

Environmental Solutions, Water Quality Standards and Assessment Section

Approaches in Monitoring and Assessment for Statewide Adoption of the Biotic Ligand Model to Derive Aquatic Life Criteria for Copper in Oregon

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May 6, 2016

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Background: Oregon's Adoption of the Biotic Ligand Model

Endangered Species Act Consultation (Salmonids)

- 8-year process on Cu & other toxic pollutants

Aug. 2012: National Marine Fisheries Service Jeopardy Decision

- Indicated that Oregon's copper criteria would cause harm to T&E species

Jan. 2013: EPA Dissapproval of Oregon's WQ Standard:

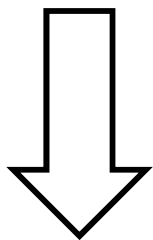
- Hardness-dependent copper criterion is potentially under-protective depending on site-specific water chemistry
- Remedy: Adopt the Biotic Ligand Model

Expected adoption Jan. 2017

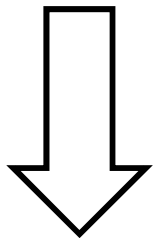
Biotic Ligand Model Overview

Water Chemistry

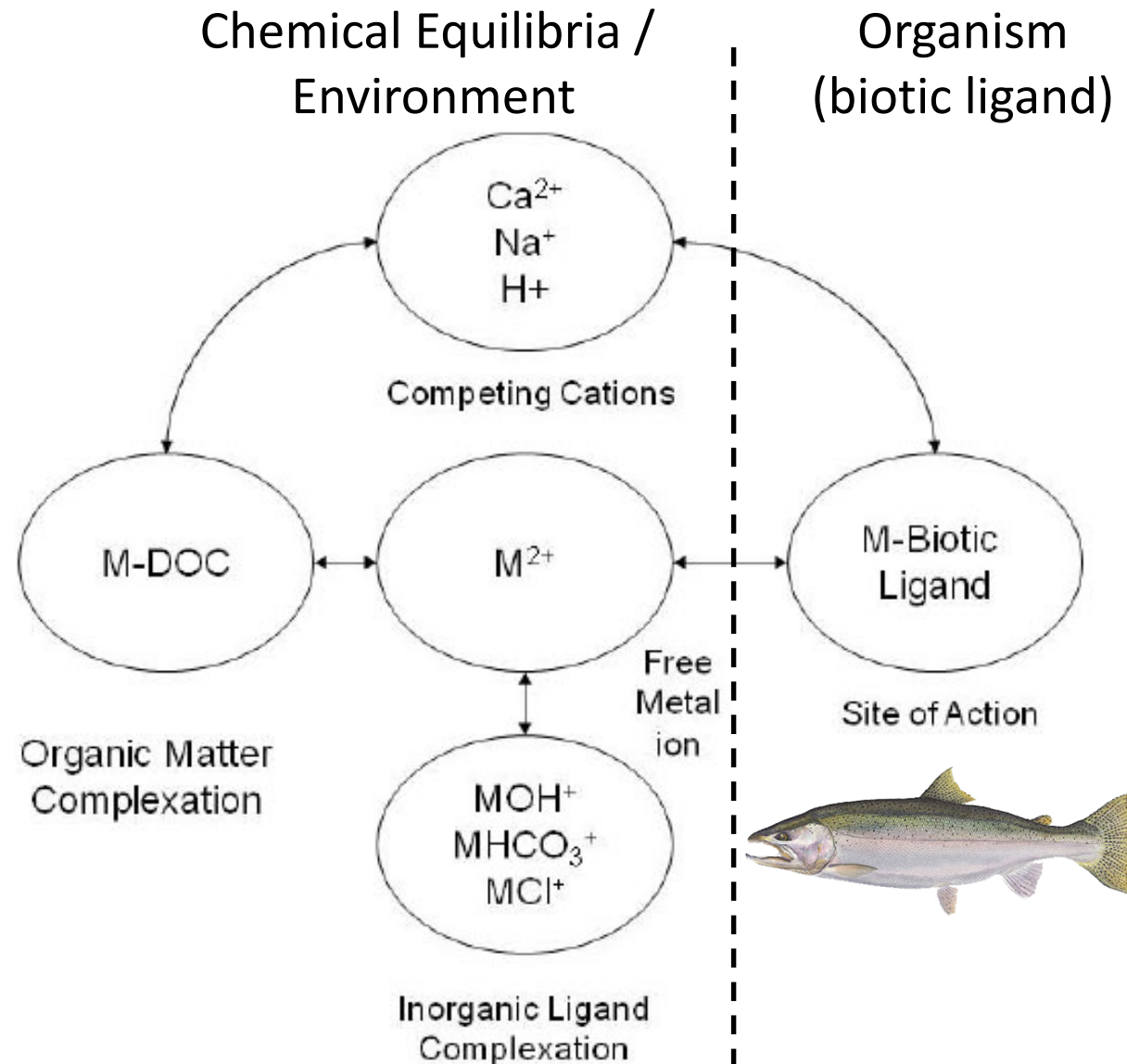
- **C**omplexation of Cu
- **C**oncentration of free Cu
- **C**ompetition of Cu with ions



Bioavailability



Organism Toxicity



adapted from Di Toro et al., 2001

Biotic Ligand Model Overview

EPA 2007 Revision - Aquatic Life Ambient Freshwater Quality Criteria – Copper

10 Required Input Parameters:

- DOC
 - pH
 - Temperature
 - Calcium
 - Magnesium
 - Sodium
 - Potassium
 - Sulfate
 - Chloride
 - Alkalinity
- Most Sensitive**

Results in

Instantaneous Water Quality Criterion (IWQC)

- Applicable to a given set of input parameters
- Acute Criterion (CMC)
 - 4hr average exposure
- Chronic Criterion (CCC)
 - 7 day average exposure

3 Optional / Alternative:

- Dissolved Inorganic Carbon
- Humic Acid
- Sulfide

Biotic Ligand Model Overview

Model results (IWQC) are:

- Water-chemistry dependent.
 - Don't know what the criterion is until you calculate it.
- Variable in time and space.
 - Specific to conditions at time and location of sampling
 - What comprises a toxic copper concentration varies with water chemistry

Implementation Challenges:

- How do you get adequate parameter data to calculate the criteria?
 - expanded monitoring
 - estimates/surrogates for parameters
- How do you implement a variable criteria?
 - Integrated Report assessment
 - NPDES permits

DEQ Biotic Ligand Model Parameter Monitoring

Monitoring objectives:

