Fish Tissue-based Water Quality Criteria

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Today's Discussion

- Why fish tissue criteria?
  - methylmercury
  - selenium
- Implementation challenges in WQS, Monitoring, and NPDES
- Discussion and questions

Criteria Expressed as Tissue Concentrations

- Are they the wave of the future?
- Not necessarily, but they have a niche.
  - Most scientifically valid approach for exposure to certain pollutants
  - Useful where it is important to account for site-specific factors in determining exposure (e.g., BAFs).
  - Not useful for important non-bioaccumulatives such as ammonia, copper, zinc, chlorine, chloride (TDS), and most others.

EPA Recommended Fish Tissue Criteria

- **Methylmercury**

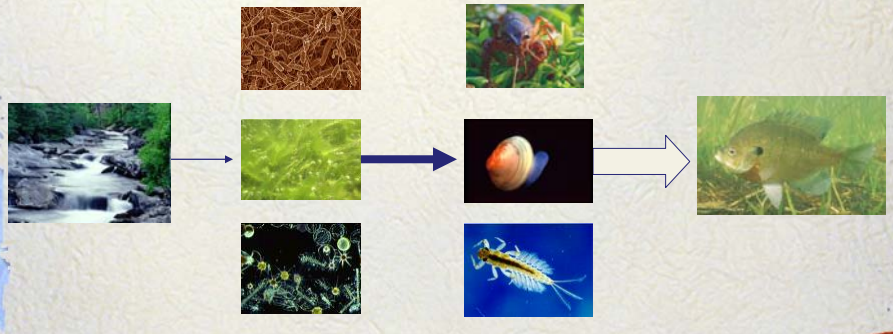
  2001 Human Health Criterion:
  - 0.3 mg/kg in fish tissue (muscle)
  - Implementation guidance - Draft final January 2009

- **Selenium**

  2004 Draft Chronic Aquatic Life Criterion:
  - 7.9 ug/g in fish tissue (whole body)
  - Draft re-proposal- Projected: May 2009
  - Final 304(a)- Projected: Jan. 2010
  - Draft implementation guidance- Projected: July 2009

Why a fish tissue criterion for Selenium?

- Toxicity to fish is better represented by a tissue value
- Bioaccumulation in fish is primarily from food consumption; accumulation from water is negligible
- Propensity to accumulate selenium varies widely, depending on food web and other factors.



Water | Primary producers | Invertebrates | Fish

Fish propensity to accumulate selenium depends primarily on:

- Fish diet and Invertebrate physiology

insects < crustaceans < bivalves

- Selenium bioavailability

Flowing waters < Still waters

→ Selenite > Selenate

→ Particulate > Dissolved

Challenges in implementing a fish tissue criterion

- **WQS**- What to adopt?
- **Assessment and Listing**-What form to monitor?
- **NPDES**- How to write permits based on a fish tissue criterion?

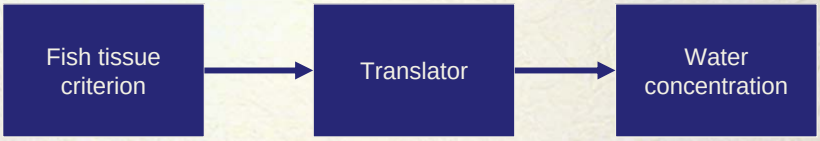
feww.files.wordpress.com

WQS- what to adopt?

- Fish tissue concentration
- Translation to local water concentrations
- Fish tissue concentration with water translator methodology
- Combination

www.qeallc.com/html/bioaccumulation.htm

Translating the selenium fish tissue criterion to a water concentration



Translator:

$$\text{Water concentration} = \frac{\text{Fish tissue criterion}}{\text{Fish trophic transfer factor (TTF)} \times \text{invert. TTF} \times \text{BCF (or Kd)}}$$

Trophic transfer factors are comprised of an organism's:

-Food ingestion rate
-Se assimilation efficiency
-Se loss rate

Translating the methylmercury criterion to a water concentration

- Methylmercury criterion may be implemented directly without translation to water concentration.
- However, if translation is desired, use Bioaccumulation Factors (BAFs).
- Three approaches include:
  - Site-specific BAFs
  - Modeled BAFs
  - BAFs derived using the results of field studies that are not site-specific (in limited circumstances)

Assessment and 303(d) Listing

- What species of fish to monitor?
- Monitor fish tissue, water or both?
- How to assess when fish tissue and water monitoring data show different results?
- Individual fish or composite samples?
- Average sample values or should one "hot" sample determine impairment?
- Alternative to killing fish for samples?
- How to avoid "waiting for fish to exceed criteria" in order to list?

Monitoring Design Factors

Considerations may differ for methylmercury and selenium

- Which fish species to monitor
- What tissue type to sample and analyze
- What study design to best assess attainment of water quality standard

Monitoring Design Factors- Fish species

Methylmercury

- What people eat
- Can average multiple species

Selenium

- Sensitivity to Se or accumulation
- Species-specific

Monitoring Design Factors- Tissue type

Methylmercury

- Fish fillet (muscle)

Selenium

- Whole body (skin, etc.)

Monitoring Design Factors- Study design

Methylmercury

- Based on fishing

Selenium

- Based on known problem or accumulation potential

NPDES- how to write permits based on a fish tissue criterion?

Translation to water concentration using:

- Site-specific bioaccumulation factors (MeHg, Se)
- Bioaccumulation translation equation (Se)
- Draft national values or modeled BAFs (MeHg)

Approaches without translation to water concentration:

- TMDL or TMDL-like analysis to assign loads(MeHg)
- Mercury minimization plans (MeHg)- implements controls without numeric effluent limits