MACROINVERTEBRATE COMMUNITY CONDITIONS of the LOWER CLACKAMAS RIVER BASIN 1997-2016

FINAL REPORT

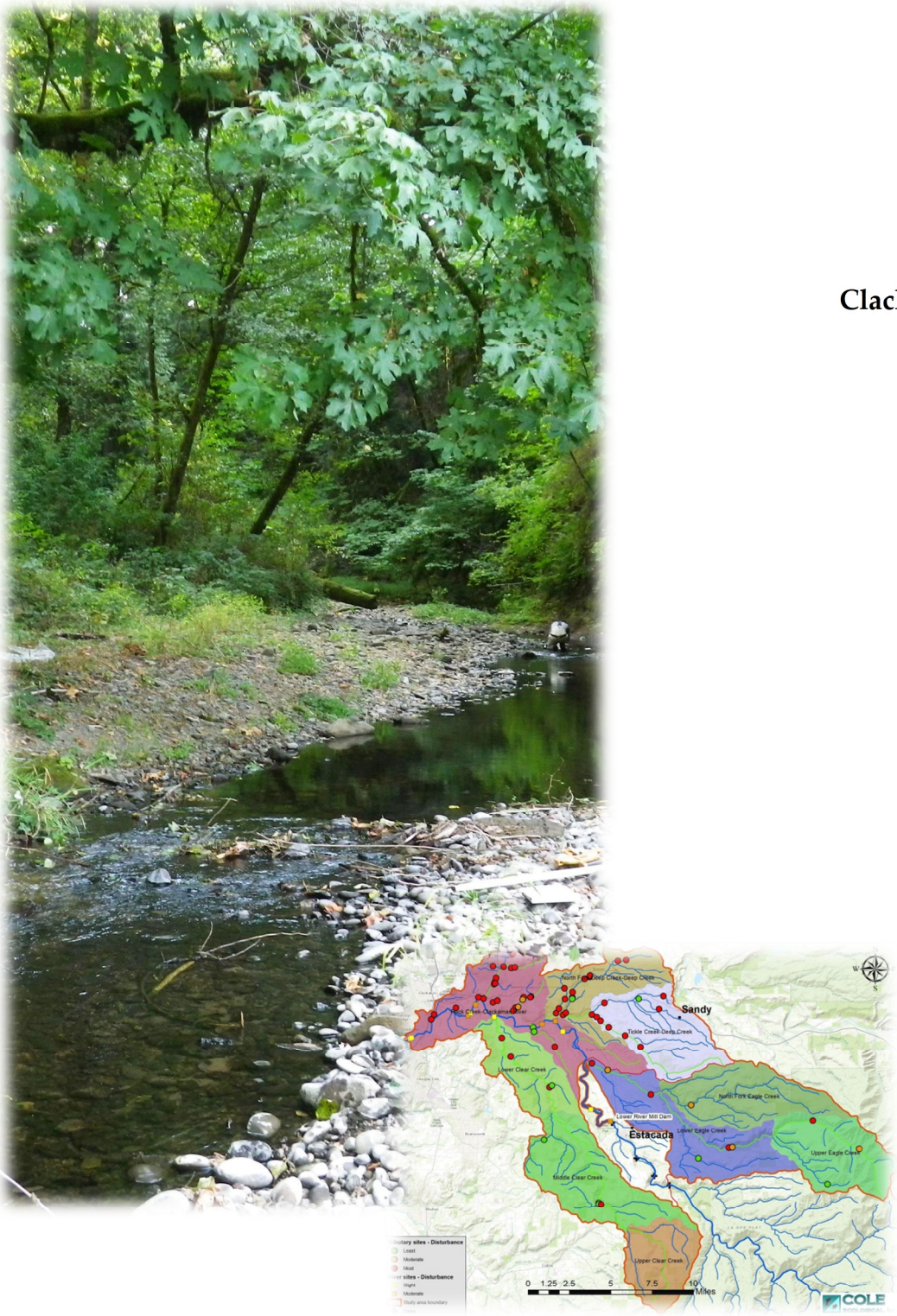

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Clackamas River is an important regional resource to the communities of northwest Oregon. The river is used for recreation, power generation, water supply, and as a receiving water for municipal discharges. The river and its tributaries are also a significant source of aquatic biological diversity in the region, supporting many species of native fish and macroinvertebrates as vital components of a healthy ecosystem. Managing the river for these multiple uses and functions requires understanding the effects of human activity on river conditions and ensuring that the river remains a viable resource for these many uses.

Clackamas River Water Providers (CRWP) is committed to understanding resource conditions of the river and its major tributaries, including ecological conditions. In 2013, CRWP contracted a review of past macroinvertebrate assessment efforts in the lower Clackamas River basin in order to inform the development of a long-term ecological monitoring plan for the lower basin (Cole 2013). This plan identified all known past macroinvertebrate assessments in the lower basin as part of the monitoring planning effort. The review revealed numerous past assessments occurring between the late 1990s and the 2013. The results of these efforts, while of significant interest and potential benefit to understanding longer-term trends in ecological conditions, have largely remained un-synthesized and unshared with local resource managers and stakeholders.

As recommended by the 2013 monitoring plan, CRWP recently began monitoring macroinvertebrate community conditions in the lower mainstem Clackamas River (the section of river extending from below River Mill Dam to the confluence with the Willamette River), and numerous other local resource management agencies and jurisdictions continue their own macroinvertebrate monitoring in the Clackamas River basin. As these monitoring efforts continue, the need only grows to understand and to give context to these collective results across the lower basin and over time. This effort was undertaken to gather, review, and synthesize all known macroinvertebrate monitoring data and results from the lower Clackamas River basin since the late 1990s to the present (winter 2016/2017). This report is a synthesis of the results of these of the past-to-present macroinvertebrate assessments in the lower basin, including quantification and description of macroinvertebrate community conditions and trends in those

conditions from the late 1990s to present. This single document can be made available to all resource managers and stakeholders in the lower basin to provide a greater understanding of recent past and present aquatic resource conditions and to ensure a complete accounting of all recent past and present assessments. This information will help ensure that limited resources are most effectively utilized to help fill information gaps, inform longer-term trends, and avoid duplicitous sampling, particularly if assessment efforts are performed in accordance with the monitoring plan developed for the CRWP in 2013 (Cole 2013).

STUDY AREA

The geographic area included in this review and analysis encompasses the mainstem Clackamas River from River Mill Dam downriver to the confluence with the Willamette River and all tributaries entering this lower section of the river (Figure 1). Nine 6th-field sub-watersheds are included in the study area: Lower Clackamas River and Rock Creek (HUC 170900110607, 27363 acres), Lower Clear Creek (HUC 170900110606, 12494 acres), Middle Clear Creek (HUC 170900110602, 21796 acres), Upper Clear Creek (HUC 170900110601, 12237 acres), North Fork Deep Creek-Deep Creek (HUC 170900110605, 13731 acres), Tickle Creek-Deep Creek (HUC 170900110604, 17845 acres), North Fork Eagle Creek (HUC 170900110502, 17841 acres), Upper Eagle Creek (HUC 170900110501, 17337 acres), and Lower Eagle Creek (HUC 170900110503, 22342 acres). Three Level-IV ecoregions occur within the study area, including two Willamette Valley ecoregions: Prairie Terraces and Valley Foothills, and one Cascades ecoregion: Western Cascades Lowlands and Valleys.

OVERALL APPROACH

A review was conducted of all macroinvertebrate monitoring and assessment efforts performed in the lower Clackamas River basin since the late 1990s. This review and synthesis included all studies identified in the 2013 lower Clackamas River Basin monitoring plan (Cole 2013) and all known work that has occurred in the lower basin since that time. Recent work (2013 through 2016) included assessments performed by the CRWP, Clackamas River Basin Council (CRBC), Clackamas Soil and Water Conservation District (SWCD), and Clackamas

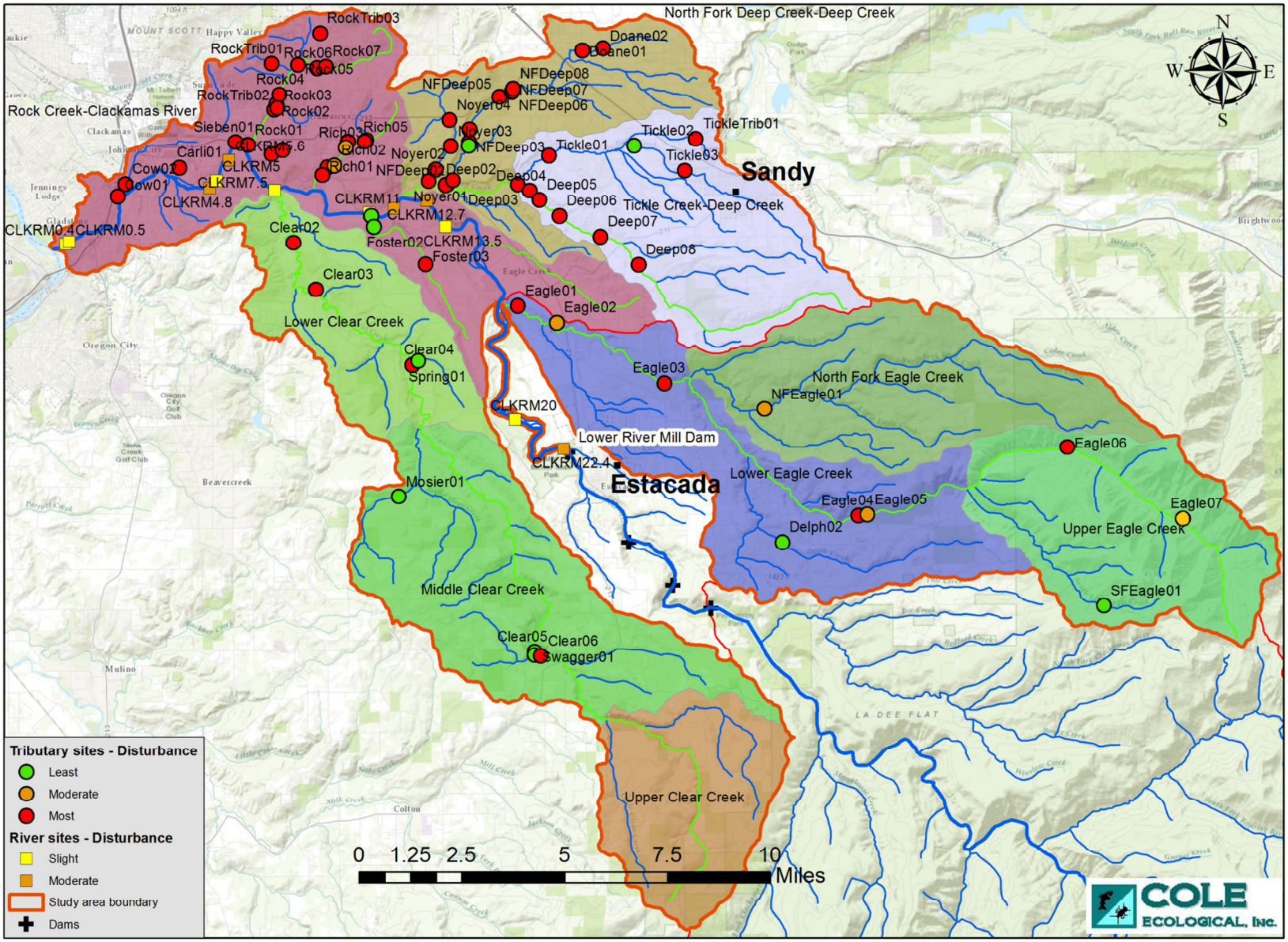


Figure 1. Macroinvertebrate sample sites and attendant disturbance classes in the lower Clackamas River Basin, 1997-20016.