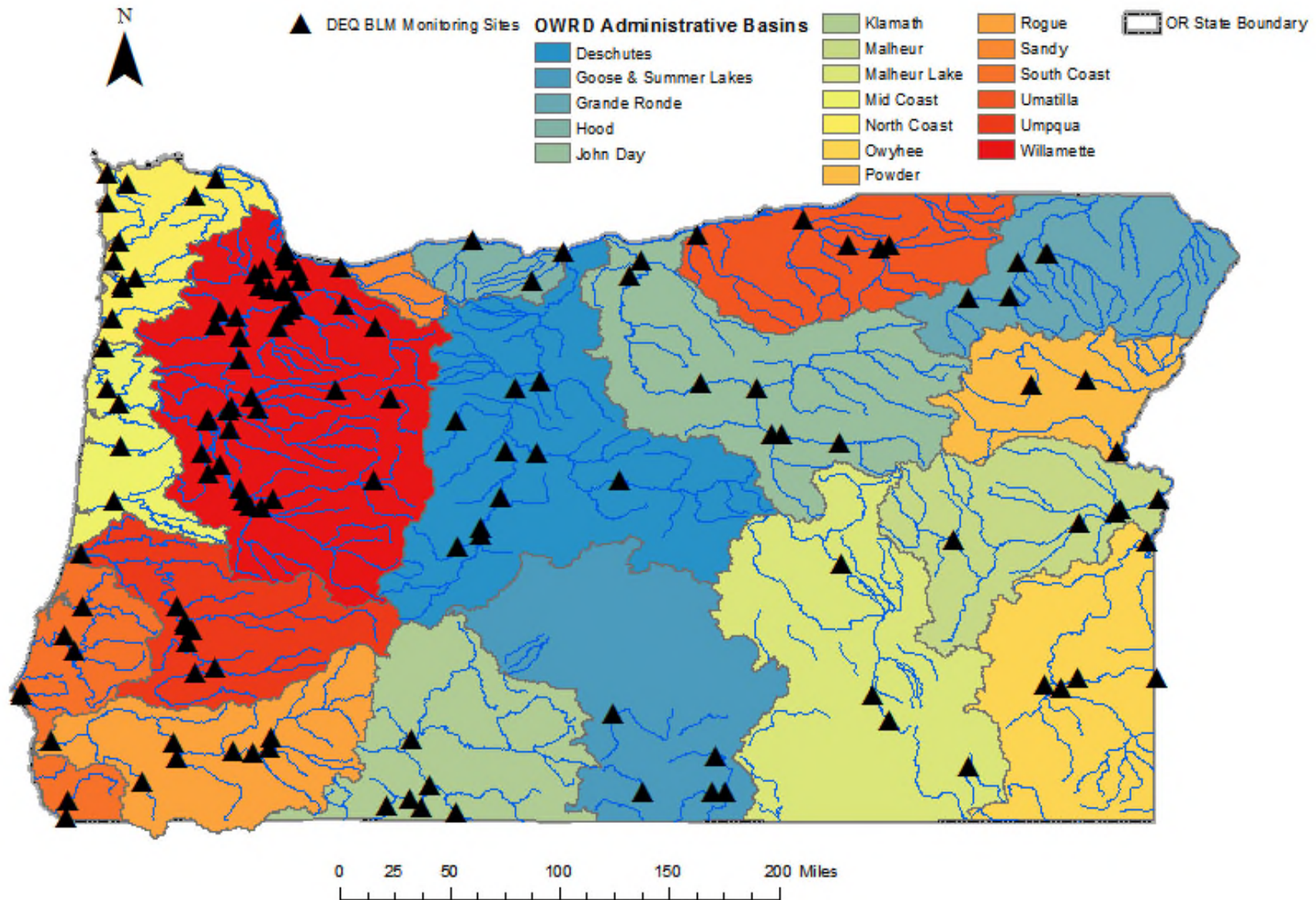
- Augment sites where parameter data not already available:
 - NWIS / STORET
 - DEQ databases
- Support evaluation of biotic ligand model
- Near NPDES discharger sites
- Sites with existing Cu samples
- Further ambient monitoring may be required as a condition of new NPDES permits

DEQ Biotic Ligand Model Parameter Monitoring

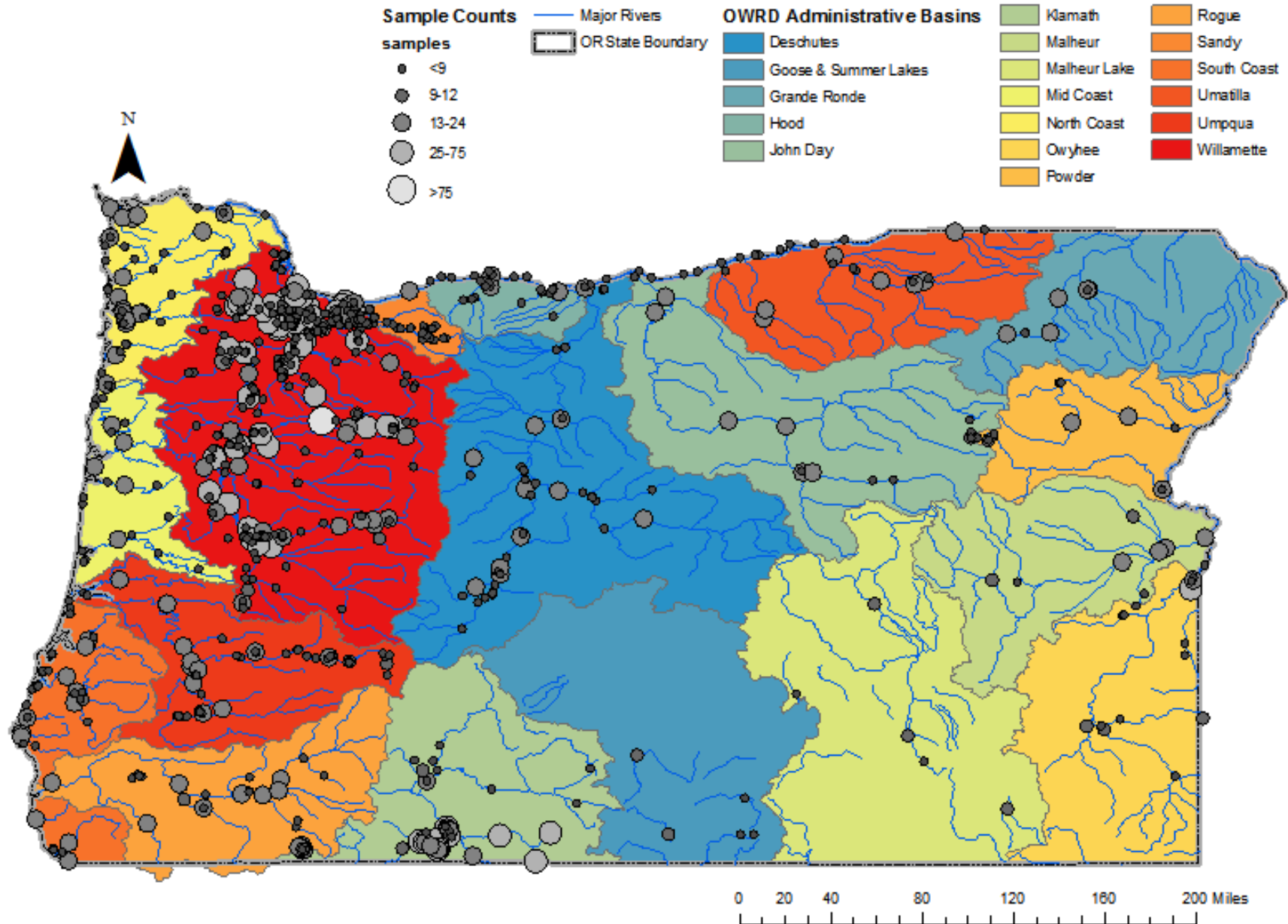
Expanded parameter monitoring:

