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

Michael B. Cole, PhD[1]; Kim Swan[2]; Andrew Swanson[3]
[1]Cole Ecological, Inc., [2]Clackamas River Water Providers, [3]Water Environment Services

## Introduction

In 2013, Clackamas River Water Providers (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). The review revealed numerous past assessments occurring between the late 1990s and the present.

This project was undertaken in 2016 to synthesize all of these known macroinvertebrate monitoring data and results from the lower Clackamas River basin since the late 1990s to the present (winter 2016/2017).

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).

## Methods

Data and methods from all known sources were reviewed to ensure that only data of sufficient technical quality were included for analysis using standard techniques for assessing ecological conditions in western Oregon rivers and streams. See "**Data Sources**" below for list of agencies/organizations whose data were included in this analysis.

As necessary, original project data were re-analyzed with taxonomic data that were re-coded to taxonomic levels appropriate to the analyses used in this study. This review summarized the results across these previous assessment and monitoring efforts.

Ecological conditions were summarized for all tributary streams using ecoregion-appropriate Oregon DEQ PREDATOR models (Hubler et al. 2008), and the for lower mainstem Clackamas River using the Oregon DEQ western Oregon multimetric index (WQIW 1999).

Data were also analyzed for this study using stressor models (Huff et al. 2006) to determine the likelihood of impacts of fine sediment and temperature pollution to macroinvertebrate Communities in Clackamas River tributaries.

To the extent that the data allowed, inferences regarding trends in conditions were made where multiple years of data exist.

## Results (Clackamas River tributaries)

Among 71 lower Clackamas River tributary sites, 10 sites received average PREDATOR O/E scores corresponding to "least disturbed" conditions, 7 sites had scores corresponding to "moderately disturbed" conditions, and 54 sites had scores corresponding to "most disturbed" conditions (see table & map).

| Subwatershed | O/E Disturbance Class 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 |

**Rock Creek & Lower Clackamas River subwatershed and the two Deep Creek subwatersheds**: Conditions were primarily "most disturbed" (red highlight = most disturbed, yellow = moderately disturbed, green = least disturbed). The tables below are PREDATOR model scores.

| 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** | | | | | | | | | | | | | |
| Trillium01 | | | | 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 |

| Waterbody | 1997 | 1998 | 1999 | 2003 | 2004 | 2005 | 2006 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | AVG | # Years |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NORTH FORK DEEP CREEK-DEEP CREEK SUBWATERSHED** | | | | | | | | | | | | | | | |
| **Deep Creek** | | | | | | | TR | TR | | | | | | | |
| Deep01 | | | | | | | | | | | | | | | |
| LT1 Deep02 | | | | 0.630 | | | | | | | | | | 0.630 | 1 |
| **Doane Creek** | | | | | | | | | | | | | | | |
| LT2 Doane01 | | | | | | | | | | 0.399 | | 0.268 | 0.333 | 0.333 | 2 |
| Doane02 | | | | | | | | | | 0.399 | | 0.268 | 0.333 | 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 | 0.845 | 3 |
| **Tickle Creek tributary** | | | | | | | | | | | | | | | |
| TickleTrib01 | | | | | | | 0.390 | | | | 0.339 | | 0.364 | 0.364 | 2 |

**Eagle Creek and Clear Creek subwatersheds:** Conditions more evenly distributed across the three disturbance classes.

| 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 |
| **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 |

