Alternatives for Deriving Site-specific Water Quality Criteria for Effluent-dependent Waters in the Arid Western U.S.

AWRA
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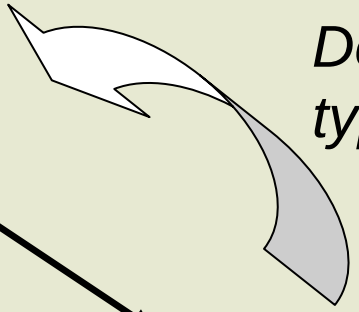
Water Quality Standards

Designated Uses

What are we trying to protect?



Default criteria typically applied

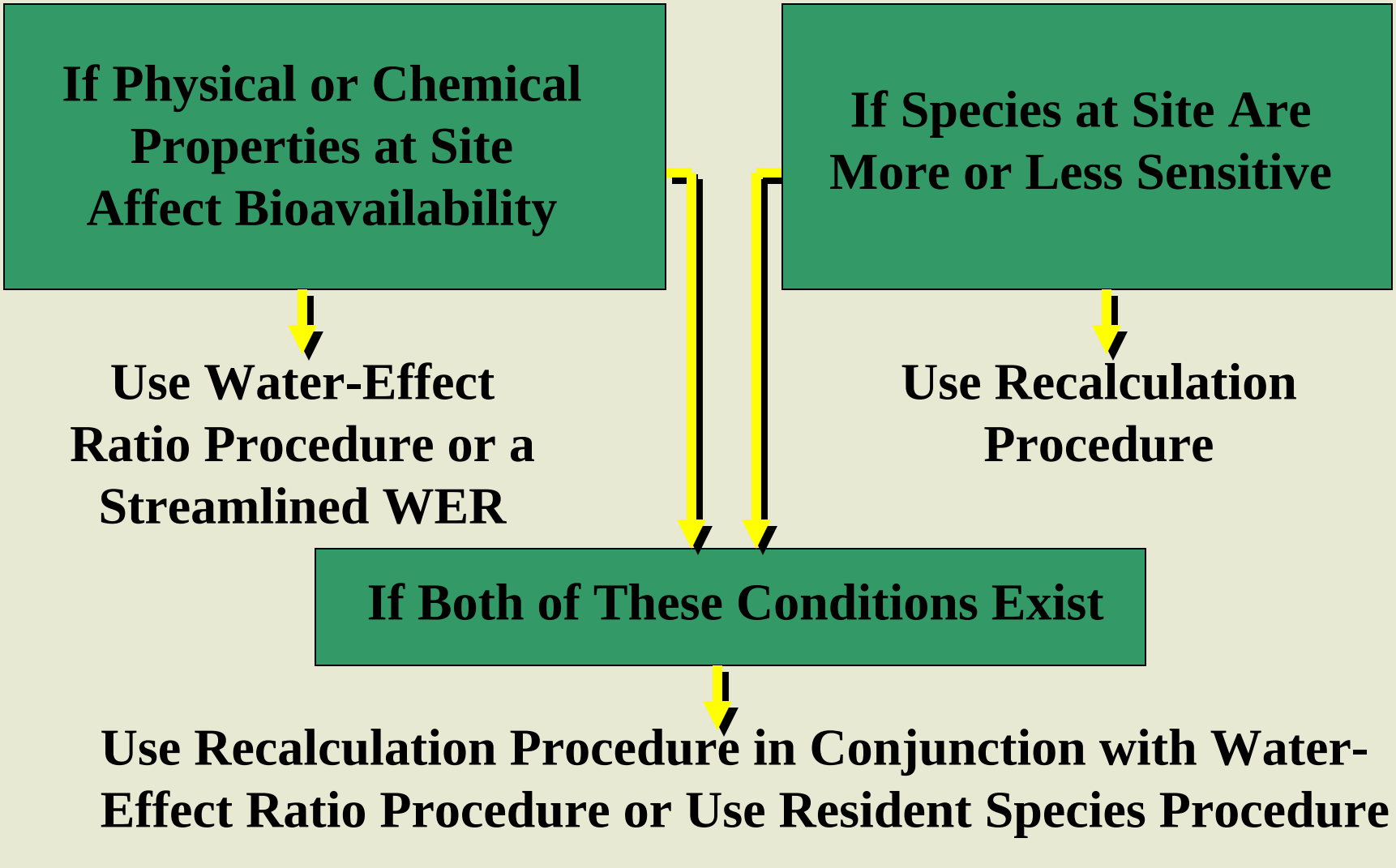
Ambient Water Quality Criteria

What are the maximum allowable pollutant levels to protect designated uses?

Antidegradation Policy

How will we protect the designated uses?

