

# Welcome!

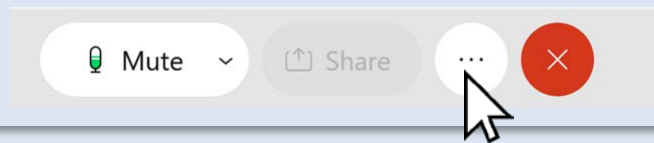
We will get started soon

No sound? Connect your audio and listen for a sound check before we start.

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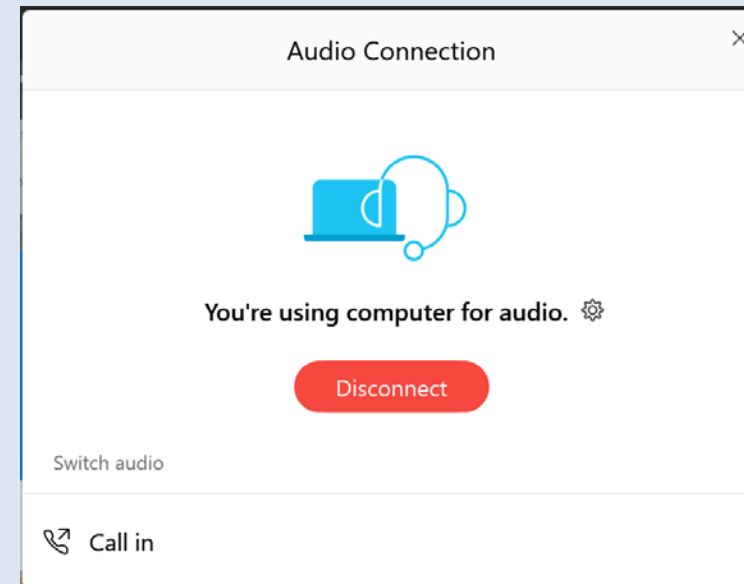
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# Salmon Spawning Habitat Protection Rule

Science Advisory Group (SAG)  
Meeting #1: Freshwater Dissolved Oxygen  
October 29, 2020

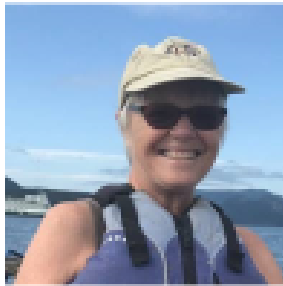


# Goals for Today's Meeting

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



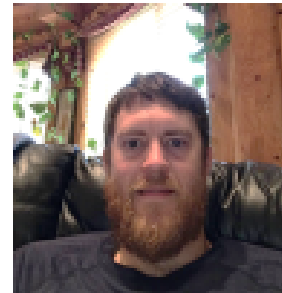
# Ecology Standards Staff



**Susan Braley**

Webinar Facilitator

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**Bryson Finch**

Water Quality Standards Scientist

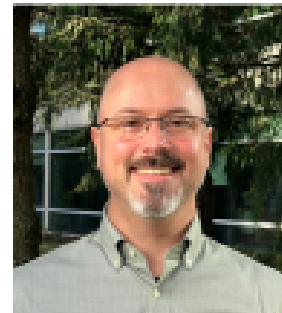
[Bryson.Finch@ecy.wa.gov](mailto:Bryson.Finch@ecy.wa.gov)



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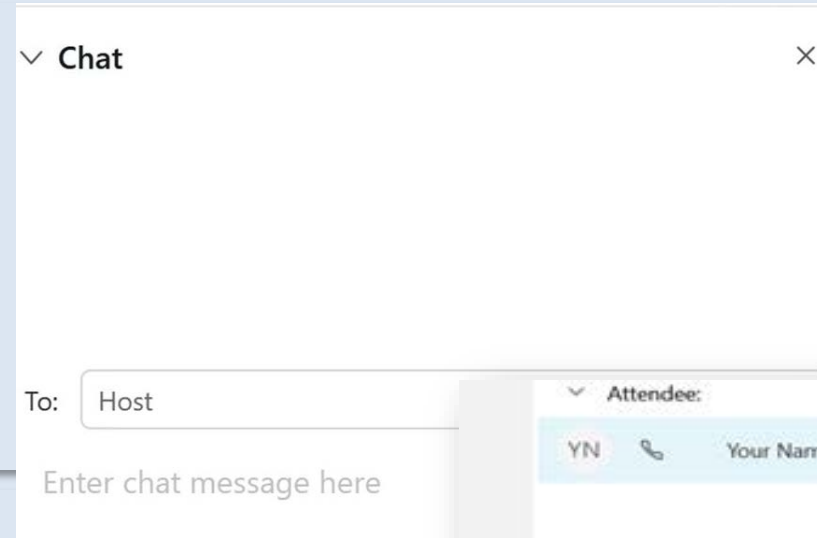
# Using Webex features



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Participants

Chat

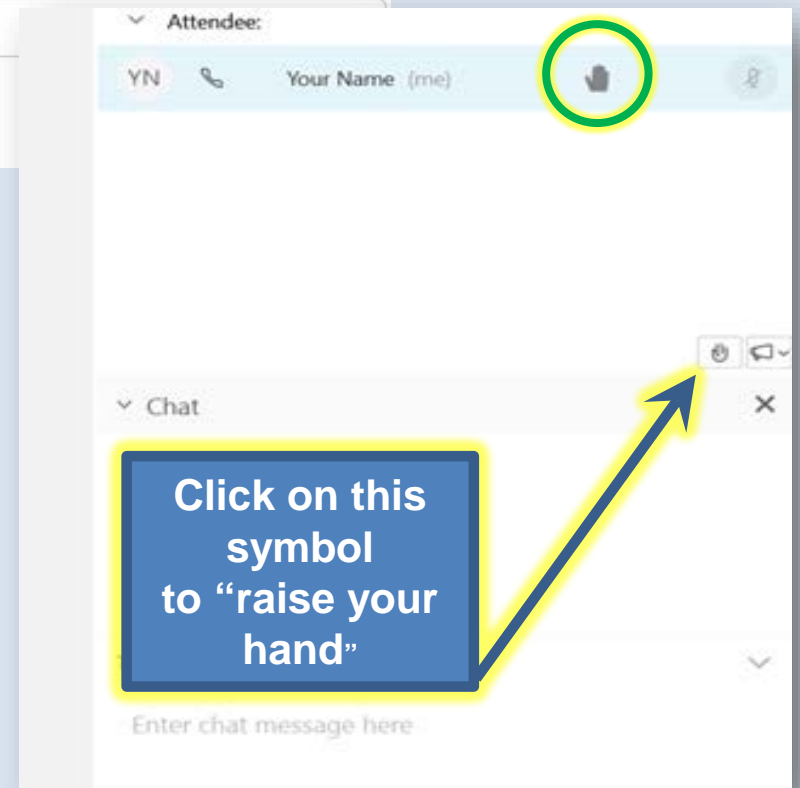


You can also ask questions by raising your hand



**We ask that you:**

1. **State your name** first before speaking.
2. **Mute your audio** unless speaking.
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# Today's Agenda

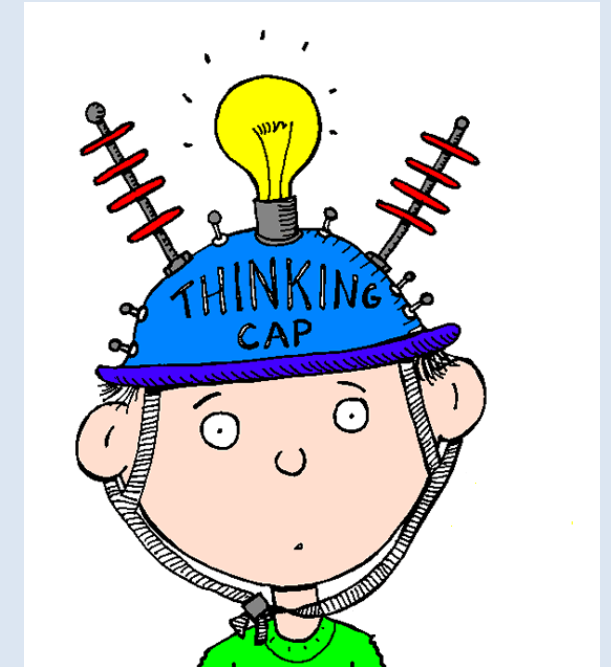
- Introductions
- Goals & objectives of the SAG
- Brief overview of the rule proposal
- Background on the freshwater DO standard
- Preliminary ideas for revisions to freshwater DO standard and discussion of averaging periods
- Next Steps





# Introductions of SAG Members

- Brief description from each public member of their affiliation and background.
- Brief description of each Ecology staff participating on the SAG and their role in applying the water quality standards.



