cover (%)	25
Rip Non-Native Cover (%)	0

Chemical Characteristics

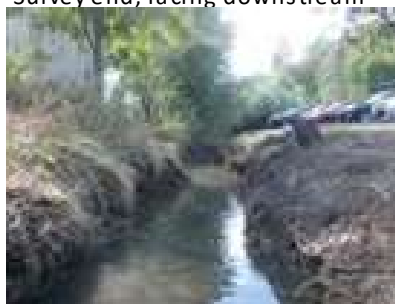
Water Temperature (°C)	16.56
Specific Cond (µS/cm)	181
Dissolved Oxygen (mg/L)	7.17
pH	6.3
Time of Measurement	1305



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

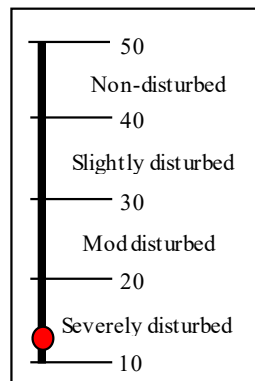
CE Sample ID: 18-122-18

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	16	1
Mavfly	0	1
Stonefly	0	1
Caddisfly	2	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	1	3
Modified HBI	6.3	1
% Tolerant Taxa	92.3	1
% Sed Tol Taxa	60.9	1
% Dominant (1)	60.0	1
TOTAL MMI SCORE		12



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.242	NA
2018	0.291	Most

Stressor Scores

Temperature Stress:	20.5
Fine Sediment Stress:	NA

Reach Assessment Summary

Stream Name: **Minthorn Creek**

Location: Box Culvert at SE Harmony/Lynwood Roads

Latitude: 45.43181479

County, State: Clackamas, Oregon

Longitude: -122.598378

Date sampled: 9/14/2018

Reach Length: 39 m

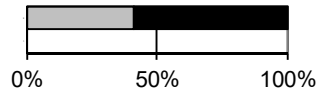
Personnel: M. Cole & C. Burtch



Physical and Chemical Conditions Summary

Instream Physical Characteristics

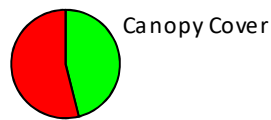
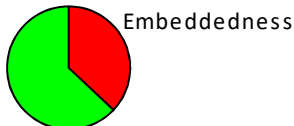
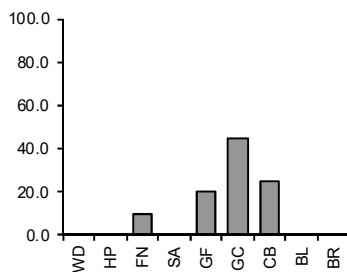
Wetted Width (m)	0.5
Bankfull Width (m)	2.0
% Rapids/Casc.	0.0
% Riffles	41.0
% Glides/Runs	0.0
% Pools	59.0



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	10.0
% Sand	SA	0.0
% Fine Gravel	GF	20.0
% Crse Gravel	GC	45.0
% Cobble	CB	25.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		37.0
LWD (pieces/100 m)		0
Eroding Banks (%)		54.6154
Undercut Banks (%)		0

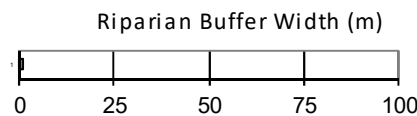


Riparian Zone Characteristics

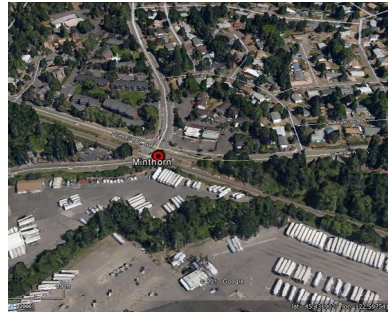
Canopy Cover (%)	46.0784
Riparian Buffer Width (m)	1
Rip Zone Tree Cover (%)	5
Rip Non-Native Cover (%)	45

Chemical Characteristics

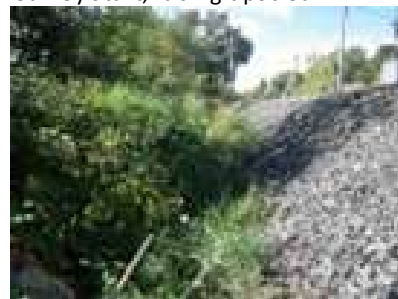
Water Temperature (°C)	17.52
Specific Cond (µS/cm)	224
Dissolved Oxygen (mg/L)	6.35
pH	7.15
Time of Measurement	1400



