Water Quality Standards and Assessment

Water-chemistry based criteria: copper as a case study

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What are water chemistry-based criteria?

The “calculated” criteria:

- Hardness-based metals
- Ammonia
- Copper-BLM
- Aluminum-MLR

Equations or look-up tables

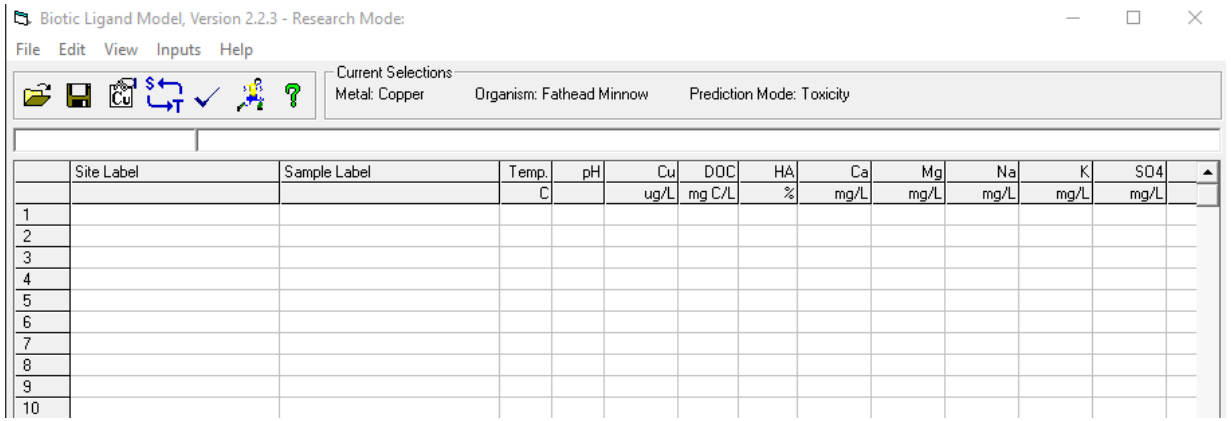
Table 30(a): Ammonia Acute Criteria Values (One-hour Average)—Salmonid Species Present Temperature and pH-Dependent and expressed as Total Ammonia Nitrogen (mg/L TAN)

Criteria cannot be exceeded more than once every three years

$$Acute\ Criterion = MIN\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times 10^{0.036\times(20-T)}\right)\right)\right)$$

	Temperature (°C)																
pH	0-14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
6.5	33	33	32	29	27	25	23	21	19	18	16	15	14	13	12	11	9.9
6.6	31	31	30	28	26	24	22	20	18	17	16	14	13	12	11	10	9.5
6.7	30	30	29	27	24	22	21	19	18	16	15	14	13	12	11	9.8	9.0
6.8	28	28	27	25	23	21	20	18	17	15	14	13	12	11	10	9.2	8.5
6.9	26	26	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9
7.0	24	24	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	8.0	7.3

Calculators or models



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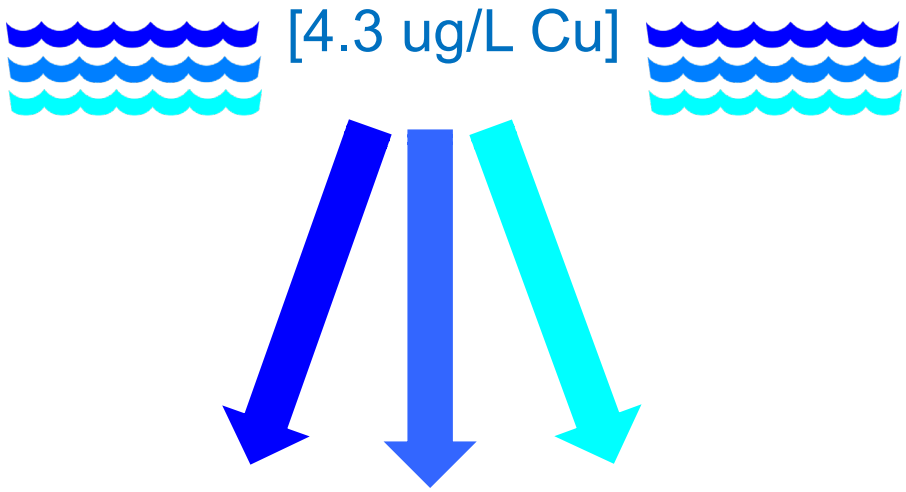
What are water chemistry-based criteria?