Water Environment Services (WES). Please refer to the 2013 plan (Cole 2013) for a detailed review of the technical elements of most of the studies included in this analysis. Just as the 2013 plan summarized sampling efforts, this review summarized the results of those efforts. As necessary, data were re-analyzed with taxonomic data re-coded to operational taxonomic units (OTUs) appropriate to the analyses used in this study. Ecological conditions are summarized for all tributary streams using ecoregion-appropriate Oregon DEQ PREDATOR models, and the for lower mainstem Clackamas River using the western Oregon multimetric index, each further described below. To the extent that the data allowed, inferences regarding trends in conditions are made where multiple years of data exist.

REVIEW AND ANALYSIS OF EXISTING DATA

Macroinvertebrate community assessments have routinely occurred in the lower Clackamas River basin since the late 1990s. While no single entity has consistently monitored macroinvertebrate communities across the lower basin during this period, the collective efforts of numerous agencies results in many stream reaches within the lower basin having been sampled, and numerous stream reaches have been sampled in three or more years. A review was performed in 2013 (Cole 2013) to determine to what extent previous studies could inform past conditions and trends in water quality at sites identified in the 2013 plan as priority long-term monitoring locations. Since the late 1990s, macroinvertebrate assessments in the lower Clackamas River and/or its tributaries have been performed by the University of Washington (UW), Portland General Electric (PGE), Clackamas County Water Environment Services (WES), OR DEQ, Clackamas River Basin Council (CRBC), Clackamas Soil and Water Conservation District (Clackamas SWCD), United States Geological Survey (USGS), Portland State University, Portland Metro Regional Services (Metro), and Portland State University (Table 1). A request for data and other information was made to each of the above agencies and entities. Each data set received was reviewed to determine suitability for inclusion in an assessment of recent past ecological conditions in the lower Clackamas River basin. To perform the review, a set of criteria was developed for reviewing data and determining their suitability for achieving

Table 1. Summary of past macroinvertebrate monitoring efforts occurring in the lower Clackamas River basin. Total number of sites includes all sites both inside and outside of the lower Clackamas River basin. Reason not included in analyses: ND = no data, TR = insufficient taxonomic resolution in the data.

Year(s)	Season	Agency	Total # Sites	# Sites w/in lower Clackamas Basin	Included in this review	Reason Not Included
1997-1998	Fall	UW	44	17	Yes	TR*
2000-2001	Summer/Fall	PGE	44	5	**No**	ND
2002	Fall	WES	14	6	Yes	
2003	Fall	Metro	40	34	Yes	
2007	Fall	WES	14	7	Yes	
2009	Fall	WES	16	8	Yes	
2011	Fall	WES	23	8	Yes	
2014	Fall	WES	24	7	Yes	
2010	Fall	CRBC	4	4	**No**	TR
2011	Fall	CRBC	4	4	**No**	TR
2013	Fall	CRBC	5	5	Yes	
2014	Fall	CRBC	8	8	Yes	
2012	Fall	Clackamas SWCD	5	5	Yes	
2016	Fall	Clackamas SWCD	5	5	Yes	
1999	Fall	USGS	many	9	Yes	
2004	Fall	USGS	28	4	Yes	
1998-2009	Summer/Fall	DEQ	many	20	Yes	
2010-2012	Various	PSU	5	3	**No**	TR
1993-2012	Spring or Fall	SWRP/PSU	many	22	**No**	TR
2013-2015	Fall	CRWP	5	5	Yes	

*insufficient taxonomic resolution was an issue for a handful of samples, as explained in the methods section of this report

stated project objectives. Criteria were established for the following study design elements: field methods (sample device and method, habitat(s) sampled, area sampled, season), laboratory methods (sample processing and subsampling methods, taxonomic resolution) and data analyses used. Please see Cole (2013) for the details of the review criteria and resulting decisions to include/exclude data sets from this longer-term assessment effort.

Once data sets were selected for inclusion in the longer-term assessment, each set was reviewed for consistency in taxonomic nomenclature, taxonomic names misspellings, and for use of operational taxonomic units appropriate to the analyses used in this study (PREDATOR and the western Oregon multi-metric index). All sample locations were examined to determine spatial overlap of sample sites across projects. Generally, sample locations occurring within 200 m of each other were deemed to be the same reach, unless a tributary stream or road crossing occurred between the locations. Once all sample locations were mapped, a "Master Site Code" was assigned to each site based on the stream name and upstream-downstream position in the stream to provide a single site coding convention across all sample sites. In each stream, sites were assigned 1 through X, starting with "1" at the downstream-most location and working in sequence upstream.

All tributary stream data were analyzed using a PREDATOR model (Hubler et al. 2008). Several data sets were available with these analyses having already been completed, while others required execution of these analyses. 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 commonly occurring (>50% probability of occurrence) at reference reaches. The expected taxa, therefore, are taxa that are predicted to occur within a reach in the absence of disturbance. Biological condition is determined by comparing the O/E score to the distribution of reference reach O/E scores. As most waterbodies included in this study occur in the Level III Willamette Valley Ecoregion (Level IV = Prairie Terraces or Valley Foothills), the Marine Western Coastal Forest (MWCF) PREDATOR model was primarily used. A handful of sites in the lower basin occur in the Cascades Lowlands Level IV ecoregion. These sites were primarily sampled by OR DEQ and were analyzed using the Western Cordillera & Columbia Plateau (WC+CP) PREDADTOR model. Using the MWCF biological condition thresholds (Hubler 2008), sites with O/E scores ≤0.85 (≤10th percentile of reference site scores) were classified as "most disturbed", 0.86 to 0.91 (>10th to 25th percentile) as "moderately disturbed", and 0.92 to 1.24 (25th to 95th percentile) as "least disturbed."

In addition to PREDATOR model analysis, data were analyzed for this study using stressor models developed by Oregon DEQ (Huff et al. 2006). Also known as weighted-average (WA) inference models, stressor models were developed to detect the deleterious effects of fine sediment and temperature pollution on macroinvertebrate communities through detecting shifts in taxonomic composition of the macroinvertebrate community. These models use taxon-specific optima values for seasonal maximum water temperature and percent fine sediments (i.e. the temperature and % fine sediment under which a taxon's abundance is at its highest). Based on these values and the relative abundance of each taxon in the sample, the models calculate the weighted mean temperature and sediment optima (i.e., "preferred" values) of the macroinvertebrate community from each sample. These inferred optima values from each sample are compared to conditions from regional reference sites to determine if there is a difference in assemblage-level preferences for temperature or fine sediment (Huff et al. 2006). DEQ's thresholds of 75th and 90th percentiles of the distribution of DEQ Willamette Valley and Cascade ecoregion reference site scores were used to determine whether each was functioning as a potential stressor at each site (Huff et al. 2006): <75% = good (not likely a stressor), 75-90% fair (potentially a stressor), and >90% = poor (likely a stressor).

Clackamas River mainstem sample data were analyzed using only the western Oregon multi-metric index because the PREDATOR models are not calibrated for use in larger Oregon rivers. Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that has been shown to be associated with one or more types of pollution or habitat degradation. Individual community metrics are each converted standardized scores, which are then summed to produce a single multimetric score that is an index of overall biological integrity. 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. 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. The standardized scores were summed to produce a multimetric score ranging between 10 and 50. Reaches were then assigned a level of disturbance based on these total scores.

RESULTS

Macroinvertebrate data from 84 stream and river reaches (including 13 reaches in the lower Clackamas River and 1 Clackamas River side channel) were available and identified as having sufficient data resolution and quality to be included in this analysis of lower Clackamas River basin conditions between 1997 and 2016 (Table 2). Among the 71 tributary sites, 10 sites received average PREDATOR O/E scores corresponding to "least disturbed" conditions, 7 sites corresponding to "moderately disturbed" conditions, and 54 sites corresponding to "most disturbed" conditions (Table 3). Conditions in the Rock Creek-Lower Clackamas River subwatershed and the two Deep Creek subwatersheds were primarily "most disturbed", while those in the Eagle Creek and Clear Creek subwatersheds included a more even distribution of conditions across the three disturbance classes. Results are presented and discussed separately below for each subwatershed.

Table 2. Summary of the number of sites included in this analysis by subwatershed and number of years sampled. Reaches sampled but not included in this analysis (see Table 1) are NOT included in this summary.

Subwatershed	HUC	Area (acres)	Level IV Ecoregion	1 Year	2 Years	3+ Years
Lower Clackamas River and Rock Creek	170900110607	27, 363	Prairie Terraces, Valley Foothills	26	1	13
Lower Clear Creek	170900110606	12,494	Prairie Terraces, Valley Foothills	4	0	0
Middle Clear Creek	170900110602	21,796	Valley Foothills, Western Cascades Lowlands & Valleys	3	1	0
Upper Clear Creek	170900110601	12,237	Western Cascades Lowlands & Valleys	0	0	0
North Fork Deep Creek-Deep Creek	170900110605	13,731	Valley Foothills, Prairie Terraces	11	2	3
Tickle Creek-Deep Creek	170900110604	17,845	Valley Foothills, Western Cascades Lowlands & Valleys	6	2	2
North Fork Eagle Creek	170900110502	17,841	Western Cascades Lowlands & Valleys	1	0	0
Upper Eagle Creek	170900110501	17,337	Western Cascades Lowlands & Valleys	3	0	0
Lower Eagle Creek	170900110503	22,342	Western Cascades Lowlands & Valleys, Valley Foothills, Prairie Terraces	5	1	0
TOTALS		135,623		59	7	18

*only reaches included in this analysis are in these totals

Table 3. Number of sample sites in each lower Clackamas River subwatershed (excluding the mainstem Clackamas River) with average PREDATOR O/E scores corresponding to least disturbed (Least), moderately disturbed (Mod), and most disturbed (Most) biological condition.

	O/E Disturbance Class		
Subwatershed	Least	Mod	Most
Rock-Clackamas	2	2	23
Lower Clear	1	0	3
Middle Clear	3	0	1
N Fk Deep-Deep	1	0	15
Tickle-Deep	1	1	8
Lower Eagle	1	2	3
N Fk Eagle	0	1	0
Upper Eagle	1	1	1
TOTAL	10	7	54

