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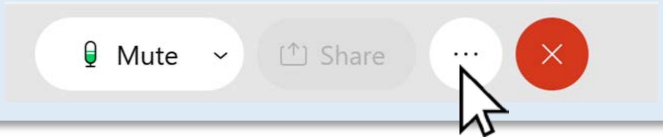

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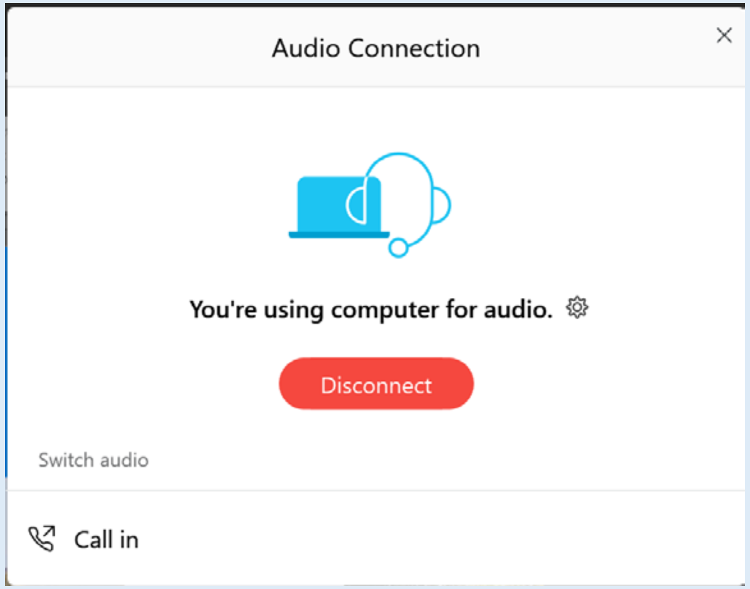

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Salmon Spawning Habitat Protection Rule

Science Advisory Group (SAG)
Meeting #2: Fine Sediment
November 19, 2020

DEPARTMENT OF
ECOLOGY
State of Washington

Goals for Today's Meeting

- Finish discussion on dissolved oxygen criteria considerations
- Share background information on fine sediment to aid in discussions
- Discuss considerations for a fine sediment criteria aimed at protecting aquatic life

Ecology Standards Staff

Susan Braley

Webinar Facilitator

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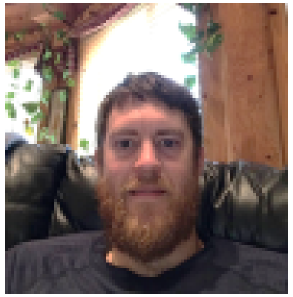

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Introductions of SAG Members

Name and affiliation of members present

Using Webex features

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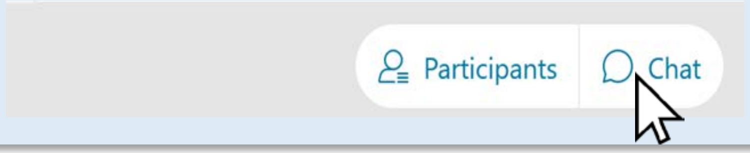

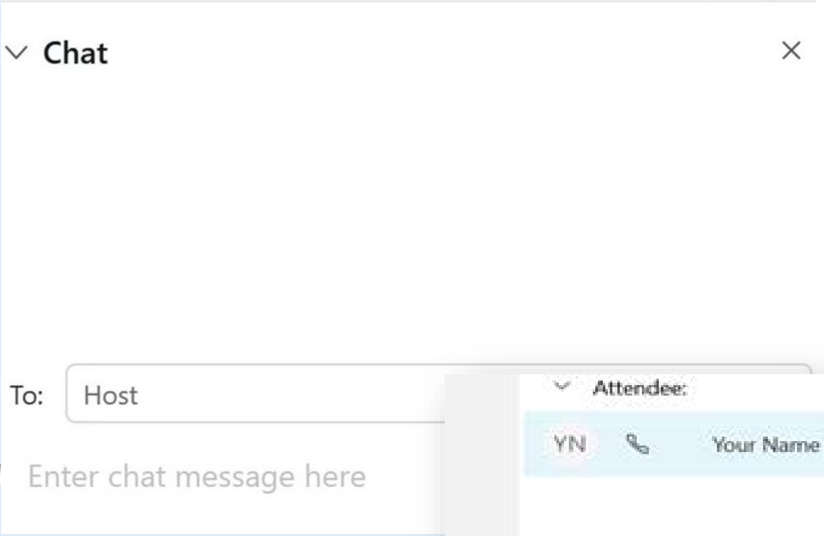

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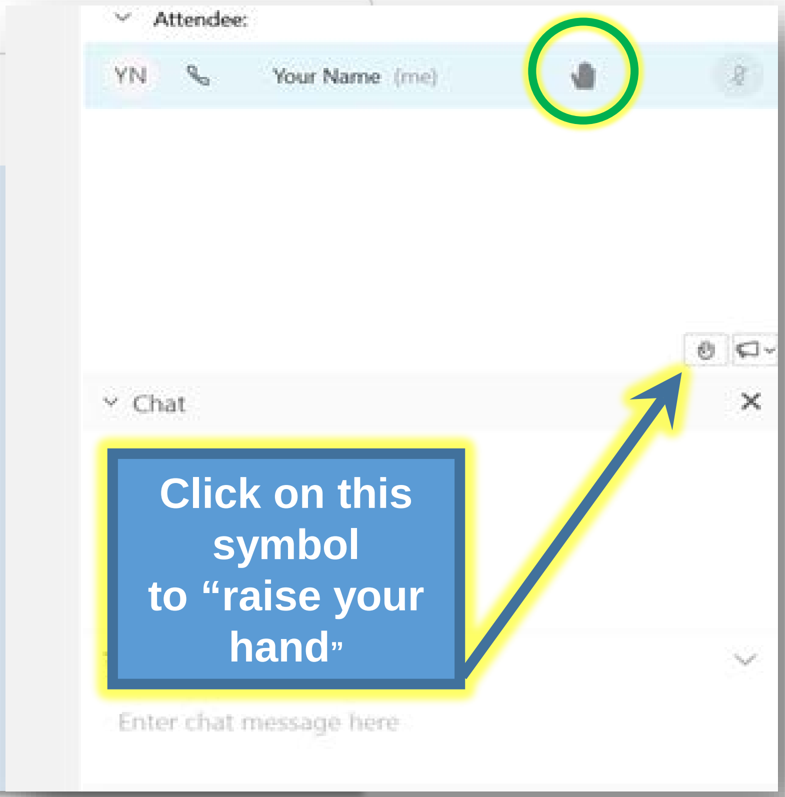


