March 12, 2025

Assessment Methodology for Oregon's 2024 Integrated Report

For development of the Water Quality Status Report and List of Impaired Waters

Pursuant to Clean Water Act Sections 303(d) and 305(b) and OAR 340-041-0046

DEQ

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Executive summary

The federal Clean Water Act requires Oregon to report on the quality of its surface waters every two years. Oregon surface waters are assessed to determine if they contain pollutants at levels that exceed protective water quality standards. The result of these analyses and conclusions is called the "Integrated Report" because it combines the requirements of Clean Water Act section 305(b) to develop a status report and the section 303(d) requirement to develop a list of impaired waters.

U.S. Environmental Protection Agency regulations require states to describe the methodology, data and information used to identify and list segments of water bodies that are considered "water quality limited" -- or impaired -- and require cleanup plans known as Total Maximum Daily Loads. This Assessment Methodology contains the "decision rules" DEQ will use to compare data and information to existing water quality standards for the development of Oregon's 2024 Integrated Report.

For the 2024 Integrated Report, DEQ incorporated new and revised assessment methodologies. The largest update this cycle is the inclusion of methodologies to assess the impacts of hypoxia and ocean acidification in Oregon's territorial sea. Additionally, DEQ revised the water contact recreation methodology and specific delisting requirements for temperature impairments. Supporting information for these can be found on the Assessment Methodology Updates website.[1] Appendices on the of the application of these methodology updates and a detailed rationale for assessing aquatic trash data received during the Call for Data are available at the end of this document.

Acknowledgements

DEQ would like to acknowledge the valuable contributions of DEQ's 2022 Ocean Acidification and Hypoxia Technical Workgroup to the development of some of the methodology updates included in this document. Recommendations and assistance offered during the workgroup process provided critical scientific and technical elements in the development of procedures for assessing impacts of ocean acidification and hypoxia in Oregon's marine territorial waters. Workgroup activities, meetings, and engagement process are summarized in a workgroup overview document available on the Integrated Report website.[2]

[1] Assessment Methodology Updates, 2024
[2] OAH Technical Workgroup Overview Document, 2024

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Introduction

The federal Clean Water Act Section 305(b) requires that states submit a biennial water quality inventory report in April of even numbered years. The report provides information on the water quality of all state surface waters; the extent to which state waters provide for the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife, and allow recreational activities in and on the water; and how pollution control measures are helping to attain water quality standards.

The CWA Section 303(d) additionally requires that each state identify waters where existing pollution controls are not stringent enough to achieve state water quality standards and establish a priority ranking of these waters. Section 303(d) requires states to develop Total Maximum Daily Loads for the identified impaired waters. TMDLs provide a science-based approach to cleaning up polluted water to meet state water quality standards. A TMDL is a numerical value that represents the highest amount of a pollutant a surface water body can receive and still meet the water quality standards. States submit the list of impaired waters needing TMDLs (303(d) list) to EPA for approval.

EPA regulations (40 CFR 130.7 and 40 CFR 130.8) specify the process for developing the 303(d) list and the content of the biennial water quality report. EPA guidance recommends that states submit an integrated report to satisfy 305(b) and 303(d) requirements.[3] The integrated report presents the results of assessing available data to determine where water quality standards are met or not met and identifies the pollutants causing water quality limitations or impairments. DEQ submits its report to the EPA through the ATTAINS database. [4]

EPA regulations require states to describe the methodology by which data and information is used to identify and list water quality limited segments requiring TMDLs. The assessment methodology contains the "decision rules" used to evaluate data and information. Oregon Administrative Rules (OAR 340-041-0046) also require the specific parameter assessment methodologies be identified. Oregon Revised Statute (ORS 468B.039) which was adopted by the legislature in 2015, requires DEQ to: (1) solicit independent scientific and technical input on alternative assessment methodologies, including scientific peer review as appropriate; (2) provide adequate public notice and an opportunity for public comment on draft assessment methodologies; (3) provide an informational overview of the draft assessment methodologies

[3] Oct. 12, 2006, Memorandum from Diane Regas, EPA Office of Wetlands, Oceans and Watersheds, Re: Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions
[4] The Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS)

before the Oregon Environmental Quality Commission (EQC); and (4) provide an opportunity for public comment on the draft assessment methodologies during the EQC meeting.

This document describes how DEQ will develop Oregon's 2024 Integrated Report for Section 305(b) and 303(d). The methodology is consistent with the key elements of Oregon's water quality standards and is the framework DEQ uses to assess water quality conditions. The methodology builds on DEQ's protocols from previous 305(b)/303(d) assessments. The 303(d) list produced from the 2024 Integrated Report incorporates, updates, and supplements 303(d) lists from previous assessment years. After submittal and approval by EPA, it will become Oregon's effective 303(d) list.

Timeline of past 303(d) actions and related rule revisions:

- EPA approved Oregon's 2022 303(d) list on Sept. 1, 2022

Oregon's Water Quality Standards

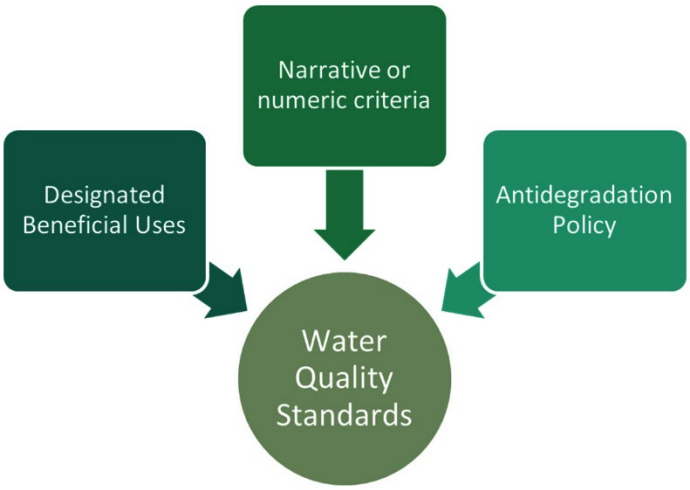


Figure 1. Water quality standards are made up of three components: designated beneficial uses, antidegradation policy, and narrative or numeric criteria

The objective of the Clean Water Act is to restore and maintain the physical, chemical and biological integrity of the nation's waters (CWA Section 101(a)). To achieve this objective, states develop and adopt water quality standards. Water quality standards include beneficial uses, narrative and numeric criteria, and anti-degradation and implementation policies (Figure 1). Oregon's water quality standards are adopted in Oregon Administrative Rules (OAR) Chapter 340 Division 41.[5] These rules include policies and criteria that are applicable throughout the state.

Beneficial uses for Oregon waters are designated by the EQC. General beneficial uses are designated by water basin or water body in OAR 340-041-0101 through OAR 340-041-0340, Figure 1, and Tables 101A through 340A, Figure 101A, Figures 220C through 220H, Figures 230C through 230H, Figures 300C and 300D and Figure 320C. Specific areas designated for

[5] Oregon Administrative Rules (OAR) Chapter 340 Division 41

coastal water contact recreation use and shellfish harvesting were added in August 2016. Specific fish uses are further designated in Tables 101B through 250B and Figures 130A through 340B. Beneficial fish use designations include explicit water body segment locations and time periods throughout the state for sensitive salmonid species and life stages that were added to Oregon's water quality standards in 2003.

Oregon water quality standards include statewide narrative criteria established in OAR 340-041-0007. Narrative criteria include provisions for:

- Prohibitions on fungi or other growths that negatively impact beneficial uses (OAR 340-041-0007(9))
- Prohibitions on tastes, odors, or toxic conditions that negatively impact beneficial uses (OAR 340-041-0007(10))
- Prohibitions on bottom deposits that negatively impact beneficial uses (OAR 340-041-0007(11))
- Prohibitions on objectionable discoloration, scum, oily sheens, floating solids, coatings on aquatic life (OAR 340-041-0007(12))
- Prohibitions on aesthetic conditions offensive to human senses (OAR 340-041-0007(13))

A statewide antidegradation policy is established in OAR 340-041-0004 to guide decisions that affect water quality. Additional policies for applying water quality standards to determine impaired waters are contained in OAR 340-041-0046 and in standards for specific pollutants.

Oregon water quality standards for specific pollutants or conditions are established in OAR 340-041-0009 (bacteria) through OAR 340-041-0036 (turbidity). These standards contain both narrative and numeric criteria for specific pollutants or conditions. Some pollutant criteria are applicable in waters with specified beneficial use designations, such as numeric criteria for temperature and dissolved oxygen that apply where and when certain fish uses are designated. Table 1 summarizes Oregon's beneficial uses and the narrative and numeric criteria that protect those uses. For the Integrated Report, DEQ evaluates pollutant data independently to determine whether beneficial uses are being supported. DEQ applies the currently effective criteria approved by EPA for CWA 303(d) purposes. The methodology to evaluate each pollutant is described in the Assessment Methodology for Specific Pollutants or Parameters section of this document.

Table 1. Oregon has designated beneficial uses for surface waters and adopts narrative and numeric criteria that are protective of those uses

Designated Beneficial Uses		Criteria Protecting Beneficial Use	
Designated Use[6]	**Use Subcategory**[7]	**Narrative Criteria**	**Parameter Numeric Criteria**
Aesthetic Quality		Statewide Narrative Criteria - Aquatic Weeds, Algae	Chlorophyll-a
Boating		Statewide Narrative Criteria - Aquatic Weeds	NA*
Fish and Aquatic Life		Narrative Criteria for: Biocriteria, Temperature, Toxic Substances, Turbidity	Dissolved Oxygen pH Temperature Total Dissolved Gas Toxic Substances - Aquatic Life
	Fish Use - Borax Lake Chub	Narrative Criteria for Temperature	Dissolved oxygen
	Fish Use - Bull Trout Spawning and Juvenile Rearing		Dissolved oxygen Temperature
	Fish Use - Cool Water Species	Narrative Criteria for Temperature	Dissolved oxygen
	Fish Use - Core Cold Water Habitat	Protecting Cold Water Narrative	Dissolved oxygen Temperature
	Fish Use - Lahontan Trout		Dissolved oxygen Temperature
	Fish Use - Redband and Hybrid Trout		Dissolved oxygen Temperature
	Fish Use - Redband or Lahontan Cutthroat Trout		Dissolved oxygen Temperature
	Fish Use - Salmon and Steelhead Migration Corridors	Cold Water Refuge Narrative	Dissolved oxygen Temperature

[6] Commercial navigation and transportation, Hydropower, Industrial water supply and Wildlife & hunting beneficial uses are protected by other more sensitive uses. DEQ may assess these uses dependent on the data and information provided.

[7] The Shad and Sturgeon spawning and rearing use is supported by protection of more sensitive uses.

Designated Beneficial Uses		Criteria Protecting Beneficial Use	
Designated Use[6]	Use Subcategory[7]	Narrative Criteria	Parameter Numeric Criteria
	Fish Use - Salmon and Steelhead Spawning		Dissolved oxygen Temperature
	Fish Use - Salmon and Trout Rearing and Migration		Dissolved oxygen Temperature
Fishing (Consumption)**		Toxic Substances Narrative Criteria – Consumption advisories	Toxic Substances - Human Health
	Fishing - Shellfish Harvesting	Statewide Narrative Criteria – HABs*** Narrative Criteria for Bacteria	Bacteria – Fecal Coliform Toxic Substances - Human Health
Irrigation			WDMC Site specific criteria in 340-041-0315****
Livestock Watering		Statewide Narrative Criteria - HABs Narrative Criteria for Bacteria	WDMC Site specific criteria in 340-041-0315
Private Domestic Water Supply		Statewide Narrative Criteria - HABs Narrative Criteria for Bacteria Narrative Criteria for Turbidity	Toxic Substances - Human Health (water + org. only)
Public Domestic Water Supply		Statewide Narrative Criteria - HABs Narrative Criteria for Bacteria Narrative Criteria for Turbidity	Toxic Substances - Human Health (water + org. only)
Water Contact Recreation		Statewide Narrative Criteria - HABs Narrative Criteria for Bacteria	Bacteria – E. coli and Enterococci

*NA – No specific applicable numeric criteria

**Fishing Use – Human consumptive use of fish and shellfish are protected by the Toxic Substances – Human Health criteria; Fish resources are protected under Fish and Aquatic Life.

***HABs – Harmful algal blooms.

****WDMC – West Division Main Canal near Hermiston, in northeastern Oregon.

Georeferenced standards maps

For convenience, the designation of beneficial uses by water basin or water body described in OAR 340-041-0101 through OAR 340-041-0350, and accompanying figures and tables, and

additional factors affecting the application of basin-specific criteria described in OAR 340-041, are depicted in a web-based GIS mapping application.[8]

While this web-based mapping tool is intended to be as accurate as possible. In the case of any discrepancy, the correct interpretation of the water quality standards rules within OAR-340-041 shall take precedence over any depictions, such as the web-based mapping application, which is not officially adopted into rule by the EQC.

Integrated Report process

DEQ prepares the Integrated Report by assembling data and information about surface waters in Oregon, comparing data and information to appropriate Oregon water quality standards, determining the condition and status of waters where data and information are available, updating assessments from previous reporting, and identifying the waters that do not meet water quality standards and support beneficial uses. The steps are described more fully in the following sections. The process is complete when DEQ receives approval from EPA on the final list of water quality limited waters that require a TMDL (Category 5: 303(d) list).

Tribal waters

Only those waters that are under the State of Oregon's jurisdiction are subject to the state's 303(d) and 305(b) assessment and reporting requirements. DEQ does not intentionally include tribal waters when assessing water quality or developing the 303(d) list and DEQ does not develop TMDLs for tribal waters unless a specific government-to-government collaboration is requested by a tribe. When a water body lies partially within tribal reservation boundaries, DEQ only assesses the segments that are within Oregon's jurisdiction to prepare Oregon's 303(d) list. Waters that form the boundary between tribal reservations and Oregon lands are assessed for the report.

Assembling data and information

To gather information on water quality for the report, DEQ assembles all available internal data, conducts a data query from publicly available state and federal databases and issues a public call for data. All data and information are reviewed by DEQ to determine completeness (required metadata elements) and data quality requirements. The process of assembling data and information for the report is described in more detail in the following sections.

8 Oregon 2024 Integrated Report Interactive Web Map

Data window

The assessment window for the 2024 Integrated Report includes data collected between Jan. 1, 2018 and Dec. 31, 2022.

Call for data

DEQ will issue a public call for data for the report by posting information on DEQ's website and notifying interested parties using an electronic email subscription list. The subscription list includes federal agencies, state agencies, tribes, local governments, academic institutions, watershed councils, private and public organizations, and individuals from the public. DEQ posted its 2024 Integrated Report statewide call for data for inland and estuarine waters from Feb. 6, 2023, through April 7, 2023, and for marine waters from June 15, 2023, through Aug. 14, 2023.

DEQ provides electronic templates for submittal of numeric grab chemical, biological and continuous data. Required data elements (monitoring location information, sample dates, etc.) are highlighted in the template to ensure completeness. Non-numeric data that cannot be tabulated in a spreadsheet must be related to specific locations within Oregon's waters. DEQ makes its water quality assessment conclusions on a water body-specific basis, and therefore, cannot base its assessment on generalized water quality information or information that is at a regional scale.

Data collected in recent years within the data window specified in the "call for data" may be submitted for consideration in the assessment. Data submitted previously that DEQ did not use because of quality assurance (QA) concerns should not be resubmitted unless new QA information is submitted that enables DEQ to use the data.

Data submitted after the deadline stated in the data call will not be considered for the current assessment/listing but can be resubmitted for the next assessment/listing cycle. Detailed data submittal information is specified in Oregon's 2024 Integrated Report Call for Data Submission Guidelines.[9]

Metadata requirements

To be able to evaluate data for the Integrated Report, DEQ requires that metadata accompany the sampling results submitted in response to the call for data, and all other readily available

[9] Oregon's 2024 Integrated Report Call for Data Submission Guidelines

sources Table 2. Required metadata are listed below. Missing or incomplete metadata may make data unusable for the report.

- Location of each monitoring station in latitude and longitude and the reference datum (example – NAD83).
- Water body name and description of the monitoring location.
- Date the sample was taken.
- Parameter(s) measured.
- Measured result for each parameter.
- Unit of measurement.
- Method used for measurement, including method detection limits (MDL) or reporting limits (RL) where applicable.
- Identification of data quality (such as Final, Rejected or Provisional)
- Identification of organization responsible for collecting and reporting the data.

Readily available data

DEQ pulls readily available numeric data from publicly available water quality databases which use a common reporting structure and contain the metadata requirements listed above. Information on water quality related advisories and reports are also pulled as outlined in parameter specific methods. Table 2 summarizes the main sources of readily available data and information DEQ currently uses.

Table 2. Current sources of readily available data used in the Integrated Report

Data Source	Location
DEQ Ambient Water Quality Monitoring System (AWQMS)	https://www.oregon.gov/deq/wq/Pages/WQdata.aspx
Water Quality Portal	https://www.waterqualitydata.us
USGS - National Water Information System (NWIS)	https://waterdata.usgs.gov/nwis/sw
Oregon Water Resources Department	https://apps.wrd.state.or.us/apps/sw/hydro_near_real_time/Default.aspx
City of Portland Bureau of Environmental Services	https://aquarius.portlandoregon.gov
Washington Department of Ecology	https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database
Portland Harbor Data	http://ph-public-data.com
Newport Hydrographic Line	By request
NOAA West Coast Ocean Acidification Cruises	https://www.ncei.noaa.gov/access/ocean-carbon-acidification-data-system/oceans/Coastal/WCOA.html
Oregon Invasive Species Hotline	https://oregoninvasiveshotline.org
Oregon Public Health Advisories for Recreation (Harmful Algal Blooms,	https://www.oregon.gov/oha/ph/newsadvisories/Pages/index.aspx

Data Source	Location
Fish Consumption Advisories, Shellfish and Beach Use)	
Oregon Department of Agriculture - Recreational Shellfish Biotoxin Closures	https://www.oregon.gov/oda/programs/foodsafety/shellfish/pages/shellfishclosures.aspx

Data quality requirements

All data used in the Integrated Report must have a project plan (Quality Assurance Project Plan or similar) and use widely accepted sampling and analysis methods. Internal DEQ and data collected through the Volunteer Monitoring Program must have data quality level of A or B. Data quality levels for parameters measured in the field are assigned following DEQ's Data Quality Matrix.[10] Analytical or laboratory analyzed data are assigned data quality levels based on quality control and assurance protocols and DEQ's internal data review. Data submitted through the call for data and queried from outside of DEQ will be screened for completeness, data quality and submission requirements and reasonable range of results. A reasonable range of results is determined by comparing the data to existing data from the region (sub-basin or basin scale). Third-party data must be labeled as "Final", or equivalent, to be included in the analysis. If data meet this first screen, DEQ will include it in its 2022 assessment. If the data are incomplete or out of the reasonable range, DEQ will analyze quality control data and may also follow up with the submitter for supporting documentation. The intent of the validation is not to eliminate data that may be showing a shift outside of a reasonable range, but rather to ensure that there is not an error in transcription or reporting units. Analytical laboratory data will be reviewed against current quality control limits established for the analytical method or the QC limits established by the laboratory that performed the testing and supplied the data to DEQ. DEQ also utilizes EPA National Functional Guidelines for Data Review as guidance when reviewing laboratory data.[11]

Where sample results included duplicates collected for QA/QC purposes, the primary sample result will be evaluated and counted only as one result.

Determining water quality status

The goal of the Integrated Report is to provide information about the condition and quality of Oregon's surface waters. Using available data, information, and water quality standards, DEQ reaches conclusions about whether conditions support the beneficial uses designated for the water body and meet water quality standards applicable in the water. The conclusions are

[10] Data Quality Matrix for Field Parameters (oregon.gov), May 2013
[11] EPA National Functional Guidelines for Data Review

communicated by using a set of assessment status categories described in EPA guidance and commonly used by states completing 303(d) and 305(b) Integrated Reports.

Assessment categories

EPA continues to recommend using five reporting categories as shown in Table 3 to classify water quality status for Oregon waters.[12] The categories represent varying levels of beneficial use support, ranging from Category 1, where all designated uses for a water body are supported, to Category 5, where a water body is impaired and a TMDL is required to return the water to a condition where the water quality standards are met.

DEQ uses the policy of independent applicability to assess attainment of water quality standards, as recommended by EPA[10]. Within an assessment unit, each water quality standard with sufficient data or information is evaluated independently and a category is assigned for that parameter. These parameter assessment conclusions are reported in DEQ's online database application. Since no water body has sufficient data or information to assess all designated uses and water quality standards, DEQ does not classify waters as Category 1. Figure 2 summarizes DEQ's general process for assigning assessment categories to assessed parameters.

Table 3. Assessment reporting categories recommended by EPA to classify water quality status of Oregon's surface waters

Category	Description
Category 1	All designated uses are supported. (Oregon does not have sufficient data to assess this category.)
Category 2	Available data and information indicate that assessed designated uses are supported and the water quality standard is attained.*
Category 3	Insufficient data to determine whether a designated use is supported.
	Oregon further sub-classifies waters if warranted as: **3B: insufficient data; potential concern:** Insufficient to determine use support but some data indicate non-attainment of a criterion. **3C: insufficient data; non-reference condition:** Biocriteria scores differ from reference condition, but are not classified as impaired.[13] **3D: insufficient data; not technologically feasible to assess:** Insufficient data to determine use support because numeric criteria are less than quantitation limits.
Category 4	Data indicate that at least one designated use is not supported but a TMDL is not needed. This includes:
	4A: TMDLs that will result in attainment of water quality standards and beneficial use support have been approved.

[12] Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act: United States Environmental Protection Agency, July 29, 2005

[13] Oregon uses subcategory Category 3C: Insufficient data; Potential Concern to identify waters where freshwater biocriteria O/E scores deviate from reference conditions but are not classified as impaired.

Category	Description
	4B: Other pollution control requirements are expected to address pollutants and will result in attainment of water quality standards.
	4C: Impairment caused by pollution, not by a pollutant (e.g., flow or lack of flow are not considered pollutants).
Category 5	Data indicate a designated use is not supported or a water quality standard is not attained and a TMDL is needed. This category constitutes the Section 303(d) list that EPA will approve or disapprove under the Clean Water Act.
	5C: Impaired; Climate Change Related: Data indicate a designated use is not supported or a water quality standard is not attained and there is sufficient information to suggest impairment is primarily due to global climate change. Waterbodies in this category will be added to the Section 303(d) list that EPA will approve or disapprove under the CWA, but given a low priority for TMDL development while appropriate restoration solutions are pursued. By maintaining these waters within category 5 (impaired waters needing a TMDL), this approach provides a public accounting of the true status of climate change related impairments.

*This category applies only to the assessed designated use or water quality standard. Other designated uses or water quality standards may or may not be attained.

EPA's supporting regulations recognize that alternative pollution control requirements may rule out the need for a TMDL. Specifically, impaired waters are not required to be included on a state's Section 303(d) list if technology-based effluent limitations required by the CWA, more stringent effluent limitations required by state, local, or federal authority, or "[o]ther pollution control requirements (e.g., best management practices) required by local, [s]tate or [f]ederal authority" are stringent enough to implement applicable water quality standards (see 40 CFR 130.7(b)(1)) within a reasonable period of time.[12] These alternatives to TMDLs are commonly referred to as "Category 4b" waters, as described in EPA's Integrated Reporting Guidance (IRG) for Sections 303(d), 305(b), and 314 of the CWA.[14]

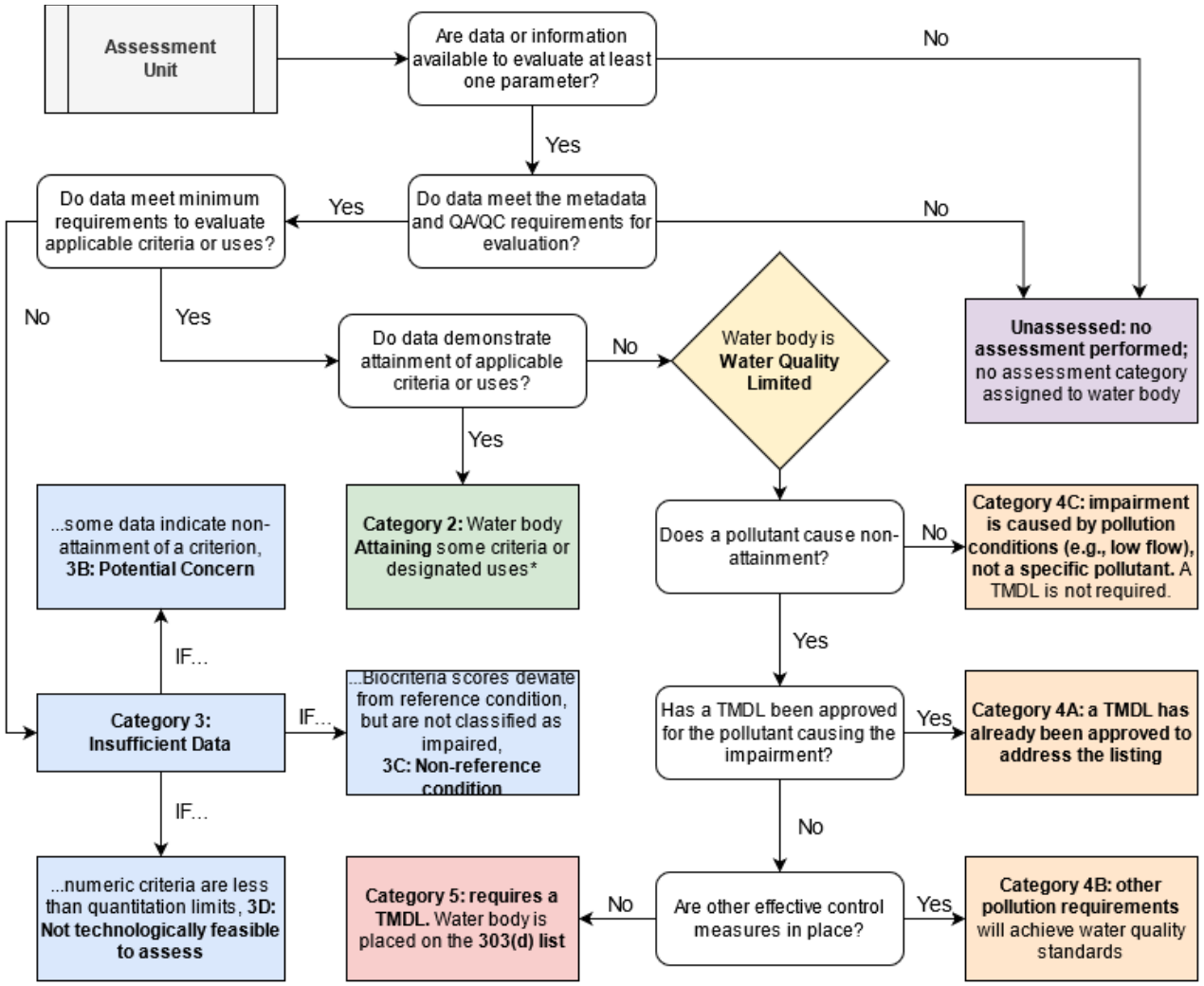
A Category 4B plan, must ensure attainment with all applicable water quality standards through agreed upon pollution control mechanisms within a reasonable time period. A Category 4B plan must be approved by both DEQ and the EPA for the affected water body to be placed in Category 4B. If a Category 4B plan is not accepted, the water body at issue will be included on the 303(d) List, as Category 5. EPA will evaluate on a case-by-case basis a DEQ's decision to exclude certain segment/pollutant combinations from Category 5 (the Section 303(d) list) based on a Category 4B alternative.

If a Category 4B plan is proposed in its Integrated Report submission, DEQ will include a rationale to support "other pollution control requirements" stringent enough to achieve

[14] EPA Integrated Reporting (IR) Categories and How ATTAINS Calculates Them, version 8/31/2018

applicable water quality standards within a reasonable period of time. The rationale will address the following six elements:

1. Identification of assessment unit and statement of problem causing the impairment
2. Description of the pollution controls and how they will achieve WQS, including a description of the pollutant loads needed to meet WQS and a description of the requirements under which the controls will be implemented
3. An estimate or projection of the time when WQS will be met
4. Schedule for implementing pollution controls
5. Monitoring plan to track effectiveness of pollution controls
6. Commitment to revise pollution controls, as necessary



*Note that Oregon does not use **Category 1: All designated uses are supported**, since no water body in the state has sufficient data available to asses all designated uses and water quality standards.

Figure 2. Decision tree for assigning assessment categories for the 2024 Integrated Report

Evaluating data and information

To characterize conditions in Oregon waters, DEQ assembles water quality data and information available from monitoring locations or sampling points on a water body. Samples may have been collected from one or more sampling locations and analyzed for a variety of pollutants or other chemical or physical characteristics. Monitoring may have occurred once or multiple times at a single location. The site monitoring data are the basis for characterizing the overall water quality status in a water body. The requirements and protocols for evaluating site monitoring data for specific pollutants and water quality standards are discussed in detail in the Assessment Methodologies for Specific Pollutants or Parameters section.

There are several water quality parameters that have separate numeric criteria for freshwater, saltwater, or estuary water types. To determine where freshwater and saltwater criteria apply, DEQ follows Oregon rules and EPA guidance.[15] Marine waters are defined in OAR 340-041-0002(34) as "...all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon." Estuarine waters are defined in OAR 340-041-0002(22) as "...all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties." In 2018, DEQ adopted the Oregon Coastal Atlas estuary classification using the Federal Coastal and Marine Ecological Classification Standard (CMECS) implemented by the Oregon Department of Land Conservation and Development to delineate the extent of estuaries and define where specific water quality criteria should apply. CMECS classification will be used to apply "estuary" criteria for dissolved oxygen, pH, nuisance phytoplankton, and to determine applicability of the more stringent of the saltwater and freshwater criteria for aquatic life toxic pollutants (OAR 340-041-0033–Table 30).

As part of the data review, DEQ confirms that site location information and analytical data results are complete, accurate, and appropriate for evaluation. Correct location information is critical to assign the monitoring site to the correct assessment unit which determines applicable water quality standards and appropriate numeric criteria to apply. Accurate and complete information about sample and analytical results is critical to determine if site data are comparable to a water quality standard and meet the assessment protocol for the specific pollutant.

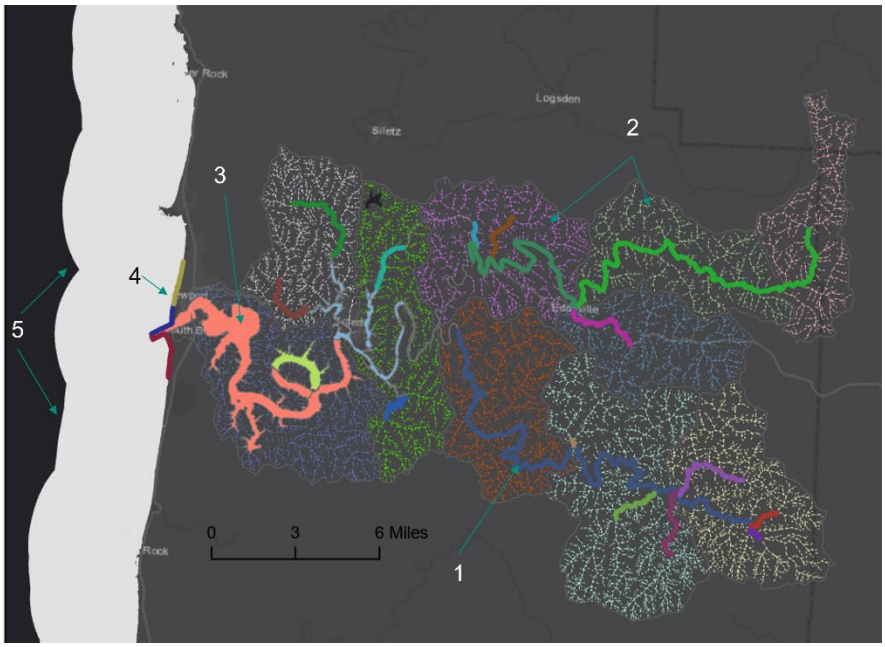
Assessment units

[15] National Recommended Water Quality Criteria: 2002, U.S. EPA Office of Water, EPA 822-R-02-047 p.9

Integrated Report conclusions are reported to EPA at an assessment unit level. Each state, tribe or territory is responsible for determining how waters will be partitioned into these reporting units. DEQ defines assessment units as segments of streams, rivers or water body areas that are predetermined based on similar hydrology and represent similar environmental hydrographic characteristics. Assessment units are represented spatially by the USGS High Resolution National Hydrography framework (NHDH; 1:24,000 or better resolution). For the 2018/2020 reporting cycle, DEQ classified all surface water bodies on the NHDH into manageable units for assessment and reporting purposes. The classification scheme for defining units is defined by water type in the following sub-sections and outlined in Figure 3.

In general, all of Oregon's assessment units:

- Are fixed locations that will remain the same over reporting cycles
- May contain multiple monitoring stations
- Will be assigned an overall status (Impaired, Attaining, Insufficient data or Unassessed) for each applicable beneficial use



1. Thick lines represent Large River and Streams Assessment Units
2. Dashed lines represent small streams grouped into watershed assessment units
3. Water bodies are represented as polygons
4. Coastlines and beach are represented as thick lines between the land and ocean assessment units.
5. Ocean assessment units are represented as polygons

Figure 3. Assessment units are represented as polygons and/or lines in the web map application as determined by water body type

River and stream assessment unit classification

Oregon's large river and stream units are defined by a Strahler Stream Order of five and higher. Assessment units were broken based on the following information:

1. A change in designated use based on water body type. For most of the state, this does not create many breaks.
2. A change in stream order. This hydrologic break accounts for the input of major tributaries.
3. If neither designated use nor stream order change occurs, then the assessment unit is broken at a HUC10[16,16] boundary.

Fish use designations (i.e., spawning designations) were not used to define assessment units.

The only exception to the classification scheme above is the Columbia and Snake river assessment units. For these rivers, DEQ aligned its assessment units for the Columbia and Snake rivers, with the bordering states of Washington and Idaho. DEQ cautions that although Assessment units may align between states, assessment conclusions may be different due to different data evaluated or different WQ criteria and assessment methodologies.

Watershed assessment unit classification

When moving to fixed assessment units using the NHDH, DEQ defined assessment units for the entire stream network statewide. This resulted in the need to classify headwater streams and small feeder drainages, many of which are intermittent. To account for this, all streams with a Strahler Stream Order of 4 or less are grouped into a watershed unit that encompasses an entire HUC12 or sub-watershed. This is currently the smallest HUC classification in Oregon.

Lakes, reservoirs, and estuaries assessment unit classification

Lakes and reservoirs greater than 20 hectares are classified as separate assessment units defined by NHDH water body features. Smaller lake units will be added as data becomes available. DEQ uses the Coastal and Marine Ecological Classification Standard[17] (CMECS) to define the extent of estuaries. Each estuary assessment unit defined by area may be further divided based on the applicable bacteria indicator (freshwater or coastal).

Beach and coastal assessment units

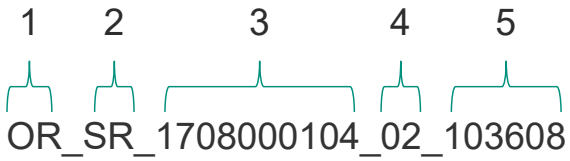
Beach assessment units are defined using NHDH coastline segments for the entire length of the Oregon coast. Delineation of beach assessment units followed existing beaches as designated by Oregon Health Authority and EPA for recreational bacteria monitoring programs. Where no beaches were designated by these agencies, DEQ used imagery interpretation of continuous beach landforms delineated by headlands and estuary mouths.

[16] USGS Hydrologic Unit Maps
[17] Coastal and Marine Ecological Classification Standard, June 2012

Ocean assessment units

DEQ worked with the scientific/technical workgroup for the assessment of ocean acidification and hypoxia to redefine ocean assessment units based on hydrological and environmental factors rather than the land based HUC 8 classification used in the past two IR cycles. The six ocean units encompass Oregon territorial waters which extend three miles offshore.

How to read an assessment unit ID (AU_ID)



1 = State identifier (Oregon)
2 = AU type
- SR = large Stream/River
- WS = Watershed Unit
- LK = Lake/Reservoir
- EB = Estuary
- CL = Coastline
- OC = Ocean

3 = HUC10 (for rivers and streams assessment units) or HUC12 for watershed units
4 = Beneficial Use Code
5 = Six digit unique identifier

Assessment unit data evaluation and reporting

One assessment unit can have data for over 150 unique parameters, collected from multiple monitoring locations. Methodologies to determine assessment conclusions for each parameter are outlined in the Assessment Methodologies for Specific Pollutants or Parameter. The overall status of an assessment unit, which is presented in the web map application and reported to EPA, is determined by the following hierarchy:

Category 5 or 4 (Impaired) > Category 2 (Attaining) > Category 3 (Insufficient Data)

The assessment unit will be given the overall status that reflects the "largest" parameter assessment categorization according to the above hierarchy.

Data pooling for non-watershed units

For rivers, streams, water bodies (lakes, reservoirs and estuaries), coastline and ocean assessments (i.e., non-watershed units), data from individual monitoring locations in assessment

units are pooled together to determine a category for each parameter. Data within assessment units are evaluated using the methods for each specific parameter to determine if the pollutant level exceeds a water quality standard and is a cause for beneficial use impairment. Figure 4 displays the flow from parameter assessment conclusions to a final assessment unit status.

