Salmon Spawning Habitat Protection Rule
Summary of Science Advisory Group Meetings

DEPARTMENT OF ECOLOGY
State of Washington

What is the Science Advisory Group?

The Department of Ecology established a Science Advisory Group to provide technical advice and feedback for the development of the Salmon Spawning Habitat Protection Rule. This proposed rule would update the water quality standards for dissolved oxygen (DO) and propose a new fine sediment narrative criterion. Our goal is to provide additional water quality benefits and habitat protection for early life stages of salmonids, which include salmon, steelhead, trout, char, and whitefish, and their spawning gravel.

The purpose of the advisory group was to discuss the relevant scientific literature associated with the impacts of DO and fine sediment on salmonid spawning. This group also discussed the different measures that can be used to determine if excess fine sediment is contributing to poor habitat quality.

Meeting information

Ecology hosted five online meetings between October 29, 2020 and July 27, 2021. The meetings were conducted by Water Quality Program staff in the Watershed Management Section, including: Susan Braley, facilitator; Marla Koberstein, webinar moderator; Bryson Finch, technical rule lead; and Chad Brown, Unit Supervisor.

The first four Advisory Group meetings were held on October 29, November 19, and December 9 in 2020, and February 3 in 2021. The meetings included technical discussions on DO and fine sediment, and summary notes of issues discussed at each technical meeting are included under the meeting summaries in this document.

At the final meeting on July 27, 2021, Ecology provided preliminary decisions on a proposed rulemaking based on the advisory group discussions and further research by Ecology staff. A summary of the preliminary decisions for a rule proposal and alternatives considered by Ecology are included under the July 29 summary in this document.

Following the final Advisory Group meeting, the preliminary decisions for a rule proposal were subsequently shared with the public at an online webinar held on September 21, 2021.

Advisory group members

The Science Advisory Group included both external stakeholders and Ecology staff with expertise in:

- DO dynamics in freshwater environments
- Salmonid habitat requirements and protection
- Biogeochemistry of materials in rivers and streams

External stakeholders

- Joy Archuleta, US Forest Service
- Jennifer Arthur, City of Seattle Public Utilities
- Seth Book, Skokomish Tribe
- Ashley Coble, National Council for Air and Stream Improvement, Inc.
- Joanna Crowe Curran, U.S. Corp of Engineers
- Chris Frissell, Salish Kootenai College, Department of Hydrology
- Lindsay Guzzo, Environmental Protection Agency
- Tim Hagan, Pierce County
- Kirk Krueger, Washington Department of Fish and Wildlife
- Brian Mattax, Consultant
- Ted Parker, Snohomish County
- Rainy Rau, City of Vancouver

Ecology staff

- Jordan Bauer, Hydropower, Water Quality
- Patrick Lizon, Non-point pollution and Forestry, Water Quality
- Glenn Merritt, Watershed Health Monitoring, Environmental Assessment
- Cleo Neculae ,Total Maximum Daily Load, Water Quality
- Cole Provence, Total Maximum Daily Load, Water Quality
- Keunyea Song, Stormwater Action Monitoring, Water Quality
- Leanne Weiss, Total Maximum Daily Load, Water Quality
- Angela Zeigenfuse, Rule Writer, Water Quality

Meeting Summaries

Oct. 29, 2020

Meeting Goals

- Introduce team members and establish Science Advisory Group goals and objectives.
- Share background information on DO to aid in group discussions.
- Discuss considerations for a revised DO standard that protects early life stages of fish and takes into account natural variability of DO and feasibility of implementation.

Meeting Summary Notes

DO: protective levels for early life stages of salmonids

Flow, substrate, temperature, and DO are important aspects to salmonid spawning.

One main point for today is current range of DO protection for salmonid-based uses in WA is 8-9.5 mg/L.

- WA criteria translates to intragravel DO levels 5-6.5 mg/L according to EPA assumption of a 3 mg/L DO depression.

Currently there is no provision in the standards for continuous or diel monitoring for DO and it raises concern because DO depressions can occur at night and early morning. Several members noted that grab samples alone do not represent DO fluctuations.

Major consideration needs to be made for early morning hour DO monitoring, such as:

- Potentially build in buffer for DO criteria to account for day and night concentration fluctuations.
- British Columbia criteria of 30-day Mean-Minimum for intragravels may be a potential to address this concern.

Salmonid growth and survival may be the most sensitive to DO concentrations and may be how EPA came up with 11 mg/L criteria for full protection.

Does the literature support 11 mg/L or is it over protective?

There may be some environmental variability that needs to be determined (sediments, temperature, groundwater influence, etc.).

