

# Oregon's Copper Aquatic Life Criteria Based on the Biotic Ligand Model

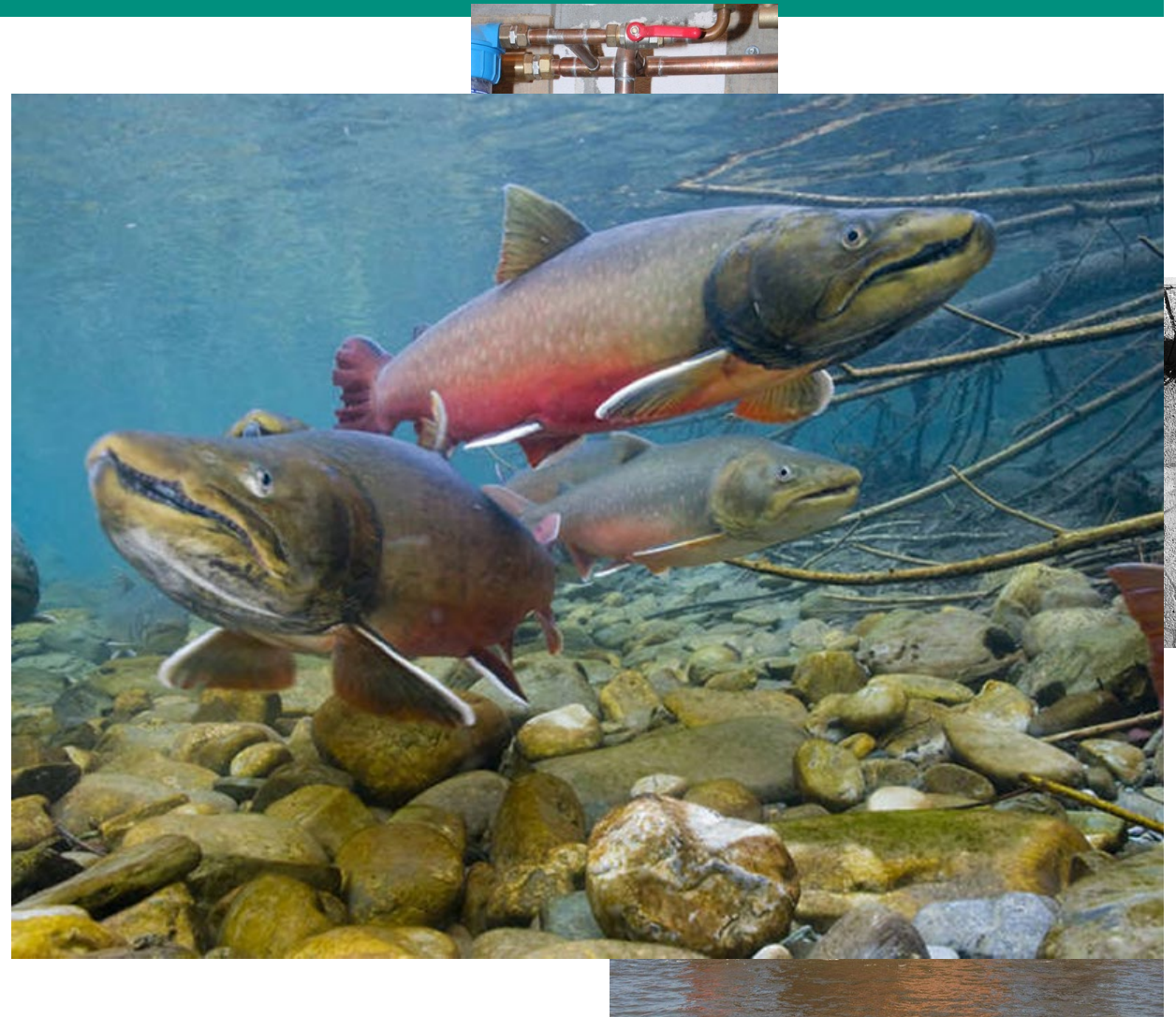
Oregon Department of Environmental Quality  
Water Quality Standards Program

April 17, 2024

Association of Clean Water Administrators (ACWA)  
Water Quality Standards Workshop, Albuquerque, New Mexico

# Copper in Oregon's Environment

- Mining / Erosion
  - Common element
- Municipal wastewater
  - Distribution Pipes
  - Commercial / industrial waste
- Industrial wastewater
  - Metals / electrical
- Runoff
  - Asphalt / Roofing materials
  - Roads (brake pads)
  - Agricultural / residential biocides
  - Marine anti-fouling paint
  - Wood preservatives

