Issue Paper: Revisions to the Water Quality Standard for Bacteria

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State of Oregon
Department of Environmental Quality

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Objectives of the Rulemaking and Project Background

Objectives of the Rulemaking

DEQ is proposing to revise Oregon's water quality standards for bacteria to adopt the U. S. Environmental Protection Agency's 2012 recommended water quality criteria for enterococci for coastal contact recreation. DEQ also is proposing to better define the boundary between where coastal and freshwater water contact recreation use occurs, as well as to clarify the waters that are designated for "shellfish harvesting" use and therefore remain subject to the current fecal coliform criteria. The use clarifications include the following:

- Adding beneficial use maps showing where "shellfish harvesting," "coastal contact recreation" and "marine contact recreation" uses are designated; and
- Identifying "shellfish harvesting" as a subcategory of fishing use in the coastal basin use tables.

In addition, DEQ recommends several minor revisions to the current bacteria standard rule language at 340-041-0028 for clarification, consistency and readability.

DEQ has coordinated its efforts with the Oregon Health Authority, including public outreach, in their promulgation of the Beach Action Value for the Beaches Environmental Assessment and Coastal Health Act of 2000.

Background

In 2004, EPA adopted Oregon's currently effective Clean Water Act criteria to protect people who engage in coastal water contact recreation as part of a federal rulemaking. The current criteria include a single sample maximum (158 colony forming units (CFU)/100 mL) and a geometric mean (GM) value (35 CFU/100 mL based on at least five samples in a 30-day period) of enterococcus as an indicator of fecal contamination and associated pathogens. OHA's Oregon Beach Monitoring Program utilizes the single sample maximum as the advisory level to warn swimmers that the beach may not be safe for swimming. DEQ utilizes the geometric mean to determine if a water body is impaired and as the basis for any needed limits in water quality permits. Unlike other Oregon water quality standards, which are contained in the Oregon Administrative Rules, these EPA-promulgated criteria are contained in the Code of Federal Regulations.

In 2012, EPA published new recommended Clean Water Act criteria for primary contact recreation in coastal waters. These recommended criteria are based on epidemiological studies

conducted in the United States that examined the correlation between direct contact exposure to and ingestion of water and subsequent gastrointestinal illness.

EPA recommended two different sets of criteria based on different rates of illness; 36 illnesses per 1000 users or 32 illnesses per 1000 users. DEQ is proposing to adopt the criteria based on the illness rate of 36 illnesses per 1000 users which includes the same geometric mean value (35 CFU/100 mL) as the currently effective criteria EPA adopted in 2004. In addition, the proposed criteria include a "Statistical Threshold Value," (130 CFU/100 mL) which is a value that may not be exceeded more than 10% of the time.

In 2014, EPA required states that receive federal grant funding for beach monitoring to develop and submit schedules for adopting EPA's new recommended CWA criteria into state water quality standards and a beach advisory value. In November 2014, DEQ and OHA submitted schedules to adopt the criteria and BAV, respectively, by EPA's deadline of September 2016. DEQ then initiated the rulemaking process to adopt the CWA criteria. Concurrently, OHA is adopting the new BAV as an advisory level to use for the OBMP. The BAV is not a water quality standard under the Clean Water Act and thus will not be used for permitting, assessment or other DEQ regulatory programs. DEQ and OHA coordinated their public outreach process to describe these relationships and distinctions between the two state programs and related requirements.

As part of this project, DEQ is also clarifying which beneficial uses are associated with each of the three different bacterial indicators in the state's water quality standards. Currently, there is a criterion for fecal coliform that has existed in Oregon's water quality standards since 1979[1] and is based on EPA's 1976 recommended criteria to protect people who consume filter-feeding shellfish from fecal contamination. This criterion currently applies to all marine waters and estuarine shellfish growing waters although the rule does not explicitly indicate where it applies. In addition, Oregon's standards contain a criterion for *E. coli* adopted in 1996 that applies to freshwaters and estuarine non-shellfish growing waters. With this rulemaking, DEQ proposes that these criteria and the newly adopted enterococcus criteria will apply as follows:

- Enterococcus criteria will apply to coastal water contact recreation use. DEQ defines coastal waters as all marine beaches and waters along the western Oregon border, as well as "coastal estuaries," consistent with the BEACH Act.
- *E. coli* criteria will apply to freshwater contact recreation use which is designated in all waters of the state not otherwise designated for coastal water contact recreation use.
- Fecal coliform criteria will apply to shellfish harvesting areas[2].

To further clarify where the bacteria criteria and associated uses apply, DEQ has also developed designated use maps for all coastal estuaries, which show the upstream extent of shellfish harvesting use and the boundary between where coastal water contact recreation and freshwater contact recreation uses apply. These maps will be incorporated into basin-specific rules that identify the criteria for coastal basins, including the Columbia River, the Umpqua River, and the

[1] The criteria initially were divided into basin-specific rules, then centralized in the statewide rule in 2003.
[2] Shellfish harvesting use is defined as areas that may support propagation and growth of filter-feeding marine and estuarine bivalves, such as clams and oysters, as the underlying fecal coliform criteria are based on consumption of filter feeders (EPA 1976).

North, Mid, and South Coast Basins. DEQ's objective in developing these maps is to clarify the application of the bacteria criteria so that the standards are implemented consistently and predictably. In addition, the bacteria standard and the basin-specific criteria rules will clarify that all marine waters are designated for shellfish harvesting and coastal contact recreation use.

It is important to note that all Oregon waters, including marine beach and offshore marine waters, are designated for "contact recreation." Due to the adoption of EPA's 2012 recreational criteria DEQ is designating the boundary between "freshwater contact recreation" and "coastal water contact recreation" to provide clarity to DEQ staff and interested parties where the uses and associated bacteria criteria apply. Any waterbody not designated as coastal water contact recreation on the maps or in the basin-specific criteria is designated as freshwater contact recreation use.

Relationship to OHA Adoption of Beach Action Value

In Oregon, DEQ and OHA both have roles in protecting people from illness due to direct exposure to bacteria and other pathogens in coastal waters. DEQ is responsible for developing permit limits for bacteria and assessing waters to ensure they are meeting the bacteria standards. OHA administers the Oregon Beach Monitoring Program under which they post health advisories on the state's beaches when levels of enterococci bacteria indicate a risk of illness from swimming or other full immersion contact with the water. Through an interagency agreement, DEQ laboratory staff sample and analyze beach water for bacteria. Both agencies use the results from these samples. OHA is engaging in a parallel process to adopt EPA's recommended BAV to use for advisory purposes. OHA plans to adopt the BAV in September 2016 and to begin utilizing the BAV during the 2017 sampling season. DEQ and the OBMP have coordinated their processes, including holding four joint public meetings in October 2015 to inform the public about the changes to their program.

Proposed Bacteria Criteria for Coastal Water Contact Recreation

History of DEQ Bacteria Criteria and EPA Recommended Criteria

DEQ first adopted bacteria criteria in the 1970s. These criteria were based on 1976 EPA recommendations and were initially based on studies linking fecal contamination in shellfish harvesting waters with contamination found on filter-feeding marine and estuarine mollusks (EPA 1976).

In 1986, EPA published recommended water quality criteria to protect those engaging in full-body contact recreation, such as swimming and surfing, in both fresh and coastal waters. These criteria were based on epidemiological studies conducted in the Great Lakes and northeastern United States that linked various bacterial indicators with incidences of gastrointestinal illness. Analysis of the studies showed that the bacterial indicators *E. coli* and enterococcus were the best indicators of illness in freshwater and that enterococcus was the best indicator in coastal waters. The Environmental Quality Commission (EQC) adopted the enterococcus criteria for freshwaters and non-shellfish growing estuarine waters to replace the fecal coliform criteria as of July 1, 1995. Fecal coliform criteria for marine waters and estuarine shellfish growing waters remained in the standards and are identical to the fecal coliform standards currently in effect.

Then, in 1996, the EQC replaced the enterococci criteria with *E. coli* criteria for "freshwaters and non-shellfish harvesting estuaries" for the following reasons:

- *E. coli* test results could be achieved in a faster time frame than enterococcus results (1 day vs. 2 days).
- *E. coli* criteria were as protective as the enterococcus criteria.
- *E. coli* test results are more specific and may avoid detection of bacteria groups from pulp and paper mills that may mimic enterococcus and show false positive results, even though such groups were not known to be correlated with fecal contamination or human health risk.

On Oct. 10, 2000, the BEACH Act was signed into law.[3] As part of the BEACH Act, EPA required all states with coastal recreation waters to adopt revised water quality standards for bacterial indicators of pathogens. In 2004, EPA adopted bacteria standards rules for coastal contact recreation in Oregon and other coastal states (69 Fed. Reg. 220, 67218-67243 (11/16/2004)). These criteria had two components: a "steady-state geometric mean indicator density" and a range of single sample maximum criteria. For marine waters, the enterococcus criterion was 35 colony forming units (CFU)/100 mL not to be exceeded in any 30-day period based on a minimum of five samples. DEQ currently uses this criterion to develop permit limits in coastal waters and to assess coastal waters as part of its Clean Water Action Section 303(d) assessment. The "single sample maximum" criteria were based on different levels of beach use, ranging from 104 to 501 CFU/100 mL. OBMP and DEQ opted to use the single sample maximum criterion of 158 CFU/100 mL based on "moderate level" beach use. OBMP uses this criterion for to issue beach advisories.

Description of changes from 2004 Federal Criteria

In 2012, EPA published revised recommended recreational water quality criteria under Section 304(a) of the Clean Water Act. EPA developed the criteria based on the same studies used to develop the 2004 criteria as well as more recent scientific information including the National Epidemiological and Environmental Assessment of Recreational Water data. The recommended recreational water quality criteria include two components: 1) a geometric mean; and 2) a

[3] Beaches Environmental Assessment and Coastal Health Act, Pub. L. No. 106-284 (2000).

"statistical threshold value," which may not be exceeded in more than ten percent of samples in the averaging period.

The 2012 recommendations include two sets of criteria values for both the geometric mean and STV. These values are based on different illness rates (32 or 36 illnesses per 1000 recreational users of coastal waters). EPA is allowing states the option to adopt criteria for either illness rate. DEQ is choosing to adopt criteria based on the higher illness rate. DEQ has concluded that this higher rate will be sufficiently protective because exposure to coastal waters in Oregon, especially rates of swimming or full immersion contact recreation, are generally much less than at those beaches upon which the criteria are based. Moreover, Oregon beaches generally are not impacted by wastewater treatment plants, whereas the beaches selected for EPA's studies were selected based on the proximity to wastewater treatment plant discharges. The proposed criteria are 35 CFU/ 100 mL for the geometric mean, which is identical to the current EPA-adopted criterion, and 130 CFU/100 mL as the STV.