11 mg/L seems high and is not achievable in some given habitats; may not lend support to that level.

- What is the potential DO level out there that can be naturally supported?
- There may need to be more research to determine the appropriate DO depression in the intragravel DO.

Is there a concern with current WA DO levels?

Would there be an opportunity to change DO criteria based on changes to designated uses?

- For example, if implementation studies take place and data cannot support achieving the DO criteria, then would there be an opportunity to adjust the DO criteria?
- This action is still being considered. However, oxygen saturation can account for the influence of temperature and barometric pressure on oxygen levels.

Other states use a combination of percent saturation and different averaging periods and/or minimum DO concentrations to compensate for intragravel DO (IGDO) uncertainty due to the difficulty and lack of resources to monitor IGDO and define those values.

Several members noted that salmonids are most fragile during these early life stages and using the highest level of protection should be considered, especially given the uncertainty of the environmental conditions and variability.

Further research is needed to identify if redd construction significantly change intragravel DO levels.

Preliminary options for DO criteria

New criteria of 11 mg/L alone will lead to many new 303(d) listings that may not in fact be impaired because the criteria can't naturally be met in many waters.

- There would need to be contingencies included with a 11 mg/L criterion or additional DO criteria options

Review recent literature papers that may refine 3 mg/L suppression in intragravel sediments. The 3.0 mg/L may be based on old methods and may need to be refined.

Present a repository and using best available science and studies to come up with change from water column and intragravel DO.

Consider applying a more restrictive seasonal fresh water DO criteria during spawning and rearing periods

Having a seasonal criteria may be impractical given the criteria would be applied statewide and each stream is unique in the timing of salmonid spawning and rearing

Salmonids have been observed to spawn through the entire year and thus a seasonal timeline would not be worthwhile to try to establish.

There is a wide range of temperatures throughout the year, and therefore seasonality of oxygen conditions should be considered.

Intragravel measurements are difficult to control and implement. Not feasible for all cases.

An if/then clause could be established where if a waterbody doesn't meet 11 mg/L then an 8 mg/L intragravel criteria would take place.

It was noted that after construction of the redd (which often displaces fine sediment), the process of accumulation of fine sediment over incubation time in the redds decreases intragravel DO.

Research on intragravel DO often requires permits from fisheries agencies in order to allow for substrate disruption of the spawning gravels. This further implies difficulty in being able to

sample intragravel DO. It was also noted that the methodology of having piezometers in streams can vary due to many environmental conditions (i.e., substrate type).

We need to have additional literature to suggest which percent saturation is most protective of salmonids and what is the fluctuation/range of the saturation in streams. How and why did states choose 90% or 95% saturation?

- Colden Baxter et al. study looks at bull trout spawning in groundwater upwelling sites, which were likely lower in DO, and thus biological variability is important to consider. It is typically not feasible to find spawning locations that have optimal conditions for both DO and temperature that would allow for the ideal protection of redds.

SIDO-UK model by Sear may be relevant to the discussion. Focus on sediment oxygen demand could be useful.

Add a percent saturation component to the freshwater DO criteria

As part of rule development for DO, Ecology is considering the feasibility of including a percent saturation in the DO criterion (percent saturation can compensate for naturally high temperatures). Using the percent saturation requirement would provide the ability to consider the degree of influence from nutrient and/or temperature impairments.

If we could establish a relationship between percent saturation and IGDO, it could provide valuable information.

Consider a combination of options for DO criteria

Several members suggested checking in with other states/tribes that have various combination criteria for DO in the water column, intragravel, and DO saturation. How successful have the criteria been in protecting the intended use? How feasible is it to monitor and implement the criteria? What are the advantages and drawbacks of the different combinations?

November 19, 2020

Meeting Goals

- Share background information on DO and fine sediment to aid in group discussions.
- DO criteria averaging period
- Fine sediment criteria structure

Meeting Summary Notes

Implementation of Oregon's DO criteria

Oregon's criteria is 11.0 mg/L DO water column criteria, 8.0 mg/L intragravel DO criteria, and 95% DO saturation.

The main point taken from discussion with Oregon DEQ is that the IGDO is not readily used unless it needs to be used for site-specific evaluations. DO saturation percentage and water column DO criteria are primarily used by the agency.

A concern was raised about how the antidegradation standard is used in Washington and whether it captures the necessary background data to define pre-anthropogenic conditions.

Percent DO saturation threshold – discussion of Davis 1975[1] paper.

The ideal protection level observed in the paper for salmonid larvae and mature eggs for temperatures 0-15℃ is 98% DO saturation, while at 20-25℃ a 100% DO saturation is needed. However, these protection levels may be overly stringent, depending on environmental conditions.