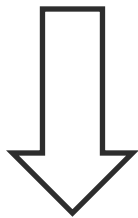


# Biotic Ligand Model Overview

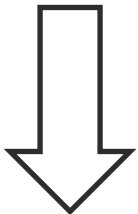
References  
Websites

## Water Chemistry

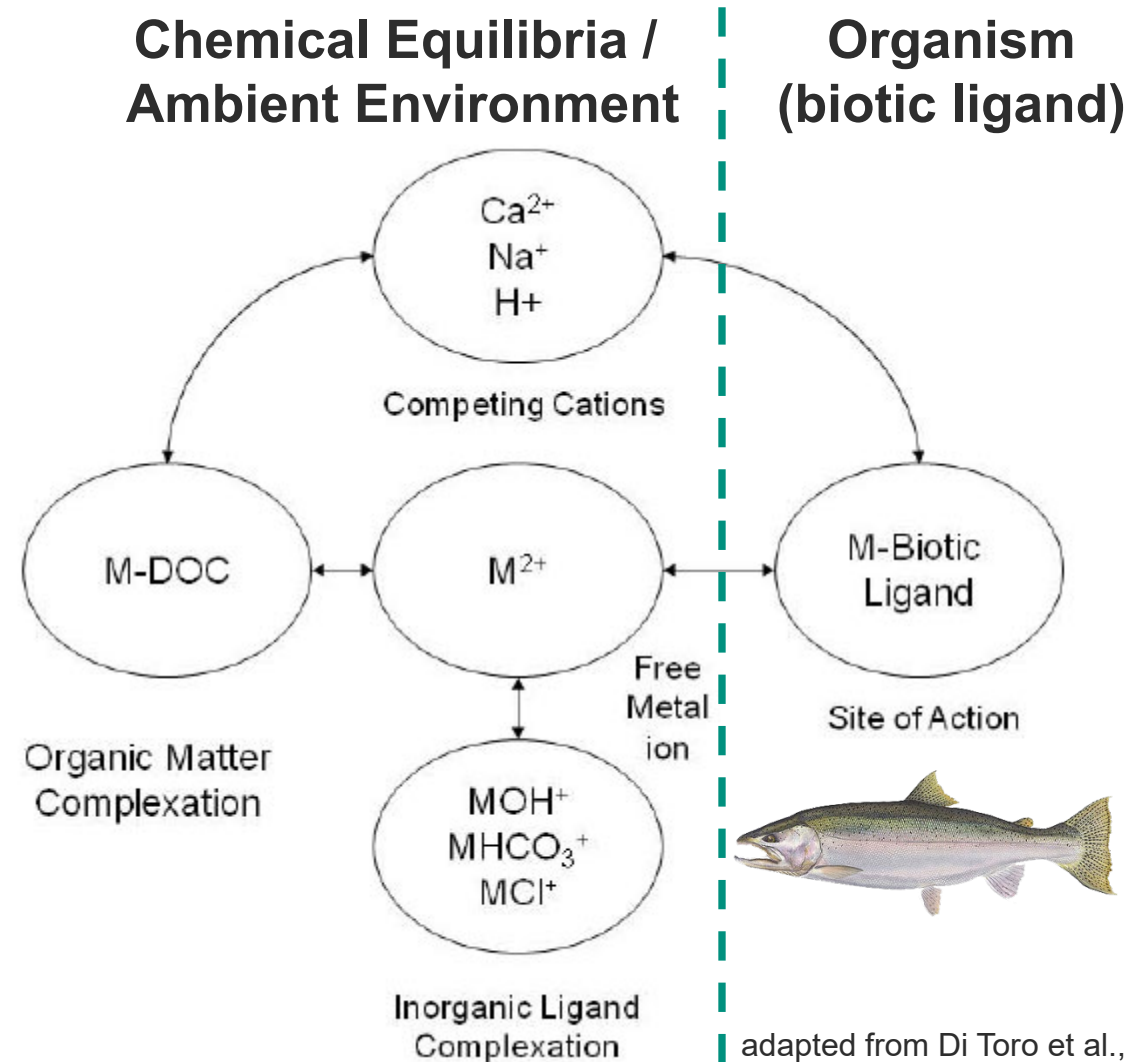
- Complexation of Cu
- Concentration of free Cu
- Competition of Cu with ions