SITE-SPECIFIC CRITERIA PROCEDURES



Ephemeral & Effluent-dependent Waters in Arid West

- **Physically variable habitat**
  - **magnitude and duration of storm flows severe**
  - **significant periods of no-flow**
- **Unique water quality characteristics**
  - **elevated hardness, alkalinity**
  - **high background contaminant concentrations**
- **Unique aquatic communities**
  - **Fish sometimes absent**
  - **Species richness low**

Presentation Objectives

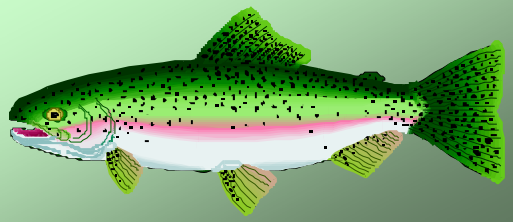
- **Compare use of two USEPA methods for site-specific AWQC modification in effluent-dependent waters of Arid West**
  - **Water-effect Ratio**
  - **Recalculation Procedure**
- **AWQC evaluated**
  - **Today: copper and ammonia**
  - **Others: aluminum, zinc, diazinon**
- **Case study sites**
  - **CA, AZ, CO, OR, NM, NV**

Recalculation Procedure

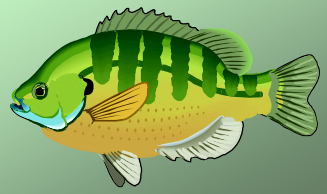
- **Adjusts AWQC magnitude for differences in species composition**
- **Used when resident species differ substantially from the national toxicity database**
- **Procedure:**
  - **Corrections/additions to toxicity database**
  - **Non-resident species removed from database**
  - **AWQC recalculated**

MINIMUM DATASET FOR FRESHWATER CRITERIA DERIVATION

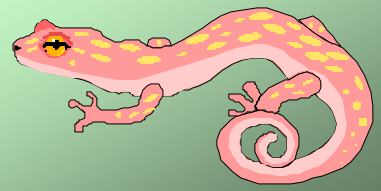
SALMONID



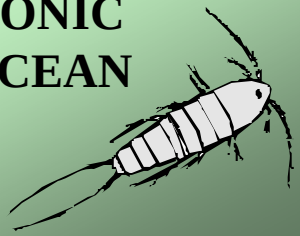
SECOND FISH FAMILY



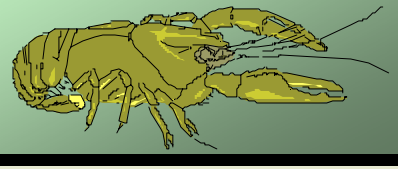
CHORDATA



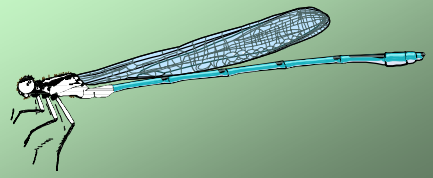
PLANKTONIC CRUSTACEAN



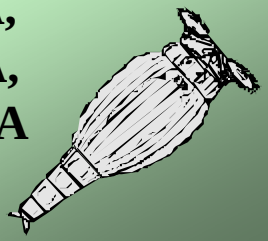
BENTHIC CRUSTACEAN



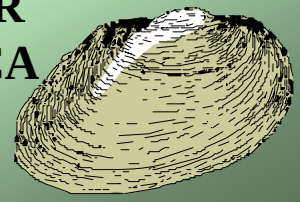
INSECT



ROTIFERA, ANNELIDA, MOLLUSCA



OTHER INSECT OR MOLLUSCA



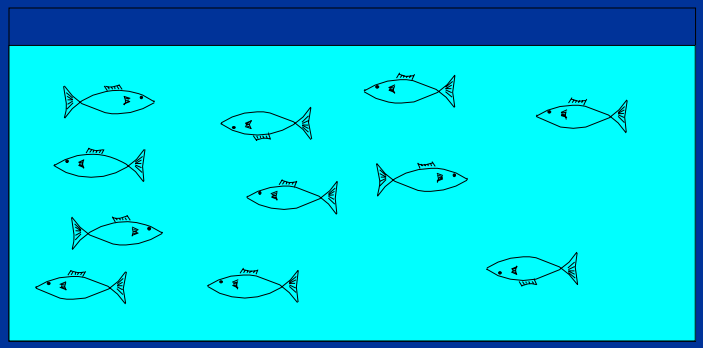
Recalculation Procedure

- **Ephemeral & effluent-dependent streams**
  - ***Salmonids usually absent***

  - ***Cladocera (water fleas) may not be resident***

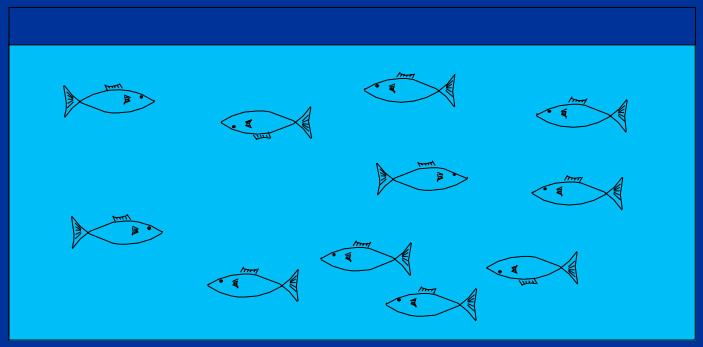
    - **may be present as “transients”**
    - **significant: metals (e.g., 20% difference, Cu acute)**