A concern was raised regarding monitoring results within the Puget Sound area showing only 10% of the monitoring stations would meet the DO water column (11 mg/L) and saturation criteria (95%), even during the winter months when DO values tend to be higher.

It was suggested that this could be because of the area being a high urban ecoregion.

A member expressed concern on how some of these criteria may be out of attainable reason and beyond financial commitments/funding.

There are other tools available to compensate for those environments that may be unique to the criterion (e.g. Use Attainability Analysis).

An important part of this whole process is coming up with criteria that provide full protection for salmonids.

Minimal work has been done supporting a threshold for DO saturation. Davis (1975) presents DO saturation recommendations for early life stages of salmonids as well as older life stages. These recommendations represent some support for DO saturation criteria, but further justification may be warranted based on environmental conditions.

[1] Davis, J. C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: a review. J. Fish. Res. Board Can. 32:2295-2312

DO in Spawning Gravel Redds

Construction of redds will initially increase intragravel DO, but levels will decrease over time due to DO consumption by the early stage salmonids and filling of intragravel spaces in the tailspin by fine sediments.

The most sensitive time during early life stages of salmonids is egg emergence; so regardless of construction or filling of spaces, the most important DO concentration comes during the emergence period.

The enhancement of DO in gravels may be depleted over time depending on the movement of sediment in the waterbody.

DO criteria averaging period

WA currently has a 1-day minimum averaging period for the DO criteria.

Members agree that a 30-day averaging period is too long, and salmonids have more of an acute impact if DO values drop. Is there a need to have chronic criteria if unique biological conditions exist?

Internal processes in lakes and deeper waterbodies can have an impact on sediment oxygen demand (SOD) and DO values that may require special criteria.

Averaging period may be appropriate for temperature but not DO since their need is acute and early salmonid life stages are not mobile.

Other states use longer averaging periods (7- and 30-day common) when an 11 mg/L water column DO criteria is applied.

If multiple pathways to reach full protection for the criteria are available, then it makes sense to choose the pathway with the easiest way to measure the required parameter.

Typically, longer averaging periods require greater protection (magnitude component increases).

One member expressed concern of the difficulty to utilize the UAA as a tool due to data acquisition.

Staff pointed out that economic considerations are not part of the EPA rule. Biological protection is the primary means of establishing criteria.

Supplemental spawning criteria would assist in streams that are unique and may not fall under the DO criteria umbrella.

We may revisit the seasonal criteria option in future discussion.

Background on fine sediment

Fines are generally <2mm.

WA water quality standards has a narrative criterion of “no deleterious materials”, but this does not specifically cover fine sediment concerns.

Other states' fine sediment impairment methods

Idaho

Uses narrative criteria and has the most parameters monitored of the other states in determining fine sediment impairments.

Parameters considered are both literature backed and site specific (e.g., embeddedness, surface sediment).

Montana

Uses narrative based criteria and has both fines and coarse substrate habitat monitoring parameters considered.

Colorado

Uses narrative based criteria.

Compares parameters to similar reference sites in sediment-like ecoregions.

Alaska

Uses numeric criteria. Measured by weight. Exceedances occur if a certain percent weight composition occurs above background conditions.

New Mexico

Uses narrative criteria.

Has a seven-step framework with assessment matrix.

Discussion of what other states do to regulate fine sediment

There is interest to use the macroinvertebrate community to characterize fine sediment impacts. There's already data collected for WA and standard operating procedures for collecting and analyzing macroinvertebrate collections in streams.

Watershed monitoring programs, including Washington, uses EPA's framework for assessing stream health and is highly regarded in other states and studies.

It was pointed out that there are no specific results showing macroinvertebrate biological (IBI) indices showing correlation with fry emergence.

The reason Alaska is using weight as a numeric criteria is because they are using McNeil core sampling and collecting physical core samples and characterizing through sieves.

There could be a combination of multiple matrices and timing with sediment methods and IBI work.

Fine sediment quantitative relationships

There are few parameters with a fine sediment quantitative relationship and targets/thresholds can be difficult to establish.

Washington has turbidity criteria, which may be useful as a parameter for relationships to other parameters.

It is clear from what other states are doing and the literature that no single measure can be used to define fine sediment.

Merits of a numeric vs. narrative criteria

After discussion, several members were not convinced that an actual fine sediment threshold exists for a specific waterbody or ecoregion.

It is very difficult to know how the natural conditions were prior to anthropogenic alterations and defining what background conditions were. Alaska's approach would be difficult to implement.

