Development of State-Specific Aquatic Life Criteria for Selenium in West Virginia

29 March, 2015

West Virginia Department of Environmental Protection

HB 2579

REVISION OF WATER QUALITY CRITERIA (AQUATIC LIFE) FOR SELENIUM

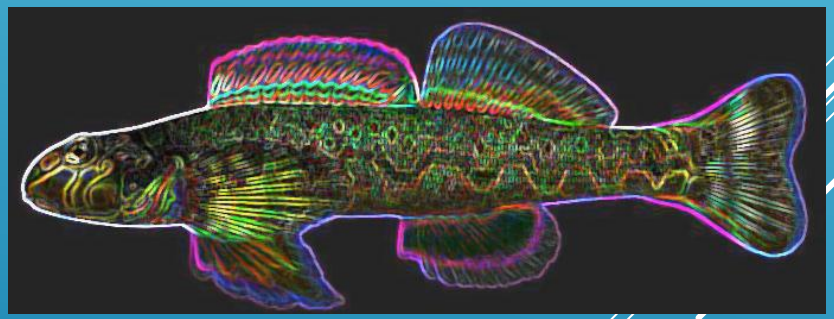
Summary

- Adopted by WV Legislature during 2013 Regular Session; Effective July, 2013
- Mirrored Kentucky's Selenium Criteria Revision
- Mandated WVDEP to propose new selenium criteria for legislative approval
- Required criteria to be implemented as a threshold standard
- Required WVDEP to establish an implementation plan
- Prescribed a monitoring plan, including water chemistry and fish population studies
- Results of studies to be used by WVDEP to develop state-specific criteria
- Does not change existing criteria in the interim

WV SELENIUM MONITORING PLAN

Major Components

- Monitoring site locations
  - 20+ locations
  - Lotic (perennial, wadeable) and Lentic
  - Flow sufficient to support fish spawning
- Water chemistry monitoring and speciation analyses
- Fish tissue monitoring
  - Whole body
  - Egg/Ovary
  - Stomach contents
- Early life stage evaluations
  - Deformity rate determinations
- Criteria calculation



WV Selenium Monitoring Plan

Water chemistry and speciation analyses

- 2X monthly surface grabs at monitoring locations during one-year study duration
- Concurrent physicochemical measures:
  - D.O.
  - pH
  - Conductivity
  - Temperature
- Total and Dissolved Se @ mdl = 0.6 µg/L
- Other potentially antagonistic analytes:
  - Cu, Hg, Pb, Zn, Cd, As, SO_4^-

- 1X selenium speciation at monitoring locations
  - Determine fractions of column Se^{+4}, Se^{+6}, Organic Se, and Se^0
  - Contrasting environments produce different selenium species
  - Differences in bioaccumulation

WV Selenium Monitoring Plan

Fish Tissue Analyses

- Fish collected 2X at monitoring locations: spring (spawn), fall
- Focus on resident stream species (e.g., minnows and suckers)
- Tissue matrices
  - Whole fish
  - Stomach/gut contents
  - Egg/ovary (gonad)
  - Muscle/fillet
  - Carcass

WV Selenium Monitoring Plan

Early Life Stage Fish Evaluation

- Spring 2014 and 2015 spawning fish collection
- Intensive field surveys March-June
- Collected eggs fertilized in field