Varying WC parameters lead to different bioavailability, and therefore toxicity, even at the same pollutant concentration.



Multiple protective “instantaneous” WQ criteria

3.4 ug/L

15 ug/L

8.2 ug/L

4.6 ug/L

6.2 ug/L

2.1 ug/L

7.5 ug/L

10 ug/L

Copper biotic ligand model overview

Water Chemistry

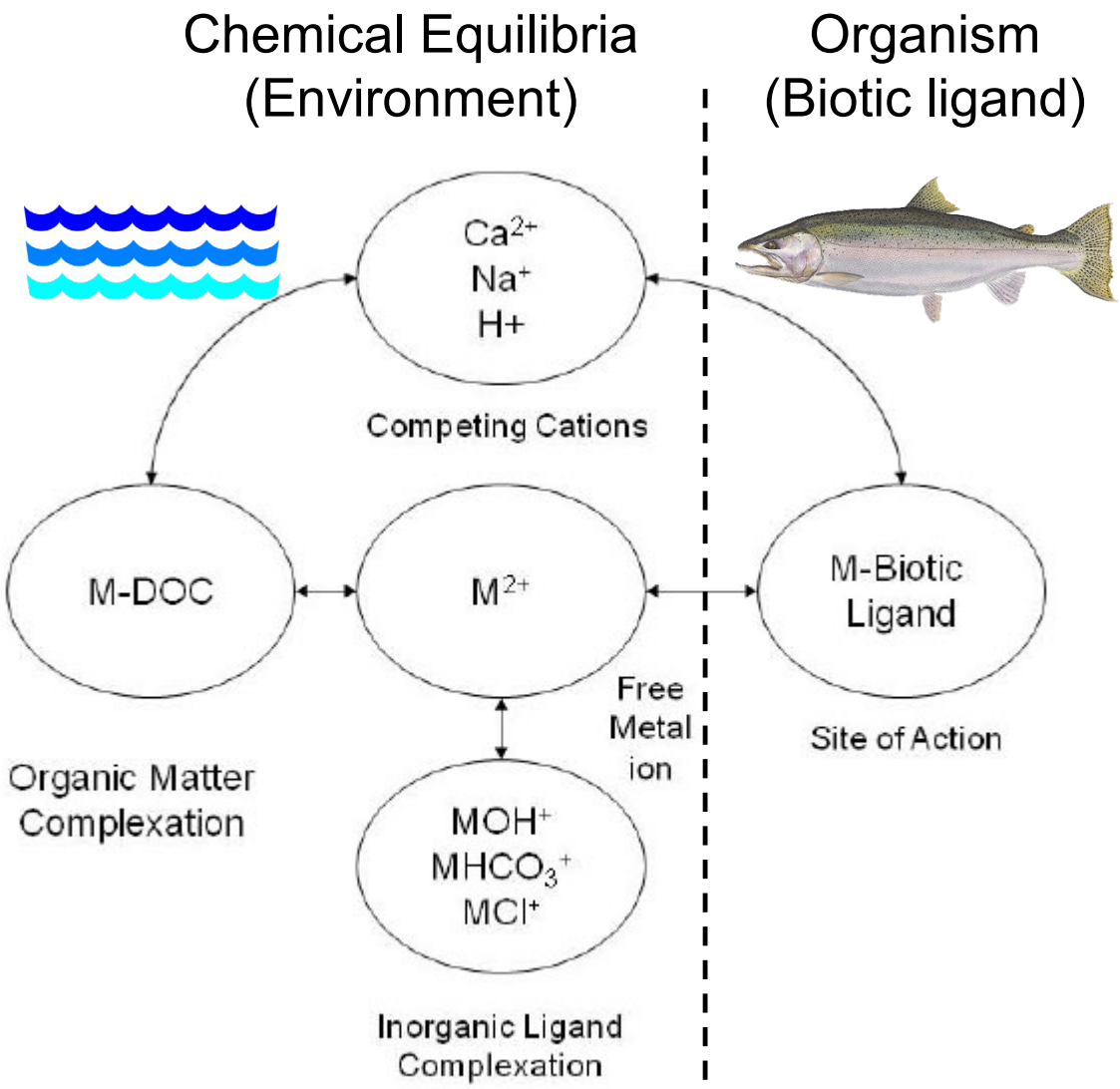
- **C**omplexation of Cu
- **C**oncentration of free Cu
- **C**ompetition of Cu with ions

