Methodology for Oregon's 2022 Water Quality Report and List of Water Quality Limited Waters

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

By: Water Quality Assessment Program
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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

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Table of Contents

List of Tables

List of Figures

1. 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 (TMDLs) for the identified waters. TMDLs describe the amount of each pollutant a water body can receive and not violate water quality standards. States submit the list of waters needing TMDLs (303(d) list) to EPA and EPA either approves or disapproves the list within thirty days after the submission.

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.[1] 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. Oregon DEQ submits its report to the EPA through the ATTAINS[2] database.

EPA regulations require states to describe the methodology data, and information 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 evaluation process 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 before the Oregon Environmental Quality Commission; and (4) provide an opportunity for public comment on the draft assessment methodologies during the EQC meeting.

This document, Methodology for Oregon's 2022 Water Quality Report and List of Water Quality Limited Waters, describes how DEQ will develop Oregon's 2022 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 2022 Integrated Report incorporates, updates, and supplements 303(d) lists from previous assessment years. After approval by EPA, it will become Oregon's effective 303(d) list.

[1] Oct. 12, 2006, Memorandum from Diane Regas, EPA Office of Wetlands, Oceans and Watershed Re: Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/2006_10_27_tmdl_2008_ir_memorandum.pdf

[2] https://www.epa.gov/waterdata/attains

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

- EPA approved Oregon's 2018/2020 303(d) list on Nov. 12, 2020
- EPA promulgated aquatic life aluminum criteria for Oregon that became effective on April 19, 2021.

2. Oregon's Water Quality Standards

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. Oregon's water quality standards are adopted in Oregon Administrative Rules (OAR) Chapter 340 Division 41[3]. 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 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 water quality limited 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

[3] https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=68695

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 Section IV. Assessment Protocols for Specific Pollutant or Parameters Assessment Protocols for Specific Pollutants or Parameters in this document.

Table 1. Oregon's designated beneficial uses for surface water and criteria assessed

Designated Beneficial Uses		Criteria Protecting Beneficial Use	
Designated Use[4]	**Use Subcategory[5]**	**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
	Fish Use - Salmon and Steelhead Spawning		Dissolved oxygen Temperature

[4] 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.

[5] 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[4]	**Use Subcategory[5]**	**Narrative Criteria**	**Parameter Numeric Criteria**
	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 340-041-0340, Figure 1, and Tables 101A through 340A, Figure 101A, Figures 220C through 220H, Figures 230C through 230H, Figures 300C, 300D, and 320C, Tables 101B through 250B, Figures 130A through 340B, and additional factors affecting the application of specific criteria described in OAR 340-041, are depicted in a web-based GIS mapping application[6].

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, not officially adopted into rule by the EQC.

[6] https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=e8af23efa28b44f39355008e8e9c784b

3. 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 Integrated Report process is complete when DEQ receives approval from EPA on the final list of water quality limited waters requiring a TMDL (Category 5: 303(d) list).

3.1. 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 for the Integrated Report 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 Oregon's Integrated Report.

3.2. Assembling data and information

To gather information on water quality for Oregon's Integrated Report, DEQ assembles all available internal data, conducts a data query from publically available state and federal databases and issues a public call for data (Table 2). All data and information is reviewed by DEQ to determine completeness (required metadata elements) and data quality requirements. The process of assembling data and information for the Integrated Report is described in more detail in the following sections.

Table 2. Data sources for 2022 Integrated Report

Data Source	Data Types	Data Quality Requirements
Oregon DEQ	Grab, Continuous, Biological	Data Quality Levels A and B
DEQ Volunteer Monitoring Program	Grab, Continuous, Biological	Data Quality Levels A and B
Water Quality Portal (EPA, USGS, Tribes, other federal sources)	Grab	Complete metadata, sampling plan, approved methods and passes validation[7]
NWIS (USGS)	Continuous	Complete metadata, sampling plan, approved methods and passes validation[7]
Call for Data	Grab, Continuous, Biological	Complete metadata, sampling plan, approved methods and passes validation[7]
Washington Department of Ecology (Columbia River)	Grab, Continuous	Complete metadata, sampling plan, approved methods and passes validation[7]
Oregon Public Health Advisories for Recreation (Harmful Algal Blooms, Fish Consumption Advisories, Shellfish and Beach Use)	Location and supporting data	N/A
City of Portland	Continuous	Complete metadata, sampling plan, approved methods and passes validation[7]

[7] http://www.oregon.gov/deq/FilterDocs/irimphighqualitydata.pdf

Oregon Water Resources Department	Continuous	Complete metadata, sampling plan, approved methods and passes validation[7]
Portland Harbor Environmenatal Data Portal	Grab	Complete metadata, sampling plan, approved methods and passes validation[7]

3.2.1. Data window

The assessment window for Oregon's 2022 Integrated Report includes data collected in calendar years 2016 through 2020 (Jan. 1, 2016 to Dec. 31, 2020).

3.2.2. Call for data

DEQ issued a public call for data for the Integrated 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 general public 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 waterbody-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 will be put into consideration for the next assessment/listing cycle. Anecdotal information, in the absence of chemical, physical, or biological data, will not in and of itself be adequate to support a listing decision.

Detailed data submittal information is specified in *Oregon's 2022 Integrated Report Call for Data Submission Guidelines*[8].

3.2.3. 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 sources. Required metadata are listed below. Missing or incomplete metadata may make data unusable for the Integrated Report.

- Location of each monitoring station in latitude and longitude and the reference datum (example – NAD83).
- Waterbody name and description of the monitoring location.
- Date the sample was taken.
- Parameter(s) measured.
- Measured result for each parameter.

[8] https://www.oregon.gov/deq/wq/Pages/irCallforData.aspx

- Unit of measurement.
- Method used for measurement, including method detection limits (MDL) or reporting limits (RL) where applicable.
- Name and contact information of the entity submitting the data.

3.2.4. QA/QC 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[9]. Analytical or laboratory analyzed data are assigned data quality levels based on quality control and assurance protocols and internal data review. Data submitted through the call for data and queried from outside 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). 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/or 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 and/or the QC limits established by the laboratory that performed the testing and supplied the data to DEQ. DEQ also utilized EPA National Functional Guidelines for Data Review as guidance when reviewing laboratory data[10].

3.3. 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 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.

3.3.1. Assessment categories

EPA continues to recommend using five reporting categories as shown in Table 3 to classify water quality status for Oregon waters.[8] 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.[9] Each water quality standard is evaluated independently and a category is

[9] March 2009, http://www.oregon.gov/deq/FilterDocs/DataQualMatrix.pdf
[10] https://www.epa.gov/clp/superfund-clp-national-functional-guidelines-data-review
[11] 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) https://www.epa.gov/sites/production/files/2015-10/documents/2006irg-report.pdf

assigned for each assessment unit where sufficient data are available. 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 1 summarizes DEQ's general process for assigning assessment categories to describe the status of Oregon waters.

Table 3. Assessment categories

Category	Description
Category 1	All designated uses are supported. (Oregon does not use this category.)
Category 2	Available data and information indicate that some 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.[11] **3C: insufficient data; non-reference condition:** Biocriteria scores differ from reference condition, but are not classified as impaired.[12] **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 to address the pollutant cause. This includes:
	4A: TMDLs that will result in attainment of water quality standards and beneficial use support have been approved.
	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.

*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.

USEPA's supporting regulations recognize that alternative pollution control requirements may obviate 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 (USEPA 2005a, 2006). These alternatives to TMDLs are commonly referred to as "Category 4b" waters, as described in USEPA's Integrated Reporting Guidance (IRG) for Sections 303(d), 305(b), and 314 of

[12] Oregon is proposing to use subcategory Category 3C: Insufficient data; Potential Concern to identify waters whose biocriteria O/E scores deviate from reference conditions but are not classified as impaired.

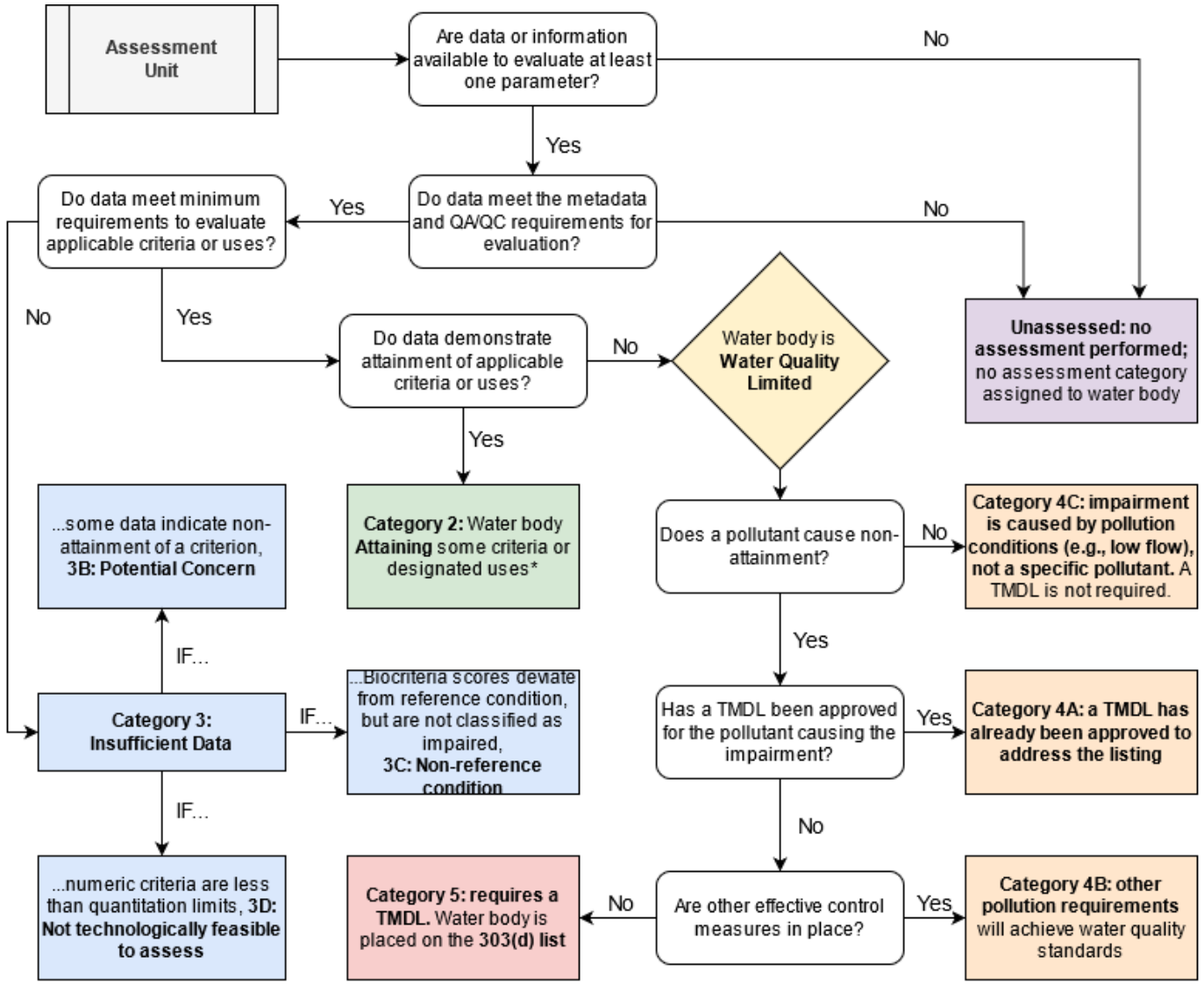
the CWA (USEPA 2005a, 2006)[13].

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 USEPA for the affected waterbody to be placed in Category 4B. In the event that a Category 4B plan is not accepted, the waterbody at issue will be included on the 303(d) List, as Category 5. The USEPA 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.

DEQ will include a rationale that supports their conclusion that there are "other pollution control requirements" stringent enough to achieve applicable water quality standards within a reasonable period of time with its Integrated Report submission. The rationale should address the following six elements:

1. Identification of segment 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

[13] https://www.epa.gov/sites/default/files/2018-09/documents/attains_calculations_of_epa_ir_categories_2018-08-31.pdf



*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 1. Assigning assessment categories for the 2022 Integrated Report

***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 assess all designated uses and water quality standards:**

3.3.2. Evaluating data and information

To characterize conditions in Oregon waters, DEQ assembles water quality data and information available from monitoring sites 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 Section IV Assessment Protocols by Pollutant or Parameter.

To determine where freshwater and saltwater criteria apply, DEQ follows Oregon rules and EPA guidance.[14] 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." DEQ follows EPA recommendations to use saltwater criteria for marine waters where the salinity is equal to or greater than 10 parts per thousand (approximately equivalent to conductivity 20,000 uS/cm) and use the more stringent of freshwater or saltwater aquatic life toxics criteria in estuarine waters where salinity is between 1 and 10 parts per thousand.[15]

As part of the site data review, DEQ confirms that site location information and analytical data results are complete, accurate, and appropriate for evaluation. Correct site location information is critical in order to assign the monitoring site to the correct assessment unit which determines what water quality standards are applicable, and dictates the 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:

- Are fixed locations
- May contain multiple monitoring stations
- Will be assigned one category determination for each assessment unit for each applicable beneficial use

3.3.3. Assessment units

DEQ created Assessment Units, which partition the state's waterbodies (streams, river, lakes, estuaries, etc.) into manageable units for assessment and reporting purposes. DEQ used the High Resolution National Hydrography (NHDH) framework (1:24,000 resolution) to create assessment unit breaks, and the assessment units are fixed units and remain the same over Integrated Reporting cycles. DEQ portioned Oregon's waterbodies into five types of assessment units as described below.

Figure 2 illustrates Oregon's different types of assessment units. The large polygons along Oregon's coast represent ocean assessment units. Moving inland, the green waterbody represents an estuary segment.

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

[15] Monitoring data are more commonly collected for conductivity. An example conversion is: Salinity 0.1 parts per thousand = 200 micro-Siemens/cm conductivity at 20°C. See general equation and table in Weyl, Peter K., (1964), On The Change In Electrical Conductance Of Seawater With Temperature. Limnology and Oceanography, Vol. 9, Issue 1, pp. 75-78. doi: 10.4319/lo.1964.9.1.0075.

Dark red and purple lines correspond to river/stream assessment units. The small flow lines encompassed within the dark grey perimeters make up the watershed assessment units (i.e. groupings of 4th order streams or less within a HUC-12 watershed). Figure 2 shows ten watershed units.

River and stream assessment unit classification

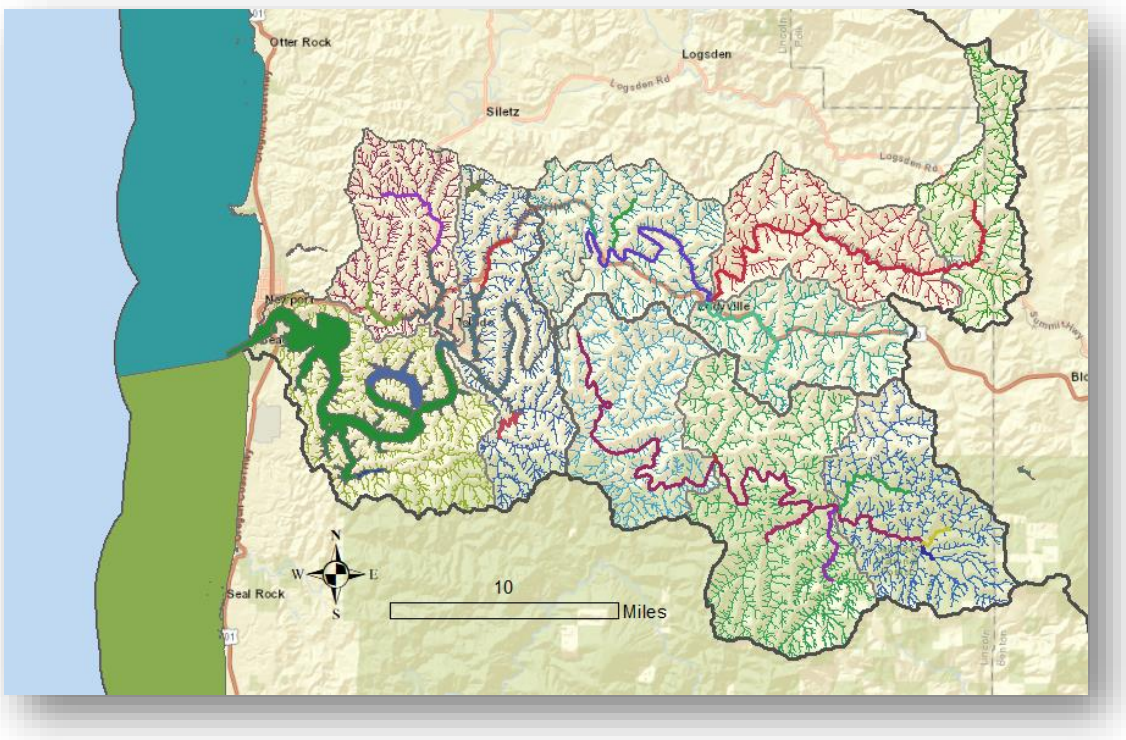
River and stream units are defined by a Strahler Stream Order[16] of 5 and higher. Assessment units were broken based on the following information:

1. A change in designated use based on waterbody 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 or stream order change separate the flow path, then the assessment unit is broken at a HUC10[17] boundary.