Summary of scientific basis of 2012 EPA Recommended Criteria

The following section is a brief summary of EPA's rationale for the recommended enterococci criteria for coastal recreation waters. More detailed information is available on EPA's website.[4]

Clean Water Act section 502(23) defines a "pathogen indicator" as "a substance that indicates the potential for human infectious disease." Fecal indicators such as enterococcus and *E. coli* indicate the potential presence of fecal pathogens that may cause gastrointestinal (GI) illness while the indicators may not always cause GI illness themselves.

In a variety of studies EPA considered in the late 1970s and early 1980s, *E. coli* and enterococcus were the best indicators of GI illness in freshwater. Enterococcus was the best indicator in marine and coastal estuarine waters.

EPA also used the recent National Epidemiological and Environmental Assessment of Recreational Water studies which looked at the relationship between indicator bacteria and GI illness using epidemiological studies at U.S. beaches impacted by wastewater treatment plants between 2003 and 2009 (U.S. EPA 2010)[5]. In the NEEAR studies, the definition of GI illness was more inclusive than that of the studies used in EPA's 1986 recommended criteria. The more recent studies did not require a fever to be counted as an illness whereas the previous studies did.

EPA compared the NEEAR studies to the studies used in developing the 1986 criteria and found that illness rates were similar. In addition, EPA found that "water quality in the range of 30 to 35 enterococci CFU per 100 mL are the lowest water quality values reported to show statistically

[4] http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/

[5] Beaches studied included three beaches on Lake Michigan, one on Lake Erie, and one marine beach each in Rhode Island, Mississippi and Alabama. Additional studies were carried out at a non-WWTP-impacted site in South Carolina and at a beach in Puerto Rico to examine illnesses in a tropical setting.

significant differences in swimming-associated illness rates." As a result, the recommended geometric mean criteria are effectively the same as in the 1986 criteria.[6]

EPA is recommending that states adopt the STV to constrain the number of samples with high levels of bacteria that could potentially occur even though the mean value is met. Levels of fecal indicator bacteria can be quite variable. EPA recommended the STV based on the 90th percentile value of the $\log_{10}$ normal distribution of fecal indicator bacteria from the studies that EPA used in developing the recommendations. For the chosen illness rate of 36 illnesses per 1000 users, the STV is 130 CFU enterococcus per 100 mL[7].

Rationale for 90-day duration period for both enterococcus and *E. coli*

The duration component of the criterion represents a critical exposure period during which the distribution of fecal indicator bacteria values should provide adequate protection for a population of recreational water users. During this critical exposure period there should not be numerous events or lengthy periods of time where very high levels of fecal indicator bacteria occur as this could lead to unacceptably high risk of illnesses. A very long critical exposure period could allow an excessive number of high exposure events over a shorter term to be "averaged out" over the long-term. EPA's recommended criteria document suggests that states use a 30-day duration period as the optimal period during which the geometric mean of all samples from a given location not exceed the criteria and no more than ten percent of samples exceed the STV.

Since release of the 2012 recommended criteria, EPA has stated that it would be acceptable for states to adopt a duration period of up to 90 days as the critical exposure period to protect recreational uses. (U.S. EPA 2015). DEQ is proposing to use a 90-day duration for the enterococcus criteria. In addition, DEQ is proposing to change the duration period for the *E. coli* criterion at 340-041-0009(a)(A) from 30 days to 90 days for consistency. The following paragraphs explain EPA's rationale for allowing up to a 90 day period.

EPA noted that the epidemiological studies used to develop the 2012 criteria recommendations were conducted over exposure periods of up to 90 days. This makes durations up to 90 days scientifically defensible. In addition, analysis of data from waters that experience short-term variability, or "transient fluctuations," from periodic high concentration releases exhibit very similar criteria attainment assessment outcomes using a 30-day or 90-day assessment period when both the GM and STV criteria components are evaluated.

For example, EPA analyzed monitoring data from locations in New Jersey impacted by combined sewer overflow (CSO) discharges. This is an example of a "transient fluctuation." EPA reviewed 17,538 records from 703 monitoring stations collected from 1996-2011. EPA combined the data into 2,890 monitoring station and year sets and assessed those combinations for attainment of the GM and STV over fixed 30 day periods and fixed 90 day periods. The STV criterion component appears to be a significant factor in preventing significant levels of fecal indicator bacteria to be "averaged out" over a 90 day assessment period. There is an overall 98%

[6] For further information, see the discussion of the criteria beginning on page 21 of EPA's criteria document.
[7] For further information, see the discussion beginning on page 39 of EPA's criteria document.

rate of agreement between results using 30 day and 90 day assessment periods and most cases of disagreement are the result of a single measurement exceeding a 30-day GM but not exceeding a 30-day STV. The small percentage of outcomes where only a 30 day assessment period indicate non-attainment are predominantly a result of a single monthly measurement that lie between the GM and STV over the period of record and may thus have a low probability of reflecting excessive risk of illness. On a station level, considering multiple years of data, 75% are in non-attainment using a 90-day assessment period and 76% are in non-attainment using a 30-day assessment period. This represents a 99% rate of agreement.

DEQ also is proposing changing the duration for the *E. coli* criteria from 30 days to 90 days. EPA considers the magnitude of DEQ's current *E. coli* criteria to be as protective as the proposed enterococcus criteria. As a result, changing the duration of the criteria to 90 days should provide the same level of protection as doing so for the enterococcus criteria for the reasons that EPA provided above.

A benefit of utilizing a longer averaging period for calculation of the geometric mean values for enterococcus and *E. coli* data and the 90th percentile value for enterococcus data is that there is a greater likelihood of having a sufficient number of samples at a given location in a 90 day period than a 30-day period. As a result, DEQ would more likely be able to calculate a valid geometric mean and a 90th percentile value to compare to the criteria for assessment and other Clean Water Act purposes.

Rationale for incorporating a monthly duration period for NPDES permitted facilities

DEQ proposes to use a monthly duration period for effluent limitations for NPDES facilities which must monitor for *E. coli* bacteria. OAR 340-041-0009(5). Under that provision, effluent discharges from NPDES-permitted facilities are required to meet the *E. coli* criteria, including the monthly log-mean and single sample maximum, in the discharge (at the end of pipe).[8] DEQ proposes to continue using a 30-day time frame for permit limits, even though the standard allows a 90-day duration, for the following reasons:

- Facilities already are required to meet this criterion on a monthly basis so that treatment technology and processes are generally in place and available to attain the standard on a shorter duration.
- DEQ would likely be unable to allow for a greater duration for attaining effluent limits than is currently used due to anti-backsliding requirements.
- A longer averaging period would make it difficult for a facility to know if it was out of compliance until well after the fact and would therefore impact its ability to resample or manage its treatment accordingly.
- Permittees are required to monitor and report compliance with their permit limits on a monthly basis.

[8] The provision allows facilities that exceed the single sample to resample in the first 28 hours to determine if they can achieve compliance with the log-mean.

For the same reasons, DEQ proposes to expand this provision to include a monthly duration for those facilities that discharge to coastal waters and thus must monitor for enterococcus. DEQ guidance requires such facilities to meet current EPA-promulgated criteria (geometric mean of 35 CFU enterococcus per 100 mL) in their effluent on a monthly basis. (ODEQ 2011). DEQ proposes to maintain these duration requirements with the addition of any limits needed to ensure achieving the STV of 130 CFU per 100 mL on a monthly basis.

DEQ is clarifying that these requirements apply to bacteria in effluent discharges associated with fecal sources, which is consistent with the existing language in the bacteria standard:

> "Numeric criteria: Organisms of the coliform group commonly associated with *fecal sources* (MPN or equivalent membrane filtration using a representative number of samples) may not exceed the criteria described in paragraphs (a) and (b) of this paragraph." OAR 340-041-0009(1) (emphasis added).

This change acknowledges that certain non-fecal discharges, such as pulp and paper effluent, may contain bacteria that are detected as *E. coli* or enterococcus, but are not pathogenic and do not indicate the presence of fecal contamination. (Gauthier and Archibald 2001; Degnan 2007; Croteau, et al. 2007). Due to the potential interference of plant-based bacteria in enterococcus tests, it may be difficult for pulp and paper mills to achieve compliance with enterococcus criteria even if the discharge poses little risk to public health due to the lack of pathogenic bacteria in the discharge. The proposed provision will allow flexibility to entities that can demonstrate to DEQ that their discharge does not come from fecal sources. DEQ would require such entities to demonstrate through biochemical species identification techniques that the effluent contains non-fecal based bacteria species. Once the demonstration is made, DEQ would include appropriate effluent limits in the permit to ensure that public health is protected.

Minor changes to the water quality standard for bacteria

Removal of reference to "MPN or equivalent membrane filtration using a representative number of samples"

The current bacteria standard specifies that criteria are to be measured using the "most probable number procedure or an equivalent membrane filtration process." DEQ's current procedure for analyzing marine samples for enterococcus uses the MPN procedure. EPA's 2012 recommended criteria require using colony forming units using EPA standard method 1600 for enterococcus and EPA Standard Method 1603 for *E. coli* or "equivalent methods that measure the appropriate culturable bacteria." (U.S. EPA 2012). The MPN method, while differing from those EPA methods measuring CFU, is an equivalent method that EPA approved.[9] As either of those procedures is appropriate and they are generally well correlated, DEQ has concluded that it is unnecessary to specify the method of measurement within the standard. The current use of the term "organism" in the numeric criteria (e.g., "No single sample may exceed 406 *organisms* per 100 mL") will allow using the CFU, MPN or other EPA-approved methods.

[9] 40 CFR 136.3(a)

Language specifying minimum sample size for calculating geometric mean and 90th percentile values

The current E. coli criteria specify that the log mean must not exceed 126 organisms per 100 milliliters "based on a minimum of five (5) samples." Because the bacteria criteria (both existing and proposed) are based on a statistical measurement (geometric mean and 90th percentile), some minimum data set is still necessary to measure compliance and attainment with the standards. However, EPA's 2012 recreational water quality criteria (RWQC) do not specify a minimum sample size for calculating either *E. coli* or enterococcus criteria. As a result of past legal decisions, minimum sample sizes are not an approvable part of water quality criteria. As a result, DEQ is removing the minimum sample size from the water quality standards. Instead, DEQ is adding an implementation provision at OAR 340-041-0009(2) requiring at least 5 samples to calculate the geometric mean and 90th percentile values. This provision will not affect permitting requirements, which are addressed separately in the implementation provision addressing "effluent limitations for bacteria.