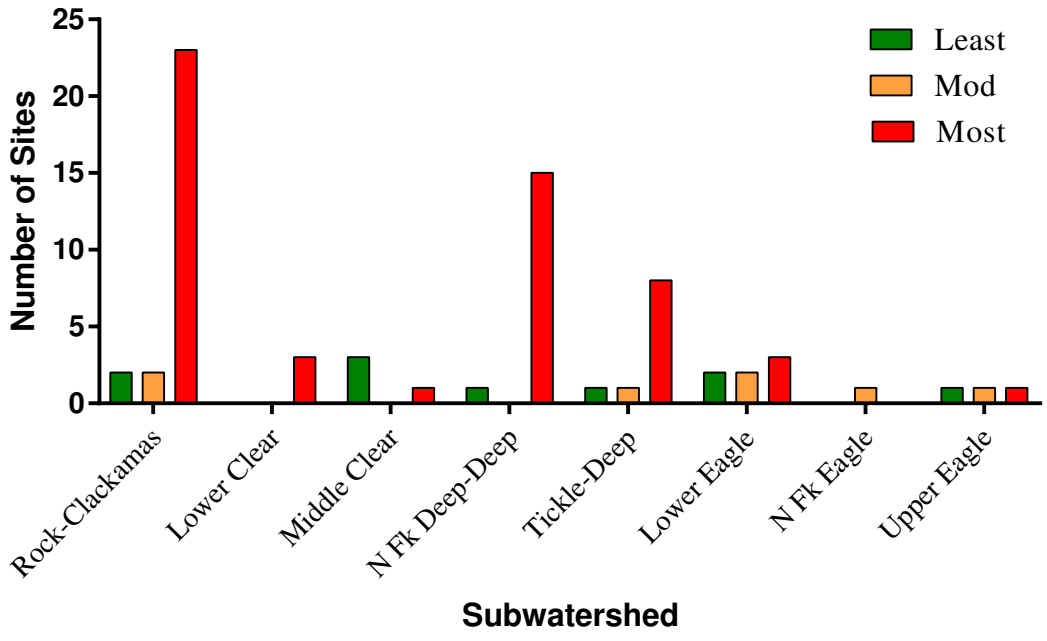
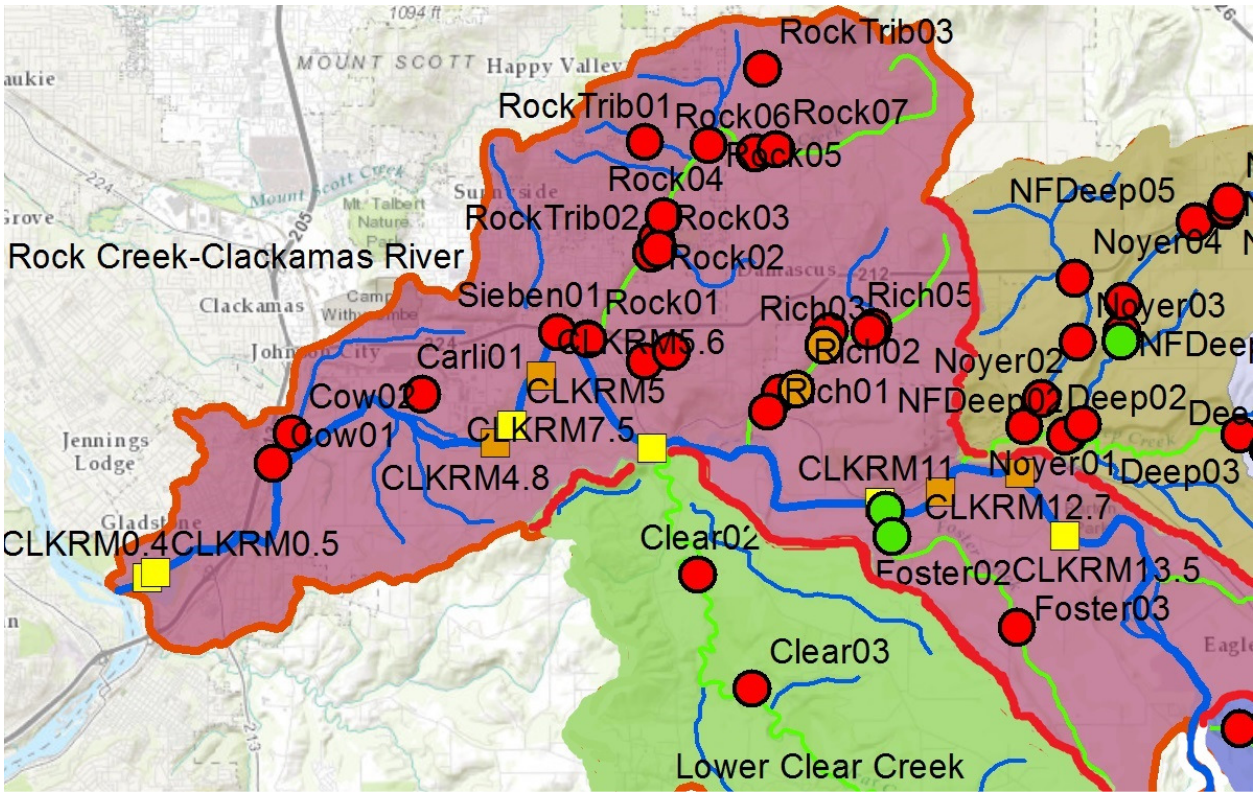


Figure 2. Number of sample sites in each lower Clackamas River subwatershed (excluding the mainstem Clackamas River) with average PREDATOR O/E scores corresponding to least disturbed (Least), moderately disturbed (Mod), and most disturbed (Most) biological condition.

LOWER CLACKAMAS RIVER & ROCK CREEK SUBWATERSHED



The lower Clackamas River and Rock Creek subwatershed has been the most intensively sampled among the nine subwatersheds. Including the Clackamas River, macroinvertebrate sampling has occurred in 9 named waterbodies. Several unnamed tributaries to both Rock and Richardson creeks have also been sampled. Excluding the Clackamas River reaches, across all 27 sampled creek reaches in the subwatershed, average PREDATOR O/E values from 23 of these reaches scored in the "most disturbed" range, while average O/E values from only 2 reaches scored in the "moderately disturbed" range and another 2 in the "least disturbed range" (Table 4).

Rock Creek and Richardson Creek are the largest tributaries in the subwatershed. The Rock and Richardson drainages occur partially within the towns of Happy Valley and Damascus, respectively. The greater sampling attention that these two creeks receive results in part from an interest in measuring the effects of local development on these waterways. While five different reaches have been sampled in Richardson Creek since 1997, only the lower-most reach (Rich01) has been sampled in more than one year. Identified in the 2013 monitoring plan as a Priority 1

Table 4. PREDATOR model O/E score results of macroinvertebrate sampling in the Rock Creek-Clackamas River subwatershed, Oregon, 1997-2016. Sites shaded in gray have been sampled in three of more years since 1997. LT1 = Priority 1long-term monitoring sites , LT2 = Priority 2 long-term monitoring sites (Cole 2013).

		Year Sampled												
Waterbody		1997	1998	1999	2002	2003	2007	2009	2011	2013	2014	2015	AVG	# Years
ROCK CREEK-CLACKAMAS RIVER SUBWATERSHED														
Carli Creek														
	Carli01						0.097	0.242	0.290		0.387		0.254	4
Cow Creek														
LT2	Cow01				0.339		0.193	0.291					0.274	3
	Cow02								0.290				0.290	1
Foster Creek														
LT2	Foster01									0.969			0.969	1
	Foster02	1.115											1.115	1
	Foster03									0.775			0.775	1
Richardson Ck tributaries														
	RichTrib01					0.775							0.775	1
	RichTrib02					0.775							0.775	1
	RichTrib03					0.823							0.823	1
Richardson Creek														
LT1	Rich01	0.970	0.776		0.774	0.776	0.773	0.823	0.919		0.871		0.835	8
	Rich02					0.871							0.871	1
	Rich03					0.871							0.871	1
	Rich05					0.775							0.775	1
Rock Creek														
LT1	Rock01	0.631	0.777		0.532	0.630	0.870		0.774		0.799		0.716	7
	Rock02					0.775							0.775	1
	Rock03					0.630							0.630	1
	Rock04				0.629	0.775	0.870	0.678	0.822		0.919		0.782	6
	Rock05					0.291							0.291	1
	Rock06		0.679					0.823	0.822		0.846		0.793	4
	Rock07					0.581							0.581	1
	RockTrib02					0.823							0.823	1
	RockTrib03					0.339							0.339	1
	RockTrib01					0.533							0.533	1
Sieben Creek														
LT1	Sieben01	0.340			0.194		0.338	0.387	0.436		0.484		0.363	6
Trillium Creek														
	Trilluim01				0.678		0.725	0.581	0.629		0.581		0.639	5
Willow Creek														
	Willow01					0.387							0.387	1
	Willow02					0.533							0.533	1

monitoring location, reach Rich01 has been sampled in 8 years between 1997 and 2014. While O/E scores have ranged from 0.773 to 0.970 in this time, no trend in increasing or decreasing values is indicated by the data (Figure 3. The most recent sampling in 2014 resulted in an O/E value of 0.835, very close to its 8-year average of 0.871 (Table 4). These data suggest that the macroinvertebrate community in lower Richardson Creek has averaged "moderately disturbed" conditions and that this condition has not noticeably declined since the late 1990s. The three Richardson Creek reaches occurring upstream (Rich02, Rich03, Rich04) have been sampled only once in 2003. Two of these reaches received 2003 O/E scores corresponding to "moderately disturbed" and one received a 2003 O/E score corresponding to "most disturbed" (Table 4). Three tributary streams to Richardson Creek were also sampled in 2003; each received an O/E score corresponding to "most disturbed" (Table 4).

Aside from the Clackamas River, macroinvertebrates have been more intensively sampled from Rock Creek than from any other waterbody in the study area. Seven reaches in Rock Creek have been sampled since 1997, and 3 of these reaches have been sampled in 4 or more years (Table 4). The 10 Rock Creek and Rock Creek tributary reaches received average O/E values exclusively in the "most disturbed" range. The lowermost reach on Rock Creek (Rock01) is a long-term Priority 1 monitoring site (Cole 2013) and has been sampled in seven different years since 1997 (not including the restoration-project-specific sampling performed by Patrick Edwards at Portland State University). O/E scores have ranged at Rock01 from 0.532 to 0.870, a fairly wide range potentially reflecting the effects of inter-annual differences in hydrologic events such as storms or drought. Despite this variability, the data do not suggest any trends in conditions between 1997 and 2014 (Table 4; Figure 3).

The smaller suburban tributaries Cow Creek (4 years of data), Carli Creek (4 years of data), Seiben Creek (6 years of data), Willow Creek (1 year of data), and Trillium Creek (5 years of data) all received average O/E scores in the "most disturbed" range. Seiben and Cow Creeks were identified as Priority 1 and 2 long-term monitoring reaches, respectively (Cole 2013). Foster Creek, the only sampled tributary in this subwatershed to occur on the south side of the Clackamas River, has been sampled in 3 locations since 1997, and each only once. Lower Foster (Foster01), identified as a Priority 2 long-term monitoring location (Cole 2013), received an O/E

score corresponding to "least disturbed" in 2013 (Table 4), as did Foster02 in 1997. The uppermost Foster Creek site (Foster03) received an O/E score corresponding to "most disturbed" in 2013.

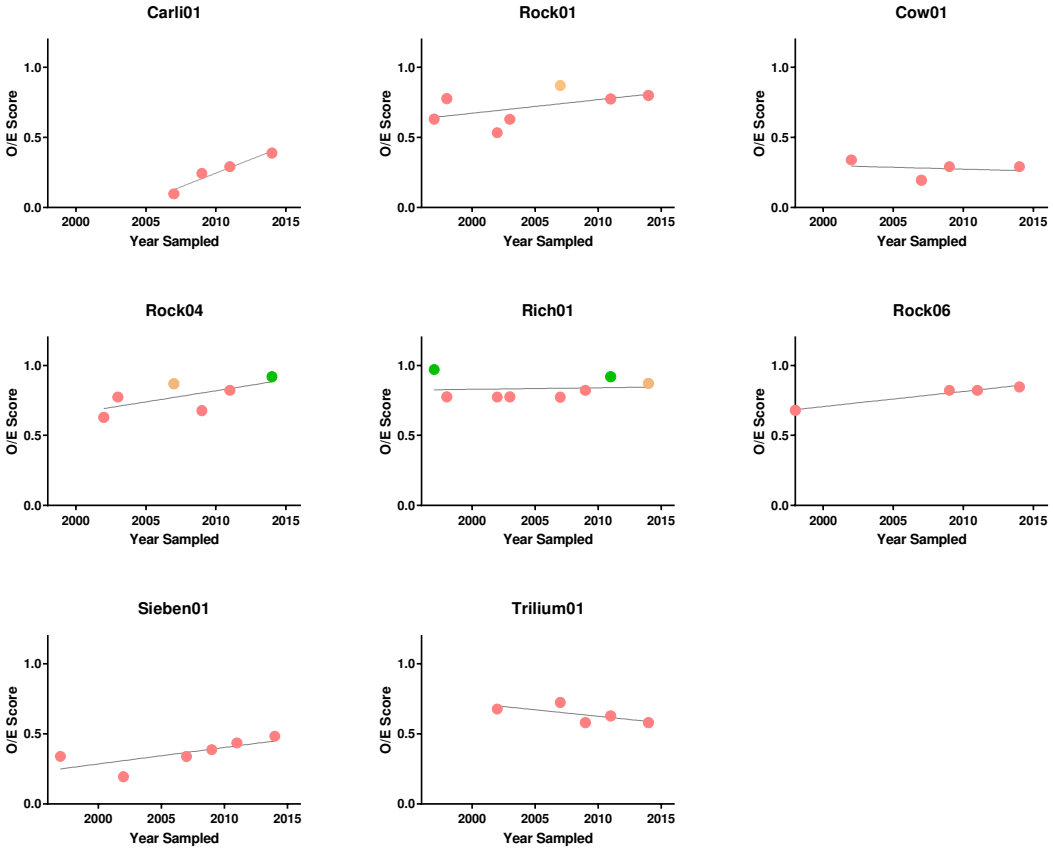


Figure 3. PREDATOR O/E scores calculated from macroinvertebrate samples collected from the tributary streams to the lower Clackamas River between 1997 and 2015.