Today's Agenda

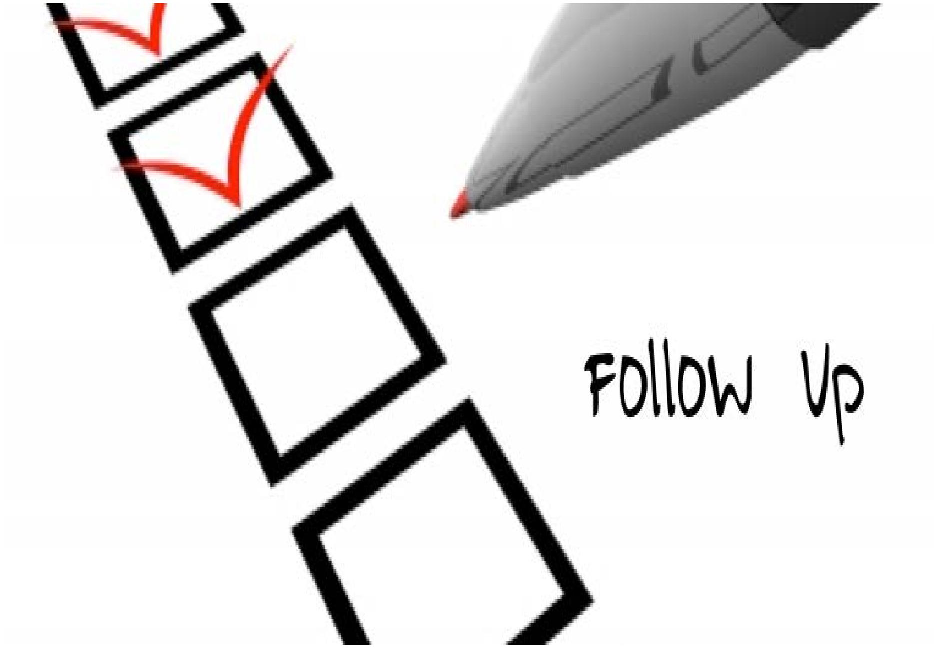
- Recap and followup from last meeting's discussion on DO criteria
- Consideration of DO averaging periods
- Background on the need for fine sediment criteria
- How other states characterize fine sediment impairments
- Fine sediment quantitative relationships
- Merits of a numeric vs. narrative criteria
- Utility and process of establishing reference sites
- Next steps

Follow-up from Last Meeting

- Implementation of Oregon's DO criteria
  - o Water column DO level of 11.0 mg/L
  - o IGDO criteria of 8.0 mg/L

- Percent DO saturation threshold

- DO: sediment dynamics in redds



Oregon's History on IGDO

- 1996: Oregon submitted an IGDO criterion of 6.0 mg/L to EPA to protect salmonid spawning
- 1999: NOAA issued a biological opinion that EPA's approval of Oregon standards would not jeopardize ESA species
- 2001: EPA approval and NOAA's biological opinion of "no jeopardy" challenged in US District Court
- 2003: Courts ruled that IGDO criteria of 6.0 mg/L inadequate
- Oregon revised IGDO to 8.0 mg/L

Implementing Oregon’s DO Criteria

- Using both 11.0 mg/L and percent DO saturation on a <u>regular basis</u>
  - Slowly incorporating more percent DO saturation monitoring
- IGDO measurements are <u>uncommon and infrequently used</u> component of Oregon’s DO criteria
  - Oregon has concerns about measuring IGDO, especially where there are threatened and endangered species
- There are no water quality listings that have taken IGDO into account and IGDO is not actively used for compliance
- IGDO is only used for a site-specific assessments of DO but not where there are ESA listed species

Percent DO Saturation Threshold

Protection Level

A: Ideal conditions

B: Average member of a species starts to exhibit oxygen distress

C: Large proportion of species experience adverse effects

TABLE 10. Oxygen criteria based on percentage saturation values derived with three levels of protection as outlined in the text. PO_2's and values of mg O_2/liter were extracted from Table 9 and rounded off for use here. The values shown for milliliters O_2/liter were calculated from the values of milligrams O_2/liter in this table.

The criteria essential for protection of aquatic fish populations are expressed as percentage saturation values at various temperatures. They were derived from both PO_2 and mg O_2/liter values, as both oxygen tension and oxygen content are critical factors. At the lower temperatures, the percentage saturation value was determined using the PO_2 values essential for maintaining the necessary oxygen tension gradient between water and blood for proper gas exchange. Higher percentage saturation values are necessary at the higher temperatures to provide sufficient oxygen content to meet the requirements of respiration as defined by the mg O_2/liter values.

Percentage saturation values are defined as "oxygen minima" at each level of protection. Graphical presentation of the results is found in Fig. 19. The temperatures corresponding to the percentage saturation criteria are defined as "seasonal temperature maxima."