- Initiated 2014-present
- No dedicated funds for biotic ligand model parameter monitoring
- Utilized existing DEQ monitoring sites
 - ambient and toxics network
 - typically representative of conditions lower in the watershed
- Sampling at 138 sites across OR
 - 4 month intervals
 - collected both total and dissolved BLM parameters

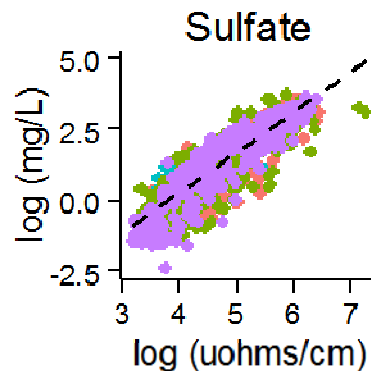
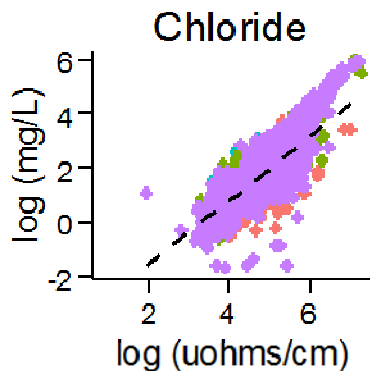
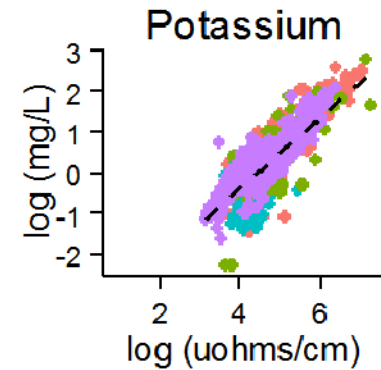
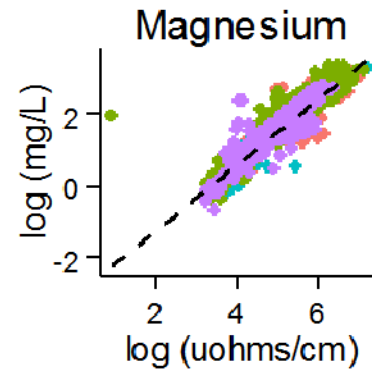
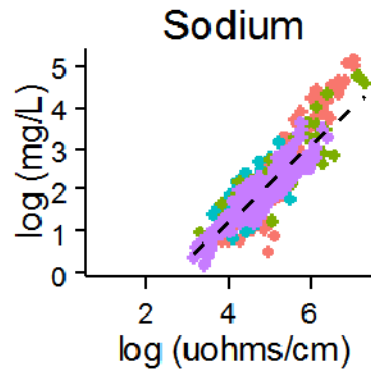
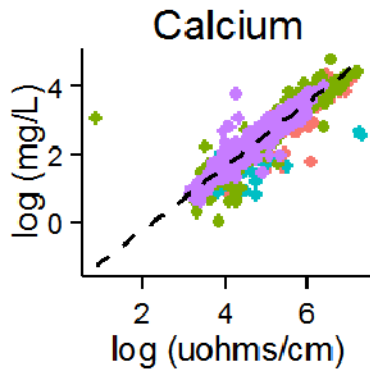
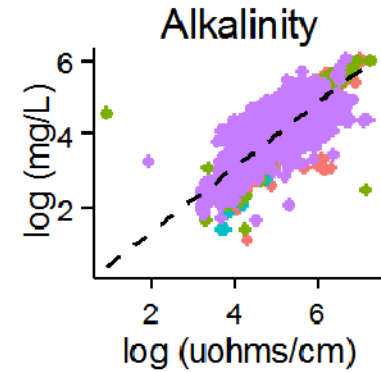
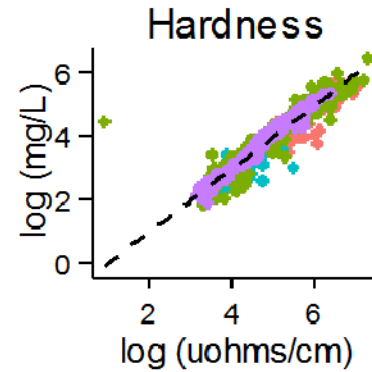
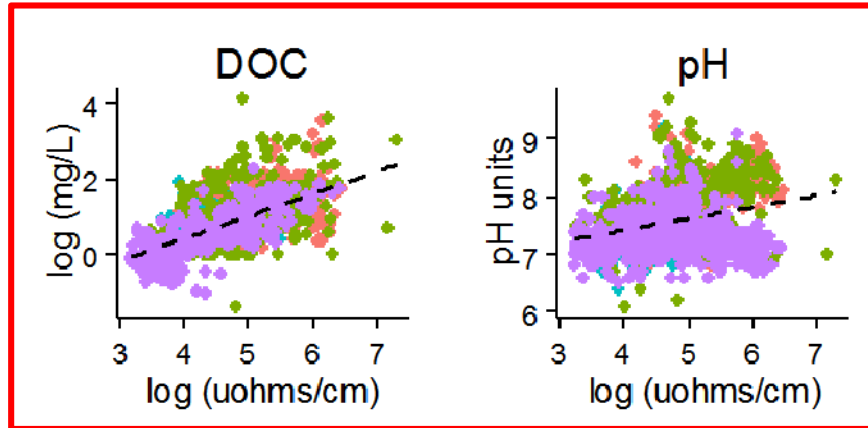
DEQ Biotic Ligand Model Parameter Monitoring



How many parameter sets are available?