Change of averaging method for *E. coli* from "log mean" to "geometric mean"

DEQ is proposing to change the averaging methodology under the *E. coli* criterion from "log mean" to "geometric mean." These terms are mathematically identical. However, using the term "geometric mean" is consistent with EPA's 2012 criteria recommendations, as well as previous iterations of *E. coli* criteria for freshwater contact recreation.

Removal of provision related to aquatic life criteria for chlorine in effluent

OAR 340-041-0009(5)(b) is a provision in the bacteria rule that requires that aquatic life criteria for chlorine established in DEQ's toxic substances rule, OAR 340-041-0033, must be met at all times outside the assigned mixing zone. This provision is redundant with the toxic substances rule to which it refers and is therefore unnecessary. As a result, DEQ is proposing to remove this provision.

Minor revisions and plain language revisions.

Other revisions to the rule implement the plain language review required under Oregon's Administrative Procedures Act or remove references to other rules that no longer exist. These minor revisions do not result in substantive changes to the rule or its implementation.

Applicability of Bacteria Criteria and Designated Use Maps

Background

Under the current bacteria criteria, *E.* coli criteria currently apply in freshwater and "non-shellfish harvesting" estuarine waters. OAR 340-041-0009(a). Fecal coliform criteria apply to all marine and shellfish harvesting estuarine waters. OAR 340-041-0009(b). Federal enterococcus criteria apply in coastal waters. However, DEQ has never described the precise locations of the uses. An objective of the rulemaking is to clarify the designated uses and the geographic extent of those uses to which the three different bacteria criteria apply. These uses include:

- Water contact recreation in coastal waters
- Water contact recreation in freshwater
- Shellfish harvesting, which is a subcategory of "fishing," a fish consumption use

DEQ recommends designating all marine waters within Oregon's territory, to a distance of three miles from Oregon's shoreline, for shellfish harvesting and coastal contact recreation uses. For major Oregon estuaries, DEQ developed designated use maps that will be adopted into the basin-specific use rules for the main stem Columbia River, the North, Mid, and South Coasts, and Umpqua River Basin. OAR 340-041-0101, 340-041-230, 340-041-220, 340-041-300 and 340-041-320. Each use map focuses on one major Oregon estuary. These maps show the furthest upstream extent of shellfish harvesting and the boundary between coastal and freshwater contact recreation uses. All waters of the state not otherwise designated for coastal contact recreation use are considered freshwater contact recreation whether or not they are included in the use maps in this rule.

Proposed use maps are included in Appendix C of this document. In addition, Appendix C includes a map showing designations along the coastline (Figure 36).[10] The following section describes to the methodology by which DEQ developed the proposed designated use maps.

Data used for use designation

DEQ evaluated two types of information in order to identify the location of shellfish harvesting and the boundary between marine contact recreation and freshwater contact recreation:

1. Salinity data collected by DEQ and the Columbia River Estuarine Operational Forecast System operated by the National Oceanic and Atmospheric Administration to determine the demarcation between fresh and saline waters.[11] Salinity is particularly important for applying bacteria criteria as *E. coli* bacteria dies quickly in salt water. As a result, *E. coli* is not a useful indicator of fecal contamination in marine waters whereas enterococci is an appropriate indicator in either freshwater or saltwater, as EPA's 2012 recommended criteria describe. Salinity data from the Center for Coastal Margin Observation and Prediction also was used as a secondary tool to ground truth whether shellfish presence was consistent with salinity levels in the Columbia River Estuary.

[10] This map will not be included in the rulemaking and is here for reference only.
[11] All Oregon waters are designated for contact recreation use. The purpose of the analysis was to determine the boundary between freshwater and coastal water contact recreation use and, as a result, where *E. coli* and enterococcus criteria apply.

2. Documented evidence of shellfish distribution from agency reports, reports provided by shellfish harvesters and confirmation with state and tribal biologists to ensure that the shellfish harvesting use designations align with shellfish habitat.

Data evaluation

Salinity Data

Salinity data are critical to demarcate the boundary between marine and freshwater uses. *E. coli* dies quickly in salt water whereas enterococcus survives longer. Anderson, et al. (1979), examined survival of a type of *E. coli* at different salinities (10, 15, 25, 30 parts per thousand) and exposure durations (2, 5, and 8 days). At 10 ppth salinity, survival of *E. coli a* was 100.6, 87.6 and 53.5 percent at two, five, eight days, respectively. At 15 ppth, survival was 27.9, 11.7 and 7.1 percent. Survival was even lower at 25 and 30 ppth. A second type of *E. coli* was tested at 10 and 30 ppth and a temperature of 44.5°C. Survival of *E. coli b* was higher at 10 ppth than at 30 ppth.

Based on the literature, DEQ focused on a median salinity level of 10 ppth to demarcate the boundary between freshwater and coastal water contact recreation in Oregon estuaries. As a result, a key objective in delineating the boundary between fresh and coastal water contact recreation was to ensure that waters in the freshwater portion are not exposed to 10 ppth salinity for two days. At the locations where DEQ is proposing this boundary, as described in the "Recommended Delineation of Use Designations" section that follows, the water is dominated by freshwater much of the time (with annual median salinities at or below 10 ppth), but can have higher salinities during high tide. Because the high tide lasts only a few hours, these waters will never be exposed to high salinity waters long enough to attenuate *E. coli* levels significantly. For example, DEQ analyzed EPA salinity data from the Alsea River near the proposed location of the boundary between fresh and coastal water recreation uses. As a conservative measure, DEQ evaluated dry season data, when salinity is generally higher due to lower freshwater flow from upstream. Percentage of occurrence in less than 10 ppth, between 10 and 20 ppth, and greater than 20 ppth are shown below. These data indicate that at all levels salinity is less than 10 ppth frequently and most of the time at mid-depth and the surface. As a result, E. coli would not be exposed to high salinity long enough to be sufficiently attenuated.

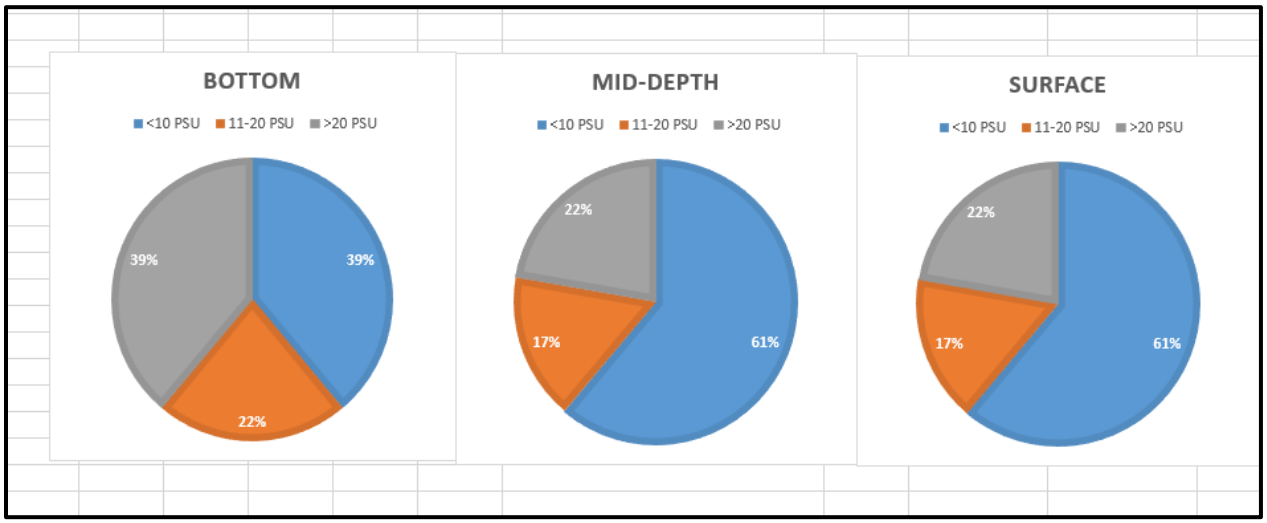


Figure 1. Salinity ranges for samples from the Alsea River near the mouth of Drift Creek. Data provided by EPA Western Ecology Division, Newport, OR.

In order to determine the boundary between freshwater and coastal water contact recreation in all coastal estuaries, DEQ analyzed estuarine salinity data available from its Laboratory Analytical Storage and Retrieval database to identify the approximate location where median annual salinity equals approximately 10 ppth. In order to ensure that there was sufficient data to evaluate where salinity in estuaries was approximately 10 ppth, DEQ used the following methodology:

- DEQ only examined data from 1985 to the present. Data from LASAR earlier than this date are more sporadically collected and also had questionable quality control due to anomalies (for example, apparent errors in the time or location samples were taken).
- In general, more salinity data was available during the late spring, summer and early fall than for the late fall, winter and spring. In addition, if there were multiple samples from a given month and year, this data was averaged. DEQ grouped data by month and calculated the median for each month to minimize sampling bias.
- Once DEQ calculated median salinity for each month, it calculated the median salinity for the entire year.
- DEQ only used locations where salinity data were taken in at least 50 months from 1985 to the present.

Once median salinity was calculated, data was plotted on maps using ArcGIS. Maps indicating the location of salinity levels at 10 ppth are shown in Appendix A.

DEQ used salinity models developed by the National Oceanic and Atmospheric Administration to evaluate salinity in the Columbia River Estuary. More information on this analysis is included under “Columbia River Estuary” in the “Rationale for Designating Uses in Each Estuary” section that follows.