Bioavailability



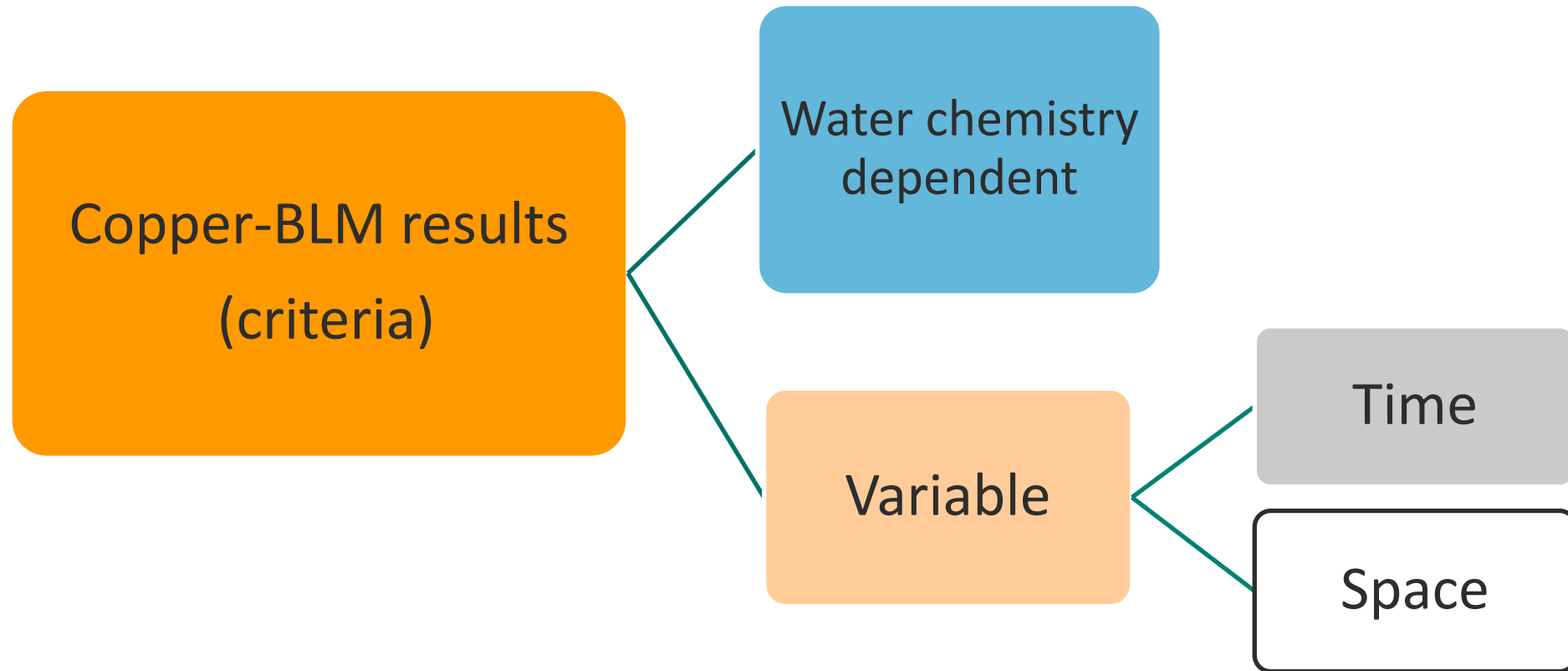
Organism Toxicity



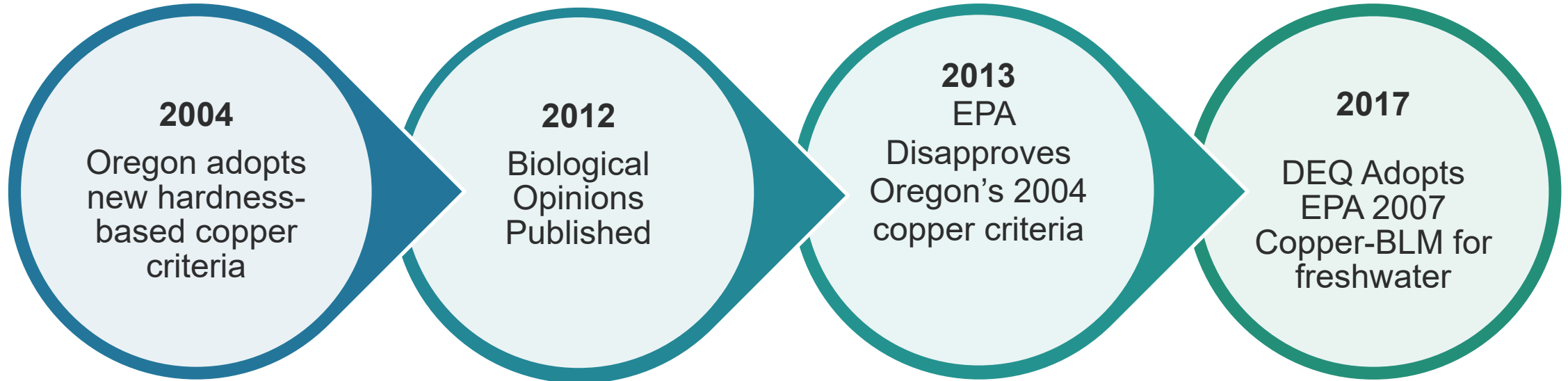
adapted from Di Toro et al., 2001

# Copper-BLM Criteria

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# Policy Background



- Hardness-based criteria (EPA, 1995)
- Endangered Species Act Consultation

**U.S. Fish & Wildlife Service Decision**

- No jeopardy.

**National Marine Fisheries Service**

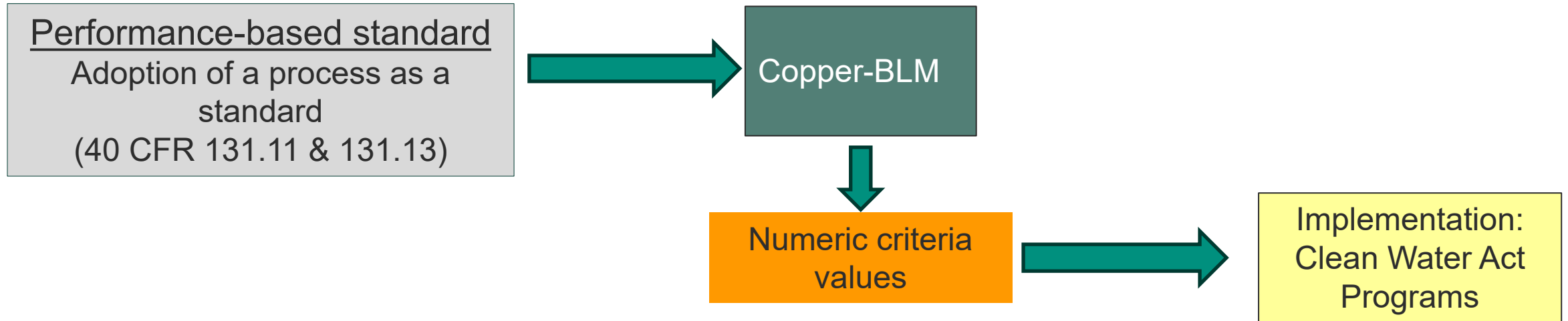
- Oregon's hardness-based copper criteria would cause jeopardy to T&E species.

- Hardness-based criteria under-protective depending on ambient water chemistry

**•Remedy:** adopt EPA's 2007 recommended criteria (Copper-BLM)

# Statewide Copper Criterion Adoption

## Hybrid Approach



# Structure of Oregon's Criteria

**OAR 340-041-8033  
Table 30  
Aquatic Life Water Quality Criteria for Toxic Pollutants**

No.	Pollutant	CAS Number	Human Health Criterion	Freshwater ( $\mu\text{g/L}$ )		Saltwater ( $\mu\text{g/L}$ )	
				Acute Criterion (CMC)	Chronic Criterion (CCC)	Acute Criterion (CMC)	Chronic Criterion (CCC)
13	Copper	7440508	y	See C, N	See C, N	4.8 <sup>C</sup>	3.1 <sup>C</sup>

<sup>C</sup> Criterion is expressed in terms of "dissolved" concentrations in the water column.

