Oregon Water Quality Index: Background, Analysis and Usage

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and

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What is the OWQI?

The Oregon Water Quality Index (OWQI) is a statistical tool used to analyze a defined set of water quality variables and produce a score describing general water quality for a particular monitoring site. OWQI scores range from 10 (worst case) to 100 (ideal water quality). These scores allow the Oregon DEQ to communicate overall water quality information to the public, agency managers and the Oregon Legislature in an easy-to-understand, non-technical manner.

To reach this point, complex water quality data is converted into sub-index values using parameter specific equations that account for variability within the data. These values are then aggregated using a formula that allows the most impaired parameter to impart the greatest influence on the water quality index and ensures that small individual changes are detectable in the aggregated index value (Cude 2001). Variables included in the OWQI are temperature, dissolved oxygen (percent saturation and concentration), biochemical oxygen demand (BOD), pH, total solids, ammonia and nitrate nitrogen, total phosphorous and bacteria. For more information on the importance of each of the included variables to water quality and aquatic life, see the Willamette River Report Card Water Quality Indicator document.

Where is the OWQI applied?

The DEQ Laboratory monitors a network of 163 ambient water quality sites throughout the state six times a year. These sites represent the diverse land use coverage and geography within Oregon, and include major rivers and streams throughout the state. The ambient network and subsequent water quality index reporting is Oregon's only long-term, systematic, continuously funded statewide river water quality monitoring program. The DEQ began monitoring the oldest sites in the late 1940s and many sites in the network contain data going back more than 30 years, allowing for long-term trending in DEQ's progress toward meeting state water quality objectives. The size of the network periodically changes due to logistical and budgetary constraints. For example, 19 sites were added to the ambient network in 2012/2013 with funding support from the Oregon Department of Agriculture.

How is the OWQI used?

Yearly Status and Trend Reporting

The DEQ presents the OWQI results in two ways: status and trends. Status is determined using the statistical package R to calculate a 10-year seasonal average for the summer (June to September) and fall-winter-spring (October to May) seasons at each site. The minimum of these two 10-year seasonal averages is for scoring purposes based on the classifications in Table 1. To identify any potential trends at a sampling site, the DEQ uses R to calculate a Seasonal Kendall test score for sites with a minimum of 30 data points during the appropriate 10-year period. The nonparametric Seasonal Kendall test accounts for seasonal variation in the data, meaning that any significant trends exist beyond normal seasonal variation. The magnitude and direction of significant trends (confidence level $\geq$ 80 percent) are reported. The magnitude is the slope of the trend line. A larger magnitude equals a more rapid rate of change at that site. In addition to an easy-to-understand comparison of water quality over the last decade, by taking a closer look at the location and sub-index scores, trend data may help identify the effects of underlying issues (e. g., point or non-point pollution). This is the first year that DEQ has used R rather than WQ Hydro to calculate OWQI status and trend information.

OWQI Score	Status
90-100	Excellent
85-89	Good
80-84	Fair
60-79	Poor
10-59	Very Poor

Table 1. OWQI Status Classifications

Reporting to the Oregon Legislature

In the 1990s and early 2000s, the Oregon Progress Board and the Oregon Legislature established benchmarks and standardized key performance measures with which to monitor progress towards strategic goals for Oregon's rivers (Table 2). The performance results for these measures since 1990 are displayed in Figure 1.

Table 2. Oregon Progress Board and Oregon Legislature benchmarks.

#	Legislative Key Performance Measure	Target
KPM 8a	IMPROVING WATER QUALITY - Percent of monitored stream sites with significantly improving trends in water quality.	20%
KPM 8b	WORSENING WATER QUALITY - Percent of monitored stream sites with significantly declining trends in water quality	2%
KPM 8c	OVERALL WATER QUALITY STATUS - Percent of monitored stream sites with good or excellent water quality	55%

