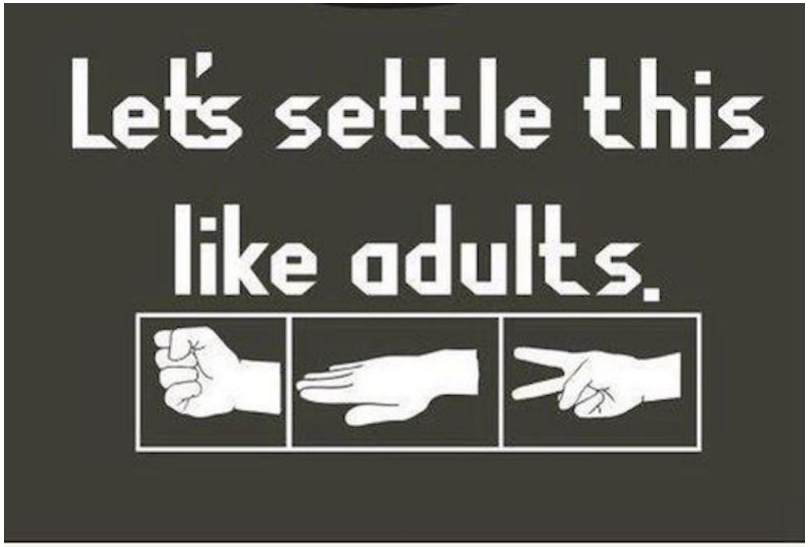
Selenium Fish Tissue Criteria Implementation

Jennie Henthorn, HENV
Kevin Seagle, WVDEP

Selenium Criteria

- Three parts:
  - Water column 5 ug/l
  - Whole body 8.0 µg/g
    or
    Fish Filet 11.3 µg/g
  - Egg/Ovary 15.8 µg/g



- Rock Paper Scissors – Egg/Ovary trumps WB/Filet trumps Water

Implementation of Fish Tissue

- DEP substantially revised *Selenium Chronic Aquatic Life Criteria Implementation*

- Now provides two options for fish tissue selenium limits
  - Bioaccumulation factor is still an option to develop water column limits
  - **Can now get fish tissue limits in the NPDES permit!**

Option 1 (2017):

- No less than two fish tissue samples (cannot mix and match WB and E/O)
- Most recent two years of water column data for instream station.

$$\text{Bioaccumulation Factor (BAF) (L/kg)} = \frac{\text{Tissue Concentration (mg/kg) dry weight}}{\text{Average Water Column Concentration (mg/L)}}$$

$$\text{Protective Water Column Concentration (mg/L)} = \frac{\text{Se Fish Tissue Criterion (mg/kg)}}{\text{BAF (L/kg)}}$$

- Will receive "translated" effluent limits at the outlet.

Option 2 (new in 2018):

- Instream compliance point is assigned for each outlet.
- Sampling point must be “nearest practicable location downstream of the outlet(s) with adequate fish community”
- Baseline fish tissue study and water column sample must be submitted with the permit application for each instream compliance point
- DEP must approve instream compliance points prior to sampling

What if exceed fish tissue criteria?

- If fish tissue limits are exceeded more than two times in rolling 24-month period, must submit permit application Option 1 (site-specific BAF effluent limits)

Implementation of Water Column

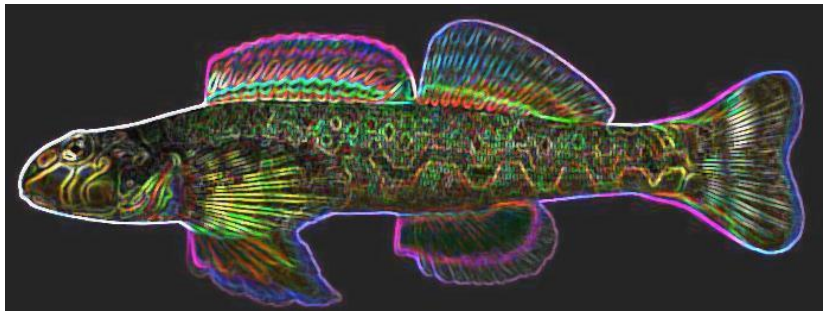
- Nothing Changes!!! (Except …)
- **On-bench outlets** –Precipitation Induced Policy takes you to benchmarks -- must apply for this (another IMPORTANT topic)
- Fish tissue implementation is an option, not a requirement