Wadeable streams were used as the primary means of establishing reference sites in Alaska for defining background conditions. Large rivers and other stream orders were based on those means since they were practical and most quantifiable to measure.

Rosgen stream order may be impractical to use with fine sediment characterization, given the diverse makeup of some wadeable streams and ecoregions. May need to look more at generalizing streams rather than having numeric criteria for all.

Using reference sites for fine sediment impairment determinations

It is not useful to talk about using a reference site if there's not an adequate number of sites to characterize a region.

Montgomery and MacDonald (2002)[2] study is a good resource for fine sediment monitoring and stream assessment.

Fine sediment characterization will change drastically during different seasons due to river dynamics and geomorphic areas. Many field visits will need to occur throughout the year.

Temporal measurements will be difficult to determine.

Biologically speaking, fine sediment additions will likely be considered harmful whatever the circumstances. Some streams may be so degraded that more fines may not be detrimental to fish; however, impacts may still be observed somewhere else.

Using multiple methods to measure fine sediments are beneficial because there may be a time when evaluation may be unclear.

The question was raised on how to define support or partial support in the standards if a matrix is used for fine sediment evaluation?

Lines of evidence approach allows flexibility in determining if an impairment exists versus natural occurrence of fine sediment and provides a tool to account for measurement variability.

[2] Montgomery, D. R., & MacDonald, L. H. 2002. Diagnostic approach to stream channel assessment and monitoring. JAWRA Journal of the American Water Resources Association, 38(1), 1-16.

December 9, 2020

Meeting Goals

- Determine feasibility, utility, and subjectivity of fine sediment measures
- Receive feedback on Ecology Watershed Monitoring Program
- Discuss next steps in rule development

Meeting Summary Notes

Discuss individual physical, biological, and chemical-based parameters used to characterize fine sediment

Water column measures

Suspended particles (<2mm) and reduced light penetration is characteristic of high turbid waters with decreased fish growth and predatory deficiency.

Total suspended solids (TSS) are a combination of both inorganic and organic materials.

TSS was originally considered a wastewater measurement method for organics while suspended sediment concentration (SSC) has been considered a more reliable natural-water measurement (Gray et al. 2000[3]).

- SSC incorporates the whole sample while TSS uses a subsample.
- TSS is more functional because of existing background database and trends. Also, one member observed that a specific fraction less than 500µm is more favorable for TSS than SSC.

The methodology for measuring TSS needs to be discussed with Ecology as well as determining what is the best fraction to consider.

Cause and effect analysis using TSS for permitting purposes and background data appears to be the most favorable, although TSS is not a complete measure for identifying the impacts for fine sediment on egg incubation.

Based on member comments, turbidity and TSS may be used depending on site accessibility and sample frequency considerations.

Streambed Measures

Embeddedness measures have a high level of variability due to observer evaluations that can differ significantly over time.

Relative bed stability may be one of the more useful measures, but is fairly involved due to multiple parameters that go into the measure.

- Parameters in the Ecology database exist to support this metric.

[3] Gray JR, Glysson GD, Turcios LM, Schwarz GE. 2000. Comparability of suspended-sediment concentration and total suspended solids data. U.S. Geological Survey, Water-Resources Investigations Report 00-4191, Reston, VA.

Multiple streambed metrics may be useful to consider. Fine sediment and embeddedness are commonly used within many state assessment tools.

Armored ratio is a grain-size metric that compares surface and subsurface substrates.

- Describes relationship of bed load transport rates over time.

Surface fine measurements underestimate the total impact of fine sediment in the stream bed. Subsurface sediment fines also play a role and should be considered.

- A combination of pebble counts for surface armor layer measurements and core samples adjacent to redds or nearby (to avoid redd disruption) has been used to identify a full substrate profile that is specific to salmonid spawning.

Choosing the appropriate streambed measure/metric may provide multiple insights into stream health. A combination of streambed parameters may be necessary to adequately characterize fine sediment.

One member expressed concerns with how measures will be implemented in TMDLs, permits, and beneficial uses.

It was noted that WDFW and Ecology recently updated their toe-width method for rapid assessment, which provides a quick and cost-effective estimate of preferred spawning and rearing stream flows for fish. This method provides site-specific spawning information.

Chemical Metrics

Intragravel DO measurement for evaluating fine sediment was discussed in previous meetings.

Biological Metrics

Benthic macroinvertebrates are used to define streambed health, but ultimately the benthic community may be affected by multiple pollutants.

These biological metrics should be accompanied by other indices/measures.

Characterizing the benthic community can be used as an indicator to define the health of a stream and can be an indicator of substrate suitability.