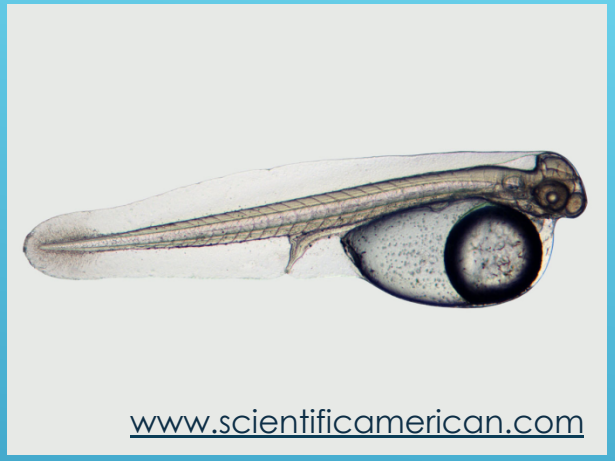

dep


1979
APPALACHIAN
REGIONAL
REFORESTATION
INITIATIVE

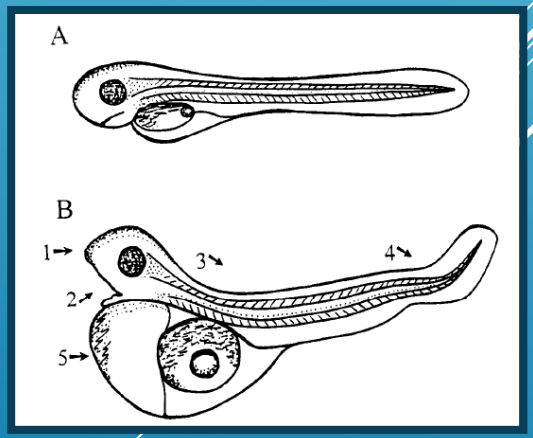
WV Selenium Monitoring Plan

Early Life Stage Fish Evaluation

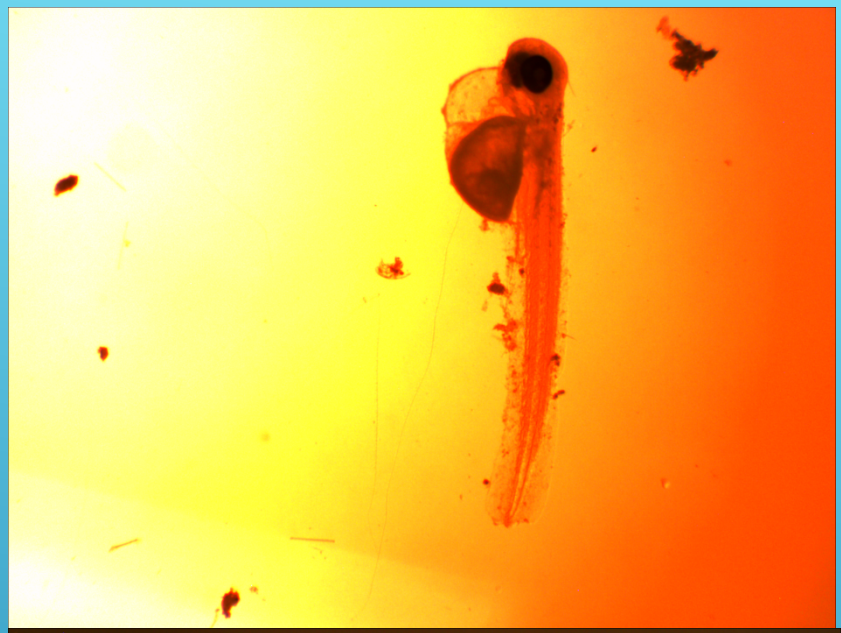
- Measure of larval deformity rates among populations examined
- Compared directly to egg/ovary tissue concentrations and maternal tissue matrices
- Graduated Severity Index
  - 3 categories of deformity expression
  - Inherent assumptions regarding deformity evaluations
  - Anomalies vs Deformities
  - Categories 2 & 3 likely to prevent individual from reaching reproductive age



