State of Oregon
DEQ Department of Environmental Quality

2026 Integrated Report – Freshwater Biocriteria Assessment Methodology Update

Summary of Scientific Peer Review

Purpose of the review

The Oregon Legislature established in statute the need for scientific and technical input including peer review as appropriate on updates to the Integrated Report assessment methodology in 2015. In 2017, the Oregon Department of Environmental Quality convened a panel of bioassessment experts to solicit independent scientific and technical input regarding the biocriteria impairment assessment benchmarks. Over the past several years, DEQ worked to address the peer review panel's findings, and made significant updates for the 2026 Integrated Report Assessment Methodology. DEQ again solicited scientific and technical peer review for the draft 2026 Integrated Report Assessment Methodology.

DEQ convened the peer review panel in October 2024. DEQ chose members of the panel first from the list of panelists involved in the 2018 biocriteria updates project and replaced those who were unavailable with individuals from the same or similar organizations. The panelists completed review of the methodology on Nov. 1, 2024.

The role of the scientific review panel was to provide technical review and input on DEQ's proposed update to the existing biocriteria assessment methodology for use in the 2026 Integrated Report (and future reporting cycles). The technical review panel was tasked with reviewing whether:

1. DEQ's updated assessment benchmarks adequately represent impairment and attainment of biocriteria.
2. A new approach for setting ecological-based benchmarks was appropriate.
3. DEQ had adequately addressed recommendations from the 2018 peer review panel.

The six panel members include experts in the aquatic ecology field and representatives from Tribal, federal agencies, academia, and professional scientists.

DEQ has updated the draft assessment methodology based on the input from the peer review panel. Pursuant to ORS 468.B.039, an overview of the panelist recommendations and the proposed updated assessment methodology is available for public review and comment.

List of panelists

1. Ashley Coble, Ph.D., Senior Research Scientist, National Council for Air and Stream Improvements.
2. Dr. Charles Hawkins, Ph.D., Director, Western Center for Monitoring and Assessment of Freshwater Ecosystems, Utah State University.
3. Dr. Ian Waite, Ph.D., Research Biologist, U.S. Geological Survey Oregon Water Science Center.
4. Dr. John Van Sickle, Ph.D., Environmental Statistics Consultant.
5. Lester Yuan, Ph.D., US EPA – Office of Water.
6. Negonne Blair, MES, Environmental Toxicologist, Confederated Tribes of the Umatilla Indian Reservation

Summary of assessment methodology update provided to the group

DEQ provided the scientific peer review panel a technical support document detailing the proposed updates to the assessment methodology and a rationale for decisions made and other supporting information. This proposed update represented the largest revision to Oregon's freshwater bioassessment methodology for the Integrated Report to date.

The primary changes described were:

1. An update to the previous approach to define reference condition.
2. Refinement of DEQ's existing observed vs. expected index (O/E index).
3. The introduction of two new assessment indices: multi-metric index (MMI) and biological condition gradient (BCG).
4. A new approach to derive ecologically relevant assessment benchmarks based on the relationship between the individual indexes and the biological condition gradient.
5. The adoption of a hybrid assessment framework that uses multiple lines of evidence.

These updates were designed to increase confidence in waterbody assessment conclusions and categorical determinations based on biological data. Questions posed to the peer review panel:

1. Do DEQ's updated assessment benchmarks adequately represent the designation of impairment and attainment based on the interpretation of Oregon's narrative biocriteria standard, designed to protect aquatic life? If not, what are the limitations of the benchmarks and how might they be improved?
2. By using the BCG to set assessment benchmark values, has Oregon effectively linked assessment benchmarks to ecological condition?
3. Has DEQ adequately addressed areas of concern raised by the 2018 peer review panel? If not, what further analysis are needed to address remaining concerns?
4. Are there any additional considerations DEQ should consider for future methodology updates?

DEQ reviewed the responses to the targeted questions posed to the review panel and summarized the major conclusions from the panel members. Based on panel recommendations, DEQ made four major updates to its proposed methodology. A summary of each update is included in the following section.

1. DEQ will not apply this methodology to biological samples with low (<300) total abundance.
2. DEQ will not use the relationship with BCG to set assessment benchmarks for O/E index and MMI. The O/E index and MMI will be the only indexes used in the hybrid assessment framework, and benchmarks will be statistically based values.
3. DEQ will use the narrative BCG to link statistically based assessment benchmarks to ecological conditions for communicating the assessment benchmarks.
4. DEQ will increase the minimum sample size for attainment and impairment decisions from one to two biological samples.