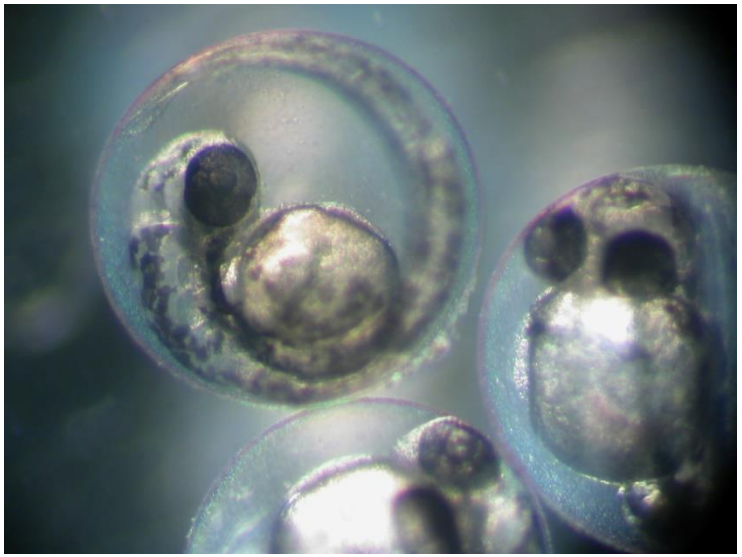
Study Plan Submittal

- Identify the proper stream location to represent your outlets
  - Must be of adequate size to have fish – previous surveys or field reconnaissance
- Target species are two most abundant minnow species and sunfish if resident.
- Compliance monitoring:
  - Good location is vital
  - Repeatable surveys
  - Consistent community composition
  - Baseline study establishes community members and compliance with tissue standard
  - KNOW WHAT YOU ARE SUBMITTING

Study Plan Submittal

- BAF option – can be applied to any outlet
- Semi-annual tissue compliance monitoring – applies to discharging outlets only (reported discharge within the last year)
- Sample plan submitted to WVDEP for review and approval (contact David Nichols)





Study Plan Submittal

- Unsure which method?
- Submit plan for semi-annual compliance monitoring.
- Site will work for BAF option
- Not guaranteed vice versa
  - Discharging outlets only

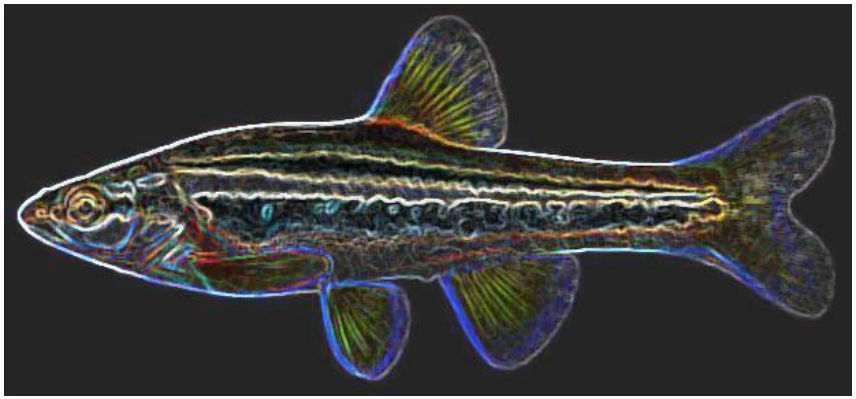


Table 3.4. Tested Reproductive-Effect Whole Body (WB) Concentrations Measured Directly or Converted to WB Concentrations from Egg-Ovary (EO) Concentrations.