www.scientificamerican.com



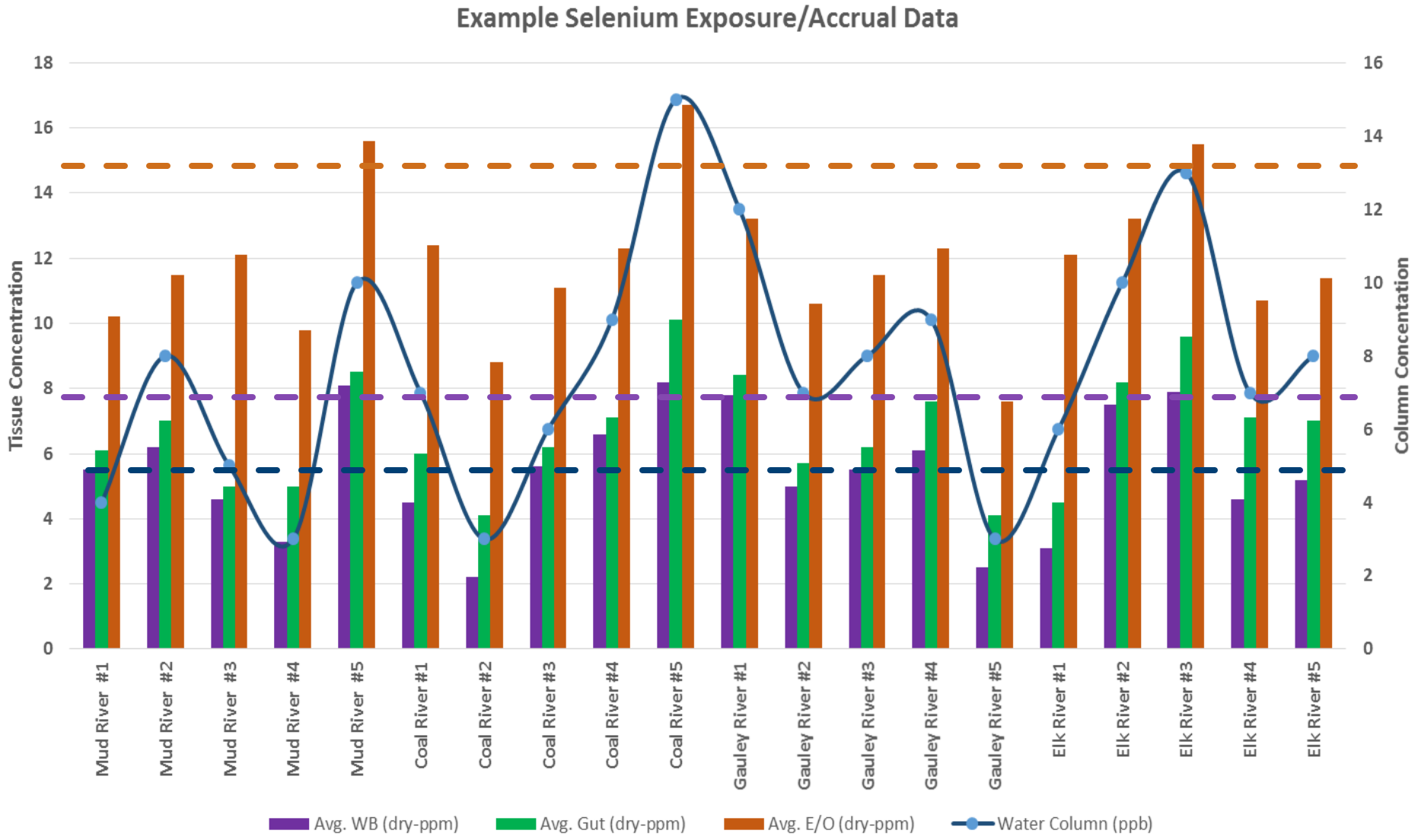
Importance of Context



Species Targeted:

- ✓ Golden Redhorse
- ✓ Central Stoneroller
- ✓ Striped Shiner
- ✓ Creek Chub
- ✓ Blacknose Dace
- ✓ White Sucker
- ✓ Green Sunfish
- ✓ Bluegill Sunfish
- ✓ Largemouth Bass