No rigorous work has been done to show the correlation between the benthic community and egg incubation/fry survival.

In-stream hydraulics may be one of the most important parameters to influence benthic communities and especially IBI scores.

Using reach-wide samples for comparisons of substrate and macroinvertebrates is more favorable than site specific samples and should be emphasized.

Channel Characteristics

Not diagnostic on their own but should be used as secondary measures.

Review Ecology's existing data and monitoring methods that collect data related to fine sediment

Ecology's watershed monitoring program has some existing infrastructure that may be used as a starting point for characterizing fine sediment.

Fine sediment sensitivity index is always calculated for biological monitoring.

There has been no attempt to validate biological metrics with salmonid egg/fry emergence and survival.

We need to understand the effects of catchment vs reach-wide sampling.

Concerns were noted that the Ecology-based methods are set up to track long term monitoring (e.g., projects), while it is difficult to identify shorter-term differences observed over a given time period.

Existing data provides context for how spatial and temporal changes occur, but if assessment does not occur on a yearly basis, then the dataset misses out on temporal variations.

Conclusion: Fine Sediment

A "lines of evidence approach" may be necessary for fine sediment since a single indicator may not substantiate a fine sediment impairment.

Concern expressed that monitoring of fine sediment needs to narrow down to reaches that may be specific to salmonid habitat and fry/egg emergence and survival.

It was noted that organic matter material may be a significant component on the gravel/oxygen exchange in the interstitial substrate area.

Sampling design and sample size are important elements for collecting data that can be used to characterize a stream. Rigorous methods that are repeatable are a necessary component to an evaluation method that accounts for spatial and temporal variability.

Final Thoughts

A seasonal criteria approach to DO would be site specific and likely not feasible to undertake for this rulemaking.

Diurnal fluctuation is important as it emphasizes the interstitial changes and, more so, focuses on the full protection of salmonid egg emergence and fry survival.

February 3, 2021

Meeting Goals

- Receive feedback from SAG members on Ecology's suggested preliminary decisions for DO and fine sediment criteria.
- Provide opportunity for SAG members to suggest alternatives if there are concerns about feasibility or protection.

Meeting Summary Notes

Preliminary decisions on DO criteria

All salmonid spawning and incubation uses for DO would increase from a range of 8.0-9.5 mg/L to 10 mg/L across the board. Additionally, there would be an oxygen saturation contingency if DO concentration does not meet 10 mg/L.

This recommendation suggests ultimate protection while balancing feasibility and implementation.

Justifications for suggested DO criteria preliminary decisions

The suggested DO criteria protects eggs halfway between max (11 mg/L) and high (9mg/L) protection according to the National Academy of Sciences and EPA (NAS, 1972; EPA, 1986).

The main point here is to what extent DO depression is observed in the gravels. A 1-3 mg/L difference is typically observed in the gravels according to EPA.

- Ecology's preliminary decision is assuming a 2 mg/L DO depression in the spawning gravels.

DO depression in the gravels is influenced by many factors (i.e. fine sediment and temperature), and WA has other criteria to regulate those influential pieces.

Literature is supportive of 2 mg/L DO depression. A member expressed concerns about the number of studies supporting this finding and their quality/relevance. The member wants to ensure decisions are decided on sound study designs.

Having the 5-10% DO saturation buffer provides natural variability within the streams for temperature, elevations, AND instrument error (+/- 0.2 mg/L DO)

EPA does not have an oxygen saturation recommendation, but DO saturation criteria have been approved for several states.

Questions or comments on DO criteria

How will 95% saturations be governed? It's likely to be instantaneous measurement during the warmest part of the day when productivity is at its peak while also considering atmospheric pressure.

A member noted that it is important to have the justification as a narrative record to back up decisions for future public reference.

- Ecology staff noted that a technical support document will be completed for all decisions made in the rulemaking process.

Why was 2 mg/L chosen? Is it a median value? What percentage of values will be recorded under 2 mg/L depression?

- More research and comparisons need to be made between field and lab studies.

Concerns were expressed with using fine sediment (and other variables) as a basis for having a lower DO depression than what would be fully protected at 3 mg/L.

Some members expressed support for 10 mg/L as it demonstrates the protection to interstitial gravel DO and provides a reasonable buffer for environmental and instrumental influences.

Some members were thinking the preliminary proposed criteria would be much higher.

One member had concerns with not having a seasonal element to the DO criteria.

- Having the 95% DO saturation criteria would be used for summer time conditions to help buffer the seasonal element.
- While it was acknowledged that there are supplemental spawning temperature criteria by stream, Ecology staff noted that having DO implemented in the same way would be difficult to justify and quantify.