Surrogate parameters: Conductivity

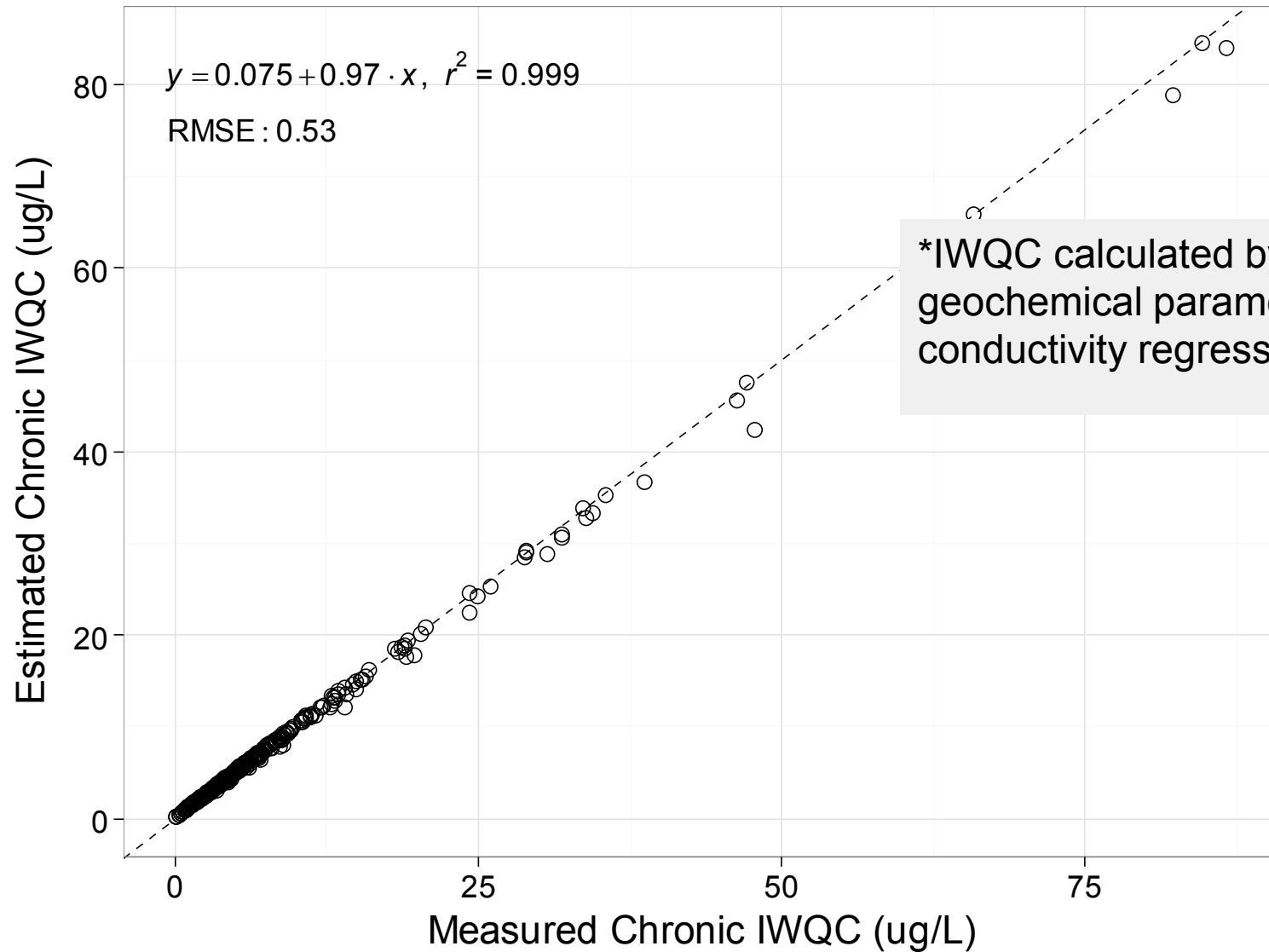


source

- Ambient
- LASAR
- Toxics
- USGS-NWIS

Estimating parameters: Conductivity

Criteria resulting from substitution of conductivity
for measured ions



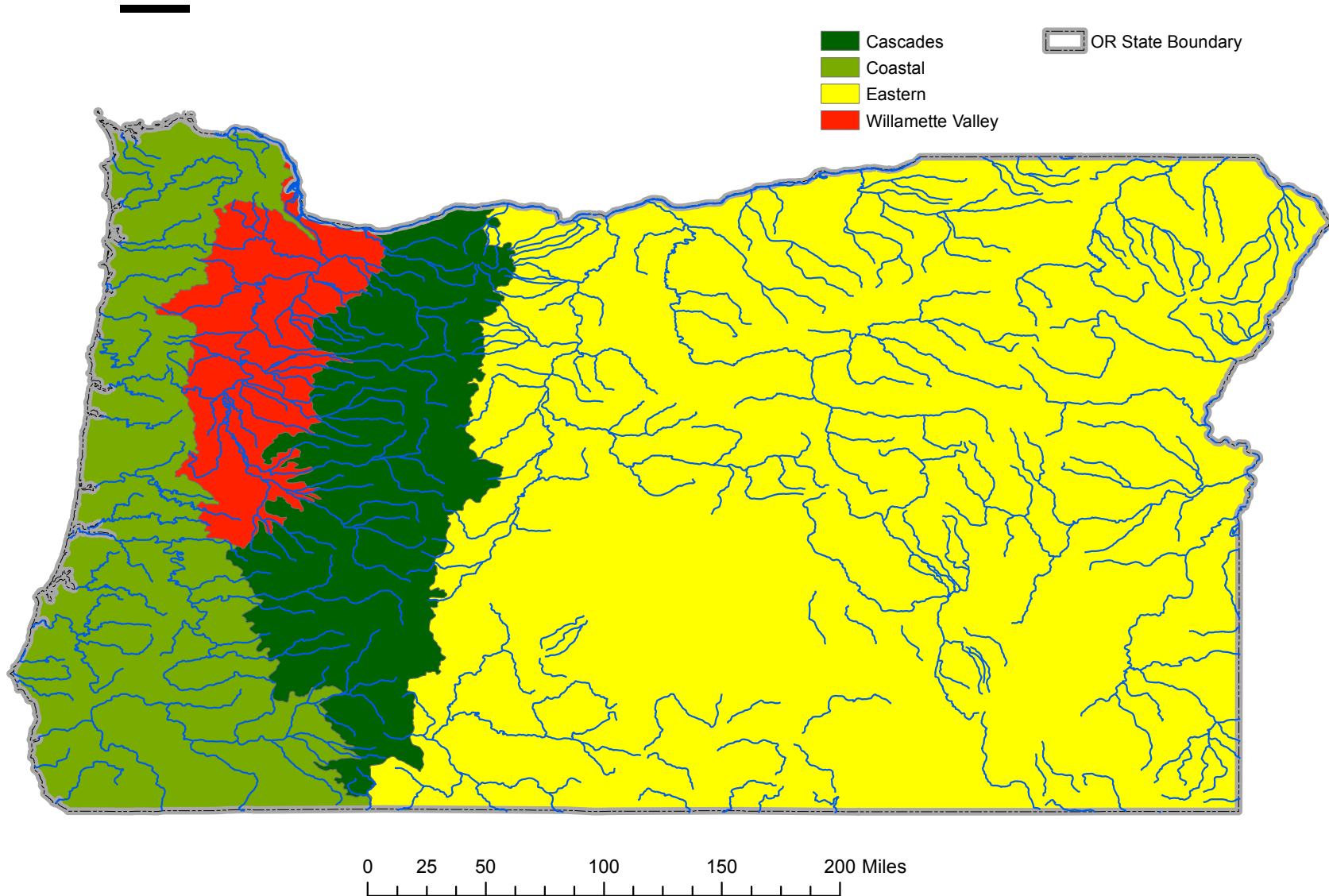
*IWQC calculated by estimating geochemical parameters from a conductivity regression are accurate.