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

The only exception to the classification scheme above are 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.

Figure 2. Example assessment units



[16] https://usgs-mrs.cr.usgs.gov/NHDHelp/WebHelp/NHD_Help/Introduction_to_the_NHD/Feature_Attribution/Stream_Order.htm
[17] https://water.usgs.gov/GIS/huc.html

Watershed assessment unit classification

When moving to fixed assessment units using the high resolution 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 which 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 reservoir greater than 20 hectares are classified as separate assessment units defined by area. Smaller lake units will be added as data becomes available. DEQ uses the Coastal and Marine Ecological Classification Standard[18] (CMECS) to define the extent of estuaries. Each estuary is a unique assessment unit defined by area. Where other relevant data and information indicate differences in estuary homogeneity, further divisions may be warranted in the assessment unit.

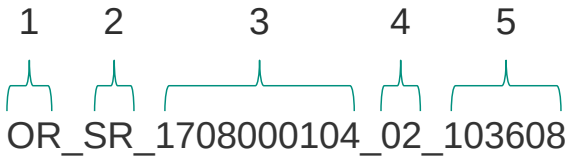
Beach and coastal assessment units

Beach assessment units are defined using NHD coastline segments for the entire length of the Oregon coast. Delineation of beach assessment units followed existing beaches as designated by OHA 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.

Ocean assessment units

Ocean assessment units were defined using Oregon's HUC 8 boundaries. The nine ocean units encompass Oregon territorial waters which extend up to 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

[18] https://www.fgdc.gov/standards/projects/cmecs-folder/CMECS_Version_06-2012_FINAL.pdf

3.3.4. Water body assessment

DEQ's assessment process is to pool all available data within an assessment unit for river and streams, lakes and reservoirs, and estuaries, and compare sampling results to water quality standards. Data within assessment units are evaluated using the assessment protocols for each specific pollutant to determine if the pollutant exceeds a water quality standard that protects a beneficial use and is a cause for beneficial use impairment. Where sample results included duplicate sample results collected for QA/QC purposes and identified as sample primary and sample duplicate, the primary sample result will be evaluated and counted only as one result. Results for individual monitoring sites are located on the appropriate assessment unit or segment of the water body.

DEQ will assess watershed units by monitoring station and make a categorical determination of impairment or attainment at each individual monitoring station. This determination is then rolled up into a single watershed unit conclusion in order to meet EPA reporting requirements. Assessment by station identifies the specific impairments that exist within the watershed and provides more precise assessment of the dataset. Identification of impaired stations may inform monitoring partners of localized impairments and guide restoration activities and future monitoring. This method also recognizes the inherent difference of grouping small streams into watershed units and is unique from all other types of assessment units through which the hydrologic homogeneity is more clearly defined.

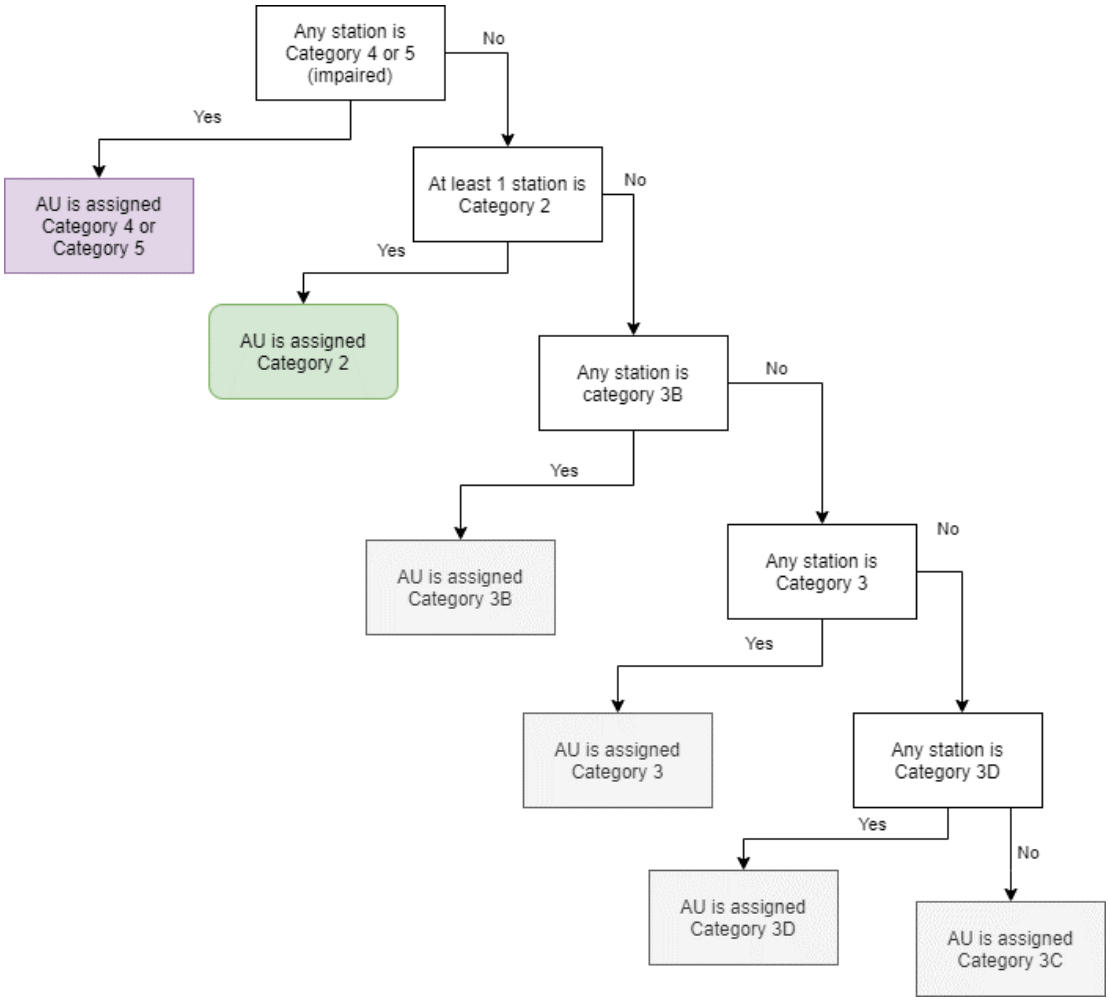


Figure 3. Watershed assessment unit flow chart

DEQ uses a statistical hypothesis testing approach (binomial test) to derive a critical number of sample excursions 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 parameter-specific assessment methods in Section IV, 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.

DEQ has retained the current assessment methodology and 15% effect size and selected to control Type II error rates (incorrectly identifying waters as attaining) by increasing the minimum sample size to make a Category 2 determination.

Minimum sample sizes for category 2

Table 4. Minimum sample size recommendations for Category 2

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

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 chosen for impairment and implemented in the 2018/2020 Integrated Report[21].

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

For a given sample size, if the number of exceedances are equal to or greater than the number of exceedances identified in Tables 6 and 7 the waterbody 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 prohibited per sample size are shown in Table 6 and Table 7.

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

[19] EPA, 2002. Consolidated Assessment and Listing Methodology (CALM) Toward a Compendium of Best Practices, First Edition. United States Environmental Protection Agency. July 2002. Chapter 4.
[20] DEQ 2018, Integrated Reporting Improvements White Paper - Statistical Methods for Listing and Assessment of Large and Long Term Data Sets
[21] https://www.oregon.gov/deq/FilterDocs/iri-statmethods.pdf

be based on the geometric mean of samples (based on a minimum of three samples) representative of the waterbody.

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.

Listing – 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

Sample Size	List if excursions ≥ :
110-125	10
126-141	11
142-158	12
159-174	13
175-191	14
192-200	15
>200	See generalized listing method for 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 pollutants22

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
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

[22] Excluding continuous dissolved oxygen and temperature

Sample Size	List if excursions ≥ :
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 listing method for 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:

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

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 $\alpha \leq 0.10$.

Censored data values

Due to limitations in field and laboratory chemical analysis procedures, small 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.
- 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 (Section III. C.1 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 waterbody 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 waterbody 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. Overwhelming evidence factors

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 of a specific location • Public health advisories

Category 3B

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

3.3.5. Delisting water bodies

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

3.3.5.1. Current 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. Data used for delisting must meet data quality requirements and minimum sample requirements for **Category 2: Attaining** as described in the "Data Requirements" section for the pollutant.

3.3.5.2. 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) site location errors (2) incorrect inclusion of inappropriate data or site data not meeting data quality requirements, (3) data evaluations not consistent with the assessment protocols, (4) a flaw in the original assessment rationale, (5) listing of water bodies that already have TMDLs in place, or (6) 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 **Delisted – Listing error**.

3.3.5.3. 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.[23] 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. Only data that are submitted through the current assessment process will be assessed against revised water quality standards. See Section IV. Assessment Protocols by Pollutant or Parameter for more detailed protocols for the pollutants with recent Oregon water quality standards changes including:

- A new federal aquatic life criterion for aluminum

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 **Delisted – Criteria change or use clarification.** 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, but a note is added saying **Criteria change or use clarification**. The delisting action is noted as **Delisted – Criteria change or use clarification.** 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, but a note is added saying **No criteria**. The delisting action is noted as **Delisted – Criteria change or use clarification.** This was the case for waters previously listed for manganese which currently does not have criteria for freshwater in Oregon water quality standards.

3.3.5.4. 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

[23] See Toxic Substances section for discussion of the applicable criteria used for the 2018 Integrated Report.

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 Section IV Assessment Protocols 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 **Delisted – Criteria change or use clarification** and the status noted **No criteria**. 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).

3.3.5.5. 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 **Delisted – TMDL approved.** 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.**

3.3.5.6. 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 **Delisted – Other control measures in place**.

3.3.5.7. 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 **Delisted – Water quality limited, not a pollutant**. 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 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.

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, as indicated in the parameter-specific assessment methods in Section IV, 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 waterbody as specified in Section III, B 3.

Water quality criteria for 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.

Water quality criteria 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 waterbody are less than the numeric criterion threshold.

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

Sample Size	Delist if excursions ≤ :
159-174	11
175-191	12
192-200	13
>200	See generalized delisting method for formula to calculate the number of excursions

Water quality criteria for dissolved oxygen

Waters shall be considered for delisting if the data in the period of record meets minimum data requirements to delist. Dissolved oxygen specific delisting requirements can be found in the parameter-specific assessment methods in Assessment Protocols for Specific Pollutants or Parameters.

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

Sample Size	Delist if excursions ≤ :
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 delisting method for 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:

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

Where n = the number of samples,
K_a = maximum number of measured exceedances to determine a waterbody 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 ka=1 for n=10. k_a is incrementally increased by 1, until $1\text{-}\alpha \leq 0.90$.

3.4. Public review

Public comment for the draft methodology was open between Jan. 19, 2021 and Mar. 8. 2021. Opportunity to comment on the draft methodology was also provided at the September 2021 Enivorinmental Quality Comission meeting. The methodology was used to develop the draft Integrated Report and a draft list of water quality limited waters (303(d) list which was made available for public review and comment from Janunary 12, 2022 through Feb. 11, 2022.

DEQ reviewed the submitted public comments and made changes to the Integrated Report and 303(d) list where appropriate. DEQ will prepared a document summarizing public comments and DEQ's response to those comments. The final Integrated Report and 303(d) list submitted to EPA will reflect all changes DEQ finds to be appropriate.

3.5. Submittal of Oregon’s Integrated Report and 303(d) list

EPA developed a national data system, ATTAINS and requires states to report Integrated Report conclusions into the ATTAINS system. ATTAINS is a publically 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 Methodology for Oregon's Water Quality Report on List of Water Quality Limited Waters, and a TMDL prioritization schedule. Only water bodies in the Category 5: Water quality limited waters needing a TMDL (Section 303(d) list) are subject to EPA’s approval.

4. Assessment Protocols 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 protocols and 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.[24] 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 protocols for the Integrated Report evaluation build on, update, and replace protocols and 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 2022 Integrated Report are described in the following sections.

[24] 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.

PARAMETER: Aquatic Weeds or Algae

Aquatic Weeds

USES ASSESSED: Boating, Aesthetic Quality

Algae

USES ASSESSED: Aesthetic Quality

Harmful algal blooms (HABs)

USES ASSESSED: Domestic Water Supply, Irrigation, Livestock Watering, Water Contact Recreation

NARRATIVE CRITERIA: OAR 340-41-0007

NUMERIC CRITERION: OAR 340-041-0019

> **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;
>
> **340-041-0019**
> **Nuisance Phytoplankton Growth**
> See: Chlorophyll-a

ASSESSMENT PROTOCOL:

This protocol 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 that will be used to determine that beneficial uses have been negatively affected by the presence of excess algal or weed growth.

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[25] or OHA recommended use values for anatoxin a or saxitoxin at the time of assessment[26]
    (4) finished water exceeds EPA Drinking Water Health Advisories for Cyanotoxins for vulnerable groups[27] AND where the waterbody 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[28]
    (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
- **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.

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[25] https://www.epa.gov/sites/production/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf

[26] https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/HARMFULALGAEBLOOMS/Documents/2019%20Advisory%20Guidelines%20for%20Harmful%20Cyanobacterial%20Blooms%20in%20Recreational%20Waters.pdf

[27] https://www.epa.gov/cyanohabs/epa-drinking-water-health-advisories-cyanotoxins

[28] Based on Australian Livestock drinking water guidelines, 2000

If raw source water exceeds drinking water values for vulnerable people for water bodies with known drinking water intakes.

Category 2: attaining

Not applicable.

DELISTING

- **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[29].
- **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.

DATA REQUIREMENTS:

Information, data or health advisories.

[29] https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/RECREATION/HARMFULALGAEBLOOMS/Documents/2019%20Advisory%20Guidelines%20for%20Harmful%20Cyanobacterial%20Blooms%20in%20Recreational%20Waters.pdf

PARAMETER: Bacteria

USES ASSESSED:

Water Contact Recreation – Freshwater
Water Contact Recreation – Coastal Water
Fishing - Shellfish Harvesting

WATER QUALITY STANDARDS:[30]

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 PROTOCOL:

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).

The indicators are:

E. coli for contact recreation in freshwater lakes, rivers, and streams;

Enterococcus for contact recreation in coastal marine and estuary waters; and

Fecal coliform for shellfish harvesting in marine and estuarine waters.

[30] Cited January 7, 2021 https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1458

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.

DETERMINING APPLICABLE CRITERIA:

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

* A waterbody shall be placed in Category 5 if two or more samples exceed 406 *E. coli* organisms per 100 mLand the minimum sample size is not met. If there are less than five samples to evaluate a 90-day period, but one sample exceeds 406 *E. coli* organisms per 100 mL the waterbody shall be placed in Category 3B.

Designated uses

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 adjacent marine waters up to three miles offshore. For these more saline waters, enterococcus is the applicable indicator of fecal contamination. 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 where 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.

For reference, the information for designated uses mapped in OAR 340-041-0101 to 340-041-0320 are also depicted in the water quality standards mapping web tool (under development).

DATA EVALUATION:

Data from sampling sites for bacterial indicators are evaluated using the appropriate criteria and protocol for the designated use. Where applicable, a geometric mean is calculated on a rolling basis for each 90-day period of data available at a sampling location. A minimum of five samples collected on different days is required to calculate a 90-day rolling geometric mean.

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. 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:

The numeric value of results reported down to the Minimum Reporting Level (MRL) is used to calculate the geometric mean or median.

A 90-day geometric mean shall be calculated for any rolling period of 90 days where there are at least five samples available.

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

Calculating the 90-day geometric mean criteria metric

The 90-day geometric mean (GM90) of bacteria concentration is calculated by taking the n^{th} root of the product of the concentration of each sample collected within a 90-day period for which $n \geq 5$.

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

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

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 a minimum of 5samples.

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

Less than five samples are available for evaluation of a 90-day period, and no single sample is greater than 406 *E. coli* organisms per 100 mL.

Category 3B: insufficient data; potential concern

Less than five samples are available for evaluation of a 90-day period, but one sample is greater than 406 *E. coli* organisms per 100 mL.

Category 2: attaining

All 90-day geometric means, with a minimum of five samples, are less than or equal to 126 *E. coli* organisms per 100 mL, and for a minimum of eight samples ≤ 10% of all samples exceed 406 *E. coli* organisms per 100 mL within the IR data window 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 based on a minimum of five samples; **OR** more than 10% of all samples within any 90-day period exceed 130 Enterococci organisms per 100 mL (as expressed in rule) using the 10% raw score method, based on a minimum of 5 samples.

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 five samples are available for evaluation of a 90-day period, and no single sample is greater than 130 Enterococci organisms per 100 mL.

Category 3B: insufficient data; potential concern

Less than five samples are available, but one or more samples within any 90-day period exceed 130 Enterococci organisms per 100 mL, **OR** where less than five samples are available, the Oregon Beach Monitoring Program has issued one or more advisories based on monitoring results for Enterococci, not including precautionary advisories.