# Goals and Objectives of SAG

- Support development of water quality standards for dissolved oxygen and fine sediment that provide protection of the most sensitive aquatic life designated uses and can be feasibly implemented.
- Provide a meeting environment that allows meaningful discussion and sharing of information on:
  - The science around water quality standards that are key to protection of salmonids and fish habitat, especially in the early life stages.
  - The development of standards that provide full protection and make sense spatially and seasonally.
  - Choosing standards and associated methods that are the most feasible to implement.





# SAG Member Roles

- The SAG is advisory to Ecology's Water Quality Standards staff as we move forward with this rulemaking. Member perspectives help inform and advise Ecology on rulemaking.
- SAG members bring their background, experience, and expertise to the table to participate in discussions and feedback that will provide Ecology Standards staff with advice and perspectives as we move forward with potential revisions to dissolved oxygen and new fine sediment standards.
- Ecology maintains the responsibility and obligation to make decisions on what will eventually go into a state rulemaking effort.



# Rule and Purpose

- Proposed rule will amend the surface water quality standards (WAC 173-201A):
  - Revisions to the freshwater dissolved oxygen criteria (WAC 173-201A-200)
  - Development a new fine sediment criterion
- **Purpose:**
  - Improve rules that protect salmonid spawning habitat
    - Ensure sufficient DO levels in spawning gravels
    - Ensure physical structure of redds are conducive to spawning success



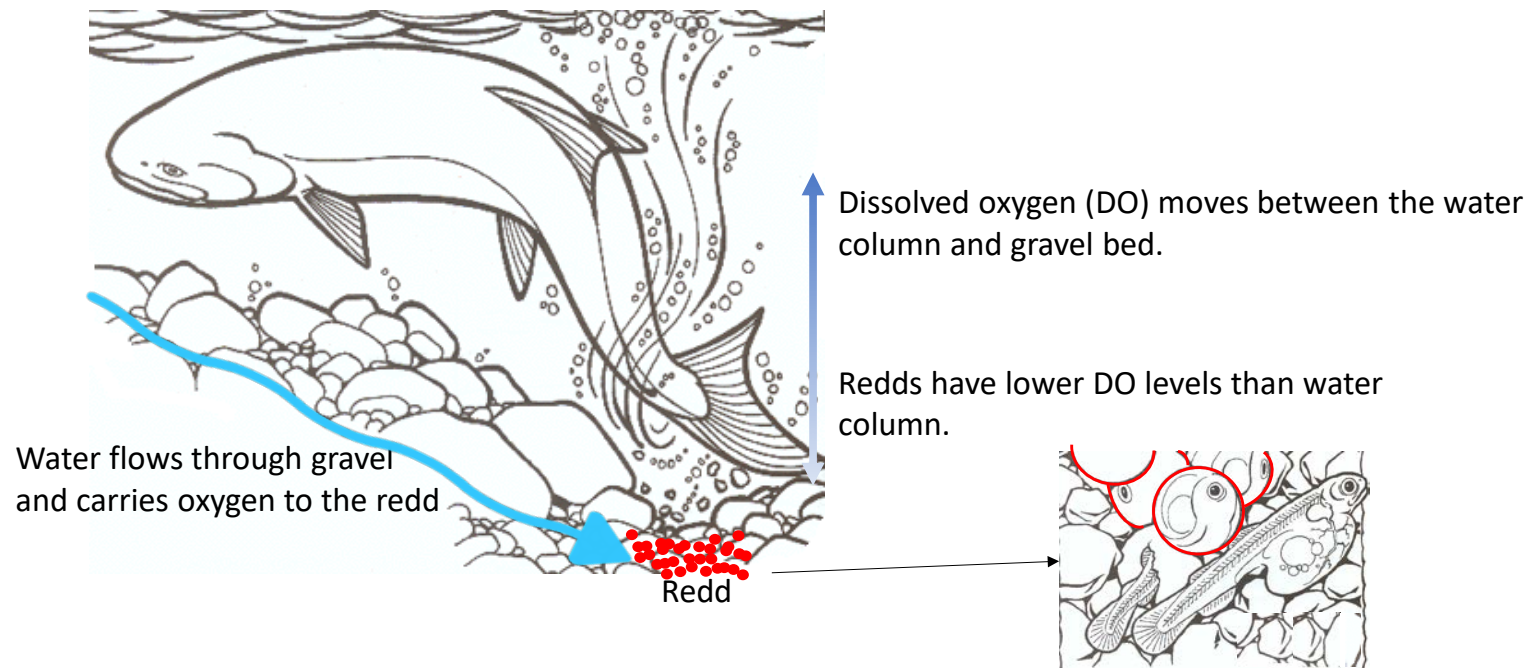


# Freshwater Dissolved Oxygen



# Dissolved Oxygen (DO) Requirements

Salmon eggs and larvae need oxygen to breathe



Images: [https://www.fws.gov/sacramento/es\\_kids/Chinook-Salmon/Images/redd\\_fws.gif](https://www.fws.gov/sacramento/es_kids/Chinook-Salmon/Images/redd_fws.gif)

# WA Freshwater DO Criteria

Use Category	1-Day Minimum
Char Spawning and Rearing	9.5 mg/L*
Core Summer Salmonid Habitat	9.5 mg/L*
Salmonid Spawning, Rearing, and Migration	8.0 mg/L*
Salmonid Rearing and Migration	6.5 mg/L
Non-anadromous Interior Redband Trout	8.0 mg/L*
Indigenous Warm Water Species	6.5 mg/L

**\*Salmonid spawning protective levels: 8.0 – 9.5 mg/L**



# EPA Recommendations

- EPA's recommendation for **full protection**: **11.0 mg/L**
  - WA standards for salmonid spawning: **8.0 – 9.5 mg/L**
- EPA assumes **3.0 mg/L reduction** in DO from the water column to interstitial spaces of gravel
- EPA: intragravel DO of 8.0 mg/L fully protective
  - WA standards are equivalent to 5.0-6.5 mg/L intragravel DO using EPA's assumption of DO depression



Table 2. A comparison of Pacific Northwest state, provincial, and tribal freshwater DO criteria for the protection of salmon spawning.

Agency	Water Column Criteria				Intragravel Criteria		
	1-Day Minimum <sup>1</sup>	7-Day Mean Minimum <sup>2</sup>	30-Day Mean Minimum	Percent Saturation	1-Day Minimum <sup>1</sup>	7-Day Mean Minimum <sup>2</sup>	30-Day Mean Minimum
State of Oregon	(9.0) mg/L <sup>3</sup>	11.0 mg/L		95% <sup>4</sup>	8.0 mg/L <sup>5</sup>		
State of Idaho	6.0 mg/L <sup>6</sup>			90% <sup>6</sup>	5.0 mg/L	6.0 mg/L	
State of Alaska	7.0 mg/L				5.0 mg/L <sup>8</sup>		
State of Washington	9.5 mg/L						
British Columbia	9.0 mg/L		11.0 mg/L		6.0 mg/L		8.0 mg/L
Makah Tribe	9.5 mg/L	11.0 mg/L					
Port Gamble S'Klallam Tribe	9.0 mg/L	11.0 mg/L					
Confederated Tribes of the Umatilla Indian Reservation	(9.0) mg/L <sup>3</sup>	11.0 mg/L		95% <sup>4</sup>	8.0 mg/L <sup>5</sup>		
Lummi Nation	(9.0) 11 mg/L <sup>3</sup>			95% <sup>4</sup>	8.0 mg/L <sup>5</sup>		
Confederated Tribes of the Warm Springs Reservation	(9.0) 11 mg/L <sup>3</sup>			95% <sup>4</sup>	8.0 mg/L <sup>5</sup>		
Confederated Tribes of the Colville Reservation	8.0 mg/L <sup>7</sup>	9.5 mg/L <sup>7</sup>			5.0 mg/L	6.5 mg/L	

1 A 1-day minimum can also be described as an instantaneous minimum. Both descriptions are applied as a minimum concentration to be met at all times.

2 A 7-day mean minimum is calculated as a moving mean of daily averages. The data must include diel variations of DO including maximum and minimum daily values.

3 DO concentrations in parentheses supersede other water column criteria when associated intragravel criteria are met.

4 The saturation criterion applies when other water column criteria are not attained.

5 Expressed as a spatial median. The median value from samples collected at multiple locations within a spawning area.

6 Both the DO minimum concentration and minimum saturation criteria must be met.

7 The water column DO concentration is a recommendation to achieve the required intragravel criteria.

8 The criterion applies to a depth of 20 cm in spawning gravels and requires the use of the IGDO standpipe method (McNeil, 1962) for collecting IGDO values.