<sup>N</sup> The freshwater criterion for copper is a function of the concentration of ions, alkalinity, organic carbon, pH and temperature in the water column. To calculate the criterion, use the Biotic Ligand Model referenced in endnote N at the bottom of Table 30. The acute copper criterion (CMC) is applied as a one-hour average concentration. The chronic criterion (CCC) is applied as a 96-hour (4 days) average concentration. See endnote N also for procedures and information.

# Input Parameters

- Need measured values for 10 input parameters
- Based on dissolved fraction (total o.k.)
- Copper data is not needed to calculate criteria values

## 12 Copper-BLM Input Parameters

temperature

**pH\***

**dissolved organic carbon (DOC)\***

calcium (Ca)

magnesium (Mg)

sodium (Na)

potassium (K)

sulfate (SO<sub>4</sub>)

chloride (Cl)

alkalinity

humic acid fraction (model default value)

sulfide (model default value)

**\*Most Sensitive**



# Running the Copper-BLM

- INPUT(s)**
- 12 Parameters:
  - Copper (optional)

Biotic Ligand Model, Version 2.2.3 - Research Mode:

File Edit View Inputs Help

Current Selections: Metal: Copper Prediction Mode: Instantaneous WQC Calculation

10344-ORDEQ

	Site Label	Sample Label	Temp.	pH	Cu	DOC	HA	Ca	Mg	Na	K	SO4	Cl	Alkalinity	S
			C		ug/L	mg C/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L
1	10344-ORDEQ	8/29/2019	21.1	7.7	1.5	1.48	10.	5.81	1.84	4.74	0.95	3.47	3.52	26.	1.E-6
2															
3															
4															
5															
6															
7															
8															
9															
10															

- OUTPUT(s)**
- Instantaneous Water Quality Criterion (IWQC):
- Final acute value (FAV)
  - Acute (CMC) Criteria
  - Chronic (CMC) Criteria

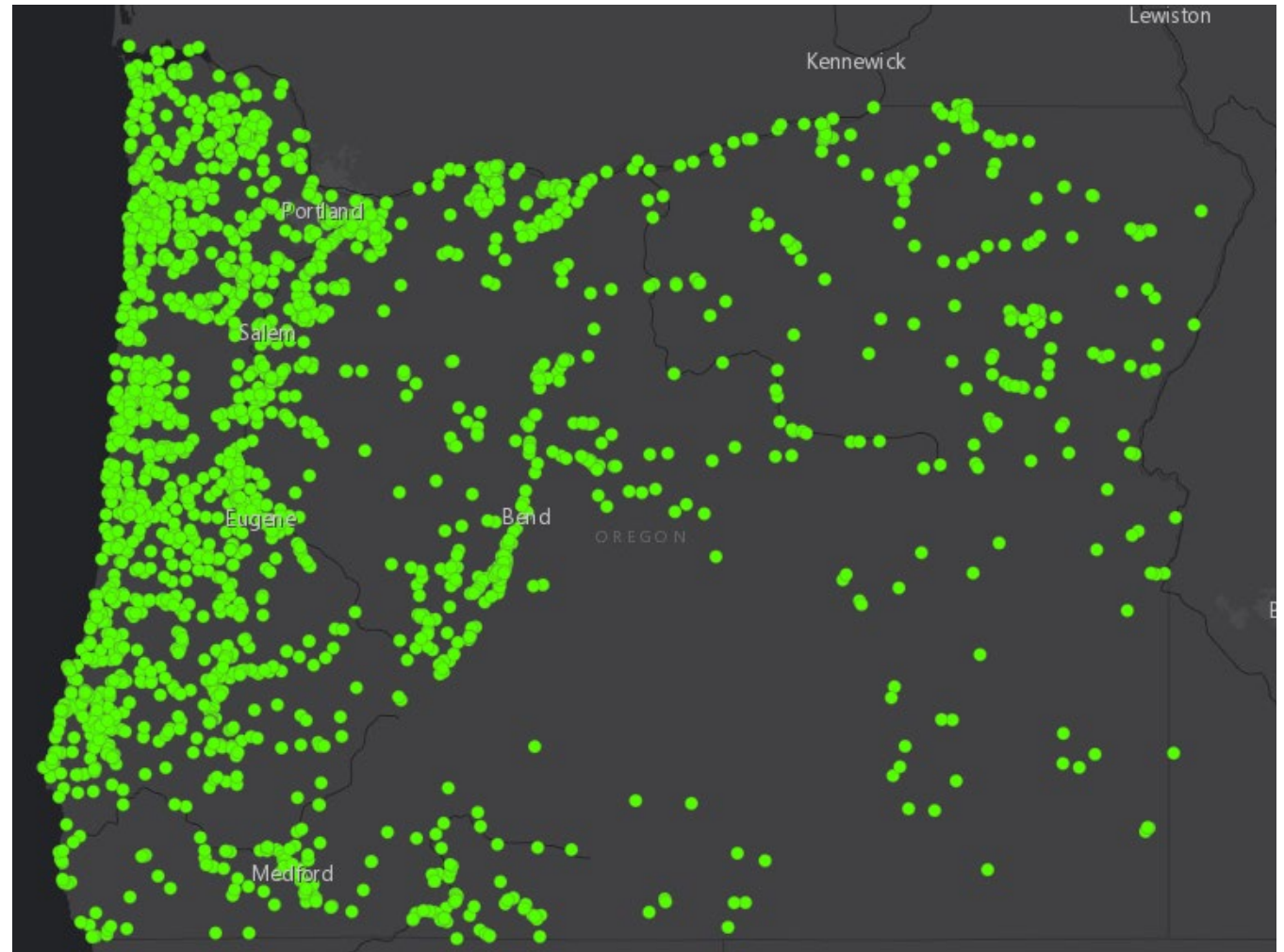
# Implementation & Challenges:

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- How do you get adequate parameter data to calculate the criteria?
- How do you implement a variable criteria?

