



Too Much of a Good Thing? An Update on the Aquatic Life Water Quality Criteria for Selenium

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Life is getting more complicated

- BAT
- Water quality based
- Metals (In hardness equation, translators)
- Ammonia (temp and pH)
- Selenium

The Inverse Relationship



Conservative
(broadly applicable)

Simple

Lenient
Site Specific

Complex

Proposed Acute Selenium Criteria

- Selenite - 258 µg/l
- Selenate - $e (0.5812[\ln \text{ sulfate}]) + 3.357$
417 µg/l at 100mg/l Sulfate

Establishes linear relationship between sulfate and selenate toxicity.

Conservative versus complex approach



Proposed Chronic Criterion

- Fish Tissue Criterion
 - 7.91 μ g/g dry weight
 - With additional sampling if whole body fish tissue concentrations exceed 5.85 μ g/g dry weight during the summer or fall.

How is that going to work?

Have to develop water column number that protects the tissue criteria

Water column criteria = TRC/BAF

Bioaccumulation Factor (BAF) –
Concentration in tissue/concentration in
water

BAF and BCF

Bioconcentration factor calculated using water column testing and food chain multiplier (FCM). Can be generated in the lab and used in place of BAF.

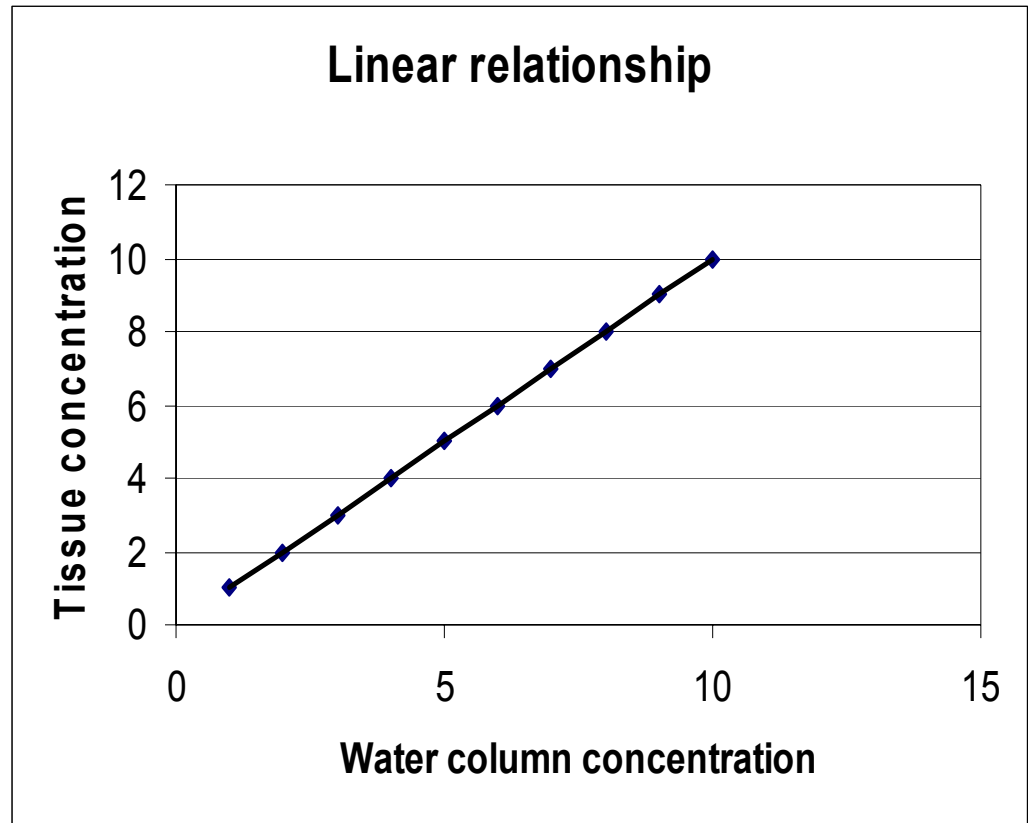
How is that going to work?

Alternatives:

- Define the relationship between water column and tissue numbers
 - Become predictive through statistics
- Generate enough field data to override the need to understand
 - Be conservative
- Combination of both
 - Become predictive by modeling