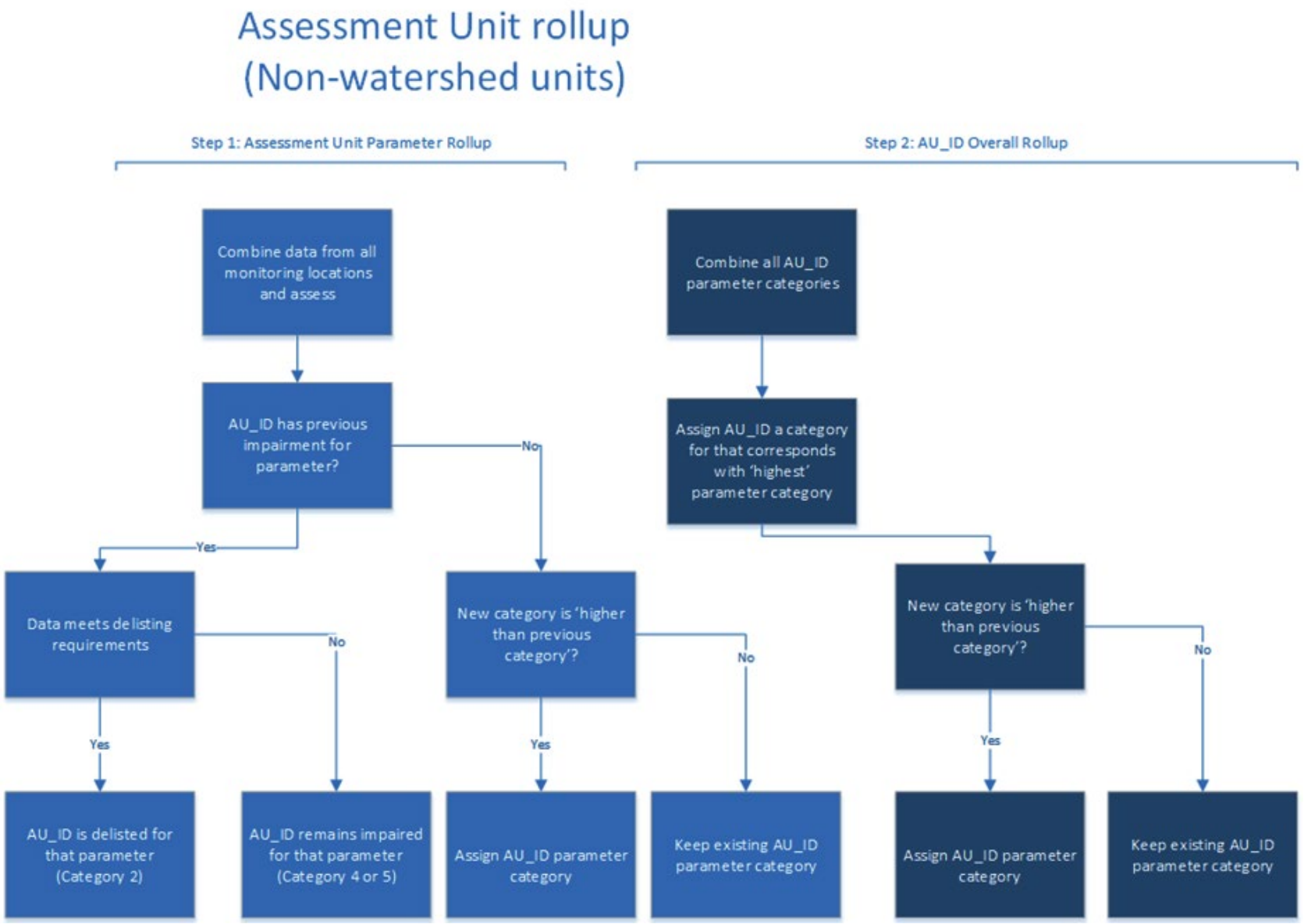


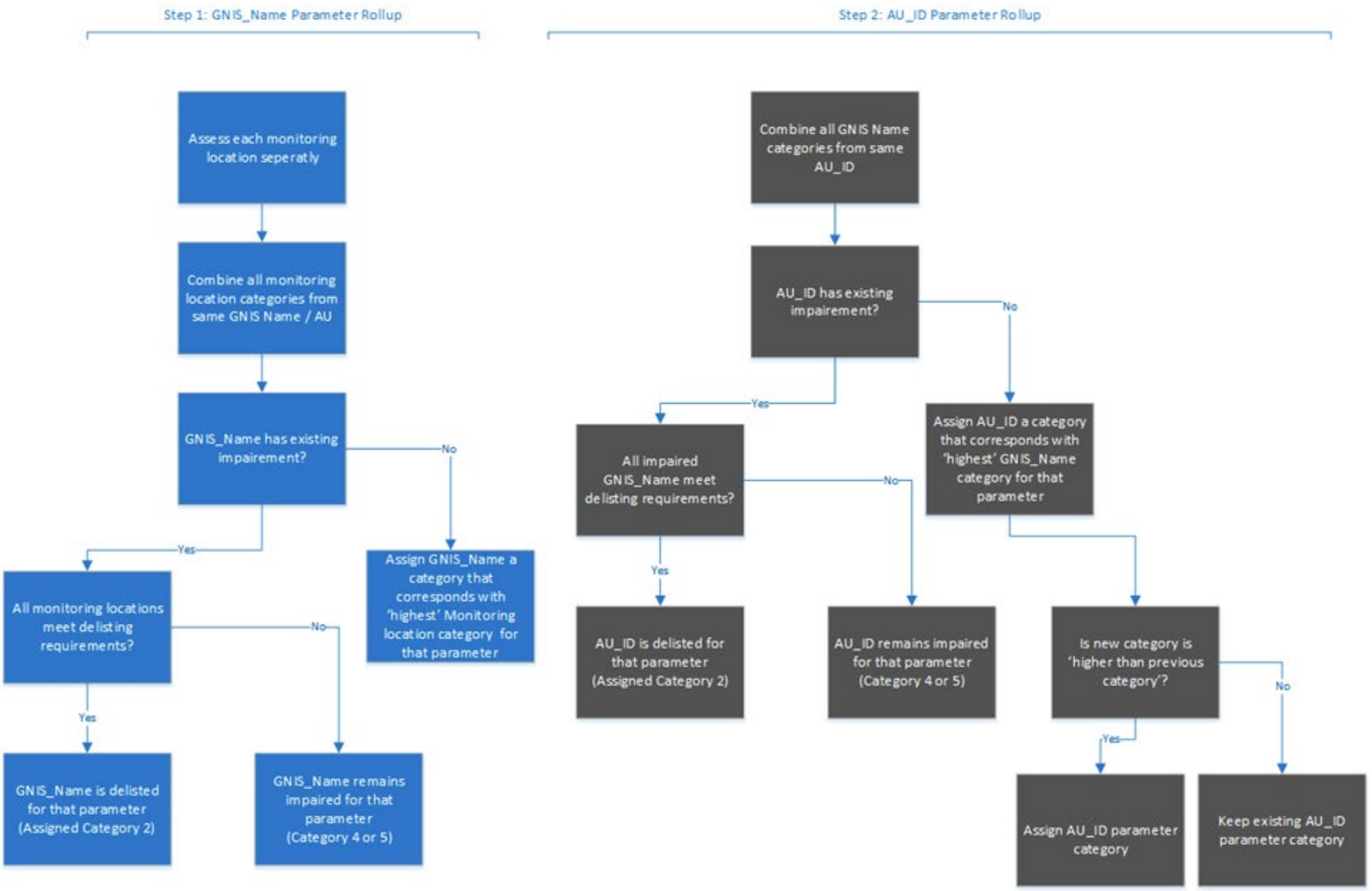
Figure 3. Decision tree used to define assessment unit status in non-watershed units

Watershed unit assessment by monitoring station

DEQ assesses watershed units by monitoring station and makes parameter categorical determinations of impairment or attainment at each individual monitoring station. This determination is then rolled up to an individual stream (as defined by the NHDH GNIS Name[18]) within the unit and then finally to a single assessment unit conclusion to meet EPA reporting requirements (Figure 5). Assessment by station within a watershed assessment unit allows DEQ to identify the specific stream with impairments and provides more precise assessment of the dataset. Identification of impaired streams in watershed units may inform monitoring partners of localized impairments and guide restoration activities and future monitoring. This method also recognizes the inherent difference between assessing watershed units, which involves grouping small streams into a single assessment conclusion, verses assessing other types of assessment units, in which hydrologic connectivity is more clearly defined.

[18] Hydrography and Geographic Names, USGS

Watershed Unit Parameter Categorization Rollup



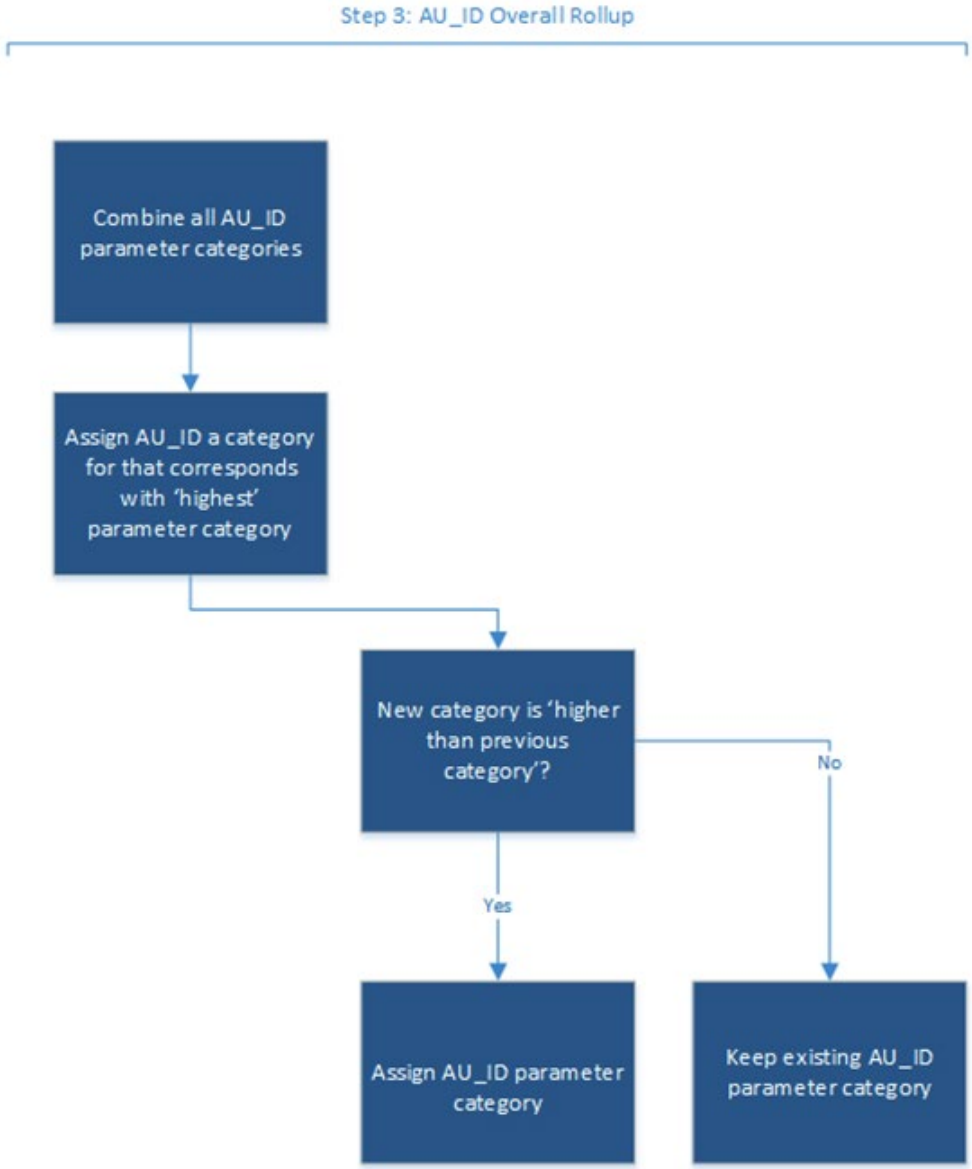


Figure 4. Decision tree used to define assessment status in watershed assessment units.

General methodologies for parameter assessments

DEQ uses a statistical hypothesis testing approach (binomial test) to derive a critical number of sample excursions (single measurement that does not meet numeric water quality criteria) that scales with the number of representative samples to evaluate beneficial use attainment status of waterbodies.[19,20] The binomial method allows DEQ to quantify a level of statistical confidence and error when different sample sizes are used for making listing and delisting decisions. Unless an alternate statistical method of evaluation is included as part of the water quality standard, as indicated in the Assessment Methodologies for Specific Pollutants or Parameters sections , the numeric water quality criteria for aquatic life toxic substances (OAR-340-041-8033, Table 30) and conventional pollutants will be evaluated using the exact binomial test for proportions method. Human health toxic substances criteria (OAR-340-041-8033, Table 40) will be evaluated for attainment against the geometric mean of pollutant concentrations for all samples within the data window.

Determining attainment

DEQ has retained the current assessment methodology and 15% effect size and selected to control Type II error rates (when an impaired water body is incorrectly identified as attaining) by setting a minimum sample size to make a Category 2 determination.

DEQ selected a Type II error rate (β) of approximately 10% which corresponds to a 90% power value (1 – β) to support its minimal sample size recommendations for both Aquatic Life toxics criteria and conventional pollutants (Table 4). This is consistent with the Type I error rate (when an attaining water body is erroneously identified to be impaired) chosen for impairment and implemented in the 2018/2020 Integrated Report.[21]

Table 4. Minimum sample size recommendations for Category 2

	Minimum sample size for Category 2
Aquatic Life Toxics	10
Conventional Pollutants	8

Water quality criteria for aquatic life: toxic substances and conventional pollutants

[19] Consolidated Assessment and Listing Methodology (CALM) Toward a Compendium of Best Practices, First Edition. United States Environmental Protection Agency. July 2002. Chapter 4.
[20] Integrated Reporting Improvements: Statistical Methods for Listing and Assessment of Large and Long Term Data Sets, DEQ 2018

For a given sample size, if the number of exceedances is equal to or greater than the number of exceedances identified in Table 6 and Table 7 the water body will be placed in Category 5. Waters will be assessed for listing and delisting purposes based on the numeric criterion thresholds described in Table 5 indicating that the water quality criteria are exceeded. The critical proportion for toxic substances is 5% of samples with 90% confidence. The critical proportion of conventional pollutants is 10% of samples with 90% confidence. The number of sample excursions that result in an impairment per sample size are shown in Table 6 and Table 7.

Table 5. Listing and delisting methods for numeric criteria

	Chronic		Acute		Confidence Level
	Category 2*	**Category 5***	**Category 2***	**Category 5***	**Minimum**
Aquatic Life Toxics Criteria	Binomial: ≤5% of samples exceed the criterion value	Binomial: >5% of samples exceed the criterion value	Binomial: ≤5% of samples exceed the criterion value	Binomial: >5% of samples exceed the criterion value	90%
Conventional Pollutants	Binomial: ≤10% of samples exceed the criterion value	Binomial: >10% of samples exceed the criterion value	NA	NA	90%
Human Health Toxics Criteria	Geometric mean sample concentration ≤ criterion value	Geometric mean sample concentration > criterion value	NA	NA	NA

*For water bodies not currently listed as Category 5, the critical values for listing in Table 6 and Table 7. apply. For waterbodies currently listed as Category 5, the critical values for delisting in Table 10 and Table 11 apply.

Determining impairment – statistical methods

Critical values for listing acute and chronic toxic substances

- Null hypothesis: Actual exceedance proportion is ≤5%
- Alternate hypothesis: Actual exceedance proportion is >5%
- Minimum confidence level is 90%
- A minimum sample size of two is required

Table 6. Minimum number of sample excursions required to list as impaired for toxic substances

Sample Size	List if excursions ≥:
2-18	2*
19-22	3
23-35	4
36-49	5
50-63	6
64-78	7
79-92	8
93-109	9
110-125	10
126-141	11
142-158	12
159-174	13
175-191	14
192-200	15
>200	See generalized binomial listing formula to calculate the number of excursions
* The use of 2 excursions to list is extended for sample sizes ≤18	

Critical values for listing conventional pollutants[21]

- Null hypothesis: Actual exceedance proportion is ≤10%
- Alternate hypothesis: Actual exceedance proportion is >10%
- Minimum confidence level is 90%
- A minimum sample size of five is required

Table 7. Minimum number of sample excursions required to list as impaired for conventional pollutants

Sample Size	List if excursions ≥:
5 - 11	2*
12-18	4
19-25	5
26-32	6
33-40	7
41-47	8

[21] Excluding continuous dissolved oxygen and temperature

Sample Size	List if excursions ≥:
48-55	9
56-63	10
64-71	11
72-79	12
80-88	13
89-96	14
97-104	15
105-113	16
114-121	17
122-130	18
131-138	19
139-147	20
148-156	21
157-164	22
165-173	23
174-182	24
183-191	25
192-199	26
≥200	See generalized binomial listing formula to calculate the number of excursions
* The use of 2 excursions to list is extended for sample sizes <11.	

Generalized binomial listing formula

For sample sizes greater than 200, calculate α from the right tailed probability of the cumulative binomial distribution:

$$\alpha = \text{Excel®}\ \text{Function BINOMDIST}(n-k_i, n, 1 - p_1, \text{TRUE})$$

Where,
n = the number of samples,
k_i = the critical value of the minimum number of sample excursions needed to place a water on the section 303(d) list, and
p_1 = regulatory critical exceedance rate.

BINOMDIST( ) is an Excel® software function that returns cumulative left tail binomial probabilities.

The number of excursions required to list is the value of k_i, where the initial value of k_i=2 for n=2, and k_i is incrementally increased by 1, until $\alpha \leq 0.10$.

The critical number of excursions can be calculated in R Statistical Software[22] by using the following equations:

For Toxics:

$$x = \text{ifelse}(n <= 18, 2, \text{qbinom}(0.90, n, 0.05, \text{lower.tail} = \text{TRUE}) + 1)$$

For Conventional Parameters:

$$x = \text{ifelse}(n <= 11, 2, \text{qbinom}(0.90, n, 0.10, \text{lower.tail} = \text{TRUE}) + 1)$$

Where,
n = the number of samples,
x = critical excursion value

Water quality criteria for human health: toxic substances

Numeric water quality criteria for the protection of human health from toxic substances shall be evaluated as the geometric mean of the observed samples of pollutant concentration. Assessment conclusions will be based on the geometric mean of samples, and require a minimum of three samples to be considered representative of the water body.

Censored data values

Due to limitations in field and laboratory chemical analysis procedures, low concentrations of some substances cannot be precisely measured. Analytical test procedures include both a Method Detection Level (MDL) and a Minimum Reporting Level (MRL). The MDL is the concentration above which a sample can be discerned from a sample blank (zero). The MRL is the concentration above which an analyte can be both detected, and an accurate concentration determined. Both values are laboratory- and instrument-dependent and can be significantly different for the same analyte.

There is no consistent reporting requirement for labs to record minimum detection and reporting levels. For example, some labs will report to the MRL while others report to the MDL. For this reason, DEQ will use the generic term Quantitation Limit (QL) to include MRL, MDL and any other reporting limit used by third parties.

For water bodies with no quantifiable sample results:

- Water bodies will be assessed as Category 2; Attaining where samples have been collected but all values are reported below the lowest available QL and the QL is less than the numeric criteria.

[22] The R Project for Statistical Computing

- Water bodies will be assessed as Category 3D; Not Technologically Feasible to Assess where samples have been collected but all values are reported below the lowest available QL, and the QL is greater than the numeric criteria (Assessment Categories).

For water bodies with a mix of quantifiable and censored data, DEQ will use the following methods for the application of the exact binomial test statistical method and the calculation of the geometric mean to apply to the human health criteria.

- When the QL is greater than the numeric criteria value, ½ of the value of the water quality criteria will be substituted for any sample reported as censored.
- When the QL is less than the numeric criteria, ½ of the value of the lowest QL will be substituted for any sample reported as censored.
- Samples reported as greater than the Maximum QL, use value.
    - For example, a bacteria sample reported as >2000 MPN, 2000 MPN will be used.

Sample concentrations measured between the MRL and the MDL are often reported as an estimated value, because the precision of the method is not enough to determine the exact concentration. For samples reported as estimated, DEQ will use the value and assign an assessment category based on these rules:

- When the QL is less than the numeric criteria and an impairment determination is based on solely estimated or a combination of estimated and quantifiable results, water bodies will be assessed as Category 3B when quantifiable results alone do not indicate impairment.
    - In cases with drastically different QL values, it may be appropriate to omit the portion of the dataset with a higher QL from the assessment of the data.
- When the QL is greater than the numeric criteria, water bodies will be assessed using the estimated values.

Overwhelming evidence

When sample sizes are minimal but there is additional information that impairment is likely, DEQ will implement the concept of "overwhelming evidence" (Table 8). Overwhelming evidence uses multiple lines of evidence based on a specific rationale to conclude that a water body is impaired. When sample sizes do not meet minimum requirements to assign a Category 5 status, additional evidence may be used to indicate that the applicable water quality standard is not being attained. Overwhelming evidence includes other credible and compelling information indicating the water body is in fact impaired. DEQ would consider the following factors for indicators of overwhelming evidence and reserve the right to use additional lines of evidence.

Table 8. Factors used in implementing the concept of overwhelming evidence

Extreme exceedance of criteria	• Samples exceed at 2x the acute magnitude
Other lines of evidence	• Documented fish kill • Studies or other data/info that demonstrate impairment at a specific location • Public health advisories

Category 3B: Insufficient data; potential concern

During the assessment process, DEQ will evaluate all factors such as magnitude of exceedance, critical time periods and additional lines of evidence when making impairment decisions. Although DEQ has tried to anticipate all cases where Category 3B may be used, this is not an exhaustive list (Table 9). There will be cases that fall outside of the guidelines that have been laid out and DEQ will address these on a site-specific basis and document them within the assessment rationale. Accumulation of assessment experience will continue to inform and contribute to future revisions of DEQ's assessment methodology.

Table 9. Category 3B guidelines

Insufficient data	• At least 1 sample exceeds the magnitude of the criteria • AND dataset does not meet minimum size requirement for Category 5 • BUT no overwhelming evidence of impairment exists.
Conflicting indicators of attainment	• When samples measured as total recoverable exceed a dissolved criterion.
Data not quantifiable	• Exceeding samples below the method minimum reporting (MRL);
When assessing hardness-dependent criteria or use of the Biotic Ligand Model with defaults	• BOTH measured and default input criteria are used • AND measured input criteria sample data do not meet minimum sample size • AND some samples exceed criteria generated from default data

Delisting water bodies

Once a water body is found to be water quality limited and is assigned to Category 5: 303(d) status, it remains on Oregon's 303(d) list until DEQ delists or removes it from the 303(d) list and EPA approves the delisting. This section describes the rationale DEQ uses to justify delisting water bodies from Category 5: 303(d) and assigning another status category.

Current information shows an error in the Category 5: 303(d) listing

A water body is delisted if there is information to show that the Category 5: 303(d) status was assigned in error. New data or review of the current assessment evaluation may show errors in previous listings due to (1) monitoring location errors (2) incorrect inclusion of inappropriate data or data not meeting data quality requirements, (3) data evaluations not consistent with the assessment protocols, (4) listing of water bodies that already have TMDLs in place, or (5) duplicate listings for the same water body and pollutant. The delisting is supported with a description and documentation of the error and the information used to correctly assign a status category to the water body. The delisting action is noted as DELISTING_ORIG_INCORRECT in the reporting spreadsheet.

Water quality standards have changed or no longer apply in certain water bodies

If water quality standards have been revised since a water body was listed in Category 5: 303(d), the data and information available for the current assessment are evaluated using the currently applicable criteria and the current assessment methodology. If water quality standards have changed or the beneficial use designations for a water body have been refined since it was first listed in Category 5: 303(d), the numeric or narrative water quality criteria appropriate to the currently designated beneficial use are applied to evaluate data and information. When available, data will be assessed against revised water quality standards. See Assessment Methodologies for Specific Pollutants or Parameter for more detailed protocols for the pollutants with recent Oregon water quality standards changes.

If available information demonstrates that the currently effective criteria are being attained, the water body is delisted and placed in Category 2: Attaining. The delisting action is noted as WQS_STANDARDS_CHANGED in the reporting spreadsheet. When no data are available to evaluate against currently applicable criteria, or data are insufficient to demonstrate attainment of the current criteria, the water body remains in Category 5: 303(d).

If the beneficial use designation is no longer appropriate in a water body, and specific pollutant criteria do not apply, the previously listed water body is delisted. No status category is assigned in this case. The delisting action is noted as DELISTING_WQS_NOT_APPLICABLE in the reporting spreadsheet. This may be the case for waters previously listed for temperature or dissolved oxygen based on spawning criteria, where the current designated use of the water body does not include salmonid or resident trout spawning use. Once delisted, the assessment for the outdated criteria or beneficial use will no longer be reported in subsequent Integrated Reports.

If there are no currently applicable criteria because the pollutant criteria are withdrawn, the previously listed water body is delisted. No status category is assigned. The delisting action is noted as WQS_STANDARDS_CHANGED in the reporting spreadsheet.

Water quality standard pollutant changed

With the water quality standard changes, several toxic substance criteria for a family or group of chemicals were replaced by criteria for individual chemicals. Examples are criteria for chemical groups such as dichlorobenzenes, dichloroethylenes, halomethanes, and polynuclear aromatic hydrocarbons that are replaced with individual criteria. Data and information available for the current assessment are evaluated using the currently applicable criteria for the individual pollutants which are discussed in more detail in Assessment Methods by Pollutant or Parameter.

If available information demonstrate that the currently effective criteria are being met for individual pollutants in the group, the water body listing for the chemical group is delisted with the delisting action noted as WQS_STANDARDS_CHANGED in the reporting spreadsheet. The water body is reported as Category 2: Attaining based on data for individual pollutants in the water body. When no data are available to evaluate against currently applicable criteria for individual pollutants, or data are insufficient to demonstrate attainment of the current criteria for individual pollutants, the water body remains in Category 5: 303(d).

TMDLs approved for water body and pollutant

After TMDLs for a water body and pollutant are completed by DEQ and approved by EPA, the water body can be delisted from Category 5: 303(d) and placed in Category 4A: Water Quality Limited TMDL Approved with the delisting action noted as DELISTING_4A in the reporting spreadsheet. The water body retains the water quality limited status (per OAR 340-41-0002(70)) until information shows that water quality standards are attained. If a TMDL is developed for a pollutant on a watershed scale, all water body segments listed for that pollutant criteria within the watershed are delisted and placed in Category 4A. When the EPA approval of the TMDL states that the allocations will lead to attainment of the water quality criteria and that other water bodies identified as impaired for those pollutants do not need to be added to the Category 5: 303(d) list, waters identified as impaired in subsequent assessments are given the status of Category 4A: Water Quality Limited TMDL approved.

Other pollution control requirements in place

When pollution controls or practices required by local, state, or federal authorities are in place, and will result in the attainment of water quality standards in a reasonable period of time, these other requirements may be satisfactory alternatives to TMDLs that address impaired water and achieve restoration. Examples of other requirements are point source National Pollutant Discharge Elimination (NPDES) permits, water treatment system upgrades or CWA Section 401 certification conditions for hydroelectric projects that address all of the significant pollutant sources on a water body. The measures and conditions are expected to result in attainment of

water quality standards. When these control measures are in place, the water bodies will be delisted from Category 5: 303(d) and placed in Category 4B: Water Quality Limited Other Control Measures in Place with the delisting action noted as DELISTING_4B in the reporting spreadsheet.

Pollutant does not cause impairment

When data or information indicate that water body impairment is not being caused by pollutants, but rather pollution, the water can be delisted from Category 5: 303(d) and placed in Category 4C: Water Quality Limited but a pollutant does not cause the impairment. The delisting action is noted as DELISTING_4C in the reporting spreadsheet. EPA defines a pollutant according to Section 502(6) of the Clean Water Act. In Oregon's 1998 assessment, DEQ placed water bodies on the Category 5: 303(d) list based on observations that habitat modification and flow modification caused impairments of beneficial uses in those waters. Habitat modification listings were based on information indicating inadequate pool frequency and lack of large woody debris. Flow modification listings were based on inadequate flow to maintain in-stream water rights purchased by Oregon Department of Fish and Wildlife. However, EPA subsequently clarified that flow and habitat modification are pollution but not pollutants under the Clean Water Act. In 2002, ODEQ removed these water bodies from the 303(d) list and placed them in Category 4C.

New data or information shows water quality standards are attained

A water body is delisted and assigned to Category 2: Attaining if there is sufficient information from the current assessment to evaluate the pollutant or parameter and the information demonstrates that currently applicable water quality standards are being met according to the parameter specific delisting method. Data used for delisting must meet data quality requirements as described in the QA/QC requirements and parameter specific "Data Requirements" sections. The delisting action is noted as WQS_NEW_DATA in the reporting spreadsheet. For watershed assessment units, all monitoring locations and individual streams within the unit must be attaining for the entire AU to be delisted.

Delisting – statistical methods

Waters shall be considered for delisting if data in the period of record meet the minimum data requirement to delist. Unless specified as part of the water quality standard or indicated in the parameter specific assessment methodologies, the minimum sample size is 18 for aquatic life toxic substances, 15 for conventional pollutants, and five for human health toxics criteria. DEQ will evaluate samples representative of the conditions in the water body as specified in Evaluating data and information.

Aquatic Life: toxic substances and conventional pollutants

Waters will be removed from the section 303(d) list if the number of sample excursions above the numeric criterion thresholds supports rejection of the null hypothesis as presented in Table 10 indicating that the water quality criteria are attaining. The critical proportion for toxic substances is 5% of samples with 90% confidence. The critical proportion of conventional pollutants is 10% of samples with 90% confidence. The number of sample excursions correlating to an impairment conclusion per sample size are shown in Table 10 and Table 11.

Critical values for delisting chronic toxic substances

- Null Hypothesis: Actual exceedance proportion is >5%
- Alternate hypothesis: Actual exceedance proportion is ≤5%
- Minimum confidence level is 90%
- A minimum sample size of 18 is required

Table 10. Maximum number of sample excursions to delist as impaired for toxic substances

Sample Size	Delist if excursions ≤ :
18-22	1
23-35	2
36-49	3
50-63	4
64-78	5
79-94	6
95-109	7
110-125	8
126-141	9
142-158	10
159-174	11
175-191	12
192-200	13
>200	See generalized delisting formula to calculate the number of excursions

Critical values for delisting conventional pollutants

- Null hypothesis: Actual exceedance proportion is >10%

- Alternate hypothesis: Actual exceedance proportion is ≤10%
- Minimum confidence level is 90%
- A minimum sample size of 15 is required

Table 11. Maximum number of sample excursions to delist as impaired for conventional pollutants

Sample Size	Delist if excursions ≤ :
15	1
16-18	2
19-25	3
26-32	4
33-40	5
41-47	6
48-55	7
56-63	8
64-71	9
72-79	10
80-88	11
89-96	12
97-104	13
105-113	14
114-121	15
122-130	16
131-138	17
139-147	18
148-156	19
157-164	20
165-173	21
174-182	22
183-191	23
192-199	24
≥200	See generalized binomial delisting formula to calculate the number of excursions

Generalized binomial delisting procedure

For sample sizes greater than 200, calculate α from the left tail probability of the cumulative binomial distribution:

$$\alpha = 1 - \text{Excel®}\ \text{Function BINOMDIST}\ (k_a\text{-}1,\ n,\ p_1,\ \text{TRUE})$$

Where,
n = the number of samples,
K_a = maximum number of measured exceedances to determine a water body is attaining, and should be removed from the 303(d) list, and
p_1 = unacceptable exceedance proportion.

BINOMDIST( ) is an Excel software function that returns cumulative left tail binomial probabilities.

The number of excursions required to delist is the value of k_a, where the initial value of k_a=1 for n=10. k_a is incrementally increased by 1, until 1-α ≤ 0.90.

The critical number of excursions for delisting can be calculated in R Statistical Software[22] by using the following equations:

For Toxics:

$$x = \text{ifelse}(n < 18, \text{NA\_real}, \text{qbinom}(0.90, n, 0.05, \text{lower.tail} = \text{TRUE}) - 1)$$

For Conventional Parameters:

$$x = \text{ifelse}(n < 15, \text{NA\_real\_}, \text{qbinom}(0.90, n, 0.10, \text{lower.tail} = \text{TRUE}) - 1)$$

Where, n = the number of samples,
x = critical excursion value

Delisting for dissolved oxygen

Dissolved oxygen specific delisting requirements can be found in the parameter-specific assessment methods in Assessment – Dissolved Oxygen.

Delisting for Temperature

Temperature specific delisting requirements can be found in the parameter-specific assessment methods in Assessment – Temperature.

Delisting for human health: toxic substances

Numeric water quality criteria for the protection of human health from toxic substances will be evaluated as the geometric mean of the observed samples of pollutant concentration. Waters

will be removed from the 303(d) list if the geometric mean of samples representative of the water body are less than the numeric criterion threshold.

Public review

DEQ held two public processes for the Draft 2024 Assessment Methodology. The inland and estuaries draft Assessment Methodologies for Oregon's 2024 Integrated Report were posted for public comment Jan. 5, 2023, and accepted comments on the methodologies through Feb. 21, 2023. The draft 2024 Ocean Acidification and Hypoxia Assessment Methodologies for marine water were posted separately on May 31, 2023, and comments accepted through July 7, 2023. The response to comments received is available on DEQ's assessment methodology webpage.

Submittal of Oregon's Integrated Report and 303(d) list

EPA developed a national data system, the Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS),[Error! Bookmark not defined.] and requires states to report Integrated Report conclusions into this system. ATTAINS is a publicly accessible database that standardizes states reporting systems. DEQ will submit Oregon's Section 303(d) list of Category 5: Water quality limited waters needing a TMDL to US EPA Region 10 through ATTAINS for review and approval. Along with the Section 303(d) list, DEQ will also submit to EPA the Integrated Report, response to comments, the Assessment Methodology for Oregon's Water Quality Report on List of Water Quality Limited Waters, and a TMDL prioritization schedule. Only water bodies in Category 5: Water quality limited waters needing a TMDL (Section 303(d) list) are subject to EPA's approval.

Assessment methodologies for specific pollutants or parameters

For the Integrated Report, DEQ evaluates water quality data and information to determine if the water quality standards set out in Oregon Administrative Rules Chapter 340 Division 41 (OAR 340-041) are being met. The following sections describe specific methods for assessment of groups or individual parameters/pollutants, narrative and numeric criteria, and designated uses. The water quality standard citation from Oregon Administrative Rules is given for each parameter.[23] Each parameter and criterion is evaluated independently. Data are evaluated for each assessment unit, and an overall status is assigned to the water body assessment unit segment based on the available site monitoring data and information. Data are not available for all parameters in each water body. Therefore, Category 1 indicating all designated uses are supported and all criteria are met is not used for Oregon's assessment.

The methods for the Integrated Report evaluation build on, update, and replace methodologies used in past water quality assessments for 303(d) and 305(b) reporting. Results from previous assessments remain valid and are incorporated in each new Integrated Report unless updated with new data or information or revised assessment protocols. All updated protocols for pollutants or parameters applied for the 2024 Integrated Report are described in the following sections.

[23] OAR numbering changes periodically as rules are revised. Every attempt has been made to update the corresponding rule citation in this document to reflect the numbering current at the date of this document.

Assessment - aquatic weeds or algae

PARAMETER	BENEFICIAL USE
Aquatic Weeds	Boating, Aesthetic Quality
Algae	Aesthetic Quality
Harmful algal blooms	Domestic Water Supply, Irrigation, Livestock Watering, Water Contact Recreation

Water quality standards

340-041-0007

Statewide Narrative Criteria

(9) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or that are injurious to health, recreation, or industry may not be allowed;

Assessment methodology

This method will be used to implement the statewide narrative criterion that prohibits deleterious or injurious effects on aquatic and human beneficial uses from biological growths and will be applied specifically to aquatic weeds or algae. The growth of aquatic weeds or algae does not in itself indicate deleterious or injurious effects on beneficial uses. Nor does it identify whether a pollutant or which pollutant is causing the impairment and should be addressed by point source or other controls through a Total Maximum Daily Load. This assessment protocol identifies the indicators used to determine that beneficial uses have been negatively affected by the presence of excess algal or weed growth.

Data evaluation

Information on aquatic weeds are obtained from the Oregon Invasive Species Hotline and assessed based on the Oregon Department of Agriculture classification system.

HABs information and data are obtained from the Oregon Health Authority Cyanobacteria Advisory Archive and assessed based on duration, frequency and magnitude of the bloom.

Data requirements

Information, numeric HABs data or/and public health advisories.

Assignment of Assessment Category

Category 5: water quality limited, TMDL needed (303(d) list)

- **Aquatic weeds:** Documented reports of excessive growths of invasive, non-native aquatic plants that dominate the assemblage in a water body and have a harmful effect on fish or aquatic life or are injurious to health, recreation, or industry. Plants include aquatic species on the Oregon Department of Agriculture Noxious Weed Policy and Classification System designated as "A", "B", or "T" weeds or those covered by a quarantine in OAR 603-052-1200.
- **Algae:** Documented evidence that algae, including periphyton (attached algae) or phytoplankton (floating algae), are causing other standards to be exceeded (e.g., pH, chlorophyll a, or dissolved oxygen) or impairing a beneficial use
- **Harmful algal blooms (HABs):** Any public health advisory issued by the Oregon Health Authority, in conjunction with other federal, state, county, city or local agencies, within the data window which;
    (1) is a permanent advisory;
    (2) has reoccurred for two or more HABs seasons; **or**
    (3) only occurred once but had cyanotoxin values above EPA recommended human health recreational water quality criteria[24] or OHA recommended use values for anatoxin a or saxitoxin at the time of assessment[25]
    (4) finished water exceeds EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups[26] AND where the water body is the source of water for a public water system
    (5) where there is a livestock watering use, only occurred once but had a microcystin value above livestock watering levels of 2.3 µg/L[27]
    (6) Recreational advisories shall be associated with impairments of the water contact recreation use. Drinking water advisories shall be associated with impairments of the domestic water supply use. Exceedance of the reference concentration for livestock shall be associated with impairment of the livestock watering use.