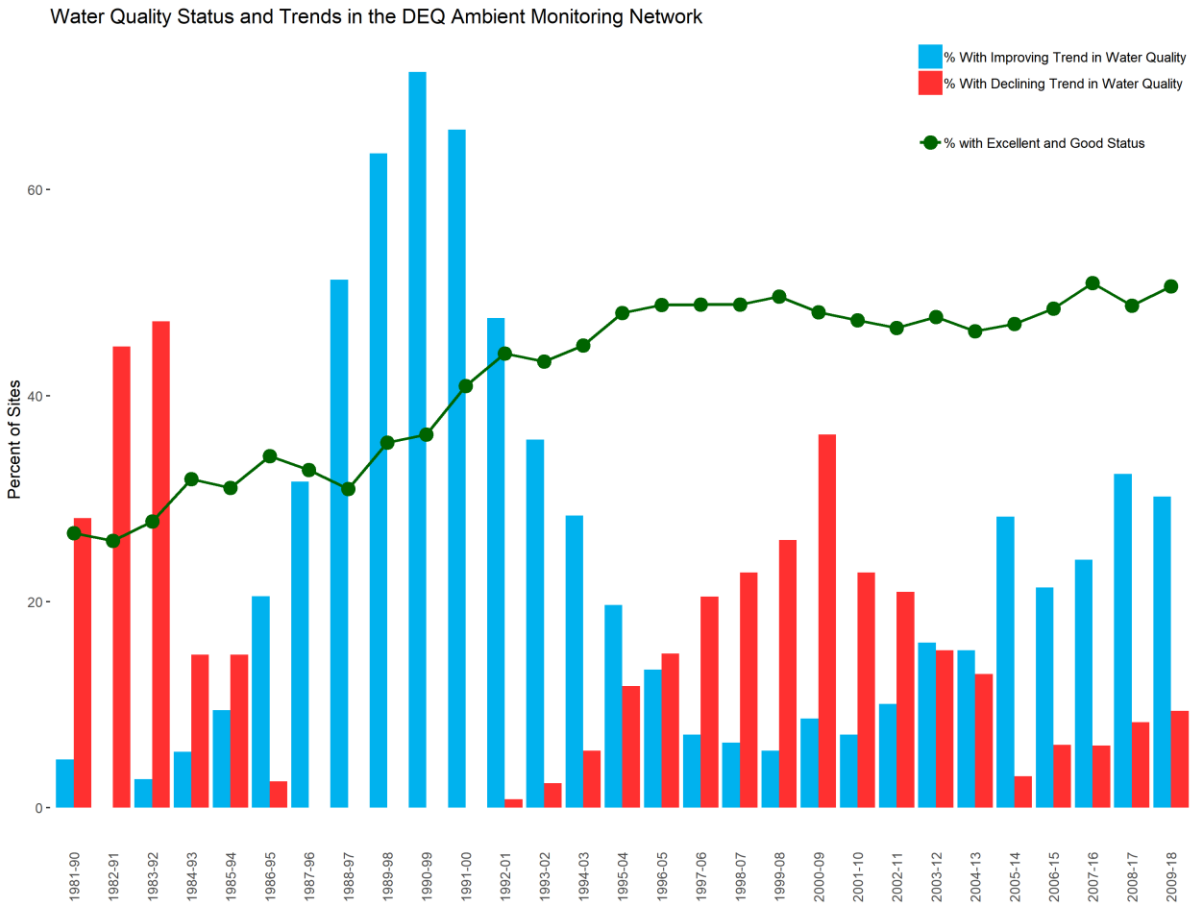

Figure 1. Performance of Oregon's waters based on the Oregon Legislatures key performance measures. Data covers WY 1981-2018. Blue bars indicate the percent of sites with improving trends. Red bars indicate the percent of sites with declining trends. The green line indicates the percentage of sites with either excellent or good status.

Indicator for the assessment of biological condition

The OWQI is also used as resource in other DEQ reports, such as the Willamette Basin Rivers and Streams Assessment and the 2004 Coastal Coho ESU Report. The Willamette Basin Assessment used the OWQI sub-index scores to identify the extent of impairment per sub-index parameter and to determine the parameters most likely to impair the biological condition of fish and macroinvertebrates within the basin (Figure 2). The Coastal Coho report relied heavily on the OWQI to compare water quality between the fall-winter-spring season when Coho are present and the summer season when Coho are largely absent from the ESU. The OWQI was also used to identify which sub-index values contributed to the improvement of water quality along the coastal evolutionarily significant unit between WY 1993-2002.