Category 2: attaining

All 90-day geometric means are less than or equal to 35 enterococci organisms per 100 mL, based on a minimum of five samples, **AND** no more than 10% of samples within a 90-day period are greater than 130 Enterococci organisms per 100 mL (as expressed in rule) using the 10% raw score method, with a minimum of five samples.

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. (as expressed in rule) 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 five samples are available for evaluation, and no single sample is greater than 43 fecal coliform organisms per 100 mL.

Category 3B: insufficient data; potential concern

Less than five samples are available for evaluation, 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 five samples; **AND** no more than 10% of all samples are greater than 43 fecal coliform organisms per 100 mL, with a minimum of five samples (as expressed in rule) using the 10% raw score method.

PARAMETER: Biocriteria

USES ASSESSED: Fish and Aquatic Life

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.

DATA EVALUATION:

Detrimental changes in resident biological communities are a form of pollution.[31, 32] EPA guidance recommends using biological community assessments as an indicator for aquatic life beneficial use support.[33] DEQ uses the protocol described here to implement Oregon's narrative standard for Biocriteria. The protocol applies numeric benchmarks to evaluate the integrity of aquatic biological communities. The protocol assesses the conditions in biological communities, but does not by itself indicate if changes are related to pollutants, or identify 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.[34] This protocol outlines the process and resulting assessment category assignments that DEQ uses for the Integrated Report.

This protocol 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.[35] 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 communities in the waters.[36]

Assessing macroinvertebrate communities

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 specifically for Oregon and produced a technical paper with the model details in 2008.[37] Similar model approaches are used for bioassessments in the United Kingdom (RIVPACS), Australia

[31] Federal Water Pollution Act Section 502(19) (33 U.S.C 1362) (Clean Water Act)
[32] Oregon Administrative Rules 340-041-0002(39)
[33] US EPA, July 29, 205, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, page 41.
[34] US EPA, July 29, 205, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, page 60.
[35] Drake, D., April 2004, Selecting Reference Condition Sites - An Approach for Biological Criteria and Watershed Assessment, ODEQ Technical Report WSA04-002. http://www.deq.state.or.us/lab/techrpts/docs/WSA04002.pdf
[36] Stoddard,J.L., et.al., 2006. Setting Expectations for the Ecological Condition of Streams: The Concept of Reference Condition. Ecological Applications. 16(4): 1267-1276
[37] 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

(AusRIVas), Canada (BEAST), and in broad areas in the United States (typically called RIVPACS models, though different from the U. K. models).

DEQ developed the PREDictive Assessment Tool for ORegon, or PREDATOR, to assess the macroinvertebrate communities in Oregon's perennial, wadeable streams. 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 4. 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 % taxa loss to determine a status category for a water body. The benchmarks are used to indicate where deviations from reference conditions and loss of native taxa are detrimental to biological communities and impair aquatic life use support in the water body. A discussion of the scientific basis for the model development, statistical analysis of reference site data, and basis for selecting benchmark values in terms of the reference site distributions in different regions in Oregon is given in separate technical papers (Drake, 2004; Hubler, 2008).

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:

- 20% or more taxa loss in the Marine Western Coastal Forest (MWCF) region,
- 27% or more taxa loss in the Western Cordillera and Columbia Plateau (WCCP) region, or
- Best professional judgement will be used in the Northern Basin and Range (NBR) region.

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

- 15% or more taxa loss in the Marine Western Coastal Forest (MWCF) region,
- 22% or more taxa loss in the Western Cordillera and Columbia Plateau (WCCP) region, or
- Best professional judgement will be used in the Northern Basin and Range (NBR) region.

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 4 if no additional TMDLs are needed. Water

bodies will also be placed in Category 4 for biological criteria if adequate information is available to indicate that detrimental changes to biological communities are not due to a pollutant.

Category 3: insufficient data

Some macroinvertebrate sampling data from perennial, wadeable streams evaluated using the PREDATOR model do not meet data quality requirements (outlined below) and are not sufficient to use to assign a status category. These include:

- Samples that do not pass the PREDATOR outlier test or have environmental predictors that are statistically outside of the distribution of predictors observed at reference sites, and have taxa loss above the threshold identified for Category 5
- Samples collected outside of the standard sampling index period (June – October), and have taxa loss above the threshold identified for Category 5
- Samples with low total abundance (less than 150 total organisms)

The stream will be assessed as a potential concern until more sampling data with acceptable data quality is evaluated and a definitive status can be assigned.

Category 3B: insufficient data; potential concern

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

- 15% to 20% taxa loss in the Marine Western Coastal Forest (MWCF) region,
- 22% to 27% taxa loss in the Western Cordillera and Columbia Plateau (WCCP) region, or
- 25% to $\geq$ 50% taxa loss in the Northern Basin and Range (NBR) region.

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 showing:

- 9% to 14% taxa loss in the Marine Western Coastal Forest (MWCF) region,
- 8% to 21% taxa loss in the Western Cordillera and Columbia Plateau (WCCP) region

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 showing:

- Less than 8% taxa loss or in the Marine Western Coastal Forest (MWCF) region,
- Less than 7% taxa loss or in the Western Cordillera and Columbia Plateau (WCCP) region, or
- Less than 25% taxa loss in the Northern Basin and Range (NBR) region.

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,[38]
- 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.

If data do not meet any one of these data quality requirements, the PREDATOR O/E score will not be used by itself to assess the biological condition, but may be used in conjunction with Best Professional Judgement and other information corroborating the PREDATOR result. Other information may include regionally appropriate multi-metric indices (MMIs) or combinations of commonly calculated metrics.

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 described above. DEQ will average the scores for field duplicates or seasonal replicate samples when available to account for variability. If samples from multiple years are available, the average O/E score for the most recent 5 years of data will determine the site status. Replicate samples must be collected in the same sampling season and in the same reach.

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

[38] ODEQ, 2009, Mode of Operations Manual, Version 3.2, DEQ03-LAB-0036-SOP, http://www.deq.state.or.us/lab/techrpts/docs/DEQ03LAB0036SOP.pdf

assessment techniques to determine if the data identifies impaired biological conditions sufficient for Category 5 assignment.

Other approaches to assess biological integrity

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 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.

Table 13. Biocriteria assessment benchmarks for a single sample

PREDATOR Model Region	Assessment Category			
	Category 5: Water Quality Limited	Category 3B: Insufficient Data; Exceedances	Category 3C: Insufficient Data; Potential Concern	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[2]	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
[2] Applies to both single and multiple samples

Table 14. Biocriteria assessment benchmarks for multiple samples

PREDATOR Model Region	Assessment Category		
	Category 5: Water Quality Limited	Category 3C: Insufficient Data: Potential Concern	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
Western Cordillera and Columbia Plateau	≥ 22% taxa loss[1]	8% to 21% taxa loss	< 7% taxa loss
	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

DELISTING:

Once TMDLs addressing biological impairments are approved, water bodies may be delisted for biocriteria. These waters will be placed in Category 4A: Water Quality Limited, TMDL Approved.

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.

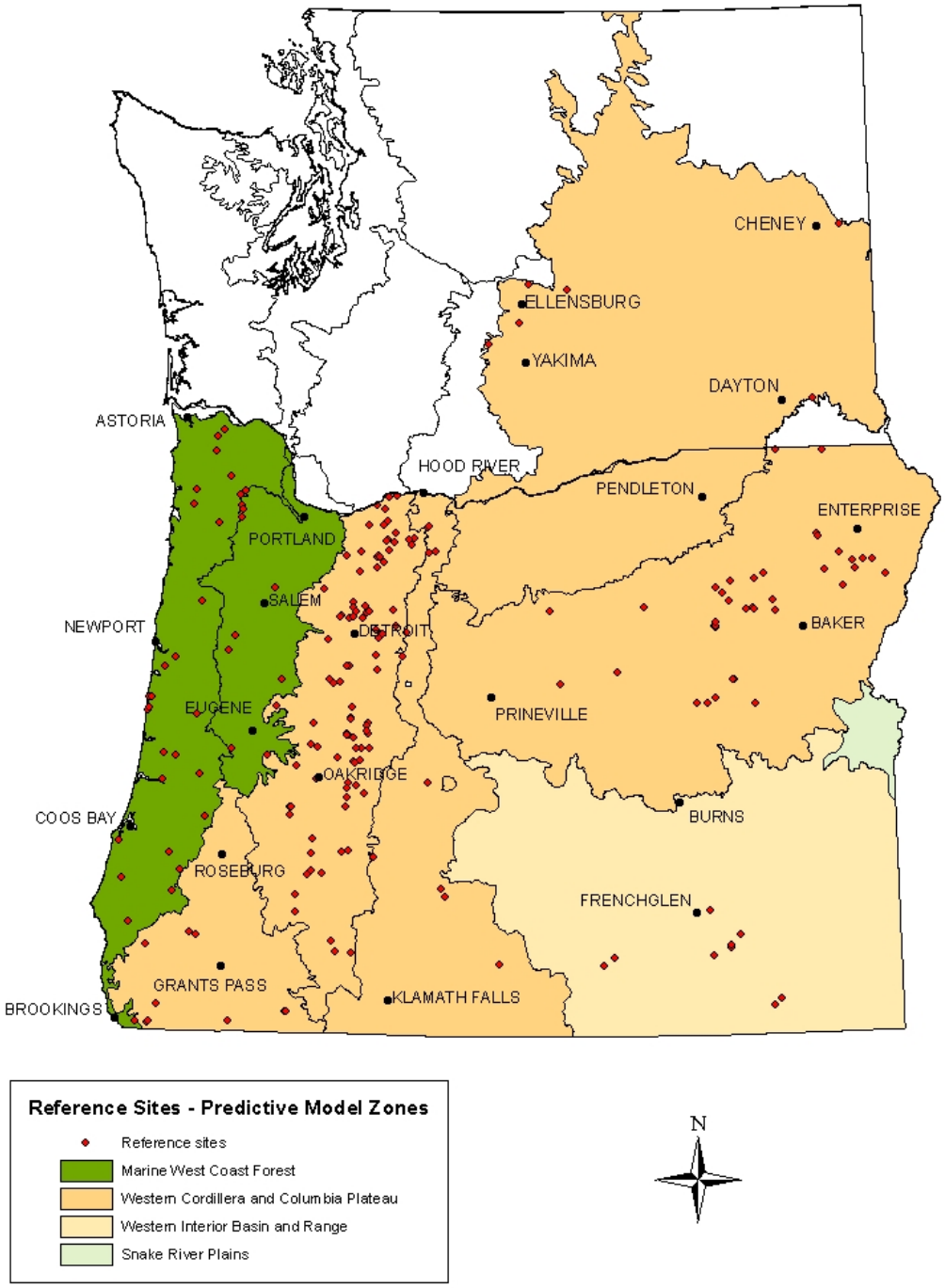

Figure 4. Map of PREDATOR reference sites and zones. PREDATOR consists of two predictive models

(1-Marine West Coast Forest, 2-Western Cordillera and Columbia Plateau) and one null model (Western Interior Basin and Range). No model exists for the Snake River Plains ecoregion.

PARAMETER: Chlorophyll-a

(Nuisance Phytoplankton Growth)

USES ASSESSED: 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 PROTOCOL

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

DATA REQUIREMENTS:

Data collected since 2008. 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).

DATA EVALUATION:

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. The average must be calculated with at least one sample in each month **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** $\leq$ 10% of monthly averages within the IR data window exceed the referenced values according to the exact binomial test..

PARAMETER: Dissolved oxygen

USES ASSESSED: 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.

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 DEQ water quality standards mapping web tool.

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 waterbody.

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.

ASSIGNMENT OF ASSESSMENT CATEGORY:

Instantaneous (or grab) dissolved oxygen concentration

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 according to the exact binomial test **AND** are also less than the percent saturation allowance.

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), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

Fewer 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

Fewer 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.

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 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 5 and Figure 6.

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.
- If both of the year round (30-D or 7-Mi) metrics are attained, two or more of the daily minimum concentration of dissolved oxygen is less than the Min. 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.

- If the spawning 7-D metric is attained, two or more of the daily minimum concentration of dissolved oxygen is less than the Min. 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.
- If both the year round (30-D and 7-Mi) are attained, 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.
- If the spawning 7-D metric is attained, ≤ 1 of the daily minimum concentration of dissolved oxygen is less than the Min. alternate minimum criteria (Min) (Table 15).

A. Calculating percent saturation

For evaluation of instantaneous or "grab" samples, the percent saturation corresponding to each sample of dissolved oxygen concentration shall be evaluated when applicable criteria are exceeded to determine if conditions of barometric pressure, altitude, and temperature preclude attainment of the standard.

For evaluation of continuous metrics, the corresponding 30-D (cold water year-round criteria) or 7-D (spawning criteria) percent saturation metrics shall be evaluated when applicable criteria are exceeded to determine if conditions of barometric pressure, altitude, and temperature preclude attainment of the standard.

Direct field instrument measurements of percent saturation are preferred and shall be used if available. However, if corresponding percent saturation data is unavailable, and corresponding water temperature data is available, the value can be calculated using Equation 2 (below)[39]. When the dissolved oxygen saturation is measured in excess of 100 percent, the saturation value used shall be limited to 100 percent for the calculation of metrics. If percent saturation is unavailable or cannot be calculated, DEQ shall apply the applicable spawning and cold-water criteria.

Equation 1:

$$DO_{Theo} = e\text{^}\left[-139.34411 + \frac{1.575701\times10^{5}}{T} - \frac{6.642308\times10^{7}}{T^{2}} + \frac{1.243800\times10^{10}}{T^{3}} - \frac{8.621949\times10^{11}}{T^{4}}\right] * \left(1 - (0.0001148 * Site\_elvm)\right)$$

[39] Pelletier and Chapra. 2008. Qual2Kw theory and documentation (version 5.1), *Washington Department of Ecology*, Olympia, WA.

Where e = a constant, the base of the natural logarithm (≈2.71828)

T = Temperature in Kelvin

Site_elvm = Site elevation in meters (recorded field value or derived from a Digital Elevation Model)

Equation 2:

$$PS = 100 * \frac{DO_{Meas}}{DO_{Theo}}$$

Where PS = Percent saturation dissolved oxygen

DO_{Meas} = Measured Dissolved Oxygen in mg/L

DO_{Theo} = Theoretical Dissolved Oxygen in mg/L

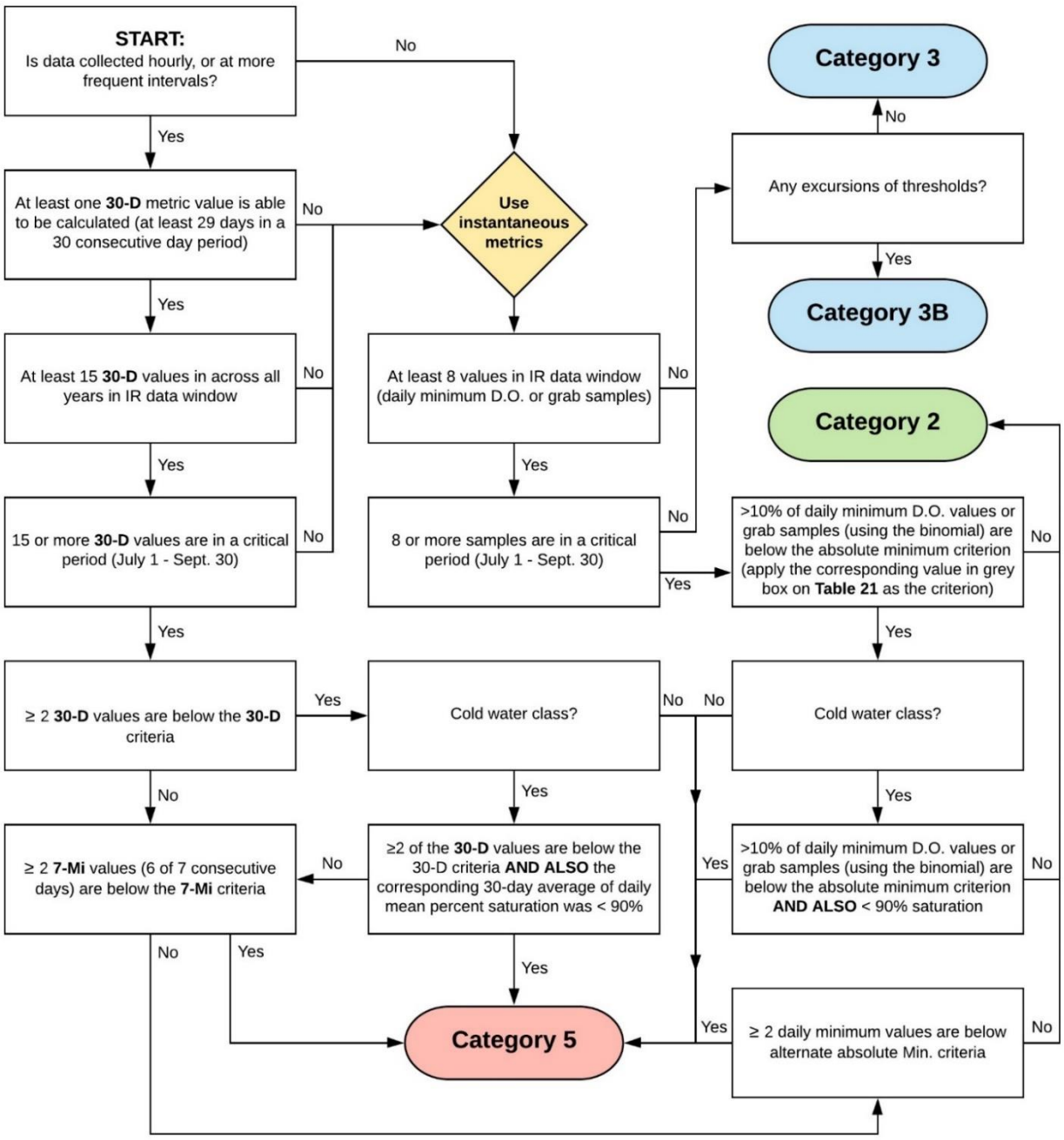

Figure 5. The decision tree for assessment of the dissolved oxygen year-round criteria