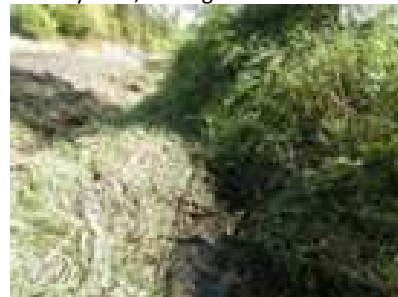
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

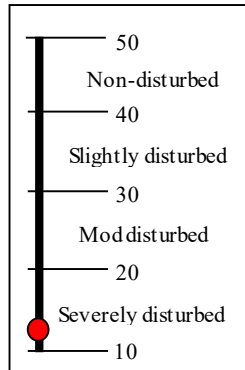
CE Sample ID: 18-122-19

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	17	1
Mayfly	1	1
Stonefly	0	1
Caddisfly	0	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.1	1
% Tolerant Taxa	81.2	1
% Sed Tol Taxa	39.3	1
% Dominant (1)	30.0	3
TOTAL MMI SCORE		12



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.388	Most
2018	0.2	Most

Stressor Scores

Temperature Stress:	19.7
Fine Sediment Stress:	62.6

Reach Assessment Summary

Stream Name: **Tanner Creek**

Location: Downstream of Imperial Drive

County, State: Clackamas, Oregon

Date sampled: 9/14/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.3516544

Longitude: -122.630998

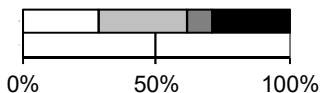
Reach Length: 50 m



Physical and Chemical Conditions Summary

Instream Physical Characteristics

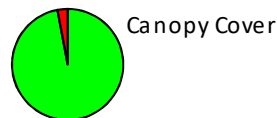
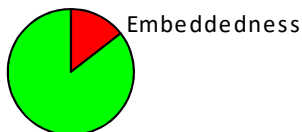
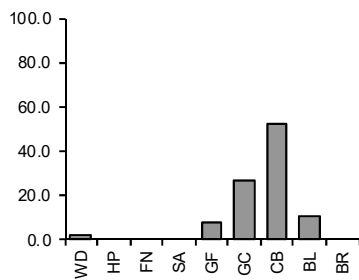
Wetted Width (m)	1.6
Bankfull Width (m)	3.1
% Rapids/Casc.	32.0
% Riffles	36.0
% Glides/Runs	10.0
% Pools	32.0



□ % Rapids/Casc. □ % Riffles
■ % Glides/Runs ■ % Pools

Substrate

% Wood	WD	2.1
% Hardpan	HP	0.0
% Fines	FN	0.0
% Sand	SA	0.0
% Fine Gravel	GF	8.3
% Crse Gravel	GC	27.1
% Cobble	CB	52.1
% Boulder	BL	10.4
% Bedrock	BR	0.0
% Embeddedness		14.5
Large Wood Rating		8
Eroding Banks (%)		6.8
Undercut Banks (%)		5.8

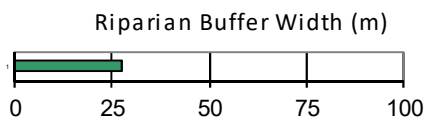


Riparian Zone Characteristics

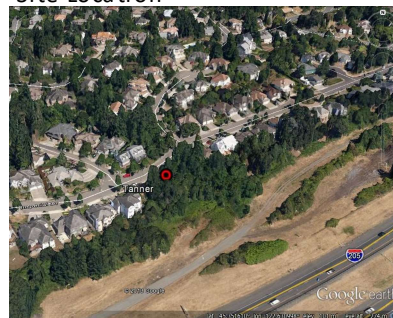
Canopy Cover (%)	97
Riparian Buffer Width (m)	28
Rip Zone Tree Cover (%)	63
Rip Non-Native Cover (%)	30

Chemical Characteristics

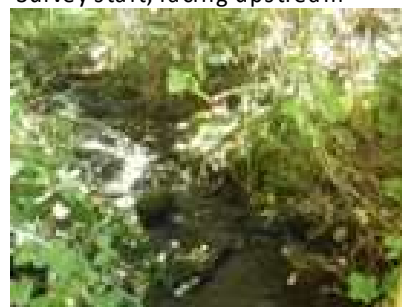
Water Temperature (°C)	13.54
Specific Cond (µS/cm)	124
Dissolved Oxygen (mg/L)	9.92
pH	7.09
Time of Measurement	1000