Calculation of the water effect ratio



Site Water

LC50 = 350µg/L



Laboratory Water

LC50 = 100µg/L

$$\frac{350\mu g/L}{100\mu g/L} = 3.5$$

Acute Ammonia AWQC (1999)

- **Acute criteria function of pH (not temp.) and presence of salmonids**

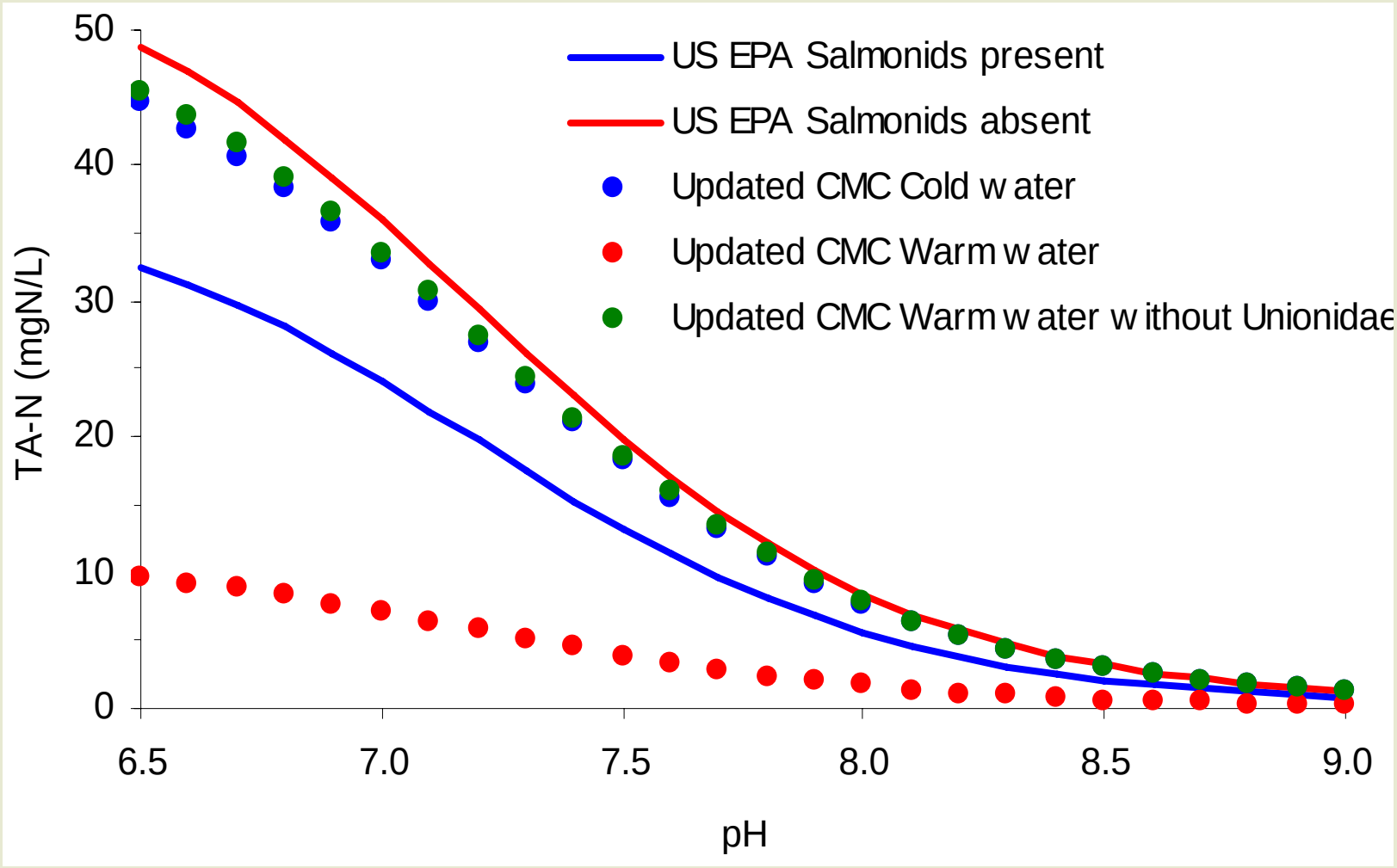
pH	CMC (mg TA-N/L)	
	Salmonids Present	***Salmonids Absent***
7	24.1	36.1
8	5.62	8.40