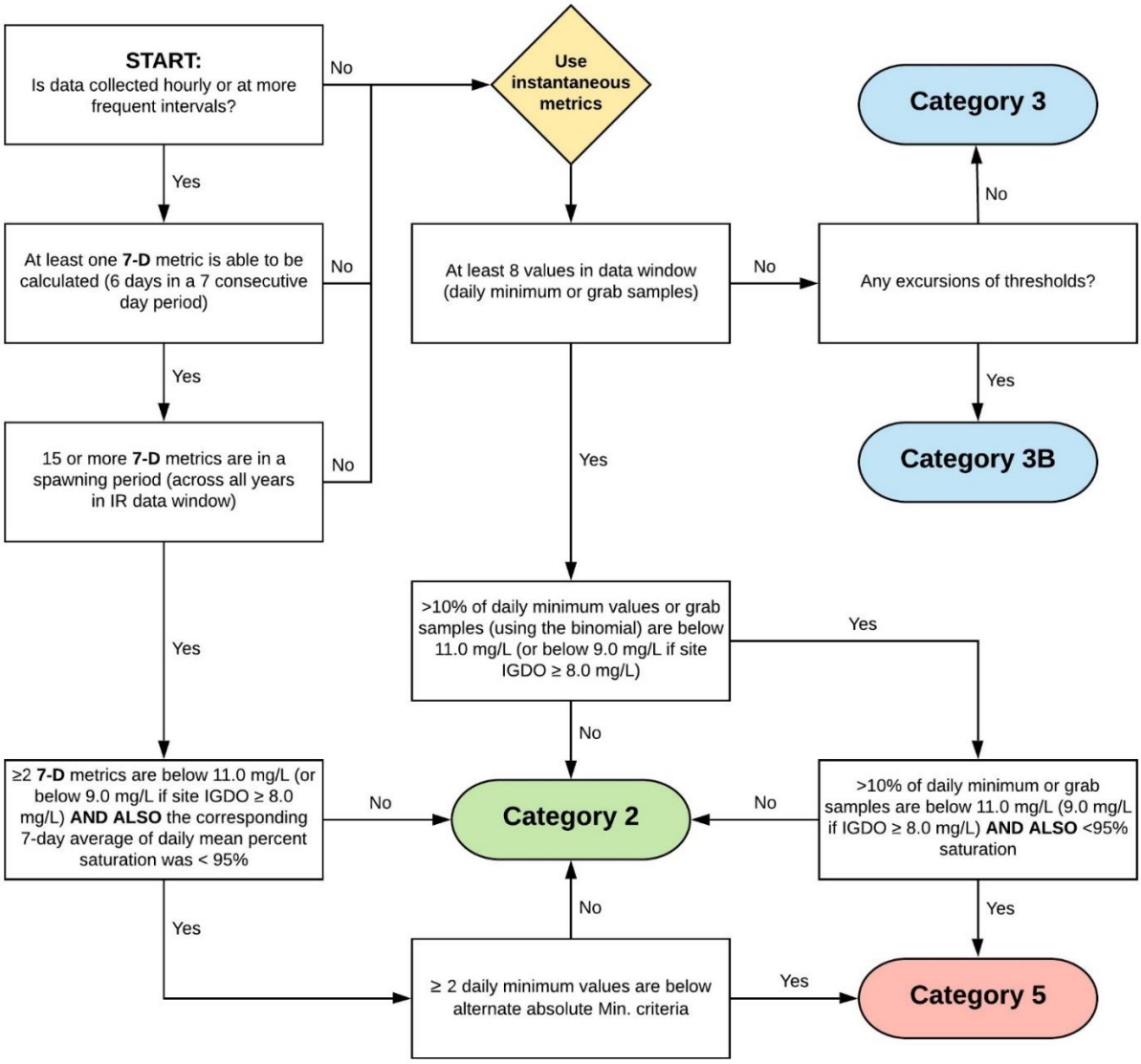

Figure 6. The decision tree for assessment of the dissolved oxygen spawning criteria

Delisting for dissolved oxygen

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 two listing cycles, 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.

PARAMETER: pH

USES ASSESSED: 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
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

Basin or Water Body	OAR	Water	Criteria Range
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
	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.

DATA EVALUATION:

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. Where only continuous data are available, DEQ will use the exact binomial test twice. Data collected in a time series fashion will be evaluated using a daily statistic. First, where > 10% of daily time series measurements fall outside the range of the appropriate criterion, the day is considered in violation of its water quality standards. Second, where greater than 10% of the daily values falls outside the range of the appropriate criterion according to the exact binomial test, the waterbody would be considered impaired. 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 exceedances for the same location and day for grab and continuous results. Where duplicate grab and continuous data results exist, 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

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

Grab only:
For eight 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 > 10% of daily time series measurements fall outside the range of the appropriate criterion according to the exact binomial test, the day is considered in violation of its water quality standards. Second, where greater than 10% of the daily values falls outside the range of the appropriate criterion according to the exact binomial test, the waterbody 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 for the time-period of interest for listing

Category 3B: insufficient data; potential concern

Fewer than eight samples collected on separate days for the time period of interest for listing, where > 10% of samples do not meet the appropriate criterion.

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:
First, where > 10% of daily time series measurements fall outside the range of the appropriate criterion according to the exact binomial test, the day is considered in violation of its water quality standards. Second, for a minimum of eight daily samples, where less than 10% of the daily values falls outside the range of the appropriate criterion according to the exact binomial test.

TIME PERIOD:

Year Round

NOTES:

Cascade Lakes are natural and man-made lakes at elevations over 3,000 or 5,000 feet, as specified in the basin criteria and shown in Table 17.

PARAMETER: Sedimentation

USES ASSESSED: 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;

DATA EVALUATION:

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

Water bodies have been previously listed[40] 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, 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.

[40] Listing Criteria for Oregon's 1998 303(d) List of Water Quality Limited Water Bodies: https://www.oregon.gov/deq/FilterDocs/1998ListCriteriaF.pdf

PARAMETER: Temperature

USES ASSESSED: Fish and Aquatic Life

NARRATIVE CRITERION: OAR 340-041-0028

NUMERIC CRITERION: OAR 340-041-0028(4)

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.

DATA EVALUATION:

Data from sampling sites are evaluated using the following protocols and criterion values identified in Table 18.

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

When continuous temperature data are collected, 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.

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), or impairment is not caused by a pollutant (Category 4C).

Category 3: insufficient data

When temperature data are collected, but data are insufficient to calculate the seven-day-average daily maximum temperature; **OR** the data are not collected during the critical warm period or an applicable spawning period.

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 waterbody.

DATA REQUIREMENTS:

Continuous data must be collected to reliably capture the daily maximum temperature for at least 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 (7dAM) 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 7dAM is repeated for each consecutive 7-day period on a moving or rolling basis. For example, the 7dAM for August 10 is calculated from T_{max} for August 4 to August 10; the 7dAM for August 11 is calculated from August 5 to 11, etc.

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

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 7dAM 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 7dAM is required to meet the spawning criteria.

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 water quality standards maps web tool.[41]

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 water quality standards maps web tool.

Application of the Klamath River cool water species narrative criterion for temperature in 340-041-0028 (9)(b). [42]

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 7dAM values exceed 28°C in this reach, except when the air temperature or low flow exclusions apply, DEQ will determine that the

[41] https://hdcgcx2.deq.state.or.us/Html5Viewer211/?viewer=wqsa
[42] DEQ 2017, Memorandum RE: Implementation of Cool Water Species Criterion for Klamath River Sucker. March 6, 2017.

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 water quality standards maps web tool.

Applicability

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.

PARAMETER: Total dissolved gas

USES ASSESSED: 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.

DATA EVALUATION:

Data from sampling sites are evaluated using the following protocols:

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

Greater than 10% of the samples exceed 110% saturation 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.

PARAMETER: Toxic substances

Toxic substances – aquatic life criteria

USES ASSESSED: Fish and Aquatic Life

Toxic substances – human health criteria

USES ASSESSED: Fishing (Consumption)
Fishing – Shellfish Harvesting

Toxic substances – human health criteria (water + organism only)

USES ASSESSED: Domestic Water Supply

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[43]
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.

340-041-8033 [44], [45]
Division 41 Tables and Figures

[43] Cited January 8, 2021 https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1458
[44] Cited January 8, 2021 https://secure.sos.state.or.us/oard/viewSingleRule.action;JSESSIONID_OARD=rtTjRAuxexQVgFAGmNz2w4Zu-LbdwrGYyWCVMCaxnhfXBBSSgCAn!-1835049044?ruleVrsnRsn=256054
[45] The Federal Clean Water Act criterion promulgated for Oregon effective 3/6/2017 supersedes Table 30 aquatic life freshwater acute criterion for cadmium https://www.federalregister.gov/documents/2017/02/03/2017-02283/aquatic-life-criteria-for-cadmium-in-oregon

(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 PROTOCOL:

DEQ applies Oregon's current and effective water quality standards for CWA 303(d) assessment purposes once the standard has been approved by EPA.

DETERMINING APPLICABLE CRITERION:

Oregon's statewide narrative

The statewide narrative criteria generally protects 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 in order 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.[46] 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." DEQ follows EPA's recommendation to use saltwater criteria for marine waters where the salinity is equal to or greater than 10 parts per thousand (approximately equivalent to conductivity 20,000 uS/cm) and use the more

[46] 2002, National Recommended Water Quality Criteria: 2002, U.S. EPA Office of Water, EPA 822-R-02-047p.9.

stringent of freshwater or saltwater aquatic life criteria in estuarine waters where salinity is between 1 and 10 parts per thousand.[47]

DEQ has adopted the Coastal and Marine Ecological Classification Standard (CMECS) implemented by the Oregon Coastal Management Program that identifies the extent of estuaries in coastal Oregon waters using geographic information and salinity data[48]. The classification of estuarine waters is consistent with EPA's recommendation for waters where salinity is between 1 and 10 parts per thousand. For these estuarine waters, DEQ applies the more stringent of either the freshwater or saltwater criteria.

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 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 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 criteria sections.

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

For fish and aquatic life

Greater than 5% of the samples exceed the appropriate **aquatic life criterion** according to the exact binomial test for listing (see Section IIII. C.4. Water Body Assessment);

[47] Monitoring data are more commonly collected for conductivity. An example conversion is: Salinity 0.1 parts per thousand = 200 micro-Siemens/cm conductivity at 20°C. See general equation and table in Weyl, Peter K., (1964), On The Change In Electrical Conductance Of Seawater With Temperature. Limnology and Oceanography, Vol. 9, Issue 1, pp. 75-78. doi: 10.4319/lo.1964.9.1.0075.

[48] https://www.fgdc.gov/standards/projects/cmecs-folder/CMECS_Version_06-2012_FINAL.pdf

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.[49]

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, ≥ 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).

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.

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[49] 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.

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 Section III. C.4. 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.

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. When 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 [50, 51] . Total recoverable hardness values are used to derive criteria for metals concentrations.

If hardness is not directly reported as $CaCO_3$, the following equation[52] 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.[53]

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

[50] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001
[51] 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
[52] 1998, Standard Methods for the Examination of Water and Wastewater, 20th edition, American Public Health Association, American Water Works Association, Water Environment Federation
[53] 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.

Ecoregion	Default Hardness (mg/L)
Klamath Mountains	28.5
Northern Basin and Range	32.3
Snake River Plain	80.9
Willamette Valley	25.0

PROTOCOL DETAILS FOR SPECIFIC TOXIC POLLUTANTS:

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 in order 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.[54,55,56, 57]. DEQ developed additional memoranda to address analytical and monitoring issues for specific toxic pollutants and criteria.[58] 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.

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."[59] Alkalinity should not be below this value in order to protect aquatic life.

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: Exceedances**. 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.

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[54] EPA National Recommended Water Quality Criteria website at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

[55] National Institute of Standards and Technology web site "Search for Species Data by CAS Registry" at http://webbook.nist.gov/chemistry/cas-ser.html

[56] Agency for Toxic Substance and Disease Registry web site at http://www.atsdr.cdc.gov/

[57] US EPA Substance Registry Services web site "Substance Search" at http://iaspub.epa.gov/sor_internet/registry/substreg/searchandretrieve/substancesearch/search.do

[58] DEQ Memorandums with Recommendations for Analysis and Implementation of Specific Toxic Pollutants https://www.oregon.gov/deq/wq/Pages/WQ-Standards-Toxics.aspx

[59] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

Aluminum criteria

EPA promulgated aluminum criteria for Oregon which became effective on April 19, 2021. The EPA's aluminum criteria for Oregon are based on EPA's 2018 final Clean Water Act section 304(a) national recommended freshwater aquatic life criteria for aluminum. The criteria magnitude for the aluminum standard is determined using EPA's Aluminum Criteria Calculator. The calculator derives instantaneous aluminum criteria values, which change based on water chemistry, including pH, dissolved organic carbon, and hardness levels. The promulgated aluminum criteria are expressed as total recoverable aluminum, however, surface waters typically contain naturally occurring suspended solids that contain aluminum in the forms of particulate oxides or clay silicates. Analytical determinations using strong acid digestion result in most or all of the inert nontoxic forms of aluminum present in solid particles being dissolved and the metal being reported as “total or total recoverable” aluminum. In surface waters with elevated suspended solids, the aluminum contributed from the suspended solids may overestimate toxicity under certain conditions when measured using typical strong digestion techniques. Therefore, it still remains unclear if, or how much, of these total aluminum concentrations are bioavailable and contribute to toxicity.

The Aluminum Criteria Calculator determines instantaneous site-specific criteria that account for changes in bioavailability, and thus toxicity, of aluminum to aquatic life due to differences in water chemistry. The aluminum Instantaneous Criteria Values (ICV) are calculated using three input parameters (DOC, pH, total hardness) collected concurrently with the aluminum sample to be assessed. If DOC is not available and cannot be estimated from TOC, then a default regional DOC input value is used to calculate the ICV. If either pH, hardness, or both are missing and cannot be credibly estimated using the methods described in the Aluminum Standard Interpretation and Application Procedures document, then the default regional aluminum criteria are applied instead.

Water quality measurements for input parameters should be taken simultaneously with aluminum samples to ensure they reflect the same hydrologic and environmental conditions. 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 Aluminum Standard Interpretation and Application Procedures document, and will subsequently assess the data according to the exact binomial test procedures.

EPA considers the 304(a) criteria protective for both total recoverable and bioavailable aluminum when applied to characterize ambient concentration of receiving waters. In the event the bioavailable method is not available for the 2024 Integrated Report listing cycle, if total recoverable aluminum data indicate a waterbody is impaired, then it will be listed in Category 5. When a bioavailable method becomes available and sufficient bioavailable data are collected, a waterbody may be delisted based on such data.

Only bioavailable aluminum

For water bodies with sufficient bioavailable aluminum results to evaluate the data, DEQ will assess the data according to the aquatic life toxics method.

Only total recoverable aluminum

For water bodies where only total recoverable aluminum data are available, if > 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 and DEQ will pursue development of a total recoverable to bioavailable aluminum translator and further study the influence of TSS on instream aluminum concentrations for future assessment cycles.

Both bioavailable and total recoverable aluminum

For water bodies with insufficient bioavailable aluminum results, but where a combination of bioavailable and total recoverable, or only total recoverable data is available and > 5% of the combined samples exceed criteria with 90% confidence according to the exact binomial test, the assessment unit will be placed in Category 3B and DEQ will prioritize collection of bioavailable data.

Use of default values

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 waterbody 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 waterbody 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 Tables 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. In order 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 limits specified in the criteria calculation equations.[59] 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.[59][60] 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 was 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 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.

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[60] 1989, Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, U.S. EPA Office of Water, EPA 440/5-88-004; http://www.epa.gov/ost/pc/ambientwqc/ammoniasalt1989.pdf

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 criterion for Oregon effective 3/6/2017 and provided equations and conversion factors to calculate the acute criterion for dissolved cadmium concentration in freshwater.[61] DEQ uses the more conservative ecoregion hardness default values for acute cadmium criterion which is consistent with the protective defaults used across its 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.

Chlorine

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.[62]

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.[63] 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

[61] Aquatic Life Criteria for Cadmium in Oregon, Federal Register 82 FR 9166 02/03/2017, p 9166-9174 https://www.federalregister.gov/documents/2017/02/03/2017-02283/aquatic-life-criteria-for-cadmium-in-oregon
[62] December 7, 2012 DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion Chlorine (CAS #: 7782-50-5) http://www.oregon.gov/deq/FilterDocs/sToxicschlorineMemo.pdf
[63] October 23, 2012 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

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[64] 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 on Table 30.