Category 4: water quality limited, TMDL not needed

- **Category 4A** - TMDLs for specific pollutants have been completed and approved to address the excessive or harmful aquatic weed or algae growth in a water body.
- **Category 4B** - Another control mechanism such as an aquatic vegetation management plan is in place and is being implemented to control plant growth.

[24] Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin, EPA 2019
[25] Oregon Cyanobacteria Harmful Algae Bloom Surveillance (CHABS) Program: ADVISORY GUIDELINES Cyanobacteria Blooms in Recreational Waters, OHA 2021
[26] EPA Drinking Water Health Advisories for Cyanotoxins
[27] Based on Australian Livestock drinking water guidelines, 2023

- **Category 4C** - Adequate information indicates that the algae or weed growth is not due to pollutants or is a natural condition.

Category 3: insufficient data

Available data or information for the water body are not sufficient to determine if the narrative criterion is being met.

Category 3B: insufficient data; potential concern

Harmful algae blooms

Single season public health advisory issued by the Oregon Health Authority, in conjunction with other federal, state, county, city or local agencies, with no associated toxin data.

If raw source water exceeds EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups[26] for water bodies with known drinking water intakes.

Category 2: attaining

Not applicable.

Delisting – new data:

- **Harmful algae blooms:** Water body must be free of an OHA health advisory for more than three consecutive seasons and have supplemental data consistent with OHA's advisory lifting procedures (photos, cell counts and toxin data below OHA guidelines) for at least two of those seasons.[25]
- **Aquatic weeds and algae:** Water body must be free of excessive growth of aquatic weeds and algae for more than three consecutive seasons and have supplemental data and information (photos) for at least two of those seasons.

Assessment - bacteria

PARAMETER	BENEFICIAL USE
E. Coli	Water Contact Recreation – Freshwater
Enterococcus	Water Contact Recreation – Coastal Water
Fecal Coliform	Fishing – Shellfish Harvesting

Water quality standards

340-041-0009

Bacteria

(1) Numeric Criteria: Organisms commonly associated with fecal sources may not exceed the criteria in subsections (a)-(c) of this section:

(a) Freshwater contact recreation:

(A) A 90-day geometric mean of 126 E. coli organisms per 100 mL;

(B) No single sample may exceed 406 E. coli organisms per 100 mL.

(b) Coastal water contact recreation, as designated in OAR 340-041-0101, 340-041-220, 340-041-230, 340-041-300 and 340-041-0320:

(A) A 90-day geometric mean of 35 enterococcus organisms per 100 mL;

(B) Not more than ten percent of the samples may exceed 130 organisms per 100 mL.

(c) Shellfish harvesting, as designated in 340-041-0101, 340-041-220, 340-041-230, 340-041-300 and 340-041-0320:

(A) A fecal coliform median concentration of 14 organisms per 100 mL;

(B) Not more than ten percent of the samples may exceed 43 organisms per 100 mL.

(2) A minimum of five samples in a 90-day period is required for calculating the criteria in sections (1)(a)(A) and (1)(b)(A) and (B) of this rule.

(3) Raw Sewage Prohibition: No sewage may be discharged into or in any other manner be allowed to enter the waters of the State, unless such sewage has been treated in a manner the Department approved or otherwise allowed by these rules.

(4) Animal Waste: Runoff contaminated with domesticated animal wastes must be minimized and treated to the maximum extent practicable before it is allowed to enter waters of the State.

(5) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health may not be allowed.

Assessment method

Bacteria related to fecal sources can impair beneficial uses of water for recreation and fishing use by shellfish harvesting. Oregon has established water quality standards for relevant bacterial indicators for specific designated uses and various water types (Table 12).

As salinity increases in estuarine waters, E. coli tend to die-off while enterococci remain viable. When data and information for the applicable bacterial indicator in a marine, estuarine, or freshwater location are available, the corresponding criteria are applied to assess each use designated for the water.

Table 12. Bacterial indicators and criteria

Designated use	Bacterial indicator	Criteria metric (CFU/100 mL)	Threshold Value (CFU/100 mL)
Freshwater contact recreation	E. coli	Geometric mean ≤ 126	No more than 10% > 406*
Coastal water contact recreation	Enterococcus	Geometric mean ≤ 35	No more than 10% > 130
Shellfish harvesting	Fecal coliform	Median ≤ 14	No more than 10% > 43

Data evaluation

Designated uses

Figure 5. Example of freshwater streams that cross the beaches and the extent of applicability of this update shown in yello

Water contact recreation is broadly designated in Oregon. Unless designated otherwise, the E. coli criteria are applicable in all freshwaters throughout the state to protect this use. Coastal water contact recreation is designated for parts of estuaries and Oregon's territorial marine waters up to three miles offshore. For these more saline waters, enterococcus is the applicable indicator of fecal contamination. Starting in the 2024 IR cycle, for freshwater streams that flow over beaches directly into the ocean, enterococcus can be used as a bacterial indicator to assess the support of the freshwater contact recreation use when there is insufficient E. coli data in an assessment unit. When enterococcus is used as the indicator for freshwater contact recreation, assignment of assessment categories will follow the coastal contact recreation method. Magnitude, duration and frequency are evaluated through a 90-day geometric mean greater than 35 Enterococci organisms per 100 mL or more than 10% of all

samples within the IR data window exceed 130 enterococci organisms per 100 mL according to the exact binomial test. If both indicators have sufficient data in an assessment unit, E. coli will be used for evaluating freshwater contact recreation use and enterococcus data will not be included in the assessment.

Oregon's bacteria standards include maps of areas designated for coastal contact recreation where the enterococcus criteria are applicable in OAR 340-041-0101 (Columbia River), 340-041-0220 (Mid-Coast Basin), 340-041-0230 (North Coast Basin), 340-041-0300 (South Coast Basin) and 340-041-0320 (Umpqua Basin). For estuaries in the Rogue Basin, E. coli criteria are the applicable indicator.

Shellfish harvesting is a designated use in marine waters and in estuarine coastal areas shown on the maps in OAR 340-041-0101 (Columbia River), 340-041-0220 (Mid-Coast Basin), 340-041-0230 (North Coast Basin), 340-041-0300 (South Coast Basin) and 340-041-0320 (Umpqua Basin). The fecal coliform criteria are applicable to protect this use. Areas designated for shellfish harvesting and coastal contact recreation frequently overlap in the coastal basins. When these uses overlap, both indicators and criteria are in effect and are assessed separately by beneficial use.

For reference, the information for designated uses mapped in OAR 340-041-0101 to 340-041-0320 are also depicted in water quality standards layer on the IR web map.[8]

DEQ will assess existing E.coli data to make the determination of impairment or attainment for the recreational use for those freshwater assessment units previously identified as impaired for fecal coliform. This methodology will apply only to those waterbodies where current E.coli data exists. Additional E. coli monitoring will be required to remove the fecal coliform listing for those fresh waters previously identified as Category 5 for fecal coliforms where no current E. coli data exists.

Data requirements

Data from sampling sites for bacterial indicators are evaluated using the appropriate criteria for the designated use. Numeric results reported down at or below the quantitation Limit, ½ of the value of the lowest QL used to calculate the geometric mean or median.

A 90-day geometric mean shall be calculated for any rolling period of 90 days with at least five samples available by taking the n^{th} root of the product of the concentration of each sample collected within a 90-day period for which $n \geq 5$.

$$\mathrm{GM90} = \sqrt[n]{x_1 x_2 \ldots x_n}$$

Where:
n = number of samples
x_n = bacteria sample concentration, as number of organisms per 100 mL

For fecal coliform, the median sample concentration shall be calculated for the entire period of record once there are at least five samples available.

Assignment of assessment category

Water contact recreation – freshwater

Category 5: water quality limited, TMDL needed (303(d) list)

Any 90-day geometric mean greater than 126 E. coli organisms per 100 mL **OR** more than 10% of all samples within the IR data window exceed 406 E. coli organisms per 100 mL according to the exact binomial test, based on the minimum sample size identified in the binomial table for listing Table 7.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant leading to attainment of water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with no single sample greater than 406 E. coli organisms per 100 mL.

Category 3B: insufficient data; potential concern

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with one or more samples greater than 406 E. coli organisms per 100 mL.

Category 2: attaining

All 90-day geometric means are less than or equal to 126 E. coli organisms per 100 mL, **AND/OR** the IR window contains eight or more samples (as outlined in the Determining Attainment section) and ≤10% of all samples exceed 406 E. coli organisms per 100 mL according to the exact binomial test.

Water contact recreation – coastal water

Category 5: water quality limited, TMDL needed (303(d) list)

A 90-day geometric mean greater than 35 Enterococci organisms per 100 mL **OR** more than 10% of all samples within the IR data window exceed 130 enterococci organisms per 100 mL according to the exact binomial test, based on the minimum sample size identified in the binomial table for listing Table 7.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with no single sample greater than 130 Enterococci organisms per 100 mL.

Category 3B: insufficient data; potential concern

Insufficient data are available for evaluation of a 90-day geomean (defined in Data Requirements section above), and the IR window contains less than eight samples with one or more samples exceeding 130 Enterococci organisms per 100 mL **OR** the Oregon Beach Monitoring Program has issued one or more advisories based on monitoring results for enterococci, not including precautionary advisories.

Category 2: attaining

If there is sufficient data to calculate a geometric mean all 90-day geometric means are less than or equal to 35 enterococci organisms per 100 mL, **AND** the IR window contains eight or more samples (as outlined in the Determining Attainment section) and ≤10% of all samples exceed 130 enterococci organisms per 100 mL according to the exact binomial test.

If there is insufficient data to calculate a geometric mean, and the IR window contains eight or more samples (as outlined in the Determining Attainment section) and ≤ 10% of all samples exceed 130 enterococci organisms per 100 mL according to the exact binomial test

Fishing - shellfish harvesting

Category 5: water quality limited, TMDL needed (303(d) list)

A median fecal coliform concentration greater than 14 fecal coliform organisms per 100 mL with a minimum of five samples, **OR** more than 10% of all samples exceed 43 fecal coliform organisms per 100 mL with a minimum of 5 samples using the 10% raw score method.

Category 4: water quality limited, TMDL not needed.

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Less than eight samples are available for evaluation (as outlined in the Determining Attainment section), and no single sample is greater than 43 fecal coliform organisms per 100 mL.

Category 3B: insufficient data; potential concern

Less than eight samples are available for evaluation (as outlined in the Determining Attainment section), but one sample is greater than 43 fecal coliform organisms per 100 mL.

Category 2: attaining

A median fecal coliform concentration less than or equal to 14 fecal coliform organisms per 100 mL based on a minimum of eight samples (as outlined in the Determining Attainment section); **AND** no more than 10% of all samples are greater than 43 fecal coliform organisms per 100 mL, with a minimum of five samples using the 10% raw score method.

Delisting – new data

Assessment units with sufficient data in the data window to meet the Delisting – statistical methods requirements for conventional pollutants and all available geometric means are less than the critical metric value (Table 12).

Assessment – biocriteria freshwater

PARAMETER	BENEFICIAL USE
Macroinvertebrate Taxa Loss	Fish and Aquatic Life - Freshwater

Water quality standards

340-041-0011
Biocriteria
Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

Assessment method - freshwater

Detrimental changes in resident biological communities are a form of pollution.[28, 29] EPA guidance recommends using biological community assessments as an indicator for aquatic life beneficial use support.[30] DEQ uses the method described here to implement Oregon's narrative standard for biocriteria in freshwater by assessing the conditions in biological communities but does not identify pollutants that are potential causes of impairment which pollutant should be addressed by point source or other controls through a Total Maximum Daily Load. EPA guidance recommends listing waters with aquatic use impairments as Category 5: 303(d) even if the pollutant is not known.[31]

This method is based on biological community information for freshwater macroinvertebrates at reference sites throughout Oregon. Freshwater macroinvertebrates include insects, crustaceans, snails, clams, worms, mites, etc. DEQ identifies sites in a given region that are least disturbed by anthropogenic activities and uses these as reference sites.[32] Biological assessment tools use information from these reference sites to predict the variety and number of aquatic species expected in Oregon streams and to make inferences about the condition of biological

[28] Federal Water Pollution Act Section 502(19) (33 U.S.C 1362) (Clean Water Act)
[29] Oregon Administrative Rules 340-041-0002(39)
[30] US EPA, July 29, 2005, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, page 41.
[31] US EPA, July 29, 2005, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, page 60.
[32] Drake, D., April 2004, Selecting Reference Condition Sites - An Approach for Biological Criteria and Watershed Assessment, ODEQ Technical Report WSA04-002.

communities in the waters.[33] The method applies numeric benchmarks to evaluate the integrity of aquatic biological communities.

Data evaluation

To assess the biological integrity of macroinvertebrate communities, DEQ uses a statistical method called a multivariate predictive model. Using data from reference sites, the model describes the number and types of macroinvertebrates that are expected to be in a stream, if the stream is in least disturbed conditions. Reference sites are grouped by predictor variables that are not affected by human activities (e.g., sampling date, ecoregion, longitude, elevation, precipitation, or air temperature). DEQ developed a model, PREDictive Assessment Tool for Oregon, specifically for Oregon's perennial wadeable streams and produced a technical paper with the model details in 2008.[34] Similar model approaches are used for bioassessments in the United Kingdom (RIVPACS), Australia (AusRIVas), Canada (BEAST), and in broad areas in the United States (typically called RIVPACS models, though different from the U. K. models).

PREDATOR analyzes data from reference sites grouped into three regions in Oregon and models the expected macroinvertebrate taxa. The three model regions are the Marine Western Coastal Forest (MWCF), the Western Cordillera and Columbia Plateau (WCCP) Northern Basin and Range (NBR) shown in Figure 6. Macroinvertebrates collected from a sampling site are compared to the macroinvertebrate taxa predicted by the model. An assessment of the water condition is made based on the difference between the observed taxa (O) and the expected taxa (E) or reference assemblage. If the observed taxa (O) equal the expected reference taxa (E), the O/E ratio is 1. For sites with ratios less than 1.0, the value expressed as a percentage represents "taxa loss" compared to reference native biodiversity. Ratios greater than 1.0 represent "taxa gain" compared to reference conditions.

For the assessment, DEQ uses benchmark values for percent taxa loss to determine a status category for a water body. The benchmarks are used to indicate where and when deviations from reference conditions and loss of native taxa are detrimental to biological communities and impair aquatic life use support in the water body.

[33] Stoddard, J. L., Larsen, D. P., Hawkins, C. P., Johnson, R. K., & Norris, R. H. (2006). Setting expectations for the ecological condition of streams: the concept of reference condition. Ecological applications, 16(4), 1267-1276.
[34] Hubler, S., July 2008, PREDATOR: Development and Use of RIVPACS-type Macroinvertebrate Models to Assess the Biotic Condition of Wadeable Oregon Streams, Technical Report DEQ08-LAB-0048-TR

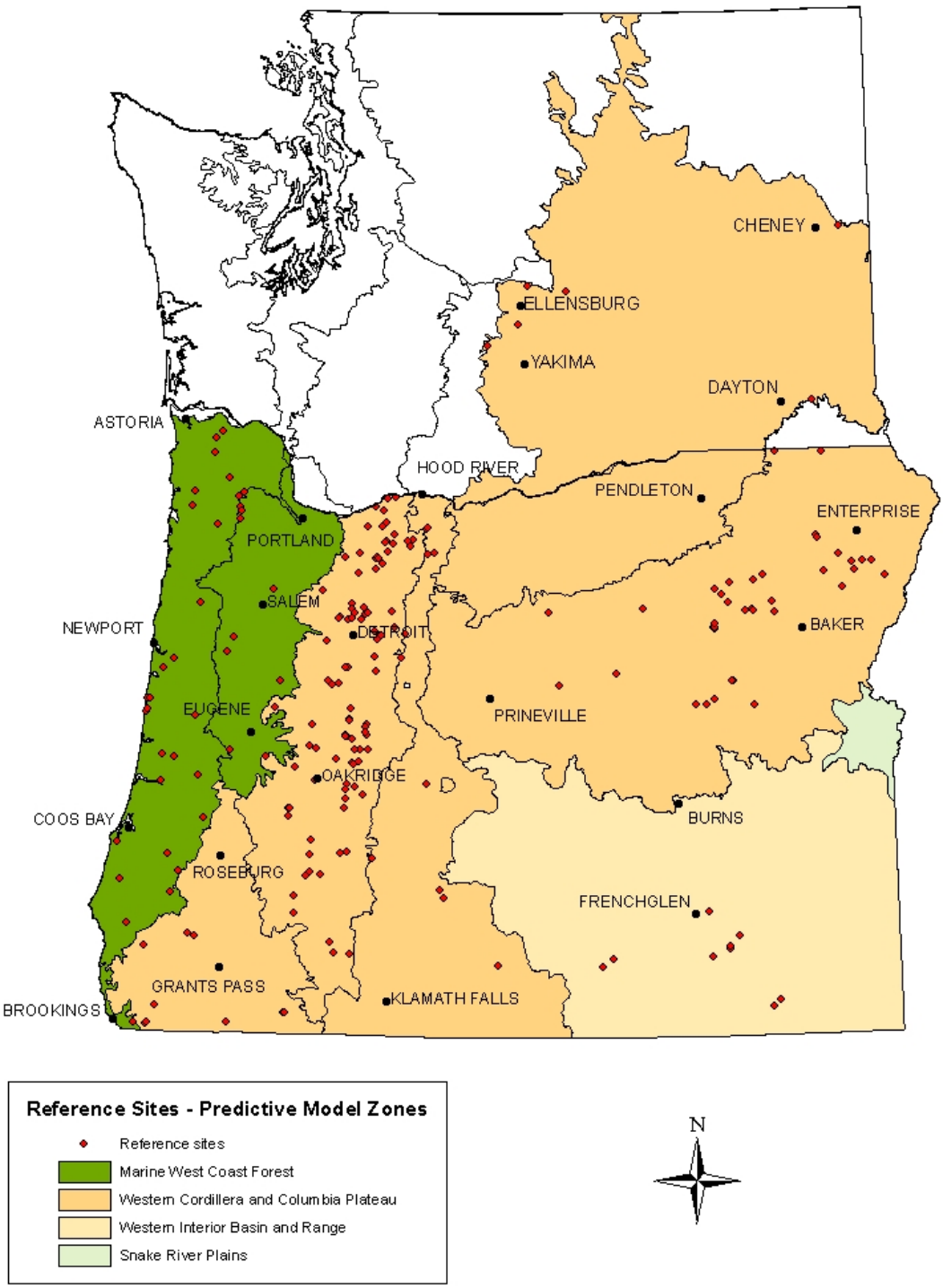


Figure 6. Map of PREDATOR reference sites and zones. PREDATOR consists of two predictive models – Marine West Coast Forest and Western Cordillera and Columbia Plateau – A null model for Western Interior Basin and Range – No model exists for the Snake River Plains ecoregion

Data requirements

For DEQ to evaluate data for the assessment using the PREDATOR model, the data must meet the following specifications and data quality requirements:

- Macroinvertebrate samples must be collected during or after 1998 to be comparable to the reference site data (1998 to 2004) used in the PREDATOR model,
- Samples must be collected within the model season of June 1 through October 15,
- Site samples must be collected using standard field methods and identified to appropriate taxonomic levels as described in the DEQ Mode of Operations Manual or equivalent protocols used throughout the Pacific Northwest,[35]
- A quality assurance project plan documenting procedures and data quality objectives is available,
- Samples are collected from wadeable streams,
- Samples are collected from riffle habitats,
- Samples must contain a total abundance greater than 150 organisms,
- Samples must pass the PREDATOR outlier test that checks for predictor variable similarity to the reference population.

Data from macroinvertebrate samples collected by entities other than DEQ may be considered for the assessment and will be evaluated using the PREDATOR model if all DEQ data quality objectives, file formats, and taxonomic consistency are acceptable. Data that does not conform to DEQ's data quality objectives and formatting requirements will not be evaluated for the assessment using the PREDATOR model.

The PREDATOR model generates one O/E score for each sample. DEQ recommends multiple samples to evaluate the biological condition using the benchmarks selected for each assessment category. If multiple samples are available for an assessment unit or station in a watershed assessment unit, the average O/E score for the period of record will be used for comparison to benchmarks.

Other approaches to assess biological integrity in freshwater

While the PREDATOR O/E model is DEQ's preferred approach and provides the most robust and contemporary method for assessing biological integrity in smaller, wadeable streams and rivers, other approaches may be appropriate for specific cases and data sets. For example, in studies examining the effects in non-wadeable rivers and/or of point-sources, study designs may look at upstream-downstream changes in macroinvertebrate community composition and function and

[35] ODEQ, 2009, Mode of Operations Manual, Version 3.2, DEQ03-LAB-0036-SOP,

provide valid information using multi-metric indices (MMIs) or simple metrics such as total richness, dominance, non-insect taxa, tolerance, etc.

While macroinvertebrates are the most commonly studied community, other aquatic communities such as fish and algae are equally valid for assessing the biological integrity of freshwater systems. At this time, DEQ does not have MMIs or predictive models for fish or algal communities that are routinely used. However, several well developed MMIs exist for these communities and may be considered suitable. In addition, metrics of community composition and function may be used in certain study designs, especially in assessing point-source impacts.

These approaches are useful to study both wadeable and larger, non-wadeable systems. DEQ will determine on a case-by-case basis if the data quality of such studies is sufficient to use for assessment purposes.

DEQ may consider alternative approaches to identifying impairment to macroinvertebrate communities or, if available, may assess data from other aquatic communities (e.g., fish, algae). DEQ's determination will consider metrics or indexes representing community composition and/or function based on taxonomic count data. The data must be supported by supplementary materials outlining field and laboratory procedures as well as quality assurance plans. DEQ's aquatic ecologists will review the submitted data and apply appropriate published indexes if at all possible, or alternatively use standardized assessment techniques to determine if the data identifies impaired biological conditions sufficient for Category 5 assignment.

Assignment of assessment category

Benchmark values are expressed in terms of the percent of taxa loss in a site assemblage compared to the expected assemblage predicted by the PREDATOR model. The benchmark values are summarized in Table 13 and Table 14.

Category 5: water quality limited, TMDL needed (303(d) list)

Single sample

Macroinvertebrate sampling data from perennial, wadeable streams evaluated by DEQ using the PREDATOR model showing:

Table 13. Biocriteria assessment benchmarks for a single sample

PREDATOR Model Region	Assessment Category			
	Category 5: Water Quality Limited	Category 3B: Insufficient Data; Potential Concern:	Category 3C: Insufficient Data; Non-Reference Condition	Category 2: Attaining
Marine Western Coastal Forest	≥ 20% taxa loss[1]	15% to 20% taxa loss	9% to 14% taxa loss	< 8% taxa loss
	PREDATOR score ≤ 0.80	PREDATOR score 0.80 to 0.85	PREDATOR score 0.86 to 0.91	PREDATOR score ≥ 0.92
Western Cordillera and Columbia Plateau	≥ 27% taxa loss[1]	22% to 27% taxa loss	8% to 21% taxa loss	< 7% taxa loss
	PREDATOR score ≤ 0.73	PREDATOR score 0.73 to 0.78	PREDATOR score 0.79 to 0.92	PREDATOR score ≥ 0.93
Northern Basin and Range	Best professional Judgement	25% to ≥ 50% taxa loss	---	< 25% taxa loss
	Best professional Judgement	PREDATOR score ≤ 0.75	---	PREDATOR score > 0.75

[1] Taxa loss rounded to nearest whole number

Two or more samples

Macroinvertebrate sampling data from perennial, wadeable streams evaluated by DEQ using the PREDATOR model showing:

Table 14. Biocriteria assessment benchmarks for multiple samples

PREDATOR Model Region	Assessment Category		
	Category 5: Water Quality Limited	Category 3C: Insufficient Data; Non-Reference Condition	Category 2: Attaining
Marine Western Coastal Forest	≥ 15% taxa loss[1]	9% to 14% taxa loss	< 8% taxa loss
	PREDATOR score ≤ 0.85	PREDATOR score 0.86 to 0.91	PREDATOR score ≥ 0.92
	≥ 22% taxa loss[1]	8% to 21% taxa loss	< 7% taxa loss

Western Cordillera and Columbia Plateau	PREDATOR score ≤ 0.78	PREDATOR score 0.79 to 0.92	PREDATOR score ≥ 0.93
Northern Basin and Range	Best professional Judgement	---	< 25% taxa loss
	Best professional Judgement	---	PREDATOR score > 0.75

Category 4: water quality limited, TMDL not needed

Where DEQ has information relating specific pollutants to impaired biological conditions in the water body, a TMDL can be developed. Where data are available for specific pollutants identified as causing detrimental changes to biological communities, and TMDLs have been approved with load allocations for all the pollutants, the water body will be placed in Category 4A if no additional TMDLs are needed. Water bodies will also be placed in Category 4C for biological criteria if adequate information is available to indicate that detrimental changes to biological communities are due to pollution and not a pollutant.

Category 3B: insufficient data; potential concern

Single sample

Macroinvertebrate sampling data from perennial, wadeable streams evaluated by DEQ using the PREDATOR are within the benchmark range in Table 13.

Assessment units on the cusp of impairment, but lack sufficient data (i.e., a single sample) to confirm the impairment conclusion are placed in Category 3B. DEQ will prioritize follow up monitoring for biocriteria sites identified as Category 3B.

Category 3C: insufficient data; non-reference condition

Single or Multiple Sample(s)

Macroinvertebrate sampling data from perennial, wadeable streams evaluated by DEQ using the PREDATOR model are within the benchmark range in Table 13 or Table 14.

Assessment units identified as Category 3C; Potential Concern refer to assessment units that are neither impaired nor equivalent to reference conditions and may reflect minimal disturbance. These are likely to be the sites that would be the easiest to reverse the impairment through restoration and best management practices in the watershed.

Category 2: attaining

Macroinvertebrate sampling data from perennial, wadeable streams evaluated by DEQ using the PREDATOR model are within the benchmark range in Table 13 or Table 14.

Delisting – new data

Water bodies may be delisted for biocriteria based on multiple site sampling events showing results that are attaining benchmarks. A minimum of two samples in different years within the most recent 5-year time period must be collected in the same sampling season and in the same reach, with the average of the samples showing results that attain appropriate benchmarks. These waters will be placed in Category 2: Attaining.

Assessment – biocriteria marine waters – ocean acidification

PARAMETER	BENEFICIAL USE
Aragonite/Pteropod Shell Dissolution	Fish and Aquatic Life – Marine Waters

Water quality standards

340-041-0011

Biocriteria

Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.

Assessment methodology - Ocean Acidification in Marine waters

The ocean absorbs about 30% of the carbon dioxide (CO_2) that is released into the atmosphere. As levels of atmospheric CO_2 increase from human activity the amount of carbon dioxide absorbed by the ocean also increases. As excess CO_2 is absorbed by seawater, a series of chemical reactions result in changes in the carbonate chemistry, lowering the pH of ocean waters. This reduction in ocean pH, called ocean acidification, poses a threat to the integrity of marine species and food webs. Calcifying invertebrates appear to be particularly vulnerable.[36,37]

The goal of this methodology is to assess changing ocean conditions while also distinguishing between natural variability and long-term change using the existing biocriteria narrative water quality standards. Biological assessments provide direct measures of the cumulative response of the biological community to stressors and the beneficial use support status for aquatic life.[30] As with DEQ's implementation of the biocriteria water quality standard for freshwater, this methodology requires understanding natural background conditions in the absence of stressors (reference conditions).

[36] Barton, A., Hales, B., Waldbusser, G. G., Langdon, C., & Feely, R. A. (2012). The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects. *Limnology and oceanography*, *57*(3), 698-710. https://doi.org/10.4319/lo.2012.57.3.0698

[37] Wootton, J. T., Pfister, C. A., & Forester, J. D. (2008). Dynamic patterns and ecological impacts of declining ocean pH in a high-resolution multi-year dataset. *Proceedings of the National Academy of Sciences*, *105*(48), 18848-18853. https://doi.org/10.1073/pnas.0810079105

The methodology applies a hybrid marine biocriteria assessment framework that allows for the assessment of biological and chemical metrics individually or in combination, depending on data availability. In this framework, biologically relevant numeric benchmarks are used to evaluate the degree of impact. The methodology does not by itself identify which pollutant should be addressed by point source or other controls through a Total Maximum Daily Load. U.S. Environmental Protection Agency guidance recommends listing waters with aquatic use impaired based directly on biological response as Category 5: 303(d) even if the pollutant is not known.

This is a new assessment methodology for use in the 2024 Integrated Report. An accompanying technical support document outlines the rationale, process, and approach DEQ is proposing to use to assess ocean acidification impacts for water quality assessment.

Data evaluation

With assistance from a group of technical experts, DEQ developed an ocean acidification biocriteria assessment framework by identifying clearly defined lines of evidence and indicators to assess biological impacts related to ocean acidification. This ocean acidification methodology will assess biological impacts to calcifying zooplankton (*Limacina helicina*) in Oregon's territorial waters in response to changes in ocean carbonate chemistry. Pteropods (*L. helicina,* and others) are pelagic sea snails that rely on the biomineral aragonite ($CaCO_3$) to form and maintain their shells. As a result, the degree of shell dissolution is closely linked with the saturation state of aragonite (Ω_{ar}) in the water column.[38] The strength of pteropods as a bioindicator for ocean acidification impact is based on global abundance and distribution, well documented stressor-specific sensitivity, ranging from evidence of exposure (e.g., shell dissolution), sublethal and lethal responses,[39,40,41] and role as an important prey group for ecologically and economically

[38] Feely, R.A., Alin, S.R., Carter, B., Bednaršek, N., Hales, B., Chan, F., Hill, T.M., Gaylord, B., Sanford, E., Byrne, R.H. and Sabine, C.L., 2016. Chemical and biological impacts of ocean acidification along the west coast of North America. *Estuarine, Coastal and Shelf Science*, *183*, pp.260-270.https://doi.org/10.1016/j.ecss.2016.08.043
[39] Lischka, S., Büdenbender, J., Boxhammer, T., & Riebesell, U. (2011). Impact of ocean acidification and elevated temperatures on early juveniles of the polar shelled pteropod Limacina helicina: mortality, shell degradation, and shell growth. Biogeosciences, 8(4), 919-932. https://doi.org/10.5194/bg-8-919-2011
[40] Bednaršek, N., Klinger, T., Harvey, C. J., Weisberg, S., McCabe, R. M., Feely, R. A., Newton, J., & Tolimieri, N. (2017). New ocean, new needs: Application of pteropod shell dissolution as a biological indicator for marine resource management. *Ecological Indicators*, *76*, 240–244. https://doi.org/10.1016/j.ecolind.2017.01.025
[41] Lischka, S., & Riebesell, U. (2012). Synergistic effects of ocean acidification and warming on overwintering pteropods in the Arctic. Global Change Biology, 18(12), 3517-3528. https://doi.org/10.1111/gcb.12020

important fishes, birds, and whale in some parts of the Pacific Ocean.[42,43,44] This robust and well-defined relationship between pteropod shell dissolution and aragonite (Ω_{ar}) allow biological measurements of severe shell dissolution and chemical measurements of aragonite (Ω_{ar}) to be the basis for biological impact assessment.[8,45,46,47]

Data metrics and benchmarks

Aragonite saturation state (Ω_{ar}) will serve as the basis for the chemical metrics used in this assessment because it represents the best available science to measure OA stress to pteropods[48]. Procedures and core principles to quantify aragonite (Ω_{ar}) are outlined in McLaughlin et al. (2015), Dickson et al. (2007), and Dickson (2010).[49,50,51] These widely approved procedures describe the primary measurement parameters required to derive aragonite (Ω_{ar}), as well as the relative uncertainty associated with each combination of parameters.[49] As a derived value, uncertainty in aragonite (Ω_{ar}) calculation is a product of several sources of potential error, including independent measurements of multiple carbonate parameters as well as the thermodynamic constants used to relate carbonate species to one another. To address these and other sources of uncertainty, members of the California Current Acidification Network have

[42] Armstrong, J. L., Boldt, J. L., Cross, A. D., Moss, J. H., Davis, N. D., Myers, K. W., Walker, R. V., Beauchamp, D. A., & Haldorson, L. J. (2005). Distribution, size, and interannual, seasonal and diel food habits of northern Gulf of Alaska juvenile pink salmon, *Oncorhynchus gorbuscha*. Deep Sea Research Part II: Topical Studies in Oceanography, 52(1), 247–265. https://doi.org/10.1016/j.dsr2.2004.09.019

[43] Aydin, K. Y., McFarlane, G. A., King, J. R., Megrey, B. A., & Myers, K. W. (2005). Linking oceanic food webs to coastal production and growth rates of Pacific salmon (Oncorhynchus spp.), using models on three scales. Deep Sea Research Part II: Topical Studies in Oceanography, 52(5), 757–780. https://doi.org/10.1016/j.dsr2.2004.12.017

[44] Karpenko, V., Volkov, A., & Koval, M. (2007). Diets of Pacific Salmon in the Sea of Okhotsk, Bearing Sea, and Northwest Pacific Ocean. North Pac Anadromous Fish Commission Bull, 4.

[45] Bednaršek, N., Feely, R. A., Reum, J. C. P., Peterson, B., Menkel, J., Alin, S. R., & Hales, B. (2014). *Limacina helicina* shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1785), 20140123. https://doi.org/10.1098/rspb.2014.0123

[46] Bednaršek, N., Feely, R. A., Howes, E. L., Hunt, B. P. V., Kessouri, F., León, P., Lischka, S., Maas, A. E., McLaughlin, K., Nezlin, N. P., Sutula, M., & Weisberg, S. B. (2019). Systematic Review and Meta-Analysis Toward Synthesis of Thresholds of Ocean Acidification Impacts on Calcifying Pteropods and Interactions With Warming. *Frontiers in Marine Science*, *6*, 227. https://doi.org/10.3389/fmars.2019.00227

[47] Waldbusser, G. G., Hales, B., Langdon, C. J., Haley, B. A., Schrader, P., Brunner, E. L., Gray, M. W., Miller, C. A., & Gimenez, I. (2015). Saturation-state sensitivity of marine bivalve larvae to ocean acidification. *Nature Climate Change*, *5*(3), 273–280. https://doi.org/10.1038/nclimate2479

[48] Bednaršek, et al. (2019), "Systematic Review and Meta-Analysis." https://doi.org/10.3389/fmars.2019.00227

[49] McLaughlin, K., Weisberg, S. B., Dickson, A. G., Hofmann, G. E., Newton, J. A., Aseltine-Neilson, D., ... & Steele, B. (2015). Core principles of the California Current Acidification Network: Linking chemistry, physics, and ecological effects. *Oceanography*, *28*(2), 160-169. https://doi.org/10.5670/oceanog.2015.39

[50] Dickson, Andrew. 2010. "The Carbon Dioxide System in Seawater: Equilibrium Chemistry and Measurements." *Guide to Best Practices for Ocean Acidification Research and Data Reporting* 17–40.

[51] Dickson, Andrew Gilmore, Christopher L. Sabine, James Robert Christian, Charlene P. Bargeron, and North Pacific Marine Science Organization, eds. 2007. *Guide to Best Practices for Ocean CO2 Measurements*. Sidney, BC: North Pacific Marine Science Organization.

suggested an uncertainty range of aragonite Ω_{ar} +/- 0.2 when linking changes in ocean chemistry to aragonite Ω changes in ecosystem function.[49]

Two benchmarks are needed within each data type to use the hybrid framework for Integrated Report categorical assessment. For each data type, a value is needed above which experts have confidence about biological impact based on a single data type (referred to as "independently applicable (IA)" benchmark), and one above which indicates biological impact, but requires confirmation multiple line of evidence (referred to here as a "combined line of evidence (CLOE)" benchmark). Use of each benchmark will be determined based on data availability within an assessment unit during the assessment period. In cases where two lines of evidence are available for assessment DEQ will rely on the combined lines of evidence benchmark, whereas in instances where only a single line of evidence is available DEQ will employ the independently applicable benchmark for that data.

Aragonite saturation state Ω_{ar} thresholds for severe shell dissolution derived experimentally, through expert consensus, and through a field stress-response study range from 1.06 to 1.3, with the final recommended value of 1.2.[52,53] For the purposes of this assessment methodology DEQ proposes to adopt the uncertainty range of +/- 0.2 outlined in McLaughlin et al. (2015) to identify the two aragonite Ω_{ar} biological impact benchmarks for severe pteropod shell dissolution[18]. The lower end of the 0.2 range around Ω_{ar} =1.2 will define the IA benchmark and the upper end will define the CLOE benchmark. DEQ and the workgroup believe aragonite Ω_{ar} = 1.0 (1.2 - 0.2) is a suitable IA benchmark value that provides the certainty needed to determine impairment on chemical data alone, and aragonite Ω_{ar} = 1.4 (1.2 + 0.2) is a suitable "CLOE benchmark to indicate biological impact but require biological data confirmation to determine impairment. The

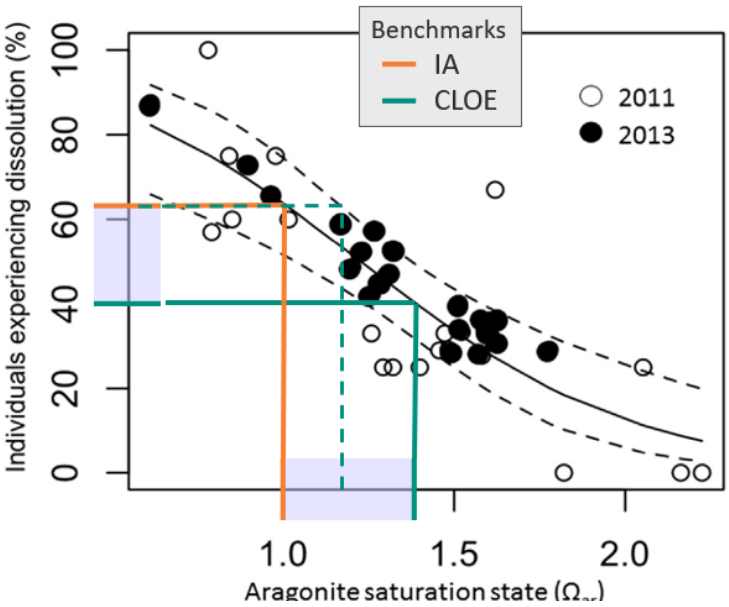


Figure 7. Figure from Feely et al. (2016) modified to show derivation of DEQ's assessment benchmark values for OA

[52] Bednaršek, et al. 2019. "Systematic Review and Meta-Analysis," https://doi.org/10.3389/fmars.2019.00227
[53] Bednaršek, et al. 2014. "*Limacina Helicina* Shell Dissolution," https://doi.org/10.1098/rspb.2014.0123

application of these chemical benchmarks to the pteropod/aragonite relationship serves as the translation to derive corresponding severe shell dissolution benchmarks (**Figure 7**).