# Dissolved Oxygen: What is Protective?

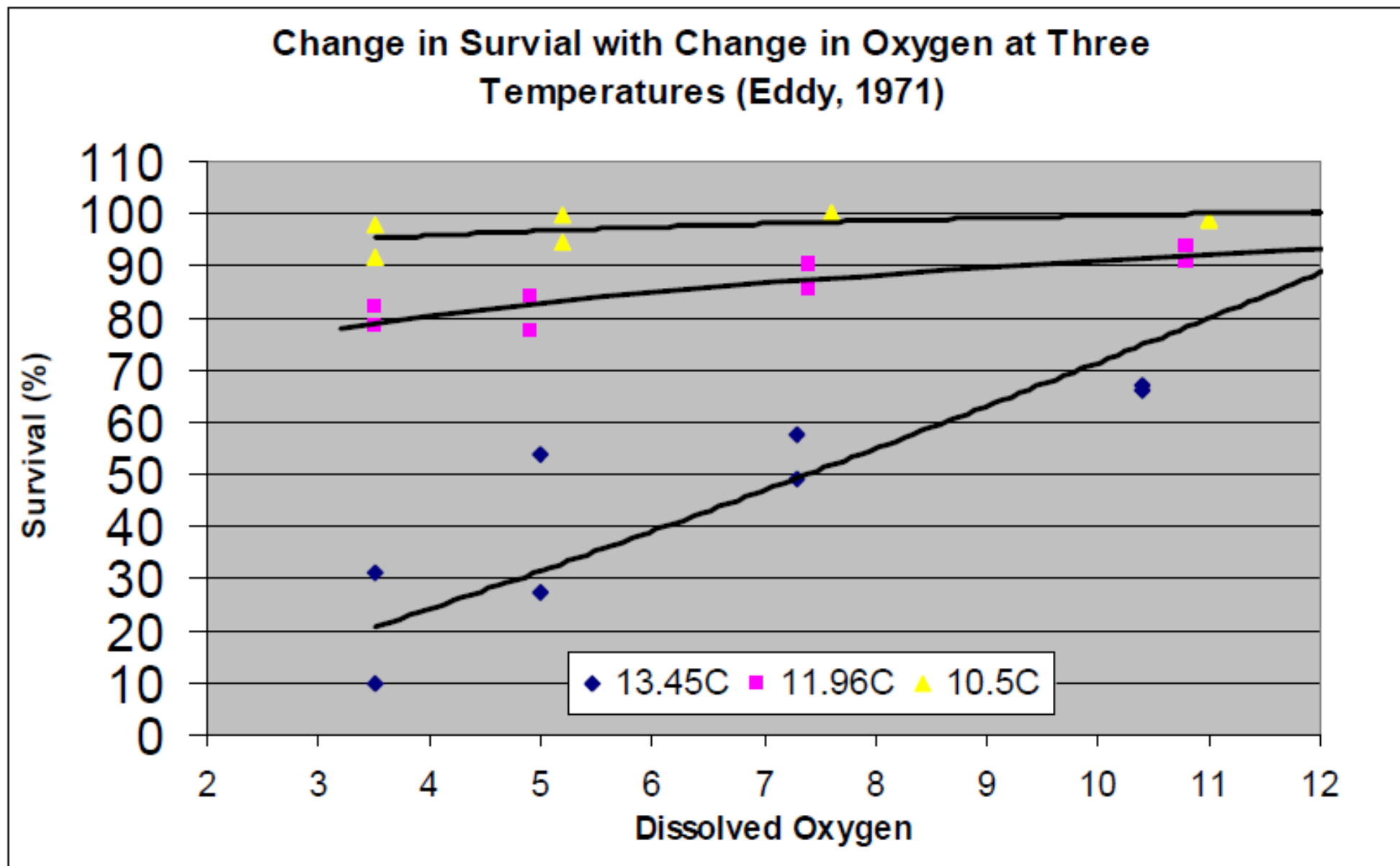


Figure 1. Relationship between incubation survival rates of chinook salmon at three temperatures (10.5, 12, and 13.5°C) and four oxygen concentrations (based on the data from Eddy, 1971).

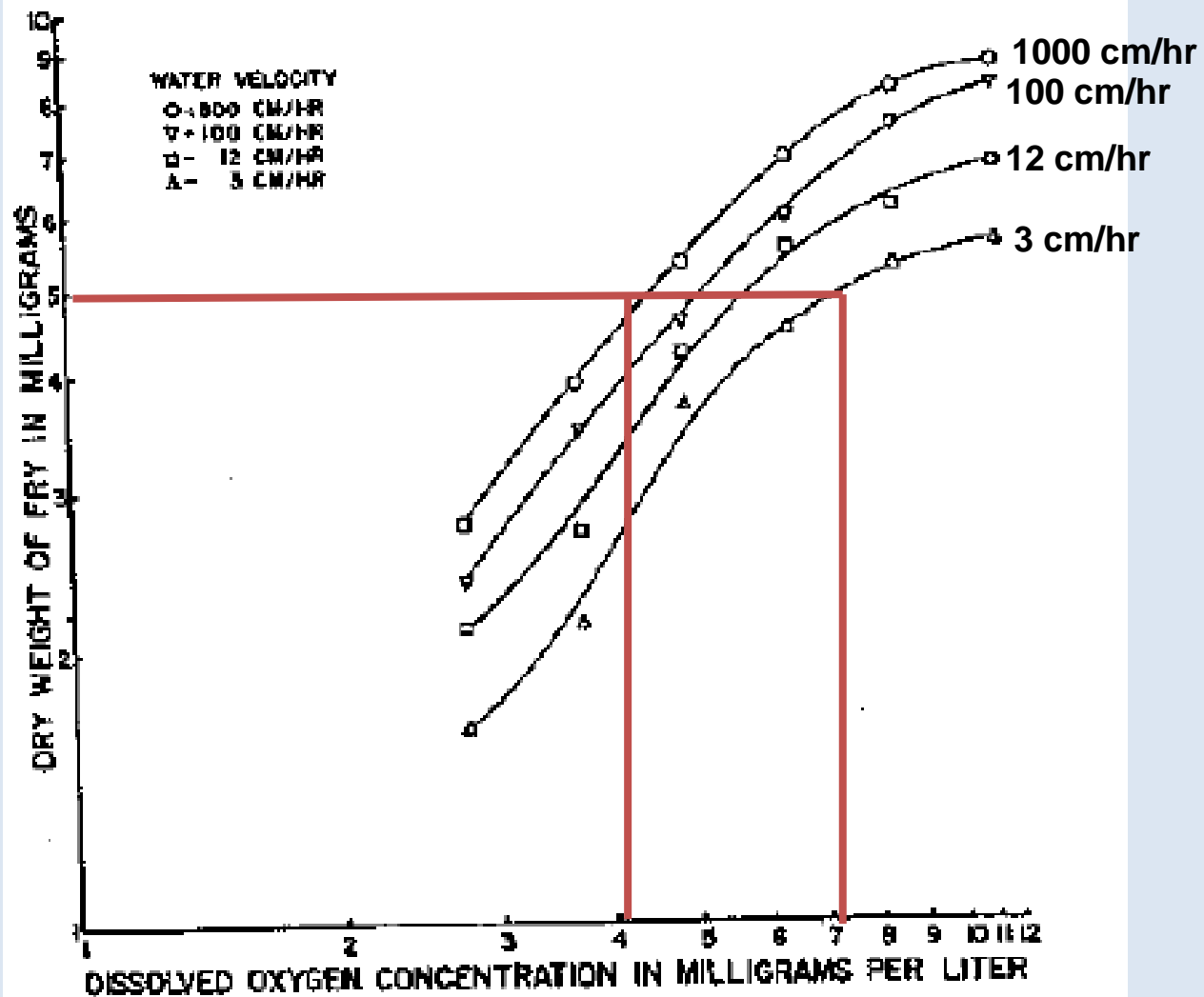


FIGURE 3.—The relation between the mean dry weights of newly hatched coho salmon fry and the dissolved oxygen concentrations at which the embryos were reared in experiment 4, at each water velocity tested.