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.[65]

DDT, DDD, and DDE criteria

The aquatic life criteria for DDT 4,4′ specify the criteria apply to the total concentration of DDT and its metabolites. DEQ sums analytical data results for DDT, DDD, and DDE and compares the sum to the applicable aquatic life criteria for DDT.[66]

This criterion applies to DDT and its metabolites; the total concentration of DDT and its metabolites should not exceed this value.

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

[64] DEQ 2016, Implementation of the Freshwater Aquatic Life Water Quality Standards for Copper. http://www.oregon.gov/deq/FilterDocs/copperBLMimp.pdf
[65] November 14, 2012 DEQ Memorandum RE: Implementation Instructions for Free and Total Cyanide Water Quality Criteria (CAS #: 57-12-5) http://www.deq.state.or.us/wq/standards/docs/toxics/cyanide.pdf
[66] March 20, 2013 DEQ Memorandum RE: Implementation Instructions for Water Quality Criterion DDT,-4,4' (CAS #: 50-29-3) http://www.deq.state.or.us/wq/standards/docs/toxics/DDTmemo.pdf

Aquatic life criteria for Guthion are applied to results for Guthion (synonym azinphos methyl) (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

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 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.[67]

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/phosphate phosphorus benchmark

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.[68]

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

[67] 1986, Ambient Water Quality Criteria for Pentachlorophenol, U.S. EPA Office of Water, EPA 440/5-86-009.
[68] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001 for Phosphorus

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. For total recoverable arsenic data, if the predicted inorganic arsenic results are greater than 2.1 µg/L calculated as a geometric mean, than the waterbody 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 analytical methods currently recommended to measure this chemical in water samples.[69]

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).[70] DEQ uses total or "available" 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.[71]

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[69] March 20, 2013 DEQ Memorandum RE: Implementation for Water Quality Criterion Bis Chloromethyl Ether (CAS #: 542-88-1) http://www.oregon.gov/deq/FilterDocs/sToxicsBisChloromethylMemo.pdf

[70] 1986, Quality Criteria for Water, U.S. EPA Office of Water, EPA 440/5-86-001

[71] March 20, 2013 DEQ Memorandum RE: Implementation Instructions for Water Quality Criterion DDT,-4,4' (CAS #: 50-29-3) http://www.oregon.gov/deq/FilterDocs/sToxicsDDTmemo.pdf

This criterion applies to DDT and its metabolites; the total concentration of DDT and its metabolites should not exceed this value.

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.

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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 data results measured as dinitrophenol 2,4 are used as the surrogate for the dinitrophenol criteria.[72]

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.[73]

Endosulfan criteria

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

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[72] October 23, 2012 DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion Dinitrophenols (CAS #: 25550-58-7) http://www.oregon.gov/deq/FilterDocs/sToxicsdinitrolphenols.pdf

[73] November 14, 2012 DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion1,2 Diphenylhydrazine (CAS #: 122-66-7) http://www.oregon.gov/deq/FilterDocs/sToxicsdiphenylhydrazine.pdf

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. Consistent with implementation guidance, DEQ applies the hexachlorocyclo-hexane-technical criteria to the sum of analytical results for the four major isomers.[74]

Manganese criterion

Oregon's human health criterion for manganese for "fish consumption only" applies only in saltwater for total manganese in order 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.[75] Scientific literature indicates that 90% or more of mercury in fish muscle (tissue not including skin) is methylmercury.[76] 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 only evaluates data from individual fish samples. DEQ compares geometric mean concentrations of mercury from skinless fish fillets in individual resident fish to the human health fish

[74] November 14, 2012, DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion Hexachlorocyclo-hexane-Technical (CAS #: 608-73-1) http://www.oregon.gov/deq/FilterDocs/sToxicsbhcTechnical.pdf

[75] 2007, Method 7473, Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. U.S. EPA Office of Solid Waste

[76] 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.

tissue criterion following EPA guidance.[77] DEQ did not evaluate fish tissue results from analyses for whole fish.

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)

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.[78]

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)

[77] 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.
[78] October 23, 2012 DEQ Memorandum RE: Implementation Instructions for the Water Quality Criterion Nitrosamines (CAS#: 35576-91-1) http://www.oregon.gov/deq/FilterDocs/sToxicsnitrosamines.pdf

Fluoranthene (CAS 206440)
Fluorene (CAS 86737)
Indeno[1,2,3-c,d]pyrene (CAS 193395)
Pyrene (CAS 1290000)

PARAMETER: Turbidity

USES ASSESSED: Aesthetic Quality, Domestic Water Supply

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.

DATA EVALUATION:

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 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 are not data to show whether shutdown is normal after 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 are 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 water quality is good. Water quality is considered good if there are 45 or less high turbidity days per year for all years for which data are available.

Appendix A. State and federal rules, guidance and policies

The 2022 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 http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_041.html
- June 22,1998 DEQ Letter to EPA Region 10, Policy Clarification of Oregon Water Quality Standards Revisions http://www.oregon.gov/deq/FilterDocs/EPALetter062298.pdf
- February 4, 2004 DEQ Letter to EPA Region 10, Oregon Responses to EPA Questions on State's Water Quality Temperature Standards http://www.oregon.gov/deq/FilterDocs/standardsclar.pdf
- December 22, 2017, Memorandum from John Goodin, Office of Wetlands, Oceans, and Watersheds Re: Information Concerning 2018 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2018-01/documents/final_2018_ir_memo.pdf
- August 13, 2015, Memorandum from Benita Best-Wong, Office of Wetlands, Oceans, and Watersheds Re: Information Concerning 2016 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/2016-ir-memo-and-cover-memo-8_13_2015.pdf
- September 3, 2013, Memorandum from Denise Keehner, Office of Wetlands, Oceans, and Watersheds Re: Information Concerning 2014 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/final_2014_memo_document.pdf
- March 21, 2011, Memorandum from Denise Keehner, Office of Wetlands, Oceans, and Watersheds Re: Information Concerning 2012 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/final_2012_memo_document.pdf
- May 5, 2009, Memorandum from Suzanne Schwartz, EPA Office of Wetlands, Oceans, and Watersheds Re: Information Concerning 2010 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/2009_05_06_tmdl_guidance_final52009.pdf
- October 12, 2006, Memorandum from Diane Regas, EPA Office of Wetlands, Oceans and Watershed Re: Information Concerning 2008 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions https://www.epa.gov/sites/production/files/2015-10/documents/2006_10_27_tmdl_2008_ir_memorandum.pdf
- July 29, 2005, Memorandum from Diane Regas, EPA Office of Wetlands, Oceans, and Watersheds Re: Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act https://www.epa.gov/sites/production/files/2015-10/documents/2006irg-report.pdf
- July 21, 2003, Memorandum from Diane Regas, EPA Office of Wetlands, Oceans, and Watersheds Re: Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to

Sections 303(d) and 305(b) of the Clean Water Act https://www.epa.gov/sites/production/files/2015-10/documents/2003_07_23_tmdl_tmdl0103_2004rpt_guidance.pdf

- November 19, 2001, Memorandum from Robert H. Wayland III, EPA Office of Wetlands, Oceans, and Watersheds Re: 2002 Integrated Water Quality Monitoring and Assessment Report Guidance https://www.epa.gov/sites/production/files/2015-10/documents/2002_02_13_tmdl_2002wqma.pdf
- July 2002, Consolidated Assessment and Listing Methodology, First Edition, U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds https://www.epa.gov/sites/production/files/2015-09/documents/consolidated_assessment_and_listing_methodology_calm.pdf
- Federal Water Pollution Control Act 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 2022 Integrated Report

DEQ conducted a public call-for-data from Feb. 1, 2021, through April 2, 2021, to solistice data from the public for use in the 2022 Integrated Report. DEQ used numerous means to advertise and reach out to government agencies and organization to advertise the 2022 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. The 2022 Call for Data was held for 60 days and DEQ received data from 14 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 7,780,785rows of data were assessed from 101 organizations. The organizations in the table below provided data.

Table B-1. Data used in the 2022 Integrated Report.

Organization Name	Number of Results	Data Source
Oregon Department of Human Services	4863	DEQ - Internal
State of Oregon Dept. of Environmental Quality	354578	DEQ - Internal
Clackamas Soil and Water Conservation District	226	DEQ Volunteer Monitoring Program
Calapooia Watershed Council	3607	DEQ Volunteer Monitoring Program
Columbia Soil and Water Conservation District	37810	DEQ Volunteer Monitoring Program
Coquille Watershed Association	39548	DEQ Volunteer Monitoring Program
Columbia Riverkeeper	547	DEQ Volunteer Monitoring Program
Curry Watershed Partnerships	15631	DEQ Volunteer Monitoring Program
Gilliam Soil and Water Conservation District	4518	DEQ Volunteer Monitoring Program
Hyla Woods	8710	DEQ Volunteer Monitoring Program
Johnson Creek Watershed Council	8066	DEQ Volunteer Monitoring Program
Klamath Soil and Water Conservation District	1988	DEQ Volunteer Monitoring Program
Long Tom Watershed Council	18052	DEQ Volunteer Monitoring Program
Lincoln Soil and Water Conservation District	12545	DEQ Volunteer Monitoring Program
Luckiamute Watershed Council	12045	DEQ Volunteer Monitoring Program
Medford Water Commission	259	DEQ Volunteer Monitoring Program
Middle Deschutes Watershed Council	2720	DEQ Volunteer Monitoring Program
North Coast Watershed Association	35671	DEQ Volunteer Monitoring Program
Oregon Department of Agriculture	14492	DEQ Volunteer Monitoring Program
Powder Basin Watershed Council	76496	DEQ Volunteer Monitoring Program
Partnership for the Umpqua Rivers	98943	DEQ Volunteer Monitoring Program
Rogue Riverkeeper	616	DEQ Volunteer Monitoring Program

Organization Name	Number of Results	Data Source
Rogue River Watershed Council	471993	DEQ Volunteer Monitoring Program
Rogue Valley Council of Governments	423	DEQ Volunteer Monitoring Program
Scappoose Bay Watershed Council	237	DEQ Volunteer Monitoring Program
Sherman County Area Watershed Council	996	DEQ Volunteer Monitoring Program
Siuslaw Watershed Council	41328	DEQ Volunteer Monitoring Program
South Santiam Watershed Council	9861	DEQ Volunteer Monitoring Program
South Suburban Sanitary District	10	DEQ Volunteer Monitoring Program
Siuslaw Soil and Water Conservation District	3070	DEQ Volunteer Monitoring Program
Tillamook Estuaries Partnership	7226	DEQ Volunteer Monitoring Program
Upper Deschutes Watershed Council	46674	DEQ Volunteer Monitoring Program
Upper Nehalem Watershed Council	20570	DEQ Volunteer Monitoring Program
Upper Willamette Soil and Water Conservation District	2986	DEQ Volunteer Monitoring Program
Salmon Drift Creek Watershed Council	2851	DEQ Volunteer Monitoring Program
Walla Walla Basin Watershed Council	22096	DEQ Volunteer Monitoring Program
Wasco County Soil and Water Conservation District	699	DEQ Volunteer Monitoring Program
Oregon Water Resources Department	5787	Integrated Report - Readily Available Data
Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling	609	Integrated Report - Readily Available Data
USGS Oregon Water Science Center	3434241	Integrated Report - Readily Available Data
Washington Department Of Ecology	186	Integrated Report - Readily Available Data
Bureau of Reclamation	4221	Integrated Report - WQP
National Park Service Water Resources Division	23	Integrated Report - WQP
Adventure Scientists(Volunteer)*	115	Integrated Report - WQP
Burns Paiute Tribe (Tribal)	3862	Integrated Report - WQP
Coquille Indian Tribe (Tribal)	836	Integrated Report - WQP
Confederated Tribes of the Grand Ronde Community of Oregon (Tribal)	25277	Integrated Report - WQP
Confederated Tribes of the Umatilla Indian Reservation (Tribal)	193865	Integrated Report - WQP
North American Lake Management Society	464	Integrated Report - WQP
USGS Idaho Water Science Center	1234	Integrated Report - WQP
USGS Oregon Water Science Center	18793	Integrated Report - WQP
(Internal) Confederated Tribes of the Warm Springs Tribe of Oregon	20723	Integrated Report - WQP
Confederated Tribes of the Warm Springs Reservation of Oregon	4914	Integrated Report - WQP
California Department of Fish and Wildlife	765	Submitted to DEQ - Data Call
Columbia River Inter-Tribal Fish Commission	71749	Submitted to DEQ - Data Call
East Multnomah Soil and Water Conservation District	22928	Submitted to DEQ - Data Call

Organization Name	Number of Results	Data Source
Idaho Power Company	78378	Submitted to DEQ - Data Call
City of Portland Water Bureau	23828	Submitted to DEQ - Data Call
Portland State University	2658	Submitted to DEQ - Data Call
City of Bend Water Quality Laboratory	165728	Submitted to DEQ - Integrated Report Call for Data
City of Gresham	75618	Submitted to DEQ - Integrated Report Call for Data
City of West Linn	495	Submitted to DEQ - Integrated Report Call for Data
Clean Water Services	982	Submitted to DEQ - Integrated Report Call for Data
Deschutes River Alliance	32014	Submitted to DEQ - Integrated Report Call for Data
National Estuarine Research Reserve System - South Slough	40285	Submitted to DEQ - Integrated Report Call for Data
NOAA Newport Hydrographic Line	5214	Submitted to DEQ - Integrated Report Call for Data
Ocean Observatories Initiative	9780	Submitted to DEQ - Integrated Report Call for Data
US Environmental Protection Agency	101411	Submitted to DEQ - Integrated Report Call for Data
US Forest Service - Umbrella	731348	Submitted to DEQ - Integrated Report Call for Data
Weyerhaueser Timber Company	3285	Submitted to DEQ - Integrated Report Call for Data
City of Jefferson	1092	Submitted to DEQ - Integrated Report DW Provider
City of Kernville-Gleneden	788	Submitted to DEQ - Integrated Report DW Provider
City of Philomath	899	Submitted to DEQ - Integrated Report DW Provider
City of Willamina	1095	Submitted to DEQ - Integrated Report DW Provider
City of Ashland	292	Submitted to DEQ - Permittee
City of Astoria	9235	Submitted to DEQ - Permittee
City of Cottage Grove	98	Submitted to DEQ - Permittee
Dallas, City of	167	Submitted to DEQ - Permittee
Hermiston, City of	183	Submitted to DEQ - Permittee
Klamath Falls, City of	118	Submitted to DEQ - Permittee
City of Molalla STP	14	Submitted to DEQ - Permittee
City of Ontario STP	46	Submitted to DEQ - Permittee
City of Sandy WWTP	37	Submitted to DEQ - Permittee
City of St. Helens and Boise Cascade Timber Company	186	Submitted to DEQ - Permittee
City of The Dalles STP	178	Submitted to DEQ - Permittee
City of Troutdale WWTP	162	Submitted to DEQ - Permittee
Dry Creek Landfill	5	Submitted to DEQ - Permittee
Dyno Nobel Inc.	167	Submitted to DEQ - Permittee

Organization Name	Number of Results	Data Source
EVRAZ Inc.	28	Submitted to DEQ - Permittee
Georgia-Pacific Consumer Operations LLC (Wauna Mill)	177	Submitted to DEQ - Permittee
International Paper (formerly Weyerhaeuser)	130	Submitted to DEQ - Permittee
Roseburg Landfill	51	Submitted to DEQ - Permittee
Rogue Valley Sewer Services	694	Submitted to DEQ - Permittee
Willamette Falls Paper Company	112	Submitted to DEQ - Permittee
City of Eugene	5494	Submitted to DEQ - Permittee/Call for Data
City of Lincoln City	1032	Submitted to DEQ - Permittee/Call for Data
City of Myrtle Point	392	Submitted to DEQ - Permittee/Call for Data
City of Newport	1363	Submitted to DEQ - Permittee/Call for Data
City of Salem	1120546	Submitted to DEQ - Permittee/Call for Data
City of Stayton	1401	Submitted to DEQ - Permittee/Call for Data
City of Portland Bureau of Environmental Services	164776	Submitted to DEQ - Permittee/Call for Data

Narrative data was also assembled for the assessment from the: Oregon Invasive Species Hotline (https://oregoninvasiveshotline.org), Oregon Health Authority Harmful Algal Bloom Advisories (https://www.oregon.gov/oha/ph/healthyenvironments/recreation/harmfulalgaeblooms/pages/blue-greenalgaeadvisories.asp

Some data provided were excluded from the Integrated Report analysis. Table B-2 identifies the reasons numeric data were excluded from the Integrated Report analysis. Table B-3 identifies the reasons narrative data submitted to DEQ were excluded from the Integrated Report analysis.

Table B-2. Numeric data excluded from the 2022 Integrated Report.

Reason data was excluded from the analysis	Number of Results
Sample not representative of surface water	12661
More precise analytical method used	71369
Duplicate data	4583
Failed data validation	4508
Duplicate samples at multiple depths	3365
Invalid method	79
Sample depth not comparable to water quality criteria	7860
Suspect data	5288

Table B-3. Narrative data excluded from the 2022 Integrated Report.

