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Androscoggin River Water-Effect Ratios and Proposed Site-Specific Criteria

Determinations for Aluminum, Cadmium, and Copper

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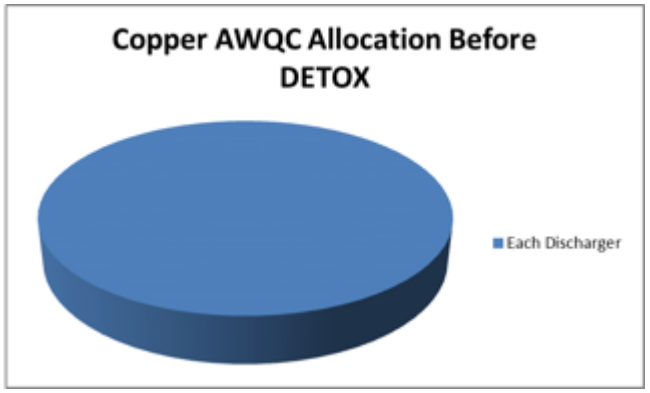
Presentation Overview

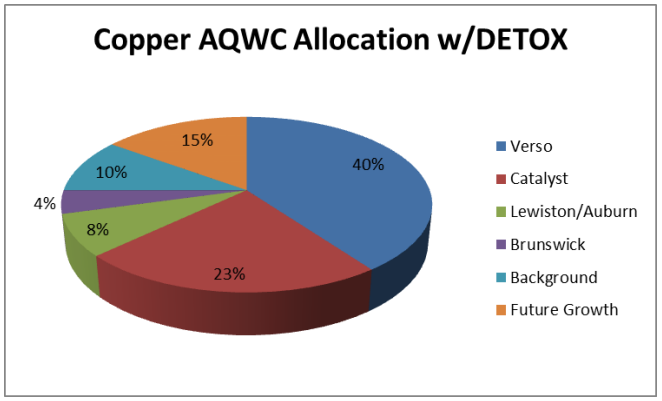
- Introduction
- Purpose of the project
- Basics of water-effect ratio (WER) and site-specific criteria (SSC) development
- Sampling and analysis program
- Chemical-specific WER & SSC results
- Analysis of SSC protectiveness
- Conclusions

Project Location

Why Develop SSC for the Androscoggin?

- 2012 MDEP MEPDES relicensing process
  - DETOX allocation tool for first time





  - Prior licensing did not allocate
  - Actual discharge remained unchanged, yet DETOX lowered threshold for exceeding or reasonable potential to exceed AWQC
  - Resulted in new, very low permit limits for Al, Cd, and Cu

Note: Figures illustrate a conceptual example only

WER and SSC

- A WER is a quantitative measure of protectiveness afforded by natural waters relative to laboratory water

$$WER = \frac{Conc_{chem_i}\ observed\ toxicity\ in\ natural\ water}{Conc_{chem_i}\ observed\ toxicity\ in\ lab\ water}$$

- WER is applied to the AWQC to derive SSC

$$SSC = WER \times AWQC$$

- USEPA 1994 WER Guidance
- DEP & EPA approved work plan

Project Purpose

- Develop SSC for Al, Cd, Cu on lower Androscoggin River
  - Adjust AWQC
    - Androscoggin River water differs from water used for AWQC development
    - Reflects site-specific conditions
    - Protective of all uses
    - Based on sound science
  - Regulatory framework
    - 40 CFR 131.11(b)(1)
    - 38 MRS §420 2(B)
    - Chapter 584(3)(B)

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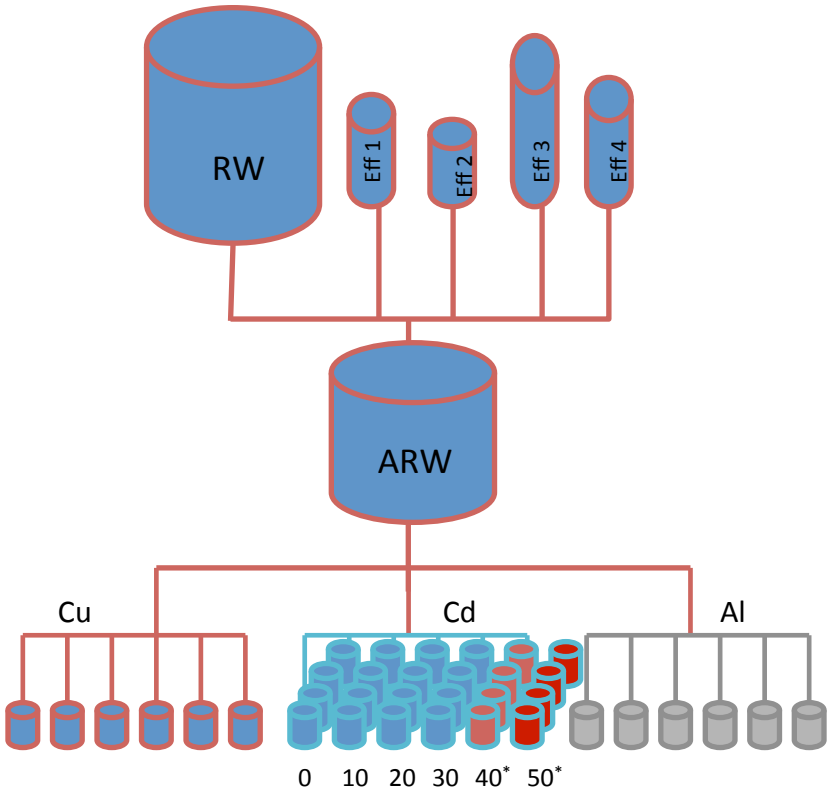
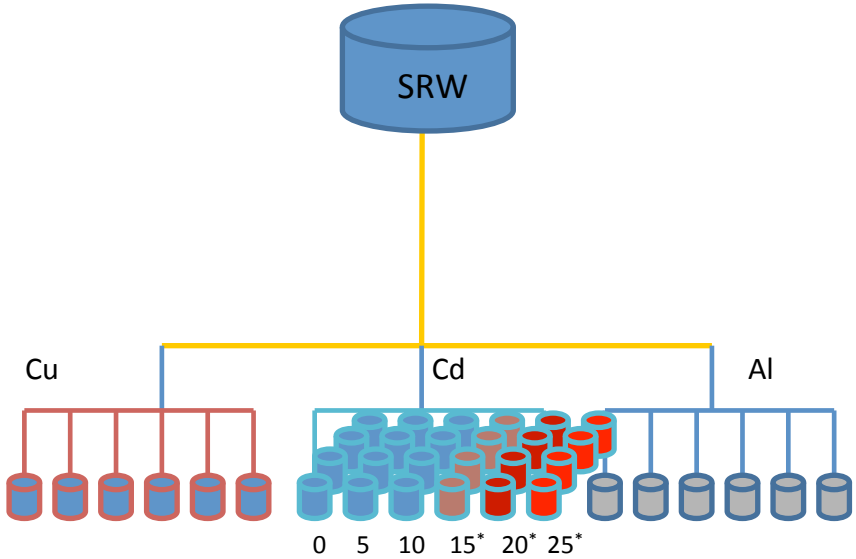
Demonstration of WER Toxicity Testing