Assessing low count samples

DEQ developed O/E and MMI indexes in consultation with experts at Utah State University's Western Center for Monitoring. Standard model development protocols call for reference and/or most disturbed samples with a goal of 300 or more individuals, but not all available samples reach this target. Using this target as a hard rule would have severely limited the number of sites available for index development and thus reduced representativeness across Oregon. Increased spatial representation was a major concern in previous public comments and the 2018 peer review process. In a wide variety of modeling scenarios, DEQ observed similar model performances with 200 count limits on reference calibration samples as with 250 count limits. Given these results, DEQ chose the 200 count minimum for model development, which resulted in greater spatial representation of the models. Only 8 out of 221 reference samples had total operational taxonomic units abundances less than 250.

Based on comments from the panel, DEQ explored the effects of varying subsample amounts on O/E index and MMI scores by altering random subsampling sizes to 300, 250, 200, and 150 counts, then repeating this 20 times for each reference calibration sample. As suggested by the reviewer, effects were more pronounced for the O/E index, which relies exclusively on richness, than the MMI. Compared to 300 count samples, results showed moderate changes (reductions in mean index scores and increased variability) for 150 count samples, minimal changes for 200 count samples, and very little changes for 250 count samples. However, based on the concern raised over incorrectly applying these models to sample with less than 300 count, DEQ proposes a conservative approach to assessment, requiring a minimum of 300 count to assess biocriteria with O/E and MMI indexes.

Using the BCG to define assessment benchmarks for impairment and attainment

In the first draft of the assessment methodology, DEQ proposed to use the BCG to define assessment benchmarks for impairment and attainment. The relationship between BCG and the other two indices was then used to translate the BCG-based benchmarks to derive assessment benchmarks for the O/E index and MMI. Multiple panelists stated that DEQ's interpretation of where biological impairment occurs along the BCG gradient was inadequate to fully protect aquatic life. Multiple panelists suggested that BCG level 4 (continuous > 3.5) should be the benchmark for impairment, rather than BCG level 5 (continuous > 4.5). Another panelist argued that BCG level 3 (continuous > 2.5) represents impairment, or specifically "detrimental change" as noted in the narrative biocriteria standard.

Prior to choosing BCG benchmarks, DEQ polled the expert panel that helped to develop the Pacific Northwest Maritime Region BCG about where they felt the lines of attainment and impairment were in relation to the BCG narrative levels. The majority of panelists agreed that BCG levels 5 and 6 were clearly impaired, BCG level 4 was likely impaired but of uncertain condition, and BCG levels 2 and 3 were attaining, with BCG level 3 representing only minor changes to resident biological communities and "comparable to that of natural habitats of the region" (i.e., equivalent to "least disturbed" reference conditions). DEQ will suggest that the BCG expert panel officially incorporate attainment and impairment benchmarks in the 2025 Pacific Northwest Maritime Region BCG expansion project, with a goal of expanding the BCG to cover the entire state.

DEQ accepts the concerns several panelists presented about BCG model performance and using the BCG to set benchmarks for other biological indexes. Given concerns over the applicability of the Pacific Northwest Maritime Region BCG to other regions, such as eastern Oregon, the need for further validation and addressing overlap among BCG levels, as well as concerns over the appropriate BCG level to represent attainment and impairment, DEQ proposes to suspend use of the BCG in establishing ecological-based assessment benchmarks.

Instead, DEQ will use the same statistical approach as used in previous interpretations of the narrative biocriteria standard for use in developing the Integrated Report. DEQ will continue to use statistical-based benchmarks at the 10^{th} and 25^{th} percentiles of index values for reference calibration samples used to build the indexes. The 2018 peer review panel confirmed that this approach was valid, derived from standard and acceptable methods, based soundly on a statistical distribution approach and similar to methods used in other states.

Using the BCG to link benchmarks to ecological condition

The majority of panelists agreed that the BCG offers an opportunity to more effectively portray the ecological losses and consequences of low quantitative biological index scores, meaning the O/E and MMI indices. Multiple panelists felt DEQ's methods for using the BCG to set ecological thresholds were problematic. There was concern that the BCG is a qualitative index of biological condition and DEQ's efforts to transform it into a quantitative measure were misguided. Specifically, two panelists mentioned there was no way to quantitatively measure the difference between BCG levels. The BCG uses an ordinal scale, which is equivalent to ranking.

There are examples of biological indexes that rely on rankings to generate continuous index values. For example, in perhaps the most widely known biotic index, Hilsenhoff (1987) used an ordinal scale to identify taxa tolerances to organic pollution, then weighted these tolerances by relative abundances of the taxa. Carlisle et al. (2007) followed this same approach of using ranked tolerances to a variety of stressors.