	Data source	Reason(s) for using or not using data source
1	Conservation Assessment for the Cascade Torrent Salamander (Rhyacotriton cascadae); Version 1.0, February 2011	The Conservation Assessment identifies probable threats to salamander populations but does not provide supporting evidence or specific locations for which particular waterbodies are of concern.

2	Center for Biological Diversity, Petition to List 53 Amphibians and Reptiles in the United States as Threatened or Endangered Under the Endangered Species Act	Identifies broad threats to these species but no site-specific information as to water quality impairment at specific locations.
3	U.S. Fish and Wildlife Service, Endangered and Threatened Wildlife and Plants; 90-Day Findings on 25 Petitions, 80 Fed. Reg. 56423 (Sept. 18, 2015)	Initiated status reviews for 23 of 25 petitions; no Oregon specific data on water quality impairment.
4	U.S. Fish and Wildlife Service, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Oregon Spotted Frog (May 11, 2016)	Identifies broad threats to the Oregon spotted frog but no site-specific information as to water quality impairment at specific locations
5	Oregon Department of Fish and Wildlife, Amphibians – Oregon Conservation Strategy, https://oregonconservationstrategy.com/ocs-strategy-species/amphibians/	No data or any specific information pertaining to water quality impairments in Oregon waterbodies.
7	Northwest Partners in Amphibian and Reptile Conservation, NW PARC Resources, https://www.nwparc.org/resources	Payment required to access journal article. Abstract summarized that variation in physical features of stream habitats may have the most important influence on distribution and abundance of Columbia torrent salamanders.
8	Cyanobacteria toxicity test results for state waters.	DEQ incorporated cyanobacteria toxicity test results for those waterbodies where cyanoHABS advisories were issued for the given period of record and cyanotoxin monitoring data collected by drinking water facilities in this assessment.
9	Status of endangered species and science on toxic contamination thereof.	Such reports identify threats from toxics to the species in general; it does not draw linkages to water quality impairment at a specific geographic location.
10	Fish passage barriers (e.g., culverts) in state waters.	Without any additional data or information to support an impairment conclusion, aside from an inventory of fish passage barriers, DEQ is unable to use this data as part of its assessment. Fish passage prioritization and inventory is a requirement of the ODFW's Fish Passage Program (FPP) through Oregon Revised Statute (ORS) 509.585 (3). This statute states that ODFW shall "complete and maintain a statewide inventory in order to prioritize enforcement actions based on the needs of native migratory fish."
11	Swimming, shellfish gathering and consumption, bed closure, and fish consumption advisories for state waters.	Shellfish bed closures and advisories and fish consumption advisories are included as part of DEQ's assessment methodology. Beach closures occur due to exceedances of the enterococci statistical threshold value (STV) which is also assessed as part of DEQ's methodology.

12	Violations of Safe Drinking Water Act standards and reports of tastes and odors in drinking water for state waters	Drinking water standards are applied after water treatment has occurred and therefore are not representative of ambient waterbody condition. If standards are not met in source water, prior to treatment, that is considered as part of DEQ's assessment methodology.
13	Modeling done for state waters	Modeling is often done for predictive purposes which may be helpful for identifying areas of concern. Model conclusions may be used to support an assessment determination, but absent any data, would not be the sole reason for listing.
14	Fish and other aquatic life kills, fish and other aquatic life lesions and health impacts (reproductive impairment, organ deformities, etc.), fish and other aquatic life extirpations and local declines, depressed populations of aquatic species, identification of candidate aquatic species under the Endangered Species Act or state ESA for species found in or dependent upon state waters.	These studies/reports would be included as supporting evidence in the assessment if they were provided as part of the call for data and contained information linking the impact to a specific parameter and waterbody location in Oregon.
15	ESA-listed aquatic species in state waters, e.g., recovery, critical habitat, five-year reviews, initial listing.	The intent of endangered species status assessments is not to demonstrate water quality impairments at specific Oregon locations. Such reports identify broad threats to the species in general.
16	ESA-listed aquatic-dependent species near or dependent on state waters.	The presence of ESA listed species may factor into priorities for TMDL development, but status assessments alone do not provide specific water quality and geographic information to be used in DEQ's Integrated Report.
17	Toxic contaminants present in tissue of invertebrates and aquatic-dependent wildlife in or near state waters, e.g., U.S. Fish & Wildlife Service.	If such data are provided as part its data call and linked to site-specific locations in Oregon state waters, DEQ will include it as part of its assessment.
18	Toxic contaminants present in tissue of aquatic life and sediments in state waters.	DEQ is currently working on a methodology to incorporate toxics in tissue samples, anticipating a final methodology for the 2026 Integrated Report assessment cycle. Absent any sediment specific toxics criteria, DEQ would not assess on sediment data alone.
19	Algal bloom information for state waters and near shore areas and beaches.	DEQ currently assesses harmful algal blooms as part of its methodology.
20	Toxics in the Columbia River including sediment, tissue, semipermeable membrane devices	The Columbia River has already been identified as impaired for toxics in previous Integrated Reports. It has been listed as impaired for arsenic, DDT, DDE, DDD, dioxin, mercury, PCBs and PAHs.
21	Conventional pollutants in the Columbia River including identification and use of thermal refugia.	DEQ currently assesses data provided on conventional pollutants in the Columbia River. A TMDL for temperature was finalized in 2021.
22	Large-scale probabilistic monitoring designs that pertain to state waters	DEQ uses data submitted voluntarily through its call for data and data it pulls from publicly accessible databases for its assessment. If there are large scale monitoring efforts contained in

		either of these sources than it is already part of DEQ's assessment process.
23	Simple dilution calculations performed for state waters	DEQ has not determined how dilution calculations would be included as part of an Integrated Report assessment.
24	Data submitted from NPDES sources and information about impacts of discharges from NPDES sources that discharge to state waters, e.g., evaluations of contaminants in hatchery fish feeds.	Per its methodology, DEQ does not analyze effluent data as part of its assessment since it is not representative of the waterbody itself. Instream toxics data submitted through the Toxics Electronic Data Delivery program is assessed as part of the Integrated Report.
25	Source assessments pertaining to CERLCA sites, sediment contamination, and Natural Resources damages assessments.	Data from source assessments contained in publicly available databases are evaluated as part of the assessment process. Any additional data must be submitted through DEQ's call for data.
26	Results of predictive and simulation modeling for state waters.	Predictive simulation modeling may be used in conjunction with data collected, but would not be used as the sole basis for an impairment listing.
27	Ecological landscape analysis that pertains to state waters.	Ecological landscape analysis is best applied following determination of a water quality impairment. It can be applied as a tool for identifying possible source contributions to water quality impairment.
28	Remote sensing information for state waters, including use of LIDAR.	Remote sensing has been used to enhance DEQ's capability to assess harmful algal blooms, however it would not be used absent any data specific to instream surface water quality.
29	Complaints from the public about state water quality problems.	Complaints from the public are investigated as appropriate as part of DEQ's complaints process. Monitoring data collected as part of a complaints response and uploaded into AWQMS is included in DEQ’s assessment.
30	Impacts of hydroelectric dams operated by the Army Corps of Engineers and others that are on or affect state waters and species.	Any ambient data submitted through the call for data in waters with hydroelectric dams will be considered. For dams collecting ambient data as part of a hydroelectric certification, those data are a priority for DEQ’s assessment team in future cycles.
31	Aquatic invasive species (plant and animal) present in state waters.	Aquatic invasive species data is utilized in the assessment using data from the invasive species hotline.
32	Pharmaceuticals and personal care products and other “chemicals of emerging concern” discharged to and present in state waters and effects on aquatic species.	Toxic pollutants are assessed as part of DEQ's toxics monitoring program, however absent water quality criteria, waterbodies would not be assessed.
33	Data and information from semipermeable membrane devices deployed in state waters.	DEQ may consider using data collected from semipermeable membrane devices as part of its assessment were an assessment methodology developed. Any methodology developed would have to undergo peer review as required under Oregon statute ORS 468B.039.

34	Data and information from biochemical analyses of tissue samples, liquid chromatography and mass spectroscopy methods to measure wastewater and estrogenic, compounds in juvenile salmon bile and plasma samples, salmon stomach contents, salmon prey, salmon otoliths, etc. that pertain to identifying potential adverse effects of contaminants on salmon and food webs in state waters.	Data from these types of studies do not demonstrate ambient water conditions at specific geographic locations in Oregon. Data generated from these studies do not document that adverse effects on salmon are related to impacts at the same location. All relevant tissue data associated are assessed as part of DEQ's assessment process.
35	Temporal and spatial trends in persistent organic pollutants in state waters.	Persistent organic pollutants are monitored as part of DEQ's Toxics Monitoring Program and data collected as part of this program are used in its Integrated Report assessment. Trends in pollutant concentrations may be evaluated through access to raw data used in the assessment available through DEQ's online database.
36	Ecological risk models that pertain to species in state waters.	These types of models are better suited for prioritization of protection or restoration areas, not as a determination of which waterbodies may be impaired. Ecological risk assessment models provide information to risk managers about potential adverse effects of different risk management decisions. Risk assessment models are typically used in nationwide rulemaking, for setting environmental limits for chemicals, Superfund site remediation, pesticide application approval or prioritizing environmental stressors for regulatory attention.
37	Closures of recreational and commercial shellfish harvesting beds in state waters.	Closures of shellfish beds are considered as part of DEQ's assessment methodology.
38	Data and information on aquatic weeds in state waters.	Data and information on aquatic weeds as contained in publicly accessible databases (e.g., Aquatic Invasive Species hotline) are considered as part of DEQ's assessment methodology.
39	Data and information on impacts from excess fine sediment and low intergravel dissolved oxygen on salmon redds in state waters.	Were data to be provided during the data call, DEQ would include it as part of its assessment.
40	Bioassessment data and information that are not River Invertebrate Prediction and Classification System and Index of Biological Integrity scores.	Were data to be provided during the data call, DEQ would include it as part of its assessment.
41	Ecoregion data that includes state waters.	Data collected as part of EPA's National Aquatic Resource Surveys is incorporated into DEQ's assessments as it becomes available.

Appendix C. Marine Dissolved Oxygen Water Quality Assessment

In the 2018/2020 Integrated Report, DEQ determined that Oregon territorial waters should be placed into Category 3B: *insufficient data; potential concern for marine dissolved oxygen where there is insufficient data to determine use to 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 are insufficient data within Oregon waters to determine nonattainment of the narrative marine dissolved oxygen criterion. DEQ received additional dissolved oxygen data during its 2022 call for data collected at the Newport Hydrographic Line. Data were collected by National Oceanic and Atmospheric Association staff on oceanographic cruises every two weeks for the past 20+ years (1998 to present) in continental shelf and slope waters off the coast of Newport Oregon, along the Newport Hydrographic Line. Data collected at sites NH01 (approximately 1.5 miles offshore) and NH03 (approximately 3 miles offshore) were used in the 2022 assessment.

In order to make a 303(d) determination for marine dissolved oxygen, DEQ evaluated if data and information provided through the data call were sufficient to determine if its narrative standard for dissolved oxygen in ocean waters was being attained and if beneficial uses were supported.

Oregon's dissolved oxygen criteria for ocean waters states:

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.*

The purpose of Oregon's marine dissolved oxygen narrative criterion is to prevent measurable reductions of dissolved oxygen in marine waters based on the language "…no measurable reduction… *<u>may</u> be allowed*." The dissolved oxygen standard in Oregon Administrative Rules 340-041-0016 provides that no waste discharges or activities conducted may cause these criteria to be exceeded.

The dissolved oxygen standard is not unique in its focus on limiting measurable change. Other Oregon water quality standards limit changes from natural conditions for parameters with natural variability such as temperature, turbidity, and several of the narrative criteria in OAR 340-041-0007, and the temperature criterion for ocean and bay waters (see the references below). When this dissolved oxygen criterion was adopted in 1996, changing ocean conditions due to climate change were not a factor of consideration.

Ocean Observatories Initiative Data

Continuous dissolved oxygen data from a single monitoring location (CE01ISSM) were pulled from the Ocean Observatories Initiative database and submitted to DEQ. Data were collected and analyzed at two depths (7.0 meters and 25.0 meters) for the period of record from 04-13-2018 through 12-31-2020. Dissolved oxygen concentrations were reported as µmol/kg and were subsequently converted to mg/L using the equation:

$$DO\ measured\ concentration * \left(\frac{1.4}{63.9}\right) * 1.42905$$

Where: (1.4/63.9) = coefficient that converts from µmols/milliliters
1.42905 = coefficient that converts from milliliters to milligrams at constant pressure

The first step in DEQ's assessment was to visualize the data. Chan et. al. 2019 defined conditions for marine DO (Table C-1).

Table C-20. Marine DO conditions defined by Chan et al 2019

Status	Value	units
Hypoxic	1.99864	mg/l
Severe Hypoxia	0.71380	mg/l
Suboxic	0.14276	mg/l
Anoxic	0.00000	mg/l

Dissolved oxygen concentrations exhibit a seasonal pattern, with regular drops into severe hypoxia conditions during summer months and occasional drops into suboxic conditions (Figure C-1). There is no corroborating evidence submitted during the data call to indicate that discharged wastes or activities, rather than natural seasonal and climatic variability caused these reduced dissolved oxygen concentrations.

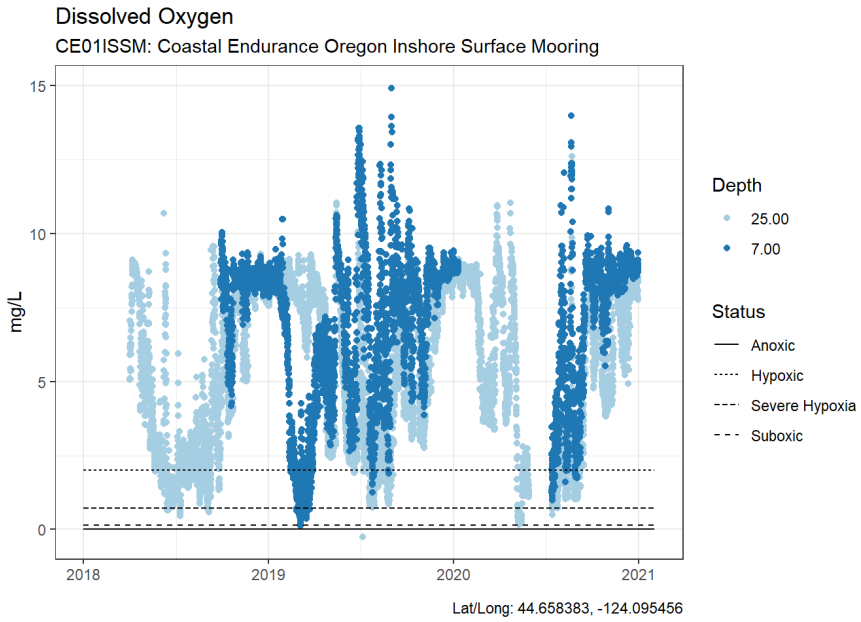

Figure C-7. Dissolved oxygen concentrations at CE01ISSM for the period of record 2018 -2021

To address the seasonal changes in dissolved oxygen concentrations, DEQ calculated monthly average dissolved oxygen concentrations and plotted the results on a graph (Figure C-2). To ensure data completeness, months with > 3 days missing were discarded from the analysis. A seasonal Mann Kendall test was run to detect trends in the dataset. Since the seasonal Mann Kendall test compares like seasons, the month was used to approximate season in order to account for seasonal dissolved oxygen variation. No trend was detected at either depth, where p-value < 0.1 is considered a significant trend (Table C-2).