Simulated Androscoggin River Water (ARW)



ARW Cd NOEC = 30 µg/L

Lab Water, Synthetic Reconstituted Water (SRW)



SRW Cd NOEC = 10 µg/L

NOEC – no-observed-effect concentration

Derivation of WERs and SSC

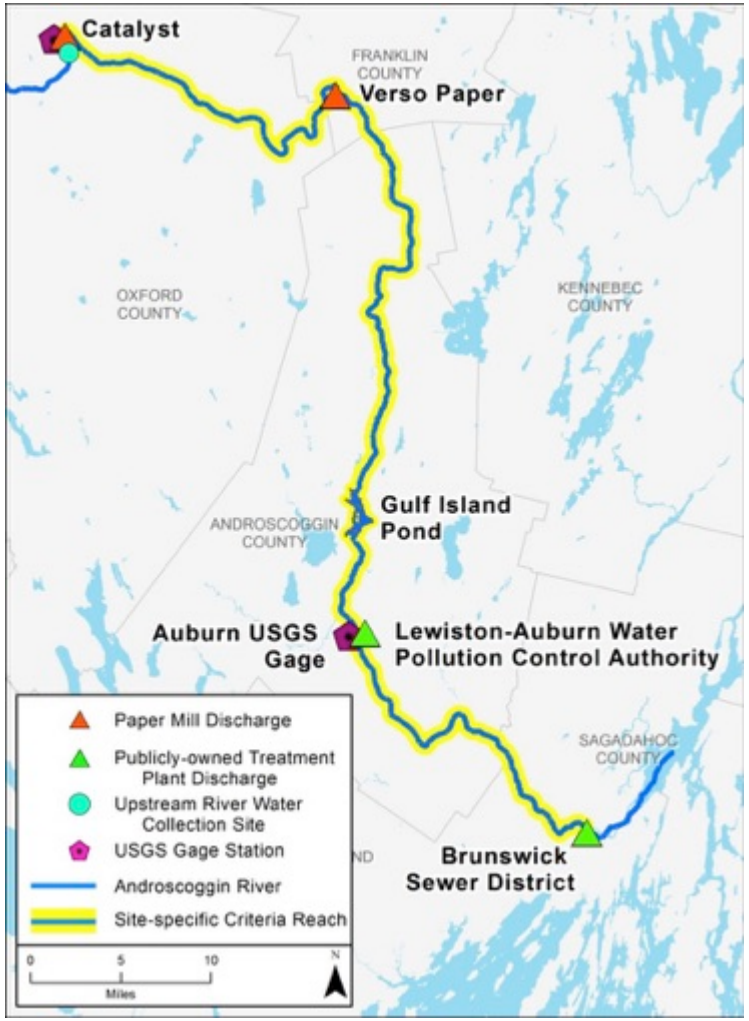
$$WER_{Cd} = \frac{ARW_{NOEC}}{SRW_{NOEC}} = \frac{30\ \mu g/L}{10\ \mu g/L} = 3.0$$

$$SSC_{Cd} = AWQC_{Cd} \times WER_{Cd} = 0.08 \mu g/L \times 3.0 = 0.24 \mu g/L$$

$$SSC_{Cd} = 0.24 \mu g/L$$

Sampling Program

- Consistent with approved work plan
- 3 Events
  - Fall 2013
  - Winter 2014
  - Summer 2014
- Each event
  - 24-hr composite samples of 4 effluents
  - Upstream water