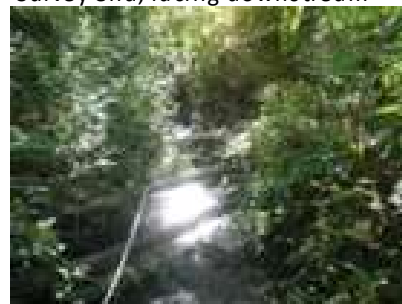
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

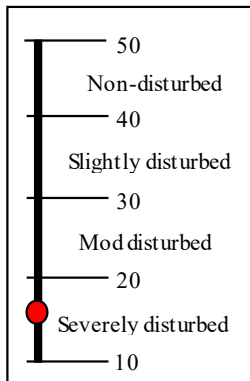
CE Sample ID: 18-122-20

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	14	1
Mayfly	1	1
Stonefly	0	1
Caddisfly	0	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.0	1
% Tolerant Taxa	30.5	3
% Sed Tol Taxa	14.8	3
% Dominant (1)	25.9	3
TOTAL MMI SCORE		16



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.242	Most
2018	0.388	Most

Stressor Scores

Temperature Stress:	16.8
Fine Sediment Stress:	22.3

Reach Assessment Summary

Stream Name: **Trillium Creek**
 Location: Caloroga Rd
 County, State: Clackamas, Oregon
 Date sampled: 9/17/2018
 Personnel: M. Cole & C. Burtch

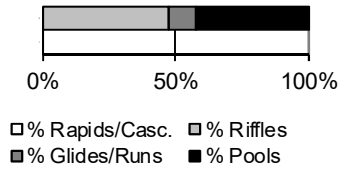
Latitude: 45.39573241
 Longitude: -122.637776
 Reach Length: 74 m



Instream Physical Characteristics

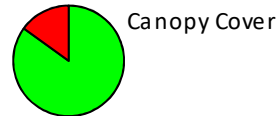
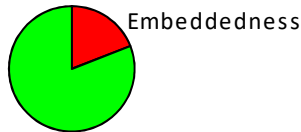
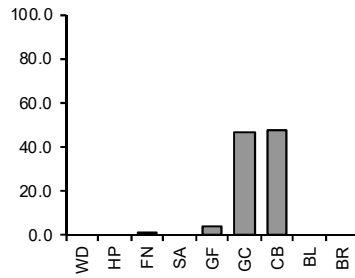
Wetted Width (m)	2.0
Bankfull Width (m)	4.3
% Rapids/Casc.	0.0
% Riffles	47.3
% Glides/Runs	10.8
% Pools	41.9

Physical and Chemical Conditions Summary



Substrate

% Wood	WD	0.0
% Hardpan	HP	0.0
% Fines	FN	0.9
% Sand	SA	0.0
% Fine Gravel	GF	4.6
% Crse Gravel	GC	46.8
% Cobble	CB	47.7
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		19.1
LWD (pieces/100 m)		7
Eroding Banks (%)		45
Undercut Banks (%)		0

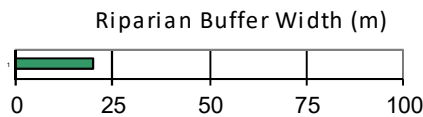


Riparian Zone Characteristics

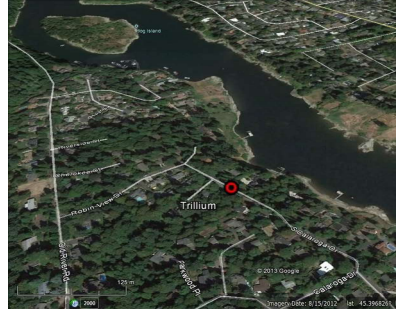
Canopy Cover (%)	85
Riparian Buffer Width (m)	20
Rip Zone Tree Cover (%)	73
Rip Non-Native Cover (%)	23

Chemical Characteristics

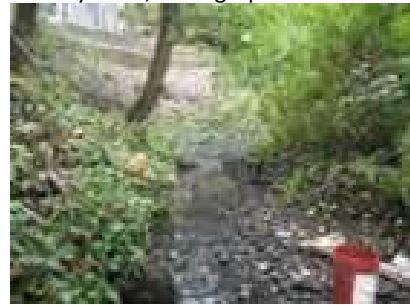
Water Temperature (°C)	12.81
Specific Cond (µS/cm)	113
Dissolved Oxygen (mg/L)	10.17
pH	6.96
Time of Measurement	800