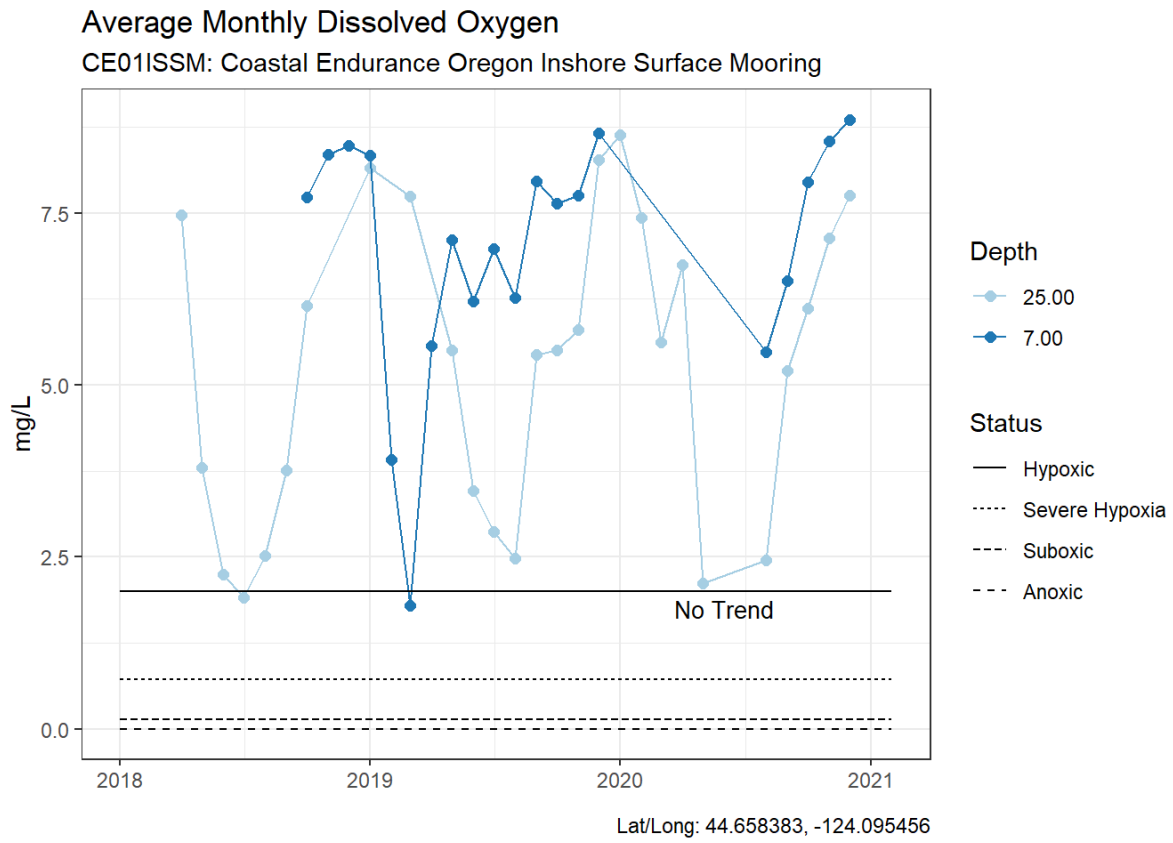

Figure C-8. Average monthly dissolved oxygen concentrations at CE01ISSM at 7 meter and 25 meter depths.

Table C-21. Seasonal Mann-Kendall results on dissolved oxygen concentrations at 7 meter and 25 meter depth.

Location_depth	Significance	P value	Slope
CE01SSM – 25 m	No Trend	0.6674365	-0.0210354
CE01SSM – 7 m	No Trend	0.5790997	0.1116678

NOAA Newport Hydrographic Line Data

The second data set analyzed was ship-based discrete dissolved oxygen samples taken along the Newport line (Figure C-3, Table C-3). These data constitute a longer dataset and represent two monitoring locations.

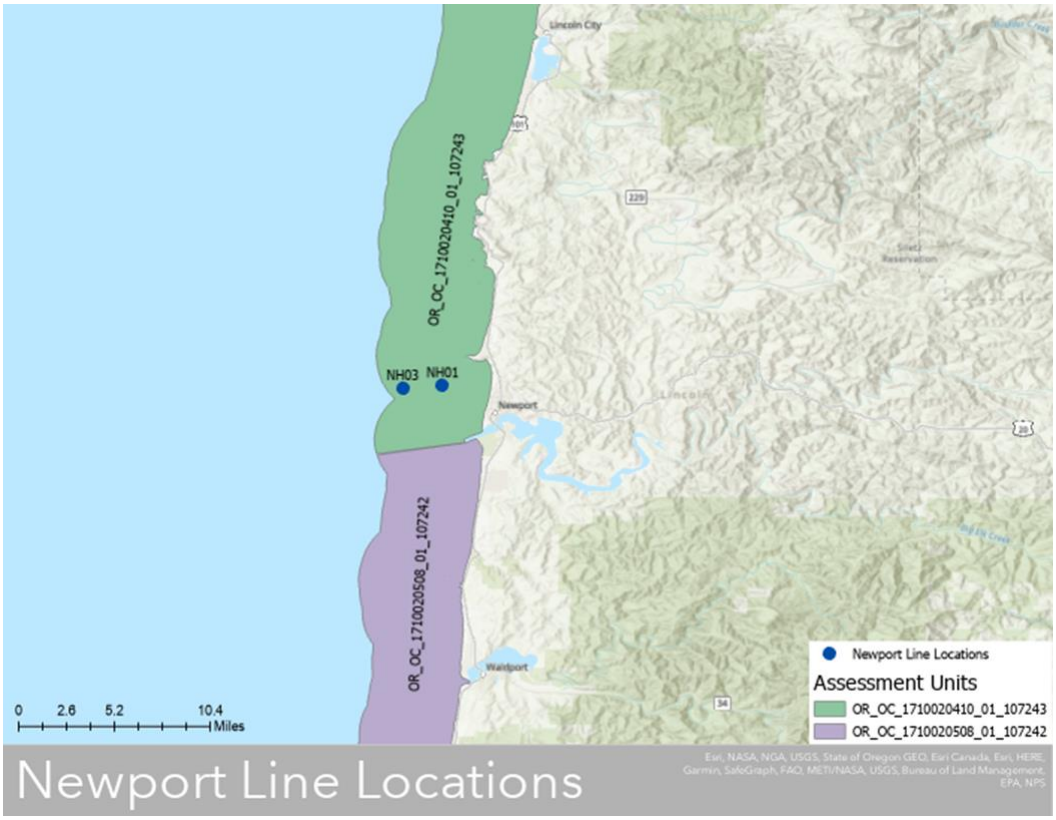

Figure C-9. Marine sampling locations along Newport Hydrographic Line

Table C-22. Data summary for Newport Hydrographic Line

Monitoring Location ID	Min. date	Max. date	Min_depth (m)	Max_depth (m)	Number_ depths
NH01	08-14-1998	03-24-2021	0.0	35.0	96
NH03	08-14-1998	03-24-2021	1.0	49.0	313

The length of time over which this data set was collected was long enough to approach the question of "has there been a 'measurable reduction in dissolved oxygen concentration'"? First, DEQ divided the data into three depth bins: Upper (≤ 16.667 m); Mid (> 16.667 and ≤ 33.334 m); and Bottom (> 33.334m). Second, the data were divided into two time periods, "IR period" which represented the current Integrated Report window (≥ 2016-01-01) and historical data (< 2016-01-01) which represented historical dissolved oxygen concentrations. The first analysis attempted to determine if the mean historical dissolved oxygen values were significantly different from the current IR data window means. Significant difference was identified where p-value < 0.05.

NH01

Site NH01 is the innermost site on the Newport Hydrographic Line. It is located approximately 1.5 miles offshore. Because this location contained only two results in the "Bottom" depth bin, "Bottom" depth was eliminated from further analysis. Next, the assessment team plotted the data to determine normality (Figure C-3).

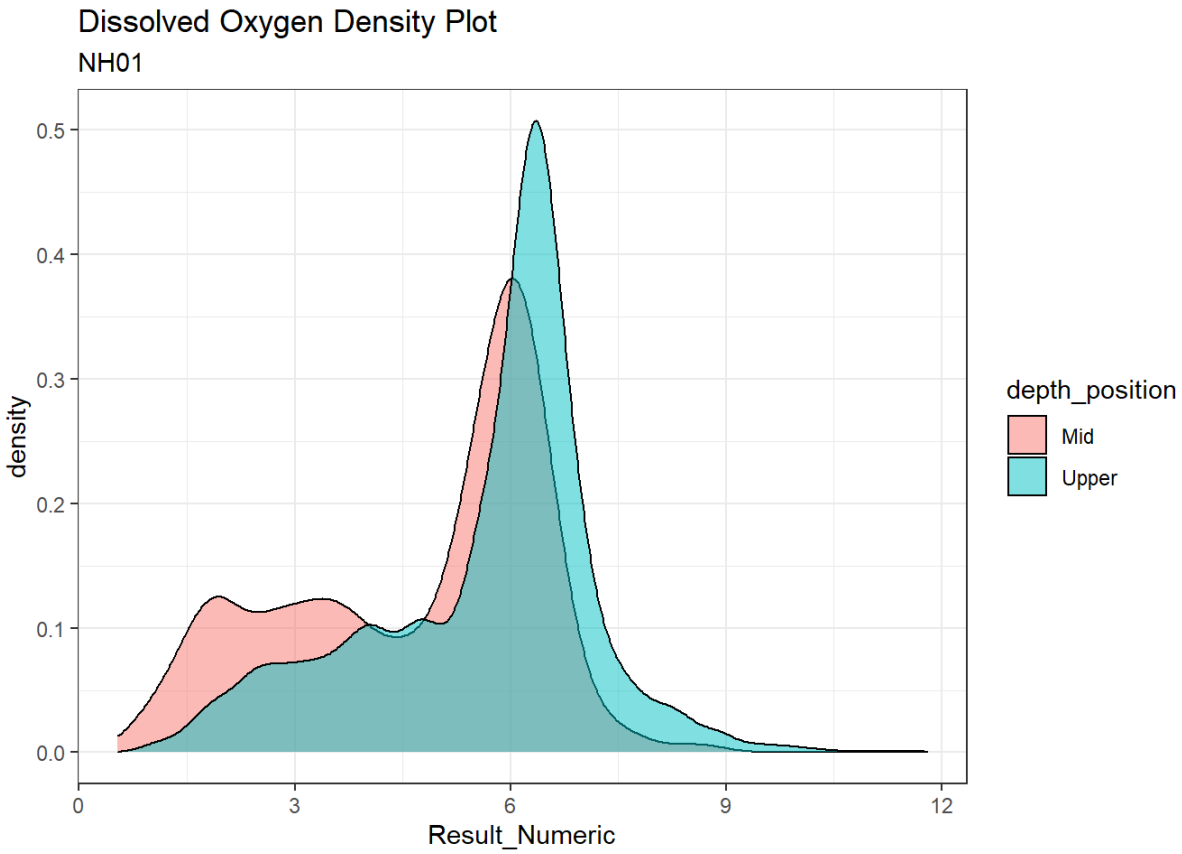

Figure C-10. Dissolved oxygen data distribution at site NH01

Due to the data's bimodal distribution, DEQ ran a two-sample Wilcoxon test to detect statistical significance between the two time periods. There was no significant difference between the two time periods for either depth (Table C-4). A boxplot of the data confirms this conclusion (Figure C-4).

Table C-23. Results from 2-sample Wilcoxan test on data periods of record

Location_depth	Significance	P value
NH01 - Top	No significant difference	0.948
NH01 - Mid	No significant difference	0.763

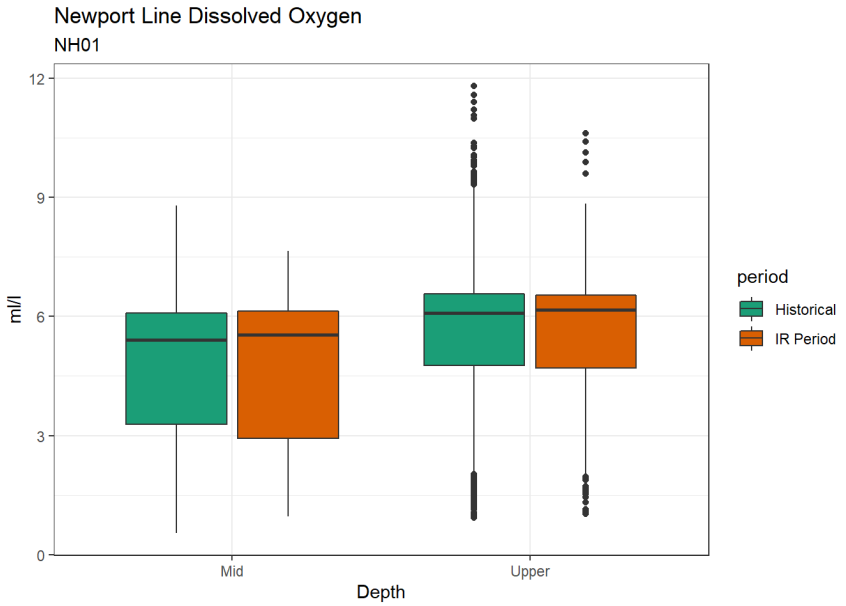

Figure C-11. Boxplot of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005)

Looking at mean dissolved oxygen levels expressed on an annual basis does not consider the fact that marine dissolved oxygen concentrations typically follow a seasonal pattern and coastal upwelling typically occurs in late summer. Therefore, the test was repeated for data for the month of August. The month of August demonstrated a significant difference between mean dissolved oxygen concentrations in the historical time period and the current Integrated Report data window (p-value = 8.103×10^{-15}). The Integrated Report data window demonstrated lower mean dissolved oxygen concentrations in both the Upper and Mid portions of the water column (Figure C-5).

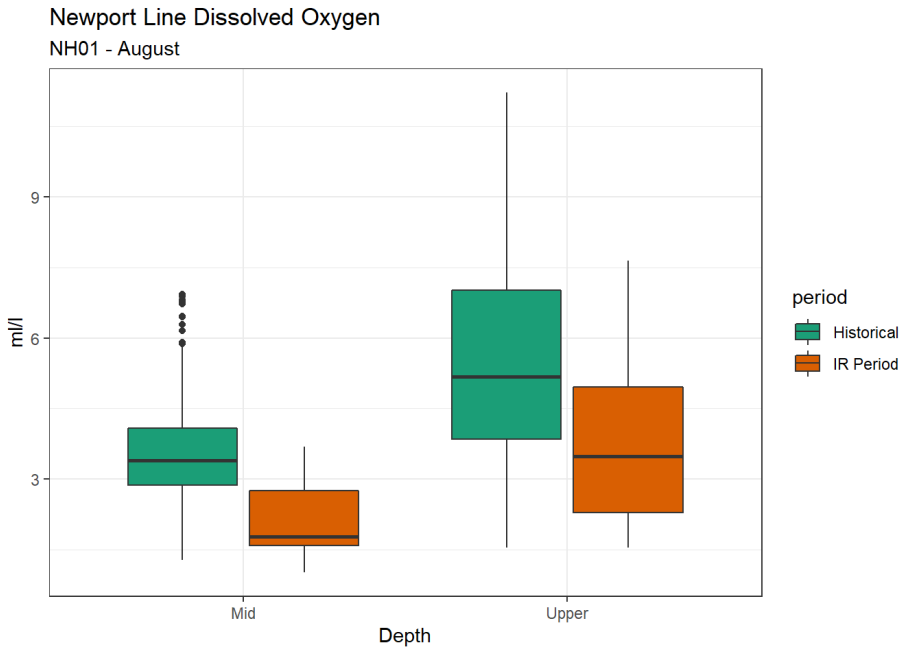

Figure C-12. Boxplot of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005) at site NH01 for the month of August

NH03

The same analysis was done on site NH03, located approximately three miles offshore, which marks the furthest extent of marine territorial waters. Site NH03 exhibited a similar bi-modal distribution (Figure C-6), so a two-sample Wilcoxon test was run to detect statistical significance between the two time periods. First, the test was run on the upper portion of the water column. Results from the upper portion of the water column suggest there is no significant difference between mean dissolved oxygen concentrations in the historical time period and the current Integrated Report window (p-value of 0.856). The following test looked at the Mid-level data. Results from the Mid-level suggest there is a significant difference between mean dissolved oxygen concentrations in the historical time period and the current Integrated Report window (p-value of 0.036). Lastly, the two-sample Wilcoxan test was run on samples collected the bottom depth range. Results from the bottom depth suggest there is a significant difference between mean dissolved oxygen concentrations in the historical time period and the current Integrated Report window in Table 5 (p-value of 0.035).

Table C-24. Results from 2-sample Wilcoxan test at site NH03

Location_depth	Significance	P value
NH03 - Top	No significant difference	0.856
NH03 - Mid	Significant difference detected	0.036
NH03 - Bottom	Significant difference detected	0.035

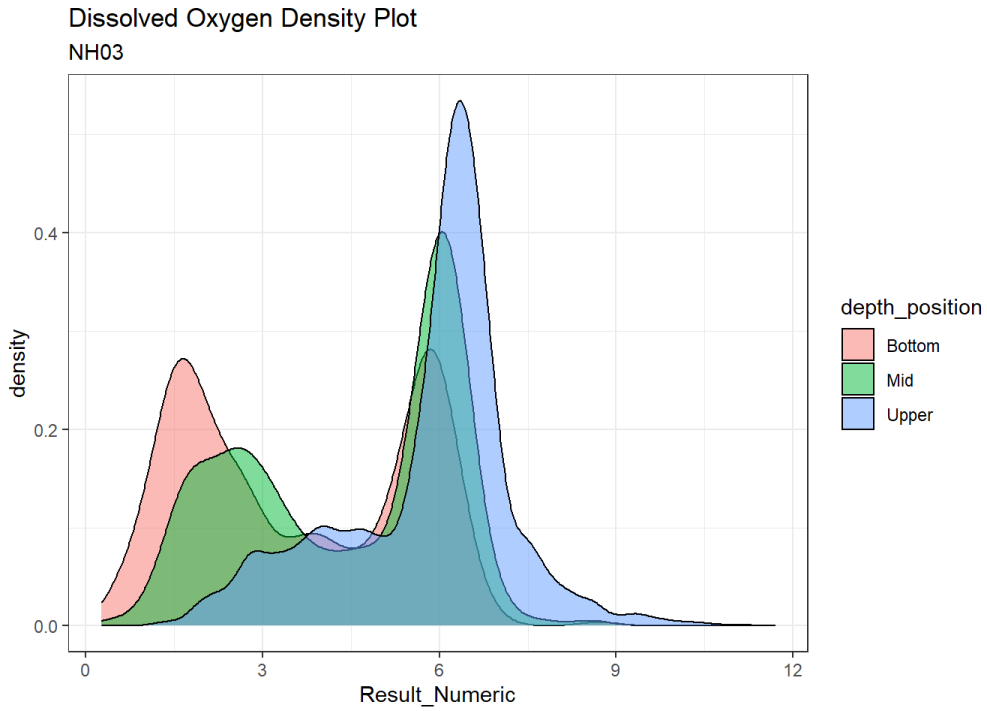

Figure C-13. Dissolved oxygen data distribution at site NH03

The boxplots show that while the means have a slight statistically significant difference, the relative distributions of the dissolved oxygen concentrations are roughly the same (Figure C-7).