The biological metric for this assessment will be the percentage of individuals within a pteropod (*L. helicina)* sample with severe shell damage (Type II & Type III) based on detailed procedures outlined in Bednarsek et al. (2012).[54] DEQ selected 62% and 40% individuals with Type II/III dissolution as the IA and CLOE biological benchmarks, respectively. The rationale for this choice is as follows. Utilizing the regression relationship of Ω_{ar} versus % individuals with Type II/III dissolution[55], 62% of individuals with dissolution represents the upper 95th confidence limit of an Ω_{ar} = 1.2 **(Figure 7** – dashed line), the threshold at which severe dissolution occurs.[56] According to Bednarsek et al. (2017, Fig 1d), a benchmark of 62% of individuals with Type II/III dissolution correlates to a mean survival probability of roughly 50%, which aligns with an acute (Lethal Concentration to 50% of the sample) effect, suggesting that 62% of individuals with Type II/III dissolution represents a severe effects/lethality threshold (**Figure 7**- orange line).[57] While the CLOE benchmark (40% individuals with combined Type II/ III dissolution) accounts for some natural variability in biological response, and therefore requires a second line of evidence from the chemical indicator to determine impairment (**Figure 7** – green line).

Natural background conditions

A critical piece of biocriteria assessment for the determination of aquatic life beneficial use impairment is establishing the natural background exceedance of the IA and CLOE benchmarks. Nearshore environments with seasonal upwelling (such as Oregon's territorial sea) intermittently become undersaturated with respect to aragonite (Ω_{ar} < 1) under naturally occurring conditions (Harris et al. 2013).[58] Thus, it is expected that chemical assessment benchmarks may be naturally exceeded with some frequency, and some percentage of pteropods would naturally be affected by Type II/III dissolution.

[54] Bednaršek, N., Tarling, G. A., Bakker, D. C., Fielding, S., Cohen, A., Kuzirian, A., McCorkle, D., Lézé, B., & Montagna, R. (2012). Description and quantification of pteropod shell dissolution: A sensitive bioindicator of ocean acidification. *Global Change Biology*, *18*(7), 2378–2388. https://doi.org/10.1111/j.1365-2486.2012.02668.x
[55] Feely, et al., 2016. "Chemical and Biological Impacts," https://doi.org/10.1016/j.ecss.2016.08.043
[56] Bednaršek, et al. 2019. "Systematic Review and Meta-Analysis," https://doi.org/10.3389/fmars.2019.00227
[57] Bednaršek, N., Feely, R. A., Tolimieri, N., Hermann, A. J., Siedlecki, S. A., Waldbusser, G. G., McElhany, P., Alin, S. R., Klinger, T., Moore-Maley, B., & Pörtner, H. O. (2017). Exposure history determines pteropod vulnerability to ocean acidification along the US West Coast. Scientific Reports, 7(1), 4526. https://doi.org/10.1038/s41598-017-03934-z
[58] Harris, Katherine E., Michael D. DeGrandpre, and Burke Hales. 2013. "Aragonite Saturation State Dynamics in a Coastal Upwelling Zone." *Geophysical Research Letters* 40(11):2720–25. https://doi.org/10.1002/grl.50460

A well developed and routinely applied approach to determine OA natural background condition is to estimate the contribution of anthropogenic carbon (C_{anth}) to observational measurements to quantify the shift from pre-industrial times.[59]

For the biological indicator, DEQ is proposing to use the most recently published pre-industrial estimates of natural background percentage individuals with Type II/III dissolution in the nearshore (36-39%) as evidence that the CLOE benchmark (40%) is on the upper end of the range of natural background condition (**Figure 8**), and impact should be confirmed with the chemical indicator.[28] DEQ is proposing that published pre-industrial pteropod dissolution estimates in nearshore environments provide sufficient evidence that levels chosen for the IA and CLOE benchmarks represent a deviation from natural background conditions. For this reason, biological IA and CLOE benchmark values will be evaluated directly to determine an excursion without additional comparison to natural background conditions.

Year	Location	Ω_{ar}, preind.	Ω_{ar}, current	% Ind. with severe dissolution, preind.
2011	nearshore	1.39	1.05	39
2013	nearshore	1.46	1.08	36
2011	offshore	2.21	1.51	8
2013	offshore	2.09	1.43	12

Figure 8. Adapted from Feely et al. (2016) reported on average current and estimated pre-industrial period aragonite saturation states and percentage of individuals affected by severe dissolution for nearshore and offshore regions of CCE calculated for years 2011 and 2013

Unlike the biological indicator, which serves as an integrator of exposure time and frequency in the water column, chemical observational data represent a snapshot in time or a selected portion of the water column. Thus, for the chemical indicator, DEQ is proposing that observational data must not only be compared to benchmark values but also evaluated against estimated background conditions to determine an excursion. Documented biological impacts related to OA taking place from decreasing available aragonite occur in part because the stratified boundary (horizon) of undersaturated ($\Omega_{ar} < 1$) conditions is moving up the water column. Pre-industrial estimations of carbonate chemistry can be used to compare present day observations of Ω_{ar} in the vertical water column to those expected in the absence of anthropogenic carbon. Additionally, these pre-industrial estimates can be used to generate a depth horizon for a given Ω_{ar} value, where concentrations in the water column below the horizon are expected to occur under natural background conditions, and above which concentrations were not expected to occur (**Figure 9**). DEQ believes estimated pre-industrial depth horizons of chemical benchmarks represent one way to compare current observational data with natural background conditions to determine impairment. At each profile monitoring location, DEQ will

[59] Feely, et al., 2016. "Chemical and Biological Impacts," https://doi.org/10.1016/j.ecss.2016.08.043

employ the best available estimate of pre-industrial depth horizon to confirm the deviation from natural background condition. Sample results below the depth horizon will be excluded from the remaining categorical assessment steps (**Figure 9**). Remaining results above the pre-industrial depth horizon will be pooled by assessment unit, and DEQ will use existing precedent of a 10% exceedance rate with a 90% confidence rate according to the exact binomial test to determine impairment. Steps for model derived depth horizons and additional options DEQ may use to derive similar depth estimates are outline in the Technical Support Document.

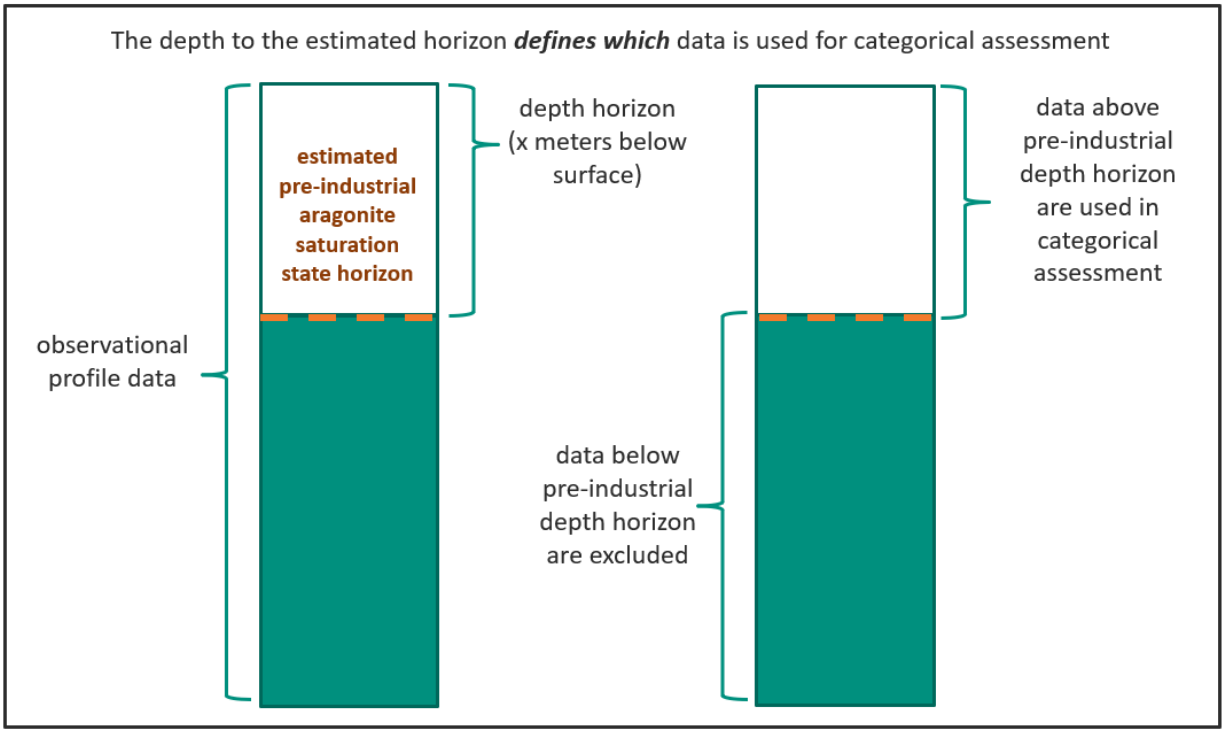


Figure 9. Pre-industrial aragonite saturation state horizon estimates will be used to define which data will be used in categorical assessment to determine impairment

Data requirements

Biological and chemical data for this assessment must be:

- Collected within the critical period and critical area
    - Critical period of April through the end of September is defined by the temporal overlap of (1) changes in ocean conditions in Oregon associated with seasonal upwelling and (2) the temporal window of data used to define the pteropod aragonite relationship.[60, 61]

[60] Bednaršek, et al., 2017. "Exposure History Determines," https://doi.org/10.1038/s41598-017-03934-z
[61] Bednaršek, et al. 2014. "*Limacina Helicina* Shell Dissolution," https://doi.org/10.1098/rspb.2014.0123

    - Critical area – defined by the spatial overlap of three considerations: (1) the boundaries of and/or relevance to Oregon's territorial waters, (2) likely pteropod habitats, and (3) applicability of pre-industrial calculations used to define natural background conditions in nearshore waters. This will be evaluated on a case-by-case basis.
- Biological data
    - Must have two or more representative samples. DEQ will use an average to compare to the appropriate assessment benchmark.
    - Consistent with sampling procedures outlined during NOAA hydrographic cruises.[62, 63]
    - Biological samples used to calculate the assessment metric must contain at least 15 organisms.
    - Calculations of the metric (% individuals with severe shell dissolution) are consistent with sample processing and the categorization scheme outlined in Bednarsek et al. (2012).[64]
- Chemical data
    - Each Assessment Unit must have five unique (different date/time) vertical profiles
    - Each profile must have vertical resolution sufficient to be representative of the water column.
    - Vertical profiles with Ω_{ar} derived from two of four possible carbonate measurements (seawater pH, partial pressure carbon dioxide (*p*CO2), total dissolved inorganic carbon (TCO_2), or total alkalinity (TA)) combined with salinity, temperature, and depth.[65] DEQ will not employ algorithm-derived approaches internally to derive Ω_{ar} in the 2024 Integrated Report cycle, but will accept pre-calculated Ω_{ar} data derived via widely approved approaches so long as the associated calculation error rates are not greater than +/- 0.2 Ω_{ar} as described in McLaughlin et al. (2015).[34]
    - When not reported directly, DEQ will use the seacarb R package to calculate Ω_{ar}.
    - An approach to determine the best available representation of pre-industrial depth horizon to confirm the deviation from natural background condition.

[62] Bednaršek, et al., 2017. "Exposure History Determines," https://doi.org/10.1038/s41598-017-03934-z
[63] Bednaršek, et al., 2014. "*Limacina Helicina* Shell Dissolution," https://doi.org/10.1098/rspb.2014.0123
[64] Bednaršek, et al., 2012. "Description and quantification," https://doi.org/10.1111/j.1365-2486.2012.02668.x
[65] McLaughlin, et al., 2015. "Core Principles," https://doi.org/10.5670/oceanog.2015.39

Other approaches to assess biological integrity in marine waters

DEQ may consider alternative approaches to identifying biological impairment to marine communities. DEQ acknowledges that impairment determinations can be made based on overwhelming evidence where multiple sources of data and/or information indicate impairment. This may include the use of some combination of observational data, published literature, and best professional judgment when interpreting data and information submitted to the agency for assessment purposes. If this approach is taken, a detailed rationale will be included in the Integrated Report.

Numeric data must be supported by supplementary materials outlining field and laboratory procedures as well as project plan that includes a purpose statement, the number of samples collected, and quality assurance and quality control protocols for collecting and analyzing samples.

Assignment of assessment category

For the 2024 IR DEQ will be assessing water bodies for impacts to biological response as a result of changing OA conditions and will therefore be evaluating Categories 5 and 3 using both data types. For the 2024 IR cycle, DEQ will not determine biocriteria attainment (Category 2) because there is uncertainty in the level of protection provided by the current CLOE benchmarks. The hybrid framework for OA biocriteria assessment **(Figure 10**) and decision tree for assigning assessment categories (**Figure 11**) outline how DEQ will assess data for categorical determination.

Global climate change, occurring as a result of excess carbon dioxide emissions into the atmosphere, is a wide ranging issue that can have impacts on water quality and beneficial use support. DEQ is taking leadership on developing assessment methodologies to identify these impacts through the Section 303(d) listing process. However, the challenge of addressing climate change related impairments demands a strategic approach and will require additional tools and resources to accompany the suite of Clean Water Act management and implementation tools traditionally used to restore impaired waters. For this reason, DEQ will use Sub-Category 5C to identify climate change related waterbody impairments on the 303(d) list, while also recognizing a broader approach than the traditional TMDL and restrictions on permitted discharges may be needed to find effective solutions.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">Aragonite Saturation State (Ω_{ar})</td></tr>
<tr><td>No data</td><td>> 1.4</td><td>≤ 1.4 (CLOE)</td><td>≤ 1.0 (IA)</td></tr>
<tr><td rowspan="4">% pteropods with severe shell dissolution</td><td>No data</td><td>No assessment</td><td>Category 3 (insufficient data)</td><td rowspan="2">Category 3B (potential concern)</td><td>Category 5 (IA - Chem)</td></tr>
<tr><td>< 40</td><td>Category 3 (insufficient data)</td><td>Category 3 (insufficient data)</td><td></td></tr>
<tr><td>≥ 40 (CLOE)</td><td colspan="2">Category 3B (potential concern)</td><td>Category 5 (CLOE)</td><td></td></tr>
<tr><td>≥ 62 (IA)</td><td>Category 5 (IA – Bio)</td><td></td><td></td><td></td></tr>
</table>

Figure 10. Marine biocriteria hybrid assessment framework outlining categorical assignments based on biological and/or chemical data. IA=Independently Applicable benchmark, CLOE = Combined Lines of Evidence benchmark

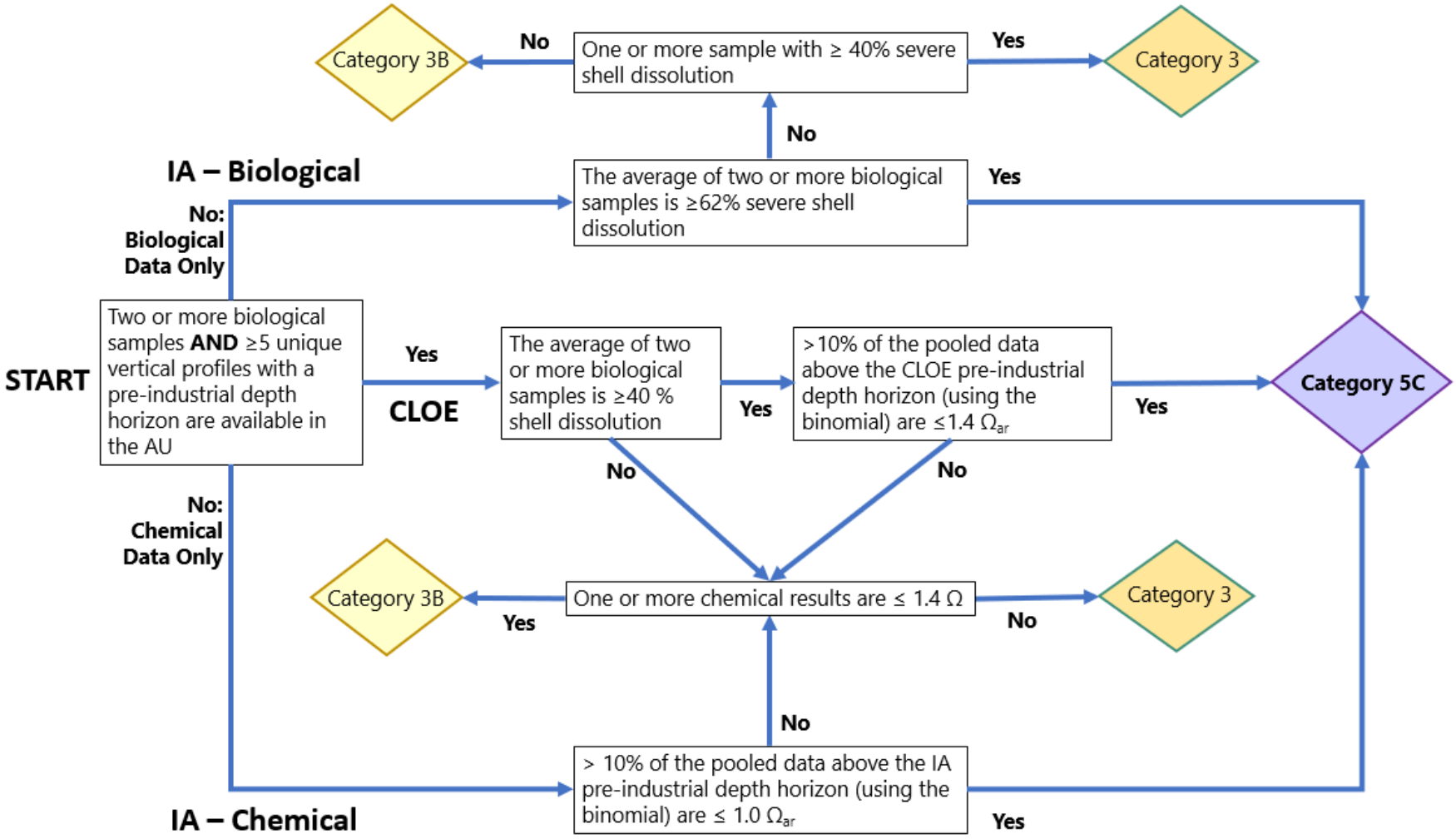


Figure 11. Decision tree for assigning assessment categories based on OA hybrid biocriteria assessment framework

5C: Impaired; Climate Change Related

Biological data - independently applicable

The average of two or more representative pteropod samples in an assessment unit that meet data requirements is greater than or equal to 62 % individuals with severe shell dissolution.

OR

Chemical data - independently applicable

- At least five unique (different date/time) vertical profiles representative of the water column collected in the critical assessment windows and data window
- Greater than 10% of all vertical profile results in an assessment unit above the estimated pre-industrial depth horizon of 1.0 Ω_{ar} are less than or equal to 1.0 Ω_{ar} according to the exact binomial test for conventional pollutants

OR

Combined line of evidence - biological data and chemical data

The average of two or more representative pteropod samples in an assessment unit that meet data requirements is greater than or equal to 40% pteropods with severe shell dissolution.

AND

- At least five unique (different date/time) vertical profiles representative of the water column collected in the critical assessment windows and data window
- Greater than 10% of all vertical profile data in an assessment unit above the estimated pre-industrial depth horizon of 1.4 Ω_{ar} are less than or equal to 1.4 Ω_{ar} according to the exact binomial test for conventional pollutants

Category 4

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address a pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3B: insufficient data; potential concern

Water bodies with be placed in Category 3B: insufficient data; potential concern when:

Biological data only

Only a single pteropod sample is available in an assessment unit that meets data requirements with greater than or equal to 40% individuals with severe shell dissolution

OR

Chemical data only

When fewer than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit:

- One or more results is less than or equal to 1.4 Ω_{ar}.

When more than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit:

- Less than 10% of all vertical profile data in an assessment unit above the estimated pre-industrial depth horizon of 1.4 Ω_{ar} are less than or equal to 1.4 Ω_{ar} according to the exact binomial test for conventional pollutants **and** one or more results is less than or equal to 1.4 Ω_{ar}.

OR

Combined lines of evidence - biological data and chemical data

One line of evidence meets the conditions for Category 5, while the other line of evidence meets the conditions for Category 3.

Category 3: insufficient data

Water bodies will be placed in Category 3: insufficient data when:

Biological data only

Only a single pteropod sample is available in an assessment unit that meets data requirements, and it has less than 40% individuals with severe shell dissolution.

OR

Chemical data only

Fewer than five unique (different date/time) vertical profiles representative of the water column are available in an assessment unit above and all results are greater to 1.4 Ω_{ar}.

OR

Combined lines of evidence - biological data and chemical data

A single pteropod sample or an average of multiple samples is available in an assessment unit that meets data requirements, and it is less than 40% individuals with severe shell dissolution

AND

When all unique (different date/time) vertical profiles representative of the water column in an assessment unit above the estimated pre-industrial depth horizon of 1.4 Ω_{ar} are greater than 1.4 Ω_{ar}.

Category 2: attaining

DEQ will not be using OA impact benchmarks (outlined above) to determine attainment for the narrative biocriteria in the 2024 assessment.

Delisting – new data

Without a pathway to attainment DEQ will evaluate potential delisting on a case-by-case basis.

Assessment - chlorophyll-a (nuisance phytoplankton growth)

PARAMETER	BENEFICIAL USE
Chlorophyll-a	Aesthetic Quality

Water quality standards

340-041-0019

Nuisance Phytoplankton Growth

(1) (a) The following values and implementation program must be applied to lakes, reservoirs, estuaries and streams, except for ponds and reservoirs less than ten acres in surface area, marshes and saline lakes:

(b) The following average chlorophyll-a values must be used to identify water bodies where phytoplankton may impair the recognized beneficial uses:

(A) Natural lakes that thermally stratify: 0.01 mg/1;

(B) Natural lakes that do not thermally stratify, reservoirs, rivers and estuaries: 0.015 mg/1;

(C) Average chlorophyll-a values may be based on the following methodology (or other methods approved by the Department): A minimum of three samples collected over any three consecutive months at a minimum of one representative location (e.g., above the deepest point of a lake or reservoir or at a point mid-flow of a river) from samples integrated from the surface to a depth equal to twice the secchi depth or the bottom (the lesser of the two depths); analytical and quality assurance methods must be in accordance with the most recent edition of Standard Methods for the Examination of Water and Wastewater.

(2) Upon determination by the Department that the values in section (1) of this rule are exceeded, the Department may:

(a) In accordance with a schedule approved by the Commission, conduct such studies as are necessary to describe present water quality; determine the impacts on beneficial uses; determine the probable causes of the exceedance and beneficial use impact; and develop a proposed control strategy for attaining compliance where technically and economically practicable. Proposed strategies could include standards for additional pollutant parameters, pollutant discharge load limitations, and other such provisions as may be appropriate. Where natural conditions are responsible for exceedance of the values in section (1) of this rule or beneficial uses are not impaired, the values in section (1) of this rule may be modified to an appropriate value for that water body;

(b) Conduct necessary public hearings preliminary to adoption of a control strategy, standards or modified values after obtaining Commission authorization;

(c) Implement the strategy upon adoption by the Commission.

(3) In cases where waters exceed the values in section (1) of this rule and the necessary studies are not completed, the Department may approve new activities (which require Department approval), new or additional (above currently approved permit limits) discharge loadings from point sources provided that it is determined that beneficial uses would not be significantly impaired by the new activity or discharge.

Assessment methodology

This method shall be used to evaluate impairment of aesthetic quality caused by excessive algae growth. The concentration of chlorophyll-a is used to indicate undesirable discoloration of the water body.

Data evaluation

Chlorophyll-a concentration results collected over a three month consecutive period will be averaged and compared applicable criteria based on water body type.

Data requirements

A minimum of three samples collected over any three consecutive months (at least one per month) at a minimum of one representative location (e.g., above the deepest point of a lake or reservoir or at a point mid flow of a river).

Assignment of assessment category

Category 5: water quality limited, TMDL needed (303(d) list)

The average Chlorophyll-a value over three consecutive months exceeds the value referenced in the rule **OR** >10% of monthly averages within the IR data window exceed the referenced values according to the exact binomial test.

Category 4: water quality limited, TMDL not needed

TMDLs for specific pollutants have been completed and approved to address nuisance phytoplankton growth and exceedance of chlorophyll a values in a water body (Category 4A); Another control mechanism such as a control strategy developed and adopted according to OAR 340- 041-0019(2) is being implemented to control phytoplankton growth (Category 4B); or Adequate information indicates that phytoplankton proliferation is not due to pollutants or is a natural condition (Category 4C).

Category 3: insufficient data

Less than 3 samples available in three consecutive months to calculate an average, or less than one sample available in any month of the three consecutive month period.

Category 3B: insufficient data; potential concern

Where one monthly sample exceeds the value referenced in the rule, but less than three samples are available in three consecutive months to calculate an average.

Category 2: attaining

The average Chlorophyll a value over three consecutive months is less than the value referenced in the rule **OR** ≤ 10% of monthly averages within the IR data window exceed the referenced values according to the exact binomial test.

Delisting – new data

Assessment units with sufficient data in the data and window to meet the Delisting – statistical methods requirements for conventional pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

Assessment – Dissolved Oxygen

PARAMETER	BENEFICIAL USE
Dissolved Oxygen	Fish and Aquatic Life

Water quality standards

340-041-0016

Dissolved oxygen

Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that, either alone, or in combination with other wastes or activities, will cause violation of the following standards: The changes adopted by the Commission on Jan. 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on Jan. 10, 1996, apply:

(1) For water bodies identified as active spawning areas in the places and times indicated on the following Tables and Figures set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, 121B, and 190B; and Figures 130B, 151B, 160B, 170B, 180A, 201A, 220B, 230B, 260A, 271B, 286B, 300B, 310B, 320B, and 340B, (as well as any active spawning area used by resident trout species), the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures and, where resident trout spawning occurs, during the time trout spawning through fry emergence occurs:

(a) The dissolved oxygen may not be less than 11.0 mg/L. However, if the minimum intergravel dissolved oxygen, measured as a spatial median, is 8.0 mg/L or greater, then the DO criterion is 9.0 mg/L;

(b) Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 11.0 mg/L or 9.0 mg/L criteria, dissolved oxygen levels must not be less than 95 percent of saturation;

(c) The spatial median intergravel dissolved oxygen concentration must not fall below 8.0 mg/L.

(2) For water bodies identified by the Department as providing cold-water aquatic life, the dissolved oxygen may not be less than 8.0 mg/L as an absolute minimum. Where conditions of barometric pressure, altitude, and temperature preclude attainment of the 8.0 mg/L, dissolved oxygen may not be less than 90 percent of saturation. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 8.0 mg/L as a 30-day mean

minimum, 6.5 mg/L as a seven-day minimum mean, and may not fall below 6.0 mg/L as an absolute minimum (Table 15);

(3) For water bodies identified by the Department as providing cool-water aquatic life, the dissolved oxygen may not be less than 6.5 mg/L as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 6.5 mg/L as a 30-day mean minimum, 5.0 mg/L as a seven-day minimum mean, and may not fall below 4.0 mg/L as an absolute minimum (Table 15);

(4) For water bodies identified by the Department as providing warm-water aquatic life, the dissolved oxygen may not be less than 5.5 mg/L as an absolute minimum. At the discretion of the Department, when the Department determines that adequate information exists, the dissolved oxygen may not fall below 5.5 mg/L as a 30-day mean minimum, and may not fall below 4.0 mg/L as an absolute minimum (Table 15);

(5) For estuarine water, the dissolved oxygen concentrations may not be less than 6.5 mg/L (for coastal water bodies);

(6) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed.

Table 15. Dissolved oxygen & intergravel dissolved oxygen criteria (OAR-340-041-0016, TABLE 21)

D.O. Standard	Concentration and Period[1] (All Units are mg/L)				Use/Level of Protection
	30-D	7-D	7- Mi	Min	
Salmonid Spawning		11.0[2,3]		9.0[3] IGDO: 8.0[4]	Principal use of salmonid spawning and incubation of embryos until emergence from the gravels. Low risk of impairment to cold-water aquatic life, other native fish and invertebrates.
Cold Water	8.0[5]		6.5	6.0	Principally cold-water aquatic life. Salmon, trout, cold-water invertebrates, and other native cold-water species exist throughout all or most of the year. Juvenile anadromous salmonids may rear throughout the year. No measurable risk level for these communities.
Cool Water	6.5		5.0	4.0	Mixed native cool-water aquatic life, such as sculpins, smelt, and lampreys. Waterbodies includes estuaries. Salmonids and other cold-water biota may be present during part or all of the year but do not form a dominant component of the community structure. No measurable risk to cool-water species, slight risk to cold-water species present.

Warm Water	5.5			4.0	Waterbodies whose aquatic life beneficial uses are characterized by introduced, or native, warm-water species.
Marine / No Risk	No Change from Background				The only DO criterion that provides no additional risks is "no change from background". Waterbodies accorded this level of protection include marine waters and waters in Wilderness areas.

OAR-340-041-0002, TABLE 21 (Continued)

Note:
Shaded values present the absolute minimum criteria, unless the Department believes adequate data exists to apply the multiple criteria and associated periods.
[1] **30-D** = 30-day mean minimum as defined in OAR 340-41-006.
7-D = 7-day mean minimum as defined in OAR 340-41-006.
7-Mi = 7-day minimum mean as defined in OAR 340-41-006.
Min = Absolute minimums for surface samples when applying the averaging period, spatial median of IGDO.
[2] When Intergravel DO levels are 8.0 mg/L or greater, DO levels may be as low as 9.0 mg/L, without triggering a violation.
[3] If conditions of barometric pressure, altitude and temperature preclude achievement of the footnoted criteria, then 95 percent saturation applies.
[4] Intergravel DO criterion, spatial median minimum.
[5] If conditions of barometric pressure, altitude, and temperature preclude achievement of 8.0 mg/L, then 90 percent saturation applies.

OAR 340-041-0006
Definitions

[…]

(15) "Daily Mean" for dissolved oxygen means the numeric average of an adequate number of data to describe the variation in dissolved oxygen concentration throughout a day, including daily maximums and minimums. For calculating the mean, concentrations in excess of 100 percent of saturation are valued at the saturation concentration.

[…]

(22) "Estuarine Waters" means all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties.

(27) "Intergravel Dissolved Oxygen" (IGDO) means the concentration of oxygen measured in the water within the stream bed gravels. Measurements should be taken within a limited time period before emergence of fry.

(34) “Marine Waters” means all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon.

[…]

(38) "Minimum" (Min) for dissolved oxygen means the minimum recorded concentration including seasonal and diurnal minimums.

(39) "Monthly (30-D) Mean Minimum" for dissolved oxygen means the minimum of the 30 consecutive-day floating averages of the calculated daily mean dissolved oxygen concentration.

[…]

(59) "Spatial Median" means the value that falls in the middle of a data set of multiple intergravel dissolved oxygen (IGDO) measurements taken within a spawning area. Half the samples should be greater than and half the samples should be less than the spatial median.

[…]

(73) "Weekly (7-D) Mean Minimum" for dissolved oxygen means the minimum of the seven consecutive-day floating average of the calculated daily mean dissolved oxygen concentration.

(74) "Weekly (7-Mi) Minimum Mean" for dissolved oxygen means the minimum of the seven consecutive-day floating average of the daily minimum concentration. For application of the criteria, this value is the reference for diurnal minimums.

Assessment methodology

Assessment methods for dissolved oxygen are determined by data type and criteria by applied. Figure 7 and Figure 8 provide decision trees to document the processes.

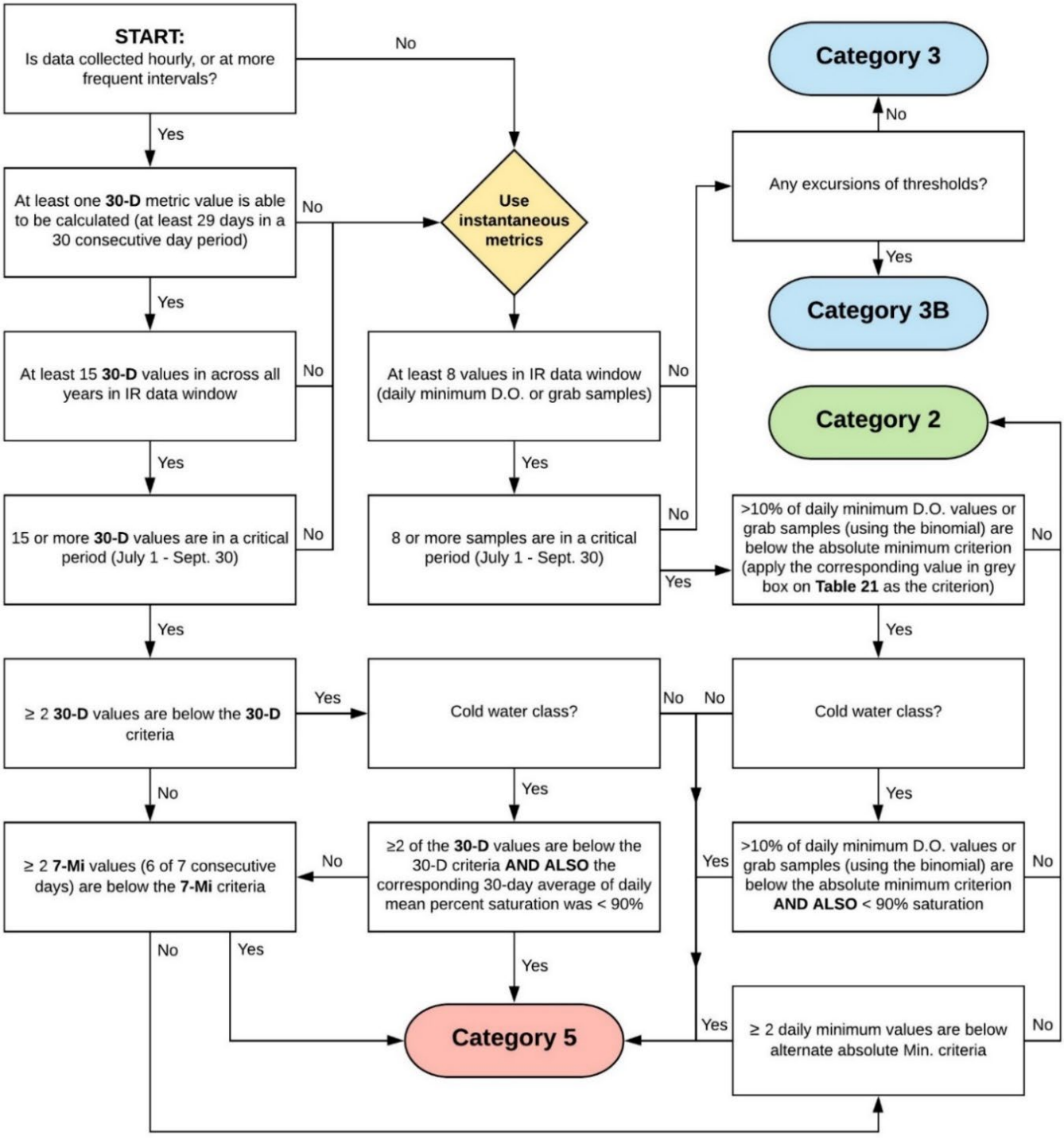


Figure 12. The decision tree for assessment of the dissolved oxygen year-round criteria

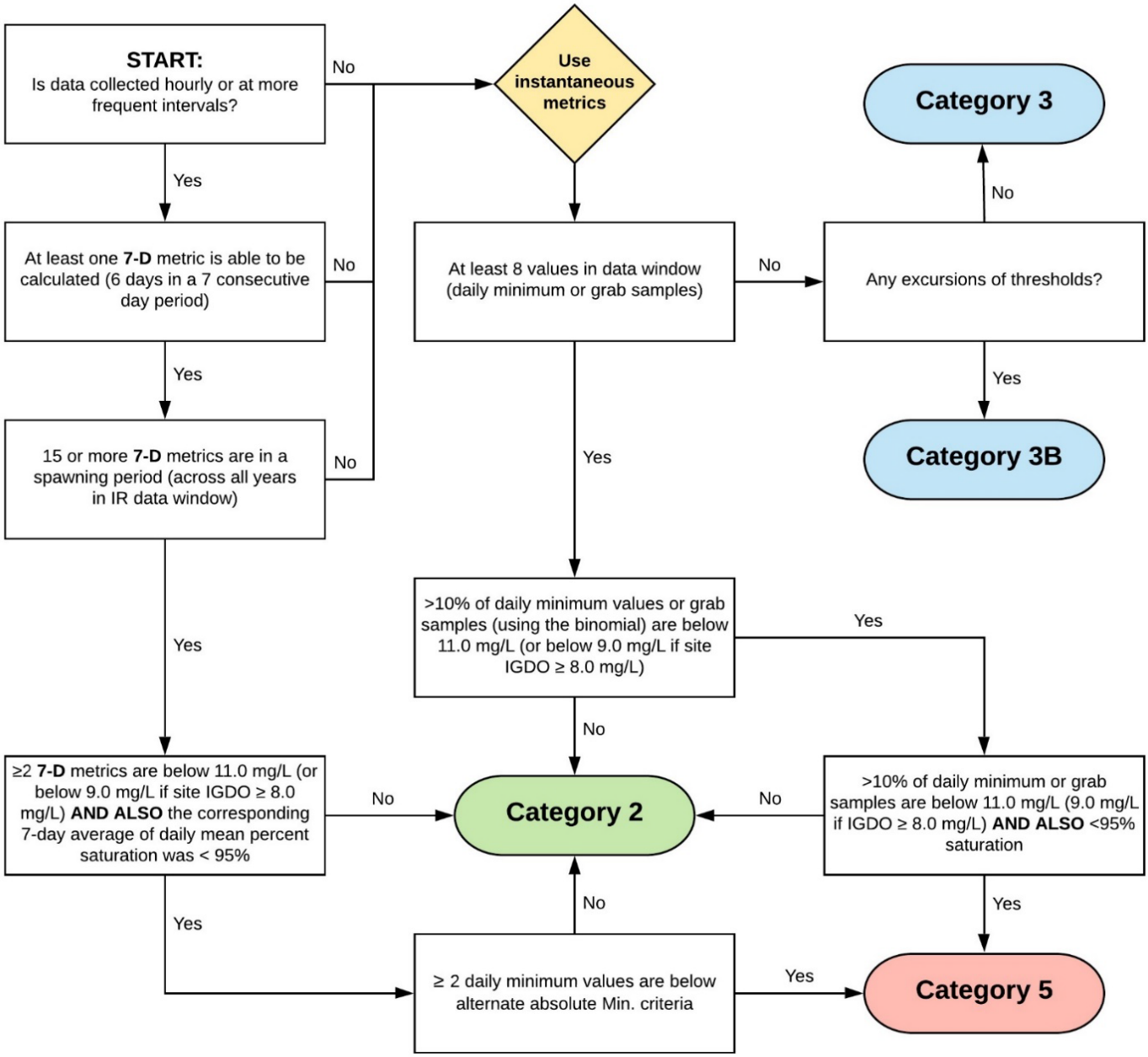


Figure 13. The decision tree for assessment of the dissolved oxygen spawning criteria

Data evaluation

Determining Applicable Criteria

The application of the various dissolved oxygen criteria is based on designated fish use as described in the tables and figures in OAR-340-041-016 (1). For convenience, the interpretation of this information is detailed in the Dissolved Oxygen Standard Implementation Guidance and depicted for reference in the water quality standards layer on DEQ IR web map.