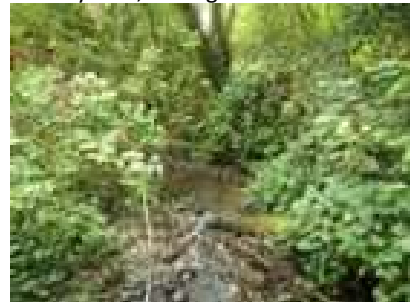
Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

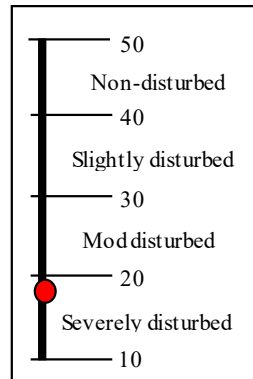
CE Sample ID: 18-122-21

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	22	3
Mayfly	3	1
Stonefly	0	1
Caddisfly	3	1
# Sensitive Taxa	1	1
# Sed Sens Taxa	0	1
Modified HBI	5.3	1
% Tolerant Taxa	60.8	1
% Sed Tol Taxa	9.1	5
% Dominant (1)	21.2	3
TOTAL MMI SCORE		18



PREDATOR O/E Score

Year	Score	Disturbance Level
2013	0.485	Most
2018	0.485	Most

Stressor Scores

Temperature Stress:	22.1
Fine Sediment Stress:	30.3

Reach Assessment Summary

Stream Name: **River Forest Creek**
 Location: at Risley Park
 County, State: Clackamas, Oregon
 Date sampled: 9/17/2018
 Personnel: M. Cole & C. Burtch

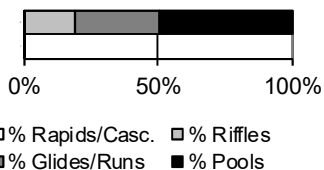
Latitude: 45.40751
 Longitude: -122.64002
 Reach Length: 75 m



Physical and Chemical Conditions Summary

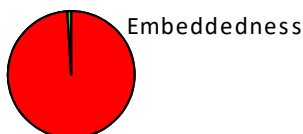
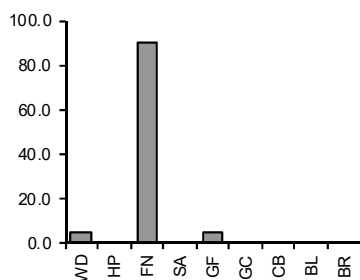
Instream Physical Characteristics

Wetted Width (m)	1.3
Bankfull Width (m)	2.2
% Rapids/Casc.	0.0
% Riffles	2.7
% Glides/Runs	37.3
% Pools	60.0



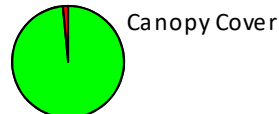
Substrate

% Wood	WD	5.0
% Hardpan	HP	0.0
% Fines	FN	90.0
% Sand	SA	0.0
% Fine Gravel	GF	5.0
% Crse Gravel	GC	0.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		99.0
LWD (pieces/100 m)		0
Eroding Banks (%)		100
Undercut Banks (%)		0



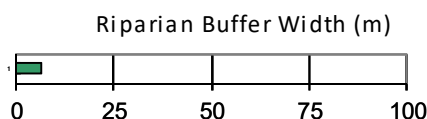
Riparian Zone Characteristics

Canopy Cover (%)	99
Riparian Buffer Width (m)	7
Rip Zone Tree Cover (%)	85
Rip Non-Native Cover (%)	8



Chemical Characteristics

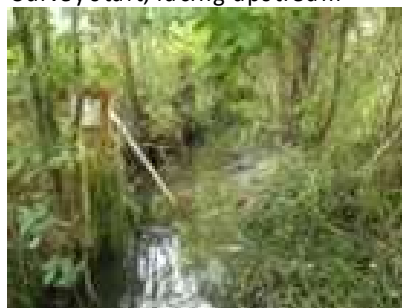
Water Temperature (°C)	14.98
Specific Cond (µS/cm)	162
Dissolved Oxygen (mg/L)	2.19
pH	6.67
Time of Measurement	1300