- **Calculated based on total ammonia-N, rather than un-ionized NH_3**

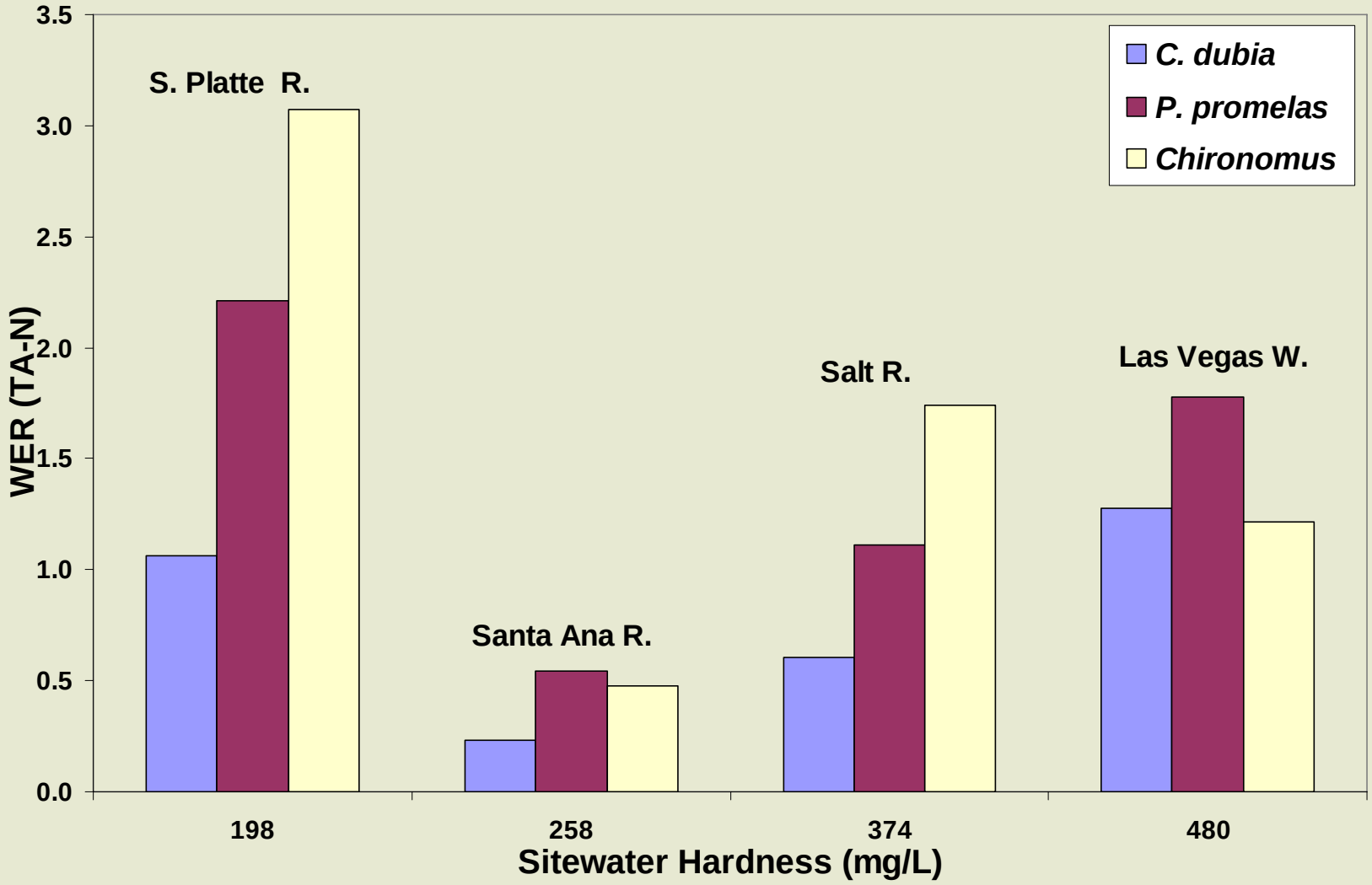
Ammonia Recalculation – Key Results

- **Split dataset based on habitat types (i.e., cold water and warm water)**
  - **Functionally equivalent to current "with and without Salmonidae" acute equations in 1999 document**
- **Warm water criteria were calculated with and w/o Unionidae**
  - **Presence of unionid clams questionable in arid west**