Taxon*	EO Chronic Value	EO/WB CF	Direct or Calculated WB Repro Chronic Value	Direct Calculation or Basis for EO/WB CF (from Appendix B)
Salvelinus	56.2	1.61	34.9	Dolly Varden EO/M (1.26) x all fish M/WB (1.27)
Esox	34.0	2.39	14.2	Northern pike EO/M (1.88) x all fish M/WB (1.27)
Cyprinodon	27.0	1.20	22.6	Desert pupfish EO/WB
O. mykiss	24.5	2.44	10.0	Rainbow trout EO/M (1.92) x all fish M/WB (1.27)
Rudolph et al. 2008	24.7	1.96	12.6	*Oncorhynchus* EO/WB
Nautilus 2011	27.7	1.96	14.1	*Oncorhynchus* EO/WB
O. clarkii	26.2	NA	13.3	Geometric mean of two studies
Oncorhynchus	25.3	NA	11.6	Geometric mean of *O. mykiss* and *O. clarkii* WB SMCVs
Micropterus	26.3	1.42	18.5	*Micropterus* EO/WB
Salmo	21.0	NA	13.2	Directly calculated EC_{10}
Coyle et al. 1993	26.3	NA	8.6	Directly calculated EC_{10}
Doroshov et al. 1992a	22.6	2.13	10.6	Bluegill sunfish EO/WB
Hermanutz et al. 1992, 1996	14.7	NA	10.6	Directly calculated EC_{10}
Lepomis	20.6	NA	9.9	Geometric mean of three studies
Acipenser	15.6	1.69	9.2	White sturgeon EO/M (1.33) x all fish M/WB (1.27)

* The GMCV for *Gambusia*, a live bearer, not included in the conversion table, was originally measured as adult WB, not EO, and is >13.38 mg Se/kg dw WB. The "greater than" sign signifies that no effects were found at the highest observed concentrations. This table also excludes *Pimephales* due to uncertainty in the chronic value for the Schultz and Hermanutz (1990) study (See Appendix C for details).

Table 1. Summary of the Recommended Freshwater Selenium Ambient Chronic Water Quality Criterion for Protection of Aquatic Life.

Media Type	Fish Tissue[1]		Water Column[4]	
Criterion Element	**Egg/Ovary [2]**	**Fish Whole Body or Muscle [3]**	**Monthly Average Exposure**	**Intermittent Exposure[5]**
Magnitude	15.1 mg/kg dw	8.5 mg/kg dw whole body or 11.3 mg/kg dw muscle (skinless, boneless filet)	1.5 µg/L in lentic aquatic systems 3.1 µg/L in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurement[6]	Instantaneous measurement[6]	30 days	Number of days/month with an elevated concentration
Frequency	Not to be exceeded	Not to be exceeded	Not more than once in three years on average	Not more than once in three years on average

1. Fish tissue elements are expressed as steady-state.
2. Egg/Ovary supersedes any whole-body, muscle, or water column element when fish egg/ovary concentrations are measured.
3. Fish whole-body or muscle tissue supersedes water column element when both fish tissue and water concentrations are measured.
4. Water column values are based on dissolved total selenium in water and are derived from fish tissue values via bioaccumulation modeling. Water column values are the applicable criterion element in the absence of steady-state condition fish tissue data.
5. Where WQC30-day is the water column monthly element, for either a lentic or lotic waters; C_{bkgrnd} is the average background selenium concentration, and fint is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).
6. Fish tissue data provide instantaneous point measurements that reflect integrative accumulation of selenium over time and space in fish population(s) at a given site.

WVDEP Se Aquatic Life Standard

PARAMETER	B1, B4 (warmwater fisheries & wetlands)		B2 (trout waters)	
	ACUTE[1]	CHRON[2]	ACUTE[1]	CHRON[2]
8.27 Selenium (ug/l) Water Column Concentration [f]		5		5
8.27.1 Selenium (ug/g) [g] (based on instantaneous measurement) 8.0 ug/g Fish Whole-Body Concentration or 11.3 ug/g Fish Muscle (skinless, boneless filet)		X		X
8.27.2 Selenium (ug/g) Fish Egg/Ovary Concentration [h] (based on instantaneous measurement)		15.8		15.8

Why tissue?

- Water column criteria derived to be protective in worst case scenarios and are much less predictive of toxic effects
- Bioaccumulation is site-specific (lentic, lotic, resident biota), species-specific (fish), and dependent upon selenium form