Currently available parameters

Samples for IWQC calculation (2000-2015) (have at least DOC & specific conductance)		
Parameter Sample Sets	4,722	%
missing pH	59	1%

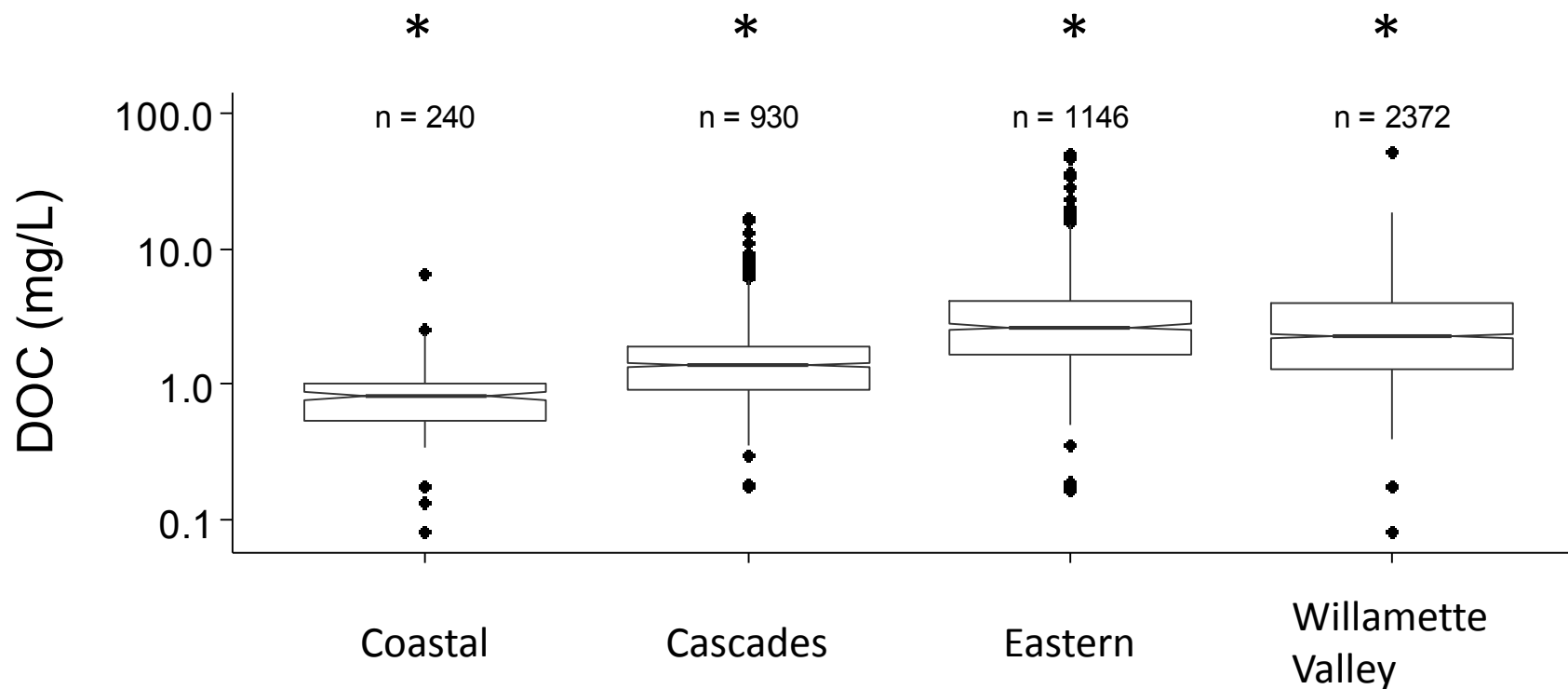
Copper samples to be assessed (2000-2015)		
Cu Samples	4,402	%
missing DOC	2427	58%
missing pH	354	8%