Bioassay Program

- ARW simulation mixtures

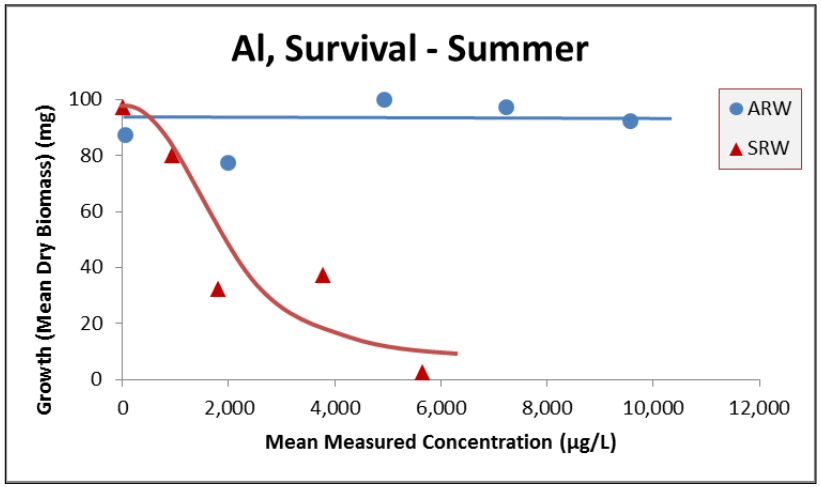
Solution	Sampling Round Mixing Ratio Basis		
	Fall 2013	Winter 2014	Summer 2014
Effluent	Permitted Max	Permitted Max	Permitted Max
River Water	10 yr. avg. flow	10 yr. avg. flow	7Q10 flow

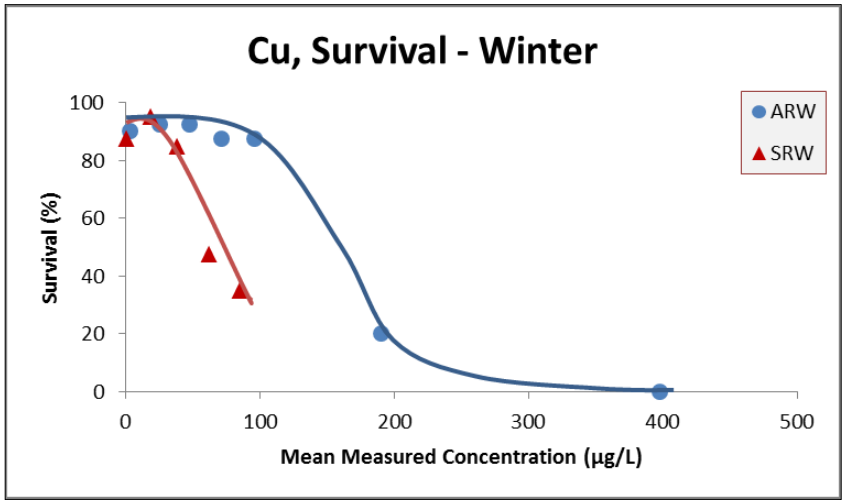
- SRW—reconstituted lab water
  - Adjusted to hardness and pH of receiving water
- Metal Solutions
  - Aluminum potassium sulfate
  - Cadmium chloride
  - Copper sulfate
- Chronic Bioassays
  - Rainbow Trout (*Oncorhynchus mykiss*), <6 months
    - Primary Species
  - Daphnid (*Ceriodaphnia dubia*)
    - Secondary Species

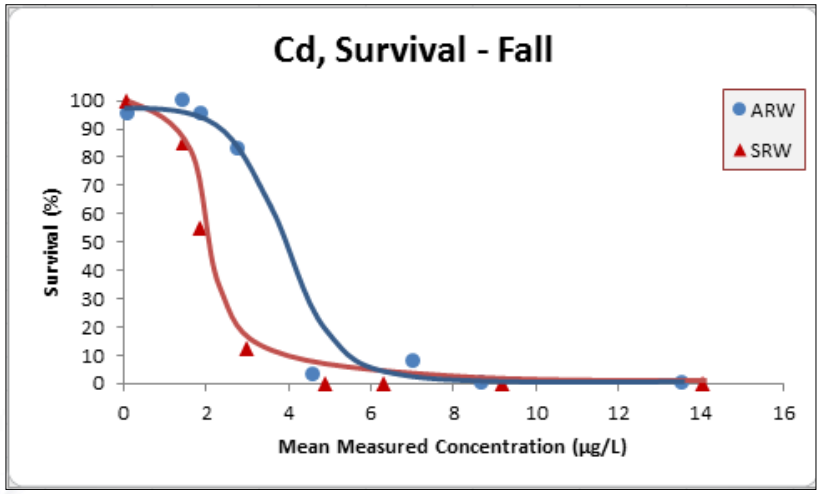
Bioassay Results—Trout

- More than 460 bioassays and nearly 5,000 fish
- Toxicity endpoints of survival and biomass
- Toxicity metrics for each endpoint
  - NOEC
  - IC-10
- Concentration-response
  - Clear illustration of protectiveness afforded by ARW relative to SRW
  - Good for both SRW and ARW
- WERs based on best combination of endpoint and metric