⇩

Bioavailability

⇩

Organism Toxicity



adapted from Di Toro et al., 2001

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Cu-BLM water chemistry input parameters

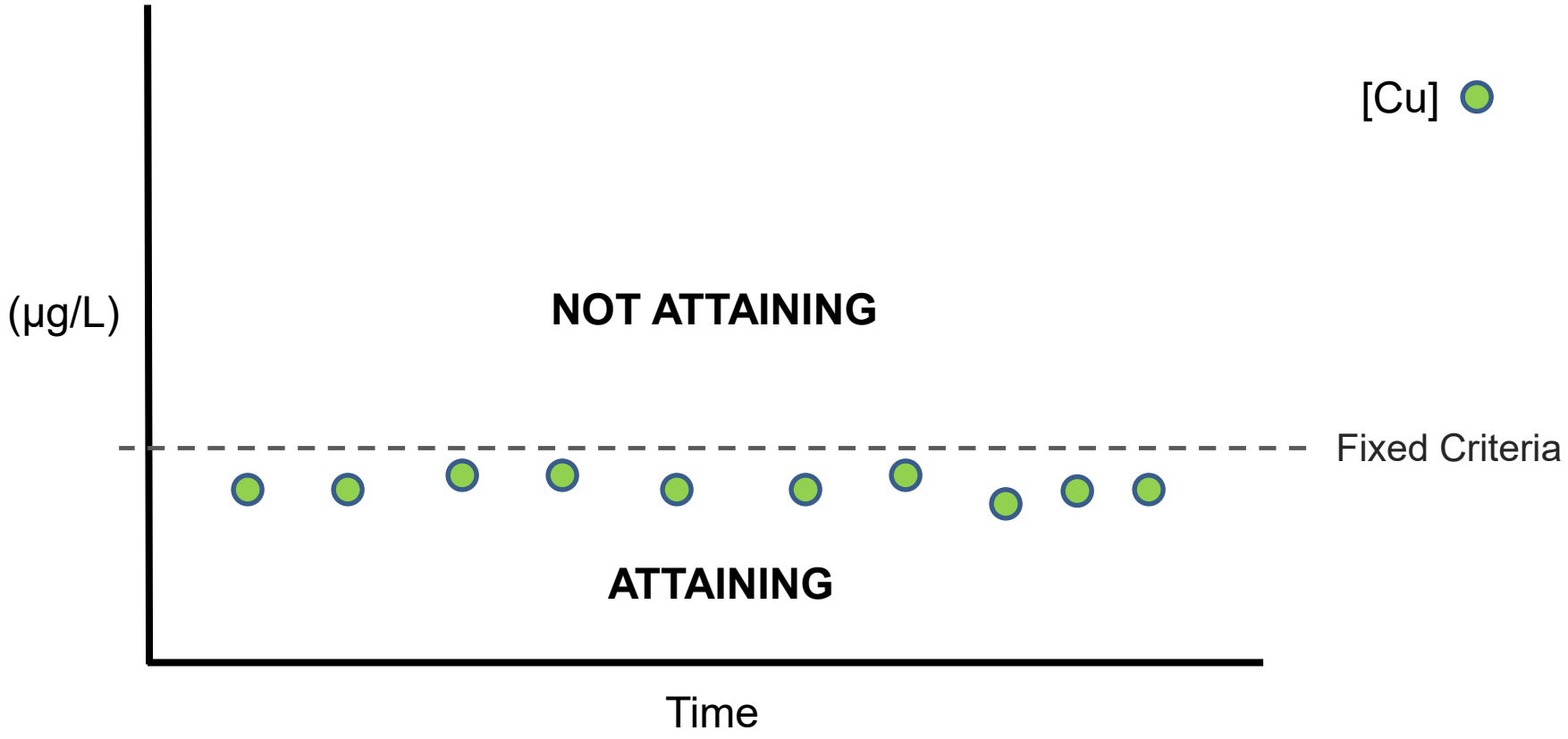
12 Water Chemistry Input Parameters
temperature
pH*
dissolved organic carbon (DOC)*
calcium (Ca)
magnesium (Mg)
sodium (Na)
potassium (K)
sulfate (SO4)
chloride (Cl)
alkalinity (or DIC if known)
humic acid fraction (assumed default value)
sulfide (assumed default value)