Group	Protection level	PO_2	ml O_2/liter	mg O_2/liter	% Satn. at C for criteria					
					0	5	10	15	20	25
Freshwater mixed fish population including salmonids	A	110	5.08	7.25	69	70	70	71	79	87
	B	85	3.68	5.25	54	54	54	57	54	63
	C	60	2.28	3.25	38	38	38	38	39	39
Freshwater mixed fish population with no salmonids	A	95	3.85	5.50	60	60	60	60	60	66
	B	75	2.80	4.00	47	47	47	47	47	48
	C	55	1.75	2.50	35	35	35	35	35	36
Freshwater salmonid population (including steelhead)	A	120	5.43	7.75	76	76	76	76	85	93
	B	90	4.20	6.00	57	57	57	59	65	72
	C	60	2.98	4.25	38	38	38	42	46	51
Salmonid larvae and mature eggs of salmonids	A	155	6.83	9.75	98	98	98	98	100	100
	B	120	5.60	8.00	76	76	76	79	87	95
	C	85	4.55	6.50	54	54	57	64	71	78
Marine, nonanadromous species[a]	A	140	6.13	8.75	88	88	95	100	100	100
	B	110	4.73	6.75	69	69	74	82	90	98
	C	80	3.15	4.50	50	51	51	55	60	65
Anadromous marine species, including salmonids[a]	A	160	6.30	9.00	100	100	100	100	100	100
	B	125	4.55	6.50	79	79	79	79	87	94
	C	90	2.80	4.00	57	57	57	57	57	58

[a]Percentage saturation calculations based on salinity of 28‰.

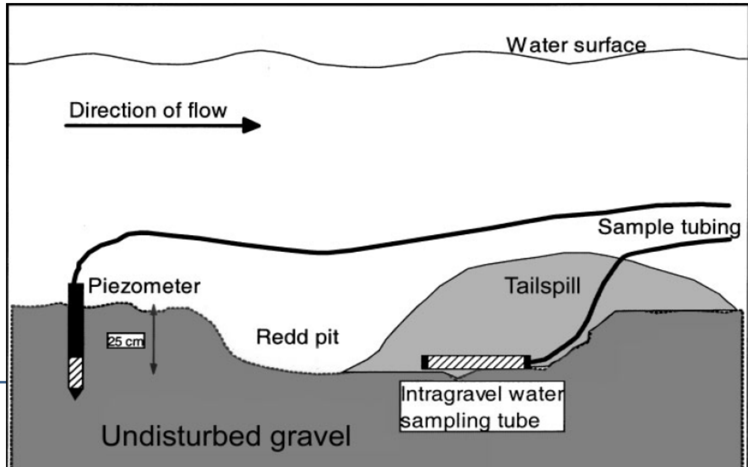
Davis 1975

DO: Sediment Dynamics in Redds

- Construction of nests lead to higher oxygen levels than nearby undistributed gravels (Groves and Chandler 2005; Chambers 1956)

- Oxygen levels slowly decrease over time after redd construction

- Water drawn from forward slope of the tailspill of a salmon redd, where eggs are deposited, consistently contain more DO than samples taken from:
    1) Identical spot prior to spawning
    2) Undistributed gravel beside the nest
    3) Other parts of the nest



DO Criteria Averaging Period

Salmonid Waters

a. Embryo and Larval Stages

- No Production Impairment = 11* (8)
- Slight Production Impairment = 9* (6)
- Moderate Production Impairment = 8* (5)
- Severe Production Impairment = 7* (4)
- Limit to Avoid Acute Mortality = 6* (3)

(* Note: These are water column concentrations recommended to achieve the required intergravel dissolved oxygen concentrations shown in parentheses. The 3 mg/l difference is discussed in the criteria document.)

would depend on innumerable other factors. If slight production impairment or a small but undefinable risk of moderate impairment is unacceptable, than one should use the "no production impairment" values given in the document as means and the "slight production impairment" values as minima. The table which pre-

DO Criteria Averaging Period

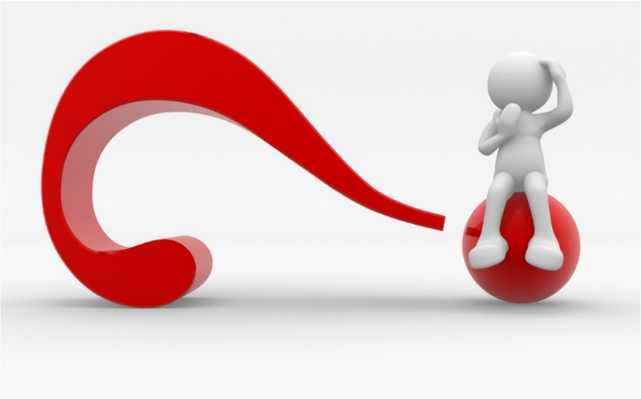
- **Averaging period of DO criteria:**
  - Currently set at a 1-day minimum

- Should we consider longer averaging periods for DO in the water column (7-day and 30-day average is common)?
- Should we consider multiple criteria set at different averaging periods?
- Will longer averaging periods for DO be used in permitting or ambient monitoring?
- What are the implications for acute vs. chronic effects with different averaging periods?

DO Criteria: Remaining Issues/ Questions

- Are there any key issues that you think need resolved before rule is developed?

- Should we revisit topics related to DO criteria development?