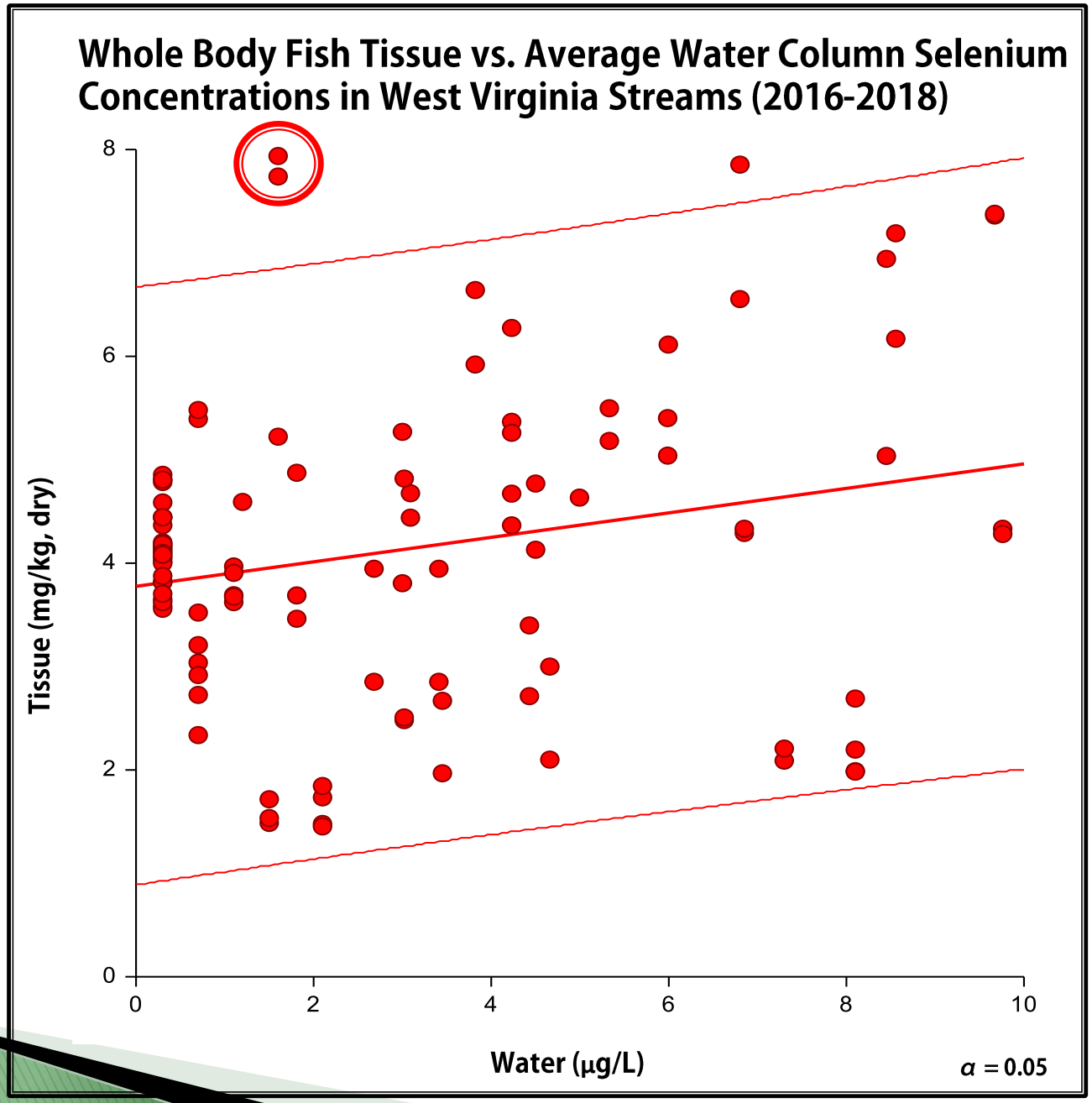
Table 2.1. Predominant Chemical Forms of Selenium in Discharges Associated with Different Activities and Industries.

Selenium Form	Sources
Selenate	Agricultural irrigation drainage Treated oil refinery effluent Mountaintop coal mining/ valley fill leachate Copper mining discharge
Selenite	Oil refinery effluent Fly ash disposal effluent Phosphate mining overburden leachate
Organoselenium	Treated agricultural drainage (in ponds or lagoons)