Among the tributaries in the lower Clackamas River-Rock Creek subwatershed that have been sampled in 4 or more years, none show any clear indication of declining biological conditions (Figure 3). In fact, lower Carli Creek (Carli01) potentially shows slightly improved conditions; however, this stream continues to support a highly impacted macroinvertebrate community. A longer time-series of data from this site will be necessary to determine whether the apparent improvement lasts or is simply a short-term expression of temporal variability.

Sampling has occurred at 14 locations in the lower Clackamas River since 1997. Data were available for at least 1 year of sampling for 11 of these reaches, and for 3 or more years for 5

reaches (Table 5). Five of these river reaches were identified as priority long-term monitoring reaches, where annual monitoring subsequently occurred between 2013 and 2015 (Table 5). Average multimetric index (MMI) scores ranged from 30 to 32.3 across the these five reaches, suggesting very similar macroinvertebrate community conditions throughout the lower Clackamas River below River Mill Dam (Table 5). Applying MMI condition classes to these average scores, the condition of macroinvertebrate communities in the lower river is presently at the lower end of the "slightly disturbed" range Earlier data from 1999 and/or 2003 also exist for 4 of these 5 reaches. Comparison of the 2013-2015 MMI scores to earlier years' scores suggests that the biological condition of the lower river has not measurably declined since in the late 1990s/early 2000s (Figure 4).

Table 5. Western Oregon multimetric index score results of macroinvertebrate sampling in the lower Clackamas River, Oregon, 1997-2016. Sites shaded in gray have been sampled in three of more years since 1997.

	Clackamas River Station	Year Sampled							
		1999	2000	2003	2013	2014	2015	AVG	# Years
LT	CLKRM0.5	30			33	35	27	31.3	4
	CLKRM4.8			24				24.0	1
LT	CLKRM5				34	31	29	31.3	3
	CLKRM5.6			28				28.0	1
	CLKRM7.5	36	ND	26				31.0	3
LT	CLKRM11			28	35	34	32	32.3	4
	CLKRM11.2		ND						1
	CLKRM11.8			24				24.0	1
	CLKRM12.7			28				28.0	1
LT	CLKRM13.5	26	ND		30	29	35	30.0	5
	CLKRM16.2		ND						1
LT	CLKRM20	28			33	35	33	32.3	4
	CLKRM22.4	24	ND					24.0	2

LT = Priority long-term monitoring site (Cole 2013). ND = no data. Data were not available for this analysis.

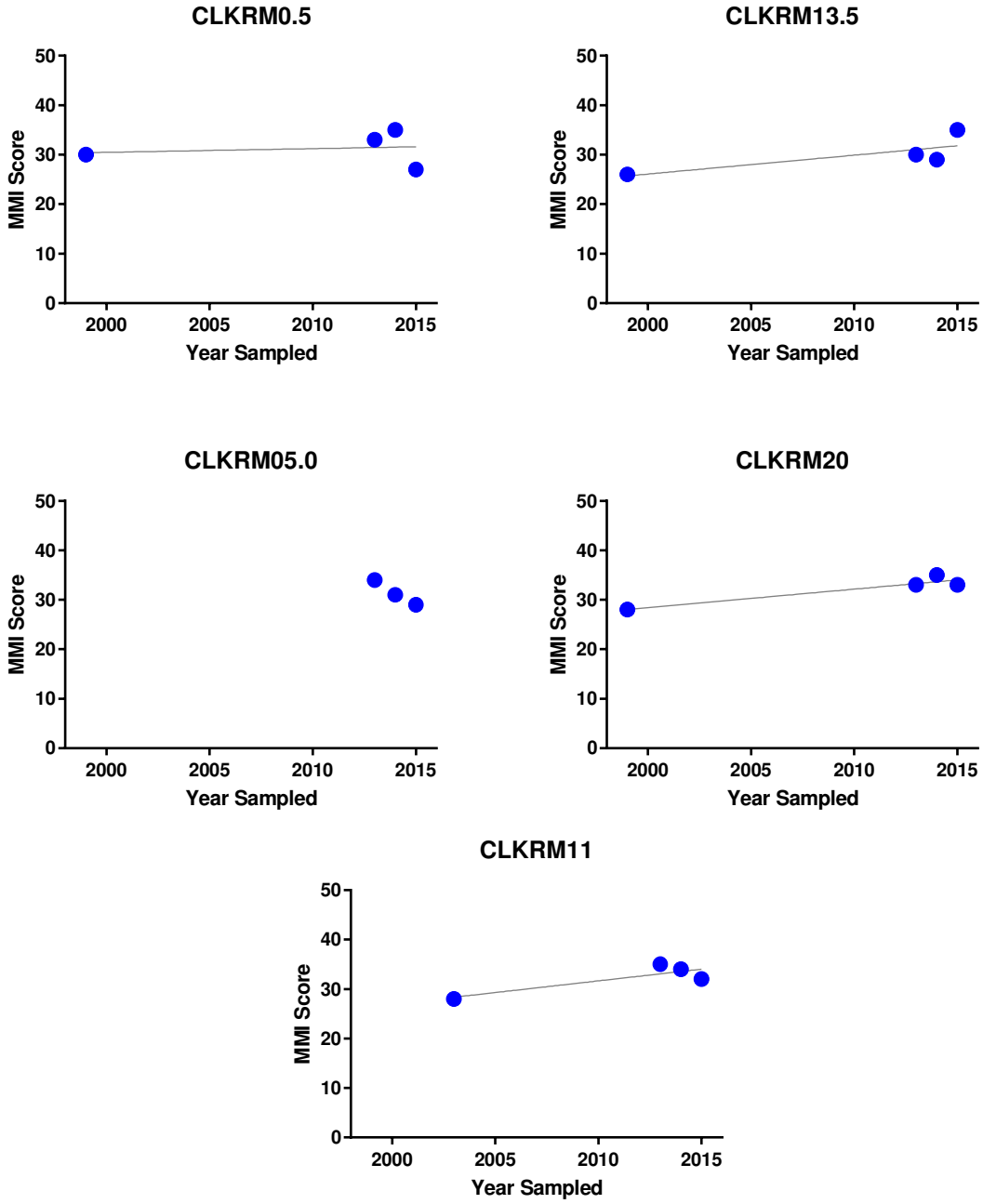
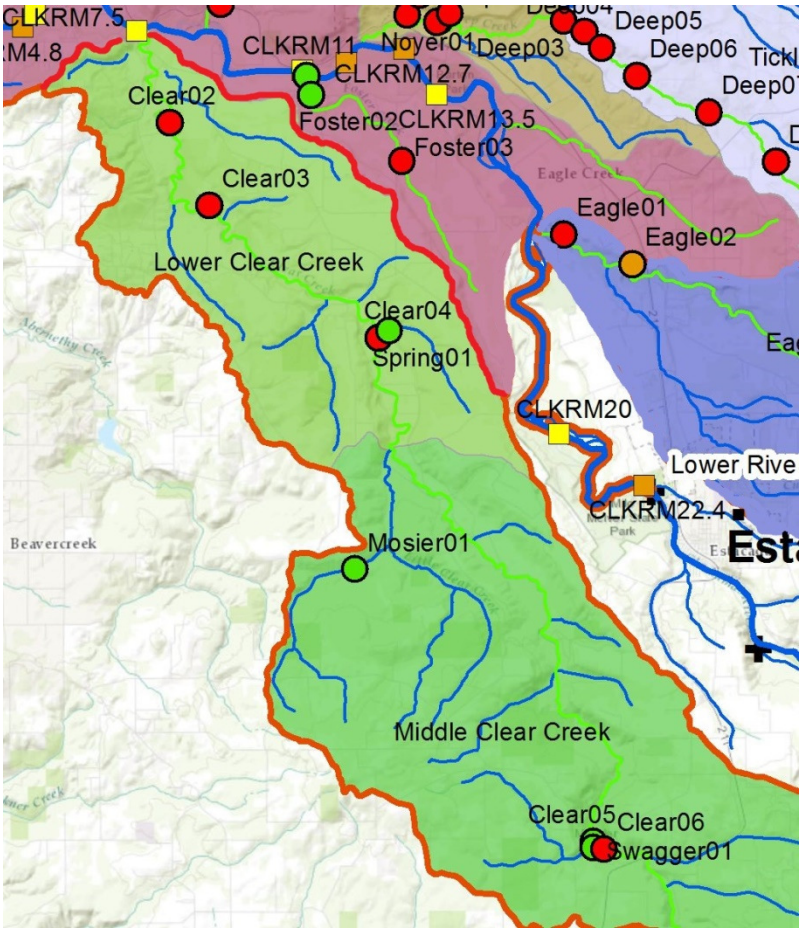


Figure 4. Multimetric scores calculated from macroinvertebrate samples collected from the lower Clackamas River between 1999 and 2015.

CLEAR CREEK SUBWATERSHEDS



Three 6th field subwatersheds occur in the Clear Creek drainage. The uppermost subwatershed. Upper Clear Creek, occurs entirely within the Western Cascades Lowlands & Valleys ecoregion, while the middle Clear Creek subwatershed occurs within both the Willamette Valley Foothills and Western Cascades Lowlands & Valleys ecoregions. The lower Clear Creek subwatershed occurs entirely within the two Willamette Valley ecoregions. Sampling has only occurred sporadically in the Clear Creek watershed. Since 1997, sampling has occurred in 6 locations in Clear Creek (Table 6). Five of these locations have been sampled only once, while one of these locations has been sampled twice. Data were available for 5 of these Clear Creek reaches; no data were available were for the lowermost Clear Creek reach, Clear01, which was last sampled 1999 and was identified as a Priority 1 monitoring location in 2013.

Four of the Clear Creek reaches occur in the lower Clear Creek subwatershed (Clear01-Clear04). Data were available for 3 of these reaches. Based on MWCF O/E scores, conditions in these lower Clear Creek reaches are exclusively in the "most disturbed" range (Table 6). While all 3 sites scored in this range, Clear02 scored considerably lower (O/E = 0.582) than did the 2 sites farther upstream in this subwatershed (Clear03 and Clear 04: O/E = 0.824). A single

tributary, Spring Creek, in the Lower Clear Creek subwatershed, was sampled in 2013 and received an O/E score of 0.920, corresponding to "least-disturbed" conditions.

Table 6. PREDATOR model O/E score results of macroinvertebrate sampling in the three Clear Creek subwatersheds, Oregon, 1997-2016. Sites shaded in gray have been sampled in three of more years since 1997. LT1 = Priority 1long-term monitoring sites , LT2 = Priority 2 long-term monitoring sites (Cole 2013).