Comparison of USEPA and Updated Acute Criteria Relationship to pH



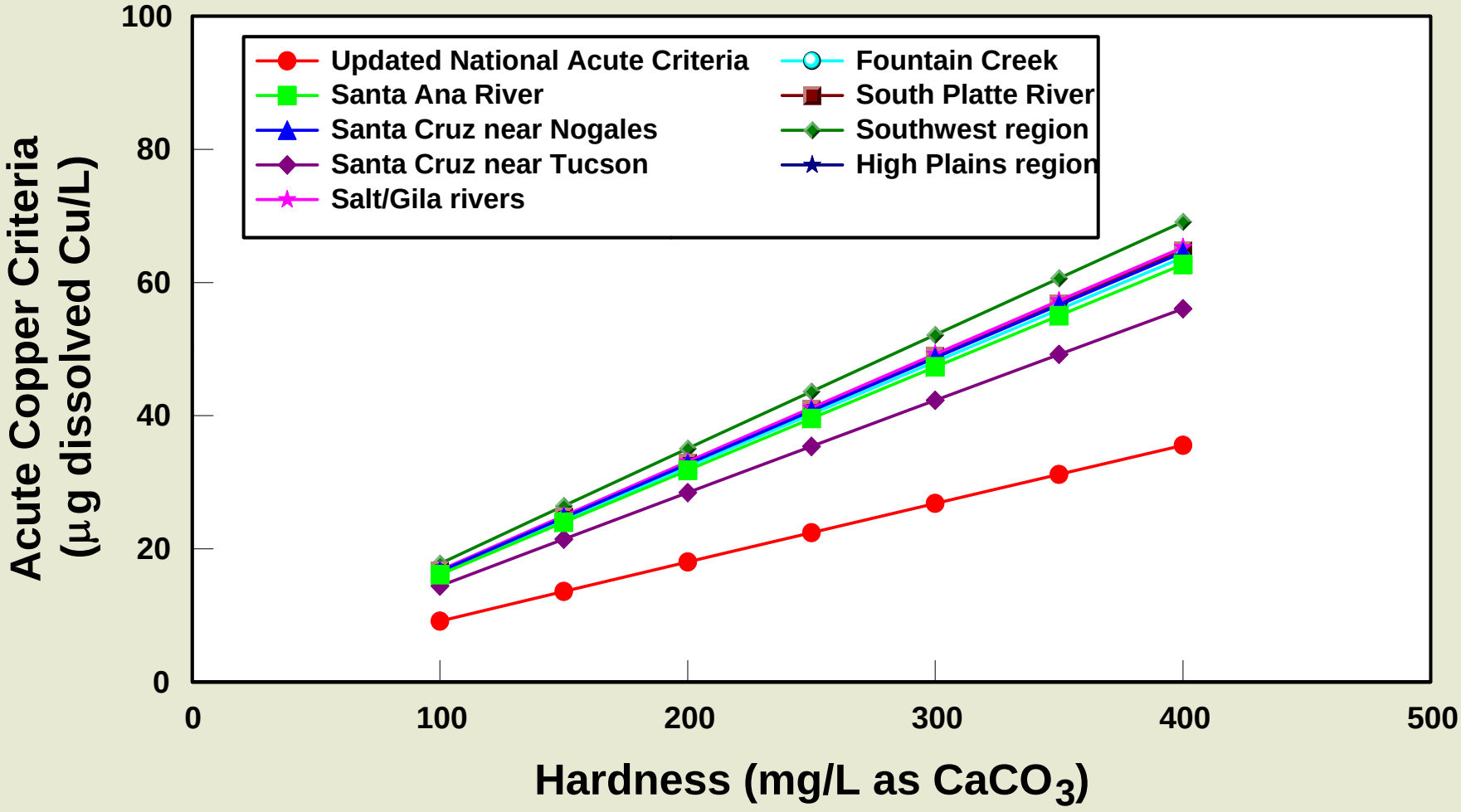
WERs – Total Ammonia



Copper AWQC (1995 updates)

- **Acute criterion = $e^{(0.9422[\ln(\text{hardness})]-1.700)}$**
  - **Cladocerans most sensitive species**
  - **Salmonids only 12th most sensitive genus**
- **2003 Draft AWQC**
  - **Acute criteria based on biotic ligand model (BLM)**