Shellfish Data

In order to protect consumers of marine and estuarine shellfish from illness due to exposure to fecal bacteria, DEQ is proposing to broadly designate shellfish harvesting use in all waters from an estuary's mouth to the furthest point upstream in each estuary where shellfish are found. DEQ examined the following lines of evidence:

- Oregon Department of Fish and Wildlife's (ODFW) "Where to Dig" maps, available on its website, which show easily accessible clamming areas in the state. (ODFW 2015).[12]
- Oregon Department of Agriculture's (ODA) Commercial Harvesting Areas, which indicate where the agency allows commercial shellfish to be grown within the Coos, Netarts, Tillamook, Umpqua and Yaquina Estuaries.[13]
- A 1979 cooperative report between the Oregon State University Sea Grant Program and the Oregon Department of Fish and Wildlife detailing subtidal clam distribution in many Oregon estuaries (Hancock, et al. 1979), as well as a number of 1970s "Resource Use" studies published by the Oregon Department of Fish and Wildlife, as cited in this document.
- Online maps showing clam harvesting areas from two websites: www.clamdigging.info and www.razorclamming.com.
- Reports on clam distribution in the Columbia River Estuary from various sources cited in this paper.
- Personal communications with tribal governments, the Oregon Department of Fish and Wildlife's Shellfish and Estuarine Assessment of Coastal Oregon program, and EPA's Western Ecology Lab in Newport, Oregon.[14]

Based on the data collected, DEQ developed maps with proposed shellfish harvesting use designations in the following estuaries: Necanicum, Nehalem, Tillamook, Netarts, Nestucca, Salmon River, Siletz, Yaquina, Alsea, Yachats, Siuslaw, Umpqua, Coos Bay, and Coquille River. For each estuary, DEQ noted the uppermost distribution of shellfish in coastal and estuarine areas. Once these areas were delineated, DEQ received peer review from ODFW shellfish biologists, who confirmed the uppermost distribution or reported areas further upstream where shellfish have been found. Based on these reports, DEQ adjusted the use maps accordingly. In addition, DEQ is proposing to designate a small portion of the Columbia River Estuary for shellfish harvesting use based on surveys conducted over the last few decades.

DEQ also used salinity data as a secondary line of evidence in examining shellfish harvesting designations. Estuarine and marine shellfish species have a preferred salinity range for survival. Pacific oysters (*Crassostrea gigas*) tolerate salinity as low as 10 ppth; softshell clams (*Mya arenaria*) tolerate salinity as low as 5 ppth, but have a preference for 10 to 20 ppth (Newell and Hidu 1986, Strasser 1999; Emmett, et al. 1991; *pers. comm., Ted Wheeler, U.S. EPA Western Ecology Division, 8/9/2016).* These shellfish must be almost continuously exposed to these salinities to survive (*pers. comm., Liz Perotti, 1/27/2016).* In several cases, shellfish presence was documented upstream of where DEQ calculated median salinity at 10 ppth; this is likely due

[12] ODFW provided DEQ with GIS layers corresponding with its maps to assist in developing maps.
[13] Commercial shellfish growing in other estuaries is prohibited. ODA provided DEQ with maps of shellfish harvesting areas which DEQ converted to a GIS layer.
[14] http://www.dfw.state.or.us/mrp/shellfish/seacor/

to the fact that DEQ salinity data is taken in surficial waters, whereas salinity at depth, where shellfish occur, is often higher than at the surface.

In rivers, such as the Sixes, Rogue, and Chetco, the degree of freshwater influence precludes propagation of bay clams. Resource surveys in these areas do not note any populations of bay clams and specifically note that the Rogue does not support populations of bay clams. Moreover, there is not sufficient salinity in these rivers to support shellfish. (*pers. comm..*, Liz Perotti, manager, SEACOR program, ODFW, 2/11/16). Other small streams and creeks that enter the Pacific do not have sufficient salinity intrusion to support bay clam propagation and ODFW is not aware of any harvest occurring in these waters. (*pers. comm.*, Liz Perotti, 2/11/16).

Please see the additional information and discussion in the section titled "Rational for Mapping Designated Uses in each Estuary" below.

Recommended delineation of use designations

Shellfish Harvesting Use

Based on the analysis in the "Data Evaluation" section above, and the information provided below supporting each estuary map, DEQ is proposing to designate all estuarine waters from the upper end of shellfish distribution downstream to the mouth of the estuary as having shellfish harvesting use, as shown in the proposed use maps. In addition, DEQ proposes to clarify that all territorial marine waters are designated for shellfish harvesting use.

Contact Recreation Uses

In all but two estuaries, DEQ proposes to delineate the boundary between coastal and freshwater contact recreation uses in the same location as the upper boundary of shellfish harvesting areas. In all estuaries except the Columbia and Necanicum estuaries, shellfish are documented slightly upstream, but no more than a few miles, of the area where median salinity was calculated as 10 ppth. As noted, enterococci criteria are equally protective in low salinity freshwater and marine water. As a result, applying enterococci criteria further upstream provides the same level of protection to recreational users of these waters. Furthermore, designating these uses in the same location provides administrative efficiency for implementing bacteria criteria for the vast majority of state waters. For example, designating coastal contact recreation in the same location as shellfish harvesting will simplify how DEQ identifies waterbody segments for assessing waters against bacteria criteria in Integrated Reports.

In two estuaries, the Columbia River Estuary and the Necanicum Estuary, harvestable shellfish are not found as far upstream as the area where median salinity is 10 ppth, possibly due to inappropriate substrate. As a result, DEQ proposes to designate the boundary between coastal water and freshwater contact recreation uses based on the location where median salinity is approximately 10 ppth. Specific information about these two exceptions is included in the corresponding sections below supporting the maps.

Under the federal BEACH Act, rivers that flow freely to ocean waters are not coastal waters for purposes of applying contact recreation criteria. In Oregon, the Sixes, Chetco, and Rogue rivers, as well as the many smaller rivers and creeks not named in this section, flow freely to the ocean and, therefore do not have sufficient saltwater intrusion to be considered coastal waters. DEQ's

proposed rules clarify that freshwater contact recreation use is designated for the entire rivers to their mouth. The marine waters adjacent to the mouths of these rivers and creeks are designated as coastal contact recreation in the proposed rule language as shown on the reference map in Figure 36.

Rationale for Mapping Designated Uses in Each Estuary

This section describes in more detail the information DEQ used to map the shellfish harvesting use and the boundary between coastal water and freshwater contact use within each estuary.

Columbia River Estuary

Shellfish harvesting designation

DEQ proposes to clarify that the area within and to the west of Trestle Bay is designated for shellfish harvesting, as shown in Figure 20 (Appendix C). Surveys are limited, but those available note that there are no native, harvestable bay clams, such as gapers or butters, present in the Columbia River Estuary, likely due the high freshwater discharge and resulting low salinities present in the Columbia (CREST 1978).

ODFW has noted that there may be some nonnative softshell clams within Trestle Bay and small, unharvestable razor clams on the upstream side of the south Jetty. (*pers. comm.,* Matt Hunter, shellfish biologist, ODFW, 2/18/16). These reports are corroborated by recent survey data (Figure 2; Sytsma, et al. 2004; *pers. comm.,* Ted Wheeler, U.S. EPA Western Ecology Division, August 9, 2016).

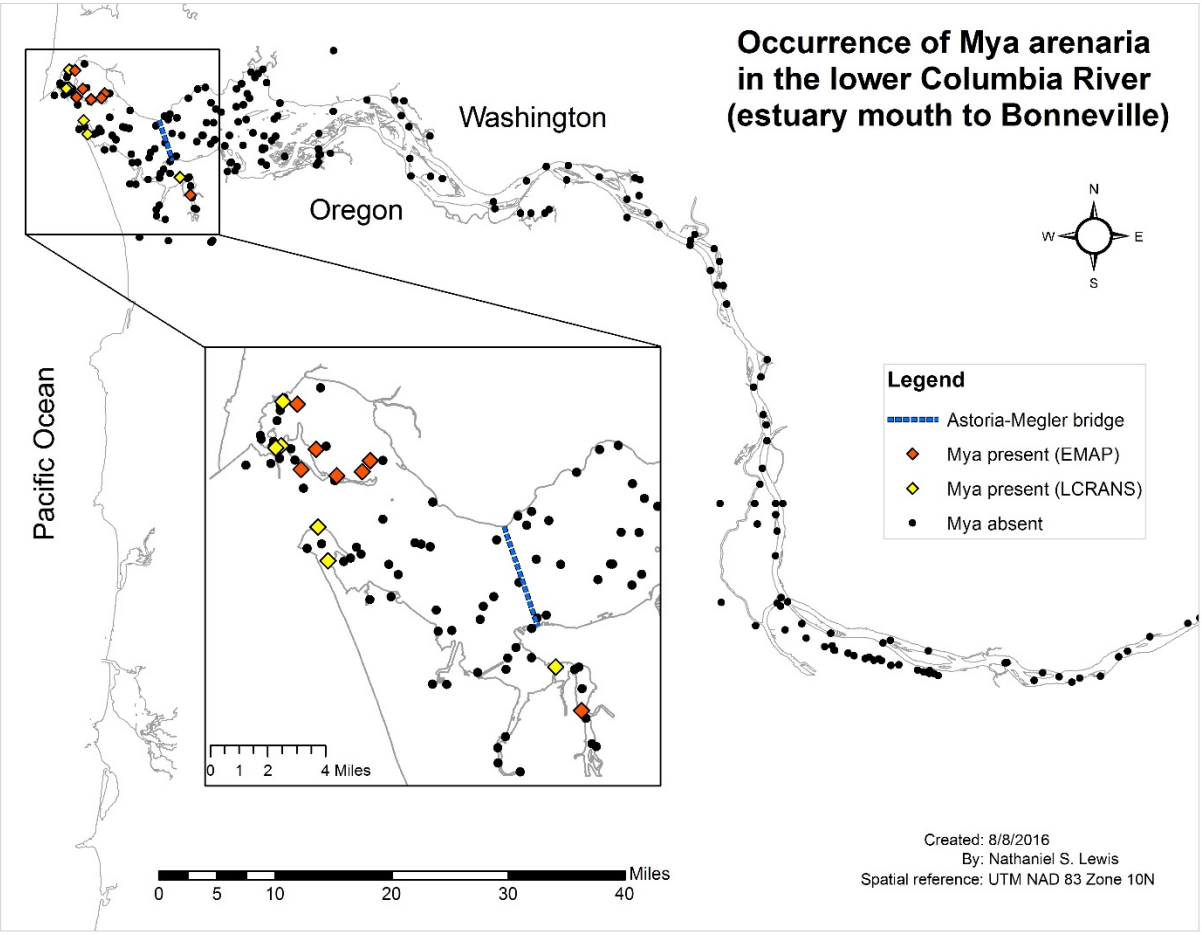
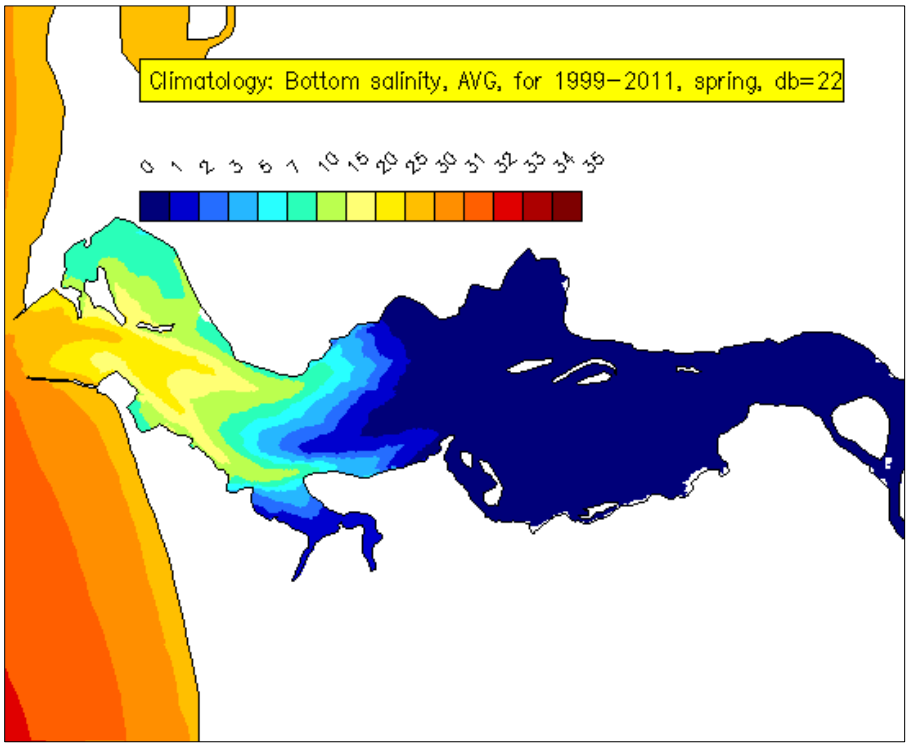