Regions with similar water chemistry characteristics



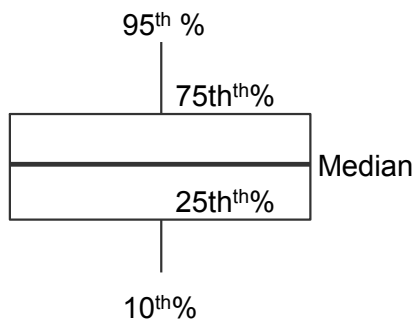
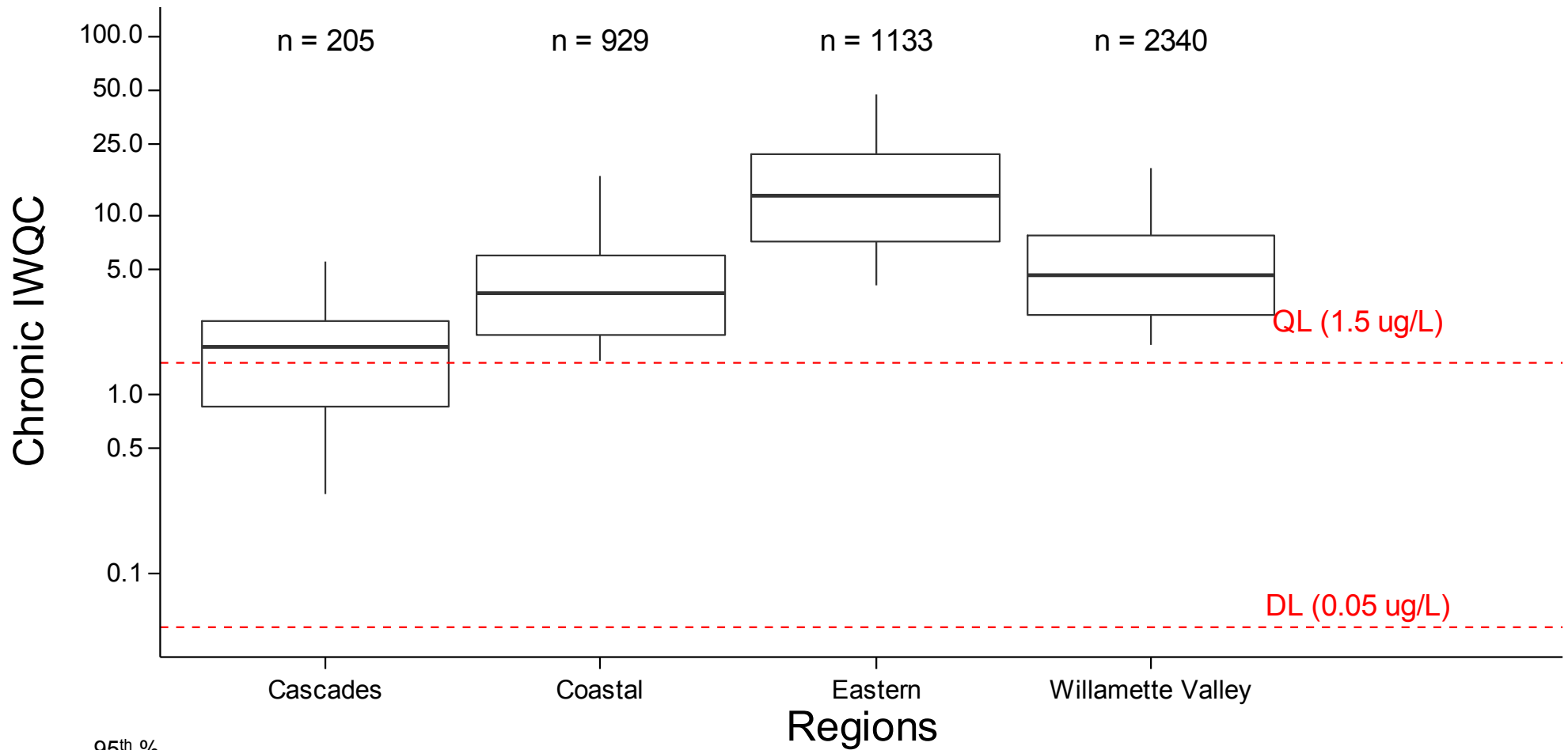
DOC distribution within regions