		Year Sampled							
Waterbody		1997	1999	2001	2003	2013	2014	AVG	# Years
LOWER CLEAR CREEK SUBWATERSHED									
Clear Creek									
LT1	Clear01		ND						1
	Clear02					0.582		0.582	1
	Clear03						0.824	0.824	1
	Clear04					0.824		0.824	1
Spring Creek									
	Spring01					0.920		0.920	1
MIDDLE CLEAR CREEK SUBWATERSHED									
Clear Creek									
	Clear05				0.922	1.017		0.970	2
	Clear06	0.82306						0.823	1
Mosier Creek									
	Mosier01	TR			0.972			0.972	1
	Mosier02	TR							
Swagger Creek									
	Swagger01			1.047				1.047	1

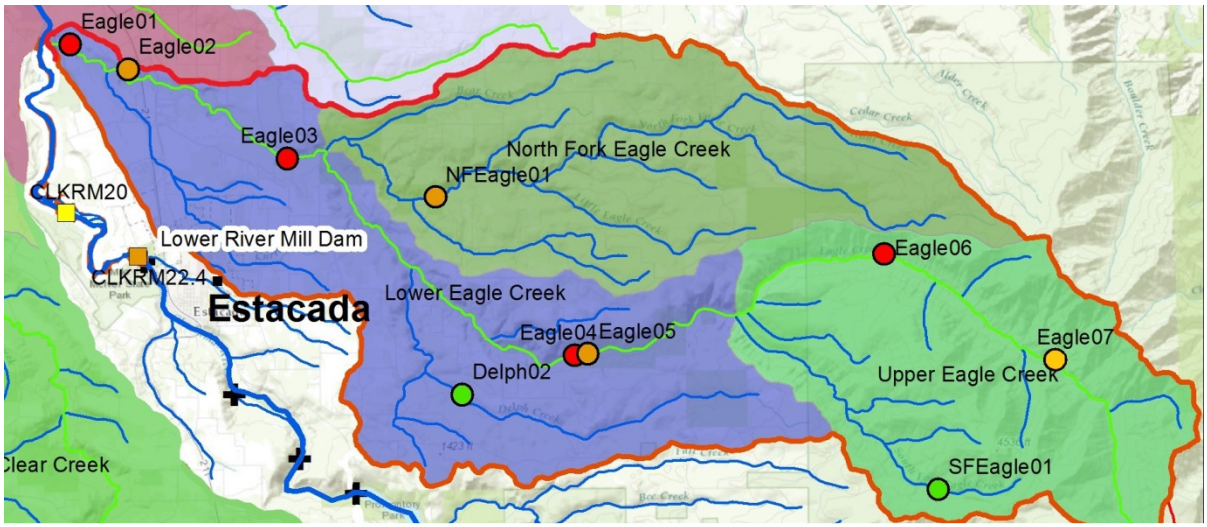
LT1 = Priority 1long-term monitoring sites , LT2 = Priority 2 long-term monitoring sites (Cole 2013). ND = no data. Data were not available for this analysis. TR = taxonomic resolution not sufficient for a PREDATOR analysis.

Within the middle Clear Creek watershed, site Clear05 has been sampled twice (2003 and 2013) and has an average O/E score of 0.970, corresponding to "least disturbed" conditions (Table 6). Clear06 was sampled only in 1997 and received a MWCF O/E score of 0.823, corresponding to "most disturbed" conditions (Table 6). Two tributary streams to Clear Creek – Mosier and Swagger creeks – have also been sampled in the middle Clear Creek subwatershed. Swagger01, sampled in 2001, received an O/E score of 1.047 (least disturbed). Mosier01, sampled in 2003, received an O/E score of 0.972 (least disturbed). Both of these scores occur

within the “least disturbed” condition class, suggesting that recent conditions in the middle Clear Creek subwatershed have largely been minimally disturbed

A re-sampling of a number of these sites in the Clear Creek drainage would help to better inform current ecological conditions in Clear Creek and its major tributaries. Furthermore, identified as a Priority 1 monitoring site as part of the lower Clackamas River basin macroinvertebrate monitoring plan, the lowermost site on Clear Creek (Clear01) has not been sampled since 1999.

EAGLE CREEK SUBWATERSHEDS



Three 6th-field subwatersheds occur within the Eagle Creek watershed. The North Fork Eagle Creek and Upper Eagle Creek subwatersheds occur exclusively within the Western Cascades Lowlands & Valleys ecoregion, while the lower Eagle Creek subwatershed also includes this ecoregion and both the Willamette Valley Foothills and Prairie Terraces ecoregions. Macroinvertebrate sampling has been infrequent across these three subwatersheds, with most effort occurring in the lower Eagle Creek subwatershed, where data were available for 6 sites, including 1 site in Delph Creek (Delph02) and 5 sites in lower Eagle Creek (Eagle01-05). Only 1 year of data was available for each of these locations, and sampling generally has occurred in different years across the sites. Two Eagle Creek reaches (Eagle02 and 05) received MWCF O/E scores corresponding to "moderately disturbed" conditions, while three Eagle Creek reaches (Eagle01, 03, and 04) received MWCF O/E scores corresponding to "most disturbed" conditions (Table 7). Last sampled in 2013, Eagle01 was identified as a Priority 1 Long-Term monitoring location, and should continue to be periodically assessed to track conditions in lower Eagle Creek.

Sampling has been very limited in the North Fork Eagle Creek subwatershed. While 4 reaches were identified as having been sampled at least once between 1997 and 2016, only 1 site on North Fork Eagle Creek (NFEagle01) had data of sufficient resolution to be used in this analysis. NFEagle01 received a WC+CP O/E score of 0.858, corresponding to a "moderately

disturbed" condition. No sampling is known have to have occurred in this subwatershed since 1999, and no Priority long-term monitoring sites were identified in the subwatershed.

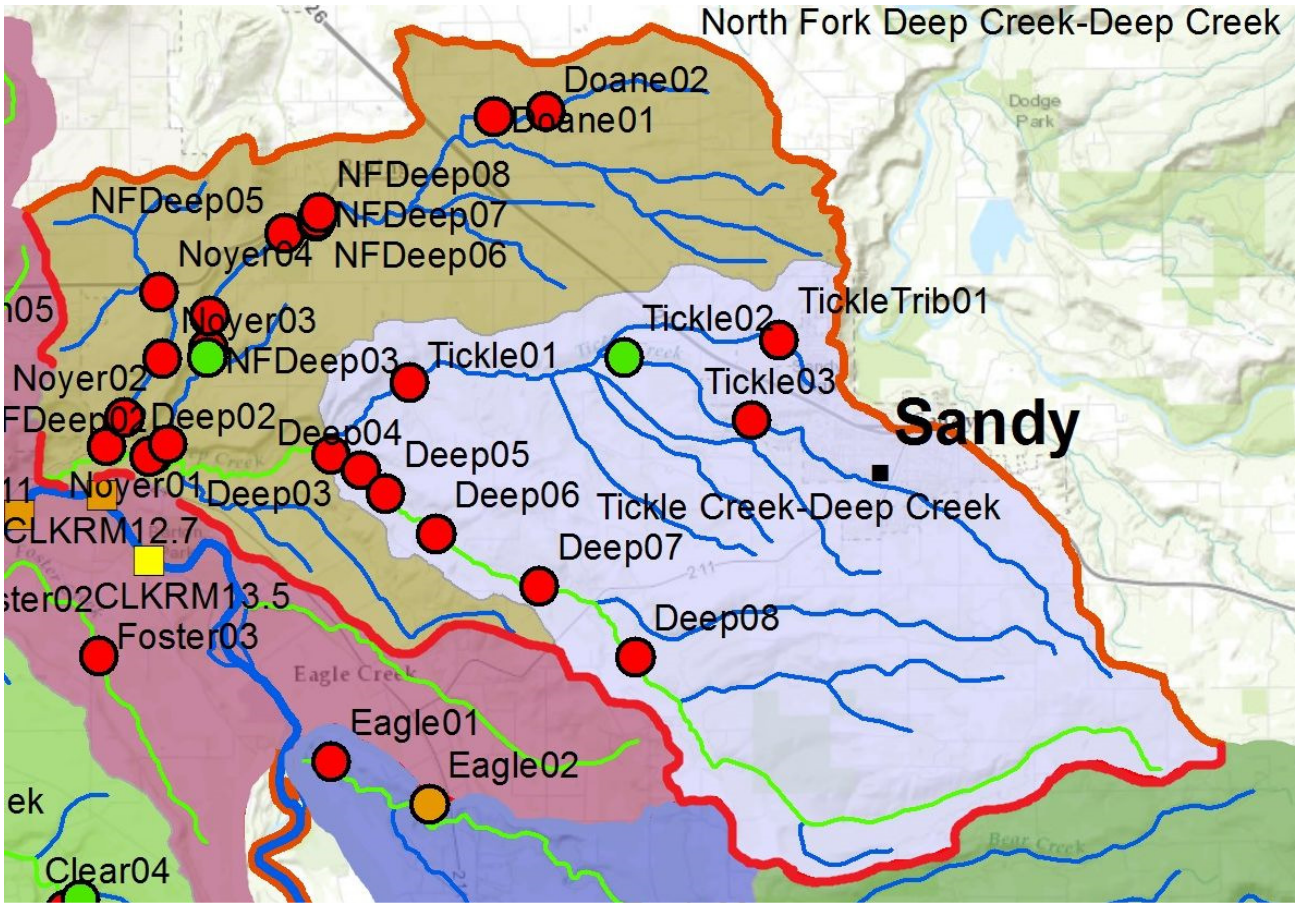
Table 7. PREDATOR model O/E score results of macroinvertebrate sampling in the three Eagle Creek subwatersheds, Oregon, 1997-2016. Sites shaded in gray have been sampled in three of more years since 1997.

		Year Sampled									
Waterbody		1997	1998	1999	2001	2003	2004	2006	2013	AVG	# Years
LOWER EAGLE CREEK SUBWATERSHED											
Delph Creek											
	Delph01	TR									
	Delph02						1.0768			1.077	1
	Delph03	TR									
Eagle Creek											
LT1	Eagle01			ND					0.6295	0.629	2
	Eagle02							0.87		0.870	1
	Eagle03				0.7253					0.725	1
	Eagle04	0.8219								0.822	1
	Eagle05	0.8702								0.870	1
Spring Creek											
	Spring01								0.9205	0.920	1
NORTH FORK EAGLE CREEK SUBWATERSHED											
Bear Creek											
	Bear01	TR	TR								
Little Eagle Creek											
	LittleEagle01	TR	TR								
NF Eagle Creek											
	NFEagle01			0.8585						0.8585	1
Sutter Creek											
	Sutter01	TR									
UPPER EAGLE CREEK SUBWATERSHED											
Eagle Creek											
	Eagle06			0.7333						0.7333	1
	Eagle07		0.8066							0.8066	1
SF Eagle Creek											
	SFEagle01					1.1459				1.1459	1

LT1 = Priority 1long-term monitoring sites , LT2 = Priority 2 long-term monitoring sites (Cole 2013). ND = no data. Data were not available for this analysis. TR = taxonomic resolution not sufficient for a PREDATOR analysis.

Three stream reaches have been sampled in the Upper Eagle Creek subwatershed since 1997, and each only once between 1998 and 2003. Upper Eagle Creek reach, Eagle 06 and received a WC+CP O/E score corresponding to "most disturbed" conditions (Table 7), while upper Eagle Creek reach Eagle07 received an O/E score corresponding to "moderately disturbed". A reach on South Fork Eagle Creek (SFEagle01) received a WC+CP O/E score of 1.146, corresponding to a "least disturbed" condition. No long-term priority monitoring sites for the lower Clackamas River basin occur in this subwatershed.

DEEP CREEK SUBWATERSHEDS



Two subwatersheds – North Fork Deep Creek-Deep Creek and Tickle Creek-Deep Creek – occur within the Deep Creek watershed. While the upper elevations on the east side of the Tickle Creek-Deep Creek subwatershed are in the Western Cascades Lowlands & Valleys ecoregion, all sample sites within these two subwatersheds are located within the two Willamette Valley ecoregions. The North Fork Deep Creek-Deep Creek subwatershed includes 17 sites distributed across Deep Creek (2 sites), Doane Creek (2 sites), North Fork Deep Creek (9 sites) and Noyer Creek (4 sites). Most sites within this subwatershed have been sampled only once, while 5 sites have been sampled 2 or 3 times (Table 8). MWCF O/E scores from 15 of these sites correspond to "most disturbed" conditions, while only one site, an unnamed tributary to North Fork Deep Creek (NFDTrib01), received an O/E score of 0.969 in 2003, indicating "least disturbed" ecological conditions (Table 8). Data from one site (Deep01) were of insufficient taxonomic resolution for inclusion in this analysis.

North Fork Deep Creek has been sampled in 8 locations, but sampling from these sites has been infrequent, as only 2 sites have been sampled more than once. O/E scores from these 8 locations occur exclusively in the "most disturbed" range (Table 8). Sampling has been most frequent in the lower North Fork Deep Creek site NFDeep02, identified in 2013 as a Priority 1 long-term monitoring site. Monitoring should continue on a routine basis in lower North Fork Deep Creek to continue to track ecological conditions in the drainage.