Figure 2. Benthic sampling data in the lower Columbia River from the Environmental Monitoring and Assessment Program (EMAP; 1999-2006) and the Lower Columbia River Aquatic Nonindigenous Species Survey (LCRANS; 2002-2003). Stations where *M. arenaria* were collected are represented by orange (EMAP station) and yellow (LCRANS station) markers. Black dots represent stations where no *M. arenaria* were collected.

The only bay clams commonly found in the lower estuary upstream of Trestle Bay are small (1-to-2 cm long) clams of the species *Macoma inconspicua* (CREST 1978; Higley and Holton 1975). Survey data from EMAP (Hayslip, et al. 2006) and LCRANS (Sytsma, et al. 2004) show that out of 327 sample locations throughout the estuary, softshell clams (*Mya arenaria*) were found in only thirteen samples, only two of which were upstream of Trestle Bay. No other species of marine shellfish were noted. The two samples where softshell clams were present upstream of Trestle Bay are near the mouth of Young's River (Figure 2). Softshell clams were not found in several other samples in this area. Moreover, the mean wet season salinity in this area, based on climatological data from 1999-2011, is approximately 1 practical salinity unit (PSU, which is equivalent to 1 ppth) (Figure 3). This is well below the usual salinity tolerance of 5 ppth and preference of 10 to 20 ppth for *Mya arenaria* (Newell and Hidu 1986, Strasser 1999). Salinity may be sufficiently high in dryer years to support *Mya arenaria* survival, but not with any regularity or predictability. The available data shows that while bay clams were found in 2

samples, they are very sparse in the area of Young's Bay and even further downstream. If salinity conditions that support the presence of softshell clams occur, they appear to occur only sporadically, potentially in dry, low flow years. In addition, DEQ has received no reports of shellfish harvesting activity occurring in Young's Bay or the mouth of Young's River. Therefore, DEQ has concluded that softshell clams are likely not harvested in this area due to their very infrequent occurrence and other species of commonly harvested clams are not present.

Based on the information available, DEQ proposes to delineate that the shellfish harvesting waters in the Columbia River extend as far upstream as the eastern edge of Trestle Bay, as shown in Figure 20 in Appendix C.



Contact Recreation Designation

DEQ analyzed salinity data obtained from the NOAA Columbia River Estuary Operational Forecast System (CRE-OFS) to determine the boundary between coastal and freshwater contact recreation. CRE-OFS provides users with present and near future forecasts of various water quality data, including salinity, four times per day in various locations along the Columbia River,

Figure 3. Mean bottom salinity (PSU) for the lower Columbia River during the spring months (1999-2011). Courtesy of: Center for Coastal Margin Observation & Prediction (CMOP).

its estuary and offshore from its mount into the Pacific Ocean.[15] Figure 1 shows an example model projection.

DEQ examined salinity projections from July 22 to July 29 from stations nearest the mouth of the Columbia River to the Astoria-Megler Bridge Station that crosses the Columbia from Astoria to Washington. The dates chosen were characteristic of low flow conditions during which upstream salinity intrusions may be higher. Evaluating data during these conditions is important to ensure the analysis captures high salinity conditions as higher salinity levels cause *E. coli* die-off. Hourly salinity was estimated by visually examining the graphs and median salinity was calculated for each 24 hour period beginning and ending at 8 a.m. each day. Figure 3 shows daily median salinities. DEQ proposes to designate coastal contact recreation use as far upstream as the eastern edge of Young's Bay. In this area, salinity sometimes exceeds 10 ppth, but daily median salinity is less than 6 ppth.

Based on the information in Figure 5, median salinity is approximately 10 ppth near Jetty A, on the Washington side of the Columbia, near Fort Canby. Salinity appears to maintain higher levels on the southern side of the Columbia, with a median salinity of 10 ppth at Tansy Point in Warrenton. Salinity is much lower than 10 ppth near the Astoria Megler Bridge and in Young's Bay, west of the Astoria-Warrenton Highway. DEQ proposes that the portion of the river from the mouth to the western edge of Astoria and north of the Young's Bay Bridge (Highway 101) be designated as coastal contact recreation, as shown in Figure 20. Upstream of these areas, median salinity is consistently lower than 10 ppth. Thus, the freshwater contact recreation use and an *E. coli* criterion are appropriate.

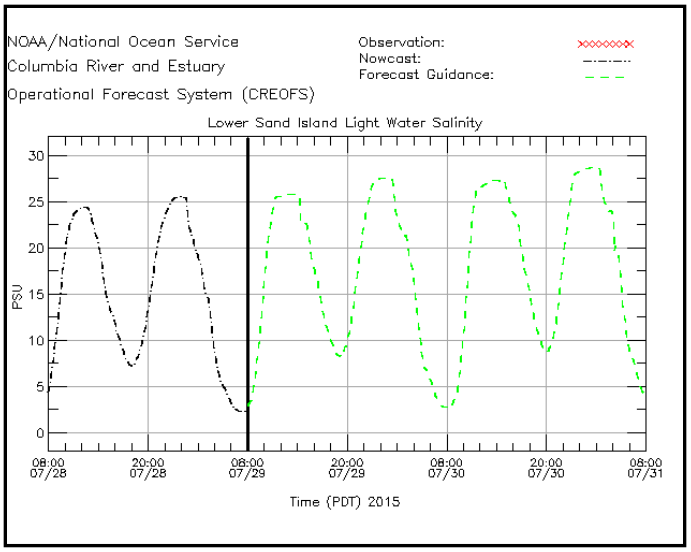


Figure 4. CRE-OFS Modeled Salinity for July 28-31, 2015 at Lower Sand Island Lighthouse. (from CRE-OFS website, accessed 7/29/2015).

[15] CREOFS website, accessed 7/29/2015

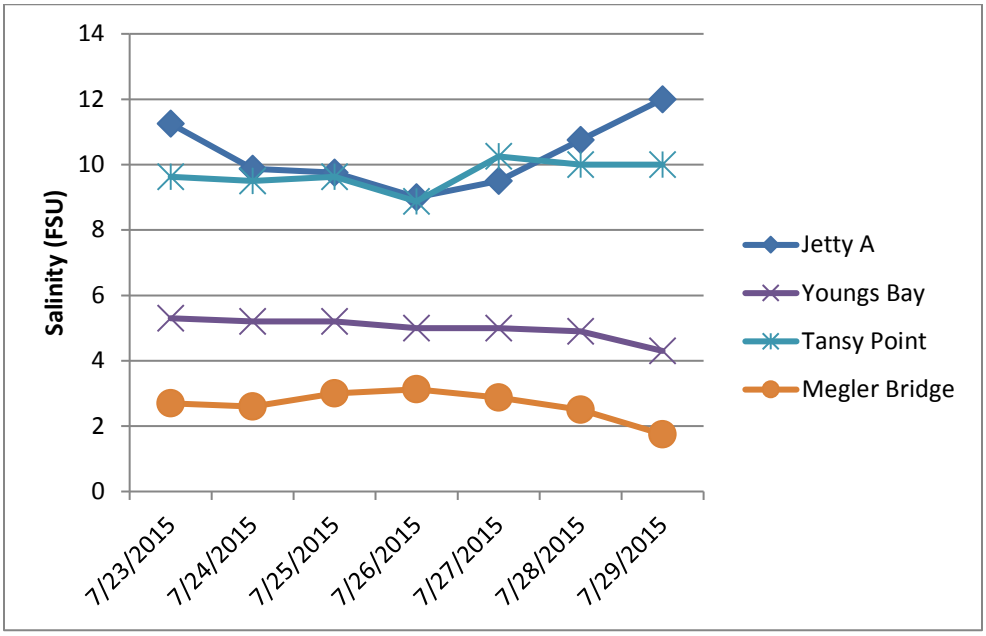


Figure 5. Median Daily Salinity at Columbia River Estuary

Necanicum River Estuary – Summary of Data and Conclusions

- *ODFW.* While ODFW identifies the Necanicum Bay as an accessible area for shellfish harvesting, the agency has not developed maps indicating where shellfish reside. However, ODFW has confirmed that shellfish harvesting only occurs in the lower estuary. (*pers. comm.*, Liz Perotti, ODFW, 1/28/16). Further upstream of this point, although salinity may be sufficient, the river most likely has insufficient substrate or other conditions for shellfish.
- *ODA.* Commercial shellfish harvest is not allowed in Necanicum Bay.
- *Other available information.* Limited data exist to determine where shellfish harvesting areas and the boundary between fresh and coastal water recreation are located in the Necanicum River. Two websites indicate that clamming is available in the lower estuary, as ODFW confirms.[16]
- *Salinity.* DEQ salinity data are limited in the Necanicum. The only sufficient data set that DEQ has is from a station at the 12th Avenue Bridge in Seaside. The data indicate that median salinity of the Necanicum River at 12th Ave. is approximately 18 ppth. Limited data taken near the Avenue U Bridge indicates that water there also has salinity greater than 10 ppth at times. Thus, while salinity south of the lower estuary may be sufficient for clam propagation, another limiting factor such as substrate, may not be appropriate for bivalves. However, salinity at the Avenue U Bridge may be sufficiently high to limit *E. coli* survival. Thus, DEQ proposes to designate this area for coastal contact recreation to ensure that appropriate criteria are applied in this area based on the water's salinity.