Time Period

Spawning time-period: The spawning criteria shall be applied for places and times indicated, in the tables and figures referenced in OAR-340-041-0016 (1), as having active salmon and steelhead spawning, or any additional assumed spawning by resident trout species. Listed status of waterbodies in violation of the spawning criteria is in effect only during the applicable spawning date range for the water body.

Year-round: The year-round dissolved oxygen criteria apply year-round. For some locations, a more stringent spawning criteria may apply in addition to the year-round criterion for part of the year. Listed status of waterbodies in violation of the year-round criteria are in effect year-round.

Critical period: The critical period for assessing compliance with the year-round dissolved oxygen standard is the summer period July 1 – September 30, when seasonal trends in dissolved oxygen are expected to be near annual minimums.

Data requirements

Continuous time series dissolved oxygen concentration

The Department shall apply the Monthly (30-D) Mean Minimum, Weekly (seven-day) Minimum Mean, and alternate absolute minimum, when it determines sufficient continuously monitored data is available.

For calculating daily means and minimums, measurements from at least 22 hours in each day must be available. Sufficient data will include, but may not be limited to, at least 29 daily mean values for calculating a 30-day average, and at least six daily mean values for calculating a seven-day average.

To assess the year-round criteria using continuous data, at least 15 instances of the 30-D metric data must be collected during the year-round critical period (July 1 – September 30) within the

integrated report data window. To assess the spawning criteria using continuous data, 15 instances of the 7-D metric must be collected during the spawning period within the integrated report data window.

In the absence of sufficient continuous monitoring of dissolved oxygen, attainment of the dissolved oxygen criterion shall be assessed as instantaneous or "grab" measurements. The daily minimum dissolved oxygen concentration shall be used as the "grab" sample unit.

Sites having insufficient data to be assessed as continuous data will be assessed according to the instantaneous criteria in the previous section. Where multiple samples are collected on the same day, the minimum DO concentration will be used in the assessment.

For the details of the following procedures please see Figure 7 and Figure 8.

Assignment of assessment category

Instantaneous (or grab) dissolved oxygen evaluation

The D.O. criteria metrics are absolute minimum D.O. concentrations referenced in OAR-340-041-016 (1)(a) _(6) (Table 16) These criteria are also depicted in grey boxes on OAR-340-041-0006, Table 21 (see Table 15, above).

Table 16. Instantaneous Minimum Dissolved Oxygen Criteria to Protect Aquatic Life

Dissolved Oxygen Standard	Salmonid Spawning	Cold Water	Cool Water	Warm Water	Estuary	Marine
D.O. Criteria (mg/L)	11.0*	8.0	6.5	5.5	6.5	No change from background
% Saturation Allowance	Not less than 95 % saturation	Not less than 90 % saturation	—	—	—	—
IGDO Criterion (mg/L)	8.0	—	—	—	—	—

*Shall be 9.0 mg/L if data shows the IGDO criterion of 8.0 mg/L is also attained.

Category 5: water quality limited, TMDL needed (303(d) list)

Where greater than 10% of the samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period) are less than the

appropriate criterion **AND** are also less than the percent saturation allowance (where applicable) according to the exact binomial test.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address the pollutant and result in the attainment of water quality standards (Category 4B),

Category 3: insufficient data

Less than eight samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period) with no sample less than the appropriate criterion, **AND** all samples less than the appropriate criterion are also less than the percent saturation allowance.

Category 3B: insufficient data; potential concern

Less than eight samples within the IR data window collected on separate days for the time-period of interest (spawning or year-round critical period); where at least one sample is less than the appropriate criterion **AND** is also less than the percent saturation allowance (where applicable).

Category 2: attaining

For a minimum of eight samples less than or equal to 10% of samples within the IR data window in the time-period of interest (spawning or non-spawning) are less than the appropriate criterion according to the exact binomial test **AND** are also less than the corresponding percent saturation allowance.

Continuous dissolved oxygen evaluation

Category 5: water quality limited, TMDL needed (303(d) list)

Where the Department concludes that sufficient continuously monitored data has been collected, it shall assign waterbodies to Category 5 if **ANY** of the following criteria are exceeded:

Year-round

- Two or more of the 30-D consecutive rolling averages of the daily mean of dissolved oxygen concentration **AND** for those water bodies classified as cold water, the corresponding 30-day average of daily mean percent saturation is less than the applicable criterion.
- Two or more of the 7-Mi consecutive rolling average of the daily minimum concentration of dissolved oxygen is less than the applicable criterion.

- Two or more of the daily minimum concentration of dissolved oxygen is less than the alternate minimum criteria (Min) (Table 15).

Spawning

- Two or more of the 7-D consecutive rolling average of the daily mean of dissolved oxygen concentration **AND** the corresponding 7-day average of daily mean percent saturation is less than the applicable criterion, or 9.0 mg/L if data shows the IGDO criterion is also attained.
- Two or more of the daily minimum concentration of dissolved oxygen is less than the alternate minimum criteria (Min) (Table 15).

Category 2: attaining

Where the Department concludes that sufficient continuously monitored data has been collected, it shall assign waterbodies to Category 2 if **ALL** of the following metrics are attained:

Year-round

- No more than one of the 30-D consecutive rolling averages of the daily mean of dissolved oxygen concentration **AND** for those water bodies classified as cold water, the corresponding 30-day average of daily mean percent saturation is less than the applicable criterion.
- No more than one of the 7-Mi consecutive rolling average of the daily minimum concentration of dissolved oxygen is less than the applicable criterion.
- No more than one of the daily minimum concentration of dissolved oxygen is less than the Min. alternate minimum criteria.

Spawning

- No more than one of the 7-D consecutive rolling average of the daily mean of dissolved oxygen concentration **AND** the corresponding 7-day average of daily percent saturation is less than the applicable criterion.
- No more than one of the daily minimum concentration of dissolved oxygen is less than the Min. alternate minimum criteria (Min) (Table 15).

Delisting – new data

A water body is delisted and assigned to **Category 2: Attaining** if there is sufficient information from the current assessment to evaluate the pollutant or parameter, and the information demonstrates that currently applicable water quality standards are being met. Data used for delisting must meet data quality requirements as described below.

An assessment unit will be eligible for delisting for dissolved oxygen if the assessment unit meets one of the following scenarios:

I. **Full critical period (or spawning option):**
   a. Continuous metrics analysis results in a category 2 designation of attaining criteria **and**
   b. Dataset must include a minimum of three years (does not have to be consecutive) of data that represent at least 80% of the critical period (July 1– September 30) in each year.

II. **Short term probe deployments:**
   a. Dataset includes a minimum of three years of data that contains at least five full days of continuous dissolved oxygen per critical period month per year (i.e., for year-round, 15 sample days in critical period per year) **and**
   b. < 10% (using the binomial) of daily minimums are below the Instantaneous Minimum Dissolved Oxygen Criteria identified in Table 16 as described in the Delisting Waterbodies Section of the Integrated Report Assessment methodology.

In addition, for the next listing cycle, assessment units may be delisted if the following conditions are met:

III. **Grab samples**
   a. Dataset includes three years of data that contain at least two results for each critical period month, and
   b. There are no excursions of any applicable criteria

For spawning delistings, the critical period represents the entire spawning period. DEQ intends to reevaluate minimum data requirements for spawning delistings as more data becomes available.

Assessment – marine dissolved oxygen

PARAMETER	BENEFICIAL USE
Dissolved oxygen	Fish and aquatic life – marine waters

Water quality standards

340-041-0016

Dissolved oxygen (excerpt for marine waters)

Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that, either alone, or in combination with other wastes or activities, will cause violation of the following standards: The changes adopted by the Commission on Jan. 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on Jan. 10, 1996, apply:

(6) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed"

From Table 15 of OAR-340-041-0016:

The only DO criterion that provides no additional risks is "no change from background". Waterbodies accorded this level of protection include marine waters and waters in Wilderness areas.

Assessment methodology

Seasonal hypoxia (low oxygen conditions) is a natural feature in upwelling regions in the Eastern Pacific, such as Oregon's territorial sea, but recent research suggests that hypoxic events have been increasing in frequency, duration, and occurring in locations where they are not commonly observed.[66] These changes have raised concerns that biological impacts are taking place outside of natural ecosystem variability, and that aquatic life beneficial uses are not being fully supported in some areas. For this assessment, DEQ is proposing an approach that will allow the agency to quantify measurable reduction of DO in Oregon's territorial sea for the purposes of interpreting Oregon's narrative marine DO criteria for aquatic life beneficial use support.

[66] Chan, F., Barth, J. A., Lubchenco, J., Kirincich, A., Weeks, H., Peterson, W. T., & Menge, B. A. (2008). Emergence of Anoxia in the California Current Large Marine Ecosystem. *Science*, *319*(5865), 920–920. https://doi.org/10.1126/science.1149016

This is a new assessment methodology for use in the 2024 report. An accompanying Technical Support Document outlines the rationale, process, and approach DEQ is proposing to use to assess hypoxia impacts for water quality assessment.

Data evaluation

For the 2024 report, DEQ is proposing to adopt a hybrid framework wherein two lines of evidence will be used to assess aquatic life beneficial use support. One line of evidence will rely on quantifying measurable reduction by comparing observational data with background conditions established either through long term observational data sets or modeled conditions. The second line of evidence will use established DO biological impact benchmarks to provide a biological lens to determine whether measurable reduction is likely affecting aquatic life beneficial use support.

Biologically relevant benchmark

Narrative criteria are descriptions of the conditions necessary for a waterbody to attain its designated use.[19] The dissolved oxygen thresholds summarized in Chan et. al. (2019) provide examples of biological responses to low dissolved oxygen conditions in marine environments.[67] Hypoxic conditions (dissolved oxygen levels of 1.4 ml/l (2.0mg/L; 62µmol/kg) or less) are reported to have biological impacts, ranging from changes in behavior, decreased metabolic fitness, to overall organism survival.[67,68] This value will be the numeric benchmark used to assess beneficial use support for fish and aquatic and by which the measurable reduction would be evaluated.

Quantifying change from background

In determining the degree of change that constitutes "measurable reduction" for the purposes of assessment, DEQ will rely on quantitative measurements of change relevant to the data and information available and may utilize multiple approaches as needed. DEQ will adapt methodologies outlined in published literature relevant to quantifying shifts in marine DO relevant to Oregon's territorial waters such as Pierce et al., (2012), Adams et al., (2013), and

[67] Chan, F., Barth, J. A., Kroeker, K. J., Lubchenco, J., & Menge, B. A. (2019). THE DYNAMICS AND IMPACT OF OCEAN ACIDIFICATION AND HYPOXIA: Insights from Sustained Investigations in the Northern California Current Large Marine Ecosystem. *Oceanography*, *32*(3), 62–71.
[68] Vaquer-Sunyer, Raquel, and Carlos M. Duarte. "Thresholds of Hypoxia for Marine Biodiversity." Proceedings of the National Academy of Sciences 105, no. 40 (October 7, 2008): 15452–57. https://doi.org/10.1073/pnas.0803833105.

others.[69,70] DEQ will also consult with regional experts as needed to ensure adaptations to methodologies to satisfy the approach outlined in this document are appropriate based on data types and locations. Detailed summaries of the application of these methodologies will be provided in the assessment rationale at the AU-parameter level of reporting.

Establishing background condition for comparison purposes is a critical component of determining measurable reduction. Changing ocean conditions are typically evaluated on decadal rather than yearly or seasonal scales. Where available, DEQ will evaluate a measurable reduction based on observational datasets collected at consistent locations over multiple decades. In assessment units where this temporal coverage is not available, DEQ will rely on validated model output to quantify background conditions.

Chemical data metric

Oceanographic DO data is measured and reported in a variety of ways. For consistency with common reporting values, DEQ will convert marine DO measurements to ml/l. DEQ is proposing to use a daily statistic of the value DO representing the lower 10th percentile as the assessment metric from which to evaluate the frequency of exceedances of the biologically relevant benchmark. This daily summary statistic allows comparison of historical data to recent observational data. Additionally, the statistic characterizes the lowest values in the water column where measurable reduction has been documented to occur, while not basing the assessment on a daily minimum value which can be a subject to data quality concerns.

Data requirements

Chemical data for this assessment must be:

- Collected within the critical period
    - DEQ will consider April through the end of September as the critical assessment window for marine DO.
- Observational data
    - Data must be collected under a project plan with widely approved sample collection methods.
    - Historical data will be evaluated for quality by consulting regional experts and published literature.

[69] Pierce, S. D., Barth, J. A., Shearman, R. K., & Erofeev, A. Y. (2012). Declining Oxygen in the Northeast Pacific. Journal of Physical Oceanography, 42(3), 495–501. https://doi.org/10.1175/JPO-D-11-0170.1
[70] Adams, K. A., Barth, J. A., & Chan, F. (2013). Temporal variability of near-bottom dissolved oxygen during upwelling off central Oregon. Journal of Geophysical Research: Oceans, 118(10), 4839–4854. https://doi.org/10.1002/jgrc.20361

    - To calculate daily 10th percentiles, a minimum vertical resolution sufficient to represent the water column.
- Model output
    - Validated in state waters.
    - Accounts for spatial and temporal variability in DO conditions.
    - DEQ may request guidance from technical workgroup members to interpret model performance for temporal, spatial and climatic variations.

Other approaches to assess biological integrity in marine waters

It is important to note that the two lines of evidence outlined in the hybrid framework are not the only lines of evidence DEQ will consider in marine DO narrative criteria assessment. DEQ acknowledges that impairment determinations can be made based overwhelming evidence where multiple sources of data and/or information indicate impairment. This may include the documented periods of prolonged anoxia tied to biological impact or the use of some combination of observational data, published literature, and best professional judgment to interpreting data and information submitted to the agency for assessment purposes. If this approach is taken, a detailed rationale will be included in the Integrated Report.

Assignment of assessment category

For the 2024 report, DEQ will be assessing water bodies for impacts to biological response as a result of increasing frequency and duration of nearshore hypoxic events and will therefore be evaluating Category 5 and 3. Without a clear understanding of what values levels of dissolved oxygen in marine waters equate to the beneficial use being fully supporting, DEQ will not be assessing for attainment. The hybrid framework for hypoxia in marine waters assessment (**Figure 14**) and decision tree for assigning assessment categories (**Figure 15**) outline how DEQ will assess data for categorical determination.

Global climate change, occurring as a result of excess carbon dioxide emissions into the atmosphere, is a wide ranging issue that can have impacts on water quality and beneficial use support. DEQ is taking leadership on developing assessment methodologies to identify these impacts through the Section 303(d) listing process. However, the challenge of addressing climate change related impairments demands a strategic approach and will require additional tools and resources to accompany the suite of Clean Water Act management and implementation tools traditionally used to restore impaired waters. For this reason, DEQ will use Sub-Category 5C to identify climate change related waterbody impairments on the 303(d) list, while also recognizing a broader approach than the traditional TMDL and restrictions on permitted discharges may be needed to find effective solutions.

		Observational Data		
		≤ 1.4 ml/l	> 1.4 ml/l	No data
Background Conditions	Observational deviation from background	**Category 5** (combined lines of evidence)	Category 3B (potential concern)	No assessment
	Modeled deviation from background	**Category 5** (combined lines of evidence)	Category 3B (potential concern)	No assessment
	No evidence of deviation from background	Category 3B (potential concern)	Category 3 (insufficient data)	No assessment

Figure 14. Marine dissolved oxygen hybrid assessment framework relies on multiple lines of evidence for categorical assignments

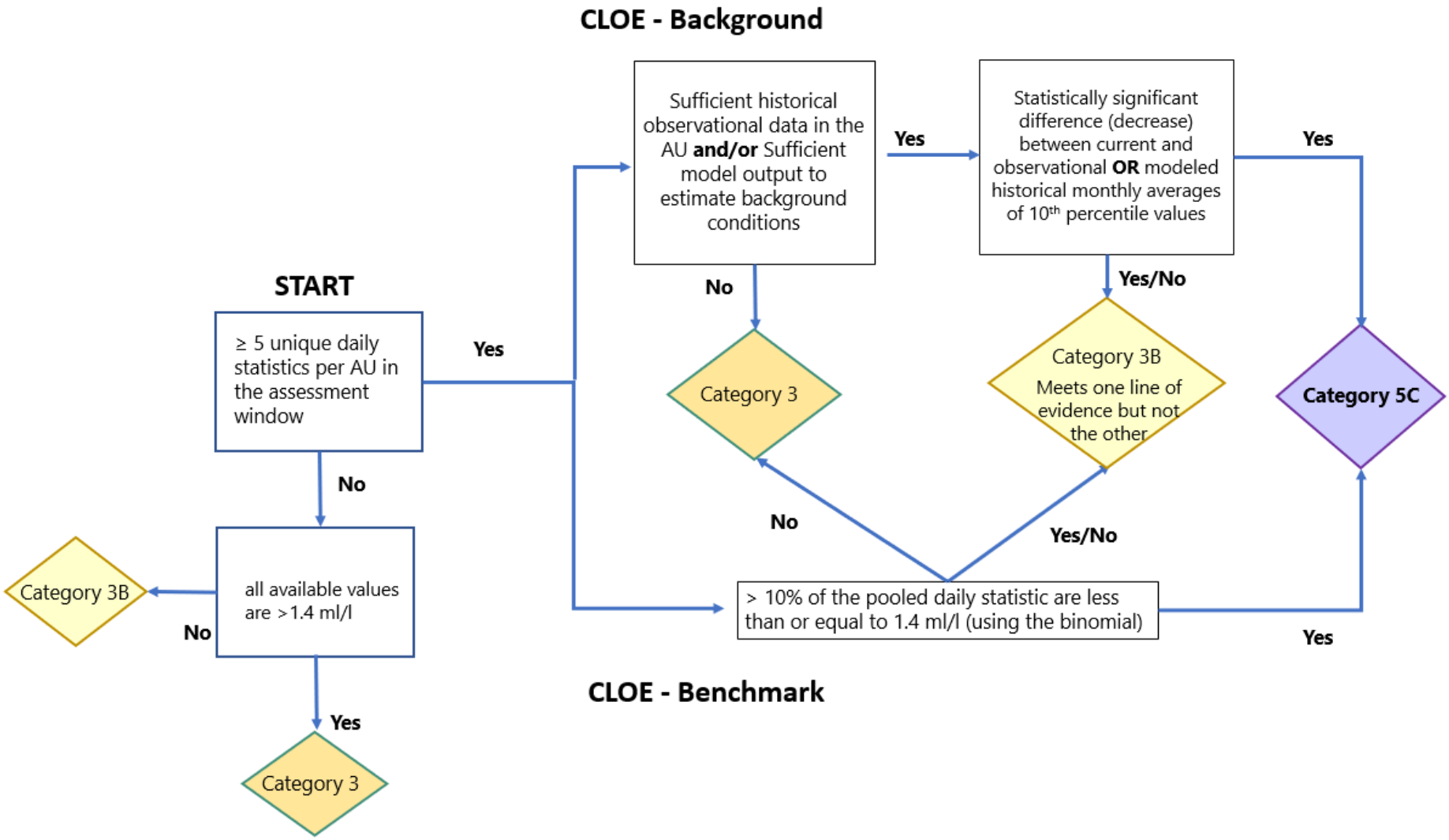


Figure 15. Decision tree for assigning categories based on the marine dissolved oxygen assessment framework

Category 5C: Impaired; Climate Change Related

Within the critical assessment window, at least five unique daily statistics where greater than 10% are less ≤1.4 ml/l according to the exact binomial test for conventional pollutants.

AND

There is a statistically significant difference (decrease) in marine DO during the critical assessment window based on either observed or modeled historical conditions.

Category 4

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3B: insufficient data; potential concern

Water bodies will be placed in Category 3B: insufficient data; potential concern when one line of evidence does not indicate impairment (illustrated in **Figure *15***).

Category 3: insufficient data

Water bodies will be placed in Category 3: insufficient data when both lines of evidence do not indicate impairment (illustrated in **Figure *15***).

OR

Fewer than five unique daily statistics are available the critical assessment window and no values are less than 1.4 ml/l.

Category 2: attaining

DEQ will not be using hypoxia related benchmarks to determine attainment for the narrative marine dissolved oxygen criteria.

Delisting – new data

Without a pathway to attainment DEQ will evaluate potential delisting on a case-by-case basis.

Assessment - pH

PARAMETER	BENEFICIAL USE
pH	Fish and Aquatic Life

Water quality standards

340-041-0021

pH

(1) Unless otherwise specified in OAR 340-041-0101 through 340-041-0350, pH values (Hydrogen ion concentrations) may not fall outside the following ranges:

(a) Marine waters: 7.0-8.5;

(b) Estuarine and fresh waters: See basin-specific criteria (OAR 340-041-0101 through 340-041-0350).

(2) Waters impounded by dams existing on Jan. 1, 1996, which have pH values that exceed the criteria are not in violation of the standard, if the Department determines that the exceedance would not occur without the impoundment and that all practicable measures have been taken to bring the pH in the impounded waters into compliance with the criteria.

340-041-0101 through 340-041-0350

Basin-specific criteria

Table 17. Summary of pH basin-specific criteria (OAR 340-041-0101 through 340-041-0350)

Basin or Water Body	OAR	Water	Criteria Range
General	**340-041-0021(1)(a)**	Marine	7.0 to 8.5
General	**340-041-0021(1)(b)**	Estuarine and fresh waters	See basin-specific criteria
Columbia River	**340-041-0104(1)**	Main stem Columbia River (mouth to river mile 309):	7.0 to 8.5
Snake River	**340-041-0124(1)**	Main stem Snake River (river miles 260 to 335)	7.0 to 9.0
Deschutes Basin	**340-041-0135(1)(a)**	All other basin streams (except Cascade lakes)	6.5 to 8.5
	340-041-0135(1)(b)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5

Basin or Water Body	OAR	Water	Criteria Range
Goose and Summer Lakes Basin	**340-041-0145(1)(a)**	Goose Lake	7.5 to 9.5
	340-041-0145(1)(b)	All other basin waters	7.0 to 9.0*
Grande Ronde Basin	**340-041-0156(1)**	All basin streams (other than main stem Snake River)	6.5 to 9.0*
Hood Basin	**340-041-0165(1)(a)**	Hood River Basin streams (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	340-041-0165(1)(b)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
John Day Basin	**340-041-0175(1)**	All basin streams (other than the main stem Colombia River)	6.5 to 9.0*
Klamath Basin	**340-041-0185(1)(a)**	Fresh waters except Cascade lakes	6.5 to 9.0*
	340-041-0185(1)(b)	Cascade lakes above 5,000 feet altitude	6.0 to 8.5
Malheur Lake Basin	**340-041-0195(1)**	All	7.0 to 9.0*
Malheur River Basin	**340-041-0207(1)**	All	7.0 to 9.0*
Mid Coast Basin	**340-041-0225(1)(a)**	Marine waters	7.0 to 8.5
	340-041-0225(b)	Estuarine and fresh waters	6.5 to 8.5
North Coast Basin	**340-041-0235(1)(a)**	Marine waters	7.0 to 8.5
	340-041-0235(1)(b)	Estuarine and fresh waters	6.5 to 8.5
Owyhee Basin	**340-041-0256(1)**	All	7.0 to 9.0*
Powder/Burnt Basins	**340-041-0265(1)**	All basin streams (other than main stem Snake River)	6.5 to 9.0*
Rogue Basin	**340-041-0275(1)(a)**	Marine waters	7.0 to 8.5

Basin or Water Body	OAR	Water	Criteria Range
	340-041-0275(1)(b)	Estuarine and fresh waters (except Cascade lakes)	6.5 to 8.5
	340-041-0275(1)(c)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
Sandy Basin	**340-041-0290(1)(a)**	All basin waters (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	340-041-0290(1)(b)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
South Coast Basin	**340-041-0305(1)(a)**	Estuarine and fresh waters	6.5 to 8.5
	340-041-0305(1)(b)	Marine waters	7.0 to 8.5
Umatilla Basin	**340-041-0315(1)**	All basin streams (other than main stem Columbia River)	6.5 to 9.0*
Umpqua Basin	**340-041-0326(1)(a)**	Marine waters	7.0 to 8.5
	340-041-0326(1)(b)	Estuarine and fresh waters (except Cascade lakes)	6.5 to 8.5
	340-041-0326(1)(c)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5
Walla Walla Basin	**340-041-0336**		6.5 to 9.0*
Willamette Basin	**340-041-0345(1)(a)**	All basin waters (except main stem Columbia River and Cascade lakes)	6.5 to 8.5
	340-041-0345(1)(b)	Cascade lakes above 3,000 feet altitude	6.0 to 8.5.

*When greater than 25 percent of ambient measurements taken between June and September are greater than pH 8.7, and as resources are available according to priorities set by the Department, the Department will determine whether the values higher than 8.7 are anthropogenic or natural in origin.

Assessment methodology

The pH of water, commonly understood as acidity or alkalinity, is a measure of the hydrogen or hydronium ions concentration. It is reported on a logarithmic scale where values under 7 represent acidic waters and values above 7 represent alkaline waters. Chemical and biological processes in natural waterbodies are influenced by the pH of the water. It is one of the most important environmental factors limiting species distributions in aquatic habitats. The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.).

DEQ compares pH data to basin specific range of numeric criteria in Table 17. Cascade Lakes natural and man-made lakes at elevations over 3,000 or 5,000 feet have naturally occurring low pH and are given specific criteria in Table 17.

Data evaluation

Where only continuous data are available, DEQ will use the exact binomial test twice (10-10 rule). First, where greater than 10 percent of a specific day's time series measurements fall outside the range of the appropriate criterion, the day is considered in violation of its water quality standard according to the exact binomial test and that day is considered an excursion. Second, all sample days in the assessment units are compiled and where greater than 10% of the days are excursions, the water body would be considered impaired according to the exact binomial test.

Where both continuous and grab datasets are available, DEQ will use the following method for pH assessment.

- Determine a daily exceedance value for each day where greater than 10% of the time-series measurements are outside the range of the appropriate criterion according to the exact binomial test.
- Tally the number of exceedances of grab data results
- Confirm that there are not data for the same location and day for grab and continuous results. Where both grab and continuous data results exist for the same location and day, preference will be given to continuous dataset statistics.
- Sum the number of grab samples and sample days from continuous results
- Sum the number of daily exceedances and the number of grab sample exceedances

Use the exact binomial with the same critical values for listing conventional pollutants (i.e., Null Hypothesis: Actual exceedance proportion is ≤10%) to determine the critical value of exceedances and the final assessment category.

Data requirements

DEQ will use both grab (instantaneous) and continuous (time series) data sets. Where only grab data are available, DEQ will compare samples to water quality criteria and use the exact binomial test to determine categorical assignment.

Assignment of assessment category

Category 5: water quality limited, TMDL needed (303(d) list)

Grab only:

For five or more samples, greater than 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test.

Continuous only (10-10 rule):

First, where greater than 10% of a day's time series measurements fall outside the range of the appropriate criteria, the day is considered an excursion according to the exact binomial test

Second, where greater than 10% of the days are excursions, according to the exact binomial test, the water body would be considered impaired

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Fewer than eight samples collected on separate days or sample days for continuous data in the assessment data window and no values are outside of the range of appropriate criteria.

Category 3B: insufficient data; potential concern

Fewer than eight samples collected on separate days or sample days for continuous data in the assessment data window and one or more values are outside of the range of appropriate criteria.

Category 2: attaining

Grab only:

For eight or more samples, less than or equal to 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test.

Continuous only:

Less than 10% of daily time series measurements fall outside the range of the appropriate criterion according to the exact binomial test, the day is considered attaining its water quality standards.

Second, for a minimum of eight daily samples, where less than 10% of the days are excursions according to the exact binomial test.

Delisting – new data

Assessment units with sufficient data in the data and window to meet the Delisting – statistical methods requirements for conventional pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

Assessment - Sedimentation

PARAMETER	BENEFICIAL USE
Sediment/others	Fish and Aquatic Life

Water quality standards

340-041-0007

Statewide Narrative Criteria

(11) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed;

Assessment methodology

Water bodies have been previously listed[71] using stream specific documentation, which demonstrated excessive sedimentation was a significant limitation to fish or other aquatic life. This included information indicating beneficial use impairment (aquatic community status, deviation from biomonitoring reference sites, or fishery data) and measurement data such as cobble embeddedness or percent fines.

For future assessments, DEQ will be evaluating approaches to apply a numeric benchmark based on measurements of stream conditions to implement the narrative criteria.

Data evaluation

DEQ will evaluate data and information received to determine if there is overwhelming evidence of impairment.

Data requirements

Data or information must be associated with a specific water body.

Assignment of assessment category

Categorical listings for sedimentation will be made using sampling site documentation in conjunction with other data and overwhelming evidence of impairment.

[71] Listing Criteria for Oregon's 1998 303(d) List of Water Quality Limited Water Bodies

Delisting – new data

There is no current delisting process for sedimentation. Assessment units will be evaluated for delisting on a case by case basis.

Assessment - Temperature

PARAMETER	BENEFICIAL USE
Water Temperature	Fish and Aquatic Life

Water quality standards

340-041-0002
Definitions
(57) "Seven-Day Average Maximum Temperature" means a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis.

340-041-0028
Temperature
[…]

(4) Biologically Based Numeric Criteria. Unless superseded by the natural conditions criteria described in section (8) of this rule, or by subsequently adopted site-specific criteria approved by EPA, the temperature criteria for State waters supporting salmonid fishes are as follows:

(a) The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use on subbasin maps and tables set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B, may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) at the times indicated on these maps and tables;

(b) The seven-day-average maximum temperature of a stream identified as having core cold water habitat use on subbasin maps set out in OAR 340-041-101 to 340-041-340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 16.0 degrees Celsius (60.8 degrees Fahrenheit);

(c) The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);

(d) The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 151A, 170A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit). In addition, these water bodies must have coldwater refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern;

(e) The seven-day-average maximum temperature of a stream identified as having Lahontan cutthroat trout or redband trout use on subbasin maps and tables set out in OAR 340-041-0101 to 340-041-0340: Tables 120B, 140B, 190B, and 250B, and Figures 180A, 201A, and 260A may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit);

(f) The seven-day-average maximum temperature of a stream identified as having bull trout spawning and juvenile rearing use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130B, 151B, 160B, 170B, 180A, 201A, 260A, 310B, and 340B, may not exceed 12.0 degrees Celsius (53.6 degrees Fahrenheit). From August 15 through May 15, in bull trout spawning waters below Clear Creek and Mehlhorn reservoirs on Upper Clear Creek (Pine Subbasin), below Laurance Lake on the Middle Fork Hood River, and below Carmen reservoir on the Upper McKenzie River, there may be no more than a 0.3 degrees Celsius (0.5 Fahrenheit) increase between the water temperature immediately upstream of the reservoir and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0 degrees Celsius (48 degrees Fahrenheit) or greater, and no more than a 1.0 degree Celsius (1.8 degrees Fahrenheit) increase when the seven-day-average stream temperature is less than 9 degrees Celsius.

[…]

(6) Natural Lakes. Natural lakes may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of a natural lake is the same as its natural thermal condition.

(7) Oceans and Bays. Except for the Columbia River above river mile 7, ocean and bay waters may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of the ocean or bay is the same as its natural thermal condition.

[…]

(9) Cool Water Species.

> (a) No increase in temperature is allowed that would reasonably be expected to impair cool water species. Waters of the State that support cool water species are identified on subbasin tables and figures set out in OAR 340-041-0101 to 340-041-0340; Tables 140B, 190B and 250B, and Figures 180A, 201A and 340A
>
> (b) See OAR 340-041-0185 for a basin-specific criterion for the Klamath River.

(10) Borax Lake Chub. State waters in the Malheur Lake Basin supporting the Borax Lake chub may not be cooled more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) below the natural condition.

[…]

(12) Implementation of the Temperature Criteria

> (c) Air Temperature Exclusion. A water body that only exceeds the criteria set out in this rule when the exceedance is attributed to daily maximum air temperatures that exceed the 90th percentile value of annual maximum seven-day average maximum air temperatures calculated using at least 10 years of air temperature data, will not be listed on the section 303(d) list of impaired waters and sources will not be considered in violation of this rule.
>
> (d) Low Flow Conditions. An exceedance of the biologically-based numeric criteria in section (4) of this rule… will not be considered a permit violation during stream flows that are less than the 7Q10 low flow condition for that water body.

Assessment methodology

Seven day average daily maximum (7DADM) values from continuous data recorders are evaluated against criterion values identified in Table 18 using the following protocols and.

Data evaluation

Determining Applicable Criteria

Table 18. Numeric temperature criteria

Designated Fish Use	Temperature Criterion, °C
Year-Round Criteria	
Salmon & trout rearing & migration	18.0
Core cold water habitat	16.0
Migration corridor (salmon & steelhead)	20.0
Lahontan cutthroat or redband trout	20.0
Bull trout spawning & juvenile rearing	12.0
Spawning Criteria	
Salmon & steelhead spawning	13.0

Designated fish uses

The year-round fish uses designated for protection of fish and aquatic life are indicated in in OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 180A, 201A, 220A, 230A, 260A, 271A, 286A, 300A, 310A, 320A, and 340A; Tables 101B, 120B, 121B, 130B 140B,151B, 160B, 170B, 180A, 190B, 201A, 250B, 260A, 310B, and 340B. For convenience, the information from the fish use figures and tables are also reproduced on the DEQ IR web map.

Designated spawning time periods

In streams designated as salmon and steelhead spawning areas, the salmon & steelhead spawning criterion (13°C) shall be applied ONLY during the time periods indicated in tables and figures referenced in OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B. Outside of these designated spawning time periods, the year-round criteria shall apply. For convenience, the information from the spawning use tables and figures are also reproduced on the DEQ Integrated Report web map application.

Application of the Klamath River cool water species narrative criterion for temperature in 340-041-0028 (9)(b)[72]

To ensure the protection of Lost River and Shortnose Suckers in the five-mile reach of the Klamath and Link Rivers associated with the urban areas of Klamath Falls, if two or more 7DADM values exceed 28°C in this reach, except when the air temperature or low flow exclusions apply, DEQ will determine that the cool water species narrative criterion is not being attained in this reach for purposes of CWA section 303(d) assessments. This reach is depicted on the DEQ IR web map.

Applicability to tributary waters

For tributary waters that are not identified on the "Fish Use Designations" maps referenced in section (4) of the rule, the applicable criteria for these waters are the same criteria as is applicable to the nearest downstream water body depicted on the applicable map. This does not apply to the "Salmon and Steelhead Spawning Use Designations" maps.

Data requirements

Continuous data must be collected to reliably capture the daily maximum temperature for at least six of seven consecutive days. At a minimum, monitoring data should be collected during the critical warm period (July 1 to September 30) that adequately captures peak temperatures **OR** any applicable spawning periods to be sufficient to demonstrate attainment of the criteria. Instantaneous or "grab" temperature readings are not sufficient to be evaluated against the biologically based numeric criteria.

Calculating the seven-day average maximum temperature metric

The seven-day average daily maximum (7DADM) stream temperature is an average of the daily maximum water temperatures for seven consecutive days. The average daily maximum temperature value for each seven-day period is assigned to the last (7^{th}) calendar day of each period.