# Incubation Survival Rates

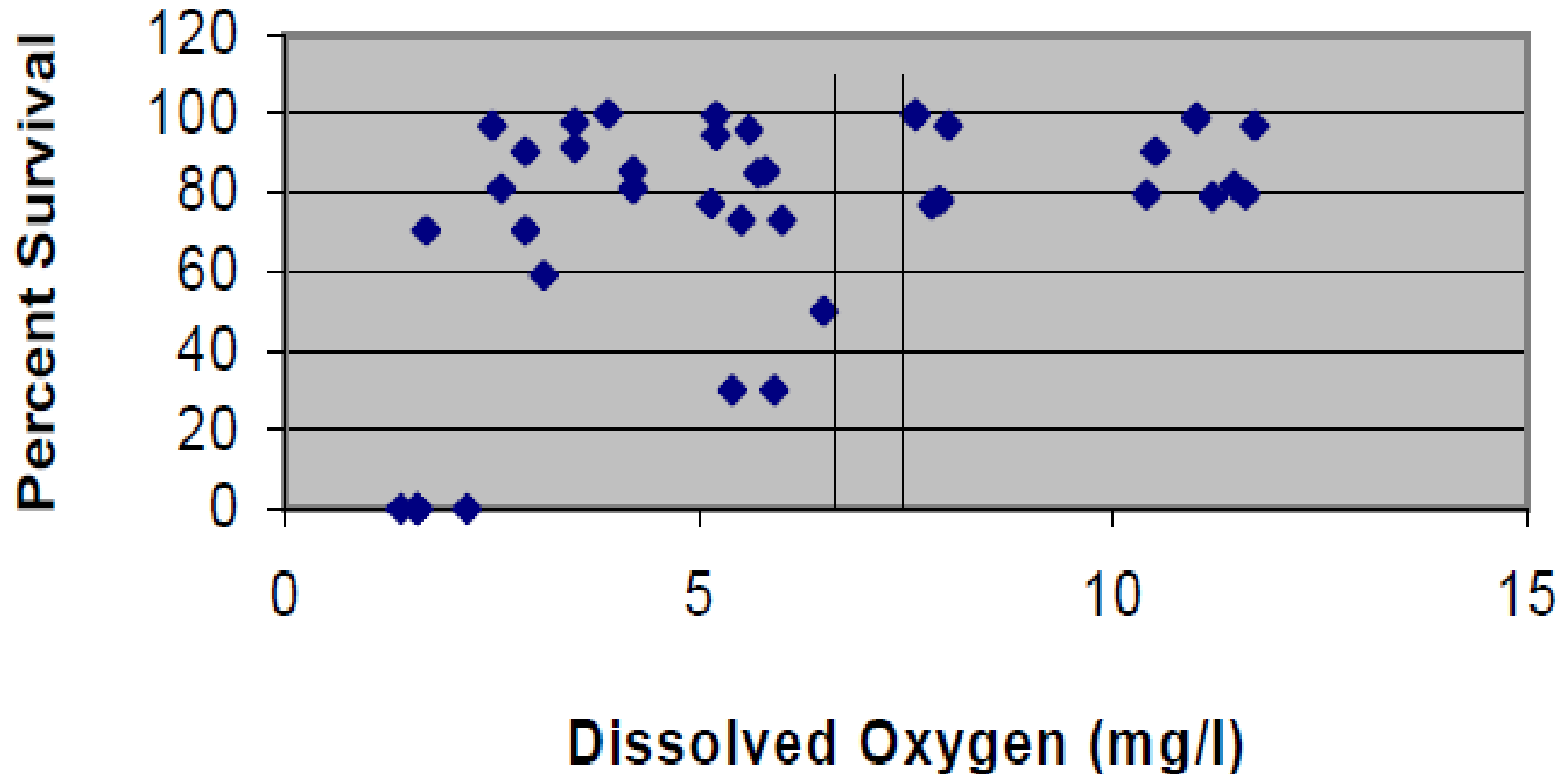


Figure 4. Incubation survival rates versus dissolved oxygen levels reported in the literature

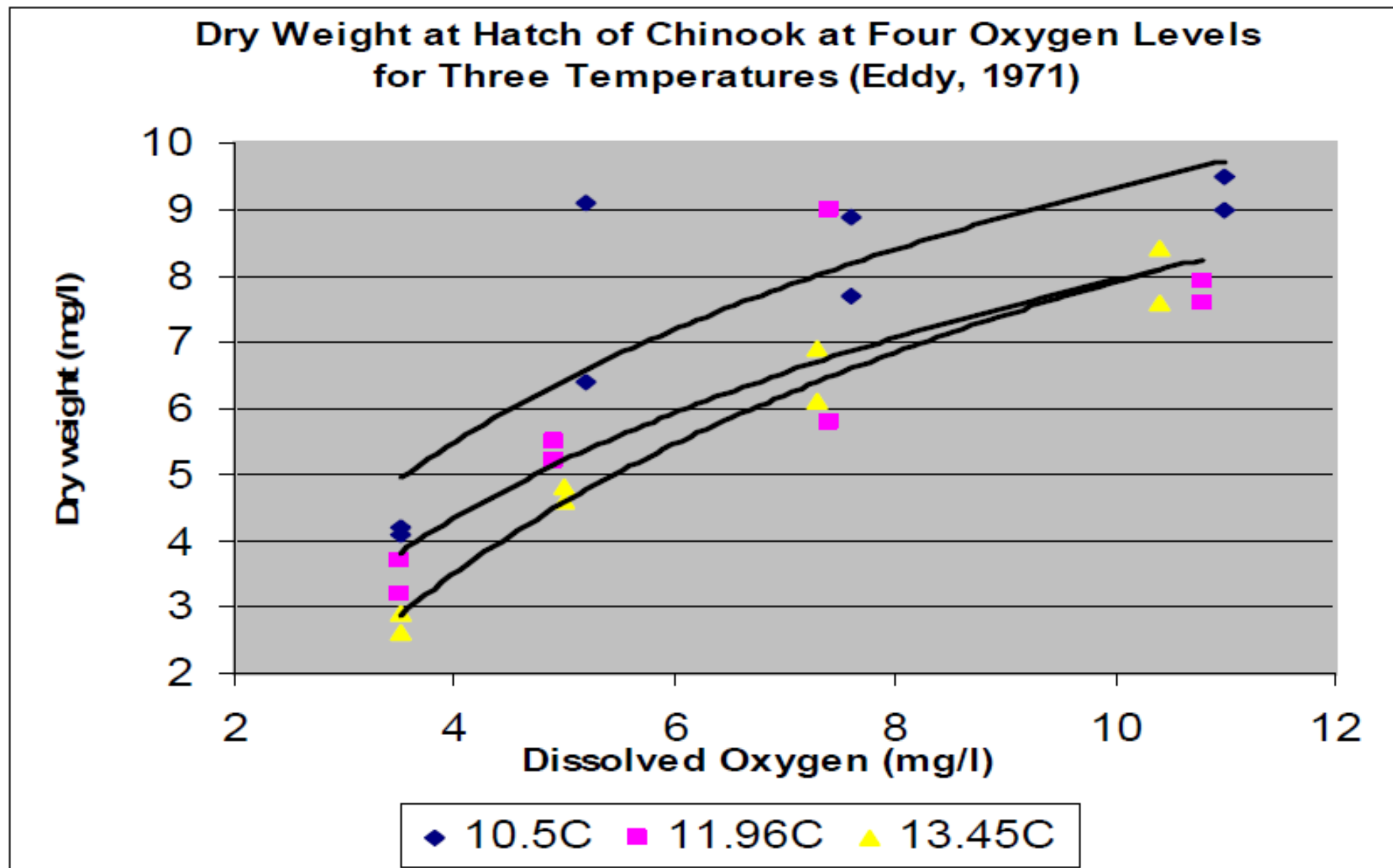
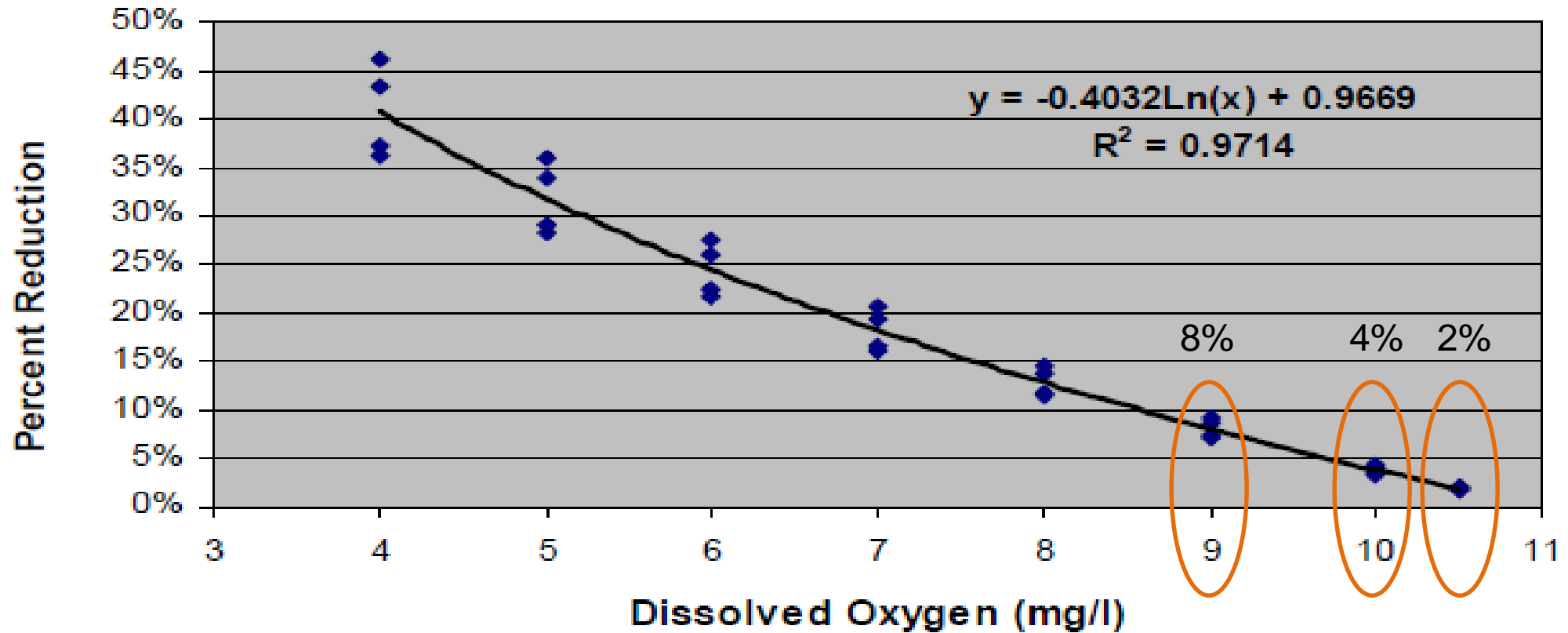