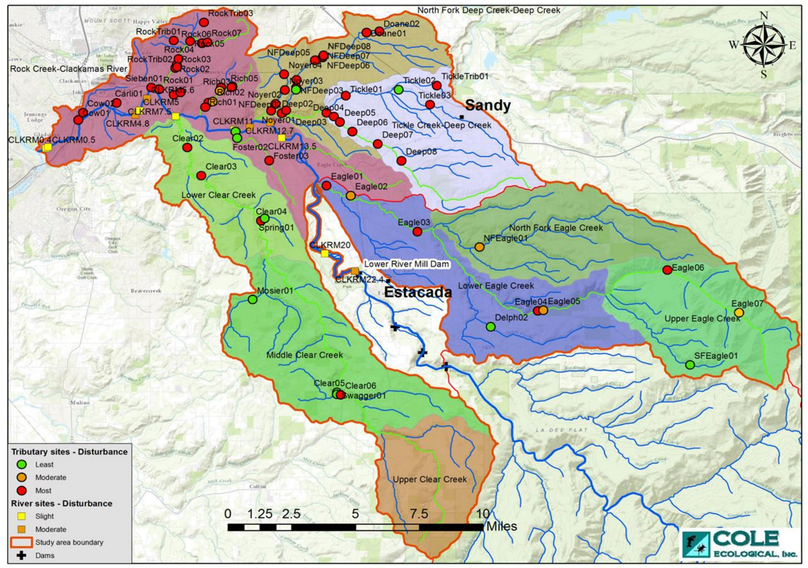
| Waterbody | 1997 | 1999 | 2001 | 2003 | 2013 | 2014 | AVG | # Years |
|---|---|---|---|---|---|---|---|---|
| **LOWER CLEAR CREEK SUBWATERSHED** | | | | | | | | |
| **Clear Creek** | | | | | | | | |
| LT1 Clear01 | | ND | | | | | | 1 |
| Clear02 | | | | | 0.582 | | 0.582 | 1 |
| Clear03 | | | | | | 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 |

**Temperature and fine sediment stressor model** results suggest that water temperature and fine sediment are each likely stressors to macroinvertebrate communities throughout much of the lower Clackamas River basin (see red highlighted cells in table).

| Site | Stressor Optima TS | FSS |
|---|---|---|
| **Lower Clear Creek** | | |
| Clear02 | 24.6 | 12.4 |
| Clear03 | 22.5 | 14.5 |
| Clear04 | 21.6 | 11.5 |
| Spring01 | 17.9 | 11.0 |
| **Middle Clear Creek** | | |
| Clear05 | 18.0 | 7.3 |
| Mosier01 | 18.7 | 15.0 |
| Swagger01 | 17.4 | 8.0 |
| **Lower Eagle Creek** | | |
| Delph02 | 18.4 | 10.0 |
| Eagle01 | 22.6 | 9.9 |
| Eagle02 | 22.7 | 8.0 |
| Eagle03 | 20.5 | 9.0 |
| **North Fork Eagle Creek** | | |
| NFEagle01 | 18.1 | 6.0 |
| **Upper Eagle Creek** | | |
| Eagle07 | 14.5 | 1.0 |
| SFEagle01 | 12.2 | 2.0 |

| Site | Stressor Optima TS | FSS |
|---|---|---|
| **North Fork Deep Creek-Deep Creek** | | |
| Deep02 | 20.7 | 17.6 |
| Doane01 | 20.7 | 51.3 |
| Doane02 | 24.5 | 58.3 |
| NFDeep01 | 21.4 | 24.9 |
| NFDeep02 | 19.4 | 32.1 |
| NFDeep03 | 18.0 | 23.5 |
| NFDeep04 | 18.0 | 28.9 |
| NFDeep05 | 19.8 | 42.0 |
| NFDeep06 | 21.3 | 37.0 |
| NFDeep07 | 20.3 | 38.0 |
| NFDeep08 | 21.4 | 29.3 |
| NFDTrib01 | 17.2 | 20.9 |
| Noyer02 | 16.1 | 14.8 |
| Noyer03 | 16.7 | 23.4 |
| Noyer04 | 19.1 | 36.5 |
| **Tickle Creek-Deep Creek** | | |
| Deep04 | 20.3 | 13.0 |
| Deep05 | 18.5 | 12.0 |
| Deep06 | 21.5 | 10.2 |
| Deep07 | 19.6 | 9.9 |
| Deep08 | 18.9 | 12.0 |
| Tickle01 | 21.7 | 21.7 |
| Tickle03 | 19.6 | 17.8 |
| TickleTrib01 | 19.9 | 47.4 |