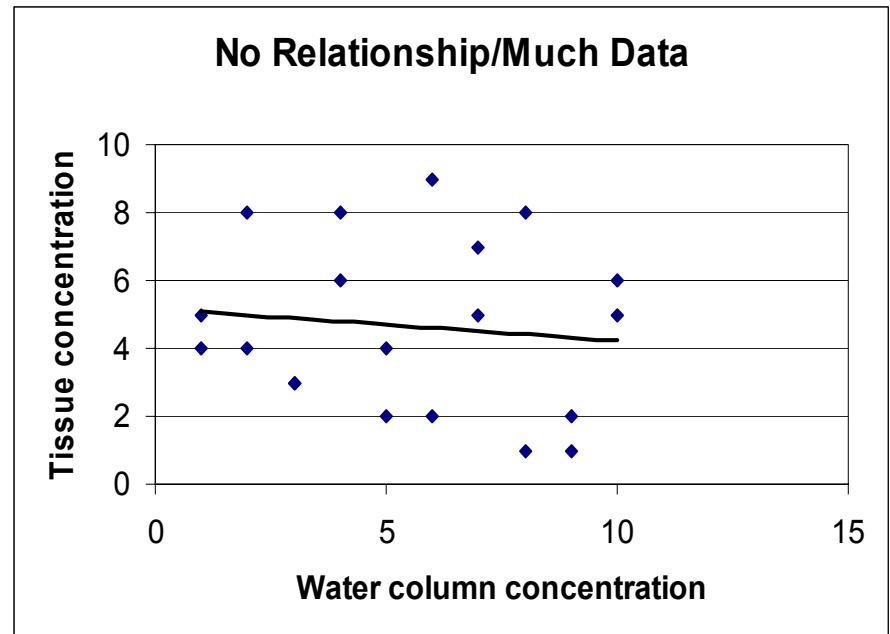
BAF is predictive

- Define linear relationship
 - Abiotic factors
(Temp, sulfate, flow, water body type, selenium form)
 - Biotic Factors
(food chain, fish size and age)



BAF is not predictive

- Establish Geometric Mean of field collected data
(i.e. EC50, protect 95% of sites)
- More similar to setting water column criteria
- Bypass the need to understand dynamics





Predictive modeling

- Recent study by Brix et al. 2005
- Combines aspects of both scenarios using Monte Carlo modeling
- More complicated with substantial data requirements and expertise

Brix et al. 2005

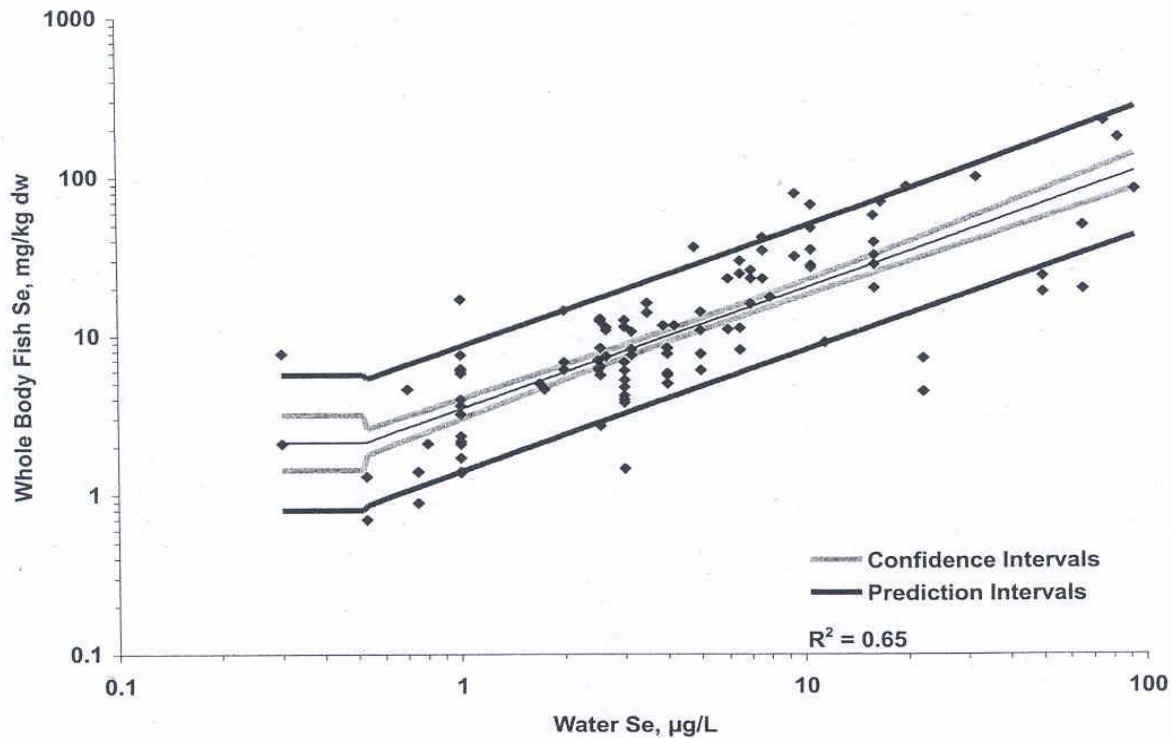


Fig. 2. Selenium bioaccumulation model for fish in lentic systems.