Salmon Spawning Habitat Protection Rule

Fine Sediments

DEPARTMENT OF ECOLOGY
State of Washington

Background

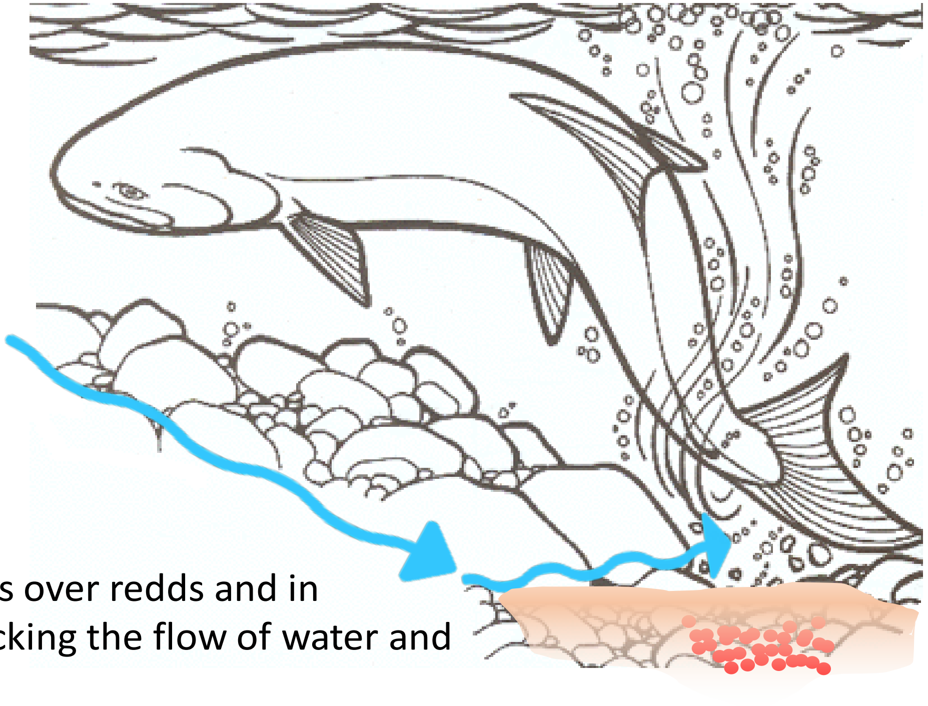
- What is Fine Sediment?
  - Generally particles less than 2 mm
- Sources
  - Erosion, runoff, flooding, land development, in-water activities, and natural stream hydrology
- Importance
  - Excess fine sediment can result in:
    - Loss of habitat
    - Poor water quality
    - Reduced oxygen
    - Reduced embryo hatching success
    - Behavioral changes
    - Mortality

Low in fine sediment

High in fine sediment

Background

Fine sediment is **not** suitable spawning habitat



Fine sediment settles over redds and in between gravel, blocking the flow of water and oxygen.

Sediment covers eggs and reduces hatching success

Why a Fine Sediment Criterion?

- Washington State lacks a defined method to characterize a fine sediment impairment

- **Current narrative criterion**: "*no deleterious materials…*"
    - o Narrative criterion can be used to address fine sediment but…
    - o Narrative criterion does not address how to characterize a fine sediment impairment

Fine Sediment Impairments: Methods from Other States

DEPARTMENT OF ECOLOGY
State of Washington

Idaho

- Guide to Selection of Sediment Targets for Use in Idaho TMDLs
  - Narrative based criteria
  - Water column and instream measures were determined to be the best indicators of sediment related impairments
  - Parameters include:
    - Light penetration
    - Turbidity
    - Total suspended solids and sediments
    - Embeddedness
    - Streambed coverage by surface fines (i.e. surface sediment)
    - Percent subsurface fines
    - Riffle stability
    - Intragravel DO levels

Idaho

Table 8. Recommended instream sediment parameters and associated target levels.

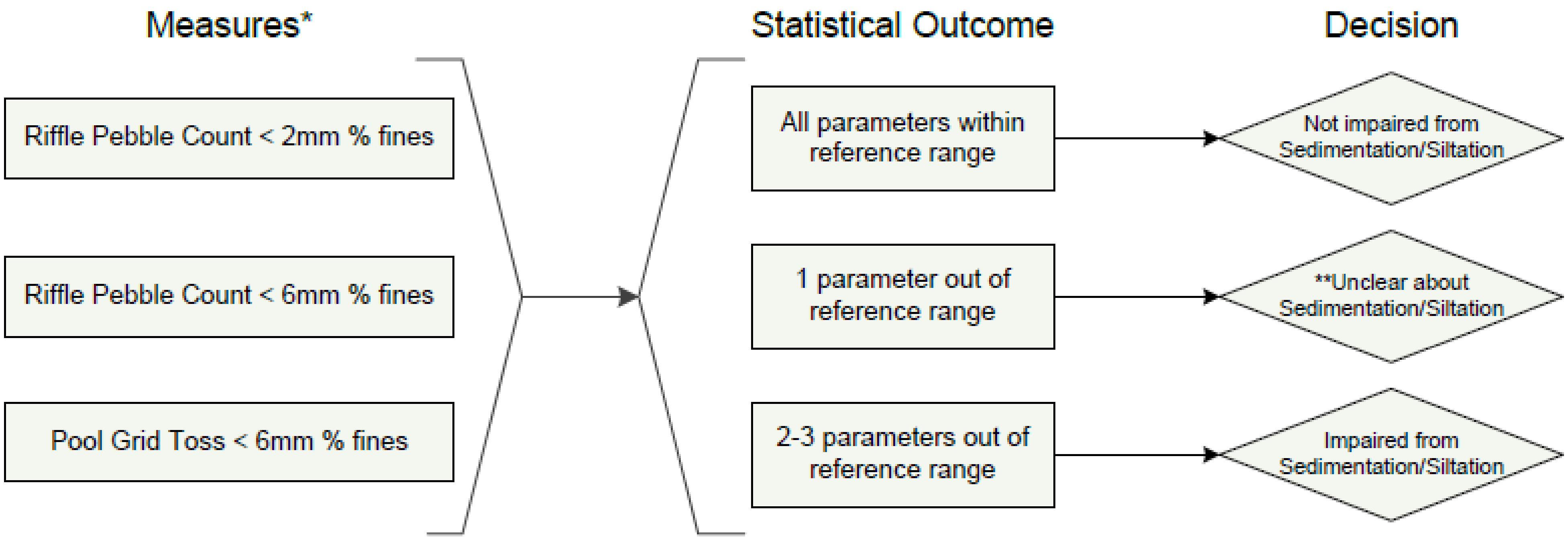
Instream Sediment Parameter	Recommended Target Levels
Turbidity	Not greater than 50 NTU instantaneous or 25 NTU for more than 10 consecutive days above baseline background, per existing Idaho water quality standard. Chronic levels not to exceed 10 NTU at summer base flow
Light Penetration	Not to reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life
Total Suspended Solids and Suspended Sediment	No specific recommendation, establish site specific reference
Embeddedness	No specific recommendation, establish site specific reference
Surface Sediment	No specific recommendation, establish site specific reference
Subsurface Sediment in Riffles	For those streams with subsurface sediment less than 27% - do not exceed the existing fine sediment volume level. For streams that exceed the 27% threshold - reduce subsurface sediment to a 5-year mean not to exceed 27% with no individual year to exceed 29%. Percentage of subsurface sediment < 0.85 mm should not exceed 10%
Riffle Stability	Not to exceed a Riffle Stability Index of 70
Intergravel Dissolved Oxygen	Not less than 5.0 mg/L for a 1-day minimum or not less than 6.0 mg/L for a 7-day average mean, per existing Idaho water quality standard