It was pointed out that while it would be difficult to demonstrate 'no spawning' is occurring, it would still be beneficial to have rule language stating when 'no spawning' conditions occur that a less stringent criteria could apply.

A member asked how a one-day minimum for the DO criteria would be implemented in terms of sampling. The primarily concern is with being able to meet criteria over a 24-hour day.

It was suggested that Ecology develop a chart showing how the DO concentration fluctuates with DO saturation percent at certain atmospheric conditions and temperatures in the rulemaking document.

Suggested Preliminary decisions on fine sediment criteria structure

Ecology would adopt a new narrative criteria that specifically addresses fine sediment.

Criteria could include the following parameters in developing fine sediment narrative criteria:

- Anthropogenic influence must be documented.
- Require water column measures (suspended sediments) and turbidity.
- Require streambed measures (bedded sediments), such as percent substrate, embeddedness, and relative bed stability (all three parameters are already included in Ecology's stream monitoring program).
- Chemical measures would be optional; i.e., intragravel DO depression.
- Biological surveys would be optional; i.e., macroinvertebrate sampling using appropriate indices

Using a weight of evidence approach for a fine sediment impairment listing

A weight of evidence approach could be established for measured parameters (for example, those having ≥75% impairment indication) to justify fine sediment impairment listings.

It was suggested that Ecology use existing data from across the state to draw correlations with the data available and whittle down the parameter list to which ones make the most sense.

- Ecology's Water Quality Assessment program will help identify parameters useful for assessing stream conditions.

Questions or comments on the fine sediment criteria

How do we implement a weighted evidence approach to measure and quantify improvements to ultimately reach a delisting goal for a fine sediment impairment?

Several questioned the lack of information available to decide a weight of evidence approach and the ties between listing for impairment and anthropogenic influences. Overall, the rule is rudimentary and needs work.

Why was turbidity chosen and not TSS or SSC?

- Any one parameter has its benefits and challenges, but turbidity was chosen based on the high quantity of background data on streams, reference site information, and current presence in the water quality standards.

A suggestion was made to include multiple water column measures such as SSC and turbidity.

Can we ultimately understand the depositional aspect of turbidity?

- A concern was expressed with establishing reference sites that make sense for a certain geographical region.

It was suggested that TSS could be used, due to its widespread monitoring and MS4 use in various permitting and implementation programs.

One member noted that it is important to establish language for a fine sediment size threshold and language on how to apply it to permits and implementation plans.

Members have concern with how anthropogenic versus natural fine sediment influences will be distinguished and determined, since nearly every watershed has been impacted by humans in some way.

A reaffirming point was made that the fine sediment criteria is being decided based on aquatic life use and not through a combination of uses.

Members agreed that careful considerations must be made when deciding on parameters to evaluate fine sediment in streams.

The primary takeaway here is that a narrative criteria is likely, but difficulties and unknowns still exist with identifying the appropriate thresholds for the parameters that best demonstrate fine sediment impairment.

July 27, 2021 – Updated Preliminary Decisions on Proposed Rule

Meeting Goals

- Share Ecology's updated preliminary decisions on moving forward with proposed rule revisions for DO and fine sediment to protect salmon spawning habitat, based on earlier feedback
- Respond to questions from Advisory Group members on Ecology's preliminary decisions
- Discuss next steps in the rulemaking process

Meeting Summary Notes

Ecology presented updated preliminary decisions for DO and fine sediment criteria. These changes are intended to increase protection for early life stages of salmonids, account for temperature and elevation impacts on DO, and provide flexibility in the criteria when certain life stages are not present in waterbodies.

Below is a summary of the preliminary decisions presented at this meeting as well as some supplemental information on those decisions and alternatives considered. More information, including a technical support document for the rule proposal, will be available on the rulemaking webpage during the public review of the rule proposal.

DO Criteria Preliminary Decisions

Ecology presented changes to the DO criteria that include more stringent water column based DO concentrations, and the addition of an oxygen saturation and intragravel DO criteria (see Table 1 below). The intragravel DO criteria is intended to be measured as a median spatial value and samples should be taken within the same aquatic habitat area. A spatial median is the middle value of multiple ranked intragravel DO measurements taken within the sampling area.