Trout Bioassay Results—Examples



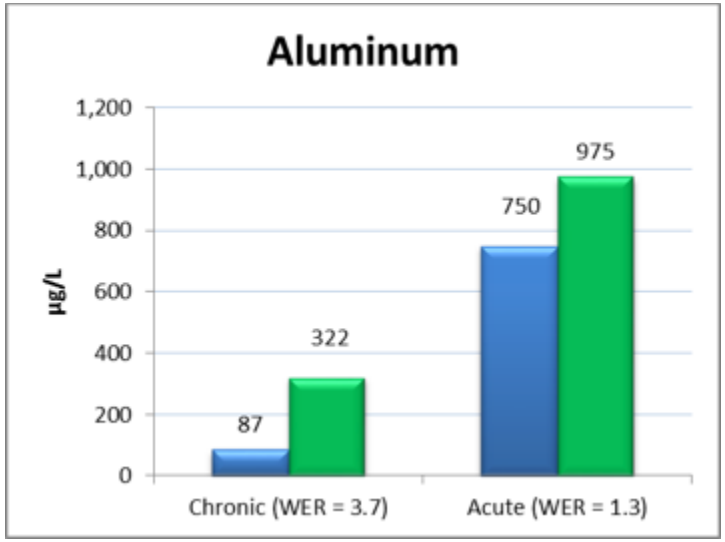


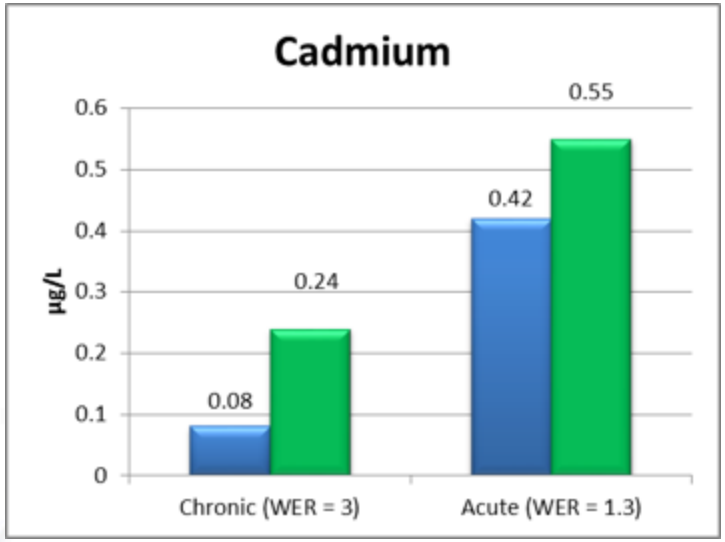


Proposed WERs

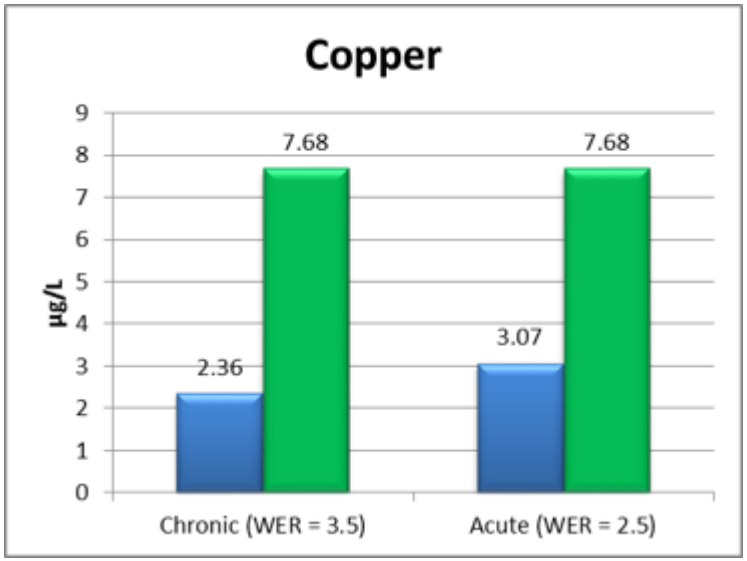
Metal	Endpoint	Toxicity Measurement	Testing	WER
Aluminum	Biomass	NOEC	Fall 2013	1.3
		NOEC	Winter 2014	3.9
		NOEC	Summer 2014	10.1
Geometric Mean/Proposed Final Chronic WER - Aluminum				**3.7**
Cadmium	Biomass	IC10	Fall 2013	1.6
		IC10	Winter 2014	5.0
		IC10	Summer 2014	3.6
		NOEC	Fall 2013	1.3
		NOEC	Winter 2014	3.9
		NOEC	Summer 2014	3.9
	Survival	IC10	Fall 2013	2.7
		IC10	Winter 2014	3.8
		IC10	Summer 2014	3.5
		NOEC	Fall 2013	1.9
		NOEC	Winter 2014	3.9
		NOEC	Summer 2014	3.9
Geometric Mean/Proposed Final Chronic WER - Cadmium				**3.0**
Copper	Survival	NOEC	Fall 2013	3.0
		NOEC	Winter 2014	2.5
		NOEC	Summer 2014	5.6
Geometric Mean/Proposed Final Chronic WER - Copper				**3.5**