Montana

- Montana DEQ Western Montana Sediment Assessment Method
  - Narrative based criteria
  - Methods only applied to streams with a Strahler order ≤ 4 unless deemed appropriate
  - Primary monitoring parameters include:
    - Percent riffle fines (<6 mm and <2 mm)
    - Percent pool tail fines (<6 mm)
    - Residual pool depth
    - Pool frequency
    - Width/depth ratio
    - Riffle stability index

Montana

- Fine sediment assessment
  - o Riffle and pool fines are compared to a reference data or literature values



* Additional fine sediment measurements may include McNeil core, V*, or a second year of data collection. If McNeil cores are readily available, they should be included with the above measures and the same decision criteria used. In addition, biology may be used.
**If decision outcome is unclear, additional data may be pursued or a collective decision will be made by experienced WQPB staff and the WQPB QA Officer.

Figure 1. Decision flow chart for determining sedimentation/siltation impairment.

Colorado

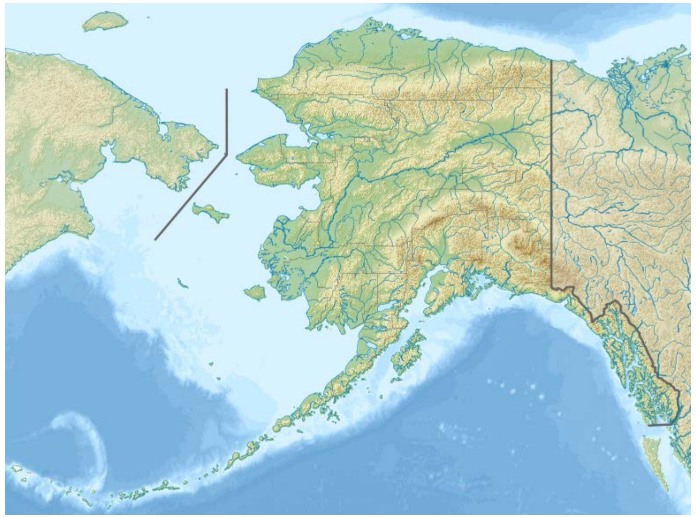
- Guidance for Implementation of Narrative Sediment Standard
  - o Parameters include:
    - Percent fines
    - TIV_{sed} score (tolerance indicator value)
    - Review of available watershed information

- Compares the parameters to reference sites in similar sediment regions

Alaska

- The percent accumulation of fine sediment in the range of 0.1 mm to 4.0 mm in the gravel bed of waters used by anadromous or resident fish for spawning may not be increased more than 5% by weight above natural conditions (as shown from grain size accumulation graph).

- In no case may the 0.1 mm to 4.0 mm fine sediment range in those gravel beds exceed a maximum of 30% by weight (as shown from grain size accumulation graph). In all other surface waters no sediment loads (suspended or deposited) that can cause adverse effects on aquatic animal or plant life, their reproduction or habitat may be present.



New Mexico

- Sedimentation/siltation impairment thresholds in New Mexico
  - Uses a narrative criteria
  - 7 step framework
    - Step 1: review background information
    - Step 2: assemble datasets with potential sediment indicators
      - Relative bed stability, percent fines (<0.06 mm), percent fines ar mm)
    - Step 3: establish reference sites
    - Step 4: classify sites
    - Step 5: characterize sediments
    - Step 6. describe stressor-response relationships
    - Step 7: recommend benchmarks or thresholds

- Dependent on modeling and mapping of sediment habitat

New Mexico

Table 4: New Mexico Final Assessment Matrix for Aquatic Life Use Attainment:

Biological ➡ Physical ⬇	Severely Impaired 0-17%	Moderately Impaired 21-50%	Slightly Impaired 54-79%	Non-impaired 84-100%
Non-Support Fines or Embeddedness >40% increase	Non-Support	Partial Support Full	Support, Impacts Observed	Full Support, Impacts Observed
Partial Support Fines or Embeddedness 28-40%increase	Non-Support	Partial Support	Full Support, Impacts Observed	Full Support, Impacts Observed
Supporting Fines or Embeddedness 11-27% increase	Non-Support[1]	Partial support[1]	Full Support, Impacts Observed	Full Support
Full Support Fines or embeddedness <10% increase[2]	Non-Support[1]	Partial Support[1]	Full Support, Impacts Observed	Full Support

Approaches to Fine Sediment

- Is there a specific state methodology that stands out or particular themes in states' methodologies (shown today or not)?
- Should we be aiming to keep our fine sediment impairment methodology as streamlined as possible for implementation purposes? By streamlined I mean selecting the most important metrics available to characterize fine sediment but not including all metrics.
- Can we reasonable complete site characterizations on a regular basis? Perhaps this is an Ecology question. Can other speak to the involvement on characterizing fine sediment?