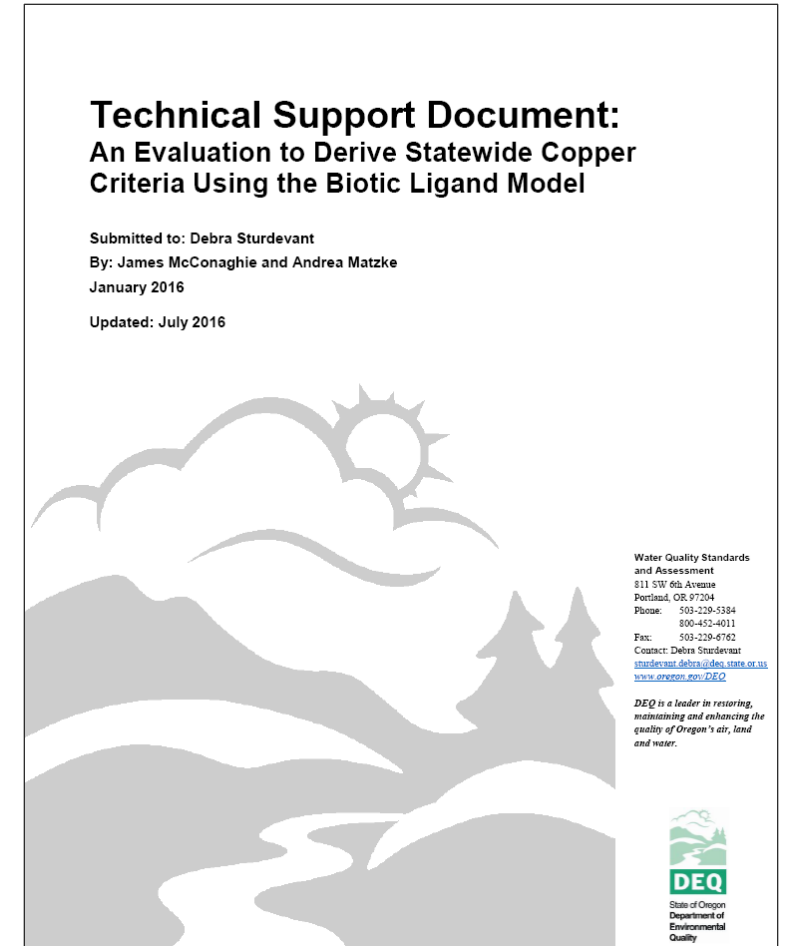
# Copper-BLM Parameter Monitoring

- Existing DEQ monitoring programs
- Always collect biotic ligand model parameters with copper.
- Permittees collect effluent AND ambient data



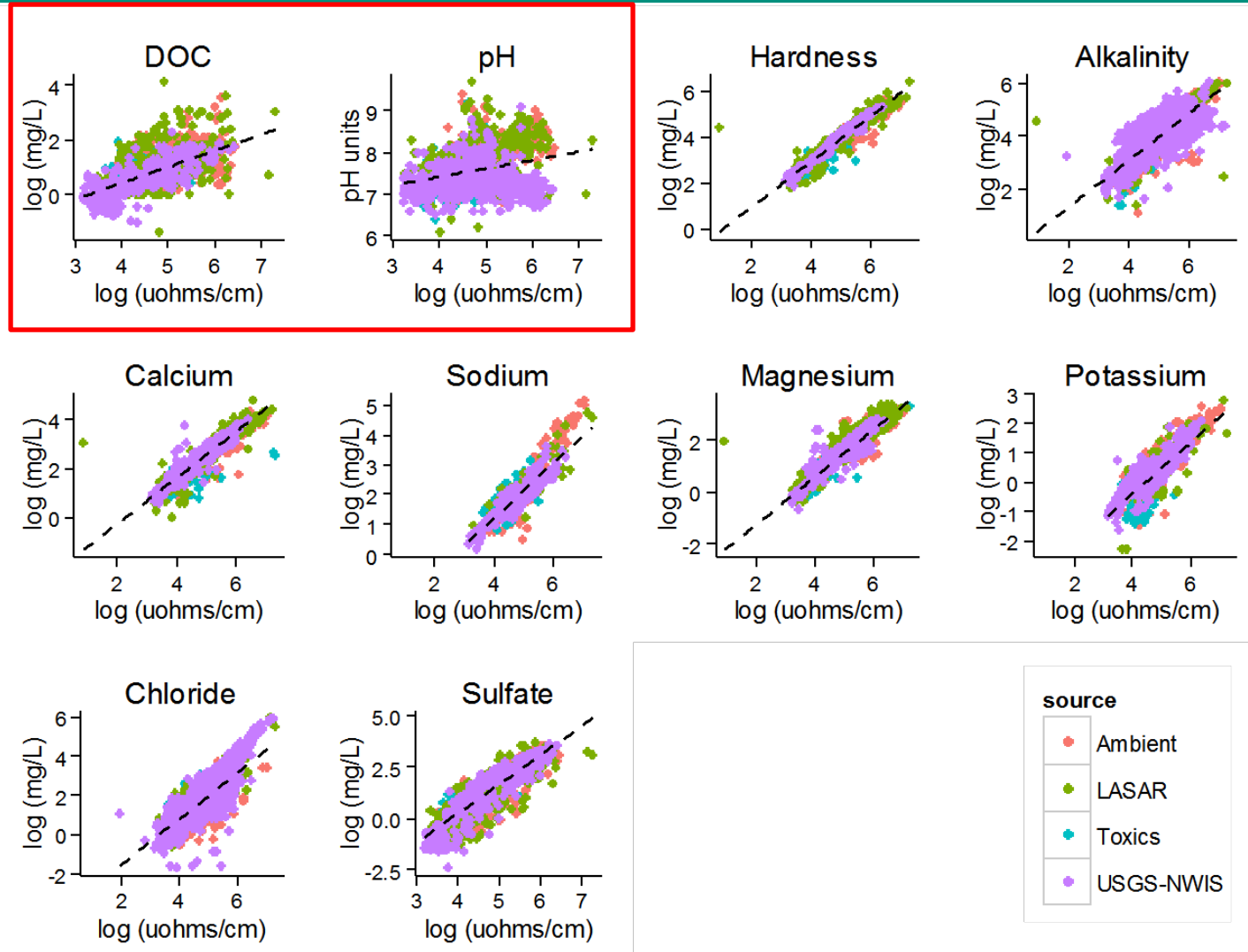
# Estimation Procedures when input data is not available