Figure 5. Change in dry weight of chinook salmon at hatching at four oxygen levels for three temperatures (Eddy, 1971)

**Effect of Reducing Oxygen on the Weight and Volume of Newly Hatched Salmonids (Based on Silver et al., 1963; Shumway et al., 1964; and Fry, 1971)**



**Figure 6. Overall effect on weight and volume of newly hatched salmonids of varying mean oxygen concentrations over the development period. (based on data from Silver, 1963; Shumway, 1964; and Fry, 1971).**

	Higher <----- Protection -----> Lower			
<b>Laboratory Mortality During Incubation through Hatching</b>	$\geq 9.0$ ( $<1\%$ )	7.0 (1-2%)	6 (2-6%)	4 (7-100%)
<b>Laboratory Studies of Emergence from Gravel (Intragravel O<sub>2</sub>)</b>		$\geq 8$ (Benefits no longer obvious)		6-6.5 (Stress and high mortality)
<b>Field Studies of Emergence from Gravel (Intragravel O<sub>2</sub>)</b>		$>8$ (High survival)	8 (Sometimes median survival)	6-7 (Significant survival reductions – 50%)
<b>Avoidance Reactions of Alevin in Gravel (Intragravel O<sub>2</sub>)</b>			8-10 (Sought out)	4-6 (7) (Avoided)
<b>Growth Reduction During Incubation</b>	10.5 ( $<2\%$ )	10 (4%)	9.5 (6%)	9 (8%)
<b>Effect on Hatch Timing</b>	$>8$ ( $<1$ day)	7 ( $<2$ days)	6 (2 days)	

*Note: Intragravel oxygen concentrations are given in both laboratory and field studies on alevin avoidance and fry emergence. These values should be adjusted upward 1-3 mg/l to get at a comparable water column concentration.*



# 1986 EPA Recommendations

## 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.)

# Protective Levels of DO

- **Water column DO Concentrations**

- EPA states that 11.0 mg/L is fully protective of salmonids
- 

- Does the literature support 11.0 mg/L as fully protective or is this value considered overly protective?
- If slight impairment is observed at 9.0 mg/L and 11.0 mg/L is fully protective (according to EPA), is full protection some value between 9 and 11 mg/L?
- Is there justification for modifying WA water column based DO concentrations?



# Protective Levels of DO

- **Water column: Intragravel DO Depression**

- EPA makes an assumption of a 3.0 mg/L DO depression
- 

- Is 3.0 mg/L a reasonable assumption supported by literature?
- Do uncontrolled environmental variables (e.g. salmonid site selection, stream type, sediment type) undermine the assumption of 3.0 mg/L DO depression?





**BREAK**



# Preliminary Ideas for Criteria

# Preliminary Ideas for DO Criteria

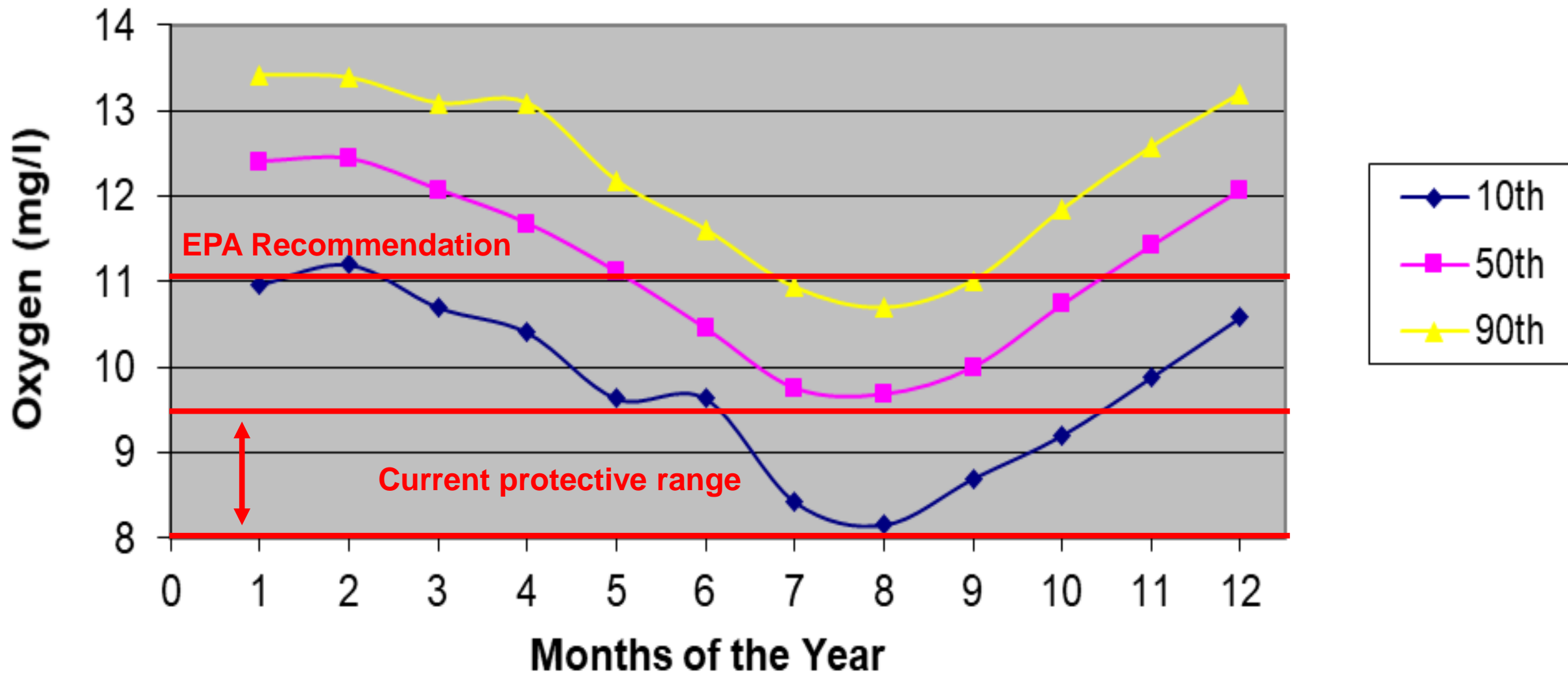
## 1. Revise Water Column DO Concentrations

- a) Set DO levels for salmonid spawning uses at 11.0 mg/L (considered full protection by EPA)
- b) Set DO levels for salmonid spawning uses at some value between 9 and 11 mg/L

- 
- Will 11.0 mg/L be met on a regular basis in the majority of state streams or will this option lead to 303(d) listings for a large proportion of WA water bodies?