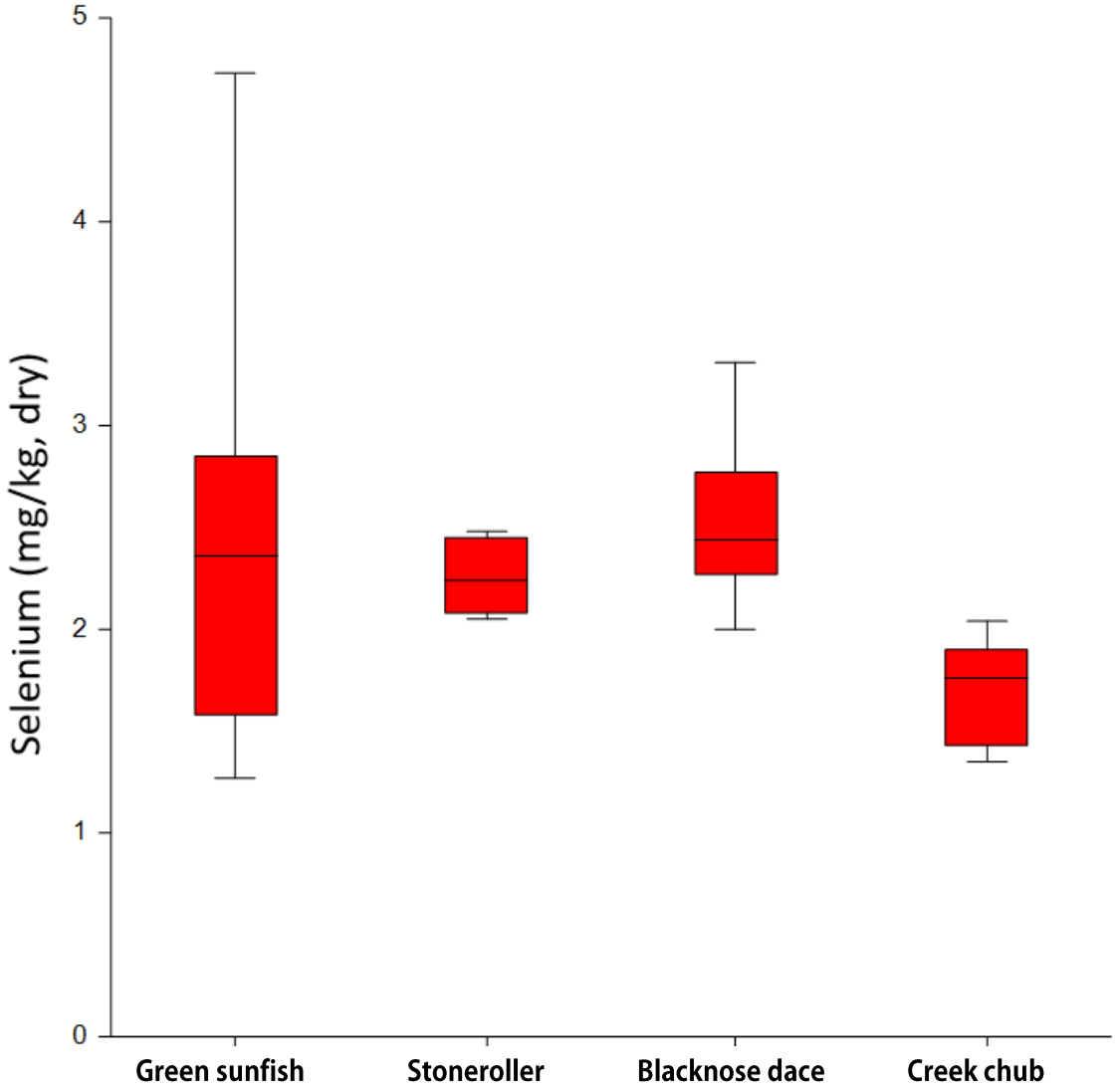
Source: Presser and Ohlendorf 1987; Zhang and Moore 1996; Cutter and Diego-McGlone 1990.