- DEQ must be able to derive BLM criteria results for any time and location
- Where measured input data is not available, use an estimate or default value
- Criteria from measured data supersede criteria from defaults



<https://www.oregon.gov/deq/wq/Documents/11161itemG.pdf>

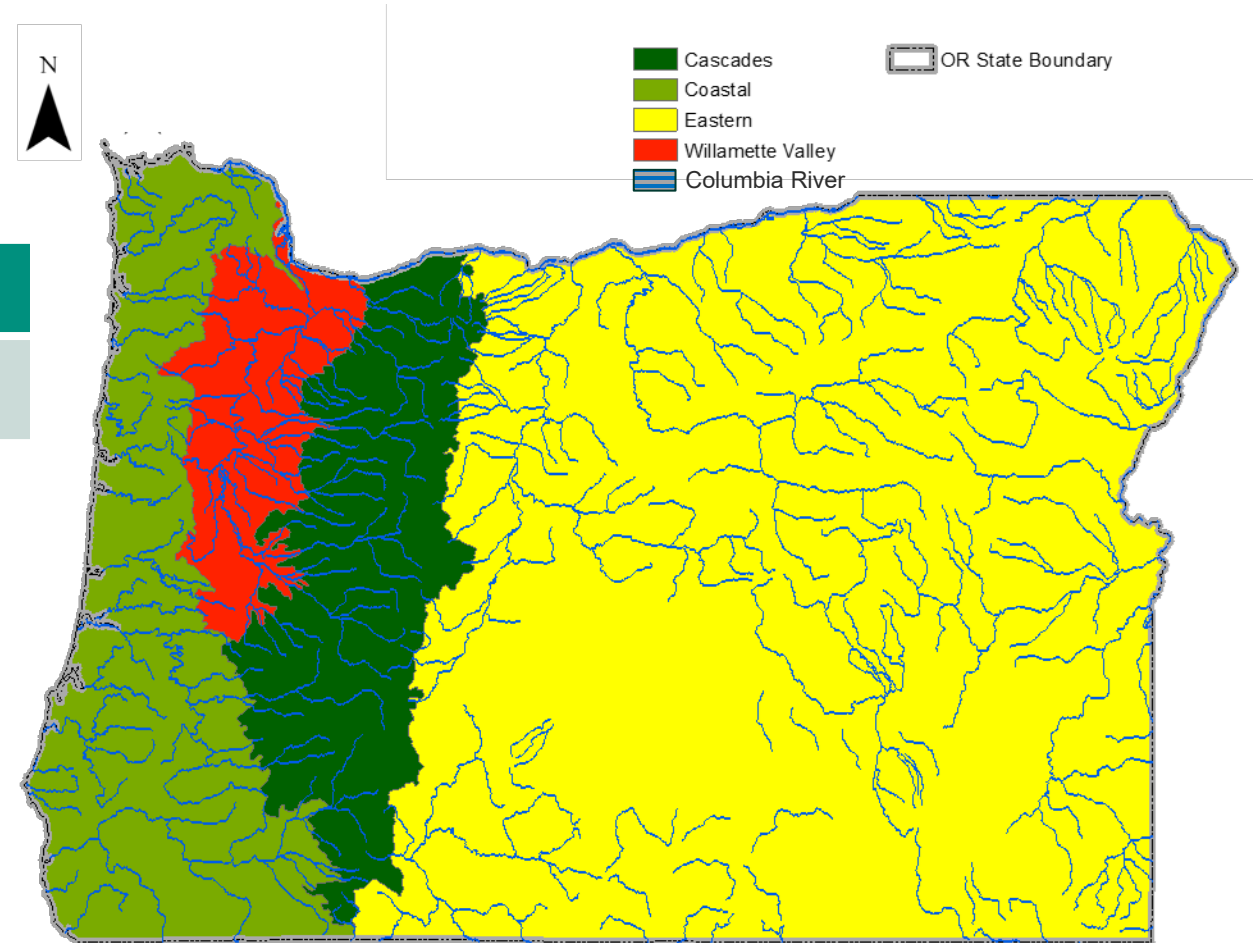
# Estimating parameters: conductivity



# Conservative Defaults: Organic Carbon

PARAMETERS	Cascades	Coastal	Columbia River	Eastern	Willamette Valley
DOC (mg/L)	0.51	0.83	1.41	1.35	1.25