Table 1 Summary of the preliminary freshwater DO criteria Ecology is considering to propose

Aquatic Life Use Category	**Water column DO concentration as a one-day minimum**		**Intragravel DO concentration as a one-day minimum***
Char Spawning and Rearing	10.0 mg/L or 90% oxygen saturation	**OR**	8.0 mg/L
Core Summer Salmonid Habitat	10.0 mg/L or 90% oxygen saturation	**OR**	8.0 mg/L
Salmonid Spawning, Rearing, and Migration	10.0 mg/L or 90% oxygen saturation	**OR**	8.0 mg/L
Salmonid Rearing and Migration Only	6.5 mg/L or 90% oxygen saturation	**OR**	Not applicable
Non-anadromous Interior Redband Trout	10.0 mg/L or 90% oxygen saturation	**OR**	8.0 mg/L
Indigenous Warm Water Species	6.5 mg/L or 90% oxygen saturation	**OR**	Not applicable

* Intragravel DO must be measured as a spatial median

Preliminary Decision: Propose an increase in minimum DO concentration levels in the water column to ensure spawning gravels have adequate DO.

We are considering a 1-day minimum water column concentration of 10 mg/L DO for protection of salmonid-based designated uses that are protective of early life stages. The 10 mg/L DO protection level is intended to be protective of both sublethal and lethal effects. The 10 mg/L DO protective level is based on EPA's recommendation of 11 mg/L as a mean value for full protection and 9 mg/L as a minimum value.

Prior to EPA's 1986 recommendations, the National Academy of Sciences (1972)[4] suggested that DO criteria for salmonid eggs be between maximum protection (11 mg/L) and high level of protection (9 mg/L). Given that Washington is continuing to use a 1-day minimum duration value for DO, the 10 mg/L value aligns with federal recommendations for DO.

Preliminary decisions for DO criteria protect all salmonids, including salmon, steelhead, trout, whitefish, and grayling. In discussions with the Advisory Group, we considered seasonal DO criteria to protect early life stages and determined that this level of detail would be beyond the scope of this rulemaking. Spawning and rearing time can vary significantly based on the waterbody and the species present. Thus, seasonal site-specific criteria would require information on salmonid spawning and rearing across waterbodies in Washington State. We also considered setting a generic seasonal criterion from fall to spring months. However, it is well known that spawning and rearing occurs almost year-round in some streams in Washington State. These streams would not be protected by a seasonal DO criterion.

[4] National Academy of Sciences (US). Committee on Water Quality Criteria. Water quality criteria, 1972. US Environmental Protection Agency, 1974.

We also considered setting acute and chronic-based DO criteria. However, the preliminary decision is to include only an acute-based DO criterion. The Advisory Group noted that salmonids are most fragile during early life stages and using the highest level of protection should be considered due to uncertainty and variability in environmental conditions. Given environmental conditions and the high sensitivity of early life stages of salmonids, we are considering proposing an acute criterion protective of both acute and chronic effects. This aligns with the current DO criteria for Washington State that includes only an acute criterion. Further support for this decision was based on previous comments by the National Oceanic and Atmospheric Administration (NOAA) that 9.5 mg/L acute criterion alone may not be fully protective.

Our review of scientific literature indicates support for a 10 mg/L DO level for the protection of both sublethal (chronic) and lethal (acute) effects. The preliminary decision to use a 10 mg/L value is based on the high sensitivity of early life stages of salmonids to fluctuations in oxygen conditions, new science demonstrating a 2 mg/L DO depression value from the water column to gravels, and comments from NOAA.

Preliminary Decision: Establish a new oxygen saturation limit to account for impacts of temperature and barometric pressure on DO concentrations in the water.

We are considering the addition of an oxygen saturation component to the DO criteria to account for temperature and elevation impacts on DO levels. Oxygen saturation also provides needed flexibility to the DO criteria during the summer months when water temperatures rise and in many streams, early life stages of salmonids are not present. During these warmer seasons, more stringent DO criteria is not necessary and often physically unachievable due to effects of temperature on oxygen capacity in waters. Washington currently has a site-specific oxygen saturation criterion of 90% on the Columbia River. We are considering a 90% oxygen saturation value for this rulemaking.

A 90% oxygen saturation value is more protective than the current biologically based criteria at sea level at the maximum allowable temperature for all salmonid related aquatic life uses, except for core summer salmonid habitat. However, Washington has supplemental spawning criteria that has identified waterbodies that have early life stages of salmonids present during the summer months, and thus require more stringent temperature criteria. When evaluating the core summer salmonid habitat use under the supplemental spawning temperature requirements of 13°C, a 90% DO saturation value is equal or more stringent than the current biologically based criteria of 9.5 mg/L. We conclude that 90% oxygen saturation is commensurate with protection levels for aquatic life uses that include early life stages during the summer months while accounting for climatic variability.