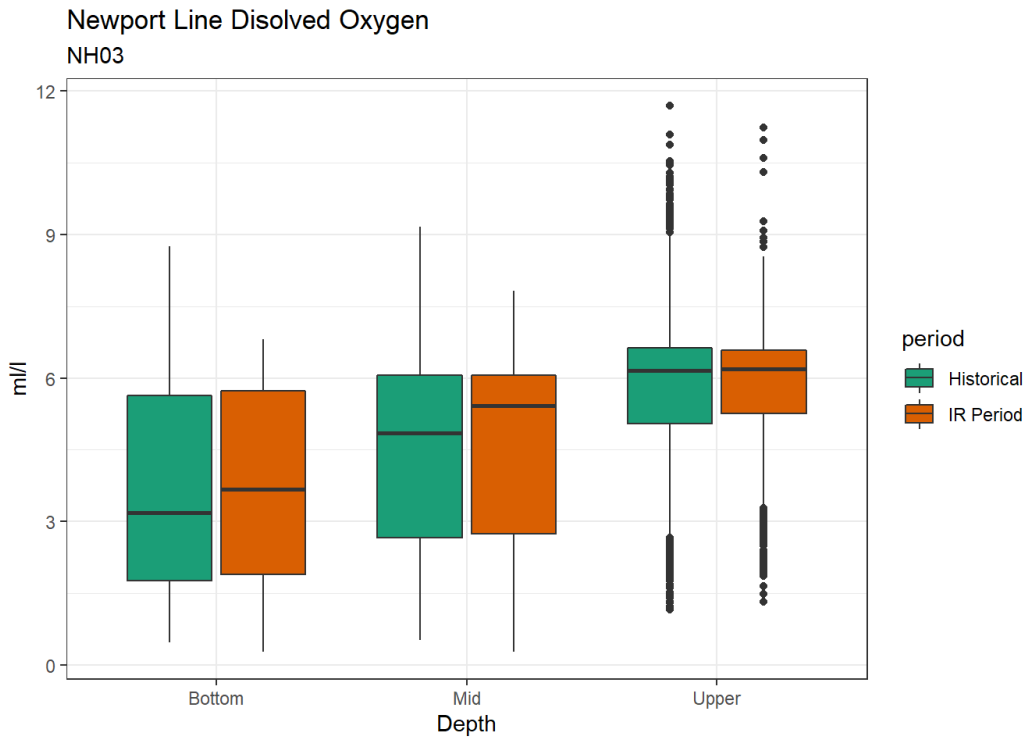

Figure C-14. Boxplot of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005) at three different depth ranges at site NH03

The next analysis looked at the month of August specifically at Site NH03. Statistical differences were reflected at all depth ranges between historical data and the Integrated Report data window (Table C-6, Figure C-8).

Table C-25. Results from 2-sample Wilcoxan test for the month of August at site NH03

Location_depth	Significance	P value
NH03 - Top	Significant difference detected	0.0000001
NH03 - Mid	Significant difference detected	0.00000000002786
NH03 - Bottom	Significant difference detected	0.0002316

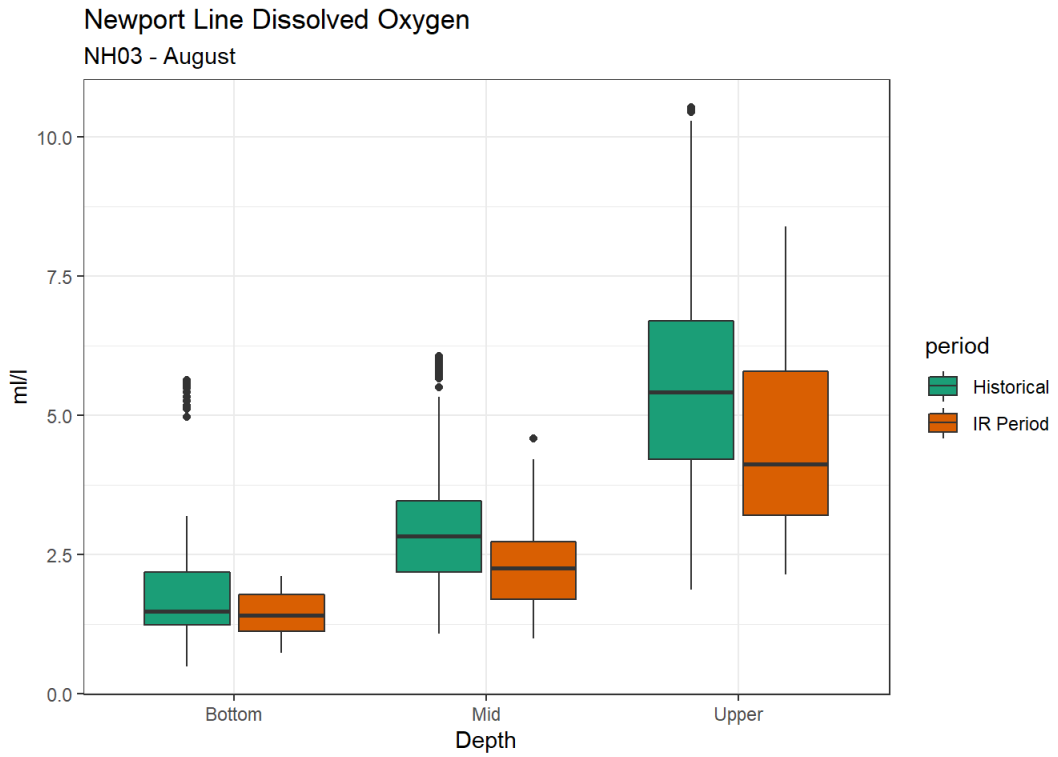

Figure C-15. Boxplot of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005) at site NH03 for the month of August

Since the month of August results were significantly different, the next step was to investigate the remaining months to determine if there were differences in all of the months of the year (Table C-7). A Bonferroni correction was done to adjust p-values when making multiple statistical tests.

Table C-26. Monthly results from 2-sample Wilcoxan test for sites NH01 and NH03, Bonferroni corrected p-value is significant.

MLocID	Month	Mid-level depth	Upper depth	Bottom Depth
NH01	Jan	Significant	Significant	NA
NH01	Feb	No statistical significance	No statistical significance	NA
NH01	Mar	No statistical significance	No statistical significance	NA
NH01	Apr	No statistical significance	Significant	NA
NH01	May	Significant	Significant	NA
NH01	Jun	No statistical significance	No statistical significance	NA
NH01	Jul	No statistical significance	No statistical significance	NA
NH01	Aug	Significant	Significant	NA
NH01	Sep	Significant	Significant	NA
NH01	Oct	No statistical significance	No statistical significance	NA
NH01	Nov	No statistical significance	No statistical significance	NA
NH01	Dec	No statistical significance	No statistical significance	NA
NH03	Jan	No statistical significance	Significant	No statistical significance
NH03	Feb	Significant	Significant	No statistical significance
NH03	Mar	Significant	Significant	Significant
NH03	Apr	No statistical significance	Significant	No statistical significance
NH03	May	Significant	No statistical significance	No statistical significance
NH03	Jun	No statistical significance	No statistical significance	Significant
NH03	Jul	Significant	No statistical significance	Significant

MLocID	Month	Mid-level depth	Upper depth	Bottom Depth
NH03	Aug	Significant	Significant	Significant
NH03	Sep	Significant	Significant	Significant
NH03	Oct	No statistical significance	No statistical significance	No statistical significance
NH03	Nov	No statistical significance	No statistical significance	Significant
NH03	Dec	No statistical significance	Significant	No statistical significance

For the monitoring location NH01, five of 12 months demonstrated statistical significance in mean dissolved oxygen concentrations at mid-level depths while six of 12 months were statistically significant at upper depths. Although five of the months demonstrated statistical significance, the months of June and September demonstrated higher mean dissolved oxygen concentration at the mid (September) and upper depths (June, September) (Figure C-9).

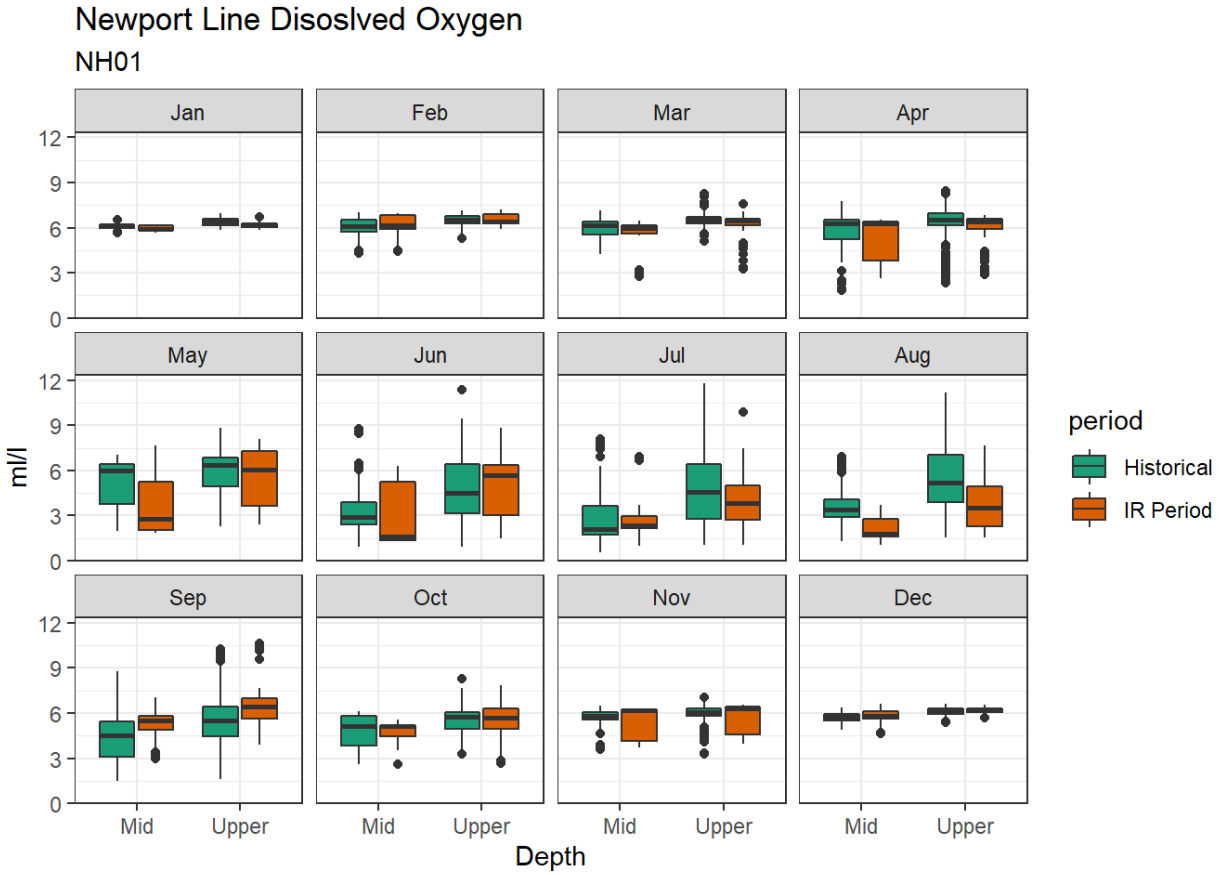

Figure C-16. Monthly boxplots of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005) at site NH01

Results from monitoring location NH03 show statistically significant differences in mean dissolved oxygen concentrations in nine of 12 months at mid-level depths, eight of 12 months at upper depths, and eight of 12 months at bottom depths. Like site NH01, several of those months showed a statistically significant increase in mean dissolved oxygen concentrations in the months June and September.

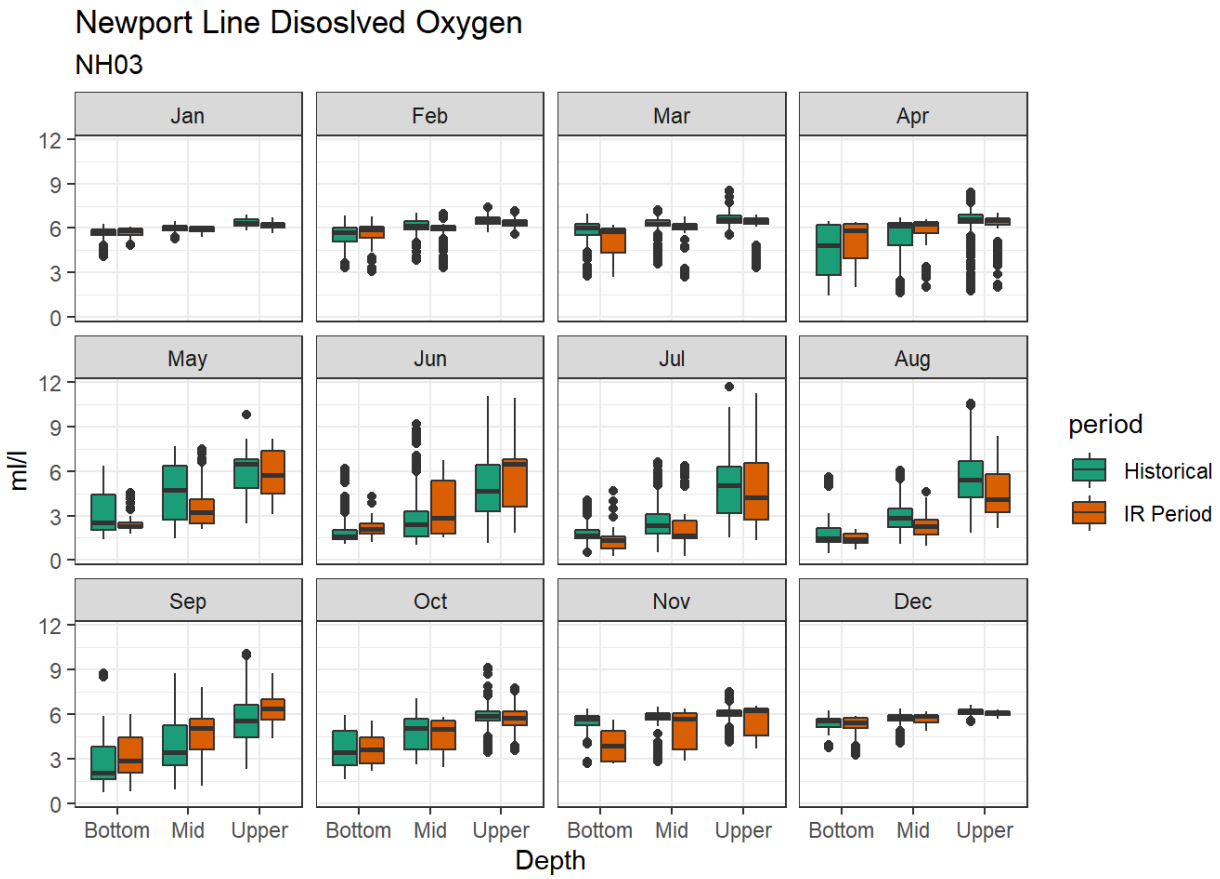

Figure C-17.Monthly boxplots of mean dissolved oxygen concentrations for current IR data window (2016-2020) and historical POR (1998-2005) at site NH03

Due to the month-to-month differences in mean dissolved oxygen levels, it is difficult to draw conclusions whether a "measurable change" in dissolved oxygen concentrations has occurred. Using this simplified method to compare the current reporting period with historical measurements across three depth bins, created from the data range, suggests a decrease in dissolved oxygen measurements during some months (Figures C-5 & C-8). However, considering the variability in the comparative differences throughout the year (Figures C-9 & C-10) combined with considerable spatial and temporal variability inherent in the system, make drawing attainment conclusions difficult. Ultimately, without clear methodological approaches to incorporate depth binning commensurate with the density of ocean layers and stratification changes and account for intraseasonal variability in hypoxic conditions and locations, determining "measurable reduction" of dissolved oxygen concentration across an entire assessment unit based on these data is not feasible at this time. Therefore, DEQ concluded this assessment unit should remain as Category 3B;insufficient data; potential concern. DEQ has convened a scientific technical work group to assist with development of an assessment method for marine dissolved oxygen for future Integrated Report cycles. Working with this recently formed group in the coming months, DEQ expects to outline appropriate methods to inform future determinations about marine dissolved oxygen concentrations in Oregon's territorial waters. DEQ seeks to understand the effects of reduced dissolved oxygen concentrations on fish and wildlife communities, and to more fully understand long term trends in marine dissolved oxygen in territorial waters and its impacts on aquatic communities.

References:

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. https://www.jstor.org/stable/26760084.

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