# Summary of Monthly Average Oxygen Concentrations (10th, 50th, and 90th Percentiles)



Based on over 30 years of statewide ambient monitoring data from 496 sites



# Preliminary Ideas for DO Criteria

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# Preliminary Ideas for DO Criteria

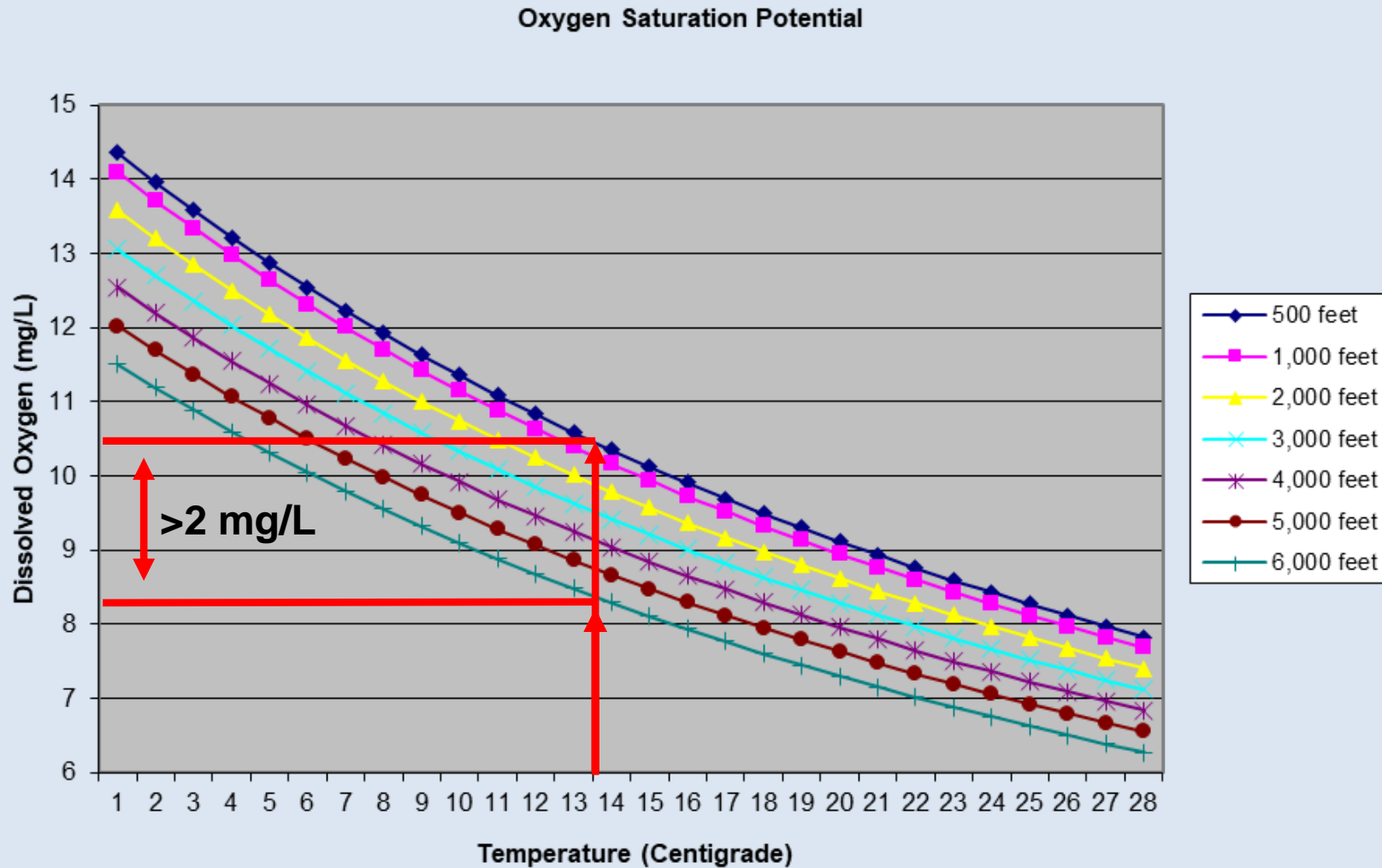
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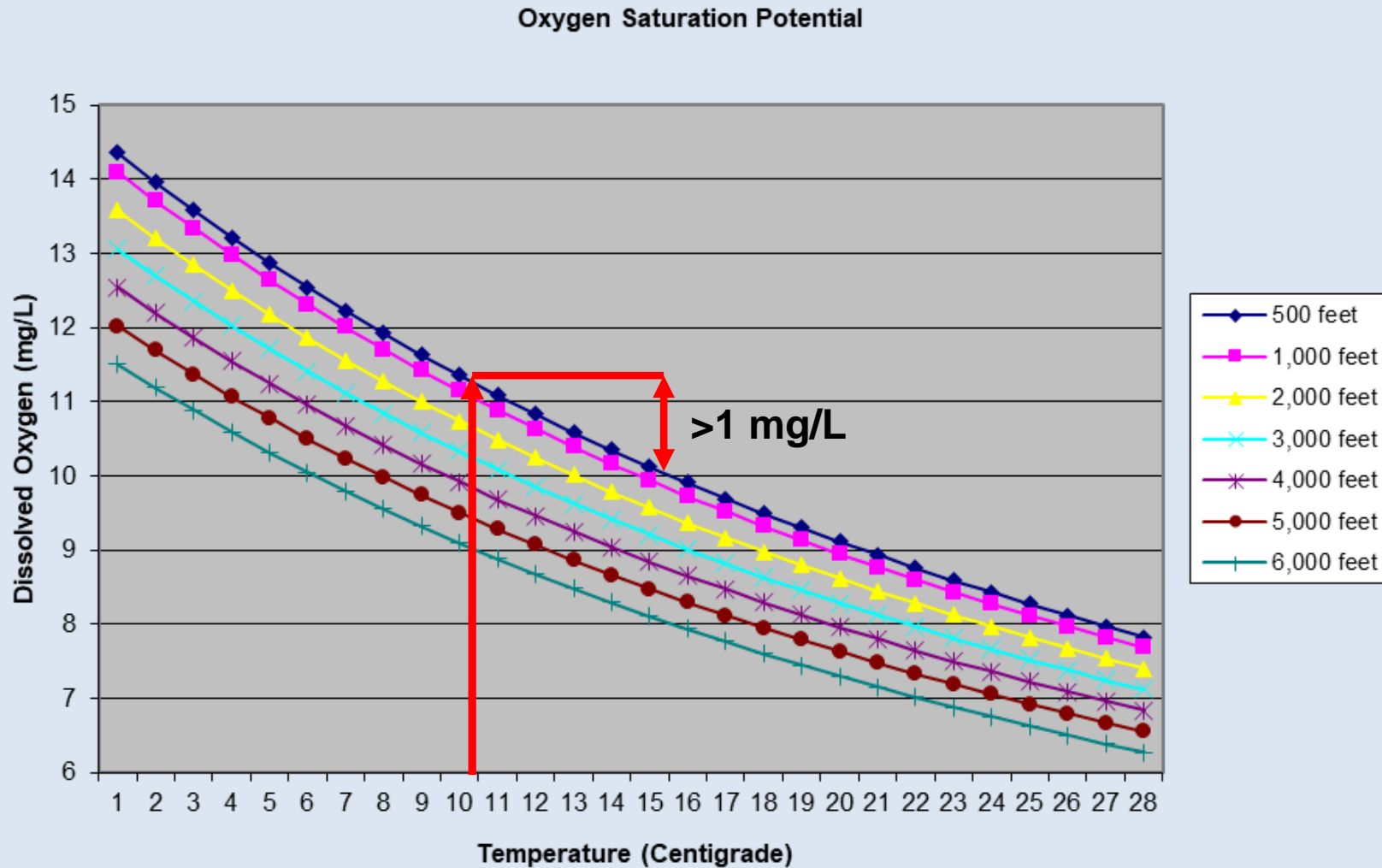
- 
- Will 11.0 mg/L be met on a regular basis in the majority of state streams or will this lead to 303(d) listings for a large proportion of WA water bodies?
  - Is a 11.0 mg/L standalone criteria realistic when considering environmental variables (i.e. water temperature and altitude)?



# Dissolved Oxygen vs Altitude and Temperature



# Dissolved Oxygen vs Altitude and Temperature



# Preliminary Ideas for DO Criteria

## 1. Revise Water Column DO Concentrations

- a) Set DO levels for salmonid spawning uses at 11.0 mg/L (considered full protection by EPA)
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- Will 11.0 mg/L be met on a regular basis in the majority of state streams or will this lead to 303(d) listings for a large proportion of WA water bodies?
  - Is 11.0 mg/L a realistic criteria when considering environmental variables such as water temperature and altitude?
  - Should Washington only rely on a standalone water column DO concentration?