| Site | Stressor Optima TS | FSS |
|---|---|---|
| **Rock Creek-Clackamas River** | | |
| Carli01 | 20.5 | 46.2 |
| CLKRM11Side | 26.4 | 76.2 |
| Cow01 | 22.8 | 76.8 |
| Cow02 | 21.6 | 75.5 |
| Foster01 | 19.3 | 12.4 |
| Foster03 | 20.5 | 31.6 |
| Rich01 | 18.4 | 13.5 |
| Rich02 | 16.8 | 12.7 |
| Rich03 | 18.3 | 13.5 |
| Rich05 | 17.5 | 12.4 |
| RichTrib01 | 15.9 | 10.7 |
| RichTrib02 | 19.2 | 30.5 |
| RichTrib03 | 17.6 | 14.7 |
| Rock01 | 18.7 | 13.0 |
| Rock02 | 18.9 | 25.7 |
| Rock03 | 17.7 | 18.0 |
| Rock04 | 20.6 | 24.5 |
| Rock05 | 21.4 | 51.6 |
| Rock06 | 20.5 | 26.9 |
| Rock07 | 20.9 | 38.4 |
| RockTrib01 | 17.4 | 31.9 |
| RockTrib02 | 18.6 | 23.2 |
| RockTrib03 | 21.4 | 67.5 |
| Sieben01 | 17.4 | 20.0 |
| Trillium01 | 17.8 | 20.0 |
| Willow01 | 19.2 | 46.2 |
| Willow02 | 16.6 | 29.1 |




## Results (mainstem lower Clackamas River)

Average multimetric index (MMI) scores ranged from 30 to 32.3 across five mainstem **Clackamas River** reaches sampled from 2013 through 2015, suggesting very similar macroinvertebrate community conditions throughout the lower Clackamas River.

These five reaches all scored in the "slightly disturbed" range . 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.

| 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 |

## Conclusions

- 54 of 71 tributary reaches were classified as "most disturbed" based on PREDATOR O/E scores
- Severe disturbance is most widespread in the Rock-Clackamas and Deep Creek subwatersheds
- Biological conditions more evenly distributed across disturbance classes in Clear and Eagle Creek drainages
- No sites with 3 or more years of data exhibited obvious indications of declining ecological conditions over the past 10-15 years
- Both temperature and fine sediment are impacting macroinvertebrate communities in much of the lower Clackamas River basin
- Of 13 long-term monitoring sites identified by Cole (2013), 6 have been sampled since 2013; only 1 site has been sampled in the last 2 years.

## Contact

Michael Cole
Cole Ecological, Inc.
Email: mikecole@comcast.net
Phone: 503-939-7428

## References

1. **Cole, M.B. 2013.** Lower Clackamas River Basin Macroinvertebrate Monitoring Plan. Unpublished report prepared for the Clackamas River Water Providers, Oregon City, OR. 35 pp.
2. **Hubler, S. 2008.** PREDATOR: Development and use of RIVPACS-type macroinvertebrate models to assess the biotic condition of wadeable Oregon streams. Oregon Department of Environmental Quality. DEQ08-LAB-0048-TR 51 pp.
3. **Huff, D. D., S. L. Hubler, Y. Pan, and D. L. Drake. 2006.** Detecting shifts in macroinvertebrate assemblage requirements: Implicating causes of impairment in streams. Oregon Department of Environmental Quality. DEQ06-LAB-0068-TR Version 1.1 37 pp.
4. Water Quality Interagency Workgroup (WQIW). 1999. Chapter 12: Stream macroinvertebrate protocol, Oregon plan for salmon and watersheds. Water Quality Monitoring Guide Book, Version 1.03. Water Quality Interagency Workgroup for the Oregon Plan.

## Data Sources

1. Adams, J. 2001. Using Aquatic Macroinvertebrates to Assess Stream Condition in the Clackamas River Basin, Oregon. Unpublished Master's Thesis. University of Washington. 83 pp.
2. Cole, M. B. 2004. Baseline Assessment of Stream Habitat and Macroinvertebrate Communities in and Adjacent to the Damascus Area Urban Growth Boundary Expansion, Oregon. Unpublished report prepared for Metro, Portland, Oregon.
3. Water Environment Services
4. Clackamas River Basin Council
5. Clackamas Soil & Water Conservation District
6. United States Geological Survey
7. Oregon Department of Environmental Quality
8. Clackamas River Water Providers

© POSTER TEMPLATE BY GENIGRAPHICS® 1.800.790.4001 WWW.GENIGRAPHICS.COM