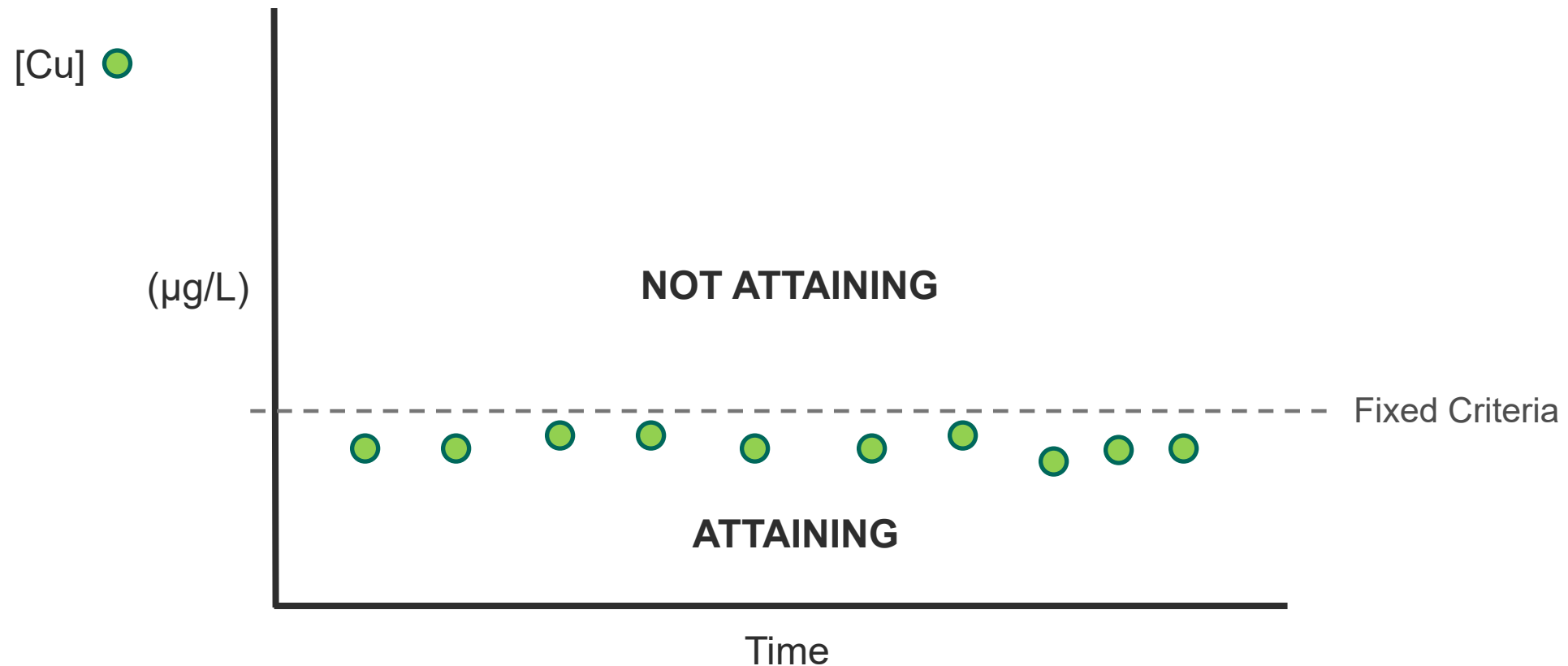
- Protective percentiles: 15-20<sup>th</sup> %
- Based on water chemistry variability
- Similar default values for major ions



# Implementation Concepts: Assessment

## Ex: Traditional Fixed Numeric Criteria

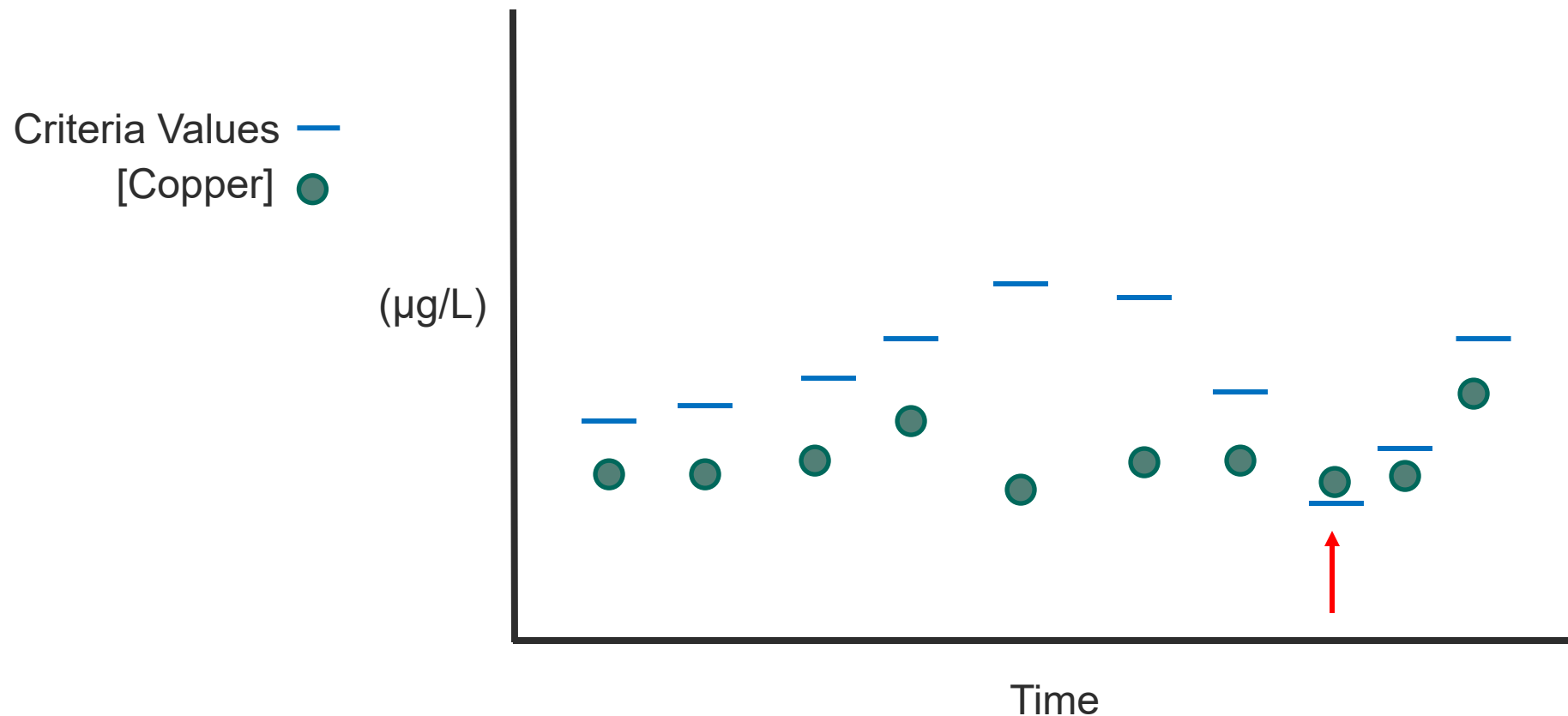
- Requires sufficient data to characterize variability in the *pollutant*