Proposed SSC





$$SSC = WER \times AWQC$$

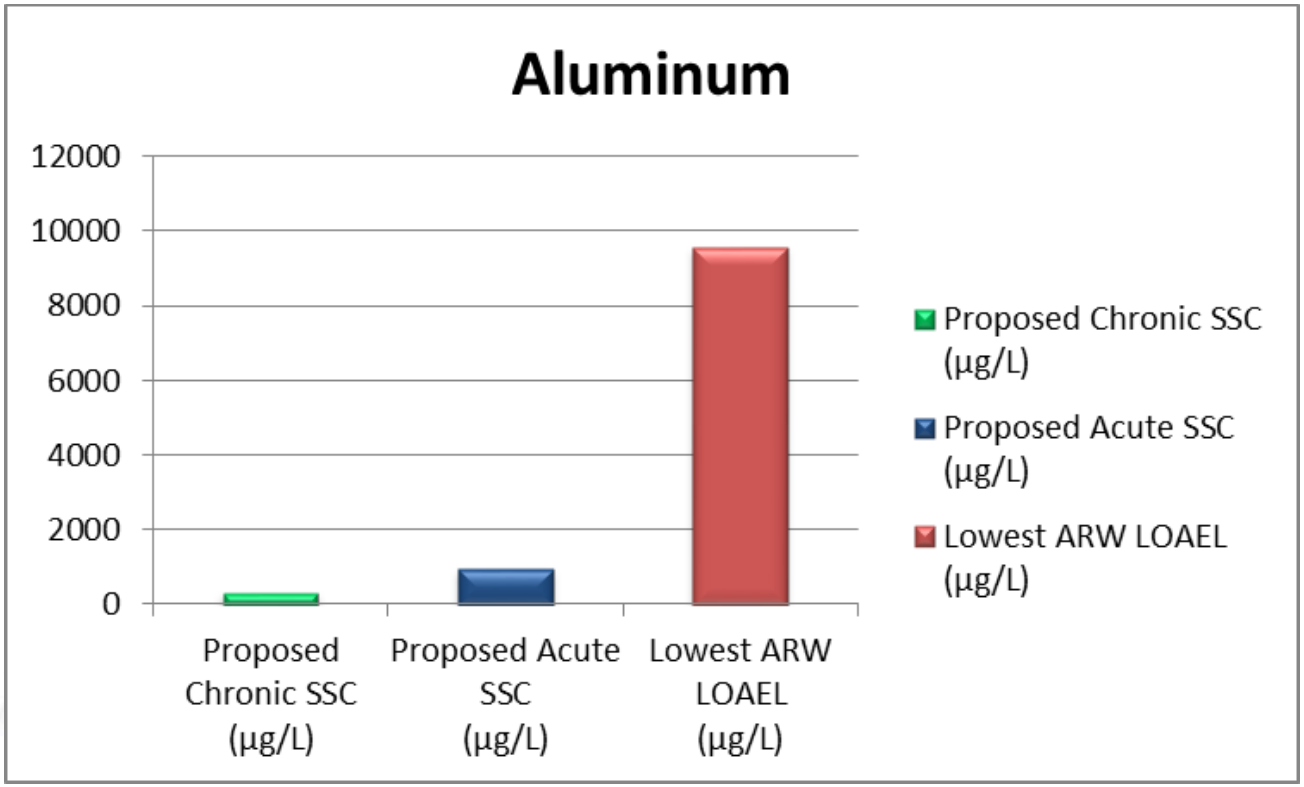


Maine AWQC

Proposed SSC

SSC Margin of Safety—Individual Metal

- Trout WER bioassays
  - Proposed SSC are lower than the lowest of the ARW LOAELs



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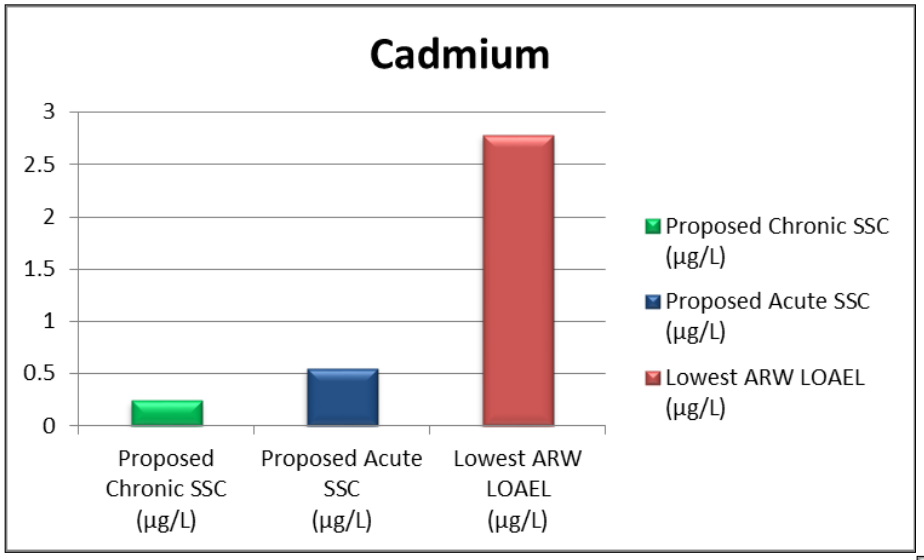
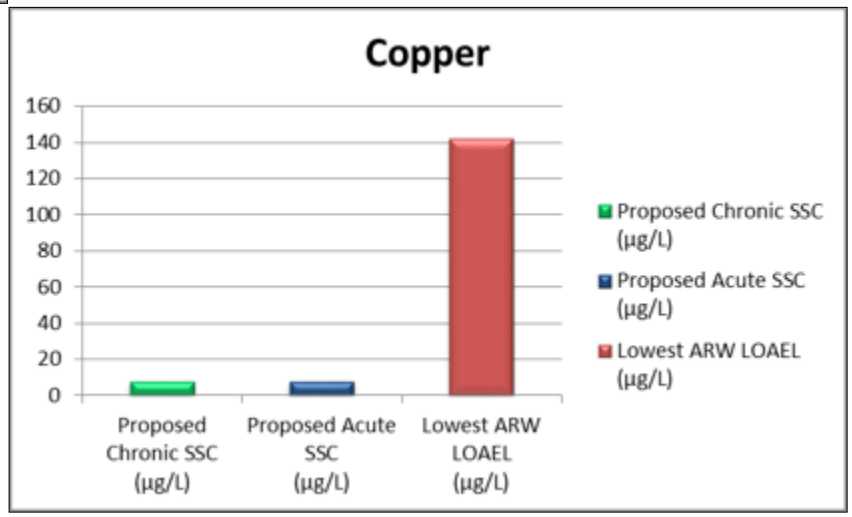
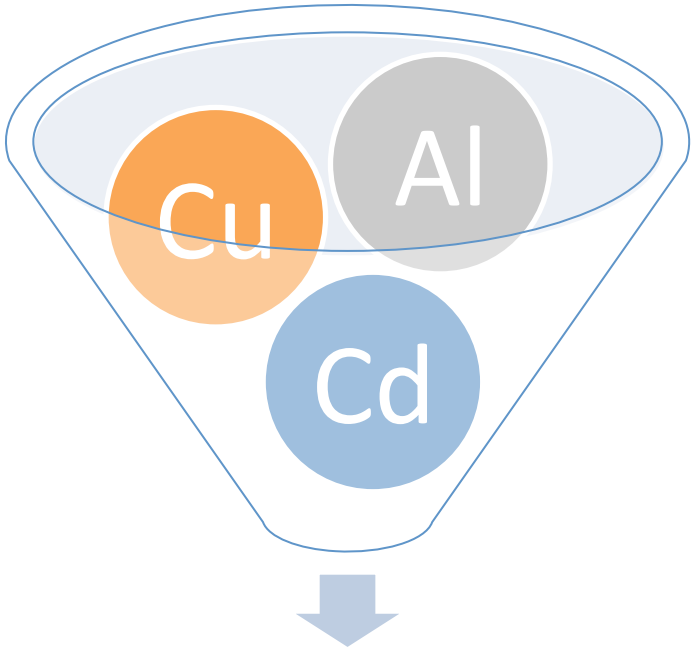