Sites on both Doane (Doane 01) and Noyer (Noyer02) creek have been identified as Priority 2 long-term monitoring locations. Doane Creek was sampled at both Doane01 and Doane02 in 2012 and again in 2016. O/E scores at each of these locations average 0.333 between the two years (Table 8). Sampling has not occurred at lower Noyer since 2003 (Table 8). Recent sampling has occurred only in upper Noyer Creek (Noyer04), where the ecological effects of upstream sediment sources are being monitored by the Clackamas SWCD.

Deep Creek at Deep02 has also been identified as a Priority 1 monitoring location, but sampling has occurred only in 2003, when the macroinvertebrate community received an O/E score of 0.630 (Table 8).

Within the Tickle Creek-Deep Creek subwatershed, 10 sites have been sampled since 1997, only 4 of which have been sampled 2 or more times. Eight of these sites, including 5 Deep Creek sites (all upstream of the Tickle Creek confluence), have received O/E scores (average scores when sampled >1 time) corresponding to "most disturbed" conditions (Table 8). One site, Deep07 in the mid-reaches of Deep Creek, received an O/E score of 0.873 (moderately disturbed) when it was sampled in 2004, while only Tickle02 received an average O/E score of 0.944, corresponding to "least disturbed" conditions.

One Priority 1 long-term monitoring site occurs in this subwatershed – lower Tickle Creek (Tickle01). Sampling from this site in 1997, 1998, and 2004 suggests that the ecology in lower Tickle Creek is significantly disturbed, as the O/E score from this site averages only 0.403 (Table 8). As a Priority 1 monitoring site, periodic sampling should resume at Tickle01 to track general trends in ecological conditions in the Tickle Creek drainage. Deep Creek upstream of the Tickle Creek confluence (Deep03) was identified as a Priority 2 long-term monitoring site.

Sampling has occurred here only in 1997, when the resulting MWCF O/E of 0.823 suggested conditions are in the "most disturbed" range.

Table 8. PREDATOR model O/E score results of macroinvertebrate sampling in the two Deep Creek subwatersheds, Oregon, 1997-2016. Sites shaded in gray have been sampled in three or more years since 1997.

		Year Sampled														
Waterbody		1997	1998	1999	2003	2004	2005	2006	2010	2011	2012	2013	2014	2016	AVG	# Years
NORTH FORK DEEP CREEK-DEEP CREEK SUBWATERSHED																
Deep Creek																
	Deep01								TR	TR						
LT1	Deep02				0.630										0.630	1
Doane Creek																
LT2	Doane01										0.399			0.268	0.333	2
	Doane02										0.399			0.268	0.333	2
N Fk Deep Creek																
	NFDeep01					0.435									0.435	1
LT1	NFDeep02	0.387			0.678							0.533			0.533	3
	NFDeep03				0.630										0.630	1
	NFDeep04				0.581										0.581	1
	NFDeep05				0.388										0.388	1
	NFDeep06						0.390								0.390	1
	NFDeep07						0.340								0.340	1
	NFDeep08										0.340			0.357	0.348	2
	NFDTrib01				0.969										0.969	1
Noyer Creek																
	Noyer01		0.582												0.582	1
LT2	Noyer02				0.484										0.484	1
	Noyer03				0.436										0.436	1
	Noyer04				0.290						0.113			0.238	0.214	3
TICKLE CREEK-DEEP CREEK SUBWATERSHED																
Deep Creek																
LT2	Deep03	0.823													0.823	1
	Deep04			0.774											0.774	1
	Deep05			0.822											0.822	1
	Deep06												0.775		0.775	1
	Deep07					0.873									0.873	1
	Deep08			0.725											0.725	1
Tickle Creek																
LT1	Tickle01	0.387	0.388	ND		0.435									0.403	4
	Tickle02	0.871	1.017												0.944	2
	Tickle03			ND							0.826			0.863	0.845	3
Tickle Creek tributary																
	TickleTrib01							0.390					0.339		0.364	2

LT1 = Priority 1long-term monitoring sites , LT2 = Priority 2 long-term monitoring sites (Cole 2013). ND = no data. Data were not available for this analysis. TR = taxonomic resolution not sufficient for a PREDATOR analysis.

LOWER BASIN PRIORITY MONITORING SITES

Across the lower Clackamas River basin, all 13 locations identified in 2013 as priority long-term monitoring have been sampled since 1997. One of these locations, lower Clear Creek (Clear01) had data of insufficient resolution to allow PREDATOR analysis. Among the other dozen sites, 11 average "most disturbed" community conditions. Only lower Foster Creek (Foster01), sampled in 2013, received an overall O/E score of "least disturbed". Among these 13 reaches, 6 have not been sampled in at least 10 years, and another 6 have not been sampled in the last 3 or 4 years (as of 2017). These frequencies fall well short of those recommended by the 2013 monitoring plan and what would be necessary to track temporal variability and potential trends in ecological conditions of lower Clackamas River basin streams.

Table 9. Lower Clackamas River basin priority long-term macroinvertebrate monitoring sites: PREDATOR O/E results and number of years since each site was last sampled. Blue horizontal bars indicate time since last sampling.

Site	1997	1998	1999	2001	2002	2003	2004	2007	2009	2011	2012	2013	2014	2015	2016	AVG	# Yrears Since Last Sampled
PRIORITY 1 SITES																	
Clear01			ND														NA
Deep02						0.630										0.630	14
Eagle01			ND									0.6295				0.629	4
NFDeep02	0.387					0.678						0.533				0.533	4
Rich01	0.970	0.776			0.774	0.776		0.773	0.823	0.919			0.871			0.835	3
Rock01	0.631	0.777			0.532	0.630		0.870		0.774			0.799			0.716	3
Tickle01	0.387	0.388	ND				0.435									0.403	13
Sieben01	0.340				0.194			0.338	0.387	0.436			0.484			0.363	3
PRIORITY 2 SITES																	
Cow01					0.339			0.193	0.291							0.274	10
Deep03	0.823															0.823	20
Doane01											0.399				0.268	0.333	1
Foster01												0.969				0.969	4
Noyer02						0.484										0.484	14

STRESSOR MODEL RESULTS

Temperature stressor model results suggest that water temperature is likely a stressor to macroinvertebrate communities throughout most of the lower Clackamas River basin. Temperature stressor scores indicated that creek segments least impacted by elevated water temperatures include upper Eagle Creek, the middle reaches of North Fork Deep Creek, Noyer Creek, and Richardson Creek (Table 10). Temperature stress scores from Seiben, Trillium, and upper Willow creeks also did not indicate temperature stress in these reaches, likely because of the very small size of these creeks. Fine sediment was also implicated as a stressor to macroinvertebrate communities throughout much of the lower Clackamas River Basin (Table 10). However, results from much of Eagle, Deep, and Richardson creeks suggest that these systems are not showing significant shifts in macroinvertebrate community composition that would result from fine sediment stress.

Table 10. Mean temperature and fine sediment stressor model scores from lower Clackamas River basin tributary streams, each sampled in select years between 1997-2016.

	Stressor Optima			Stressor Optima			Stressor Optima	
Site	TS	FSS	Site	TS	FSS	Site	TS	FSS
Lower Clear Creek			**North Fork Deep Creek-Deep Creek**			**Rock Creek-Clackamas River**		
Clear02	24.6	12.4	Deep02	20.7	17.6	Carli01	20.5	46.2
Clear03	22.5	14.5	Doane01	20.7	51.3	CLKRM11Side	26.4	76.2
Clear04	21.6	11.5	Doane02	24.5	58.3	Cow01	22.8	76.8
Spring01	17.9	11.0	NFDeep01	21.4	24.9	Cow02	21.6	75.5
			NFDeep02	19.4	32.1	Foster01	19.3	12.4
Middle Clear Creek			NFDeep03	18.0	23.5	Foster03	20.5	31.6
Clear05	18.0	7.3	NFDeep04	18.0	28.9	Rich01	18.4	13.5
Mosier01	18.7	15.0	NFDeep05	19.8	42.0	Rich02	16.8	12.7
Swagger01	17.4	8.0	NFDeep06	21.3	37.0	Rich03	18.3	13.5
			NFDeep07	20.3	38.0	Rich05	17.5	12.4
Lower Eagle Creek			NFDeep08	21.4	29.3	RichTrib01	15.9	10.7
Delph02	18.4	10.0	NFDTrib01	17.2	20.9	RichTrib02	19.2	30.5
Eagle01	22.6	9.9	Noyer02	16.1	14.8	RichTrib03	17.6	14.7
Eagle02	22.7	8.0	Noyer03	16.7	23.4	Rock01	18.7	13.0
Eagle03	20.5	9.0	Noyer04	19.1	36.5	Rock02	18.9	25.7
						Rock03	17.7	18.0
North Fork Eagle Creek			**Tickle Creek-Deep Creek**			Rock04	20.6	24.5
NFEagle01	18.1	6.0	Deep04	20.3	13.0	Rock05	21.4	51.6
			Deep05	18.5	12.0	Rock06	20.5	26.9
Upper Eagle Creek			Deep06	21.5	10.2	Rock07	20.9	38.4
Eagle07	14.5	1.0	Deep07	19.6	9.9	RockTrib01	17.4	31.9
SFEagle01	12.2	2.0	Deep08	18.9	12.0	RockTrib02	18.6	23.2
			Tickle01	21.7	21.7	RockTrib03	21.4	67.5
			Tickle03	19.6	17.8	Sieben01	17.4	20.0
			TickleTrib01	19.9	47.4	Trilluim01	17.8	20.0
						Willow01	19.2	46.2
						Willow02	16.6	29.1

CONCLUSIONS AND RECOMMENDATIONS

Results of PREDATOR model analyses suggest that ecological conditions in streams across much of the lower Clackamas River basin are significantly impacted by human activity. Macroinvertebrate communities in 54 of 71 stream reaches in the lower basin were classified as "most disturbed" based on PREDATOR O/E scores. Severe disturbance is most widespread in the Rock-Clackamas and Deep Creek subwatersheds, where human development is most intensive, and where more sampling has occurred to assess the effects of this increased development. Many of these classifications are derived from only one sampling event, and our data suggest that O/E scores can range across disturbance classes from year to year. Also, while a lower sampling intensity prevents a more complete understanding of the range of conditions in Clear and Eagle creek subwatersheds, the available data suggest that biological conditions appear to be more evenly distributed across disturbance classes in these two drainages.

Three or more years of data were available for numerous sites, particularly in the lower subwatersheds. Based on the available data, none of these sites exhibited obvious indications of declining ecological conditions over the past 10-15 years. Data from these sites generally suggested that conditions have remained stable, if not slightly improved, in a few reaches.

Limits to these data must also be recognized. This review attempts to make inferences about ecological conditions in local waterbodies, and compares conditions across waterbodies with often only one sample from each site and with data collected in different years across sites. Moreover, while collection and lab methods were generally similar with respect to sampling effort and taxonomic effort, some differences in sampling gear and taxonomic levels of resolution did occur. These issues of comparability were explicitly addressed during the project and data review process (Cole 2013), but are still in need of recognition. As a result of the efforts made to standardize data sets prior to analyses, comparisons of conditions among sites and across years were made with confidence in this review.

Temperature and fine sediment models suggested that both of these stressors are impacting macroinvertebrate communities in much of the lower Clackamas River basin. While the models were used in this study to determine the extent to which these two stressors are likely acting on the biology in these streams, this review was not an effort to comprehensively examine or

identify specific stressors (causes) acting in specific reaches. The causes are likely many, particularly in the more developed lower portions of the basin. The reader is referred to the following studies that have sought to further address the issue of causation of ecological disturbance in streams the lower Clackamas River basin: Carpenter 2003, Carpenter et al. 2016, Waterways Consulting and Cole Ecological 2015.

Among the 13 locations identified in the 2013 monitoring plan as priority long-term monitoring sites, this review revealed that 6 sites have been sampled since implementation of the plan (2013), and only 1 site has been sampled in the last 2 years. In order to generate a long-term data set that can be used to reliably reveal trends in ecological conditions when they occur, monitoring should occur more regularly at these locations. An effort could be undertaken at these priority tributary locations to better characterize present ecological conditions in the tributaries of the lower basin in a manner similar to the recent concerted effort undertaken by CRWP to characterize current biological conditions in the lower mainstem Clackamas River,.