- Accuracy vs. complexity tradeoff
- Need input data to evaluate Cu toxicity
- Do not need Cu data to derive criteria

Implementation Concepts: traditional threshold criteria

e.g. Fixed Numeric Criteria

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



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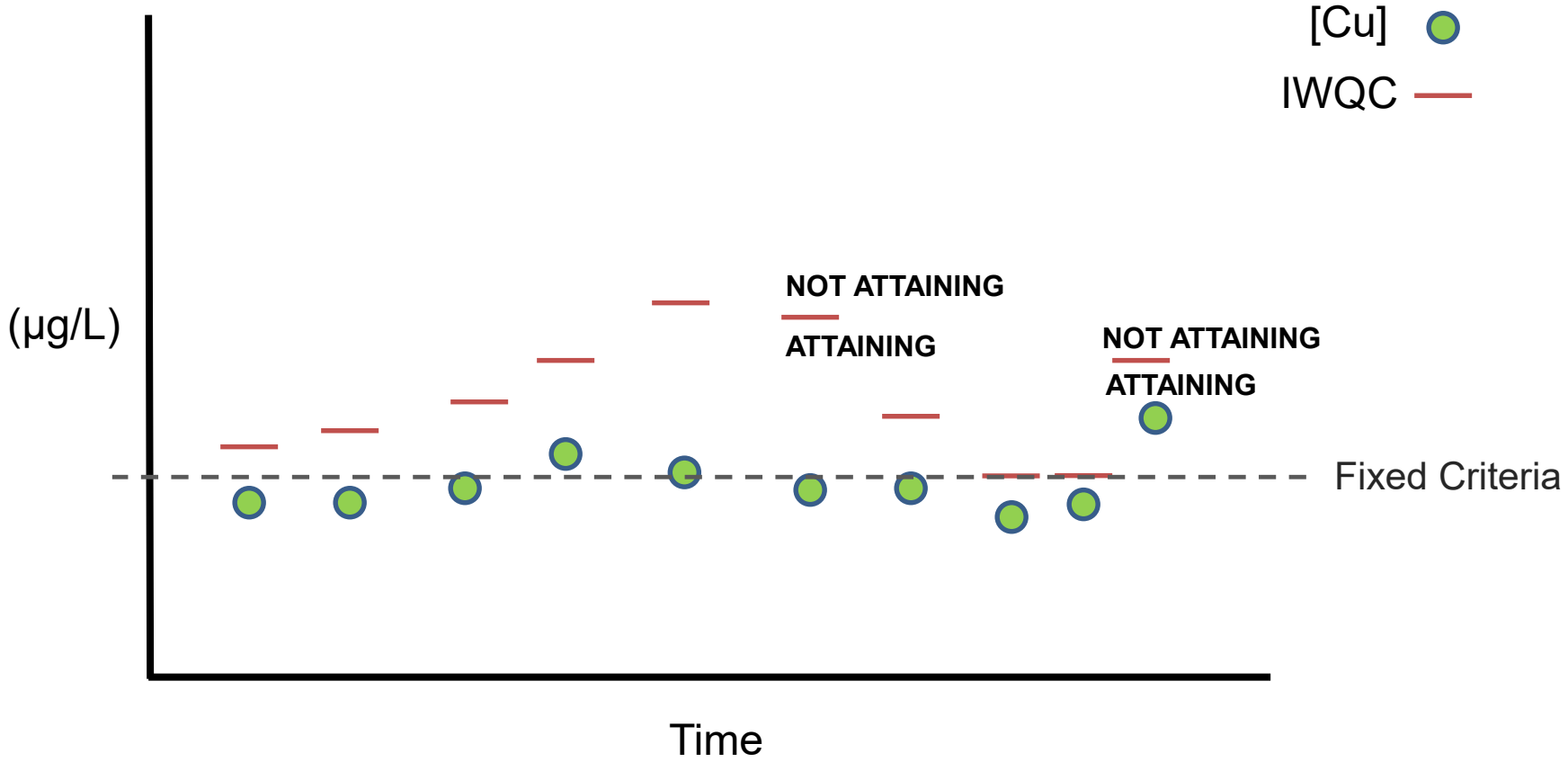
Implementation concepts: water chemistry-based criteria