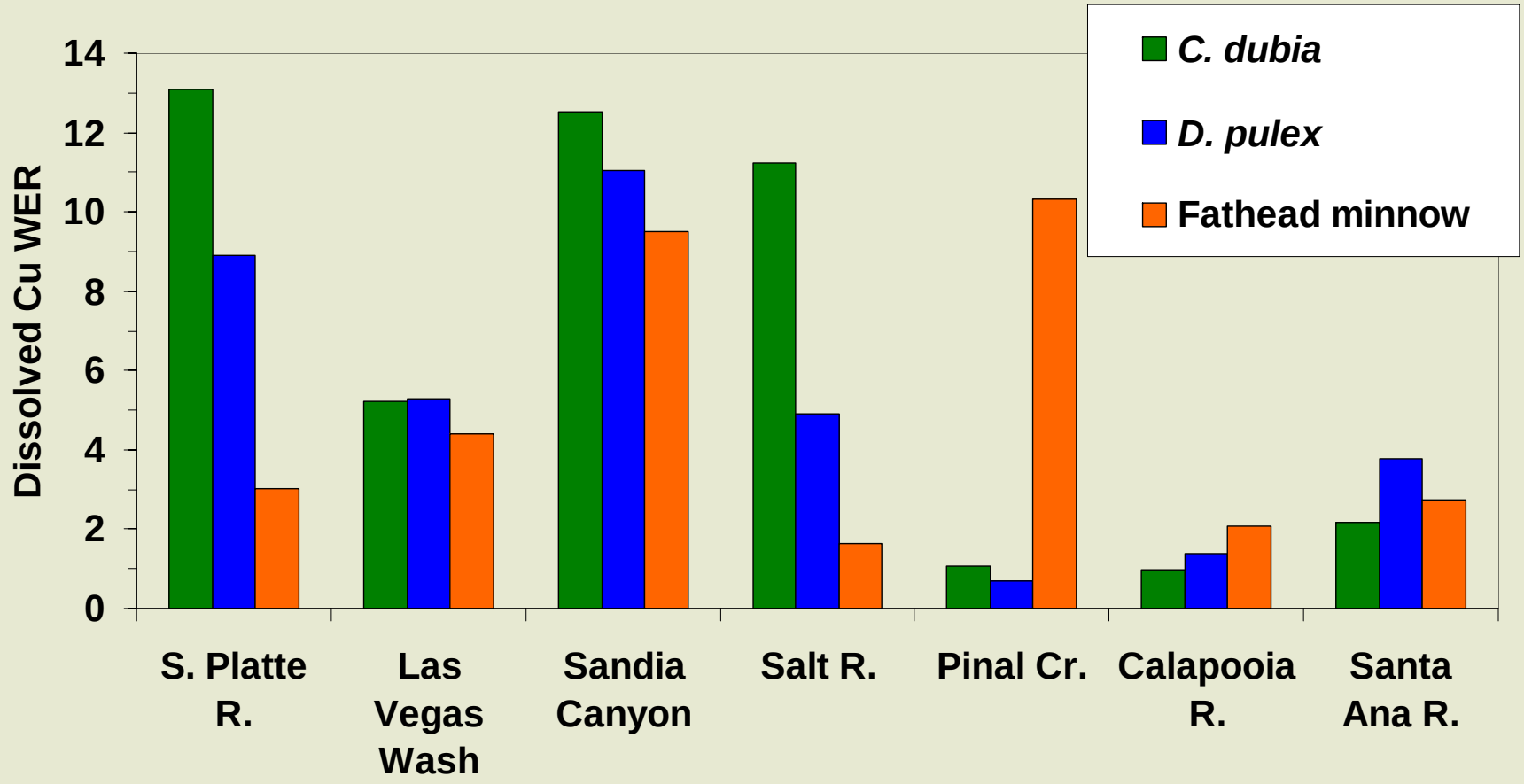
Recalculation - Copper



Copper – Study Sites

Site	Hardness	Alkalinity	DOC
	mg/L as $CaCO_3$		mg/L
S. Platte R., CO	280	204	9.8
Las Vegas Wash, NV	780	128	5.4
Sandia Canyon, NM	56	124	4.4
Salt R., AZ	388	180	6.9
Pinal Cr., NV	1100	16	0.7
Calapooia R., OR	284	228	1.2
Santa Ana R., CA	188	164	2.5

Water Effect Ratio Results

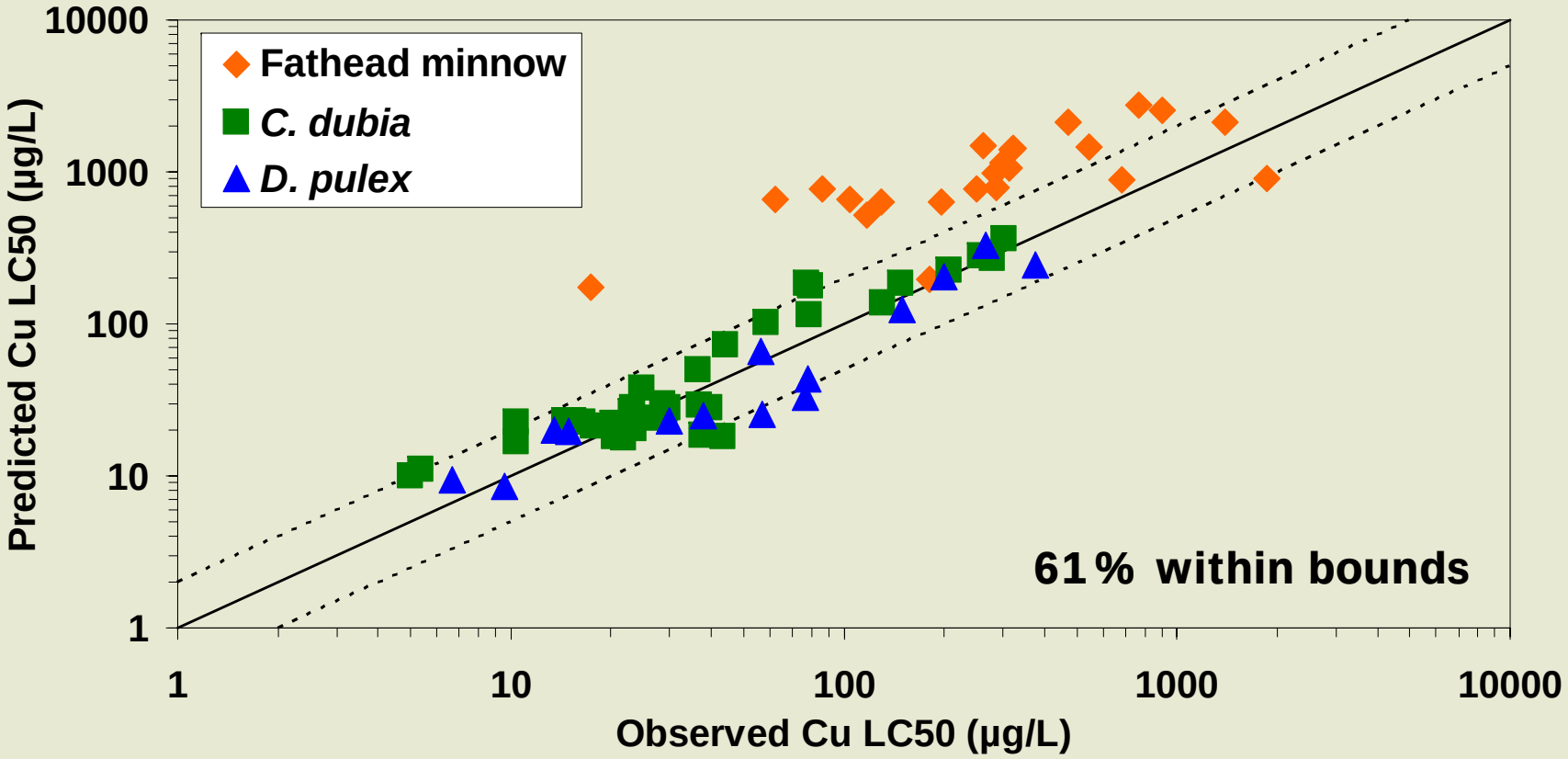


WER = Site LC50 / Lab LC50

Biotic Ligand Model (BLM)