Brix et al. 2005

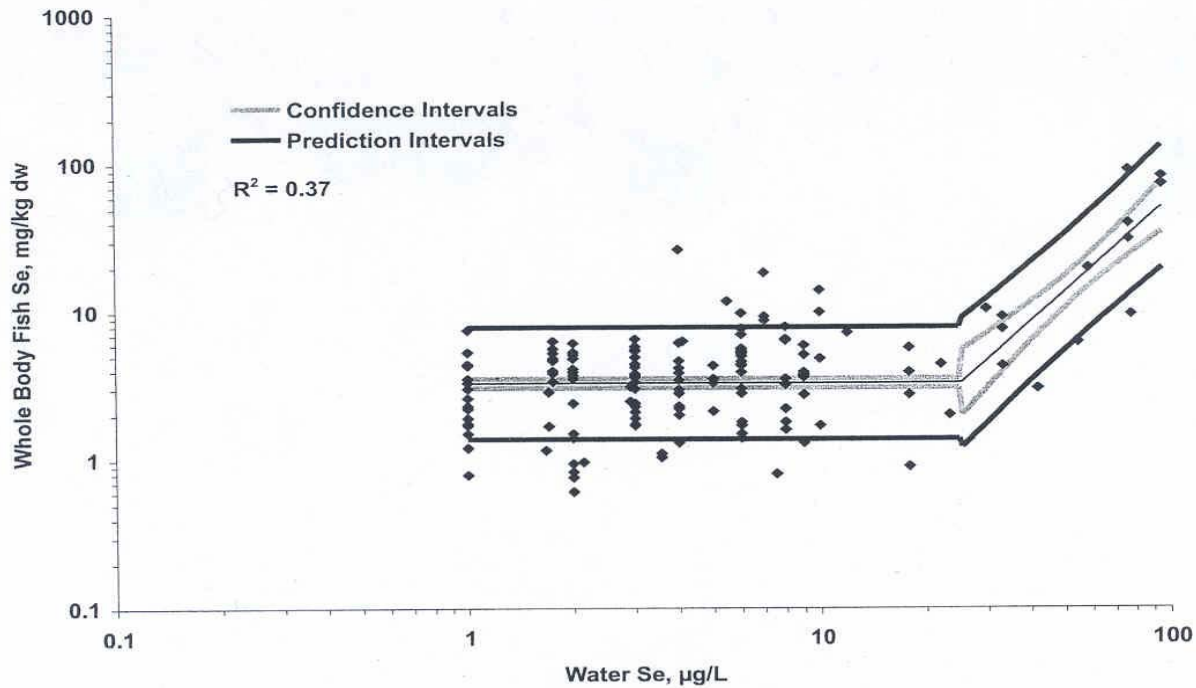


Fig. 3. Selenium bioaccumulation model for fish in lotic systems.



EPA Preferred Method

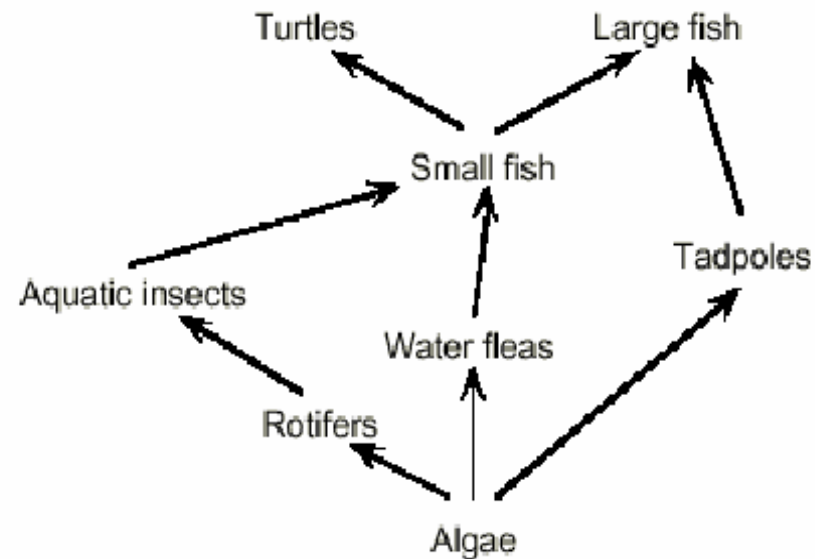
- Field measured bioaccumulation factors are most preferred approach for developing BAFs for inorganic chemicals but regional or site-specific BAFs are encouraged
- Site specific or regional BAFs will be less conservative and more realistic