e.g. Instantaneous WQ Criteria

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



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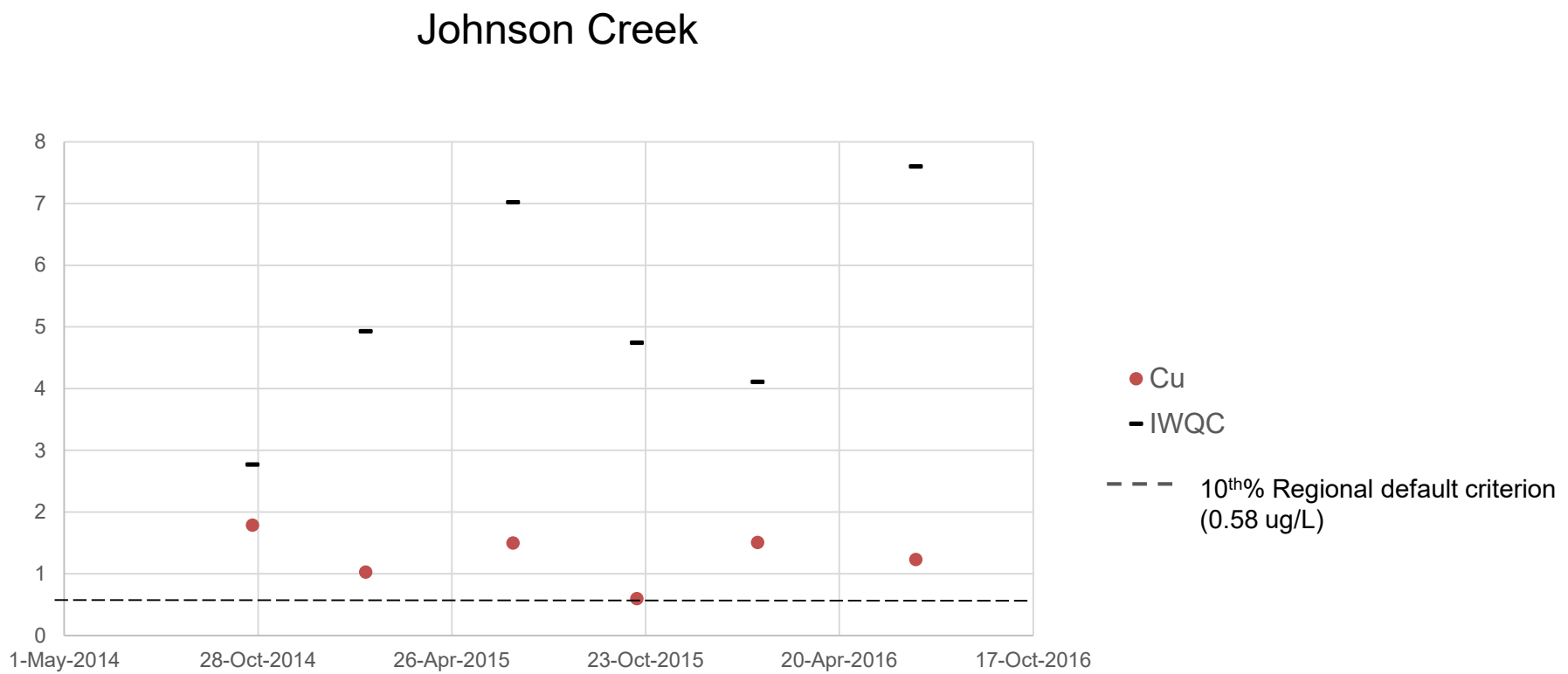
Assessment Example: Johnson Creek, OR