SSC Margin of Safety—All Metals

- Combined metal effects
  - 7 years of WET test data
  - No effects observed when Al, Cd, and Cu all above SSC
  - No observed concentration-response relationship



Conclusions

- Robust data set based on three rounds of trout bioassays
- Illustration of river water protectiveness is clear
- Proposed WERs are based on strongest metrics and endpoints
- Proposed SSC are protective of water body uses
- Proposed SSC are protective of ecological health and human health

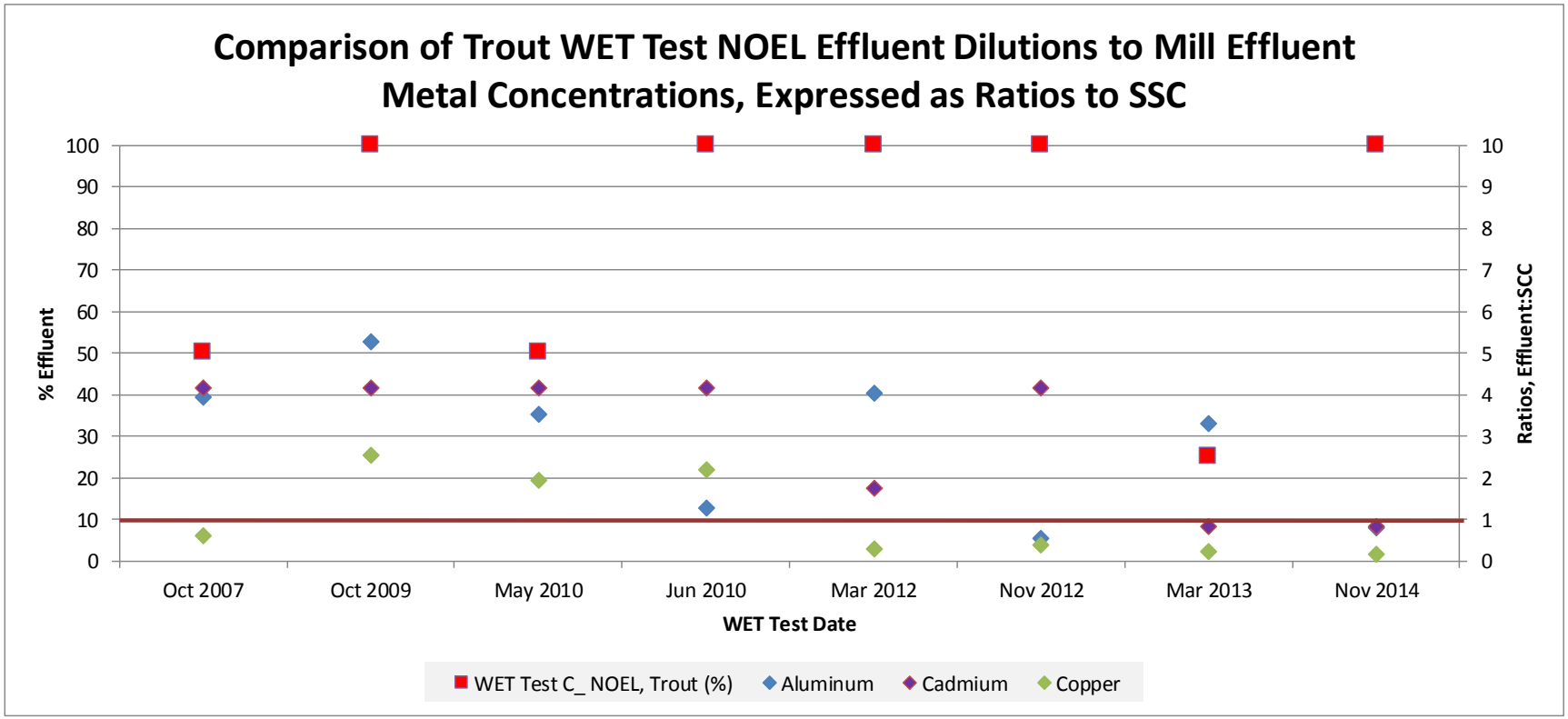
Questions?

Questions?