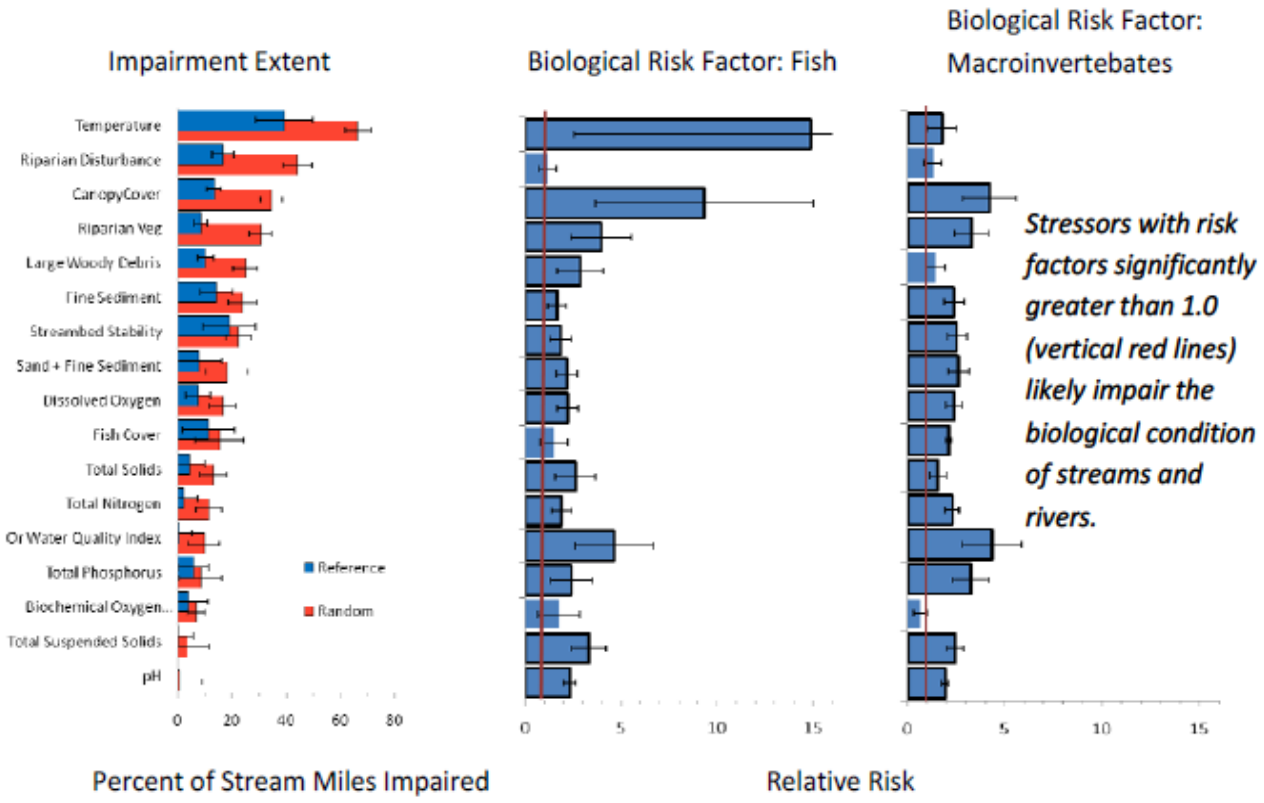

Figure 2. Shows low scores in the Oregon Water Quality Index can pose a significant risk factor to the health of both fish and macroinvertebrates in the Willamette basin rivers and streams (Willamette Basin Rivers and Streams Assessment).

Comparison to land use

Land use for sites in the ambient network is defined at the local level, using five mile radius buffer upstream of the sampling location. The percent of land use type, defined by a simplified classification of the National Land Cover Data set (NLCD; Table 3), for each buffer is calculated using GIS. For a site to be classified into a particular land use class there must be at least 50 percent cover in the buffer area. If there is no dominant class (≥50 percent), the site is classified as *mixed* land use.

Table 3. Land use categories used in this report (Simplified Anderson) were modified from more descriptive NLCD land use categories.

NLCD	Anderson Level 1	Simplified Anderson
11- Open Water	**1** -(Open Water)	Open Water
12 – Perennial Ice/Snow	**8** - (Ice/Snow)	Other
21 – Developed, Open Space	**2** - Urban	Urban
22 – Developed, Low intensity	**2** - Urban	Urban
23 – Developed, Medium Intensity	**2** - Urban	Urban
24 – Developed, High Intensity	**2** - Urban	Urban
31 – Barren Land	**3** -Barren	Other
41 – Deciduous Forest	**4** -Forest	Forest
42 – Evergreen Forest	**4** -Forest	Forest
43 – Mixed Forest	**4** -Forest	Forest
52 – Shrub/Scrub	**5** - Grassland/Shrub	Range
71 – Grassland/Herbaceous	**5** - Grassland/Shrub	Range
81 – Pasture Hay	**6** -Agriculture	Agriculture
82 – Cultivated Crops	**6** -Agriculture	Agriculture
90 – Woody Wetlands	**7** - Wetlands	Other
95 – Emergent Herbaceous Wetlands	**8** - Wetlands	Other
Anderson Classification: http://landcover.usgs.gov/pdf/anderson.pdf *NLCD: http://www.mrlc.gov/index.php*		

What are the limitations of the OWQI?

While the OWQI represents a rich source of information for documenting the state's success in restoring, maintaining and enhancing the quality of its rivers, the index does not include many possible stressors to rivers (i.e., toxic contaminants, habitat condition or biological community heath). It is simply one of several tools that help the DEQ better understand Oregon's water quality. The ambient network is not a randomly selected, statistically valid sample of water quality conditions statewide. Sampling sites were selected to reflect the integrated effects of land use, and point source discharges upstream of them. The data is representative of just the sampling site and does not represent the water quality conditions of other locations in the same basin or of the whole river. Furthermore, DEQ cannot use OWQI results to infer the status of all river miles across the state.

The OWQI assumes that samples are collected from freshwater rivers and streams, however, some of the sampling locations within the ambient network are tidally-influenced or estuarine, meaning that conductivity above 200 µS/cm can occur. High conductivity may potentially bias Total Solids sub-index scores and unfairly assign a lower status at these locations. As of the 2014 OWQI report, samples from these sites (n = 5) have been excluded from both status and trend analysis.

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