Selenium tissue data within WV

- Most all coal mining discharges within the state of WV:
  - Lotic – flowing waters = lower bioaccumulation
  - Selenate – least bioaccumulative oxyanion
  - Sensitive species are rarely present
- Existing water quality criteria are overprotective in most flowing waters within the State of WV


Whole Body Fish Tissue vs. Average Water Column Selenium Concentrations in West Virginia Streams (2016-2018)
Tissue (mg/kg, dry)
Water (µg/L)
α = 0.05
0
2
4
6
8
10

Background Whole Body Selenium Tissue Concentrations for Common Lotic Target Species in West Virginia



Calculator at low Se concentrations

Protective Selenium Water Column Concentration Calculator (Whole Body - 8.0 mg/kg)

Fish Tissue

	Composite Wet Weight (mg/kg)	% Moisture	Composite Dry Weight (mg/kg)
Species 1	1.8		1.8
Species 2	2.2		2.2
Species 3	2.5		2.5

* ensure values entered are wet weight and % moisture (not % solids)

** if you have dry weight enter it under wet weight with % moisture value of 0

Water Column

Average Water Column Se Exposure (mg/L)
0.0003

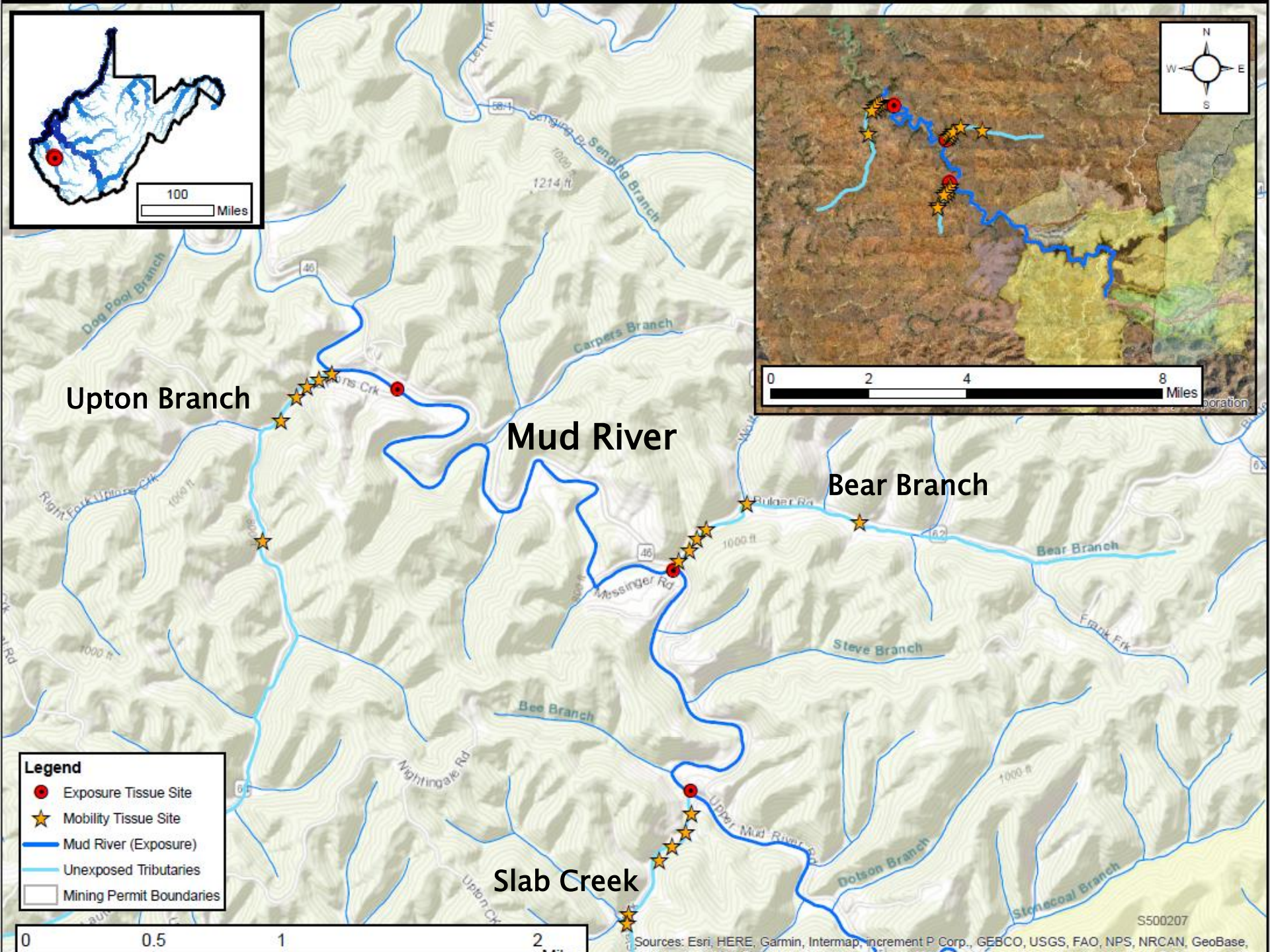
*ensure units are mg/L (0.0056) **not** µg/L (5.6)