TAKE A BREAK!

Fine Sediment Impairments: Quantitative Relationships

Numeric Threshold Concept

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State of Washington

Fine Sediments Measures

X axis: percentage fines
Y axis: percentage emergence

Species:

- Chinook salmon
- Steelhead trout

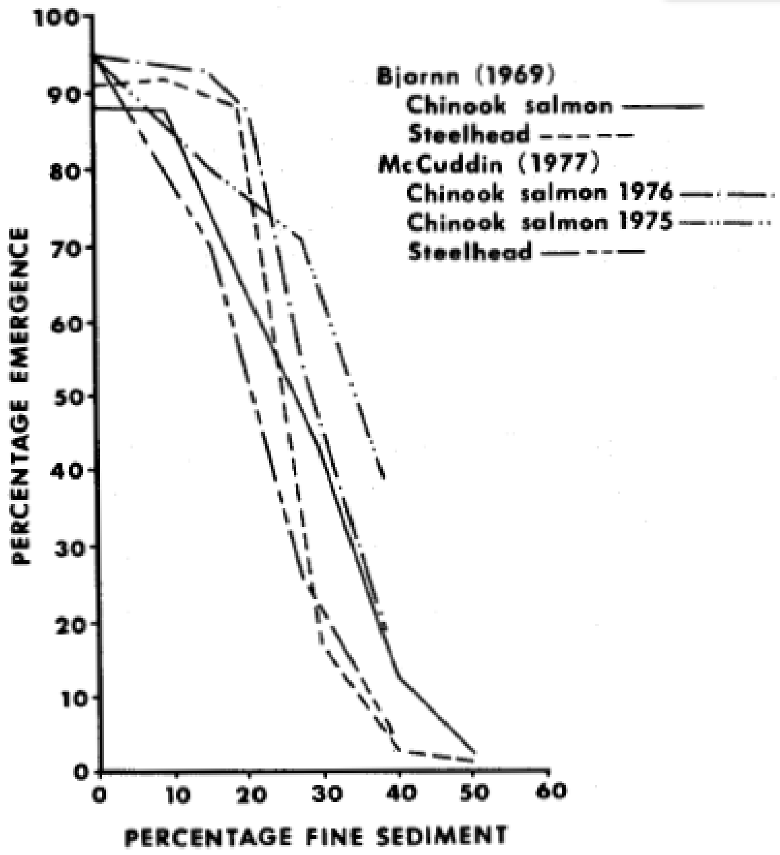


Figure 19—Percentage emergence of fry from newly fertilized eggs in gravel-sand mixtures. Fine sediment was granitic sand with particles less than 6.4 mm.