* non-parametric ANOVA on ranks, $p < 0.001$



*Distribution of DOC is statistically different in each region

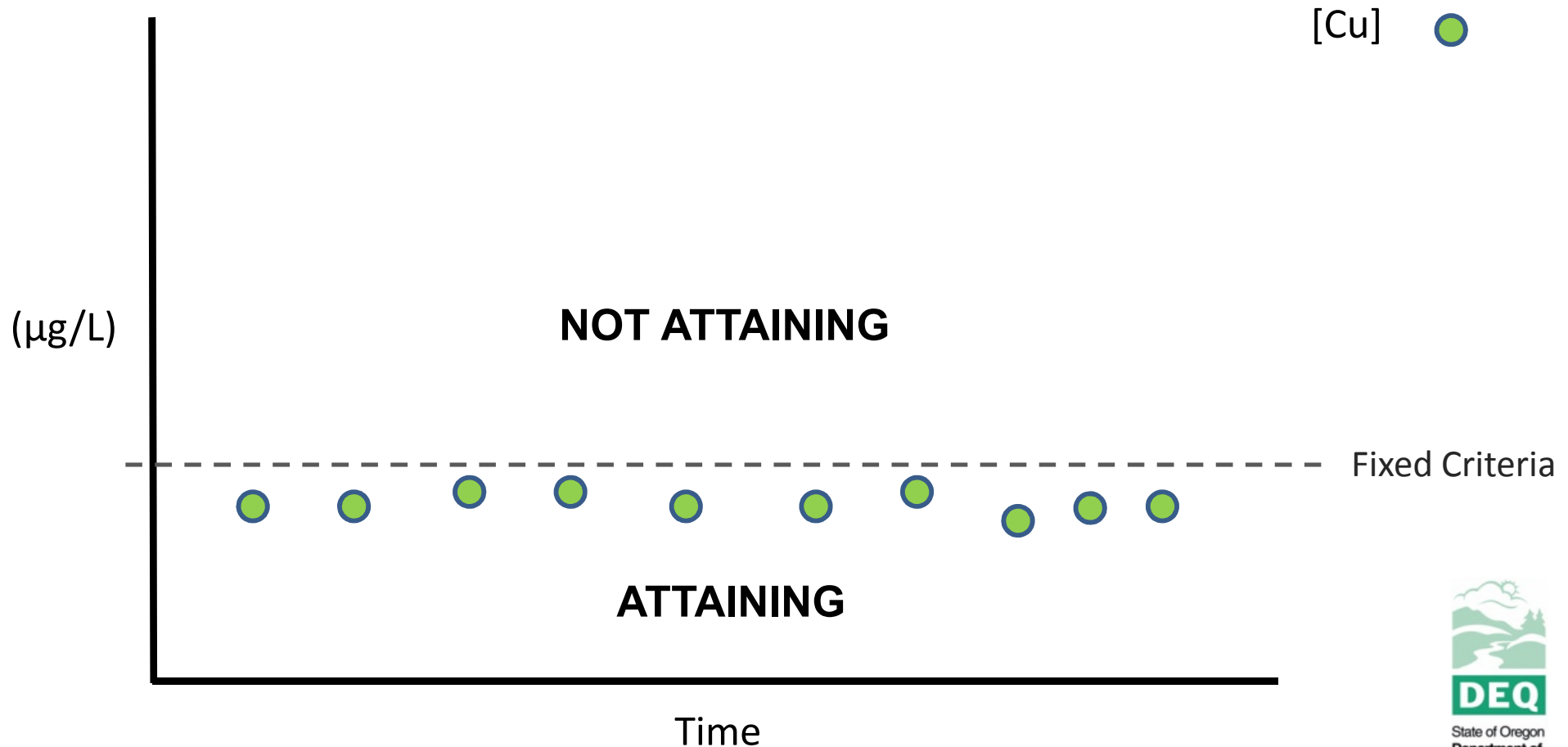
Preliminary IWQC results



Implementation Concepts: Assessment

Eg. Fixed Numeric Criteria

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

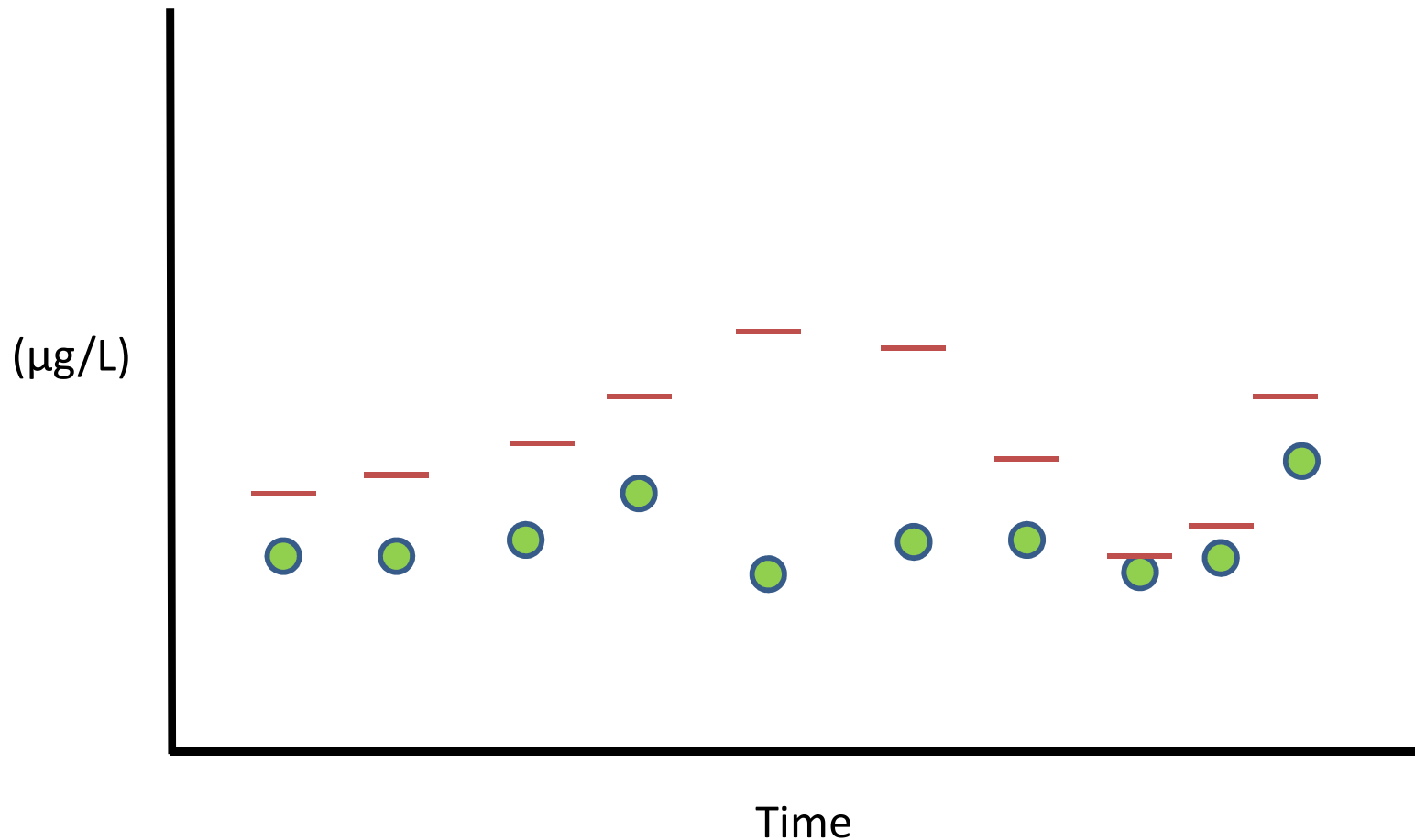


Implementation Concepts: Assessment

Instantaneous Criteria

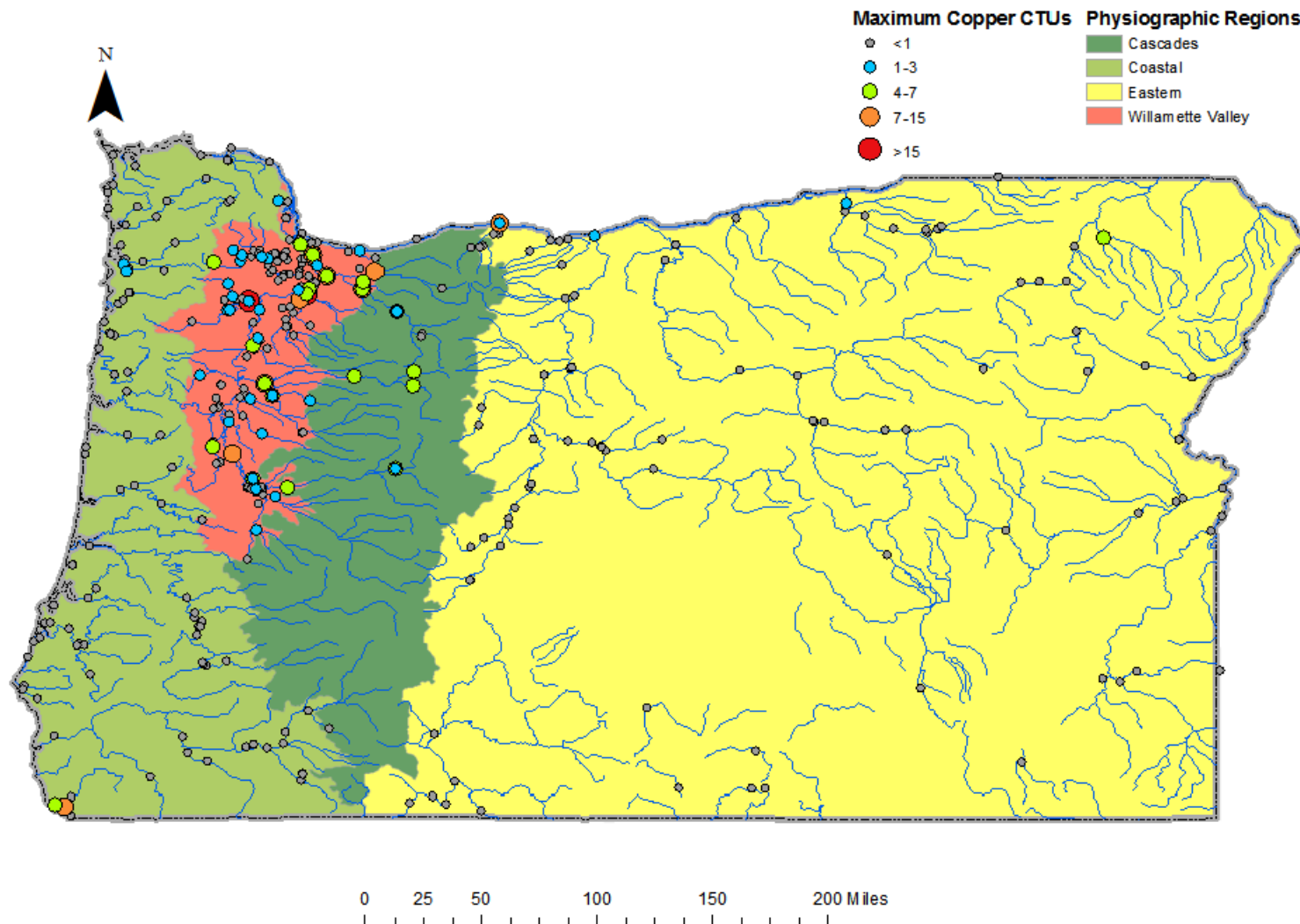
- Requires sufficient data to characterize variability :
 - in the pollutant
 - & the *protective criteria*