# Implementation Concepts: Assessment

## Copper-BLM Criteria

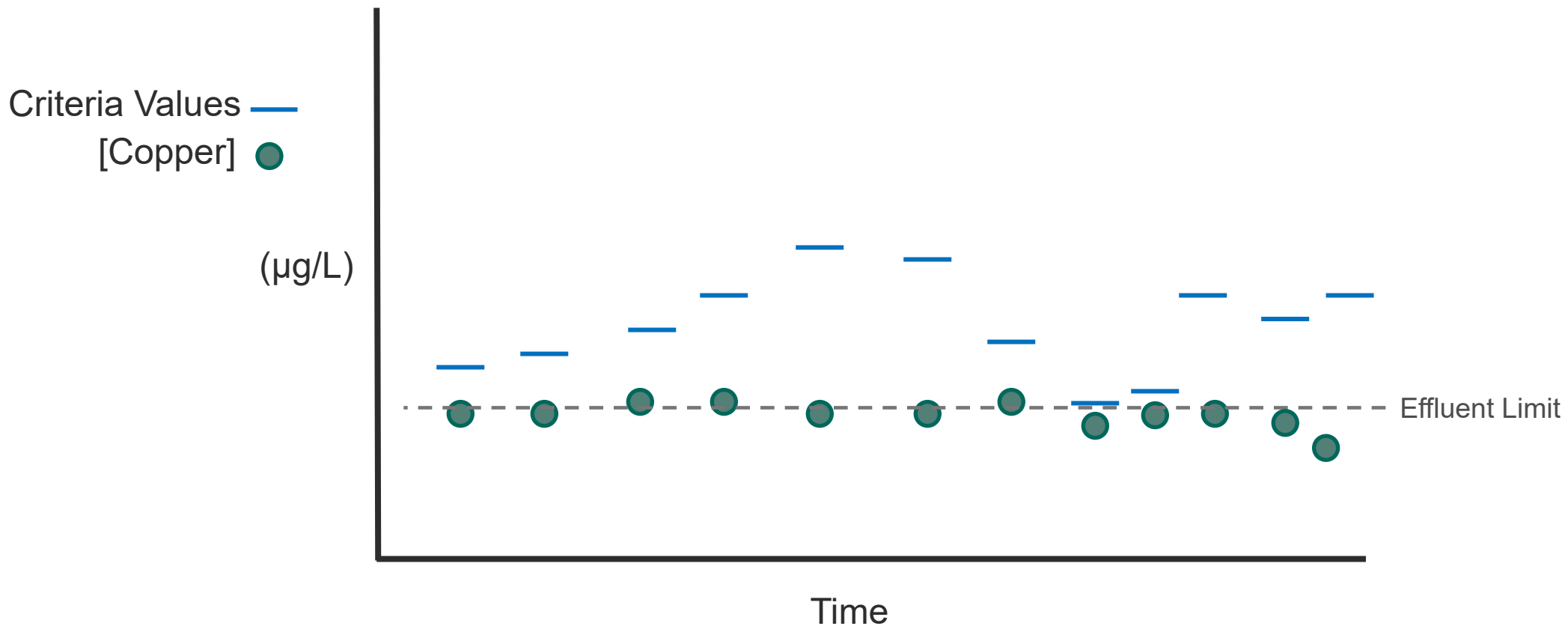
- Requires sufficient data to characterize variability in the *pollutant* and the *criteria*





# Implementation Concepts: NPDES Permits

- Requires sufficient data to characterize variability in the *pollutant* and the *criteria* in both the effluent and receiving water.



# Lessons Learned

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- Robust monitoring is essential
- Availability of parameter data can be limiting
  - Standards Development
  - Implementation
- Develop reasonable parameter estimation techniques when possible/necessary
- Ensure protective over time
  - identify and protect the most critical water chemistry conditions

# Questions?



Metolius River, Oregon

Oregon's Website: <https://www.oregon.gov/deq/wq/Pages/WQ-Standards-Copper.aspx>

Biotic Ligand Model Resources: <https://www.epa.gov/wqs-tech/copper-biotic-ligand-model>  
<https://www.windwardenv.com/biotic-ligand-model/>

Contact: James McConaghie, WQS Program Coordinator [james.mcconaghie@deq.oregon.gov](mailto:james.mcconaghie@deq.oregon.gov)

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# Copper-BLM Parameter Sensitivity Analysis