# Preliminary Ideas for DO Criteria

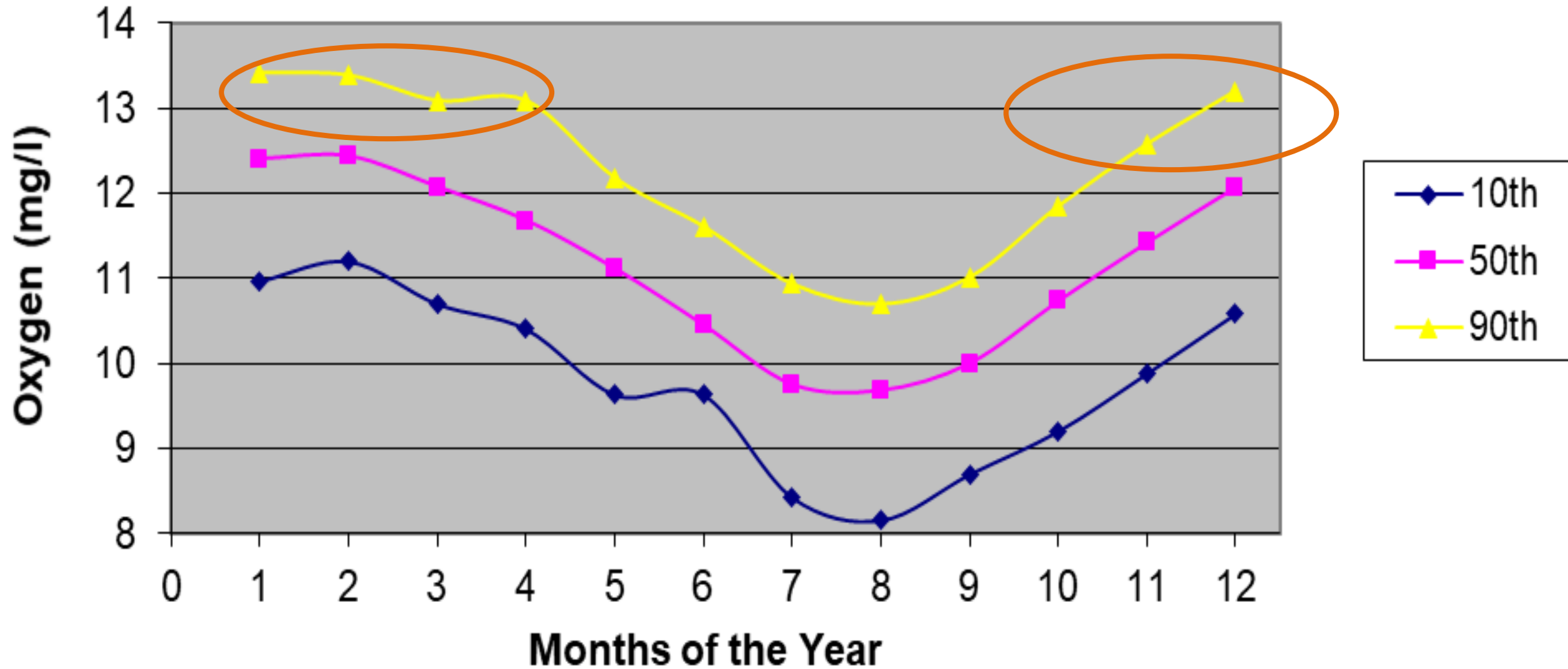
## 2. Apply a seasonal freshwater DO criteria during spawning and rearing periods

- Map spawning periods for salmonids in water bodies and apply more restrictive DO criteria during spawning periods

- 
- Can we rely on existing mapping data such as the supplemental spawning and incubation criteria currently in the standards for temperature?
    - Supplemental spawning criteria provide additional protection for early life stages of salmonids in late spring or early fall
    - Supplemental spawning criteria assumes salmonids spawning in late fall or whose young emerge before late spring do not require added protection



# Summary of Monthly Average Oxygen Concentrations (10th, 50th, and 90th Percentiles)

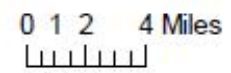
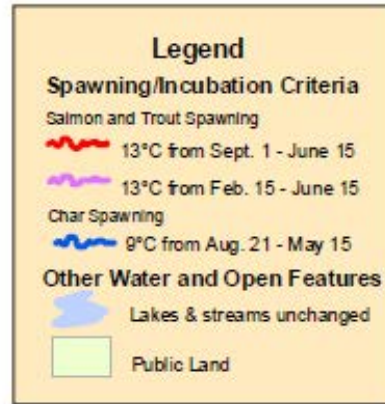
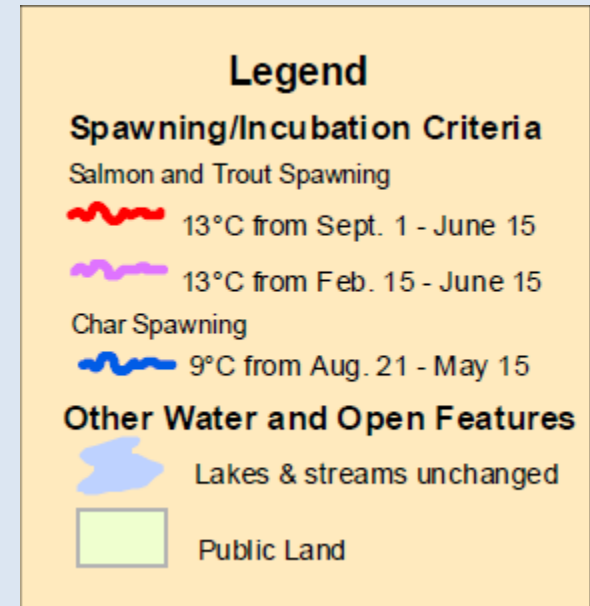
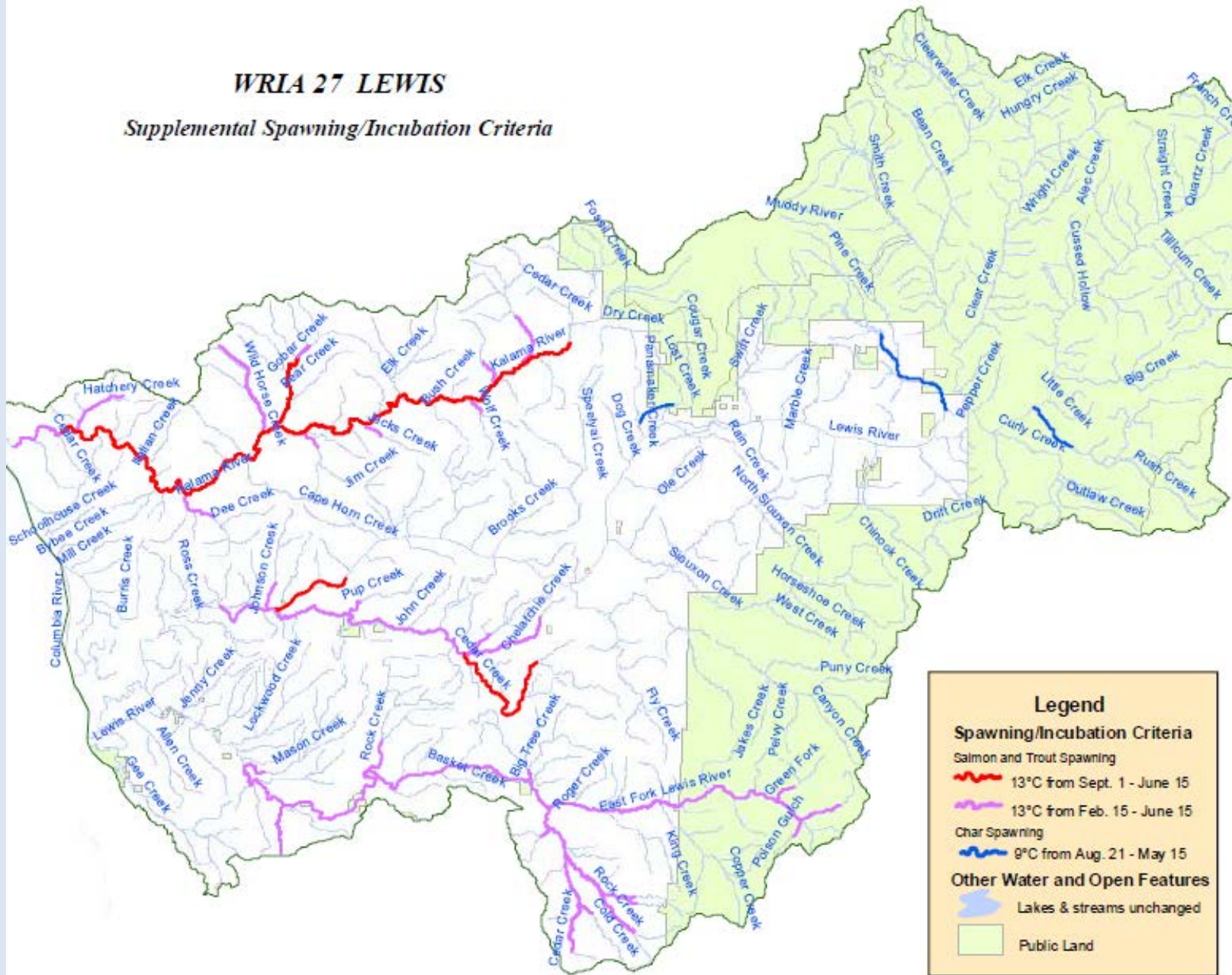