Hypothetical Scenario



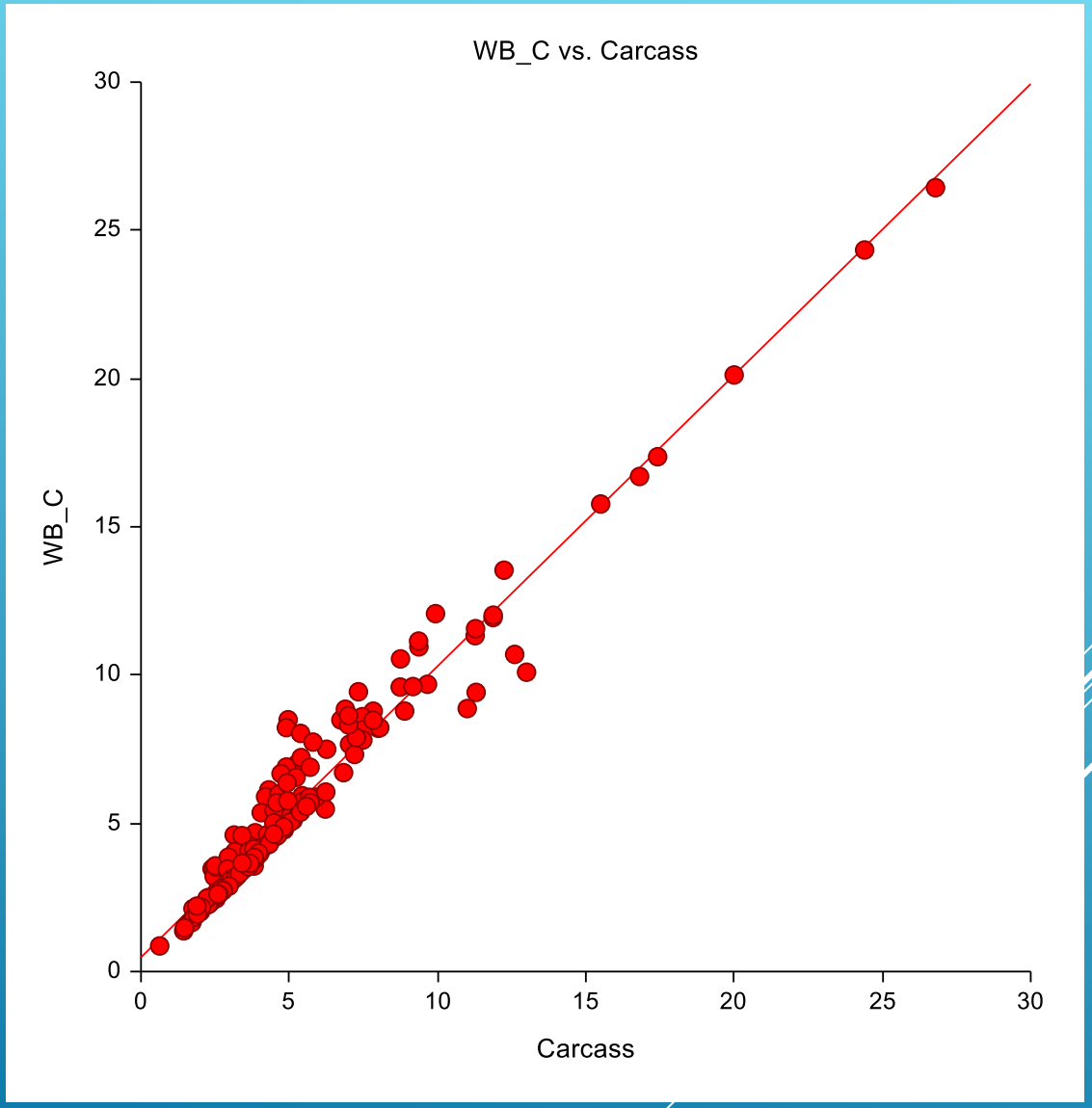
Hypothetical Scenario

Example WB Threshold Determination: Stoneroller

Data Development

Citical Decisions

- Site exclusions
- Sample size and community-level analyses
- Deformity analyses and graduated severity index: fitness and reproductive capacity
- Data gaps and all available information
- Threshold analyses and accrual phenomena



Data Development

Design Assumptions

- Deformity rates not exclusive to selenium exposure
- Individual variation (morphometrically) present at earliest life stages
- Certain developmental conditions (e.g., slight edema) may be recoverable

Moving Forward…

Threshold calculation and publication:

- Thresholds for tissue matrices (whole body or egg/ovary) established @ EC_{10} larval deformity rates
- Community-level tissue/deformity relationships established for use in small streams
- Effluent limits and water column concentrations established to prevent tissue exceedances
- Submit for publication

Plight of the Polar Bear: the hidden role of selenium

Global Climate Change and Selenium: the deadliest nexus

Decline of the Delta Smelt and Selenium: an unbelievable relationship

DEP's Emergency (Se) Rule

- Submitted and approved by the WV SOS, October 2015

- Specified tissue-based chronic aquatic life criteria:
  - -8.0 ppm for whole body matrices
  - -15.8 ppm for egg/ovary matrices