[16] http://www.razorclamming.com/locations/oregon-clam-bays/necanicum-river-estuary_map/. Accessed December 1, 2015; http://www.clamdigging.info/Necanicum%20River.html. Accessed December 1, 2015.

Based on current information, DEQ proposes to designate the Necanicum estuary as shown in Figure 21.

Nehalem River Estuary – Summary of Data and Conclusions

- *ODFW.* According to the current ODFW maps, accessible shellfish areas in Nehalem Bay include areas north of and across the estuary from Brighton, as well as the flats northwest of Wheeler. (Figure 3).
- *ODA.* Commercial shellfish harvest is not allowed in Nehalem Bay.
- *Other information sources.* ODFW staff indicate that shellfish harvesting occurs somewhat further upstream than their maps indicate, approximately to the northern end of Wheeler. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *Salinity data.* DEQ salinity data indicate that median salinity is approximately 8 ppth at Paradise Cove (west end of Wheeler), 14 ppth at the Nehalem Bay State Park boat ramp and 5 ppth near the Wheeler Marina. (Figure 3).

Based on available information, DEQ is proposing to designate the Nehalem River Estuary as shown in Figure 22.

Tillamook Bay – Summary of Data and Conclusions

- *ODFW.* Accessible recreational harvesting areas ODFW identified occur in the northern half of Tillamook Bay (Figure 4).
- *ODA.* ODA has approved commercial shellfish growing in the northern half of Tillamook Bay, overlapping with accessible ODFW areas. (Figure 4).
- *Other information sources.* Other documentation indicates that softshell clams are distributed much more broadly: as far south as Dick's Point on the western side of the bay and the mouth of the Kilchis River on the eastern side of the bay. (Hancock, et al. 1979; Figure 5).
- *Salinity.* DEQ's salinity data collected throughout Tillamook Bay suggests that salinity in the southern portion of the bay is sufficient for propagation of softshell clams and oysters. (Figure 4).

Based on available information, DEQ recommends designating the Tillamook Bay as shown in Figure 23.

Netarts Bay – Summary of Data and Conclusions

- *ODFW.* ODFW maps indicate that there are shellfish harvesting areas throughout the northern portion of the bay. Native littleneck clams are found throughout the harvestable area of the bay which extends as far south as the mouth of Whiskey Creek. (ODFW 2014). South of this point, ODFW has established a shellfish preserve that extends as far south as the mouth of Austin Creek, which supports a wide array of clam populations.[17] South of this area, DEQ has no information suggesting that clams reside in this area, potentially due to lack of appropriate substrate. (Hancock, et al. 1979).
- *ODA.* Commercial harvesting is approved in the entire bay as far south as Whiskey Creek.

[17] http://www.dfw.state.or.us/mrp/shellfish/seacor/findings_netarts_bay.asp. Accessed December 2, 2015.

- *Other information sources.* DEQ did not consult other information sources for Netarts Bay, as information ODFW provided was comprehensive.
- *Salinity data.* As the bay is primarily fed by marine water without a sizeable freshwater input, DEQ data indicate the salinity is well above minimum levels needed to support bay clams.

DEQ recommends designating the entire Netarts Bay for shellfish harvesting and coastal contact recreation use as shown in Figure 24. Although the southern portion of the bay does not include shellfish populations based on available information, there is a risk that any fecal contamination in this area would reach shellfish beds. Therefore, DEQ recommends this portion be included as part of the designation.

Sand Lake – Summary of Data and Conclusions

- *ODFW.* Sand Lake is not included within accessible shellfishing areas on ODFW maps.
- *ODA.* Commercial shellfish harvest is not allowed in Sand Lake.
- *Other information sources.* One report notes that there is one clamming area within the "bay system" of Sand Lake. (Kreag 1979). Online information indicates that there is a small clamming area on the north side of Whalen Island.[18] DEQ staff confirm that there is clamming in the Sand Lake Estuary. (*pers. comm..*, York Johnson, DEQ, 12/16/15).
- *Salinity data.* DEQ has little salinity data within Sand Lake.

While information on shellfish harvesting is scarce, DEQ recommends erring on the side of inclusiveness in the Sand Lake Estuary and designating the entire estuary for shellfish harvesting and coastal contact recreation use as shown in Figure 25.

Nestucca and Little Nestucca Estuaries – Summary of Data and Conclusions

- *ODFW.* According to the current ODFW maps, the primary accessible area for clamming in Nestucca Bay is in most of the eastern lobe of the bay. (Figure 6). ODFW confirmed that clamming occurs in the tidal flats near the boat ramp near the intersection of Brooten Road and Nestucca Manor Drive. (*pers. comm.*, Liz Perotti, ODFW, 1/28/16).
- *ODA.* Commercial shellfish harvest is not allowed in Nestucca Bay.
- *Other information sources.* Studies are generally consistent with ODFW-identified shellfishing areas. (Hancock, et al. 1979; Figure 7).
- *Salinity data.* DEQ has very little salinity data within the Nestucca Estuary. The EPA Western Ecology Division provided DEQ with data that it has collected for research. The data indicate that, on average, salinity is approximately 11 ppth at the mouth of the Nestucca River into the bay. In the Little Necanicum portion of the bay, median salinity is approximately 13.5 near the Highway 101 bridge.

Based on available information, DEQ recommends designating Nestucca Bay as shown in Figure 26.

Salmon River Estuary – Summary of Data and Conclusions

[18] http://www.clamdigging.info/Sand%20Lake.html. Accessed December 23, 2015.

- *ODFW.* ODFW does not have information related to shellfish harvesting areas in the Salmon River.
- *ODA.* Commercial shellfish harvest is not allowed in the Salmon River Estuary.
- *Other sources of information.* A study by the Fish Commission of Oregon indicates that there are shellfish beds in mud flats across the river from the mouth of Crowley Creek and in a narrow area that runs from the mouth of Crowley Creek upstream to approximately the mouth of Mink Creek. (Gaumer, et al. 1973; Figure 8). Hancock, et al. (1979) shows similar distribution for softshell and Baltic clams. Other online information indicates that clam beds do not exist as far south as the 1973 study.[19]
- *Salinity data.* DEQ does not have sufficient data at any location within the Salmon River Estuary to assist in determining where shellfish may reside. EPA Western Ecology Division data, although limited, indicates that salinity during the wet season in the estuary near Mink Creek may not be high enough to support softshell clam populations.

Based on available information, DEQ is recommending designating the Salmon River Estuary as shown in Figure 27.

Siletz Bay – Summary of Data and Conclusions

- *ODFW.* ODFW maps indicate that accessible shellfish harvesting areas in the northern area of the bay near Highway 101, reaching approximately as far south as the intersection of Highway 101 and SW Jetty Avenue. (Figure 9). In addition, ODFW has communicated that shellfish are found in Schooner Creek, at least 300 meters upstream of the bay.
- *ODA.* Commercial shellfish harvest is not allowed in Siletz Bay.
- *Other sources of information.* Distributional sampling in the 1970s indicated that softshell clams and Baltic clams extend almost to the southern edge of the estuary. (Figure 10).
- *Salinity data.* DEQ has some salinity data in Siletz Bay, but primarily located in the northern half of the bay. Even in this area, available data are almost exclusively taken from the May-September period, with samples taken during other months during one or two years. As a result, DEQ does not consider that available data provide sufficient basis for delineating shellfish harvesting areas.

Based on this information and paucity of data for some locations in Siletz Bay, DEQ recommends erring on the side of inclusiveness and designating the all of Siletz Bay west of Highway 101 for shellfish harvesting and coastal contact recreation use, as shown in Figure 28.

Yaquina Bay – Summary of Data and Conclusions

- *ODFW.* ODFW shellfish harvesting maps indicate that there are accessible shellfish areas as far upstream as Babcock Creek, south of Toledo. Several other areas are accessible around Newport. (Figure 11). ODFW also confirms that shellfish are harvested in Poole and McCaffery Sloughs. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *ODA.* ODA has approved commercial shellfish growing in Yaquina Bay as far east as Green Point. (Figure 11).

[19] http://www.clamdigging.info/Salmon%20River%20Estuary.html. Accessed December 3, 2015.

- *Other available information.* Softshell clam distribution may occur as much as one mile further upstream of Babcock Creek than ODFW "where to clam" maps indicate. (Hancock, et al. 1979; Figure 12). More recent online information is consistent with this report.[20]
- *Salinity information.* DEQ salinity data on Yaquina indicate that median salinity in the uppermost areas of clam distribution is 5 ppth, somewhat lower than that typically found to support shellfish propagation. (Figure 11). Such data suggest that salinity is about 9 ppth at the uppermost accessible area based on ODFW "where to fish" maps. It may be that DEQ's data, which are taken from near the surface, do not represent salinity in the bottom substrate, which may be higher.

Based on the available information, DEQ recommends designating Yaquina Bay as shown in Figure 29.

Alsea River Estuary – Summary of Data and Conclusions

- *ODFW.* ODFW shellfish harvesting maps show that there are accessible shellfishing areas as far upstream as Eckman Creek. (Figure 13). ODFW staff suggest there also is clamming east of Eckman Lake and maybe as far upstream as Drift Creek. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *ODA.* ODA has not approved commercial shellfish growing in the Alsea River Estuary.
- *Other available information.* Hancock, et al. (1979), indicates that softshell clams and California softshells occur primarily in the flats in the area near Bayview. (Figure 14). It does not appear that the survey conducted in that report included areas further upstream than this area. Other online information indicates that clamming is accessible near Eckman Creek, consistent with ODFW maps.[21]
- *Salinity information.* DEQ has collected sufficient salinity data from three stations to calculate median salinity. Median salinity at the station furthest upstream (50 yards downstream of mid-channel island) is 12.9 ppth. Limited EPA data indicate that median salinity slightly upstream of Eckman Creek is 10 ppth.