Based on over 30 years of statewide ambient monitoring data from 496 sites



# WRIA 27 LEWIS

## Supplemental Spawning/Incubation Criteria



# Preliminary Ideas for DO Criteria

## 2. Apply a seasonal freshwater DO criteria during spawning and rearing periods

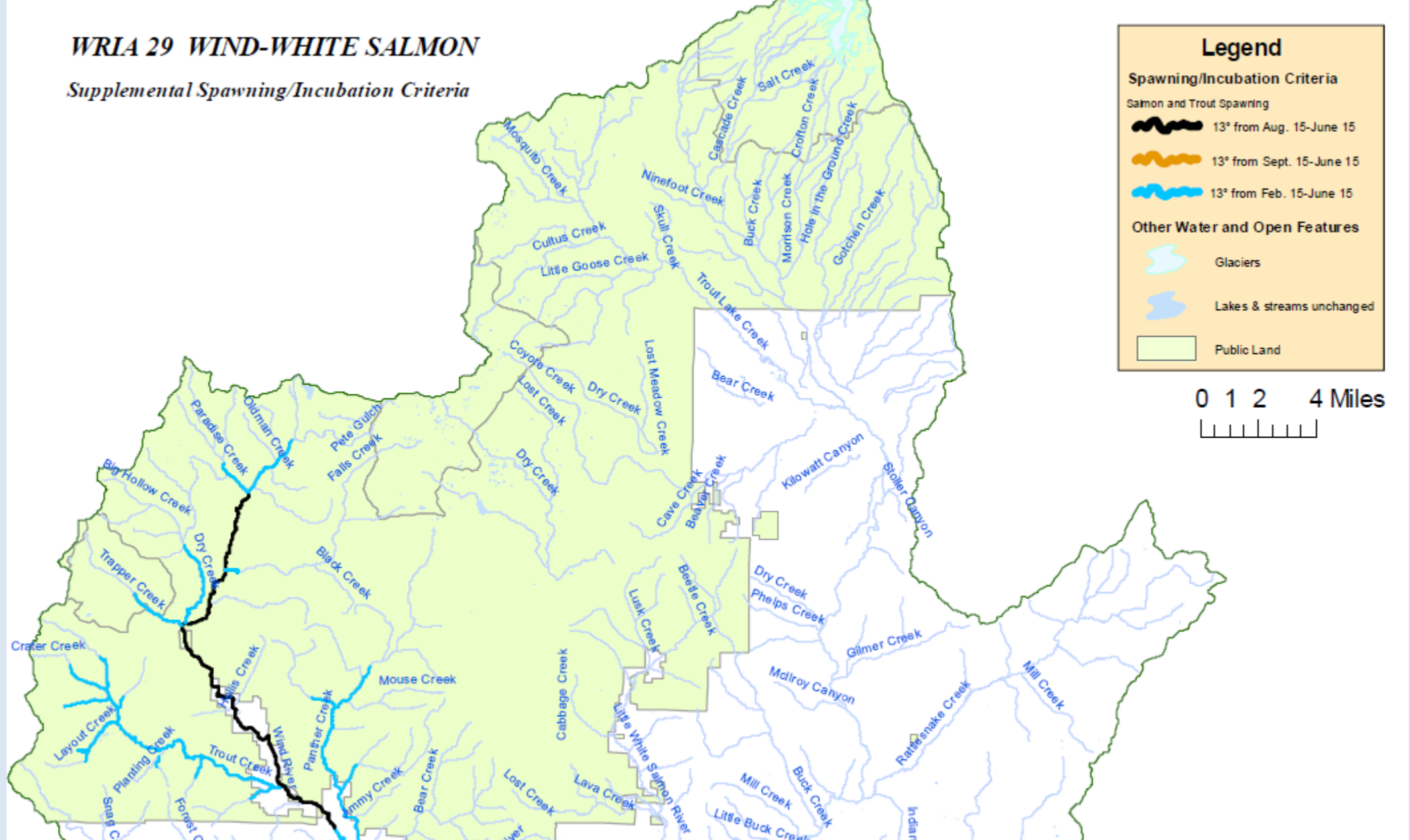
- Map spawning periods for salmonids in water bodies and apply more restrictive DO criteria during spawning periods

- 
- Can we rely on existing data and mapping or surveys such as the supplemental spawning and incubation criteria currently in the standards for temperature?
  - Does salmonid spawning or rearing encompass year-round periods in some water bodies or can we apply a generic seasonal spawning criteria to all water bodies (Ex. September through May)?



# WRIA 29 WIND-WHITE SALMON

## Supplemental Spawning/Incubation Criteria



WRIA 29: Supplemental spawning criteria occurs in some waters from August 15 to June 15

# Preliminary Ideas for DO Criteria

## 2. Apply a seasonal freshwater DO criteria during spawning and rearing periods

- Map spawning periods for salmonids in water bodies and apply more restrictive DO criteria during spawning periods

- 
- Can we rely on existing data and mapping or surveys such as the supplemental spawning and incubation criteria currently in the standards for temperature?
  - Does salmonid spawning or rearing encompass year-round periods in most water bodies?
  - How long would it take to complete a project of this magnitude or does the existing mapping data suffice?



# Preliminary Ideas for DO Criteria

## 3. Develop and implement intragravel DO criterion

- Direct measurements of intragravel DO
- Set intragravel DO criteria to 8.0 mg/L

- 
- What methods are available to measure intragravel DO and are they easily implementable?
  - Do the spatial and temporal variations of intragravel DO make it a good measure of water quality?
  - Is it feasible to regularly monitor intragravel DO levels?
  - What expenses would be anticipated if required to measure intragravel DO?





# Preliminary Ideas for DO Criteria

## 4. Add a percent saturation component to the freshwater DO criteria

- 90 or 95% DO saturation common among states

- 
- Does a percent DO saturation criteria add needed flexibility to the current DO criteria?
  - Will a percent saturation better define water quality impairments for temperature versus dissolved oxygen?
  - Should we account for altitude and temperature impacts to DO that are not incorporated into water column DO concentrations?
  - Does scientific literature support a threshold for DO saturation (90 or 95%)?



## Percent Saturation at Sea Level

Temperature (C)	100% Saturation	95% Saturation	90% Saturation
<b>1</b>	14.2	13.5	12.8
<b>2</b>	13.8	13.1	12.4
<b>3</b>	13.5	12.8	12.1
<b>4</b>	13.1	12.5	11.8
<b>5</b>	12.8	12.1	11.5
<b>6</b>	12.5	11.8	11.2
<b>7</b>	12.1	11.5	10.9
<b>8</b>	11.8	11.3	10.7
<b>9</b>	11.6	11.0	10.4
<b>10</b>	11.3	10.7	10.2
<b>11</b>	11.0	10.5	9.92
<b>12</b>	10.8	10.2	9.70
<b>13</b>	10.5	10.0	9.48
<b>14</b>	10.3	9.79	9.28
<b>15</b>	10.1	9.58	9.08
<b>16</b>	9.87	9.38	8.88
<b>17</b>	9.66	9.18	8.70
<b>18</b>	9.47	8.99	8.52

Char spawning/  
incubation

Salmon & trout spawning/  
incubation

Maximum temp: 17.5 C



# Preliminary Ideas for DO Criteria

## 5. Combination options:

- Couple water column DO concentration with a percent DO saturation criterion
- Couple water column DO criteria with an intragravel criterion
- Couple water column DO criteria with intragravel criterion and percent DO saturation

- 
- Does a multifaceted approach make the most sense?
  - Is there a preferred combination option?
  - Does a combination approach make implementation of the WQ standards more difficult or easier?
  - Does a combination approach account for environmental factors such as temperature related DO impairments, elevation, and natural characteristics of water bodies?







# DO Averaging Period

# DO Criteria Averaging Period

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

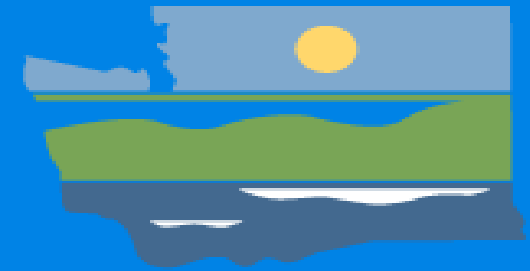
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- Should we consider longer averaging periods for DO in the water column?
  - Should we consider multiple criteria set at different averaging periods?



# Next Steps

- The next two meetings of the SAG to continue discussions on DO and fine sediment are:
  - November 19<sup>th</sup> (Thurs), afternoon
  - December 9<sup>th</sup> (Weds), afternoon
- 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.





Thanks for Your Participation!  
Have a good afternoon.