IWQC —
[Cu] ●



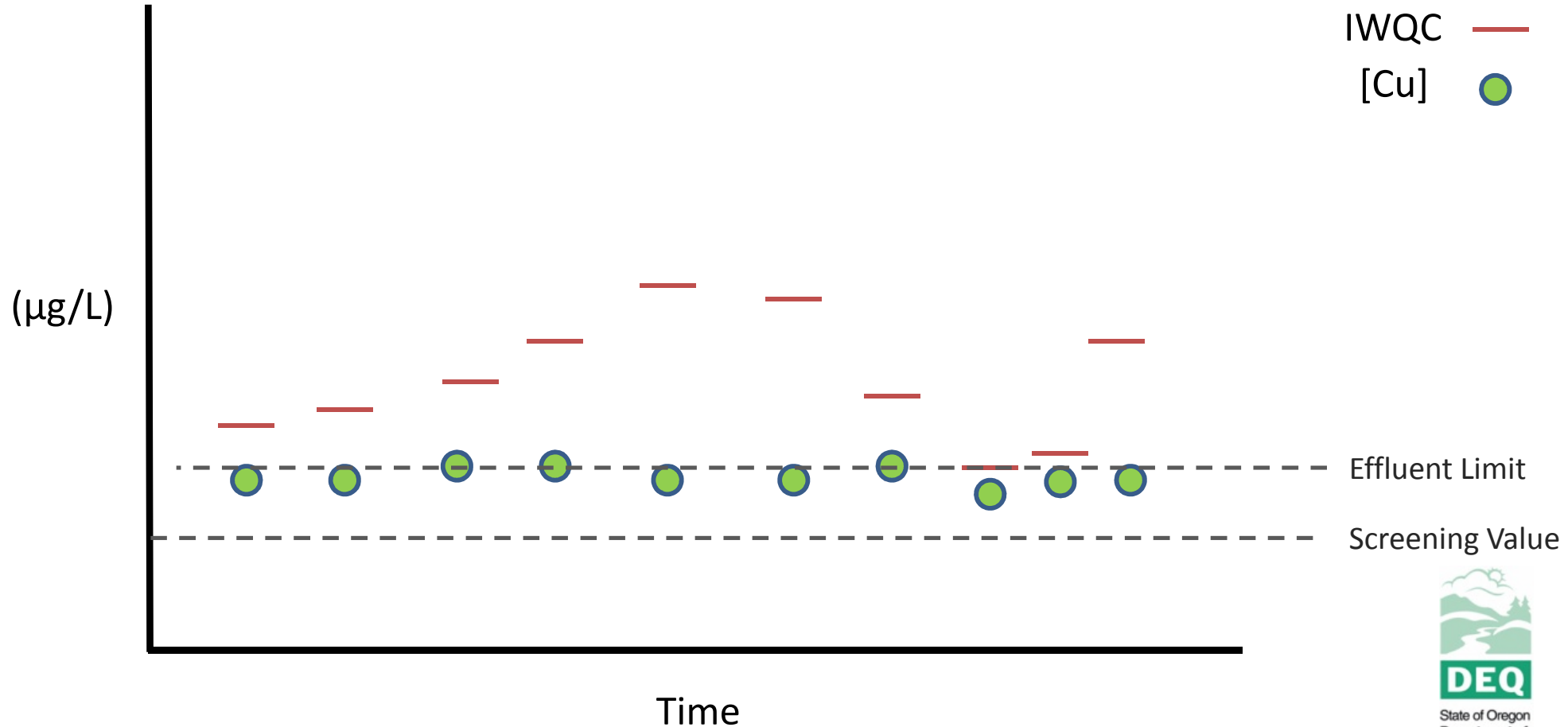
Preliminary IWQC results

- Copper concentrations exceed instantaneous chronic criteria (CCC) at a rate of ~9% statewide.



Implementation Concepts: NPDES Permits

1. Asses reasonable potential to exceed the standard
 - apply a conservative screening value
 - paired effluent and ambient parameters
2. Assign an effluent limit that will ensure copper concentration will not exceed critical instantaneous criteria over time



Conclusions

- Monitoring and Data Management
 - Availability of parameter data is limiting
 - monitoring of ambient data
 - require ambient collection by NPDES permittees
 - pollutant *plus* the parameters to evaluate it
 - Make use of reasonable parameter estimation techniques when necessary
 - specific conductance as a surrogate for geochemical parameters
 - conservative estimates of key parameters, i.e. DOC
 - which defines the protective criterion?

Conclusions

- Policy Implementation

- Assess attainment against the biotic ligand model results as the standard
 - Requires sufficient data to assess the pollutant AND determine the applicable criteria
- Establish effluent limits that ensure attainment of standard over time
 - account not only for variation in pollutant, but also variation in protective criteria
 - begin by identifying and protecting the most vulnerable conditions

Acknowledgements

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Oregon DEQ Standards and Assessments

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- Andrea Matzke