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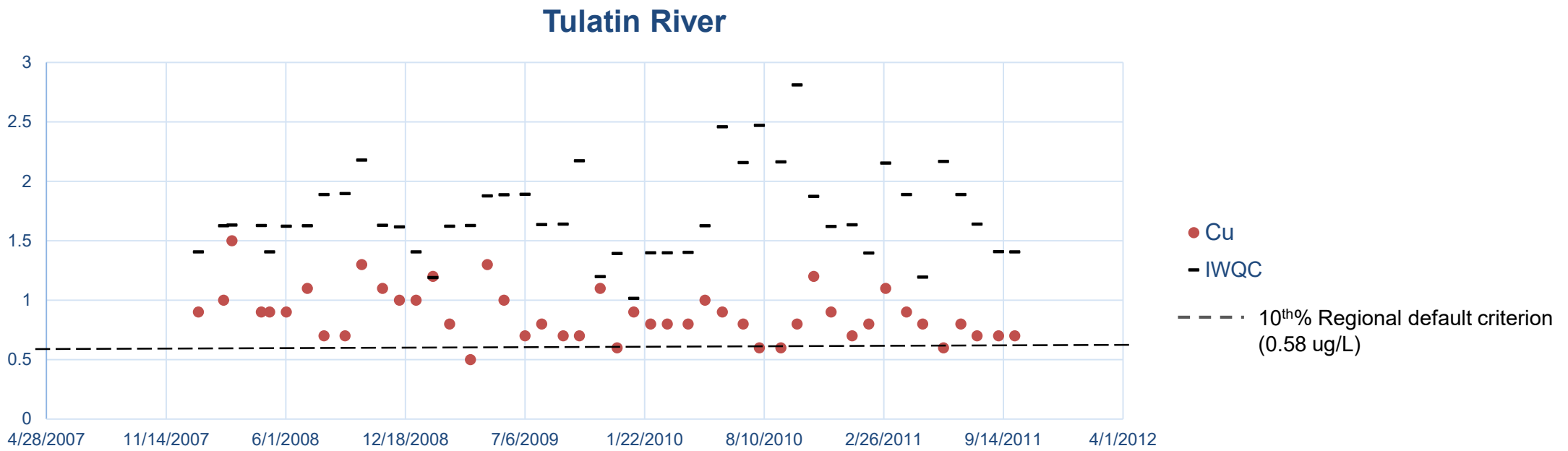
Assessment example: Tualatin River, OR