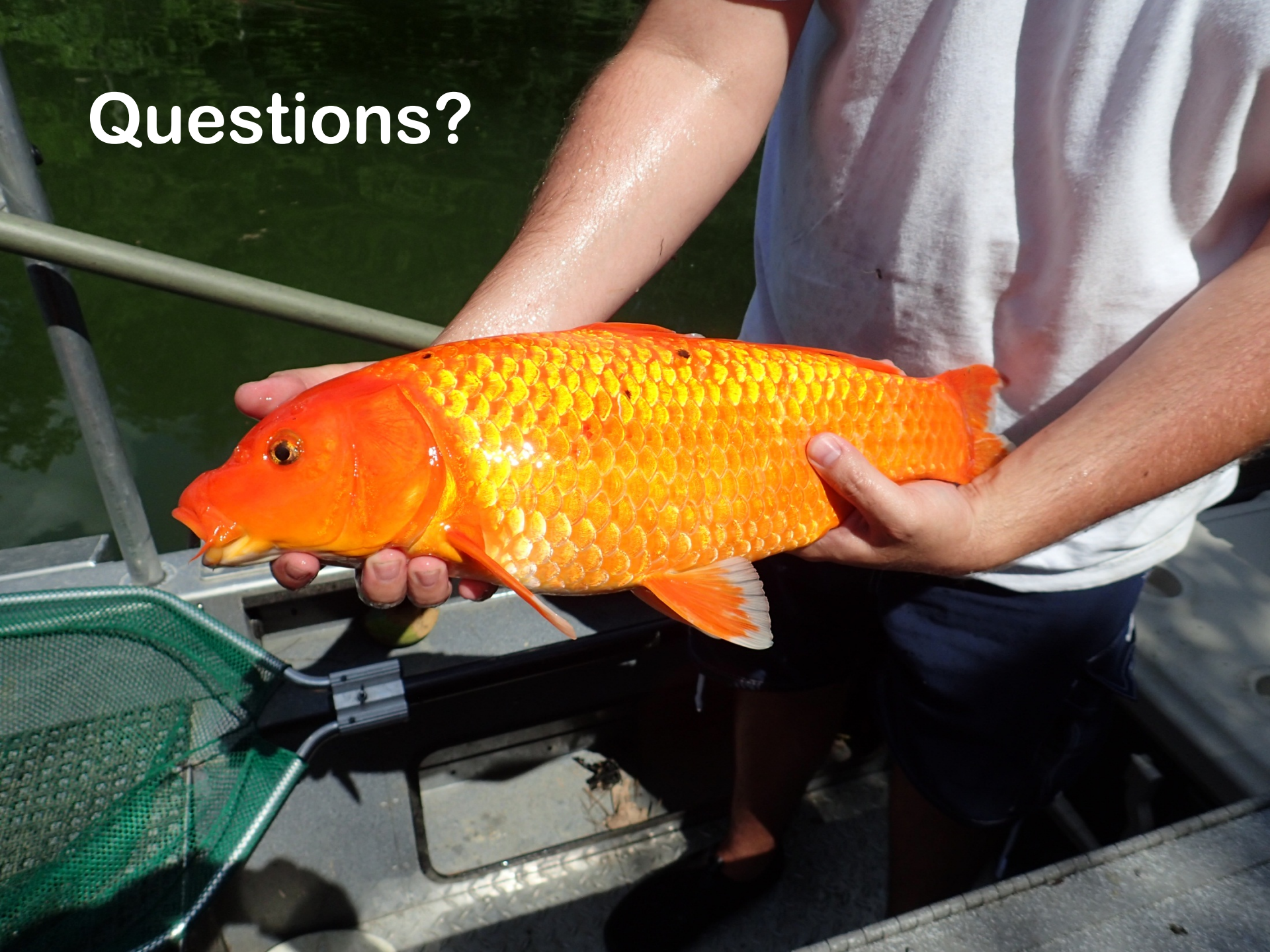
- Tissue information overrides any water column information

- EPA provided "views" of the proposed rule, February 2016
  - -Concern regarding egg/ovary concentrations
  - -Recommends tissue endpoint utilizing muscle/fillet
  - -Concerned for protection of endangered species

- WV Legislature did not consider the rule during the 2016 regular session

Meanwhile, at EPA…

- Attempting to finalize tissue-based criteria since 2004:
  - 7.91 ppm whole body
  - 5.85 ppm whole body (overwintering)
- Revised criteria in 2008, replicating WSS study:
  - Approx. 10 ppm whole body (bluegill)
- Published draft aquatic life criterion for Se in July 2015:
  - Recommends 8.0 ppm whole body
  - Recommends 15.8 ppm egg/ovary*
  - Recommends 11.3 ppm muscle/fillet
  - Utilizes USGS model to derive protective column concs.
  - Translates tissue criteria in lotic waters to 3.1 ppb
  - Translates tissue criteria in lentic waters to 1.2 ppb
- Anticipates criteria finalized in 2016


Questions?