Bioassay Results—Daphnid

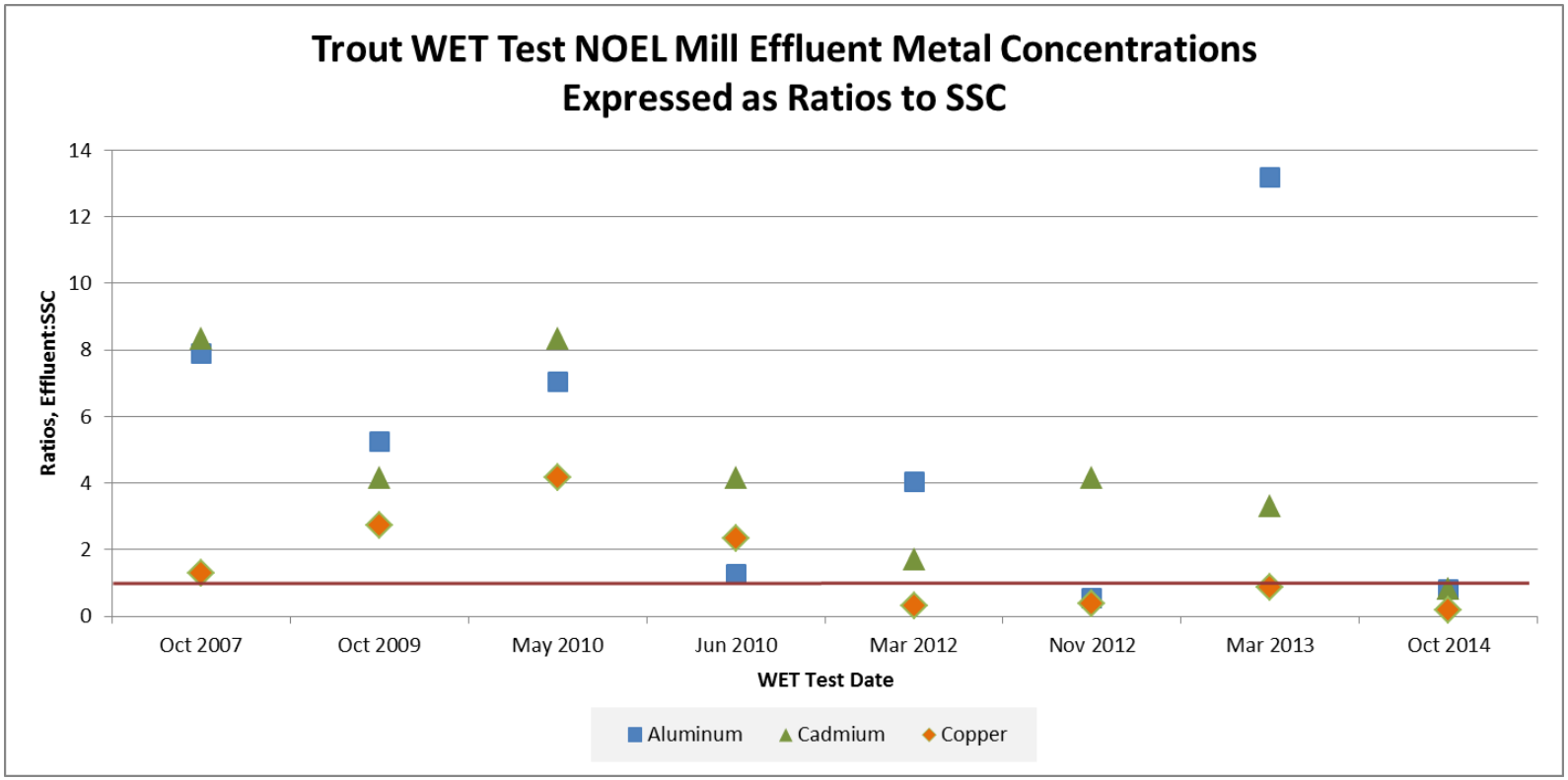
- Fall 2013 results acceptable
- Winter 2013 results not suitable for WER
  - Poor reproduction and survival for SRW control
  - Poor reproduction for ARW control
  - Poor response found to result from
    - Time of year
    - Water softness
    - Exacerbated by YCT mix
- Secondary Species
  - Fall 2013
    - Daphnid WERs within ~3x trout results
    - Confirmed the trout bioassay WERs

SSC Protectiveness—Synergism



- No effects observed with Al, Cd, and Cu > proposed SSC
- No observable concentration-response curve
- No observable synergism

SSC Protectiveness—Synergism



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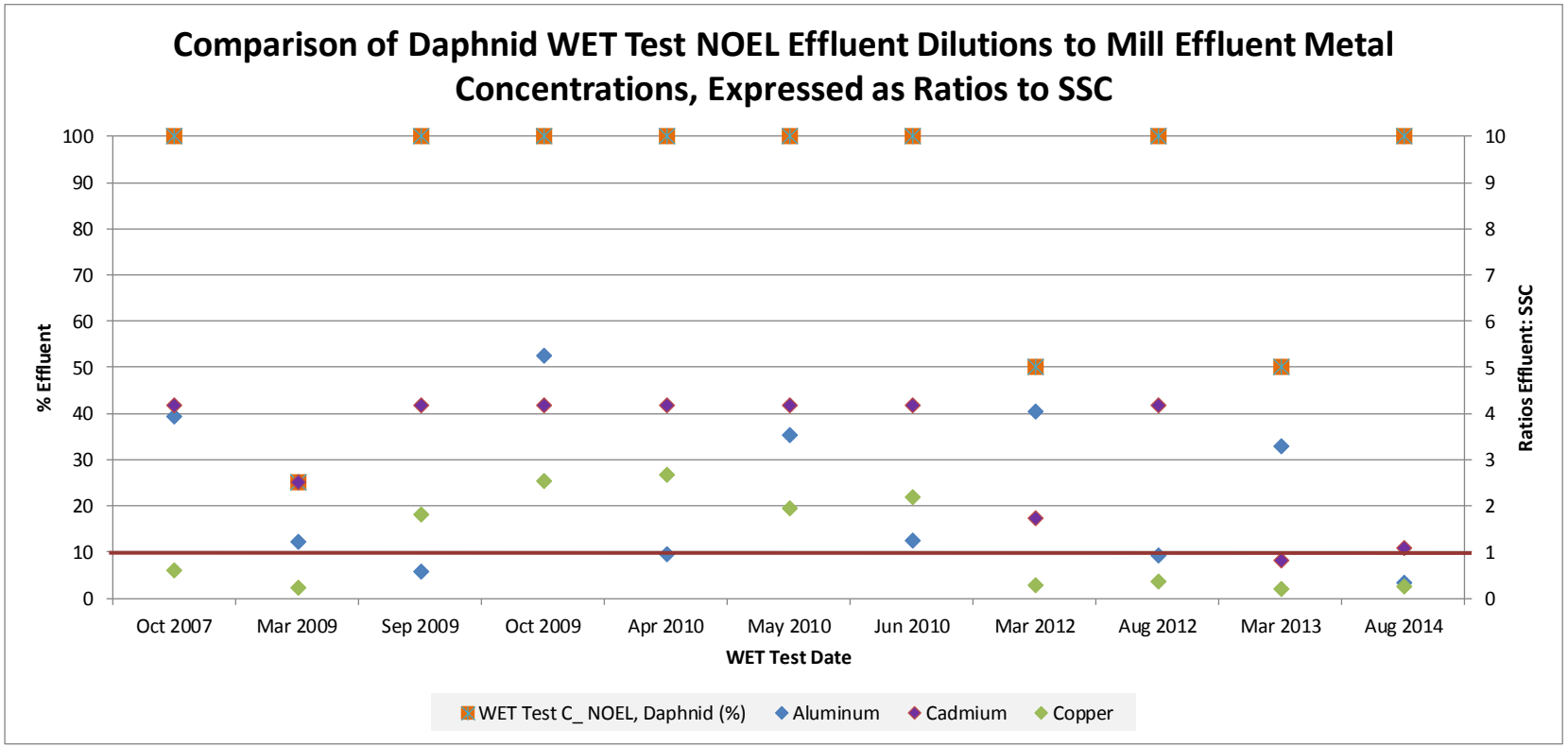
SSC Protectiveness—Synergism, cont'd