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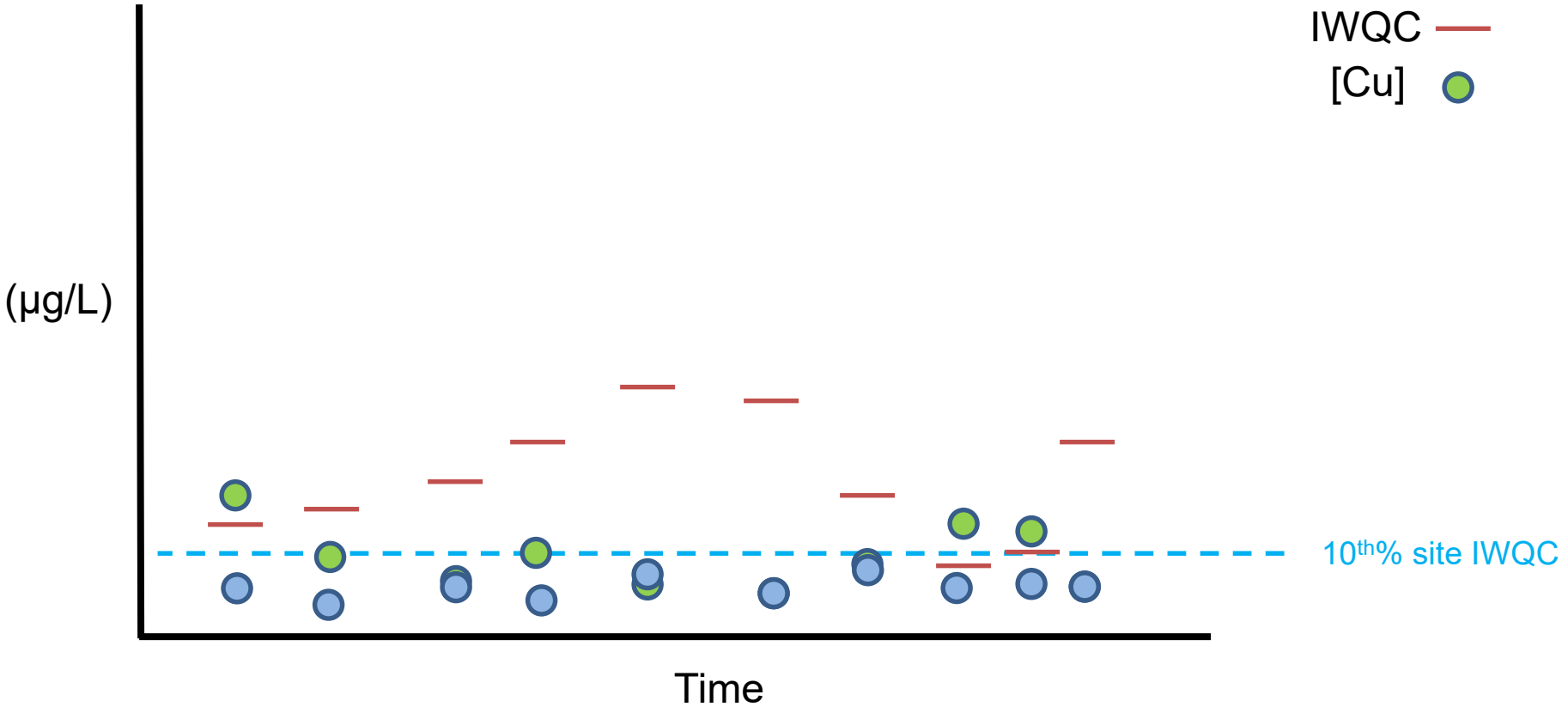
Implementation concepts: NPDES Permits

1. Ensure that the discharge meets the criteria during bioavailable conditions that occur at the site

2. DEQ uses at least 24 samples and the 10th percentile of site IWQC



Water chemistry-based criteria conclusions

- Availability of input parameter data limits ability to evaluate pollutant toxicity
  - ongoing ambient monitoring of inputs is required
- Assess attainment against the WC-based model results as the standard
  - sufficient data to characterize variability in the pollutant AND the applicable criteria
- Establish effluent limits that ensure attainment of standard over time
  - account for variation in pollutant, discharge, and protective criteria
  - identify and protecting the most vulnerable conditions
- Example processes for copper can be applied to other WC-based metals