As such, DEQ supports the idea that the BCG can be used to establish quantitative differences in biological conditions of macroinvertebrate assemblages. The idea that BCG level 2 is lower (higher ecological value) than BCG level 3 (slight signs of ecological stress) is similar to the difference between a taxon with a tolerance value of 2 (intolerant) or a tolerance value of 3 (slightly more tolerant, but overall, still intolerant). That said, at this point DEQ accepts this feedback and will use the qualitative bins of the BCG levels to show that as O/E index and MMI values decline, they generally follow declines in ecological condition as defined by the BCG narrative.

There was also concern for using the BCG in regions where it was not calibrated. Given the panelists' concerns over BCG variability and calibration area, DEQ agrees that the existing BCG needs further validation and should be expanded to cover the entire state prior to using it to select specific biocriteria benchmarks. For the time being, DEQ will use the narrative descriptions of ecological condition provided by the BCG to help interpret the statistically derived O/E and MMI benchmarks. Once the BCG is calibrated statewide and more closely aligned with the other indexes, DEQ hopes to further integrate the BCG into the future assessment methodology.

Additional considerations raised by the panel

Assessment options for xeric regions

DEQ's O/E and MMI indices were developed by excluding sites in southeast Oregon, due to samples from this region substantially reducing index performance. This decision currently leaves this region without modeled (i.e., site-specific expectations) bioassessment indexes. Instead, DEQ will use a best professional judgement approach, where experts in bioassessment examine each sample in detail and make decisions on attainment or impairment.

As background, DEQ worked with Utah State University to incorporate as many new reference sites as possible in this region, in hopes to include it in the updated O/E and new MMI indexes. Unfortunately, just as in our previous modeling efforts (PREDATOR, or RIVPACS v1.0), inclusion of southeast Oregon samples in our indexes dramatically reduced global model performance.

Future work for southeast Oregon, and xeric streams in general

One panelist referenced the use of a potential alternative approach to assessing streams in arid regions. Modeled taxa richness was suggested as an improved alternative to null or full O/E models to assess macroinvertebrates in xeric streams. DEQ will work with Utah State University in the future to explore the use of this approach to assess southeast Oregon and other xeric regions across the state.

Lack of reference sites in some regions

One panelist noted that there were no reference sites in the Columbia Plateau ecoregion, and they expressed the need to work with Washington's Department of Ecology to share reference data. In DEQ's O/E v1.0, several Washington sites from this region were incorporated into the index. DEQ initially explored integrating these and other Washington Ecology reference sites into our analyses. However, there were significant and inconsistent levels of disturbance in Washington Ecology's reference sites that complicated their use in the context of DEQ's Reference Condition Approach, or RCA, improvement process which controlled for similar disturbance levels across Oregon's landscape.

There have been limited conversations between DEQ and Washington Ecology about potential work to fully share RCA methods. In lieu of Washington Ecology adopting DEQ's RCA and thus being able to share all reference data equally, DEQ could explore selectively drawing from those Washington reference sites that meet DEQ's RCA criteria to boost representativeness for the Columbia Plateau. However, given the large-scale human impacts in this region across both states, it is uncertain how many additional reference sites can be gained with additional efforts.

BCG index needs additional development and exploration before widespread use

As mentioned above, there were a variety of concerns with the integration of the BCG into DEQ's biocriteria assessment methodology. These ranged from a need for further validation to ensure accuracy and distinctions between levels, as well as a reassessment of which levels constitute attainment/impairment and explicitly defining the levels in association with DEQ's narrative biocriteria water quality standard.

DEQ will be actively participating in the next round of the Oregon and Washington BCG workgroup, which is currently scheduled to begin in 2025. The primary goal will be to expand the BCG to cover the eastern portions of both states. In addition, DEQ will work with the BCG expert panel come up with recommendations on the application and interpretation of the BCG to address the concerns expressed by the peer review panel.

Conclusion

DEQ is grateful for the thorough review provided by the scientific review panel. This proposed assessment methodology and accompanying technical support document have been revised in response to concerns raised by the panel.

Contact

Lesley Merrick, Water Quality Assessment Lead

Shannon Hubler, Biomonitoring Program Lead

Non-discrimination statement

DEQ does not discriminate on the basis of race, color, national origin, disability, age, sex, religion, sexual orientation, gender identity, or marital status in the administration of its programs and activities. For translations or alternate formats, visit DEQ's Civil Rights and Environmental Justice page.