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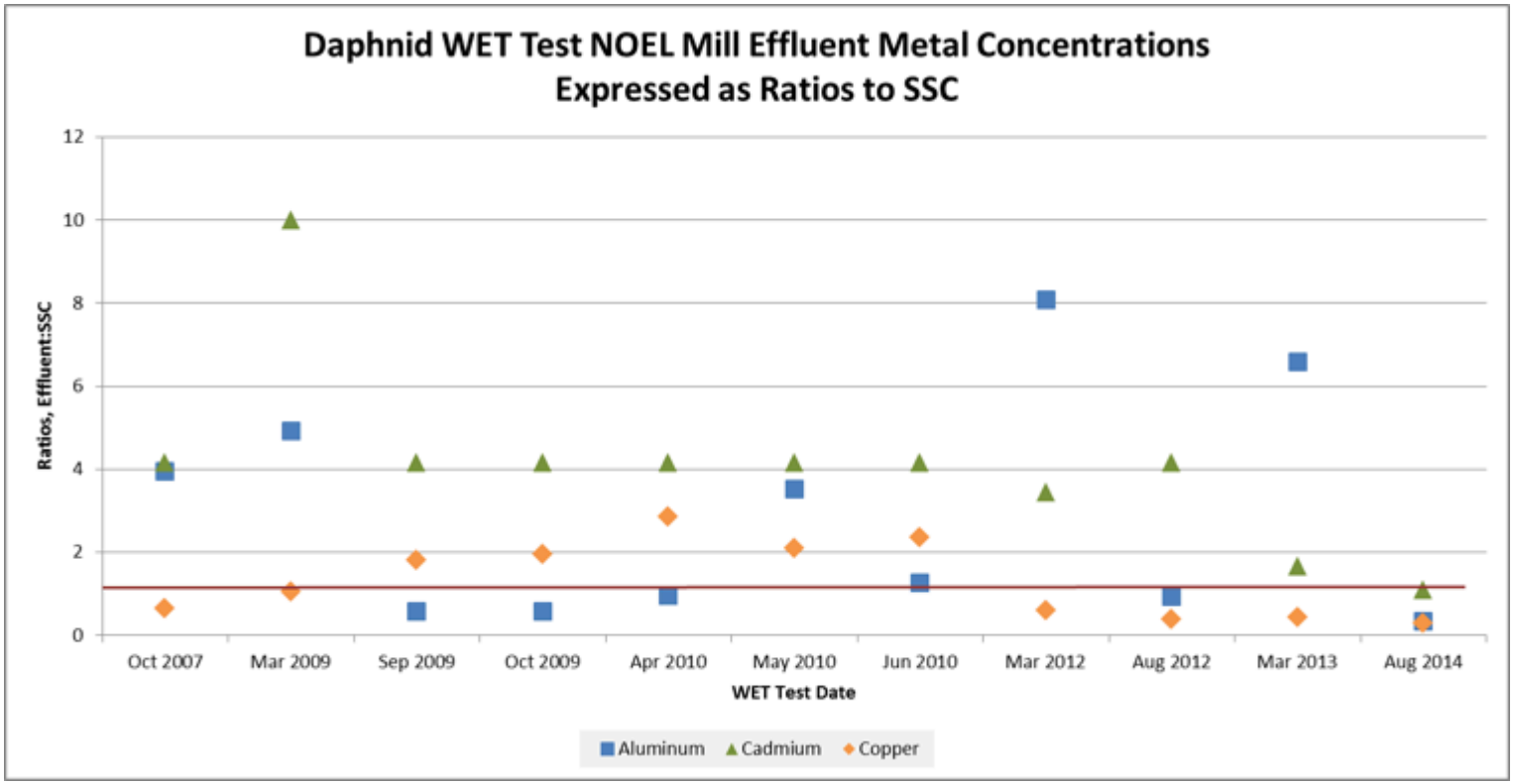

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