Based on the available information, DEQ recommends designating the Alsea River as shown in Figure 30.

Yachats River Estuary – Summary of Data and Conclusions

- *ODFW.* Personal communications from ODFW indicate that there are some razor clams in the Yachats River Estuary, but not as far upstream as the Highway 101 bridge. (*pers. comm.*, Steve Rumrill, ODFW, 12/16/15).
- *ODA.* ODA has not approved commercial shellfish growing in the Yachats River Estuary.
- *Other available information.* DEQ has not found other information about clams found in the Yachats River Estuary.
- *Salinity information.* Limited conductivity information indicates that the Yachats River is estuarine up to Highway 101.

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[20] http://www.razorclamming.com/locations/oregon-clam-bays/yaquina-bay-newport/, accessed December 3, 2015.
[21] http://www.clamdigging.info/Alsea%20Bay.html. Accessed December 8, 2015.

Based on this information and paucity of data for some locations in the Yachats River Estuary, DEQ recommends erring on the side of inclusiveness and designating the all of the Yachats River Estuary west of Highway 101 for shellfish harvesting and coastal contact recreation use, as shown in Figure 31.

Siuslaw River Estuary – Summary of Data and Conclusions

- *ODFW.* ODFW shellfish harvesting maps include a few areas as far upstream as the east bank mouth of the North Fork Siuslaw River. (Figure 15). ODFW confirms that shellfish are found further east of these areas. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *ODA.* ODA has not approved commercial shellfish growing in the Siuslaw River Estuary.
- *Other available information.* Hancock, et al. (1979), shows that shellfish beds exist in similar areas as the ODFW maps, as well as in a few areas in the lower extent of the North Fork Siuslaw River, up to about 500 meters downstream of Bull Island. (Figure 16). Other online information indicates that there is some clamming in the Siuslaw slightly upstream of ODFW-identified areas as far as the upstream end of Cox Island.[22]
- *Salinity Data.* DEQ has little salinity information in the Siuslaw River Estuary.

Based on available information, DEQ recommends designating the Siuslaw River Estuary as shown in Figure 32.

Umpqua River Estuary/Winchester Bay – Summary of Data and Conclusions

- *ODFW.* ODFW maps indicate that in some years, clams can be found as far upstream as Bolon Island, slightly downstream of the mouth of Smith River. (Figure 17). In addition, ODFW staff note that shellfish harvesting may occur further upstream along the Smith River and on the Umpqua somewhat east of Smith River. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *ODA.* Commercial shellfish harvesting is allowed in the lower portion of the Umpqua as far upstream as Henderson Cove. (Figure 17).
- *Other available information.* Online information indicates that there may be clamming in the area of Blacks Island, just upstream of Bolon Island at the mouth of the Smith River.[23] ODFW has confirmed that shellfish are found on Blacks Island. (*pers. comm.,* S. Rumrill, ODFW, 12/14/15)
- *Salinity Data.* DEQ analyzed salinity data from several stations in the Umpqua River. The data indicate that median salinity is 10 ppth a few miles upstream above. (Figure 17). ODFW and online sources note that clams inhabit areas approximately several miles further upstream of this point. An ODFW report noted that the Umpqua has a significant saline wedge on the bottom when river flow is high and which can extend up to six miles upstream from the mouth. (Ratti 1979). This wedge may result in the presence of softshell clams further upstream than DEQ's salinity data indicate would allow clams to survive.

Based on the available information, DEQ recommends designating the Umpqua River as shown in Figure 33.

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[22] http://www.clamdigging.info/Siuslaw%20River%20Estuary%201.html. Accessed December 8, 2015.
[23] http://www.clamdigging.info/Winchester-Bay%201.html, accessed December 8, 2015.

Coos Bay – Summary of Data and Conclusions

- *ODFW.* According to ODFW, there are several clamming areas in Coos Bay. These include several areas in South Slough as far south as Day Inlet and in Coos Bay as far east as Kentuck Slough and as far north as Haynes Inlet. (Figure 18). In addition, native oysters are found in Isthmus Slough as far south as Millington and clams have been found under the Davis Slough bridge. (*pers. comm.,* Liz Perotti, ODFW, 1/27/16).
- *ODA.* Commercial shellfish harvesting is allowed in much of Coos Bay including from the mouth to Sitka Dock; in South Slough as far south as Elliot Creek; in portions of Haynes Inlet and in the bay offshore of North Bend. (Figure 18).
- *Other available information.* Online information indicates that there is clamming for softshell clams south of Kentuck Slough into Cooston Channel almost all the way to the mouth of the Coos River.[24] DEQ also has reports of softshell clams at the mouth of Catching Slough and just above the Coos River Bridge and native oysters at and above the Newport Lane Bridge across Isthmus Slough. (*Pers. comm.,* John Schaefer, Biologist, Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians, November 16, 2015).
- *Salinity Data.* Median salinity at DEQ LASAR stations indicates that salinity levels are well above 10 ppth throughout Coos Bay and the connecting sloughs and inlets, as far upstream as the mouth of the Coos River. (Figure 18).

Based on the available information, DEQ recommends designating Coos Bay as shown in Figure 34.

Coquille River Estuary – Summary of Data and Conclusions

- *ODFW.* ODFW indicates that clamming beds are accessible in the Bandon Marsh area of the estuary. (Figure 19).
- *ODA.* Commercial shellfish growing is not approved in the Coquille River.
- *Other available information.* Online information indicates that softshell clams may be found upstream of the 101 bridge.[25] ODF reports corroborate this. (Kreag, 1979b).
- *Salinity Data.* DEQ has collected sufficient salinity data from one station in the Coquille River, near the 101 bridge. At that station, the median salinity is just above 10 ppth, consistent with where softshell clams are found.

Based on available information, DEQ recommends designating the Coquille River as shown in Figure 35.

[24] http://www.razorclamming.com/locations/oregon-clam-bays/coos-bay-map/, accessed December 9, 2015.
[25] http://www.clamdigging.info/Coquille%20Bay.html. Accessed December 9, 2015.

Implementation of Proposed Revisions

Implementation of Enterococcus Criteria for Permitting Individual NPDES Facilities

Implementation of the proposed standard for developing effluent limits for individually permitted facilities discharging to waters designated for coastal contact recreation will be much the same as implementation of the current suite of bacteria standards. As noted in the previous section, DEQ is proposing a monthly duration for facilities to show that they are meeting the geometric mean criterion of 35 CFU enterococcus per 100 mL[26]. This requirement is identical to current requirements for such facilities. (DEQ 2011). Additionally, permits for these facilities will include requirements as necessary to ensure that the enterococcus levels in their effluent are less than 130 CFU per 100 mL (the statistical threshold value) 90 percent of the time on a monthly basis.[27] The following examples indicate how the calculation would work:

Example #1. Facility meets geometric mean but exceeds 90th percentile value. A facility takes five bacteria samples of their effluent in a month. The bacteria level from one sample is 145 CFU enterococcus per 100 mL but the levels in the remaining four samples are 10 CFU per 100 mL. In this case, the facility would be meeting its geometric mean limit: $(145*10*10*10*10)^{1/5}$= approximately 17 CFU enterococcus/100 mL. However, 20% of the samples exceeds the STV of 130 CFU/100 mL. This facility exceeds the STV-based limit.

Example #2. Facility meets both geometric mean and 90th percentile value. The same facility as in example #1 takes ten samples within the month. One sample is at 145 CFU of enterococcus per 100 mL and the remaining samples measure 10 CFU of enterococcus per 100 mL. As only ten percent of samples exceeds 130 CFU per 100 mL, the facility is meeting the STV-based limit and the geometric mean (approximately 13 CFU per 100 mL).

Example #3. Facility exceeds geometric mean but meets 90th percentile value. The same facility takes 10 samples. Samples equal 10, 15, 30, 30, 40, 60, 65, 90, 120, and 140 CFU per 100 mL. The geometric mean of the samples is approximately 45 CFU enterococcus per 100 mL, which

[26] Monthly geometric means are calculated by multiplying all samples from a location in a given month, then taking the "nth" root of the samples, where n equals the number of samples. For example, if you have five samples, the results of all five samples are multiplied together, then the 5th root is taken of the result. The purpose of the geometric mean is to ensure that one very high sample is not heavily weighted.

[27] The 90th percentile is calculated by taking the results of all samples collected within a month and sorting them from lowest to highest. For the enterococcus criteria, if more than ten percent of samples is greater than 130 CFU enterococcus per 100 mL or the appropriate limit, it would be in violation of permit requirements. In many cases, a facility collects less than ten samples in a month, so only one sample in excess of 130 CFU per 100 mL would result in a violation. However, if more than 10 and less than 20 samples were collected, one sample could be in excess of 130 CFU per 100 mL without a violation.

exceeds the limit of 35 CFU per 100 mL. However, only one out of ten samples exceeds 130 CFU per 100 mL, so the facility is meeting the 90th percentile value.

Implementation of *E. coli* Criteria for Permitting Individual NPDES Facilities

DEQ's current procedures for effluent limitations for *E. coli* will not change. These procedures are outlined in the Oregon Bacteria Criteria Internal Management Directive (DEQ 2011). These procedures state: "*E. coli* criteria…must be met at end-of-pipe whenever the existing or designated use is water contact recreation (WCR); no [mixing zones] are allowed in this situation." The IMD will be modified slightly to reflect that the designated use associated with the *E. coli* criteria is "freshwater contact recreation," to be consistent with use designations in this rulemaking. The requirement that the criteria must be met at end-of-pipe will not change.

Implementation of Recreational Criteria in Water Quality Assessments

Every two years, DEQ is required to prepare an Integrated Report that includes an assessment of whether each water body is meeting water quality standards, where data are available. If DEQ determines that the water body is not meeting water quality standards, the water body is placed on Oregon's 303(d) list of impaired waters. DEQ then develops a total maximum daily load that outlines what steps need to be taken to reduce pollutant loads to meet standards.

As part of the Integrated Report, DEQ prepares a methodology that it uses to determine whether the water body meets each water quality standard (Category 2), is not attaining the standard (Category 5) or if there are insufficient data to make a determination (Category 3).

The following describes DEQ's preliminary concepts about how DEQ would assess waters under the proposed amendments. As part of the Integrated Reporting process, DEQ develops an Assessment Methodology that documents how water bodies are assessed under each standard.[28] The Assessment Methodology will describe DEQ's methodology more specifically and will be made available for public comment prior to development of the next Integrated Report.