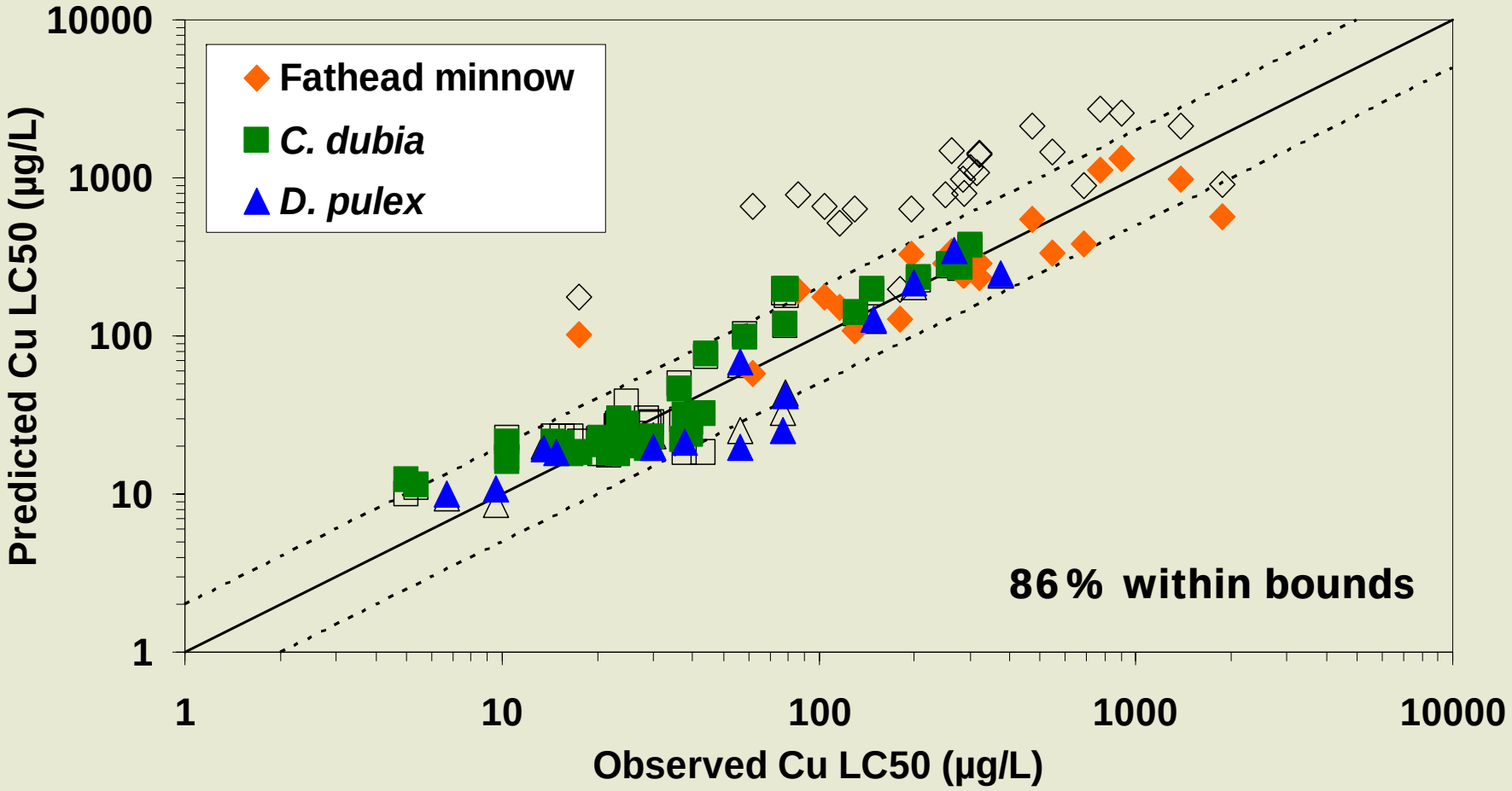
- **Uses water chemistry and metal-organism interactions to predict metal toxicity.**
- **Toxicity occurs when metal accumulation reaches a critical concentration within the most sensitive tissue (e.g., the gills of freshwater fish).**
- **Relates Cu toxicity to pH, DOC, Ca, Mg, alkalinity.**
- **Key component of freshwater CMC in draft AWQC (USEPA 2003)**