The 7DADM is repeated for each consecutive 7-day period on a moving or rolling basis. For example, the 7DADM for August 10 is calculated from T_{max} for August 4 to August 10; the 7DADMfor August 11 is calculated from August 5 to 11, etc.

$$7\text{DADM} = \frac{1}{7}\sum_{i=1}^{7} T_{max-i}$$

[72] Memorandum RE: Implementation of Cool Water Species Criterion for Klamath River Sucker, March 6, 2017.

Where:
i = day in the sequence
T_{max} = maximum temperature of day, i

When spawning criteria apply, the first 7-day averaging period begins on the date the spawning period begins. The first 7DADM value will be assigned to the 7th calendar day following the start date of the spawning period. Therefore, the 7th calendar day of the spawning period is the first day that the 7DADM is required to meet the spawning criteria.

The exceedance is attributed to daily maximum air temperatures that exceed the 90th percentile value of annual maximum seven-day average maximum air temperatures calculated using at least 10 years of air temperature data

Assignment of assessment category

Category 5: water quality Limited, TMDL needed (303(d) list)

Any two instances of the seven-day-average daily maximum temperature exceed the applicable criteria within a three-year period.

Potential listings shall be reviewed for exception under the air temperature exclusion and low flow exclusion before being finalized. Listings that DEQ determines are subject to the air temperature exclusion will be confirmed prior to publishing the final 303(d) list. Listings invalidated due to the air temperature exclusion shall be placed in Category 2, or will be put through the delisting process is applicable.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address impairment and the pollutant will attain water quality standards (Category 4B),

Category 3: insufficient data

When less 80 percent of data collected during the critical warm period or an applicable spawning period and no excursions.

Category 3B: insufficient data; potential concern

When temperature data are collected and show at least one instance of the seven-day-average daily maximum temperature exceeding the criteria within a three-year period, but data are insufficient to place in Category 5.

Category 2: attaining

When continuous temperature data are collected, no seven-day-average of the daily maximum temperature exceed the applicable criterion. Data represent the duration of the critical warm period or an applicable spawning period. Attainment of the year-round criteria and the spawning criteria shall be listed separately within a water body.

Delisting – new data

A water body is delisted and assigned Category 2: Attaining if there is sufficient information from the current assessment to evaluate the pollutant or parameter, and the information demonstrates that currently applicable water quality standards are being met. Data used for delisting must meet data quality requirements described below. An assessment unit will be eligible for delisting for temperature if the assessment unit meets the following scenario:

For year-round listings:

1. Assessment results in a Category 2 designation (no excursions of the 7DADM temperature criteria) **and**
2. Dataset must include a minimum of three years (does not have to be consecutive) of data in the current IR data window that represent at least 80% of the critical period (July 1– September 30).

For spawning listings:

1. Assessment results in a Category 2 designation (no excursions of the spawning 7DADM temperature criteria) **and**
2. Dataset must include a minimum of three years (does not have to be consecutive) of data in the current IR data window that represent at least 80% of the spawning critical period (spawning period overlap of April through November). If the spawning period extends across the non-critical period months, the dataset must include 80% of the period from each of the fall and spring critical periods.

Assessment - Total Dissolved Gas

PARAMETER	BENEFICIAL USE
Total dissolved gas – Saturation	Fish and Aquatic Life

WATER QUALITY STANDARDS:

340-041-0031

Total Dissolved Gas

(1) Waters will be free from dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases, in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such water.

(2) Except when stream flow exceeds the ten-year, seven-day average flood, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation. However, in hatchery-receiving waters and other waters of less than two feet in depth, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 105 percent of saturation.

Assessment methodology

Releasing water over the dams' spillways is a fishery-management tool on the Columbia River and other rivers in Oregon. However, spilling water over the dams increases the level of total dissolved gas in the river. Water plunging from a spillway traps air and carries it to a depth where the pressure forces the gas into solution. Total dissolved gas levels above 110 percent of saturation can cause gas bubble trauma in fish. This methodology is used to assess waters impacted by the excess total dissolved gases.

Data evaluation

Data reported to DEQ and/or in the DEQ AWQMS database.

Data requirements

Total dissolved gas data reported as percent saturation.

Assignment of assessment category

Category 5: water quality limited, TMDL needed (303(d) list)

Greater than 10% of the samples exceed 110% saturation or applicable temporary criteria approved by the Environmental Quality Commission according to the exact binomial test **OR** a survey identifies beneficial use impairment due to total dissolved gas such as assessment of fish conditions.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Available data are not sufficient to determine if the use is impaired.

Category 2: attaining

Less than or equal to 10% of the samples are outside the range of the appropriate criterion according to the exact binomial test **AND** no impairments have been observed from dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases.

Delisting – new data

There is no current delisting process for total dissolves gas. Assessment units will be evaluated for delisting on a case by case basis.

Assessment - Toxic substances

PARAMETER	BENEFICIAL USE
TABLE 30: Aquatic Life Water Quality Criteria for Toxic Pollutants	Fish and Aquatic Life
TABLE 40: Human Health Water Quality Criteria for Toxic Pollutants	Fishing (Consumption) - Shellfish Harvesting
TABLE 40: Human Health Water Quality Criteria for Toxic Pollutants (water + organism only)	Domestic Water Supply
Public Health Advisories	Fishing (Consumption) - Shellfish Harvesting

Water quality standards

340-041-0007

Statewide Narrative Criteria

(10) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed;

340-041-0033

Toxic Substances

(1) Toxic Substances Narrative. Toxic substances may not be introduced above natural background levels in waters of the state in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife or other designated beneficial uses.

(2) Aquatic Life Numeric Criteria. Levels of toxic substances in waters of the state may not exceed the applicable aquatic life criteria as defined in Table 30 under OAR 340-041-8033.

(3) Human Health Numeric Criteria. The criteria for waters of the state listed in Table 40 under OAR 340-041-8033 are established to protect Oregonians from potential adverse health effects associated with long-term exposure to toxic substances associated with consumption of fish, shellfish and water.

NOTE: Tables 30, 31 and 40 are found under OAR 340-041-8033 and 340-041-8033

Division 41 Tables and Figures

(1) Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.
(2) Table 31: Aquatic Life Water Quality Guidance Values for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.
(3) Table 40: Human Health Water Quality Criteria for Toxic Pollutants. This table, referenced in OAR 340-041-0033, contains information about the applicability and content of the criteria contained in the table.
[ED. NOTE: Tables referenced are not included in rule text.]

Assessment methodology

Oregon's toxic substance water quality standards in OAR 340-041-0033 Table 30 and Table 40 contain detailed information on how to apply and calculate criteria in footnotes, endnotes, supplemental equations and tables, and cited model software. The following section describes additional protocols for specific toxic pollutants to make best use of all available data. Pollutant chemicals in EPA National Recommended Water Quality Criteria documents are correlated to chemical names and unique CAS registry number and are identified with criteria in Table 30 and Table 40.[73,74,75,76] DEQ has developed additional memoranda to address analytical and monitoring issues for specific toxic pollutants and criteria.[77] DEQ follows these guidelines to resolve questions on how to group various chemical species and evaluate data for the Integrated Report assessment. The sections below include criteria-specific detailed protocols for aquatic life criteria followed by human health criteria.

Pollutant Specific Aquatic Life Water Quality Criteria

Alkalinity criterion

EPA's recommendation for the aquatic life freshwater criterion for alkalinity is "20 mg/L or more as $CaCO_3$ except where natural concentrations are less."[78] Alkalinity should not be below this value to protect aquatic life.

[73] EPA National Recommended Water Quality Criteria
[74] National Institute of Standards and Technology
[75] Agency for Toxic Substance and Disease Registry
[76] US EPA Substance Registry Services
[77] Memorandums with Recommendations for Analysis and Implementation of Specific Toxic Pollutants are available at DEQ's Standards for Toxics Pollution webpage
[78] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

Alkalinity is a measure of carbonate and bicarbonate ions and the buffering capacity of water to pH changes. Freshwater systems have natural variations in pH that are related to photosynthetic activity and other inorganic and organic chemical reactions. Applying the alkalinity criterion as an isolated standard may lead to incorrect conclusions about overall natural water quality or the causes of beneficial use impairments. For Integrated Report evaluations, analytical data indicating alkalinity less than the criterion is flagged as a **Category 3B Insufficient Data: Potential concern**. Professional judgment should be used during TMDL development or on a case-by-case basis to consider alkalinity information along with information for other related pollutants such as pH, chlorophyll a, aquatic weeds or algae growth, and dissolved oxygen when addressing beneficial use support.

Aluminum criteria

In 2021, EPA promulgated freshwater aluminum aquatic life criteria for Oregon[79] as the result of a 2016 federal consent decree. The promulgated aluminum criteria are based on EPA's current recommended freshwater aluminum aquatic life criteria published in 2018.[80] The criteria vary with the water chemistry parameters pH, dissolved organic carbon (DOC), and hardness, because these parameters modify aluminum toxicity to aquatic life. The aluminum aquatic life criteria magnitudes are determined by inputting pH, DOC, hardness and into EPA's Aluminum Criteria Calculator based on multiple linear regression models and species sensitivity distributions. This calculator produces instantaneous criteria values that account for changes in toxicity of aluminum to aquatic life due to differences in water chemistry.

Aluminum is naturally occurring and may be found in many different chemical forms in the aquatic environment. However, not all forms of aluminum are toxic to aquatic organisms. EPA defines "bioavailable aluminum" (or the bioavailable fraction of aluminum) as: "the amount of aluminum that is available to cause a biological response in an aquatic organism."[81] The non-bioavailable (and therefore non-toxic) fraction of aluminum includes large suspended particles, clays, and aluminosilicate minerals. The aluminum criteria were based on toxicity tests performed in laboratory waters that were free of colloidal, particulate, and clay-bound aluminum. The aluminum criteria are expressed as total recoverable aluminum, because in the absence of suspended solids, the total recoverable aluminum fraction is also the bioavailable fraction. However, when total recoverable aluminum is measured in an ambient water body, the suspended particles, clays and minerals are included in the measured concentration value. The

[79]USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.
[80] USEPA (2018). Final Aquatic Life Ambient Water Quality Criteria for Aluminum. Office of Water. Docket No. EPA-822-R-18-001.
[81]USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.

rule, as recorded in the federal register, recognizes that "total recoverable aluminum concentrations measured in natural waters may overestimate the potential risks of toxicity to aquatic organisms if suspended solids, clays, or particulate matter to which aluminum may be bound are present, because total recoverable methods measure bioavailable and non-bioavailable forms of aluminum."[82] In the promulgated rule, EPA included the option for Oregon to use bioavailable fraction of aluminum implement the criteria in ambient waters.

At the time of the promulgation, a method for measuring bioavailable aluminum had been proposed and was planned for submission as a standard method to the ASTM. In 2022, the DEQ laboratory and others began using the analytical method described by Rodrigues et al.[83] to quantify bioavailable aluminum in surface waters[84].

Sufficient bioavailable aluminum

For water bodies with sufficient bioavailable aluminum results in the IR data window to determine either impairment Table 6 or attainment Table 4, DEQ will assess the data according to the aquatic life toxics methodology.

Only total recoverable aluminum

For water bodies where only total recoverable aluminum data are available, if greater than 5% of total recoverable samples exceed criteria with 90% confidence according to the exact binomial test, the assessment unit will be placed in Category 3B.

Both bioavailable and total recoverable aluminum

For water bodies with insufficient bioavailable samples in the IR data window to determine attainment Table 4, but where a combination of bioavailable and total recoverable is available, the assessment unit will be placed in Category 3B if the combined samples exceed criteria with 90% confidence according to the exact binomial test. DEQ will prioritize collection of bioavailable data at these locations.

If the combined samples do not exceed criteria with 90% confidence according to the exact binomial test, the assessment unit will be placed in Category 3.

Use of default values

[82] USEPA (2021). Federal Aluminum Aquatic Life Criteria Applicable to Oregon. Docket No. 40 CFR Part 131. Docket No. EPA-HQ-OW-2016-0694.
[83] Rodriguez et al. (2019). Determination of bioavailable aluminum in natural waters in the presence of suspended solids. *Environmental Toxicology and Chemistry*, 38(8), 1668-1681.
[84] Standard Operating Procedure. Extraction of Bioavailable Al and Fe at pH of 4.0. Oregon Department of Environmental Quality, 2022. DEQ22-LAB-0009-SOP

If a default DOC input parameter value is used (along with measured pH and hardness) to determine criteria, and the bioavailable aluminum concentration exceeds the criteria according to the exact binomial test, the water body will be listed as Category 5 (consistent with the use of default input parameters for copper). If the aluminum concentration exceeds the default regional aluminum criteria (absent measured pH or hardness data) according to the exact binomial test, the water body will be listed as Category 3B.

Ammonia criteria

Aquatic life criteria for ammonia are pH, temperature, and salinity dependent. Additionally, different equations are used to calculate acute criteria values (one-hour average) for ammonia, based on presence or absence of salmonids. Ammonia chronic criteria values are calculated as 30-day rolling averages. See OAR 340-041-8033 Table 30(a-c) and DEQ's websites and calculators for instructions to calculate the appropriate criteria for each sample result. These criteria cannot be exceeded more than once every three years on average. Acute ammonia criteria are assessed using the exact binomial test. To be assessed as Category 2; Attaining, less than 5% of the samples may exceed the appropriate criterion according to the exact binomial test.

For the assessment data evaluation, if temperature or pH data are not available, criteria are not calculated and the sample result is not evaluated. Ammonia criteria for estuarine waters are calculated using the appropriate equations for freshwater. EPA recommends criteria calculations not be extrapolated beyond the pH and temperature range specified in the criteria calculation equations. To calculate criteria for results with pH values outside the specified range (6.5 - 9.0), DEQ uses 6.5 when reported pH values are less than 6.5, and 9.0 when reported pH values are greater than 9.0.

Ammonia criteria for saltwater are established for un-ionized ammonia (NH_3) which is the principal toxic form of ammonia.[85] For the assessment data evaluation, the criteria for marine sites are calculated using the saltwater equations. Marine sites are identified using geographic information and confirmed with salinity or conductivity data. A default salinity value of 10 ppt is used if site specific data are not available.

Arsenic criteria

Oregon's aquatic life criteria for arsenic apply to dissolved concentrations of total inorganic arsenic (arsenic (III) plus arsenic (V)). Available data for arsenic are typically for either total recoverable or total dissolved arsenic. DEQ completed an Oregon specific study of 460 samples

[85] 1989, Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, U.S. EPA Office of Water, EPA 440/5-88-004;

of paired total recoverable and inorganic arsenic data. Based on its results, absent inorganic arsenic data, DEQ will use a conversion factor of 0.80 (freshwater) and 0.59 (estuary) to convert total recoverable arsenic to inorganic arsenic for assessment purposes.

Cadmium criteria

The aquatic life cadmium criteria for freshwater are hardness-dependent and must be calculated for each result. EPA promulgated Federal Clean Water Act acute aquatic life criterion for Oregon effective on 3/6/2017 and provided equations and conversion factors to calculate the acute criterion for dissolved cadmium concentration in freshwater.[86] DEQ uses the more conservative ecoregion hardness default values for acute cadmium criterion which is consistent with the protective default values used for other hardness-based metals (Table 19).

The freshwater acute criterion is calculated using the equations and conversion factors in Table 30 Endnote E. The freshwater chronic criterion is calculated using the equations and conversion factors in Table 30 Endnote F.

DEQ prefers to use ambient hardness data specific to the sample result, but uses ecoregion default values when sample data are not available in order to calculate criteria for cadmium and other hardness-dependent metals.

Chlordane (CAS No. 57749) and heptachlor (CAS No. 76448) criteria

Aquatic life criteria for chlordane are applied to sample results reported for the technical product (CAS No. 12789036) or non-specific chlordane (CAS No. 57749), or to the sum of isomers, other constituents, and metabolites of chlordane including cis-chlordane (synonym α-chlordane) (CAS No. 5103719), trans-chlordane (synonym γ- chlordane) (CAS No. 5103742), γ-chlordane (CAS No. 5566347), cis-nonachlor (CAS No. 5103731), trans-nonachlor (CAS No. 39765805), and oxychlordane (CAS No. 27304138). Another known major constituent of chlordane mixtures is heptachlor (CAS No. 76448). Aquatic life criteria for heptachlor are applied separately for this chemical.

Chloride

Chloride is a major component of salinity and it is expected that elevated chloride concentration will occur naturally in estuary areas. Therefore, DEQ will not apply the freshwater criterion for chloride in estuaries. Data from coastal streams near estuaries will be evaluated for salinity values or spatial proximity to brackish waters before applying the freshwater criteria.

Chlorine

[86] Aquatic Life Criteria for Cadmium in Oregon, Federal Register 82 FR 9166 02/03/2017, p 9166-9174

The aquatic life criteria for chlorine in freshwater and saltwater are expressed as "total residual chlorine" which is the sum of free and combined chlorine.[87]

Chromium criteria

The aquatic life criteria include criteria for two oxidation states of chromium - chromium III (trivalent) and chromium VI (hexavalent). The criteria for chromium III are hardness-dependent and must be calculated.

Most sample analyses are done for total chromium and do not report concentrations for the separate oxidation states.[88] To evaluate available data, results for total chromium are compared to the most stringent applicable criterion for either oxidation state. When chromium data are available as total chromium, and the chromium VI (hexavalent) criteria are exceeded, waterbodies will be identified as Category 3B: Insufficient Data - Potential Concern until follow up monitoring can occur for laboratory confirmation of chromium VI, specifically. When chromium data are available as total chromium, and the chromium III (trivalent) criteria are exceeded, waterbodies will be identified as Category 5. Table 30 Endnote F contains the conversion factors to convert total chromium to dissolved chromium.

Copper criteria

The aquatic life criteria for copper in freshwater are functions of water chemistry including ions, alkalinity, organic carbon, pH, and temperature in the water column. The criteria are derived using the biotic ligand model referenced in Table 30 Endnote N. DEQ prefers to use criteria derived from site-specific measured input parameter values for the model. If measured data for one or more of the model input parameters are not available, DEQ will follow the copper criteria implementation procedures[89] and (1) substitute an estimated input parameter or use default values, or (2) derive a default action value using regional default input parameter values for the biotic ligand model. DEQ will subsequently assess the data according to the exact binomial test procedures.

The aquatic life criteria for copper in saltwater are not derived from the model, and results for copper are compared to the applicable saltwater criteria in Table 30.

[87] 2023 DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion Chlorine (CAS #: 7782-50-5) https://www.oregon.gov/deq/FilterDocs/sToxicschlorineMemo.pdf
[88] 2014 DEQ Memorandum RE: Implementation Instructions for Water Quality Criteria Chromium III (CAS #: 16065-83-1) and Chromium VI (CAS #: 18540-29-9) http://www.oregon.gov/deq/FilterDocs/sToxicschromium.pdf
[89] DEQ 2016, Implementation of the Freshwater Aquatic Life Water Quality Standards for Copper

Cyanide criteria

The aquatic life criteria for cyanide are expressed as free cyanide (µg (CN)/L). DEQ uses total or "available" cyanide data as a conservative surrogate for free cyanide in cases where there are no analytical results based on free cyanide.[90]

DDT, DDD, and DDE criteria

The aquatic life criteria for DDT 4,4' specify that the criteria apply to the total concentration of DDT and its metabolites. The total concentration of DDT and its metabolites should not exceed this value. DEQ sums analytical data results for DDT and metabolites. [91]

Demeton criteria

The aquatic life criteria for demeton are applicable to sample results reported as demeton (CAS No. 8065483) and disulfoton (CAS No. 298044). The two pesticides are toxicologically similar and EPA uses toxicity data for both compounds. DEQ applies the demeton criteria to both pesticide products.

Endosulfan criteria

The aquatic life criteria for the group endosulfan are applied to sample results reported for endosulfan (CAS No. 115297) or to the sum of sample results reported for the isomers α-endosulfan (CAS No. 959988) and β-endosulfan (33213659).

Guthion (azinphos methyl) criteria

Aquatic life criteria for Guthion are applied to results for Guthion (labeled Azinphos-methyl in the AWQMS database) (CAS No. 86500) but not for the metabolic breakdown product azinphos methyl oxygen analog (CAS No. 961228).

Hexachlorocyclohexane, BHC, and lindane criteria

BHC gamma (synonym hexachlorocyclohexane (Lindane)) are applied to sample results reported for that chemical (CAS No. 58899). The pesticide product Lindane is generally > 99% the gamma isomer (synonyms γ-HCH or γ-BHC).

Iron criterion

[90] 2022 DEQ Memorandum RE: Implementation Instructions for Free and Total Cyanide Water Quality Criteria (CAS #: 57-12-5) https://www.oregon.gov/deq/FilterDocs/sToxicscyanide.pdf
[91] 2014, DEQ Memorandum RE: Implementation Instructions for Water Quality Criterion DDT,-4,4' (CAS #: 50-29-3) https://www.oregon.gov/deq/FilterDocs/sToxicsDDTmemo.pdf

The aquatic life criterion for iron is applicable to total recoverable concentrations of iron in a water sample. Sample results for dissolved iron fractions are not considered valid to use to determine attainment of the criteria. This is because the dissolved iron concentration generally constitutes only a fraction of total iron concentration in an ambient water sample. However, if the dissolved iron fraction exceeds the iron criterion, the results are counted as valid results to determine exceedance since the total fraction will also exceed the criterion.

Mercury criteria

The aquatic life criteria for mercury apply to total mercury in the water column.

Parathion criteria

The aquatic life criteria for parathion are applied to results for ethyl parathion (CAS No. 56382).

PCB Criteria

The aquatic life criteria for PCBs (Polychlorinated Biphenyls) are applied to either the sum of sample results reported as Aroclors, or the sum of sample results reported as individual congeners.

Pentachlorophenol criteria

The aquatic life criteria for pentachlorophenol (CAS No. 87865) in freshwater are pH-dependent and will be calculated by using equations given in Table 30. Saltwater criteria are not pH-dependent.[92]

Generally, as pH decreases, the toxicity of pentachlorophenol increases. If pH data are not available, the freshwater criteria for pentachlorophenol cannot be calculated.

Phosphorus criterion

The aquatic life criterion of 0.1 µg/L applies to elemental phosphorus (P) in marine or estuarine waters to protect marine organisms against toxic effects.[93]

Pollutant Specific Human Health Water Quality Criteria

Numeric water quality criteria for the protection of human health from toxic substances shall be evaluated as the geometric mean of the observed samples of pollutant concentration.

[92] 1986, Ambient Water Quality Criteria for Pentachlorophenol, U.S. EPA Office of Water, EPA 440/5-86-009.
[93] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001 for Phosphorus

Assessment conclusions will be based on the geometric mean (based on a minimum of three samples) of representative samples of the water body.

Arsenic criteria

Oregon's human health criteria for arsenic are based on total inorganic arsenic (CAS No. 7440382) rather than total recoverable arsenic. Similar to assessment of aquatic life criteria above, DEQ will use a conversion factor of 0.80 (freshwater) and 0.59 (estuary) to convert total recoverable arsenic to inorganic arsenic for assessment purposes. If the geometric mean for inorganic arsenic concentration, which are converted from total recoverable arsenic are greater than 2.1 µg/L the water body will be placed in Category 5.

Beryllium criteria

Oregon's Clean Water Act human health criteria for beryllium were withdrawn in June 2010. However, public drinking water systems in Oregon are subject to the federal Safe Drinking Water Act Maximum Contaminant Level (MCL) for beryllium (4 µg/L). To identify where beryllium is impairing drinking water beneficial use, DEQ compares available data to the beryllium MCL. If sample results from public water system (PWS) source water and finished water exceed the MCL, the water body will be placed in Category 5: Water Quality Limited, TMDL Needed (303(d) List).

Bis chloromethyl ether (CAS No. 542881) criteria

Current human health criteria include numeric criteria for chloromethyl ether, bis (CAS 542881). However, there are no recommended analytical methods to measure this chemical in water samples given its rapid hydrolysis in water.

Chlordane (CAS No. 57749) and heptachlor (CAS No. 76448) criteria

Human health criteria for chlordane are applied to sample results reported for the technical product (CAS No. 12789036) or non-specific chlordane (CAS No. 57749), or to the sum of isomers, other constituents, and metabolites of chlordane including cis-chlordane (synonym α-chlordane) (CAS No. 5103719), trans-chlordane (synonym γ- chlordane) (CAS No. 5103742), γ-chlordane (CAS No. 5566347), cis-nonachlor (CAS No. 5103731), trans-nonachlor (CAS No. 39765805), and oxychlordane (CAS No. 27304138).

Another known major constituent of chlordane mixtures is heptachlor (CAS No. 76448). Human health criteria for heptachlor are applied separately for this chemical.

Cyanide criteria

Human health criteria for cyanide specify the criteria apply to total cyanide (CAS No. 57125). Information from EPA guidance used to develop Oregon's criteria indicates the recommended criteria were derived from drinking water MCLs that are based on free cyanide (µg (CN)/L). DEQ uses total cyanide data as a conservative surrogate for free cyanide.

DDT, DDD, and DDE criteria

Human health criteria are specified for DDT 4,4' (CAS No. 50293), DDD 4,4' (CAS No. 72548), and DDE 4,4' (CAS No. 72559). DEQ implementation guidance indicates results for each pollutant are compared to the appropriate human health criteria.

Dichlorobenzenes criteria

Human health criteria for the class dichlorobenzenes were replaced with criteria for the individual isomers dichlorobenzene (m) 1,3 (CAS No. 541731), dichlorobenzene (o) 1,2 (CAS No. 95501), and dichlorobenzene (p) 1,4 (CAS No. 106467). Results for each isomer are compared to the individual criterion.

Dichloroethylenes criteria

Human health criteria for the class dichloroethylenes were replaced with criteria for the individual chemicals dichloroethylene 1,1 (synonyms 1,1-dichloroethene or 1,1-DCE) (CAS No. 75354) and dichloroethylene trans 1,2 (CAS No. 156605). Results for each chemical are compared to the individual criterion.

Dichloropropene criteria

Human health criteria for the compound dichloropropene were replaced with criteria for the compound specifically identified as dichloropropene 1,3 (CAS No. 542756). Only this specific chemical is compared to the criteria.

Dinitrophenols criteria

Human health criteria include numeric criteria for the class of dinitrophenol isomers (CAS No. 25550587) and for one of the isomers dinitrophenol 2,4 (CAS No. 51285). DEQ implementation guidance indicates analytical results measured as dinitrophenol 2,4 are used as the surrogate for the dinitrophenol criteria.

Dioxin (2,3,7,8-TCDD) (CAS No. 1746016) criteria

Human health criteria for dioxin are applied to sample results reported for the specific congener 2,3,7,8-tetrachlorodibenzodioxin (TCDD) (CAS No. 1746016).

Diphenylhydrazine 1,2 (CAS No. 122667) criteria

Human health criteria include numeric criteria for diphenylhydrazine 1,2 to protect human health. Diphenylhydrazine 1,2 is difficult to analyze given its rapid decomposition rate in water. Instead, azobenzene, which is a decomposition product of 1,2 diphenylhydrazine, is analyzed as an estimate of this chemical. The water quality criterion for diphenylhydrazine 1,2 will be applied to analytical results from azobenzene.

Endosulfan criteria

Human health criteria include values for individual chemicals endosulfan Alpha, endosulfan Beta, and endosulfan sulfate.

Halomethanes criteria

Human health criteria for the class Halomethanes include individual criteria for bromoform (synonym tribromomethane) (CAS No. 75252), dichlorobromomethane (CAS No. 75274), methyl bromide (CAS No. 74839), and methylene chloride (synonym dichloromethane) (CAS No. 75092). These criteria are applied to sample results for the individual chemicals.

Hexachlorocyclohexane, BHC, and lindane criteria

Human health criteria for BHC gamma (synonym hexachlorocyclohexane (Lindane)) are applied to sample results reported for that chemical (CAS No. 58899). The pesticide product Lindane is generally > 99% the gamma isomer (synonyms γ-HCH or γ-BHC).

Human health criteria for the isomer BHC alpha (synonyms hexachlorocyclohexane alpha , α-HCH or α-BHC) are applied to results for that chemical (CAS No. 319846).

Human health criteria for the isomer BHC beta (synonyms, hexachlorocyclohexane beta, β-HCH or β-BHC) are applied to results for that chemical (CAS No. 319857).

Human health criteria for the hexachlorocyclo-hexane-technical (CAS No. 608731) apply to the technical grade pesticide which is a mixture consisting of α, β, γ, δ, and ε isomers. To be consistent with implementation guidance, DEQ applies the hexachlorocyclo-hexane-technical criteria to the sum of analytical results for the four major isomers.

Manganese criterion

Oregon's human health criterion for manganese for "fish consumption only" applies only in saltwater for total manganese to protect consumption of oysters and other marine mollusks in marine and estuarine sites.

Mercury and methylmercury criteria

The human health criterion for mercury is expressed as a fish tissue concentration of methylmercury (CAS No. 22967926) rather than total mercury in the water column and applies only to fish consumption.

Data for mercury in fish tissue from resident fish are analyzed for total mercury using EPA Method 7473, rather than methylmercury.[94] Scientific literature indicates that 90% or more of mercury in fish muscle (tissue not including skin) is methylmercury.[95] To evaluate data, DEQ uses sample results for total mercury in skinless fish fillets reported in mg/kg with "significant figures" limited to two decimal places. Based on the approximation that 90% of the reported mercury is methylmercury, DEQ concludes that any total mercury fish tissue result exceeding the methylmercury criterion (0.040 mg/kg) is a reasonable approximation of the methylmercury component in fish tissue. Fish tissue analyses for mercury may be from skinless fillets of individual fish, individual whole fish analyses, or composited skinless fillets from multiple fish. DEQ compares geometric mean concentrations of mercury from skinless fish fillets in individual resident fish to the human health fish tissue criterion following EPA guidance.[96]

DEQ also reviews fish consumption advisories issued due to mercury levels in fish to identify where mercury is causing impaired beneficial use for fish consumption.

Nitrosamines criteria

The human health criteria apply to the nitrosamine class of nitrogen containing chemicals as well as for the following individual derivatives in the class:

- Nitrosodibutylamine N- (CAS No. 924163)
- Nitrosodiethylamine N- (CAS No. 55185)
- Nitrosodimethylamine N- (CAS No. 62759)
- Nitrosodi-n-propylamine, N (CAS No. 621647)
- Nitrosodiphenylamine N- (CAS No. 86306)
- Nitrosopyrrolidine N- (CAS No. 930552)

[94] 2007, Method 7473, Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. U.S. EPA Office of Solid Waste

[95] Ullrich, S.M., Tanton, T.W. and Abdrashitova, S.A., 2001. Mercury in the Aquatic Environment: A Review of Factors Affecting Methylation. Critical Reviews in Environmental Science and Technology, **31**(3): 241-293.

[96] US EPA Office of Science and Technology, 2001. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA 823-R-10-001. Washington, D.C.

The sum of all the results for individual nitrosamines is compared to the criteria for Nitrosodiethylamine N. This is the most toxic of the nitrosamine derivatives and its numerical criteria are equal to the criteria established for total nitrosamines.

PCB criteria

The human health criteria for PCBs (Polychlorinated Biphenyls) are applied to either the sum of sample results reported as Aroclors, or the sum of sample results reported as individual congeners.

DEQ also reviews fish consumption advisories issued due to PCB levels in fish to identify where PCBs are causing impaired beneficial use for fish consumption.

Pentachlorophenol criteria

The human health criteria for pentachlorophenol are not pH-dependent and water quality data can be directly compared to the criteria.

Polynuclear aromatic hydrocarbons criteria

The human health criteria for the group Polynuclear Aromatic Hydrocarbons (PAHs) are evaluated based on the individual criteria for the following isomers:

- Acenaphthene (CAS 83329)
- Anthracene (CAS 120127)
- Benz[a]anthracene (CAS 56553)
- Benzo[a]pyrene (CAS 50328)
- Benzo[b]fluoranthene (CAS 205992)
- Benzo[k]fluoranthene (CAS 207089)
- Chrysene (CAS 218019)
- Dibenz[a,h]anthracene (CAS 53703)
- Fluoranthene (CAS 206440)
- Fluorene (CAS 86737)
- Indeno[1,2,3-c,d]pyrene (CAS 193395)

Pyrene (CAS 1290000)

Data evaluation

Data from sampling sites are evaluated using the following protocols. Unless specified otherwise in pollutant-specific protocols below, the assumed durations associated with grab samples are 1-hour (acute) and 96-hours (chronic). The following methodologies apply to all toxics. Where there are specific considerations for particular criteria, those are specified in further detail within the ASSESSEMENT METHODOLOGY sections above.

Determining Applicable Criteria

Oregon's statewide narrative

The statewide narrative criteria generally protect fish and aquatic life, and human consumption of drinking water and fish from toxic conditions and effects. Oregon's toxic substance narrative and numeric water quality standards protect human health, fish and aquatic life, and wildlife beneficial uses of water.

DEQ uses the narrative and numeric toxic pollutant criteria to determine where pollutants are causing impairments to applicable beneficial uses. Some toxic pollutants have criteria that apply to more than one beneficial use. For the assessment, DEQ applies criteria relevant to each use to determine water quality conditions and identify waters with impaired beneficial uses. Additional information about criteria applicable at specific locations is available using the DEQ water quality standards maps web tool.

Aquatic life

The OAR 340-041-8033 Table 30 criteria establish levels for specific toxic substances that are not to be exceeded more than once every three years on average to protect fish and aquatic life. DEQ evaluates data from the water column using the most stringent of the acute (1-hour average) or chronic (4-day average) pollutant criterion appropriate for the type of water (freshwater or saltwater).

To determine when freshwater or saltwater criteria are applicable, DEQ follows Oregon rules and EPA guidance.[97] Marine waters are defined in OAR 340-041-0002(34) as "...all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the State of Oregon." For marine waters, DEQ applies the saltwater criteria. Estuarine waters are defined in OAR 340-041-0002(22) as "...all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties." In 2018, DEQ adopted the Oregon Coastal Atlas estuary classification using the Federal Coastal and Marine Ecological Classification Standard (CMECS) implemented by the Oregon Department of Land Conservation and Development to delineate the extent of estuaries and define where specific water quality criteria should apply. CMECS classification is used to determine applicability of the more stringent of the saltwater and freshwater criteria as described above in the Evaluating data and information section.

The aquatic life toxicity of some pollutants is a function of water chemistry factors such as pH, temperature, salinity, or hardness. The applicable criterion is calculated for each monitoring

[97] 2002, National Recommended Water Quality Criteria: 2002, U.S. EPA Office of Water, EPA 822-R-02-047p.9.

result using water chemistry data. Criteria for ammonia, pentachlorophenol, and metals including cadmium, chromium, copper, lead, nickel, silver, and zinc are calculated using the equations, factors, and models cited in Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants.

Human health uses – drinking water and fishing

Statewide narrative and toxic substance narrative criteria protect human beneficial uses of water for drinking water and fishing. Public health advisories limiting fish consumption due to pollutant concentrations in fish or shellfish tissue are direct indicators of impairments to human beneficial uses and are used by DEQ to identify waters impaired by toxic pollutants.

The OAR 340-041-8033 Table 40 criteria protect human uses of water for public and private domestic water supply (i.e., drinking water consumption) and fishing (i.e., fish and shellfish consumption). DEQ evaluates data from the water column using the 'water + organism' criterion where both drinking water and fishing are designated uses. Most freshwaters in Oregon are designated for both drinking water and fishing. When fishing is a designated use but drinking water is not, DEQ applies the 'organism only' criterion. Most estuaries, marine waters, or saline waters are not designated for drinking water. In marine waters and estuaries if there is no 'organism only' criterion for a specific pollutant, DEQ may apply the 'water + organism' criterion. The criterion for methylmercury is the only fish consumption criterion based on fish tissue concentrations.

Data Requirements

Total recoverable or dissolved metals criteria

Oregon's human health and aquatic life criteria for metals are established for either the "total recoverable" or "dissolved" fraction of the pollutant in water. The dissolved metal concentration in a water sample is usually a lesser proportion of the total recoverable metal concentration in the water. To evaluate water quality data, DEQ compares sample results to the applicable criteria using parameter results that match the fraction specified by the criterion, when available. Where sample results for both total recoverable and dissolved fractions are reported for the same date, only the result matching the fraction of the applicable criterion is evaluated.

Total recoverable criteria

When the criterion is expressed as a total recoverable fraction, sample results for the dissolved fraction are considered valid for determining impairment. If the dissolved sample result exceeds the total recoverable criterion the samples may be used to assign Category 5. A dissolved sample result less than a total recoverable criterion is not considered valid for determining

attainment of the criterion, and the samples may be used to assign Category 3, but not Category 2, unless there are enough valid total recoverable samples to assign Category 2.

Dissolved criteria

When the criterion is expressed as a dissolved fraction, sample results for the total fraction are considered valid if the sample result is converted to an equivalent dissolved fraction by multiplying by a site-specific conversion factor or translator. The converted results are valid to determine attainment or impairment of the dissolved criterion.

When no site-specific translator is available, but the total recoverable sample is less than a dissolved criterion, it is considered valid to determine attainment of the criterion and may be used to assign Category 2. If total recoverable samples are greater than a dissolved criterion, Category 3B may be assigned if there are no other dissolved samples to indicate impairment.

Hardness-dependent criteria

The freshwater aquatic life criteria for six toxic metals (cadmium, chromium III, lead, nickel, silver, and zinc) are a function of hardness (mg/L) in the water column. Criteria for these metals are calculated using the equations and factors provided in Table 30 Endnote F and in 40 CFR Part 131 the federal criteria for acute cadmium in Oregon [98, 99]. Total recoverable hardness values are used to derive criteria for metals concentrations.