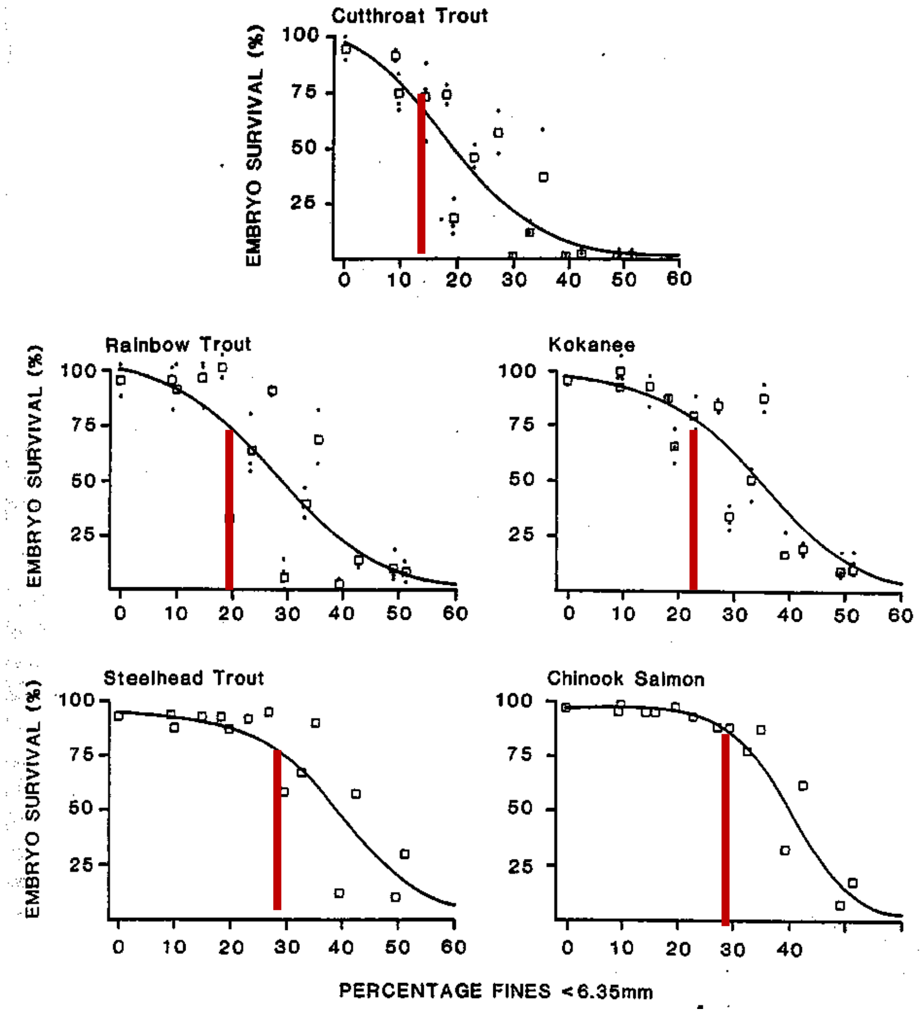
Bjornn and Reiser 1991

Fine Sediment Measures

X axis: percent fines (<6.4mm)
Y axes: embryo survival

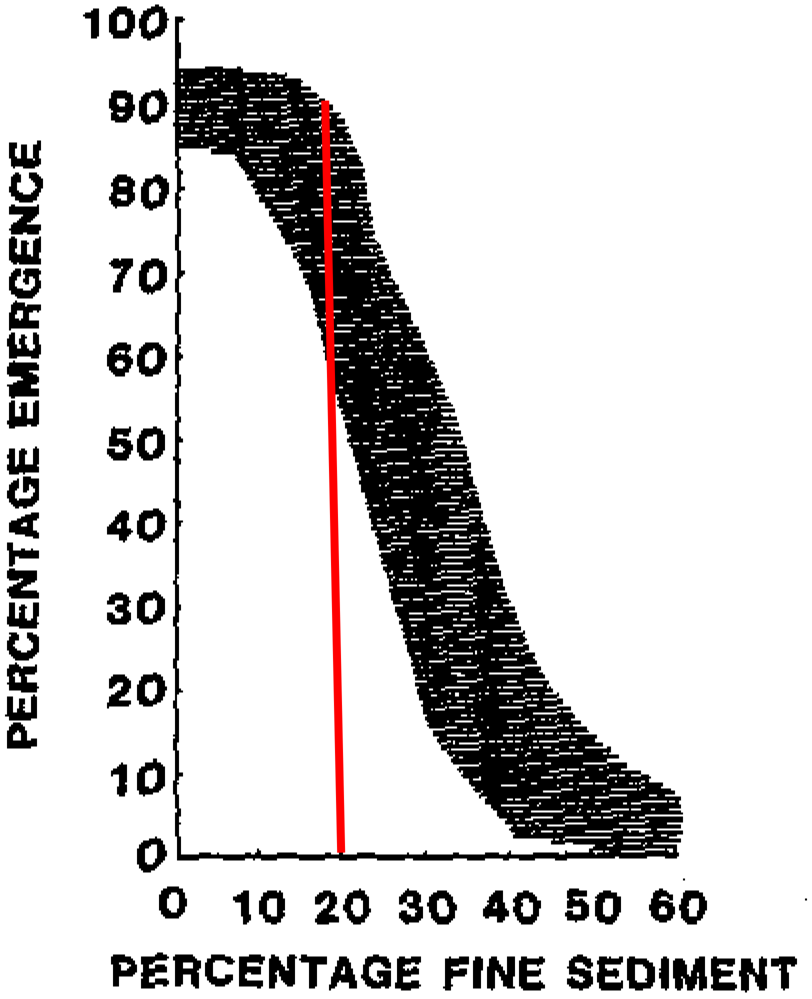
<u>5 species</u>:

- Cutthroat trout
- Rainbow trout
- Kokanee
- Steelhead trout
- Chinook salmon



Bjornn and Reiser 1991

Fine Sediment Measures



Bjornn and Reiser 1991

FIGURE 4.13.—Percentage emergence of swim-up fry placed in gravel–sand mixtures in relation to the percentage of sediment smaller than 2–6.4 mm in studies by Bjornn (1968), Phillips et al. (1975), Hausle and Coble (1976), and McCuddin (1977). The stipled area includes data from eight tests on brook trout, steelhead, and chinook and coho salmon.

Intragravel Dissolved Oxygen

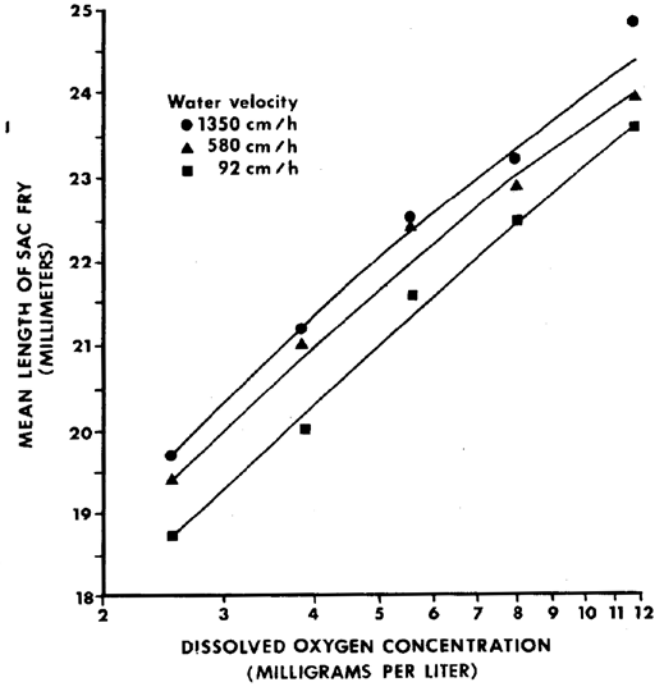


Figure 11—Relation between mean lengths of chinook salmon sac fry at hatching and dissolved oxygen concentrations at which the embryos were incubated at different water velocities and at 11°C (from Silver et al. 1963).