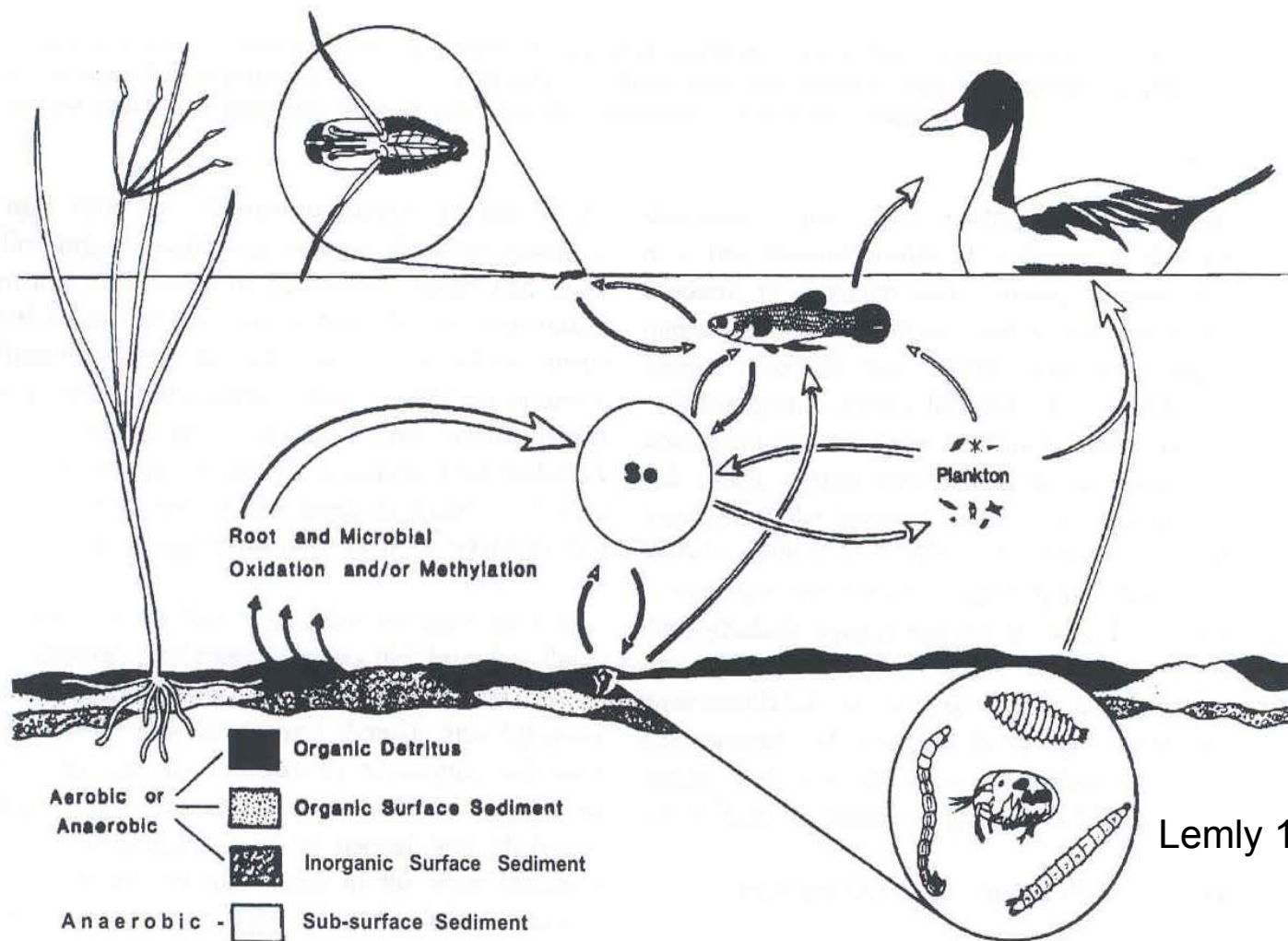


Reasons Selenium is Difficult

- Abiotic factors – pH and hardness not that important
 - Other factors: temp, sulfate, flow, water body type, selenium form harder to evaluate
- Biotic factors – controlling selenium tissue concentrations primarily via diet

Ecology Lesson – Food Web





Lemly 1999



Lessons Learned

- Much research on organics accumulation and concentration in fish tissue BUT they tend to correlate with tissue lipid concentrations and are easier to make linear (predictive)
- Most work done for human fish consumption (PCBs and dioxin)

Lessons Learned

- Methyl mercury
 - First tissue criteria for inorganic – January 2001
 - Attempted national criteria but had too much variability
 - Did not find sign. differences in lentic/lotic but it was close and they used a lot of canal data so ???

Where to go from here?

Need to develop database for regional or state BAFs (Maine use 95% UCL from regional database for MeHg BAF).

Best to get predictive data (develop a model) but any regional database likely to be better than national

Keep up to date on modeling efforts and consider more complex techniques



Need to be involved

Relationship with sulfate critical to the development of BAF that works in coal mining areas – most people will not care if that relationship is developed fully.