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Appendix 1. Complete list of all macroinvertebrate samples used in the summary of 1997-2016 lower Clackamas River basin macroinvertebrate community conditions.

Agency/Juris	Waterbody	OrigSiteCode	Master SiteCode	location Description	DateSam	HabSam	Lat	Long
CRBC	Clear Creek	7	Clear02	Lower Clear Crk @ Carver	9/20/2013	Riffle	45.374	-122.487
CRBC	Clear Creek	8	Clear05	Clear Crk @ Metzler Co. Park	9/23/2013	Riffle	45.229	-122.368
CRBC	Foster Creek	3	Foster01	at confluence with Clackamas River	10/10/2013	Riffle	45.38317	-122.448
CRBC	Clear Creek	2	Clear04	Clear Crk @ Cedarhurst	10/16/2013	Riffle	45.33053	-122.428
CRBC	N Fk Deep Creek	4	NFDeep02	North Fork Deep Crk	10/21/2013	Riffle	45.39675	-122.408
CRBC	Spring Creek	1	Spring01	Spring Creek @ Mattoon	10/23/2013	Riffle	45.33186	-122.425
CRBC	Eagle Creek	5	Eagle01	Eagle Crk @ Bonnie Lure	10/25/2013	Riffle	45.351	-122.375
CRBC	Foster Creek	6	Foster03	Foster Crk @ Harding	10/30/2013	Riffle	45.366	-122.421
CRBC	N Fk Deep Creek	4 DUP	NFDeep02	North Fork Deep Crk	9/27/2013	Riffle	45.39675	-122.408
CRBC	Rock Creek	1	Rock01	Rock Creek Confluence	9/26/2014	riffle	45.4091	-122.513
CRBC	Clackamas R: disconnecte	2	CLKRM11Side	Fisher's Bend	9/11/2014	pool	45.3843	-122.448
CRBC	Clear Creek	3	Clear03	Lower Clear Crk at Metro Property	9/26/2014	riffle	45.3573	-122.476
CRBC	Deep Creek	4	Deep06	Deep Creek along Judd Rd.	9/19/2014	riffle	45.3827	-122.354
CRBC	Tickle Creek tributary	5	TickleTrib01	Sandy Bluff Park	9/19/2014	pool	45.4097	-122.286
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/17/2013	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/17/2013	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/17/2013	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/17/2013	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/18/2013	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/18/2013	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/18/2013	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/18/2013	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/17/2013	Riffle	45.395961	-122.5252
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/17/2013	Riffle	45.395961	-122.5252
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/15/2014	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/15/2014	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/15/2014	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/15/2014	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/15/2014	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/15/2014	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/15/2014	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/15/2014	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/15/2014	Riffle	45.395961	-122.5252

Agency/Juris	Waterbody	OrigSiteCode	Master SiteCode	location Description	DateSam	HabSam	Lat	Long
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/15/2014	Riffle	45.395961	-122.5252
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/21/2015	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM0.5	CLKRM0.5	200 m US McLaughlin Blvd Bridge	9/21/2015	Riffle	45.3746316	-122.59901
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/21/2015	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM11	CLKRM11	0.5 miles US 197th Ave	9/21/2015	Riffle	45.384545	-122.44883
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/21/2015	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM13.5	CLKRM13.5	Barton Park	9/21/2015	Riffle	45.379247	-122.41082
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/21/2015	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM20	CLKRM20	Milo McIver State Park	9/21/2015	Riffle	45.31087	-122.37666
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/21/2015	Riffle	45.395961	-122.5252
CRWP/CE	Clackamas River	CLKRM5	CLKRM5	East side of Sah-Hah-Lee Golf Course	9/21/2015	Riffle	45.395961	-122.5252
Metro/ABR	Rock Creek	1	Rock01	lower mainstem - along Rt. 212	10/2/2003	Riffle	45.40857	-122.50898
Metro/ABR	Rock Creek	2	Rock02	middle mainstem - Weaver property	10/7/2003	Riffle	45.42085	-122.49605
Metro/ABR	Rock Creek	3	Rock04	middle mainstem - below Sunnyside Road	10/6/2003	Riffle	45.426415	-122.49325
Metro/ABR	Rock Creek	4	Rock05	middle mainstem - above Troge Road	10/7/2003	Glide	45.436599	-122.484123
Metro/ABR	Rock Creek	5	Rock07	upper mainstem - west of Foster Road	10/7/2003	Riffle	45.435916	-122.470196
Metro/ABR	Rock Creek Tributary	10	RockTrib01	tributary on Blake Property	10/6/2003	Riffle	45.437031	-122.497331
Metro/ABR	Rock Creek	13	RockTrib02	tributary on Weaver property	10/7/2003	Riffle	45.421536	-122.494578
Metro/ABR	Willow Creek	17	Willow02	middle Willow Creek	10/3/2003	Riffle	45.406538	-122.492149
Metro/ABR	Willow Creek	18	Willow01	lower Willow Creek	10/7/2003	Glide	45.40509	-122.49753
Metro/ABR	Rock Creek	19	RockTrib03	tributary on Embree property - east of 188	10/7/2003	Glide	45.447657	-122.472955
Metro/ABR	Richardson Creek	20	Rich01	lower - above 224 road crossing	9/29/2003	Riffle	45.398097	-122.471849
Metro/ABR	Richardson Creek	21	Rich03	middle mainstem on Bonner property	10/9/2003	Riffle	45.407305	-122.460546
Metro/ABR	Richardson Ck trib	23	RichTrib01	tributary to lower Richardson on Andersor	10/8/2003	Riffle	45.40038	-122.46971
Metro/ABR	Richardson Ck trib	24	RichTrib02	tributary on Bonner property	10/9/2003	Riffle	45.409271	-122.459434
Metro/ABR	Richardson Ck trib	27	RichTrib03	tributary to upper Richardson (may be Ric	10/8/2003	Riffle	45.40989	-122.45009
Metro/ABR	Richardson Creek	28	Rich05	below confluence with tribs on Alexander/	10/8/2003	Riffle	45.40925	-122.45088
Metro/ABR	Noyer Creek	29	Noyer02	lower mainstem	10/10/2003	Riffle	45.399358	-122.415696
Metro/ABR	Noyer Creek	30	Noyer03	middle mainstem	10/10/2003	Riffle	45.407508	-122.407877
Metro/ABR	Noyer Creek	31	Noyer04	At Hwy 212	10/10/2003	Riffle	45.416875	-122.408401
Metro/ABR	N Fk Deep Creek	42	NFDeep03	NF Deep above sampled trib	10/1/2003	Riffle	45.40883	-122.3989
Metro/ABR	N Fk Deep Creek	43	NFDTrib01	tributary to lower NF Deep	9/30/2003	Riffle	45.40766	-122.39906
Metro/ABR	N Fk Deep Creek	44	NFDeep02	lower NF Deep - lowermost of sites on Nl	10/1/2003	Riffle	45.39633	-122.40952
Metro/ABR	Deep Creek	45	Deep02	lower Deep Creek above NF Deep	10/2/2003	Riffle	45.393959	-122.409817
Metro/ABR	N Fk Deep Creek	46	NFDeep04	middle NF Deep	10/2/2003	Riffle	45.41343	-122.39858

Agency/Juris	Waterbody	OrigSiteCode	Master SiteCode	location Description	DateSam	HabSam	Lat	Long
Metro/ABR	N Fk Deep Creek	47	NFDeep05	middle NF Deep - uppermost of sites on N	10/2/2003	Riffle	45.424978	-122.383556
Metro/ABR	Rock Creek	48	Rock03	middle - above trib on Weaver property	10/7/2003	Riffle	45.422885	-122.495065
Metro/ABR	Richardson Creek	49	Rich02	lower Richardson above trib on Anderson	10/8/2003	Riffle	45.400968	-122.466224
Metro/ABR	Richardson Creek	50	Rich04	middle mainstem above trib on Bonner pro	10/9/2003	Riffle	45.407871	-122.458408
Metro/ABR	Clackamas River	51	CLKRM11.8	~1/4 mile below Deep Creek	10/9/2003	Riffle	45.38574	-122.43653
Metro/ABR	Clackamas River	52	CLKRM11	~1 mile below Deep Creek, immed below	10/9/2003	Riffle	45.38429	-122.44901
Metro/ABR	Clackamas River	53	CLKRM12.7	~0.5 mile above Deep Creek (0.6 mi DS fi	10/9/2003	Riffle	45.3884	-122.42012
Metro/ABR	Clackamas River	54	CLKRM7.5	~1 mile below Richardson, at Carver Park	10/9/2003	Riffle	45.3924	-122.49616
Metro/ABR	Clackamas River	55	CLKRM4.8	~1.5 miles below Rock Creek	10/9/2003	Riffle	45.39324	-122.52855
Metro/ABR	Clackamas River	56	CLKRM5.6	~0.5 mile below Rock Creek	10/15/2003	Riffle	45.40306	-122.51898
ODEQ	Clear Creek	30361	Clear05	Clear Crk @ Metzler Co. Park	8/13/2003	Riffle	45.22931	-122.36785
ODEQ	Deep Creek	21629	Deep04	Deep Creek at RM 4.45 (Clackamas)	9/17/1999	Riffle	45.39156	-122.36875
ODEQ	Deep Creek	21630	Deep05	Deep Creek at RM 4.80 (Clackamas)	9/17/1999	Riffle	45.38845	-122.36375
ODEQ	Deep Creek	21631	Deep08	Deep Creek at RM 7.97 (Clackamas)	9/17/1999	Riffle	45.36528	-122.31463
ODEQ	Delph Creek	31639	Delph02	Delph Creek	8/10/2004	Riffle	45.26692	-122.24392
ODEQ	Eagle Creek	33905	Eagle02	Eagle Creek at river mile 2.0	9/5/2006	Riffle	45.34497	-122.35564
ODEQ	Eagle Creek	25777	Eagle03	Eagle Creek (Clackamas)	9/12/2001	Riffle	45.3234	-122.30204
ODEQ	Eagle Creek	17048	Eagle07	Eagle Creek at RM 22.76 (Clackamas)	8/13/1998	Riffle	45.27366	-122.04408
ODEQ	Mosier Creek	30350	Mosier01	Mosier Creek	8/14/2003	Riffle	45.284	-122.43503
ODEQ	N Fk Deep Creek	32448	NFDeep06	North Fork Deep Creek 50 feet downstrea	7/21/2005	Riffle	45.42656	-122.37725
ODEQ	N Fk Deep Creek	32446	NFDeep07	North Fork Deep Creek upstream of Borin	7/21/2005	Riffle	45.42688	-122.3771
ODEQ	NF Eagle Creek	21870	NFEagle01	NF Eagle Creek 2 mi U/S of Kitzmiller Rd	7/7/1999	Riffle	45.3139	-122.25233
ODEQ	SF Eagle Creek	30331	SFEagle01	SF Eagle Creek	9/23/2003	Riffle	45.24327	-122.08393
ODEQ	Swagger Creek	25778	Swagger01	Swagger Creek (Clackamas) @ Metzler C	9/11/2001	Riffle	45.22773	-122.36801
ODEQ	Swagger Creek	25778	Swagger01	Swagger Creek (Clackamas) @ Metzler C	7/2/2001	Riffle	45.22773	-122.36801
ODEQ	Tickle Creek tributary	33494	TickleTrib01	Tickle Creek tributary near Sandy	7/19/2006	Riffle	45.40945	-122.28533
SCWD/ABR	Doane Creek	Lower Doane	Doane01	At SE 312th Ave.	03-Oct-12	Riffle	45.44100	-122.3418
SCWD/ABR	Doane Creek	Brooks/Doane C	Doane02	At SE Revenue Rd.	03-Oct-12	Riffle	45.44175	-122.33135
SCWD/ABR	N Fk Deep Creek	Richey/NF Dee	NFDeep08	At SE Richey Rd.	03-Oct-12	Riffle	45.42777	-122.37659
SCWD/ABR	Noyer Creek	Noyer Ck	Noyer04	At Hwy 212	04-Oct-12	Riffle	45.41677	-122.4085
SCWD/ABR	Tickle Creek	Tickle Ck/362nd	Tickle03	At Duncan Rd.	04-Oct-12	Riffle	45.39822	-122.2909
SWCD/CE	Doane Creek	Lower Doane	Doane01	At SE 312th Ave.	07-Oct-16	Pool	45.44100	-122.3418
SWCD/CE	Doane Creek	Brooks/Doane C	Doane02	At SE Revenue Rd.	07-Oct-16	Riffle	45.44175	-122.33135
SWCD/CE	N Fk Deep Creek	Richey/NF Dee	NFDeep08	At SE Richey Rd.	07-Oct-16	Riffle	45.42777	-122.37659
SWCD/CE	Noyer Creek	Noyer Ck	Noyer04	At Hwy 212	07-Oct-16	Riffle	45.41677	-122.4085
SWCD/CE	Tickle Creek	Tickle Ck/362nd	Tickle03	US 362nd Dr.	07-Oct-16	Riffle	45.39822	-122.2909
USGS	Clear Creek	CLEAR	Clear01	confluence w Clackamas River (Carver B	08-31-1999	Riffle	45.390341	-122.492986