BLM Results



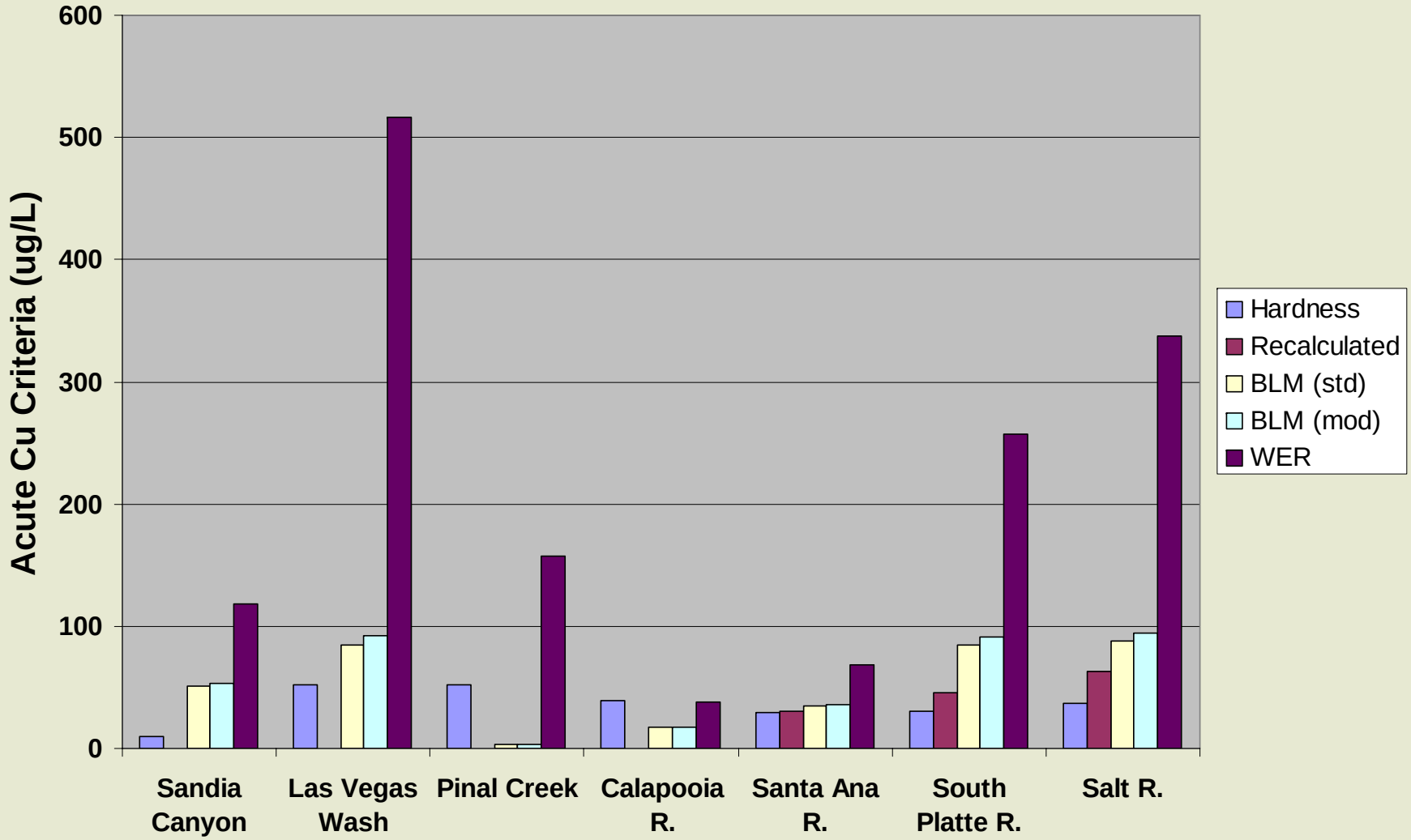
Model Adjustment: None

BLM Results



Model Adjustment: Carbonate and Mg Influence

Criteria Comparisons - Copper



Conclusions - Ammonia

- **Recalculation**
  - **Little impact on either existing or recalculated criteria**
  - **Non-resident salmonids already incorporated**
    - **Development of warmwater ammonia equations**
  - **However, presence/absence of unionid clams potentially significant**
    - **up to 4X more conservative if present**
- **WER**
  - **WERs up to 3 possible**
  - **Related to hardness? Or correlated factor (e.g., sodium)?**
  - **Additional study required**

Conclusions – Copper

- **Recalculation**
  - **Acute criteria can increase ca. 2X**
  - **Related to lack of any resident cladocera (water fleas)**
- **WER**
  - **WERs range from ca. 2 – 12X**
  - **However, may not adequately protect most sensitive aquatic life in all cases**
- **BLM**
  - **Better represents actual water quality modification of Cu toxicity**
  - **Criteria usually less conservative, *but not always*!**
  - ***Even most acutely sensitive species always protected by BLM-based criteria***

General Conclusions

- **Several opportunities exist for modification of default national criteria in arid west**
  - **Species composition**
  - **Water quality characteristics**
- **2 – 10X changes possible**
  - **However, resident aquatic life still protected**
  - **In fact, current methods (e.g., BLM) may be most protective, even if criteria concentrations are higher.**