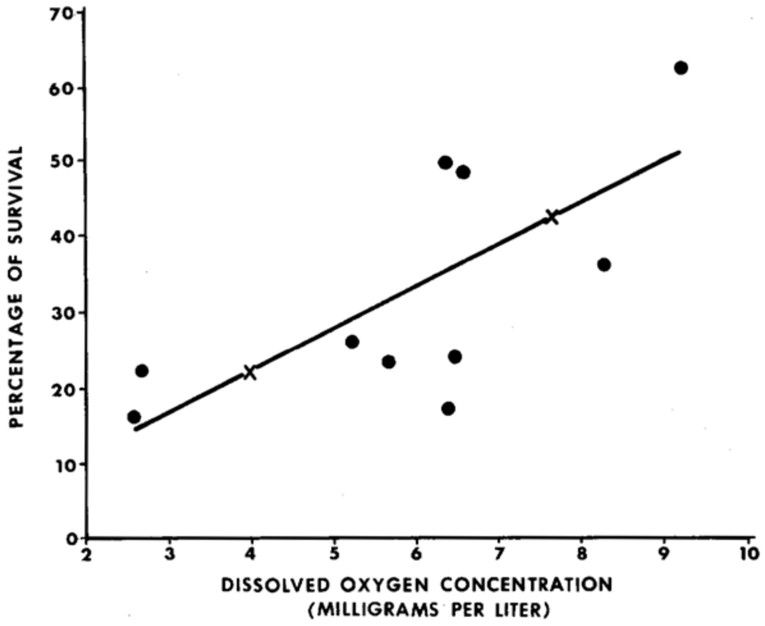


Figure 14—Relation between dissolved oxygen concentration and embryo survival (from Coble 1961).

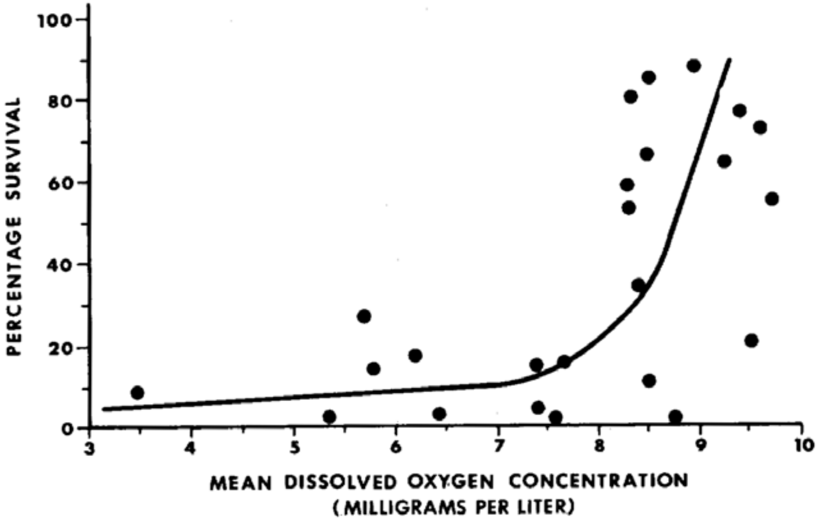


Figure 15—Relation of mean dissolved oxygen to survival of coho embryos, Needle Branch, December 20, 1960, to February 28, 1961 (from Phillips and Campbell 1961).

Reiser and Bjornn 1979

WA Existing Turbidity Criteria

- Based on the ability to forage / behavioral endpoints

- Salmonid spawning and rearing uses:
  - 5 NTU over background when background is 50 NTU or less; or
  - A 10 percent increase turbidity when the background turbidity is more than 50 NTU

- Salmonid rearing and migration & warm water species uses:
  - 10 NTU over background when the background is 50 NTU or less; or
  - A 20 percent increase in turbidity when the background turbidity is more than 50 NTU

Young et al. 1991

- Estimates of the substrate composition was best measured by geometric mean particle size, which accounted for greatest proportion of variation in survival to emergence in laboratory studies
- Percentage of substrate less than 0.85mm diameter was the most sensitive measure of changes in substrate composition in field studies
- Concluded that a single measure of substrate composition may be inadequate to assess survival to emergence and detect changes in substrate composition by land use

Fine Sediment Criteria: Discussion

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State of Washington

Criteria Type

- **Narrative vs. Numeric**
- Can we modify our current narrative criteria with more specific information on fine sediment or do we need to specifically address fine sediment with a new narrative?
  - Current narrative: "Toxic, radioactive, or deleterious material concentrations must be below those which have the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health."
- Can fine sediment be adequately characterized using a single numeric threshold? (Ex. Percent fines)
- Can sediment impairments be characterized by a combination of a single numeric threshold and a natural condition statement (Ex. Alaska)?
- Should a fine sediment criteria focus on particular stream orders or types?

Reference Site Comparison

- Is using a reference site a useful method to compare fine sediment measures within a given area?

- Are there downfalls to using a reference site comparison to determine sediment impairments?

- Are there any streams without anthropogenic influences that can accurately serve as a reference site? What is background conditions?

- What are some different approaches to identify reference sites?

Approaches

- Do different tiers or gradation of aquatic life support work for characterizing fine sediment impairment?
    - Fully supported, partially supported, not supported
        - 5 out of 5 metrics meet thresholds = full support
        - 4 out of 5 metrics meet thresholds = full support with observed impacts
        - 3 out of 5 metrics meet thresholds = partial support
        - <3 metrics meet thresholds = not supported

- Statistical approach to differences in thresholds/reference site
    - Site of interest within a certain percentage of reference site
    - Ex. Percent fines is within 10% of the reference site = full support

Next Meeting: Continuation of Fine Sediment

- Next meeting will focus on specific parameters to characterize fine sediment
  - o How difficult to measure? How feasible to implement?
  - o How useful is the data? How expensive? What resources are needed?
- Expertise in a particular parameter(s) and want to share?
  - o Example parameters:
    - Light penetration
    - Percent fine sediment
    - Suspended solids
    - Percent fines (by weight or volume)
    - Geometric mean diameter of sediment
    - Intragravel dissolved oxygen
    - Turbidity / light penetration
    - Riffle stability
    - Embeddedness
    - Subsurface sediment in riffles
    - Benthic macroinvertebrate index (BIBI)
    - Relative bed stability

Next Steps

- The last scheduled meeting of the SAG will continue discussions on fine sediment:
    - December 9th (Weds), 1:15 - 4:15 p.m.

- Ecology will type up summary notes from the meeting and share with SAG members prior to next meeting

- Provide reading assignments to help prepare for discussions at follow-up meetings

Thank you for your participation!