Coastal Contact Recreation Criteria

The following shows DEQ's initial concept regarding the listing methodology under the proposed enterococcus criteria to protect contact recreation designated use in coastal waters. This is similar to how DEQ has assessed coastal waters previously but includes a 90-day duration consistent with the proposed standard.[28] Note that, because samples may be taken over a period that is greater than 90 days, DEQ anticipates calculating a rolling 90-day mean during the period

[28] DEQ's assessment methodology for the 2012 Integrated Report is available here: http://www.oregon.gov/deq/WQ/Documents/Assessment/AssessmentMethodologyRep.pdf.

during which samples are available.[29] If any calculated 90-day geometric mean was greater than 35 Enterococci per 100 mL or if more than 10 percent of samples in one 90-day period was greater than 130 Enterococci per 100 mL, the waterbody or beach would be listed as water quality limited if a statistically valid minimum number of samples are available during the 90-day period.

Category 5: Water Quality Limited, TMDL Needed (303(d) List). A geometric mean for samples collected over 90 days is greater than 35 Enterococci per 100 ml or greater than ten percent of samples collected over 90 days is greater than 130 Enterococci per 100 mL, based on a sample set of 5 or more samples.

Category 4: Water Quality Limited, TMDL Not Needed. This category incorporates any waterbodies that were listed as impaired and for which TMDLs already have been approved or where other pollution controls would result in attainment of water quality standards. The proposed revisions aren't expected to affect DEQ's evaluation of data in this category.

Category 3: Insufficient Data. Less than 5 samples are available for evaluation for a 90 day period.

Category 3B: Insufficient Data – Potential Concern. Less than 5 samples are available for a seasonal sampling period, and one or more samples exceeds 130 Enterococci per 100 ml, or the Oregon Beach Monitoring Program has issued one or more advisories based on monitoring results for Enterococci in a seasonal sampling period, not including precautionary advisories.

Category 2: Attaining. The geometric mean for samples collected over all 90 day periods for which there is at least 5 samples is equal to or less than 35 Enterococci per 100 ml and no more than ten percent of samples in any 90 day period is equal to or more than 130 Enterococci per 100 mL.

Freshwater Contact Recreation

As DEQ is changing the duration of the geometric mean *E. coli* criterion from 30 days to 90 days, DEQ will consider all data collected from a particular site over a 90-day period in assessing whether the water body is meeting the criterion with a minimum of 5 samples. As with the enterococcus criteria, if data collected from a site are taken over a greater than 90 days, a rolling geometric mean would be calculated for each 90 day period.

Category 5: Water Quality Limited, TMDL Needed (303(d) List) A 90-day geometric mean greater than 126 *E. coli* organisms per 100 ml based on a minimum of five samples, or more than 10% of the samples exceed 406 *E. coli* organisms per 100 ml, with a minimum of at least two exceedances.

Category 4: Water Quality Limited, TMDL Not Needed This category incorporates any waterbodies that were listed as impaired and for which TMDLs already have been approved or

[29] In general, DEQ assesses based on enterococcus data collected from beaches as part of the Oregon Beach Monitoring Program. The OBMP currently collects data between late May and early September. Assuming that this remains the case, DEQ could only assess for attainment of the enterococcus standard during this time. If additional data outside this time period become available, DEQ would assess on all available data.

where other pollution controls would result in attainment of water quality standards. The proposed revisions are not expected to affect DEQ's evaluation of data in this category.

Category 3: Insufficient Data Less than five samples are available to evaluate for all 90 day periods, or five to nine samples are available for the season of interest with one sample exceeding 406 *E. coli* organisms per 100 milliliters. Category 3B: Insufficient Data – Potential Concern Less than five samples are available to evaluate for the season of interest, with two or more samples exceeding 406 *E. coli* organisms per 100 milliliters.

Category 2: Attaining The 90-day geometric mean is equal to or less than 126 *E. coli* organisms per 100 ml based on a minimum of five samples, and, if data from 10 or more samples are available, 90% of the samples are below 406 *E. coli* organisms per 100 ml. If data from five to nine samples are available, no exceedances of 406 *E. coli* organisms per 100 ml.

Public Involvement for this Rulemaking

DEQ held a series of meetings in Oct. 2015 to provide information to interested parties and to answer questions related to the rulemaking. These meetings took place in Coos Bay, Newport, Cannon Beach and Portland. The meetings were conducted jointly with OHA, which provided information related to adoption of the BAV for purposes of issuing advisories. Approximately 40 people attended the meetings, not including DEQ and OHA staff. Summaries of these meetings and meeting materials pertinent to the rulemaking are included in Appendix B.

DEQ also held meetings and phone conversations with individual stakeholders to answer questions relevant to their interests. Meetings included those with Oregon Farm Bureau, League of Oregon Cities, Oregon Department of Agriculture, Northwest Pulp and Paper Association and a representative of a commercial oyster grower.

Bibliography

Anderson, I.C., M. Rhodes and H. Kator. 1979. Sublethal Stress in Escherichia coli: a Function of Salinity. Applied and Environmental Microbiology 38(6): 1147-1152.

CREST 1978. Columbia River Estuary Inventory of Physical, Biological, and Cultural Characteristics. M. Seaman, *ed.* Prepared for the Columbia River Estuary Study Taskforce.

Croteau, M. C., V. E. Renner, F. Archibald, V. S. Langlois, J. Cahn, J. Ridal, V. L. Trudeau and D. R. S. Lean. 2007. Investigation of pathogenic *Escherichia coli* and microbial pathogens in pulp and paper mill biosolids. Water Environment Research 79(9): 1050-1056.

Degnan, A. J. 2007. Examination of indigenous microbiota and survival of *Escherichia coli* 0157 and *Salmonella* in a paper milling environment. Journal of Applied Microbiology 104:534-540.

DeWitt, T. H. and N. Lewis. 2015. "Estimating the distribution of harvested estuarine bivalves with natural-history-based habitat suitability models." Presentation at 23rd Biennial Conference, Coastal and Estuarine Research Foundation. Portland, OR. November 8-12, 2015.

Emmett, R. L., S. L. Stone, S. A. Hinton and M. E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Volume II: species life history summaries. ELMR Rep. No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD 329 p.

Gaumer, T., D. Demory and L. Osis. 1973. 1971 Salmon River Estuary Resource Use Study. Fish Commission of Oregon, Division of Management and Research. Available at: http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/21248/Compressed1971SalmonRiverEstuary.pdf?sequence=1.

Gauthier, F., and F. Archibald. 2001. The ecology of "fecal indicator" bacteria commonly found in pulp and paper mill water systems. *Water Resources* 35(9):2207-2218.

Hancock, D. R., T. F. Gaumer, G. B. Willeke, G. P. Robart and J. Flynn. 1979. Subtidal Clam Populations: Distribution, Abundance, and Ecology. Oregon State University Sea Grant College Program Publication no. ORESU-T-79-002. Corvallis, OR.

Hayslip, G., L. Edmond, V. Partridge, W. Nelson, H. Lee, F. Cole, J. Lamberson, and L. Caton. 2006. Ecological condition of the estuaries of Oregon and Washington: an environmental monitoring and assessment program (EMAP) report. Environmental Protection Agency, Office of Environmental Assessment, Region 10, Seattle, Washington.

Higley, D. L., and R. L. Holton. 1975. Biological baseline data, Youngs Bay, Oregon. Final Rep. 75-6, 1 November 1973-30 April 1975. School Ocean., Oregon State Univ., Corvallis, OR. 90 pp.

Kreag, R. A. 1979a. Natural Resources of the Sand Lake Estuary. Inventory Report Vol. 2, No. 2. Oregon Department of Fish and Wildlife. Portland, OR.

Kreag, R. A. 1979. Natural Resources of the Coquille Estuary. Estuary Inventory Report Vol. 2, No. 7. Oregon Department of Fish and Wildlife. Portland, OR.

Lee II, H. and Brown, C. A. (eds.) 2009. Classification of Regional Patterns of Environmental Drivers and Benthic Habitats in Pacific Northwest Estuaries. U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Western Ecology Division. EPA/600/R-09/140.

Marriage, L. D. 1954. The Bay Clams of Oregon: Their Economic Importance, Relative Abundance, and General Distribution. Fish Commission of Oregon, Contribution No. 20. Portland, OR.

Newell, C.R., and H. Hidu. 1986. Species profiles: life histories and environmental requirements of coastal fish and invertebrates (North Atlantic) – softshell clam. Biological Report 82(11.53).

Oregon Department of Environmental Quality. 2011. Oregon Bacteria Rule: Bacteria Criteria for Marine and Estuarine Water. DEQ 11-WQ-005. Portland, OR.

Oregon Department of Fish and Wildlife. "Where to Dig" webpage. http://www.dfw.state.or.us/mrp/shellfish/bayclams/dig_where_to.asp. Accessed by Aron Borok, September 9, 2015.

ODFW. 2014. *Brochure,* "Where to Harvest Bay Clams: Netarts Bay." Marine Resources Program. Newport, OR. Available at: http://www.dfw.state.or.us/mrp/shellfish/seacor/docs/TART%2011x17%20fold%20down%20trifold%20brochure_lazerquick.pdf

Ratti, F. 1979. Natural Resources of Umpqua Estuary. Estuary Inventory Report Volume 2, Number 5. Oregon Department of Fish and Wildlife. Portland, OR.

Strasser, M. 1999. Mya arenaria – an ancient invader of the North Sea coast. Hegolander Meeresunters 52: 309-324.

Sytsma, M.D., J.R. Cordell, J.W. Chapman, and R.C. Draheim. 2004. Lower Columbia River Aquatic Nonindigenous Species Survey 2001-2004. Final Technical Report for the U.S. Coast Guard and the U.S. Fish and Wildlife Service.

U.S. EPA. 2015. *Memo:* "Narrative Justification for Longer Duration Period for Recreational Water Quality Criteria."

U.S. EPA. 2010. Report on 2009 National Epidemiologic and Environmental Assessment of Recreational Water Epidemiology Studies (NEEAR 2010 – Surfside and Boquerón). EPA-600-R-10-168. Available at: http://www.epa.gov/near/files/Report2009v5_508comp.pdf.

U.S. EPA. 1986. Ambient Water Quality Criteria for Bacteria - 1986, EPA 440/5-84-002, Office of Water Regulations and Standards, Washington, DC.

U.S. EPA. 1976. Quality Criteria for Water (Red Book). EPA 440-9-76-23. Washington, DC.