If hardness is not directly reported as $CaCO_3$, the following equation[100] is used to calculate hardness from the concentration of Ca^{+2} and Mg^{+2}, if available. All units are in mg/L:

$$\text{Hardness, equivalent } CaCO_3 = 2.497\ Ca^{+2} + 4.1189\ Mg^{+2}$$

To determine the hardness-dependent criteria, DEQ follows EPA guidance to use the concentration of ambient hardness to calculate criteria, even if the actual ambient hardness is less than 25 mg/L as calcium carbonate, and a maximum hardness value of 400 mg/L as calcium carbonate, even if the actual ambient hardness is greater than 400 mg/L as calcium carbonate.[101]

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[98] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

[99] Federal Clean Water Act criterion promulgated for Oregon effective 3/6/2017. 40 CFR Part 131 [EPA–HQ–OW–2016–0012; FRL–9958–40–OW] RIN 2040–AF60 https://www.federalregister.gov/documents/2017/02/03/2017-02283/aquatic-life-criteria-for-cadmium-in-oregon

[100] 1998, Standard Methods for the Examination of Water and Wastewater, 20th edition, American Public Health Association, American Water Works Association, Water Environment Federation

[101] 40 CFR Section 131.36(c)(4)(i). EPA 2002, National Recommended Water Quality Criteria: 2002. U.S. Environmental Protection Agency. EPA-822-R-02-047. EPA-822-R-02-047, p.8. November 2002.

DEQ will preferentially use concurrent measured hardness values when available but will use default values when needed for calculating protective hardness criteria. When ambient hardness concentration data is not available for a specific metal sample, DEQ will apply one of the default hardness values depending on the Ecoregion where the sample was collected (Table 19).

Table 19. Ecoregion default hardness values

Ecoregion	Default Hardness (mg/L)
Blue Mountains	21.7
Cascades	10.0
Coast Range	14.5
Columbia Plateau	23.4
Columbia River Mainstem	48.7
Eastern Cascades Slopes and Foothills	19.3
Klamath Mountains	28.5
Northern Basin and Range	32.3
Snake River Plain	80.9
Willamette Valley	25.0

Assignment of assessment category

Category 5: water quality limited, TMDL needed (303(d) list)

For fish and aquatic life

For two or more samples, greater than 5% of the samples exceed the appropriate **aquatic life criterion** according to the exact binomial test for listing Table 6;

For fishing and shellfish harvesting

The geometric mean of a minimum of three or more samples is greater than the appropriate **human health criterion**;

OR

Any fish or shellfish consumption advisory issued by the Oregon Health Authority or Oregon Department of Agriculture for a specific water body based on pollutants in fish or shellfish tissue. Fish advisories are posted at:
http://public.health.oregon.gov/newsadvisories/Pages/RecreationalAdvisories.aspx or
https://www.oregon.gov/ODA/programs/FoodSafety/Shellfish/Pages/ShellfishClosures.aspx

OR

The geometric mean of a minimum of three or more valid results exceeds the fish tissue criterion for methylmercury if the results are from skinless fillets of individual fish and/or shellfish.[102]

OR

The arithmetic mean of two or more valid results exceeds the fish tissue criterion for methylmercury if the results are from composited skinless fillets from multiple fish and/or shellfish of the same species.

For domestic water supply

The geometric mean of a minimum of three or more samples is greater than the appropriate human health (water + organism) criterion.

Category 4: water quality limited, TMDL not needed

TMDLs needed to attain applicable water quality standards have been approved (Category 4A), other pollution control requirements are expected to address pollutant and will attain water quality standards (Category 4B), or impairment is not caused by a pollutant (Category 4C).

Category 3B: insufficient data; potential concern

For fish and aquatic life

For fewer than 10 samples, one exceedance of the appropriate **aquatic life criterion**.

For fishing and shellfish harvesting

For fewer than three samples, more than one sample is greater than the appropriate **human health criterion**.

Category 3D: insufficient data; not technologically feasible to assess

For fishing and shellfish harvesting or domestic water supply

Data are not sufficient to determine use support because numeric criteria are less than quantitation limits.

Category 3: insufficient data

Data are not sufficient to determine impairment or attainment (unless assigned Category 3B).

[102] Protocol based on US EPA Office of Science and Technology, 2001. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. EPA 823-R-10-001. Washington, D.C.

For fishing and shellfish harvesting

Less than three valid samples for methylmercury in fish tissue when the results are from skinless fillets of individual fish and/or shellfish,

OR

Less than two samples for methylmercury in fish tissue from a composite sample composed of skinless fillets of multiple fish and/or shellfish of the same species.

Category 2: attaining

For fish and aquatic life

For a minimum of 10 samples, less than or equal to 5% of the samples exceed the appropriate aquatic life criterion according to the exact binomial test (see Water Body Assessment);

For fishing and shellfish harvesting

The geometric mean of a minimum of three (3) valid samples is less than or equal to the appropriate human health criterion;

OR

Public health advisories are no longer needed based on fish tissue concentrations of pollutants;

OR

The geometric mean of a minimum of three valid samples meeting the human health criterion for methylmercury when the results are from skinless fillets of individual fish and/or shellfish;

OR

The arithmetic mean of a minimum of two valid samples meeting the human health criterion for methylmercury when the results are from a composite sample composed of skinless fillets of multiple fish and/or shellfish of the same species.

For domestic water supply

The geometric mean of a minimum of three valid samples is less than or equal to the appropriate human health (water + organism) criterion.

Delisting – new data

For fish and aquatic life

Assessment units with sufficient data in the data and window to meet the Delisting – statistical methods requirements for toxic pollutants will be removed from the 303(d) list and put in Category 2: Attaining.

For human health criteria

Numeric water quality criteria for the protection of human health from toxic substances will be evaluated as the geometric mean of the observed samples of pollutant concentration. Waters will be removed from the 303(d) list if the geometric mean of samples representative of the water body are less than the numeric criterion threshold.

Assessment – turbidity

PARAMETER	BENEFICIAL USE
Turbidity	Domestic water supply
Turbidity	Fish and aquatic life

Water Quality Standards

340-041-0007

Statewide Narrative Criteria

(10) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish may not be allowed;
(11) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed;
(12) Objectionable discoloration, scum, oily sheens, or floating solids, or coating of aquatic life with oil films may not be allowed;
(13) Aesthetic conditions offensive to the human senses of sight, taste, smell, or touch may not be allowed;

340-041-0036

Turbidity

Turbidity (Nephelometric Turbidity Units, NTU): No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

(1) Emergency activities: Approval coordinated by the Department with the Oregon Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare;

(2) Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of section 401 or 404 (Permits and Licenses, Federal Water

Pollution Control Act) or OAR 14l-085-0100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.

Assessment Methodology

Turbidity measures the "cloudiness" of water; more precisely, it measures the extent to which light is scattered and absorbed by suspended sediment, dissolved organic matter, and, to a lesser extent, plankton and other microscopic organisms[10388]. Turbidity is also referred to as the inverse of the "clarity" of water. Light that is not scattered or absorbed by turbidity-causing particles passes through the water. In other words, increased turbidity reduces the distance that light can penetrate into the water column. This methodology detail how DEQ assess turbidity for domestic drinking water and fishing and aquatic life uses.

Data evaluation

DEQ will evaluate data or information submitted through the Call for Data to assess turbidity impairments for applicable beneficial uses.

Data requirements

DEQ turbidity assessment of the drinking water criteria is based on voluntary submission of data and information by drinking water providers.

Assignment of assessment category

Category 5: water quality limited, TMDL needed (303(d) list)

For fish and aquatic life

A systematic or persistent increase (of greater than 10%) in turbidity due to an operational activity that occurs on a persistent basis (e.g., dam release or irrigation return, etc.).

For domestic water supply

For impairments to beneficial use as drinking water supply, Public Water System operator indicates that high turbidity days (days with turbidity ≥5 NTU) are causing operational difficulty **AND** source water data validate this impairment. The data are considered to validate an

[103] Clesceri, L. S., A. E. Greenberg, and A. D. Eaton (eds.) 1994. Standard Methods for the Examination of Water and Wastewater, 20 ed. American Public Health Association, Washington, DC.

impairment if more than 45 high turbidity days per year occur for any year for which data are available.

Category 3: insufficient data

For fish and aquatic life

There is insufficient data to show whether or not a systematic or persistent increase in turbidity due to an operational activity is occurring on a persistent basis

For domestic water supply

Available data are not sufficient to determine if the use is impaired. One or more turbidity shutdowns are documented in the Safe Drinking Water Information System database, but there is not data to demonstrate whether shutdown is due to a large storm event or indicates a problem and impaired beneficial use.

Category 3B: insufficient data; potential concern

For beneficial use as drinking water supply, available data are not sufficient to determine if the use is impaired, but indicate a potential concern. The Public Water System operator indicates that high turbidity days are causing operational difficulties, but there is not data available to validate this impairment, or if shutdowns due to high turbidity may be the result of unusual or infrequent weather events.

Category 2: attaining

For fish and aquatic life

Less than a 10% increase in turbidity due to an operational activity that occurs on a persistent basis (e.g., dam release or irrigation return, etc.).

For domestic water supply

Public Water System operator indicates that high turbidity days are not causing operational difficulty **AND/OR** source water data show 45 or less high turbidity days per year for all years for which data are available.

Delisting – new data

There is no current delisting process for turbidity. Assessment units will be evaluated for delisting on a case-by-case basis.

Appendix A: State and federal rules, guidance, and policies

The 2024 Integrated Report methodology is consistent with the following state and federal rules, guidance, and policies:

- Water Quality Standards, Beneficial Uses, Policies, and Criteria for Oregon: Oregon Administrative Rules Chapter 340 Division 41
- June 22,1998 DEQ Letter to EPA Region 10, Policy Clarification of Oregon Water Quality Standards Revisions
- February 4, 2004 DEQ Letter to EPA Region 10, Oregon Responses to EPA Questions on State's Water Quality Temperature Standards
- EPA memoranda to states for each reporting cycle 2002-2024
- July 2002, Consolidated Assessment and Listing Methodology, First Edition, U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds
- Federal Water Pollution Control Act §1315, Chapter 26 - Water Pollution Prevention and Control
- 40 CFR Part 130.7 (Code of Federal Regulations)
- 40 CFR Part 130.8 (Code of Federal Regulations)

Appendix B: Data used in the 2024 Integrated Report

DEQ conducted a statewide call for data for inland and estuarine waters from Feb. 6, 2023, through April 7, 2023, and for marine waters from June 15, 2023, through Aug. 14, 2023, to solicit data from the public for use in the 2024 Integrated Report. DEQ used numerous means to advertise and reach out to government agencies and organization to advertise the 2024 Call for Data, including GovDelivery, press releases, webinars, social media, and direct communication with stakeholders, other state natural resource agencies, and federal agencies. DEQ provided data templates, tutorials and submission guidelines to assist with data submittal for the report. Both 2024 Calls for Data were held for 60 days and DEQ received data from 13 separate organizations including several municipalities, federal agencies, research organizations and environmental groups. Submittal to DEQ is on a voluntary basis. Additionally, DEQ used readily available data collected internally, from partner agencies, volunteer monitoring groups, USEPA's Water Quality Portal, USGS National Water Information System, the City of Portland and Public Water Systems turbidity data. A total of 9,288,900 rows of data were assessed from 141 organizations. The organizations in the table below provided data.

Table B-20. Organizations, results, and sources of data used in the 2024 Integrated Report

Organization Name	Number of Results	Data Source
Oregon Department of Human Services	9857	DEQ - Internal
State of Oregon Dept. of Environmental Quality	400720	DEQ - Internal
Benton Soil and Water Conservation District	2668	DEQ Volunteer Monitoring Program
Calapooia Watershed Council	7214	DEQ Volunteer Monitoring Program
Clackamas Soil and Water Conservation District	831	DEQ Volunteer Monitoring Program
Columbia Riverkeeper	788	DEQ Volunteer Monitoring Program
Columbia Soil and Water Conservation District	65614	DEQ Volunteer Monitoring Program
Coos Watershed Association	12372	DEQ Volunteer Monitoring Program
Coquille Watershed Association	59905	DEQ Volunteer Monitoring Program
Curry Watershed Partnerships	11536	DEQ Volunteer Monitoring Program
Gilliam Soil and Water Conservation District	9036	DEQ Volunteer Monitoring Program
Hood River Watershed Group	17340	DEQ Volunteer Monitoring Program
Hyla Woods	11780	DEQ Volunteer Monitoring Program

Johnson Creek Watershed Council	10970	DEQ Volunteer Monitoring Program
Klamath Soil and Water Conservation District	12700	DEQ Volunteer Monitoring Program
Lincoln Soil and Water Conservation District	12704	DEQ Volunteer Monitoring Program
Long Tom Watershed Council	29604	DEQ Volunteer Monitoring Program
Luckiamute Watershed Council	52292	DEQ Volunteer Monitoring Program
Medford Water Commission	158	DEQ Volunteer Monitoring Program
Middle Deschutes Watershed Council	5440	DEQ Volunteer Monitoring Program
Nestucca-Neskowin Watershed Council	18868	DEQ Volunteer Monitoring Program
North Coast Watershed Association	91040	DEQ Volunteer Monitoring Program
North Fork John Day Watershed Council	3868	DEQ Volunteer Monitoring Program
Oregon Department of Agriculture	14446	DEQ Volunteer Monitoring Program
Partnership for the Umpqua Rivers	150635	DEQ Volunteer Monitoring Program
Powder Basin Watershed Council	103276	DEQ Volunteer Monitoring Program
Rogue River Watershed Council	157847	DEQ Volunteer Monitoring Program
Rogue Riverkeeper	473	DEQ Volunteer Monitoring Program
Rogue Valley Council of Governments	139	DEQ Volunteer Monitoring Program
Salmon Drift Creek Watershed Council	716	DEQ Volunteer Monitoring Program
Sherman County Area Watershed Council	1992	DEQ Volunteer Monitoring Program
Siuslaw Soil and Water Conservation District	31516	DEQ Volunteer Monitoring Program
Siuslaw Watershed Council	26089	DEQ Volunteer Monitoring Program
South Santiam Watershed Council	23866	DEQ Volunteer Monitoring Program
South Suburban Sanitary District	11	DEQ Volunteer Monitoring Program
Tillamook Estuaries Partnership	5663	DEQ Volunteer Monitoring Program
Tualatin Soil and Water Conservation District	1676	DEQ Volunteer Monitoring Program
Umpqua Soil and Water Conservation District	9632	DEQ Volunteer Monitoring Program
Upper Deschutes Watershed Council	81414	DEQ Volunteer Monitoring Program
Upper Nehalem Watershed Council	9548	DEQ Volunteer Monitoring Program
Upper Willamette Soil and Water Conservation District	5972	DEQ Volunteer Monitoring Program
Walla Walla Basin Watershed Council	54776	DEQ Volunteer Monitoring Program
Wasco County Soil and Water Conservation District	545	DEQ Volunteer Monitoring Program
Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling	609	Integrated Report - Readily Available Data
USGS Oregon Water Science Center	3698435	Integrated Report - Readily Available Data
Adventure Scientists(Volunteer)*	907	Integrated Report - WQP
Bureau of Reclamation	5888	Integrated Report - WQP
Burns Paiute Tribe (Tribal)	6627	Integrated Report - WQP

Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians (Tribal)	44594	Integrated Report - WQP
Confederated Tribes of the Grand Ronde Community of Oregon (Tribal)	34649	Integrated Report - WQP
Confederated Tribes of the Umatilla Indian Reservation (Tribal)	349733	Integrated Report - WQP
Coquille Indian Tribe (Tribal)	1261	Integrated Report - WQP
EPA National Aquatic Resources Survey (NARS)	491	Integrated Report - WQP
Klamath Tribes (Tribal)	2129	Integrated Report - WQP
Kraft Heinz Foods Company	36	Integrated Report - WQP
National Park Service Water Resources Division	308	Integrated Report - WQP
North American Lake Management Society	109	Integrated Report - WQP
USGS Idaho Water Science Center	1187	Integrated Report - WQP
USGS Oregon Water Science Center	14152	Integrated Report - WQP
City of Portland Water Bureau	23320	Submitted to DEQ - Data Call
Columbia River Inter-Tribal Fish Commission	69250	Submitted to DEQ - Data Call
East Multnomah Soil and Water Conservation District	23488	Submitted to DEQ - Data Call
Idaho Power Company	72844	Submitted to DEQ - Data Call
Bureau of Land Management - Umbrella	1017296	Submitted to DEQ - Integrated Report Call for Data
City of Bend Water Quality Laboratory	224358	Submitted to DEQ - Integrated Report Call for Data
City of Gresham	90397	Submitted to DEQ - Integrated Report Call for Data
City of West Linn	245	Submitted to DEQ - Integrated Report Call for Data
Clean Water Services	1410	Submitted to DEQ - Integrated Report Call for Data
Deschutes River Alliance	36392	Submitted to DEQ - Integrated Report Call for Data
National Estuarine Research Reserve System - South Slough	73440	Submitted to DEQ - Integrated Report Call for Data
NOAA Newport Hydrographic Line	6994	Submitted to DEQ - Integrated Report Call for Data
Ocean Observatories Initiative	6216	Submitted to DEQ - Integrated Report Call for Data
Oregon Department of Fish and Wildlife	30	Submitted to DEQ - Integrated Report Call for Data
US Environmental Protection Agency	88760	Submitted to DEQ - Integrated Report Call for Data
US Forest Service - Umbrella	566275	Submitted to DEQ - Integrated Report Call for Data

Weyerhaueser Timber Company	2364	Submitted to DEQ - Integrated Report Call for Data
City of Jefferson	698	Submitted to DEQ - Integrated Report DW Provider
City of Kernville-Gleneden	788	Submitted to DEQ - Integrated Report DW Provider
City of Philomath	957	Submitted to DEQ - Integrated Report DW Provider
City of Willamina	1095	Submitted to DEQ - Integrated Report DW Provider
Arauco	450	Submitted to DEQ - Permittee
Arclin	54	Submitted to DEQ - Permittee
Arkema Groundwater	229	Submitted to DEQ - Permittee
Canby, City of	180	Submitted to DEQ - Permittee
Cascade Pacific Pulp	250	Submitted to DEQ - Permittee
City of Albany	54	Submitted to DEQ - Permittee
City of Ashland	266	Submitted to DEQ - Permittee
City of Astoria	5867	Submitted to DEQ - Permittee
City of Brookings, STP	86	Submitted to DEQ - Permittee
City of Cottage Grove	569	Submitted to DEQ - Permittee
City of Lake Oswego	1486	Submitted to DEQ - Permittee
City of Lebanon	9	Submitted to DEQ - Permittee
City of McMinnville	30	Submitted to DEQ - Permittee
City of Milwaukie	31	Submitted to DEQ - Permittee
City of Molalla STP	126	Submitted to DEQ - Permittee
City of Myrtle Creek	100	Submitted to DEQ - Permittee
City of Newberg	187	Submitted to DEQ - Permittee
City of Ontario STP	90	Submitted to DEQ - Permittee
City of Oregon City	475	Submitted to DEQ - Permittee
City of Prineville	27	Submitted to DEQ - Permittee
City of Sandy WWTP	161	Submitted to DEQ - Permittee
City of St. Helens and Boise Cascade Timber Company	226	Submitted to DEQ - Permittee
City of Sweet Home	100	Submitted to DEQ - Permittee
City of The Dalles STP	702	Submitted to DEQ - Permittee
City of Tillamook	348	Submitted to DEQ - Permittee
City of Troutdale WWTP	170	Submitted to DEQ - Permittee
City of Woodburn	201	Submitted to DEQ - Permittee
Clackamas Water Environment Services -Tri City WWTF	137	Submitted to DEQ - Permittee
Dallas, City of	109	Submitted to DEQ - Permittee
Deschutes Valley Water District	12116	Submitted to DEQ - Permittee
Dry Creek Landfill	5	Submitted to DEQ - Permittee
Dyno Nobel Inc.	305	Submitted to DEQ - Permittee

EVRAZ Inc.	294	Submitted to DEQ - Permittee
Frank Lumber Co Inc	150	Submitted to DEQ - Permittee
Georgia Pacific Halsey	50	Submitted to DEQ - Permittee
Georgia-Pacific Consumer Operations LLC (Wauna Mill)	145	Submitted to DEQ - Permittee
Graphic Packaging International	90	Submitted to DEQ - Permittee
Hermiston, City of	183	Submitted to DEQ - Permittee
International Paper (formerly Weyerhaeuser)	115	Submitted to DEQ - Permittee
Klamath Falls, City of	129	Submitted to DEQ - Permittee
McFarland Cascade Holdings, Inc. (MCHI-Sheridan aka Stella-Jones)	144	Submitted to DEQ - Permittee
OAK LODGE WATER SERVICES DISTRICT	120	Submitted to DEQ - Permittee
Oregon Cherry Growers, Inc.	178	Submitted to DEQ - Permittee
Oregon Cherry Growers, Riverside Plant	13	Submitted to DEQ - Permittee
Rogue Valley Sewer Services	641	Submitted to DEQ - Permittee
Roseburg Landfill	52	Submitted to DEQ - Permittee
Siltronic Inc.	153	Submitted to DEQ - Permittee
StarLink Logistics Inc.	97	Submitted to DEQ - Permittee
Sunstone Circuts	110	Submitted to DEQ - Permittee
Univar Solutions	90	Submitted to DEQ - Permittee
Water Environment Services	1903	Submitted to DEQ - Permittee
WES KELLOGG CREEK WWTP	150	Submitted to DEQ - Permittee
Willamette Falls Paper Company	229	Submitted to DEQ - Permittee
Wilsonville, City of	125	Submitted to DEQ - Permittee
City of Eugene	2734	Submitted to DEQ - Permittee/Call for Data
City of Lincoln City	1147	Submitted to DEQ - Permittee/Call for Data
City of Myrtle Point	392	Submitted to DEQ - Permittee/Call for Data
City of Newport	818	Submitted to DEQ - Permittee/Call for Data
City of Portland Bureau of Environmental Services	125852	Submitted to DEQ - Permittee/Call for Data
City of Salem	1132115	Submitted to DEQ - Permittee/Call for Data
City of Stayton	958	Submitted to DEQ - Permittee/Call for Data

Narrative data was also assembled for the assessment from the: Oregon Invasive Species Hotline Oregon Health Authority Advisories.

Some data provided were excluded from the Integrated Report analysis. **Table B-20** identifies the reasons numeric data were excluded from the Integrated Report analysis.

Table B-21. Data excluded from the 2024 Integrated Report

Reason data was excluded from the analysis	Number of Results
Sample not representative of surface water	862
More precise analytical method used	61066
Duplicate data	197
Duplicate samples at multiple depths	4417
Invalid method	14360
Suspect data	400

For this cycle, DEQ received narrative and numeric data from the Center for Biological Diversity on the topic of ocean acidification. Many of the journal articles and research provided had been used by DEQ to develop the marine biocriteria – ocean acidification assessment methodology. DEQ also pulled numeric data relevant to the methodology and worked directly with the data owners. This is covered in Appendix C.

Appendix C: Marine biocriteria – ocean acidification assessment

In the 2018/2020 Integrated Report, DEQ determined that Oregon territorial marine waters should be placed into Category 3B for the biocriteria narrative*: insufficient data to determine use support but some data that indicates nonattainment of beneficial use criterion.* This action recognized the body of information indicating negative impacts to aquatic life and fisheries from changing ocean conditions while acknowledging there was not a clear pathway to determine nonattainment of the narrative biocriteria in marine waters. Waters remained in this category during the 2022 cycle while DEQ was in the process of convening a technical workgroup to help DEQ integrate impacts related to changing ocean conditions into the Integrated Report process.

In 2022, DEQ formed an Ocean Acidification and Hypoxia technical workgroup to provide assistance in the development of methodology to interpret Oregon's narrative marine DO criteria and biocriteria. The technical workgroup was not a decision-making body, rather it facilitated the sharing of scientific data and information. Information about the technical workgroup process can be found on DEQ's Integrated Report Improvements webpage.

Oregon's narrative biocriteria is defined in OAR 340-041-0011:

> *Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.*

For the 2024 IR report, DEQ has adopted a hybrid assessment framework wherein two lines of evidence can be used to assess aquatic life beneficial use support based on the narrative biocriteria (**Figure 10**). DEQ's framework allows for chemical (aragonite saturation state) or biological (pteropod shell dissolution) data to be used individually or in combination. The framework relies on two types of benchmarks to conduct IR categorical assessment, the use of which is dependent on data availability. One benchmark value, referred to as the "independently applicable (IA)" benchmark, is defined as a value which, if exceeded, there is confidence about biological impact based on biological or chemical data alone. The second benchmark value, referred to as the "combined line of evidence (CLOE)" benchmark, is defined as a value which, if exceeded, indicates biological impact, but requires confirmation from an additional line of evidence. In cases where two lines of evidence are available, DEQ will rely on the CLOE benchmark, whereas in instances where only a single line of evidence is available DEQ will employ the IA benchmark for those data.

Assessment metrics

As outlined in the OAH assessment technical support document, the biological metric is defined as the percentage of individual pteropods in a biological sample with moderate to severe shell damage (Type II & Type III), hereafter referred to as severe dissolution.[104] Aragonite saturation state (Ω_{ar}) serves as the basis for the chemical metric used in this assessment because it represents the best available science to quantify OA stress to pteropods.[105]

Data sources and availability

For the 2024 IR cycle, DEQ based its assessment of the marine narrative biocriteria on data collected by National Oceanic and Atmospheric Administration during the West Coast Ocean Acidification (WCOA) cruises. DEQ considered data collected over the last 10 years (2012-2022), consisting of 5 cruises. WCOA cruises are designed to characterize spatial variability in the carbon cycle across the continental margin of North America, and as such, sampling extends from British Columbia to Baja California. For the purposes of the Integrated Report, DEQ selected a subset of WCOA sampling locations relevant to Oregon's Territorial Sea.

Chemical data availability

At all stations visited during the WCOA cruises NOAA personnel conducted CTD casts and collected discrete water samples in Niskin bottles. Water samples were analyzed for a suite of parameters, including carbonate measurements used to calculate aragonite saturation state. Rigorous data quality checks were completed, and quality control flags were assigned to the data before it was submitted to the National Center for Environmental Information (NCEI), where it is available to the public and scientific community. Only data assigned quality control flags of "good value" & "mean of replicates" were included in this assessment.

Based on the subset of sample locations relevant to this assessment, 31 profile casts were identified within Oregon's Territorial Sea during the 5 cruise years examined. By request, NOAA Pacific Marine Environmental Laboratory staff calculated aragonite saturation state for each sample within those profiles. A minimum of 5 unique profiles within an AU is needed to conduct an assessment as defined in DEQ's **(Table 7**). Of the chemical profile data available for this

[104] Bednaršek, N., Klinger, T., Harvey, C. J., Weisberg, S., McCabe, R. M., Feely, R. A., Newton, J., & Tolimieri, N. (2017). New ocean, new needs: Application of pteropod shell dissolution as a biological indicator for marine resource management. Ecological Indicators, 76, 240–244. https://doi.org/10.1016/j.ecolind.2017.01.025

[105] Bednaršek, N., Feely, R. A., Howes, E. L., Hunt, B. P. V., Kessouri, F., León, P., Lischka, S., Maas, A. E., McLaughlin, K., Nezlin, N. P., Sutula, M., & Weisberg, S. B. (2019). Systematic Review and Meta-Analysis Toward Synthesis of Thresholds of Ocean Acidification Impacts on Calcifying Pteropods and Interactions With Warming. Frontiers in Marine Science, 6, 227. https://doi.org/10.3389/fmars.2019.00227

assessment there were sufficient profiles to apply the biocriteria assessment framework in three of the six marine AUs.

Biological data availability

Pteropod samples were collected during the 2011, 2013, and 2016 WCOA cruises at a subset of total cruise sampling locations. Severe shell dissolution metric was calculated for those data using methodology outlined in Bednarsek et al., 2012.[106] Upon request, pteropod shell dissolution data were provided to DEQ by the research scientist responsible for the data collection. All sample locations where pteropod data was collected were outside of Oregon's territorial sea. For this assessment, due to uncertainty around the representativeness of biological data collected outside of state waters to specific assessment units, pteropod shell dissolution data was not assessed using the hybrid assessment framework. Instead, sites appearing most relevant to Oregon waters are summarized in this appendix to serve as additional context for the assessment conclusions, which are based on chemical data.

Assessing deviation from background

Applying the hybrid assessment framework to chemical profile data alone relies on the comparison of observational data to the IA (independently applicable) benchmark of 1.0 Ω_{ar}. At each profile location, DEQ relies on the best available estimate of pre-industrial depth horizon to decide which data represent a deviation from natural background condition. In this instance, NOAA Pacific Marine Environmental Laboratory (PMEL) staff provided three estimates of pre-industrial Ω_{ar} for each data point in the dataset used in this assessment. There was good agreement among the three estimates (σ = 0.022), which Applying the hybrid assessment framework to chemical profile data alone relies on the comparison of observational data to the IA (independently applicable) benchmark of 1.0 Ω_{ar}. At each profile location, DEQ relies on the best available estimate of pre-industrial depth horizon to decide which data represent a deviation from natural background condition. In this instance, PMEL staff provided three estimates of pre-industrial Ω_{ar} for each data point in the dataset used in this assessment. There was good agreement among the three estimates (σ = 0.022), which were derived using three

[106] Bednaršek, N., Tarling, G. A., Bakker, D. C., Fielding, S., Cohen, A., Kuzirian, A., McCorkle, D., Lézé, B., & Montagna, R. (2012). Description and quantification of pteropod shell dissolution: A sensitive bioindicator of ocean acidification. Global Change Biology, 18(7), 2378–2388. https://doi.org/10.1111/j.1365-2486.2012.02668.x

distinct approaches.[107, 108, 109] For each datapoint, the three estimates were averaged to determine a single pre-industrial Ω_{ar} value for the purposes of assessment.

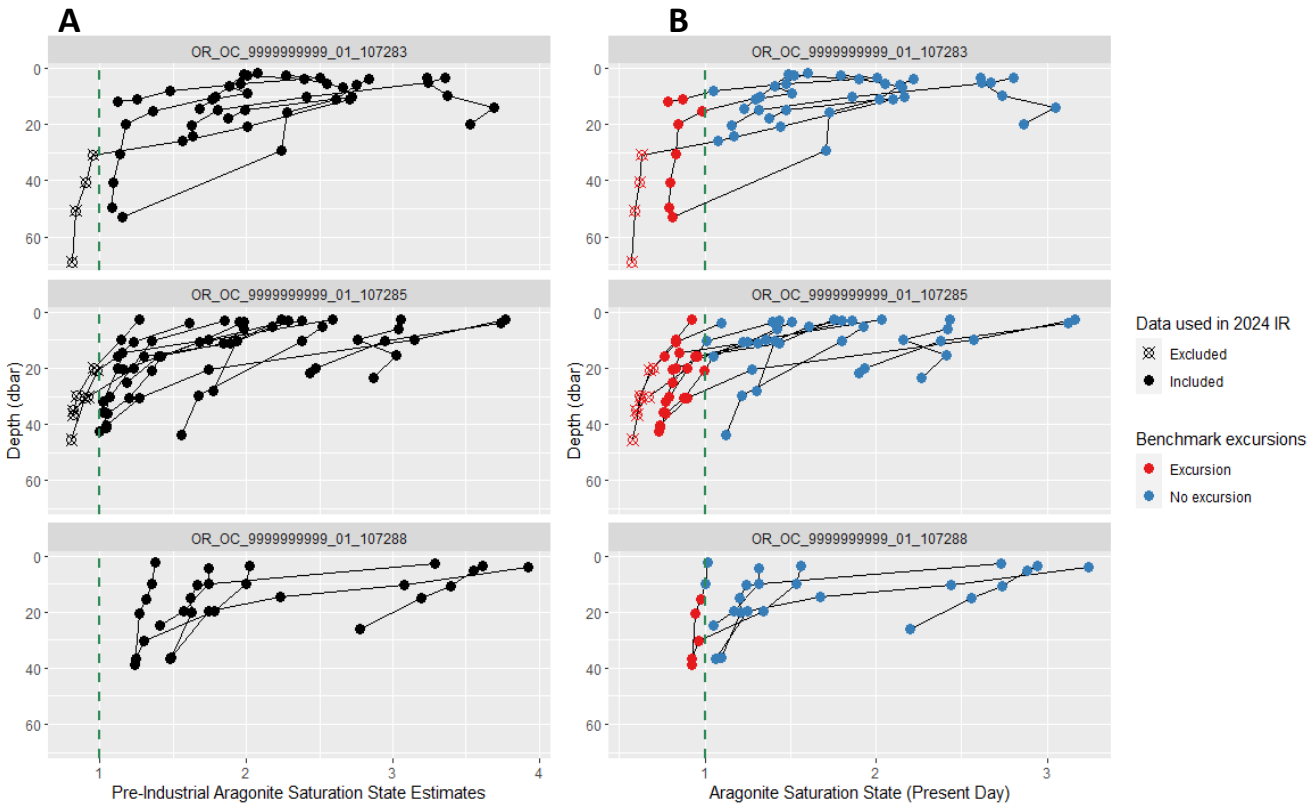

Figure C-16. (A) Within each assessment unit, data points below the Independent Applicable chemical benchmark (1.0) using pre-industrial aragonite saturation state estimate were excluded from the assessment. (B) Remaining data points were assessed using present day aragonite saturation state estimates. Excursions of the IA benchmark were assessed using the binomial table for conventional pollutants to determine impairment within each assessment unit

Samples with pre-industrial estimates below the IA benchmark (Ω_{ar} = 1.0) were excluded from the remaining categorical assessment steps (**Figure C-16(A)**), as any excursions of those data in the present day would not be considered a deviation from background. Remaining samples above the pre-industrial IA benchmark are pooled by AU, and excursions of the present-day IA

[107] Arroyo, M.C., Fassbender, A.J., Carter, B.R., Edwards, C.A., Fiechter, J., Norgaard, A. and Feely, R.A., 2022. Dissimilar sensitivities of ocean acidification metrics to anthropogenic carbon accumulation in the Central North Pacific Ocean and California Current Large Marine Ecosystem. Geophysical Research Letters, 49(15), p.e2022GL097835. https://doi.org/10.1029/2022GL097835

[108] Feely, R.A., Alin, S.R., Carter, B., Bednaršek, N., Hales, B., Chan, F., Hill, T.M., Gaylord, B., Sanford, E., Byrne, R.H. and Sabine, C.L., 2016. Chemical and biological impacts of ocean acidification along the west coast of North America. Estuarine, Coastal and Shelf Science, 183, pp.260-270. https://doi.org/10.1016/j.ecss.2016.08.043

[109] Carter, B. et al., in Prep

benchmark (Ω_{ar} = 1.0) were compared to the critical number according to the exact binomial test for conventional pollutants to determine impairment (**Figure C-16(B)**).

Conclusions – marine biocriteria

In applying the hybrid biocriteria assessment framework (**Figure 10**) using the data and tools available for the 2024 assessment, DEQ's assessment team has developed a list of assessment conclusions. In this framework, the benchmark applied is determined by available data within an AU to determine impairment. In this assessment, DEQ relied on the chemical IA benchmark and found there was sufficient profile data to assess three assessment units (**Table C-22**).

Table C-22. Within each assessment unit, availability of data types determined which benchmark was applied and resulting status changes. *3B status (potential concern) from 2020 Integrated Report will be carried forward in unassessed AUs

Assessment Unit Description (ID)	Data type	Meets data require-ments?	Benchmark applied	n (Ωar)	# of Excursions	Critical # per binomial	Status
WA border - Cape Lookout OR_OC_9999999999_01_107283	Chemical	Yes	IA - Chemical	45	8	8	**Category 5 (Impaired)**
	Biological	No					
Cape Lookout – Cape Foulweather OR_OC_9999999999_01_107284	Chemical	No	Insufficient data				Unassessed*
	Biological	No					
Cape Foulweather – Siltcoos River OR_OC_9999999999_01_107285	Chemical	Yes	IA - Chemical	56	21	10	**Category 5 (Impaired)**
	Biological	No					
Siltcoos River - Cape Arago OR_OC_9999999999_01_107286	Chemical	No	Insufficient data				Unassessed*
	Biological	No					
Cape Arago - Cape Blanco OR_OC_9999999999_01_107287	Chemical	No	Insufficient data				Unassessed*
	Biological	No					
Cape Blanco - CA border OR_OC_9999999999_01_107288	Chemical	Yes	IA - Chemical	29	5	6	Category 3B (potential concern)
	Biological	No					

Biological data summary

Though pteropod samples were not used in the hybrid assessment framework to determine impairment in the 2024 IR cycle, they provide important context for the conclusions drawn from the chemical data assessment. Biological samples collected offshore from the two impaired AUs (OR_OC_9999999999_01_107283 & OR_OC_9999999999_01_107285) display increasing severity of pteropod dissolution in samples taken closer to state waters (**Figure C-17**). Furthermore, biological data offshore from the southernmost AU (OR_OC_9999999999_01_107288), which contained sufficient chemical data for assessment but did not indicate impairment based on the binomial, does not display the same increasing severity closer to shore as the other two impaired units (**Figure C-17**). These biological data are well aligned with the assessment conclusions drawn from chemical profile data within Oregon's Territorial Sea.