Site Location



Survey start, facing upstream



Survey end, facing downstream

Biological Conditions Summary

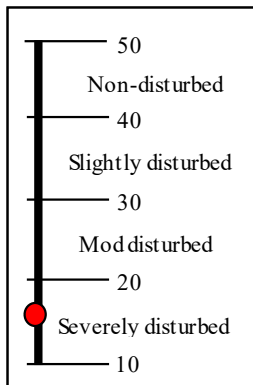
CE Sample ID: 13-121-12

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	12	1
Mayfly	0	1
Stonefly	0	1
Caddisfly	0	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	7.4	1
% Tolerant Taxa	19.7	3
% Sed Tol Taxa	3.5	5
% Dominant (1)	64.2	1
TOTAL MMI SCORE		16



PREDATOR O/E Score

Year	Score	Disturbance Level
2018	0.194	NA

Stressor Scores

Temperature Stress:	20.7
Fine Sediment Stress:	NA

Reach Assessment Summary

Stream Name: **Boardman Creek REST**

Location: restoration reach in Stringfield Park

County, State: Clackamas, Oregon

Date sampled: 9/17/2018

Personnel: M. Cole & C. Burtch

Latitude: 45.39876

Longitude: -122.62534

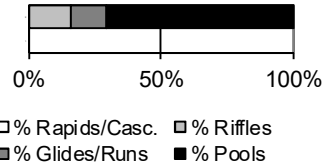
Reach Length: 75 m



Physical and Chemical Conditions Summary

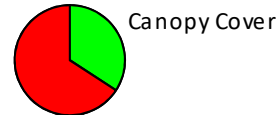
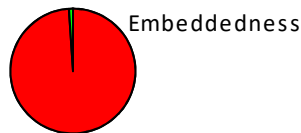
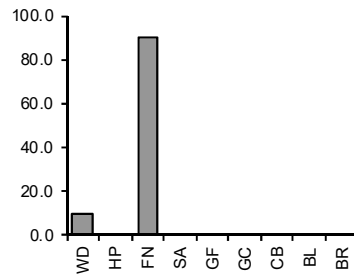
Instream Physical Characteristics

Wetted Width (m)	4.9
Bankfull Width (m)	9.1
% Rapids/Casc.	0.0
% Riffles	0.0
% Glides/Runs	0.0
% Pools	100.0



Substrate

% Wood	WD	10.0
% Hardpan	HP	0.0
% Fines	FN	90.0
% Sand	SA	0.0
% Fine Gravel	GF	0.0
% Crse Gravel	GC	0.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		99.0
LWD (pieces/100 m)		9
Eroding Banks (%)		50
Undercut Banks (%)		0

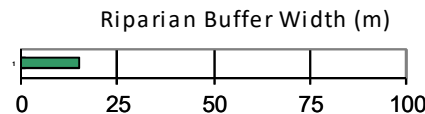


Riparian Zone Characteristics

Canopy Cover (%)	34
Riparian Buffer Width (m)	15
Rip Zone Tree Cover (%)	20
Rip Non-Native Cover (%)	3

Chemical Characteristics

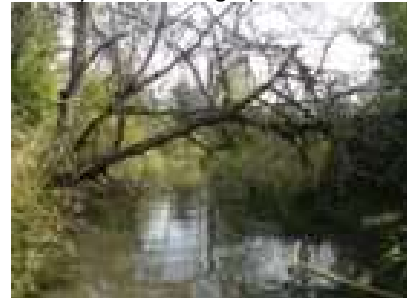
Water Temperature (°C)	16.87
Specific Cond (µS/cm)	186
Dissolved Oxygen (mg/L)	2.99
pH	6.63
Time of Measurement	1410



Site Location



Survey start, facing upstream



Survey end, facing downstream



Biological Conditions Summary

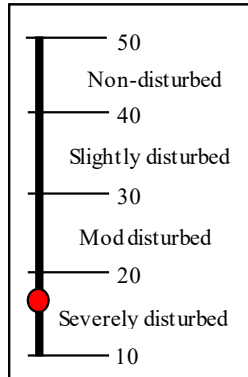
CE Sample ID: 18-122-23

Sample Method: OR 8-kick

Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	19	3
Mayfly	1	1
Stonefly	0	1
Caddisfly	0	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.6	1
% Tolerant Taxa	45.5	1
% Sed Tol Taxa	23.2	3
% Dominant (1)	34.3	3
TOTAL MMI SCORE		16