We also considered a 95% oxygen saturation value but found this alternative more burdensome compared to the same level of protection, and therefore have landed on a 90% oxygen saturation value to consider for the proposed rule. Setting a 95% oxygen saturation value does not provide adequate flexibility during summer months when water temperatures can become elevated and early life stages of salmonids are not present. A 95% oxygen saturation value at sea level and at the maximum allowable water temperatures is considered more stringent than the current water column based DO criteria and therefore, does not meet the stated goals of

providing flexibility when water temperatures and elevations are high and early life stages are not present.

Preliminary Decision: A new minimum intragravel DO concentration level directly applied to spawning gravels.

We are considering an IGDO criterion of 8.0 mg/L, consistent with EPA's 1986 recommendations and Ecology's review of the scientific literature (Hicks 2002)[5]. The IGDO criteria is a necessary alternate criteria based on data that indicates pristine waterbodies may not meet 90% oxygen saturation or 10 mg/L during summer months. The 10 mg/L water column criteria is based on the worst-case assumption that there is a 2.0 mg/L drop in DO levels from the water column to gravels.

However, the DO depression of 2.0 mg/L may be overestimated in some waterbodies, especially those with optimal substrate conditions. The IGDO criteria presents an alternate method to demonstrate that early life stages of salmonids are being protecting by directly measuring DO levels in the small spaces in between gravels. This provides additional flexibility in the DO criteria. The IGDO criteria also relies on site-specific conditions and not on assumptions regarding DO depression values or the quality of substrate for a given waterbody. While direct IGDO levels may be more difficult to measure accurately, they may be the most relevant method to determine if early life stages of salmonids are protected.

We note that guidance will be needed on how to sample for IGDO (for example, identifying "fish windows").

Fine Sediment Criteria Preliminary Decisions

Ecology's preliminary decision is to add a narrative criterion that specifically addresses fine sediment. We have made a preliminary decision that a multi-parameter approach to address fine sediment concerns is necessary to understand sediment quality from a biological, chemical, geological, and physical perspective, and that a narrative criteria will provide the best approach for protecting spawning habitat.

We considered development of numeric fine sediment criteria but after further research, a review of what other states have done, and discussions with the Advisory group, determined a numeric criteria was not feasible. A single fine sediment threshold cannot be generalized statewide as each waterbody's sediment characteristics are unique. Furthermore, the science surrounding relationships between fine sediment based parameters and biological responses are not fully developed. Current science suggests that a single parameter to measure fine sediment will not adequately capture sediment dynamics, changes within a waterbody, or harmful effects on aquatic life.

Guidance would be provided to implement the narrative criteria using reference ecoregions and background conditions, including eventual revisions to the 303(d) listing methodology

[5] Hicks, M. 2002. Evaluating Criteria for the Protection of Freshwater Aquatic Life in Washington's Surface Water Quality Standards. Draft Discussion Paper and Literature Summary. Washington Department of Ecology Publication Number 00-10-071

when appropriate. A weight of evidence approach is something we are likely to move forward with in the 303(d) listing methodology.

We also anticipate establishing thresholds for individual parameters as a potential screening analysis of areas of concern for fine sediment. For example, we could set thresholds for parameters and if those thresholds are exceeded, it warrants an in-depth look at that waterbody. A potential approach may be to use screening level thresholds or target levels to identify areas of concern. One could apply statistical comparisons between reference sites or ecoregion reference values and the waterbody of interest for each parameter. Then, use the weight of evidence approach based on those statistical comparisons with reference sites to determine the impairment listing status of a waterbody.

An example of what the narrative criteria may look like: “Human related sources of fine sediment shall not cause adverse effects on aquatic life, their reproduction, or habitat. Sediment loading shall be compared to reference sites that represent naturally attainable conditions and are minimally impacted by anthropogenic influences.”

Preliminary parameters being considered most appropriate for analyzing fine sediment were presented with rationale given for each, and whether Ecology considered the various parameters to be primary or optional. Table 2 shows those parameters discussed.

Table 2 Parameters considered to analyze fine sediment

Environmental Compartment	**Measure**
Water Column	Suspended Solids
Streambed	Percent Substrate
Streambed	Subsurface Fines
Streambed	Relative Bed Stability
Chemical	Intragravel Dissolved Oxygen
Biological	Fine Sediment Biotic Index

At the end of the final meeting, the Advisory Group members were thanked for their participation and encouraged to continue to be involved as the rulemaking process moves forward. Ecology noted that the preliminary decisions for a rule proposal will also be shared with the public at an online webinar held on September 21, 2021, and that we anticipate a public review of the rule proposal to begin in October 2021.

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[6] www.ecology.wa.gov/contact