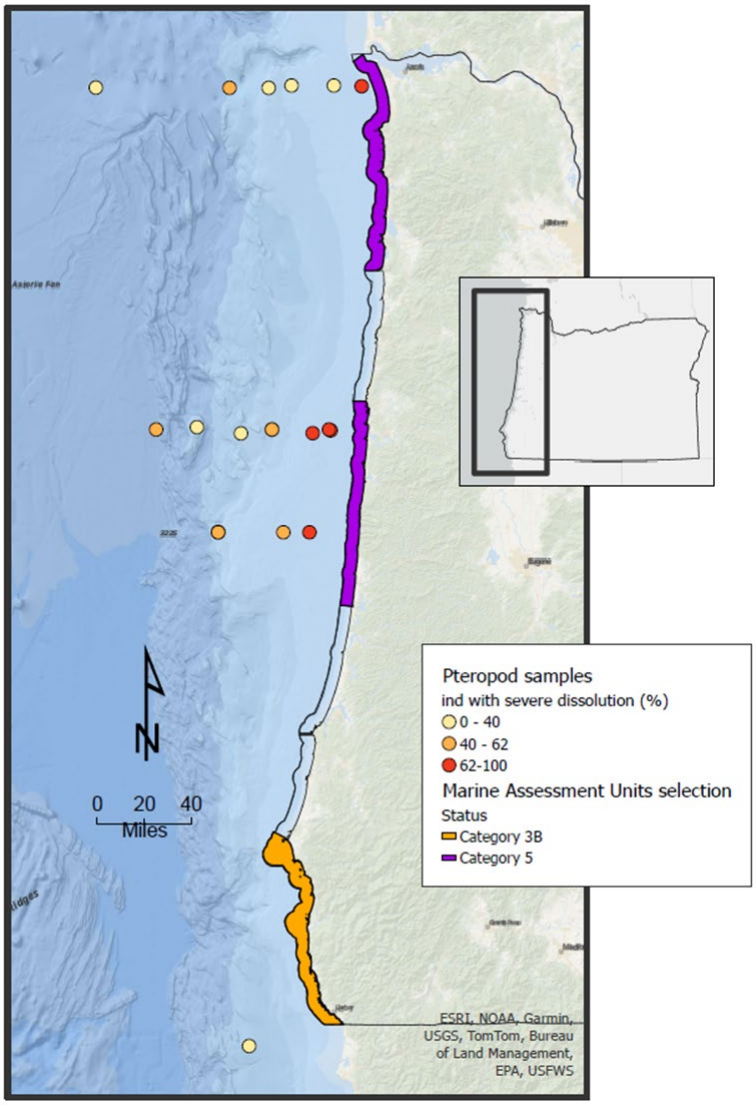

Figure C-17. Within assessment units, purple indicates Category 5 (impaired) status determinations and orange indicates Category 3B status (potential concern) based on the results of the chemical data assessment. Biological pteropod dissolution data collected outside of the Territorial Sea provides additional context to assessment conclusions based on chemical data. Biological data indicates increasin severity of dissolution in nearshore sites and supports status determinations

Appendix D: Marine dissolved oxygen – hypoxia assessment

In the 2018/2020 Integrated Report, DEQ determined that Oregon territorial marine waters should be placed into Category 3B*: insufficient data; potential concern for marine dissolved oxygen where there is insufficient data to determine use support, but some data indicate non-attainment of a criterion.* This action recognized the body of information indicating negative impacts to aquatic life and fisheries from changing ocean conditions while acknowledging there was not a clear pathway to determine nonattainment of the narrative marine dissolved oxygen criteria. Waters remained in this category during the 2022 cycle while DEQ was in the process of convening a technical workgroup to help DEQ integrate impacts related to changing ocean conditions into the Integrated Report process.

In 2022, DEQ formed an Ocean Acidification and Hypoxia technical workgroup to provide assistance in the development of methodology to interpret Oregon's narrative marine DO criteria and biocriteria. The technical workgroup was not a decision-making body, rather it facilitated the sharing of scientific data and information. Information about the technical workgroup process can be found on DEQ's Integrated Report Improvements webpage.

Oregon's narrative marine DO criteria is defined in OAR-340-041-0016:

> *340-041-0016 Dissolved oxygen (DO): No wastes may be discharged and no activities may be conducted that either alone or in combination with other wastes or activities will cause violation of the following standards:*
>
> *(1)…*
>
> *(6) For ocean waters, no measurable reduction in dissolved oxygen concentration may be allowed.*

Marine DO is further classified as "No Risk" in Table 21 of OAR-340-041-0016, which states:

> *The only DO criterion that provides no additional risks is "no change from background". Waterbodies accorded this level of protection include marine waters and waters in Wilderness areas.*

For the 2024 IR report, DEQ has adopted a hybrid assessment framework wherein two lines of evidence are used to assess aquatic life beneficial use support based on the marine DO narrative criteria (**Figure 14**). One line of evidence relies on quantifying measurable reduction by comparing observational data with background conditions established either through long term

observational data sets or modeled conditions. The second line of evidence uses established DO biological impact benchmarks to provide a biological lens to determine whether measurable reduction is likely affecting aquatic life beneficial use support.

Assessment metric

As outlined in the OAH assessment technical support document, a daily 10th percentile metric is used for both lines of evidence in this assessment.

Background conditions assessment

The background conditions assessment line of evidence relies on the comparison of long-term observational data (historical sample) with recent observations at the matching locations (current day sample). The limiting factor with long term observational data is that it is confined to certain parts of Oregon's territorial waters, limiting the extent of this analysis to those locations. Another pathway to determine change from background is to interpolate change based on long term observational data to parts of the territorial sea where those data are not available using modeling. General principles of this approach are outlined in DEQ's methodology document, but tools to carry out this type of analysis were not available for the IR 2024 assessment cycle.

Historical sample data

Long term observational data is available on the Newport Hydrographic Line dating back to the early 1960s, when consistent water column profile measurements were recorded over a ten year period, commonly referred to as the "TENOC" period (Ten Years of Oceanography, 1961-1972).[110] During this period, the Office of Naval Research funded the routine oceanographic monitoring the NH line, providing a valuable baseline dataset from which to evaluate changing ocean conditions.[111] For this assessment, data from the TENOC period was queried from the World Ocean Database based on NH line coordinates, seasonal critical assessment period (May-Sept), and the primary research vessels active during that time (R/V Acona & R/V Yaquina). Data quality flags were included in the export, and only "accepted" dissolved oxygen values were included in the assessment. Data from NH1, NH3, and NH5 stations were included in the analysis, limiting the background condition assessment based on long term observational data to one of the six delineated marine assessment units. During the TEONOC period, 53 profile

[110] Huyer, A., Wheeler, P. A., Strub, P. T., Smith, R. L., Letelier, R., & Kosro, P. M. (2007). The Newport line off Oregon–Studies in the north east Pacific. Progress in Oceanography, 75(2), 126-160. https://doi.org/10.1016/j.pocean.2007.08.003

[111] Pierce, S. D., Barth, J. A., Shearman, R. K., & Erofeev, A. Y. (2012). Declining oxygen in the Northeast Pacific. Journal of Physical Oceanography, 42(3), 495-501. https://doi.org/10.1175/JPO-D-11-0170.1

casts were identified between May and August during the 1962-1972 period **(Figure D-18A**). Daily 10th percentile values were calculated from each profile cast, generating 53 daily statistics for the historical sample.

Current sample data - IR 2024 period

Recent profile observations from the NH line were submitted to DEQ during the 2022 integrated reporting cycle dating back to the late 1990s. For the IR 2024 assessment, a 20-year lookback (2002-2022) was used to determine the IR 2024 "current day" data sample, identifying 248 profile casts at the NH1 and NH3 stations **(Figure D-18B**) between May-Aug during those years. Daily 10th percentile values were taken from each profile cast, generating 248 daily statistics in the IR 2024 current day sample.

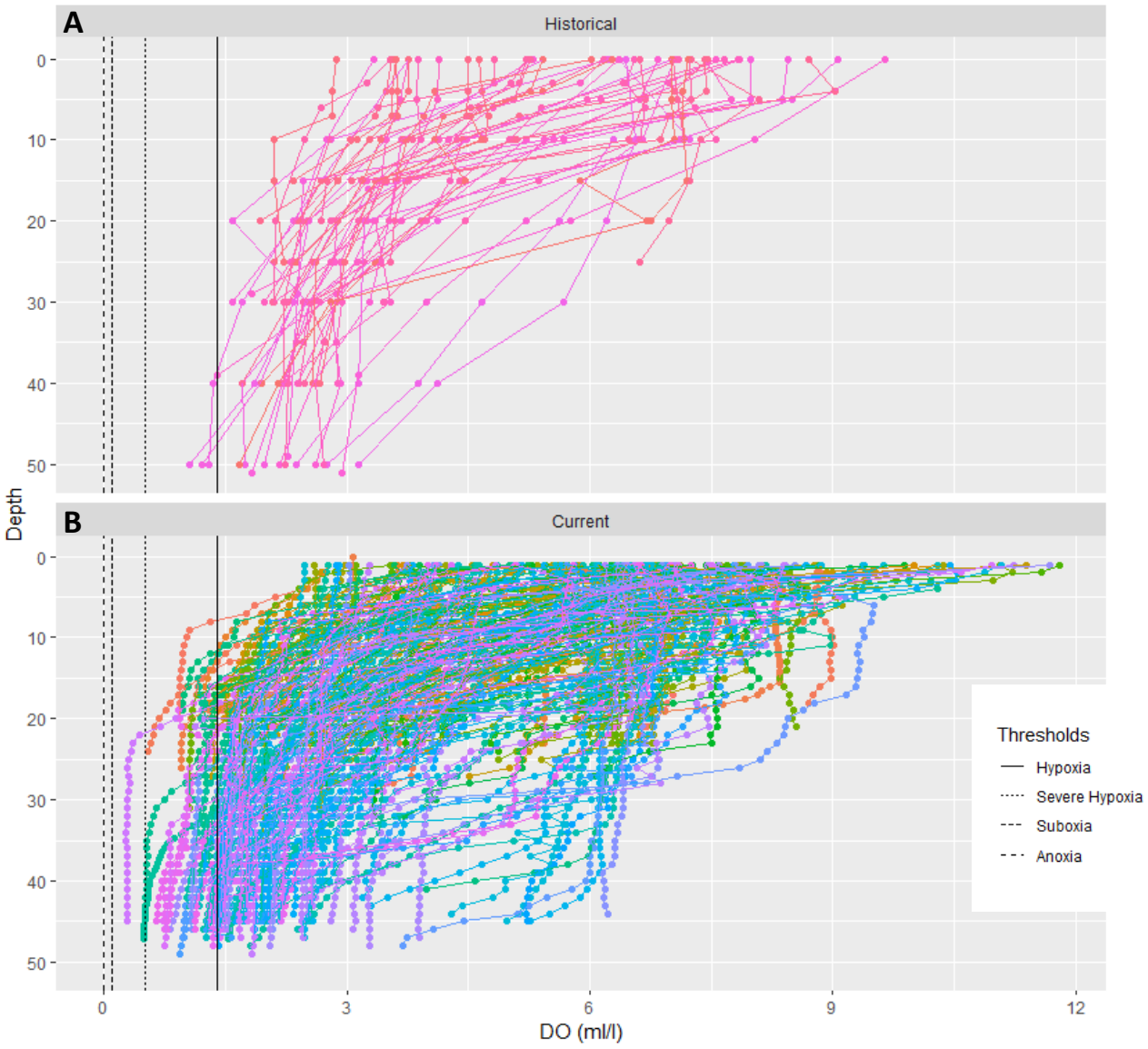

Figure D-18. (A) 53 profile casts during the TEONOC period (1962-1972) were used to generate the historical sample. (B) 248 profile casts between 2002-2022 comprise the current period sample

Assessing deviation from background based on observational data

Visual inspection of plotted daily 10th percentiles of the historical and current day samples suggests a clear difference between the two periods **(Figure D-19)**. Statistical comparison of the two groups provides confirmation that the current day sample is less than the historical sample based on a one-sided Wilcoxon rank-sum test (W=5119, p=0.0059), a non-parametric comparison of two independent samples. Based on this comparison of observational data, DEQ finds a clear deviation from background in the assessment unit (OR_OC_9999999999_01_107285), signifying a measurable reduction in dissolve oxygen.

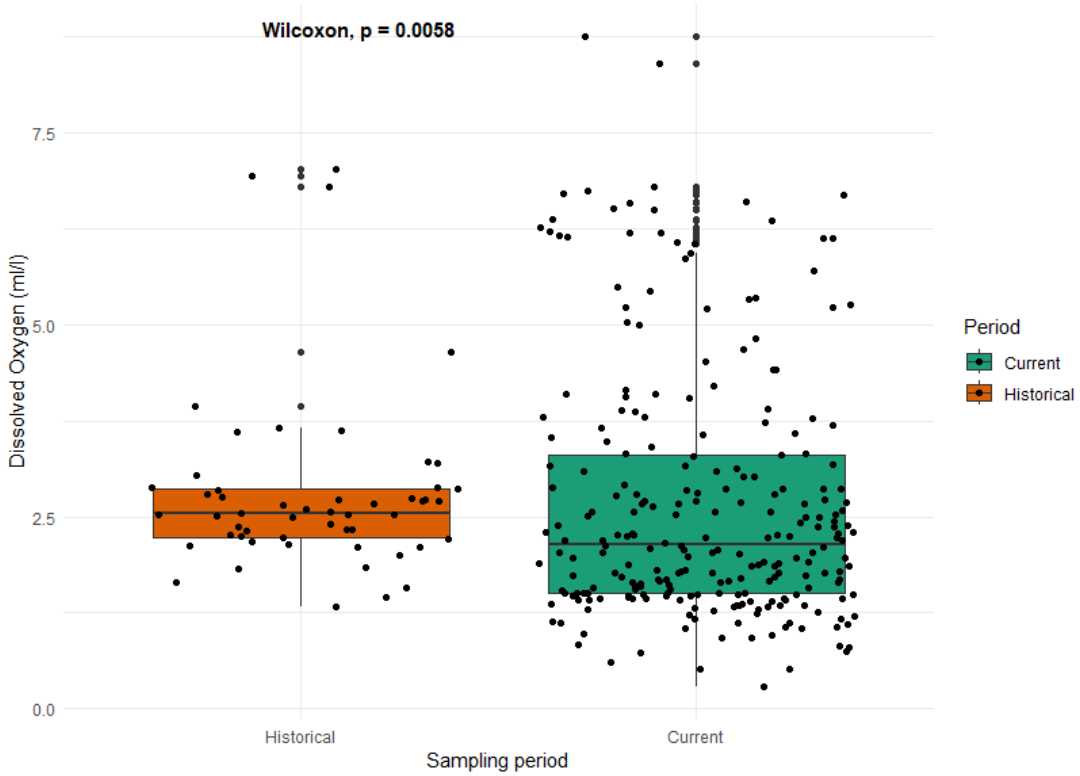

Figure D-19. Boxplots illustrating the non-parametric comparison of daily 10th percentiles between the historical and current day samples on the Newport Hydrographic Line

Pacific decadal oscillation and the Oceanic Nino index are two climate and atmospheric indicators commonly used to describe and predict biological conditions in the northern California Current.[112,113] Each index fluctuates between warm and cold phases depending on the sign of sea surface temperature anomalies along in the pacific coast of North America (for PDO) and equatorial waters (for ONI).[3,4] Relationships between these oscillations and ocean conditions and biological responses in the Eastern Pacific is well documented, so the potential impact of this natural variability should be considered when comparing data from two time periods decades apart.[114,115] In this instance, since the current and historical periods each spanned more than 10 years and comprised a nearly balanced representation of warm and cold phases during the assessment periods (**Figure D-20**), the relative influence of these two processes on the data was not investigated further.

[112] Pacific Decadal Oscillation (PDO) | National Centers for Environmental Information (NCEI) (noaa.gov)
[113] Climate Variability: Oceanic Niño Index | NOAA Climate.gov
[114] Chavez, F. P., Ryan, J., Lluch-Cota, S. E., & Ñiquen C, M. (2003). From anchovies to sardines and back: multidecadal change in the Pacific Ocean. science, 299(5604), 217-221. https://doi.org/10.1126/science.1075880
[115] Chavez, F. P., Pennington, J. T., Michisaki, R. P., Blum, M., Chavez, G. M., Friederich, J., ... & Messié, M. (2017). Climate variability and change: response of a coastal ocean ecosystem. Oceanography, 30(4), 128-145.

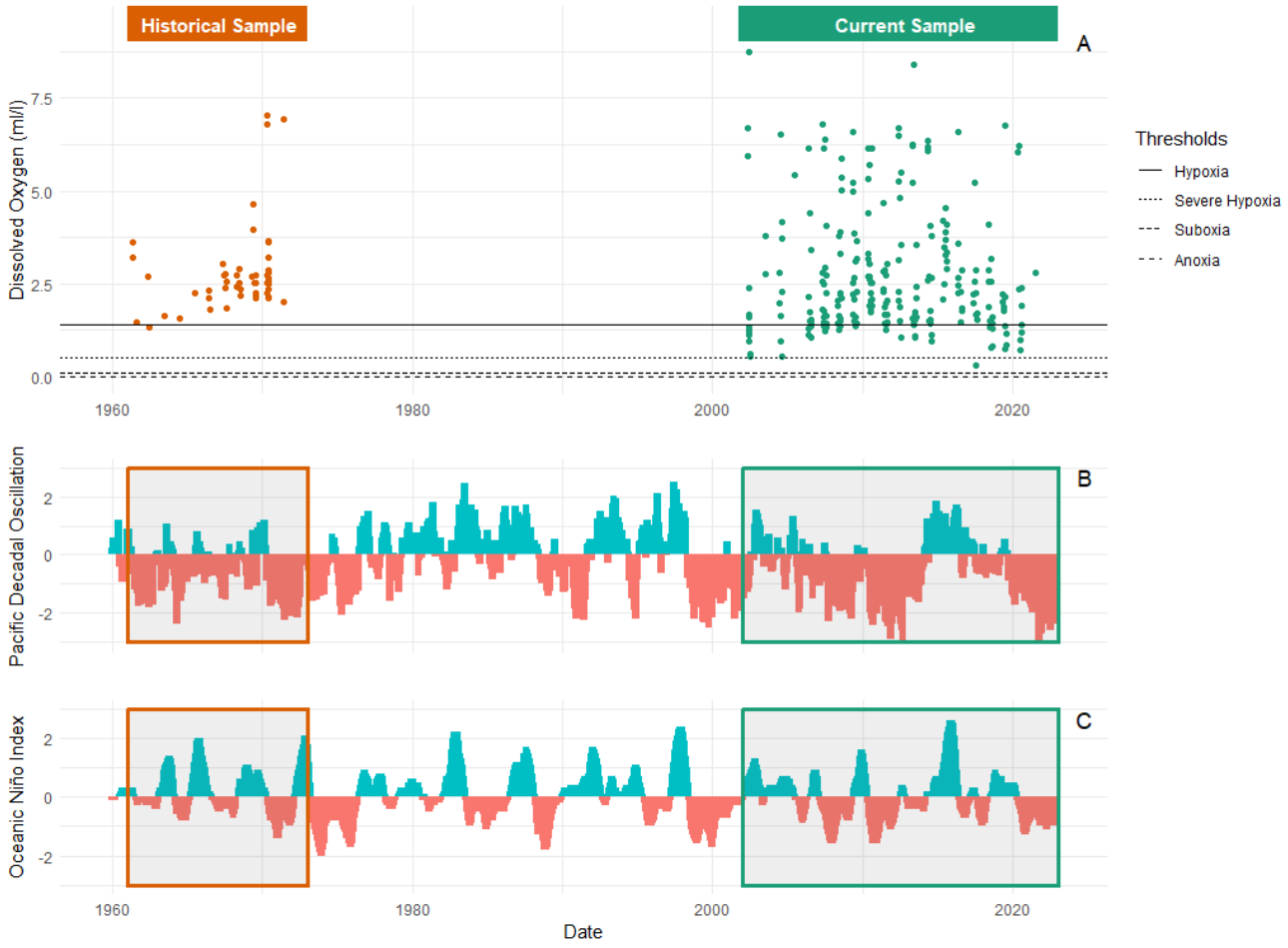

Figure D-20. Time series of Historical and Current Day samples plotted alongside Pacific Decadal Oscillation and Oceanic Nino Index time series show relatively similar instances of warm and cold phases between the two samples

Benchmark assessment

As outlined in detail in DEQ's OAH Assessment Technical Support Document, the benchmark assessment line of evidence relies on the comparison of observational data within the IR assessment window to the dissolved oxygen biological impact benchmark indicating hypoxia (1.4 ml/l). Daily 10th percentile values are used to assess this benchmark, allowing for the use of continuous and profile data. DEQ received two submissions of continuous data. One dataset from the Ocean Observatories Initiative's Oregon Inshore Surface Mooring in its Coastal Endurance Array situated off the coast from Newport.[116] Another continuous dataset was submitted from a collaborative monitoring effort between Oregon Department of Fish and Wildlife and Oregon State University, consisting of seasonal moorings at two depths in and

[116] CE01ISSM - Ocean Observatories Initiative

around Oregon's marine reserves.[117] These submissions joined existing long term profile data from the Newport Hydrographic Line, provided during DEQ's 2022 IR reporting cycle, already in DEQ's AWQMS database. Data used in this assessment cycle spanned a 10 year look back and consisted of 3,406 daily 10th percentile values (**Figure D-21**).

Figure D-21. Time series of 3,406 daily 10th percentile values used in the 2024 marine dissolved oxygen benchmark assessment line of evidence

Daily 10th percentile metrics were calculated for profile and mooring data within each assessment unit. Of the six ocean AUs, four met the minimum data requirement of five daily metrics within the assessment window of May-September (**Table D-23**). All four AUs that met the minimum data requirements were found to be below the biological impact benchmark of 1.4 ml/l DO according to the binomial table for conventional pollutants.

[117] Ecological Monitoring - Oregon Marine Reserves

Table D-23. Data availability, excursion breakdown, and status within designated assessment units for the benchmark assessment line of evidence

Assessment Unit Description (ID)	Data Type	n (10th percentiles)	Count of Excursions	Binomial Critical Number	Result
WA border - Cape Lookout (OR_OC_9999999999_01_107283)	Mooring	607	80	71	Below benchmark
	Profile	9	0	2	
Cape Lookout – Cape Foulweather (OR_OC_9999999999_01_107284)	Mooring	271	64	35	Below benchmark
	Profile	1	0	2	
Cape Foulweather – Siltcoos River (OR_OC_9999999999_01_107285)	Mooring	2097	588	228	Below benchmark
	Profile	154	23	21	
Siltcoos River - Cape Arago (OR_OC_9999999999_01_107286)	Mooring	0	0	0	Insufficient data
	Profile	2	0	2	
Cape Arago - Cape Blanco (OR_OC_9999999999_01_107287)	Mooring	0	0	0	Insufficient data
	Profile	1	0	2	
Cape Blanco - CA border (OR_OC_9999999999_01_107288)	Mooring	242	42	31	Below benchmark
	Profile	6	0	2	

Conclusions – marine dissolved oxygen

In applying the marine dissolved oxygen hybrid assessment framework (**Figure 14)** using the data and tools available for the 2024 assessment, DEQ's assessment team has developed a list of assessment conclusions. In this framework, an impairment determination relies on multiple lines of evidence, and in this assessment, we found there was sufficient data to assess both lines of evidence in one assessment unit, and sufficient data to assess a single line of evidence in four assessment units (**Table D-24**).

Table D-24. Conclusions of the marine dissolved oxygen hypoxia assessment are based on two lines of evidence

Assessment Unit Description (ID)	Line of Evidence	Results	Status
WA border - Cape Lookout (OR_OC_9999999999_01_107283)	Benchmark	Below benchmark	Category 3B (potential concern)
	Background conditions	Insufficient data	
Cape Lookout – Cape Foulweather (OR_OC_9999999999_01_107284)	Benchmark	Below benchmark	Category 3B (potential concern)
	Background conditions	Insufficient data	
Cape Foulweather - Siltcoos (OR_OC_9999999999_01_107285)	Benchmark	Below benchmark	**Category 5 (Impaired)**
	Background conditions	Deviation from background	
Siltcoos - Cape Arago (OR_OC_9999999999_01_107286)	Benchmark	Insufficient data	Category 3 (insufficient data)
	Background conditions	Insufficient data	
Cape Arago - Cape Blanco (OR_OC_9999999999_01_107287)	Benchmark	Insufficient data	Category 3 (insufficient data)
	Background conditions	Insufficient data	
Cape Blanco - CA border (OR_OC_9999999999_01_107288)	Benchmark	Below benchmark	Category 3B (potential concern)
	Background conditions	Insufficient data	

Appendix E: Aquatic trash water quality assessment

2024 Willamette Riverkeeper aquatic trash data submittal

During the 2024 Integrated Report Call for Data, Willamette Riverkeeper (WRK) submitted numeric aquatic trash data, photographic evidence and information from river trash cleanup events conducted in the past five years throughout the Willamette River Basin. The stated purpose of submittal is for DEQ to identify the Willamette River as impaired for trash pollution (add to the 303(d) list), due to an increasing trash crisis in the basin. The submittal included:

- Project Plan and explanation of the beneficial uses impaired by aquatic trash
- Numeric data tabulating the volume of aquatic trash removed from clean up events with reach length coordinates
- Photographs from some of the trash cleanups Willamette Riverkeeper has conducted from 2018-2022 with coordinates
- Willamette Riverkeeper's 2022 Petition for Rulemaking which provides a narrative explanation of the trash issues in the basin

The submitted project plan includes documentation of purpose statement, collection methods, sample size, quality assurance and control protocols which meets the requirements of DEQ's 2024 Integrated Report Call for Data Submission Guidelines. At this time, there are no widely approved collections methods for quantifying trash in waterbodies, so the WRK project plan included documentation of how the reporting metric was calculated using a standard truck bed size to derive cubic yards of aquatic trash removed. Clean up events, reported at a reach length scale, were said to have taken place on water (by boat), riverbanks and riparian areas. Aquatic trash collection included large debris to small "micro-trash" such as bottle caps and small pieces of plastic. In total WRK provided numeric data for 264 clean up events conducted between 1/1/2018 and 12/31/2022 (DEQ's 2024 IR data window) on the Willamette River and some tributaries. It is noted that not all clean up events that occurred in the lower Willamette River during this time period contained sufficient documentation to be included in the data submission.

DEQ's 2024 data submission guidelines requests that data and information submitted for evaluation of parameters without current assessment methodologies, include a reference to the beneficial use that is being impacted. In the project plan, WRK provided reasoning that all

thirteen designated beneficial uses on the Willamette River are being impaired by the increasing amount of aquatic trash seen on reoccurring clean up events.

Assessment of WRK aquatic trash data submission

DEQ reviewed the project plan, numeric data and information on aquatic trash clean up events submitted by WRK and concluded it met all elements outlined in DEQ's data submission guidelines and is of sufficient quality for use in the 2024 Integrated Report. The Assessment Methodology for Oregon's 2024 Integrated Report does not have a specific methodology for evaluating the impacts of aquatic trash on designated beneficial uses. Due to the submission of high-quality aquatic trash data, the fact that EPA's 2024 IR guidance memo contains a section on trash related impairments, and the federal CWA requirement to use all readily available data; DEQ is proposing to assess these data using the concept of overwhelming evidence. This concept, defined in the **Overwhelming evidence** section of this document, states that credible and compelling information indicating waters are not attaining applicable water quality standards can be used to determine impairment with multiple lines of evidence based on a specific rationale.

In assessing the data and information submitted by WRK, DEQ used the following rationale to define overwhelming evidence of impairment.

- **Water Quality Standard** = Statewide Narrative Criteria- 340-041-0007 (13) *Prohibitions on aesthetic conditions offensive to human senses*
- **Affected Beneficial Uses** = Aesthetic Quality, Water Contact Recreation
- **Lines of evidence (must meet all at the Assessment Unit Level)**
    - Numeric clean up event data summarized by assessment unit
        - Magnitude = total amount of aquatic trash removed is substantial
        - Duration = multiple clean up events in the data window
        - Frequency = greater than two events in one year separated by one or more months with least 1 cubic yard of trash removed per event
    - Geo-referenced photographs of aquatic trash in water or wetted bank within the assessment unit

DEQ narrowed the affected beneficial uses from those proposed by WRK because there was not sufficient evidence in the data submitted to link the impact of aquatic trash to all uses. DEQ concluded there was sufficient evidence in the submittal to show impacts to aesthetic quality and water contact recreation. Overwhelming evidence of impairment in this assessment was considered based on two lines of evidence within each assessment unit: (1) Geo-referenced photographs demonstrating impacts to beneficial uses and (2) numeric data summarizing clean up event metrics. The evaluation of numeric data in this case was guided by the core water quality principles of magnitude, duration, and frequency. For the purposes of this assessment, DEQ considered an assessment unit impaired when the total amount of aquatic trash removed was substantial when compared to other AUs in the submission (magnitude), multiple collection events took place during the data window (duration), and with at least two events occurring at the same location within the same year with a minimum of 1 cubic yard per event (frequency). It should be noted that this is the only submittal related to assessing aquatic trash that DEQ has received to date. As such, DEQ's evaluation of numeric data is specific to overwhelming evidence in this submittal and should not be considered an update to DEQ's assessment methodology document. The photographic evidence provides a critical second line of evidence to visualize to impacts on the beneficial uses. As WRK stated in the project plan, needles and broken glass are direct signs of impact to recreation, but the visual perception of trash in waterbodies, takes away the appeal to use these the waterbody for recreating.

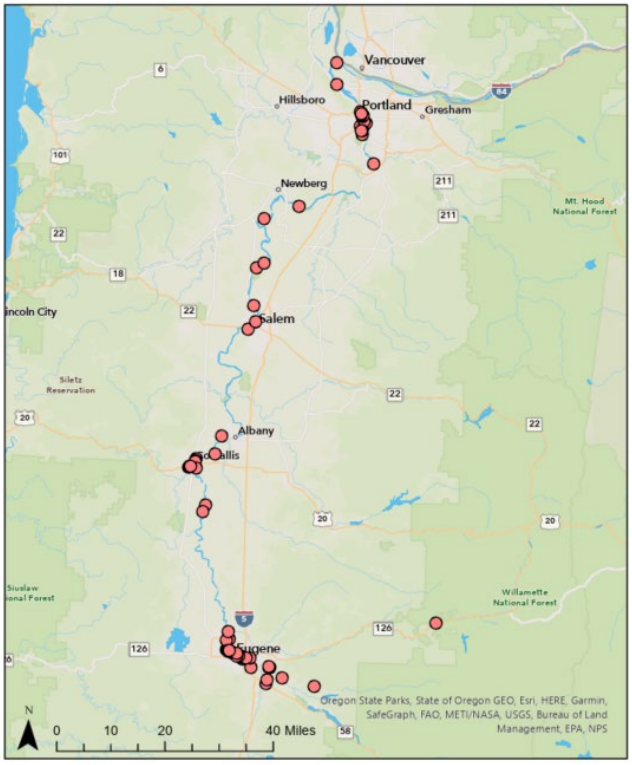

Figure E-22. Map of beginning coordinates for submitted clean up events

DEQ formatted, plotted, and reviewed reach scale coordinates for each clean up event with a reported metric of volume of trash removed. DEQ validated 239 of the 264 events submitted for use in the 2024 assessment (**Figure E-22**). Events were rejected if the location could not be confirmed, multiple beginning coordinates that spanned multiple assessment units were provided for one event and volume of trash removed could not be parsed or coordinates plot on land and DEQ couldn't confirm event took place in water. For validated clean up events, assessment unit id was assigned using the beginning coordinates. If the event spanned multiple

assessment units, the end coordinates were evaluated to determine the appropriate assessment unit.

2024 aquatic trash assessment rationale for assessment conclusions

The WRK submission included validated numeric data from 239 river clean up events in 11 assessment units in the Willamette River basin (**Figure E-22**). Numeric results were summarized at the AU level and the first line of evidence rationale for overwhelming evidence was applied. The georeferenced photographs were summarized by AU as a second line of evidence. While many photographs were submitted, only those that showed aquatic trash in the water or wetted back were used as evidence of impact to beneficial uses. After reviewing the numeric data and the photographs, DEQ is proposing to identify three assessment units as impaired (Category 5) for Aesthetic Quality, Water Contact Recreation use support based on overwhelming evidence of impact of the total volume removed, number of clean up events that took place and the recurrence of large amounts removed at each event. Five assessment units met two out of the four rationales for overwhelming evidence and are proposed in Category 3B - insufficient data; potential concern: Insufficient to determine use support but some data indicate non-attainment of a criterion. The remaining three assessment units with numeric data did not meet any of the four rationales and are proposed to be placed in Category 3 - Insufficient data to determine whether a designated use is supported for trash related impacts. **Table E-25** and **Figure E-23**. show these assessment conclusions. Raw numeric data on the submitted clean up events and photographic evidence used is available on the online database.

Figure E-23. Map showing assessment unit status for aquatic trash. Impaired units are shown in purple and units with insufficien data are shown in yellow

Table E-25. Assessment conclusions for aquatic trash

AU_ID	AU_Name	AU_Description	Magnitude (Total volume of trash removed (yards))	Duration (Total number of clean up events in the data window)	Frequency (At least two events in one year separated by one or more months)	Photo Evidence	Assessment Category
OR_SR_1709000306_05_103854	Willamette River	confluence of Middle Fork Willamette River and Coast Fork Willamette River to Luckiamute River	549.25	145	Yes - each year has multiple events separated by a month	Yes	Category 5
OR_SR_1709001202_88_104175	Willamette River	Johnson Creek to confluence with Columbia River	168.5	42	Yes - 2021 and 2022 have multiple events in different months	Yes	Category 5
OR_SR_1709000302_02_103812	Marys River	Muddy Creek to confluence with Willamette River	130.5	14	Yes - three years with multiple this of repeated events	Yes	Category 5
OR_SR_1709000703_04_104013	Willamette River	Willamette Slough to Chehalem Creek	63.5	19	Yes - 2021 and 2022 have multiple events in different months	No	Category 3B
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Fall Creek to confluence with Willamette River	16	8	Yes - 2021 and 2022 have multiple events in different months	No	Category 3B

AU_ID	AU_Name	AU_Description	Magnitude (Total volume of trash removed (yards))	Duration (Total number of clean up events in the data window)	Frequency (At least two events in one year separated by one or more months)	Photo Evidence	Assessment Category
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Christy Creek to confluence with Middle Fork Willamette River	11	3	Yes - Two events in 2022, one in spring one in fall	No	Category 3B
OR_SR_1709000204_02_103787	Coast Fork Willamette River	Row River to confluence with Willamette River	11	2	Yes - Two events in 2022	No	Category 3B
OR_SR_1709000104_02_103719	Salmon Creek	Black Creek to confluence with Middle Fork Willamette River	9	2	No - only two events in the data window	Yes	Category 3B
OR_SR_1709000703_05_104014	Willamette River	Rickreall Creek to Willamette Slough	2.5	1	no	No	Category 3
OR_WS_170900030601_02_104287	HUC12 Name: Sring Creek-Willamette River	Watershed Assessment Unit	1	1	no	No	Category 3
OR_SR_1709000703_88_104015	Willamette River	Chehalem Creek to Champoeg Creek	0.5	1	no	No	Category 3

TMDL Priority Ranking for proposed impaired assessment units

Waterbodies identified as impaired for a particular parameter on the 303(d) list, must include a priority ranking for total maximum daily load development prior to submittal to EPA. As required by 40 CFR 130.7, DEQ considers the severity of pollution and the uses to be made of the impaired waters in determining TMDL rankings. DEQ also considered other critical factors, such as court-ordered timelines, resource constraints and age of listings, to propose ranking assessment units with new aquatic trash-related impairments as low priority.

By identifying the issue of trash as pollution to be regulated under the Clean Water Act, DEQ's goal is to begin to work collaboratively with local communities on pollution prevention across water, land and social programs, which all have important roles in addressing this issue.

Appendix F: Water contact recreation assessment

Methodology updates

For the 2024 Integrated Report, DEQ implemented new assessment methodology updates for water contact recreation. The first element of the updates allow enterococcus to be used as the bacteria indicator in small streams that cross the beach when no e. coli data is available. The second update is the application of the binomial test to evaluate the enterococcus threshold value. This appendix describes the evaluation of coastal areas where these methodology updates to the bacteria indicator in small streams was applied.

Monitoring location review

Monitoring locations with enterococcus data were evaluated to confirm the assessment unit assignment was associated with the correct waterbody. Generally, monitoring locations from ocean waters, stream mouths in the tidal areas and end of pipes draining onto the beach were assigned to the coastline assessment unit, and locations on small stream out of the tidal area were assigned to the applicable flowline. If a monitoring location also had e. coli data and was assigned to a river and stream assessment unit, the enterococcus data was not used. Estuary were assessed according to the bacterial indicator defined in rule.

In total DEQ assessed 265 additional results, from eight monitoring locations for due to this methodology update (**Table F-26**).

Table F-26. List of assessment units where enterococcus was used the bacteria indicator to evaluate freshwater

MLocID	Station Description	AU_ID	Bacteria Indicator
30890-ORDEQ	Watseco Creek 100 m upstream from the mouth	OR_SR_1710020309_05_105941	enterococcus
34726-ORDEQ	Big Creek at Agate Beach Wayside at footbridge	OR_SR_1710020409_02_106000	enterococcus
11253-ORDEQ	Spencer Creek at Beverly Beach at Hwy 101 bridge	OR_SR_1710020409_02_106001	enterococcus
30750-ORDEQ	Hubbard Cr between Hwy 101 and Beach	OR_SR_1710030604_02_104635	enterococcus

MLocID	Station Description	AU_ID	Bacteria Indicator
37257-ORDEQ	Chisana Creek 40m west of Highway 101 u/s of Wayside Inn	OR_WS_171002010105_05_106216; Chisana Creek	enterococcus
37266-ORDEQ	Chisana Creek trib. ditch u/s of residences at E. Warren Way and unnamed rd. jct. at clear cut	OR_WS_171002010105_05_106216; Chisana Creek	enterococcus
37260-ORDEQ	Gower Street creek SE of Hwy. 101 u/s of secondary drainage pipe	OR_WS_171002010105_05_106216; Unnamed Trib to Cannon Beach	enterococcus
37262-ORDEQ	Gower Street creek from culvert to ditch at E. Dawes and Cypress Ct.	OR_WS_171002010105_05_106216; Unnamed Trib to Cannon Beach	enterococcus