PREDATOR O/E Score

Year	Score	Disturbance Level
2018	0.194	NA

Stressor Scores

Temperature Stress:	24.6
Fine Sediment Stress:	NA

Reach Assessment Summary

Stream Name: **Boardman Creek UPPER**
 Location: at Boardman Ave (UPPER)
 County, State: Clackamas, Oregon
 Date sampled: 9/17/2018
 Personnel: M. Cole & C. Burtch

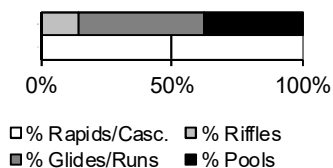
Latitude: 45.394506
 Longitude: -122.61751
 Reach Length: 60 m



Physical and Chemical Conditions Summary

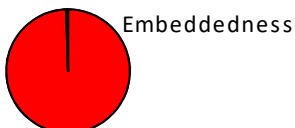
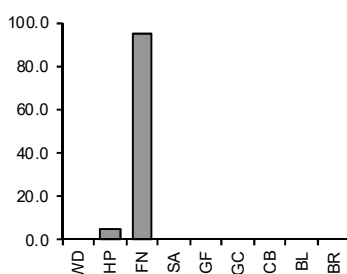
Instream Physical Characteristics

Wetted Width (m)	1.2
Bankfull Width (m)	3.1
% Rapids/Casc.	0.0
% Riffles	0.0
% Glides/Runs	75.0
% Pools	25.0



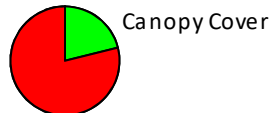
Substrate

% Wood	WD	0.0
% Hardpan	HP	5.0
% Fines	FN	95.0
% Sand	SA	0.0
% Fine Gravel	GF	0.0
% Crse Gravel	GC	0.0
% Cobble	CB	0.0
% Boulder	BL	0.0
% Bedrock	BR	0.0
% Embeddedness		99.5
LWD (pieces/100 m)		0
Eroding Banks (%)		0
Undercut Banks (%)		0



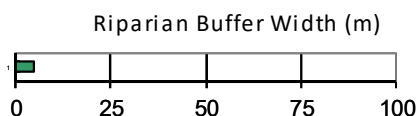
Riparian Zone Characteristics

Canopy Cover (%)	21
Riparian Buffer Width (m)	5
Rip Zone Tree Cover (%)	8
Rip Non-Native Cover (%)	25



Chemical Characteristics

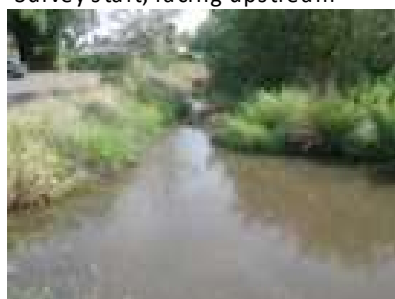
Water Temperature (°C)	18.9
Specific Cond (µS/cm)	230
Dissolved Oxygen (mg/L)	0.52
pH	6.63
Time of Measurement	1510



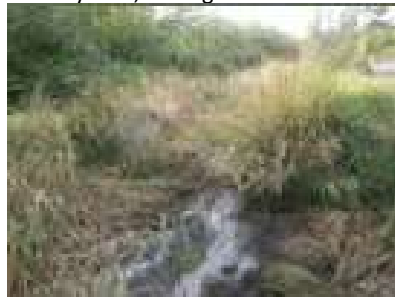
Site Location



Survey start, facing upstream



Survey end, facing downstream

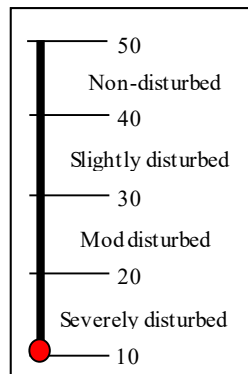


Biological Conditions Summary

CE Sample ID: 18-122-24
 Sample Method: OR 8-kick
 Target Habitat: Riffle

DEQ METRIC SCORES

	Raw	Stand.
Richness	9	1
Mayfly	0	1
Stonefly	0	1
Caddisfly	0	1
# Sensitive Taxa	0	1
# Sed Sens Taxa	0	1
Modified HBI	6.4	1
% Tolerant Taxa	161.5	1
% Sed Tol Taxa	67.7	1
% Dominant (1)	58.3	1
TOTAL MMI SCORE		10



PREDATOR O/E Score

Year	Score	Disturbance Level
2018	0.194	NA

Stressor Scores

Temperature Stress:	22.8
Fine Sediment Stress:	NA