Agency/Juris	Waterbody	OrigSiteCode	Master SiteCode	location Description	DateSam	HabSam	Lat	Long
USGS	Clackamas River	CR_GLAD	CLKRM0.4	@Gladstone nr. mouth	09-09-1999	Riffle	45.373976	-122.60078
USGS	Clackamas River	CR_BAR	CLKRM13.5	at Barton Park, 1.1 mi US Deep Creek	09-01-1999	Riffle	45.3816	-122.4130
USGS	Clackamas River	CR_MCIV	CLKRM20	at McIver Park, 2.7 mi below River Mill D	08-30-1999	Riffle	45.3121	-122.3788
USGS	Clackamas River	CR_RMDAM	CLKRM22.4	below river mill dam	08-30-1999	Riffle	45.300396	-122.352771
USGS	Clackamas River	CR_CARV	CLKRM7.5	@below Carver bridge	08-30-1999	Riffle	45.3924	-122.49616
USGS	Eagle Creek	EAGLE	Eagle01	near mouth	09-01-1999	Riffle	45.350911	-122.375933
USGS	Tickle Creek	TICKLE_D	Tickle01	US SE Tickle Creek Rd	09-03-1999	Riffle	45.40378	-122.358882
USGS	Tickle Creek	TICKLE_U	Tickle03	US 362nd Dr.	09-03-1999	Riffle	45.398536	-122.290094
USGS	Deep Creek	Deep	Deep07	0.6 mi DS Rt 211	9/15/2004	Riffle	45.375286	-122.333348
USGS	N Fk Deep Creek	NFDep	NFDeep01	immed US conflu w Deep Creek	9/16/2004	Riffle	45.393798	-122.410701
USGS	Tickle Creek	Tickl	Tickle01	US SE Tickle Creek Rd	9/15/2004	Riffle	45.403872	-122.358870
UW	Clear Creek	Upper Clear 97	Clear06	near south end of Metzler County Park ap	9/2/1997	Riffle	45.227435	-122.364942
UW	Deep Creek	Deep 97	Deep03	above Tickle Creek confluence at end of I	9/4/1997	Riffle	45.393844	-122.374594
UW	Eagle Creek	Eagle One 97	Eagle04	approximately 1/3 mile upstream of hatche	9/5/1997	Riffle	45.276021	-122.205823
UW	Eagle Creek	Eagle Two 97	Eagle05	approximately 1/3 mile downstream of hat	9/5/1997	Riffle	45.276338	-122.201446
UW	Foster Creek	Foster 97	Foster02	approximately 50m upstream of Bakers Fe	8/28/1997	Riffle	45.379433	-122.446648
UW	N Fk Deep Creek	North Fk Deep	NFDeep02	near confluence with Deep Creek; approx	9/4/1997	Riffle	45.395432	-122.406965
UW	Noyer Creek	Noyer Fk Deep	Noyer01	approximately 30 meters upstream of conf	8/27/1998	Riffle	45.395179	-122.419173
UW	Richardson Creek	Richardson 97	Rich01	approximately 100m upstream of HWY 22	8/27/1997	Riffle	45.398072	-122.470796
UW	Richardson Creek	Richardson 98	Rich01	approximately 100m upstream of HWY 22	9/2/1998	Riffle	45.398072	-122.470796
UW	Rock Creek	Rock Two 97	Rock01	approximately 75m upstream of confluenc	8/28/1997	Riffle	45.409028	-122.510915
UW	Rock Creek	Rock Two 98	Rock01	approximately 75m upstream of confluenc	8/26/1998	Riffle	45.409028	-122.510915
UW	Rock Creek	Rock One 98	Rock06	approximately 50m downstream of Foster	8/26/1998	Riffle	45.435378	-122.474508
UW	Sieben Creek	Sieben 97	Sieben01	approximately 100m upstream of confluen	8/27/1997	Riffle	45.409436	-122.515601
UW	Tickle Creek	Tickle Two 97	Tickle01	US SE Tickle Creek Rd	9/3/1997	Riffle	45.404986	-122.358
UW	Tickle Creek	Tickle Two 98	Tickle01	US SE Tickle Creek Rd	8/27/1998	Riffle	45.404986	-122.358
UW	Tickle Creek	Tickle One 97	Tickle02	approximately 40m upstream of Sandy Wa	9/3/1997	Riffle	45.407239	-122.316126
UW	Tickle Creek	Tickle One 98	Tickle02	approximately 40m upstream of Sandy Wa	8/27/1998	Riffle	45.407239	-122.316126
WES/ABR	Carli Creek	SD1-M16	Carli01	11814 Jennifer Street downstream of large	09-Oct-07	Riffle	45.40056	-122.54375
WES/ABR	Carli Creek	SD1-M16	Carli01	11814 Jennifer Street downstream of large	12-Oct-09	Riffle	45.40056	-122.54375
WES/ABR	Carli Creek	SD1-M16	Carli01	11814 Jennifer Street downstream of large	12-Oct-09	Riffle	45.40056	-122.54375
WES/ABR	Carli Creek	SD1-M16	Carli01	11814 Jennifer Street downstream of large	21-Sep-11	Riffle	45.40056	-122.54375
WES/ABR	Cow Creek	SD1-M14	Cow01	Upstream of farm road bridge crossing	25-Sep-02	Glide	45.39055	-122.57471
WES/ABR	Cow Creek	SD1-M14	Cow01	Upstream of farm road bridge crossing	15-Oct-07	Glide	45.39055	-122.57471
WES/ABR	Cow Creek	SD1-M14	Cow01	Upstream of farm road bridge crossing	14-Oct-09	Glide	45.39055	-122.57471

Agency/Juris	Waterbody	OrigSiteCode	Master SiteCode	location Description	DateSam	HabSam	Lat	Long
WES/ABR	Cow Creek	SD1-M14a	Cow02	Downstream of private driveway off of SI	21-Sep-11	Glide	45.39488	-122.57084
WES/ABR	Richardson Creek	SD1-M12	Rich01	Upstream of Highway 224	17-Sep-02	Riffle	45.39766	-122.47233
WES/ABR	Richardson Creek	SD1-M12	Rich01	Upstream of Highway 224	09-Oct-07	Riffle	45.39766	-122.47233
WES/ABR	Richardson Creek	SD1-M12	Rich01	Upstream of Highway 224	01-Oct-09	Riffle	45.39766	-122.47233
WES/ABR	Richardson Creek	SD1-M12	Rich01	Upstream of Highway 224	22-Sep-11	Riffle	45.39766	-122.47233
WES/ABR	Rock Creek	SD1-M10	Rock01	Approximately 5 m upstream of the conflu	17-Sep-02	Riffle	45.40843	-122.50940
WES/ABR	Rock Creek	SD1-M10	Rock01	Approximately 5 m upstream of the conflu	11-Oct-07	Riffle	45.40843	-122.5094
WES/ABR	Rock Creek	SD1-M10	Rock01	Approximately 5 m upstream of the conflu	11-Oct-07	Riffle	45.40843	-122.5094
WES/ABR	Rock Creek	SD1-M10a	Rock01	Approximately 120 m upstream of the con	23-Sep-11	Riffle	45.40918	-122.50835
WES/ABR	Rock Creek	SD1-M11	Rock04	Downstream of Sunnyside Road	17-Sep-02	Riffle	45.42627	-122.49340
WES/ABR	Rock Creek	SD1-M11	Rock04	Downstream of Sunnyside Road	11-Oct-07	Riffle	45.42627	-122.4934
WES/ABR	Rock Creek	SD1-M11	Rock04	Downstream of Sunnyside Road	28-Sep-09	Riffle	45.42627	-122.4934
WES/ABR	Rock Creek	SD1-M11a	Rock04	Downstream of Sunnyside Road	22-Sep-11	Riffle	45.42554	-122.4939
WES/ABR	Rock Creek	SD1-M17	Rock06	Along Troge Road at Foster Road	14-Oct-09	Riffle	45.43609	-122.474
WES/ABR	Rock Creek	SD1-M17	Rock06	Along Troge Road at Foster Road	22-Sep-11	Riffle	45.43609	-122.474
WES/ABR	Sieben Creek	SD1-M8	Sieben01	Downstream of Hwy 212/224	19-Sep-02	Riffle	45.41017	-122.52204
WES/ABR	Sieben Creek	SD1-M8	Sieben01	Downstream of Hwy 212/224	11-Oct-07	Riffle	45.41017	-122.52204
WES/ABR	Sieben Creek	SD1-M8	Sieben01	Downstream of Hwy 212/224	05-Oct-09	Riffle	45.41017	-122.52204
WES/ABR	Sieben Creek	SD1-M8	Sieben01	Downstream of Hwy 212/224	21-Sep-11	Riffle	45.41017	-122.52204
WES/ABR	Trillium Creek	SD1-M7	Trilluim01		17-Sep-02	Riffle		
WES/ABR	Trillium Creek	SD1-M7	Trilluim01		09-Oct-07	Riffle		
WES/ABR	Trillium Creek	SD1-M7a	Trilluim01	Near confluence with Rock Creek	30-Sep-09	Riffle	45.4083	-122.5091
WES/ABR	Trillium Creek	SD1-M7a	Trilluim01	Near confluence with Rock Creek	23-Sep-11	Riffle	45.4083	-122.5091
WES/CE	Carli Creek	SD1-M16	Carli01	~300 m downstream of SE 120th Ave.	9/22/2014	Riffle	45.40055	-122.54378
WES/CE	Richardson Creek	SD1-M12	Rich01	Upstream of Highway 224	9/16/2014	Riffle	45.39766	-122.47236
WES/CE	Rock Creek	SD1-M10a	Rock01	~120 m upstream of the confluence with T	9/16/2014	Riffle	45.4091	-122.50836
WES/CE	Rock Creek	SD1-M11a	Rock04	Downstream of Sunnyside Road	9/23/2014	Riffle	45.425553	-122.493981
WES/CE	Rock Creek	SD1-M11a	Rock04	Downstream of Sunnyside Road	9/23/2014	Riffle	45.425553	-122.493981
WES/CE	Rock Creek	SD1-M17	Rock06	Along Troge Road at Foster Road	9/24/2014	Riffle	45.43610103	-122.473981
WES/CE	Rock Creek	SD1-M17	Rock06	Along Troge Road at Foster Road	9/24/2014	Riffle	45.43610103	-122.473981
WES/CE	Sieben Creek	SD1-M8	Sieben01	Downstream of Hwy 212/224	9/23/2014	Riffle	45.40952101	-122.522071
WES/CE	Trillium Creek	SD1-M7a	Trilluim01	Near confluence with Rock Creek	9/16/2014	Riffle	45.40831201	-122.509122