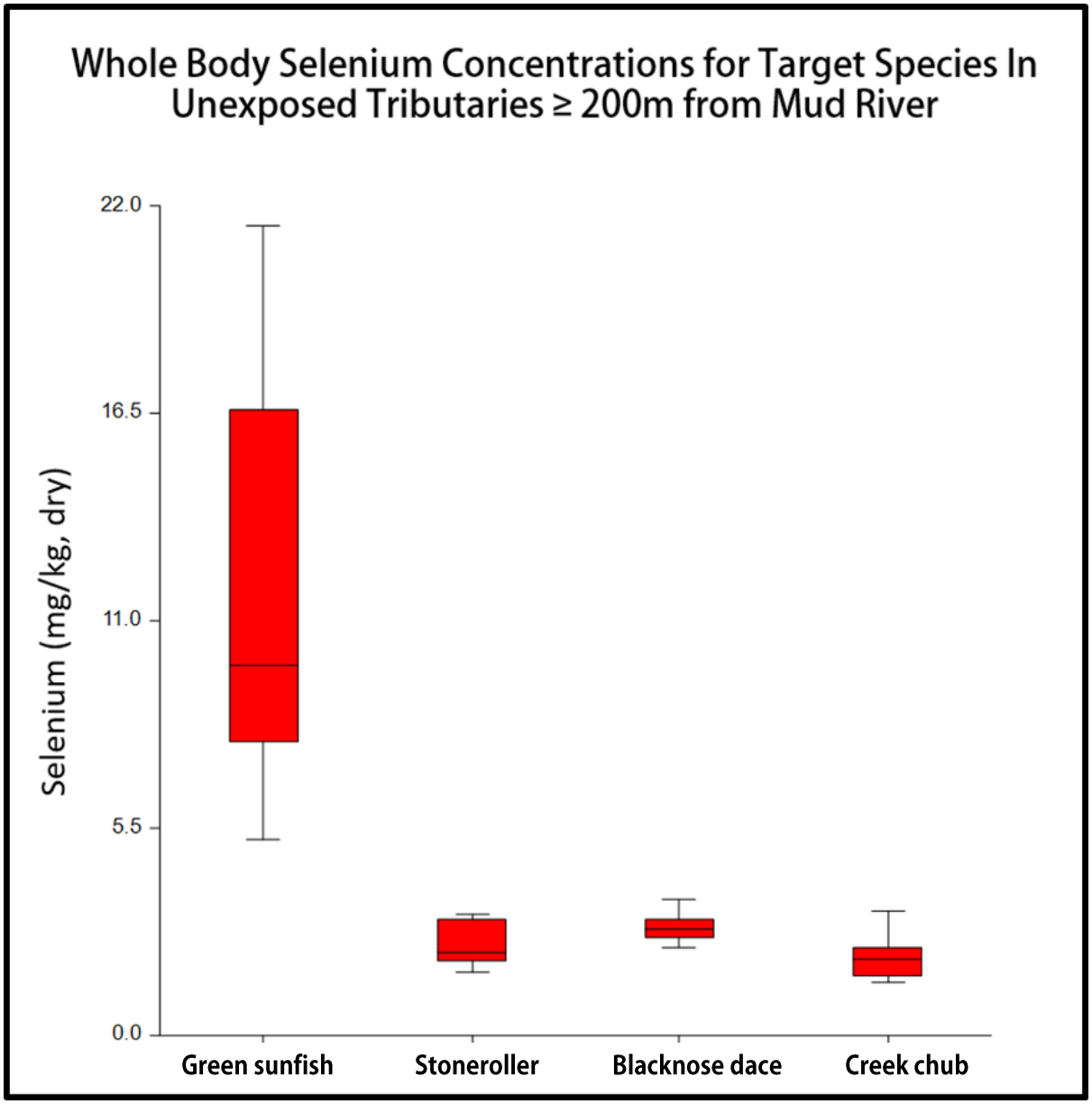
** minimum 12 months bimonthly samples for existing sites, 6 months @ new sites

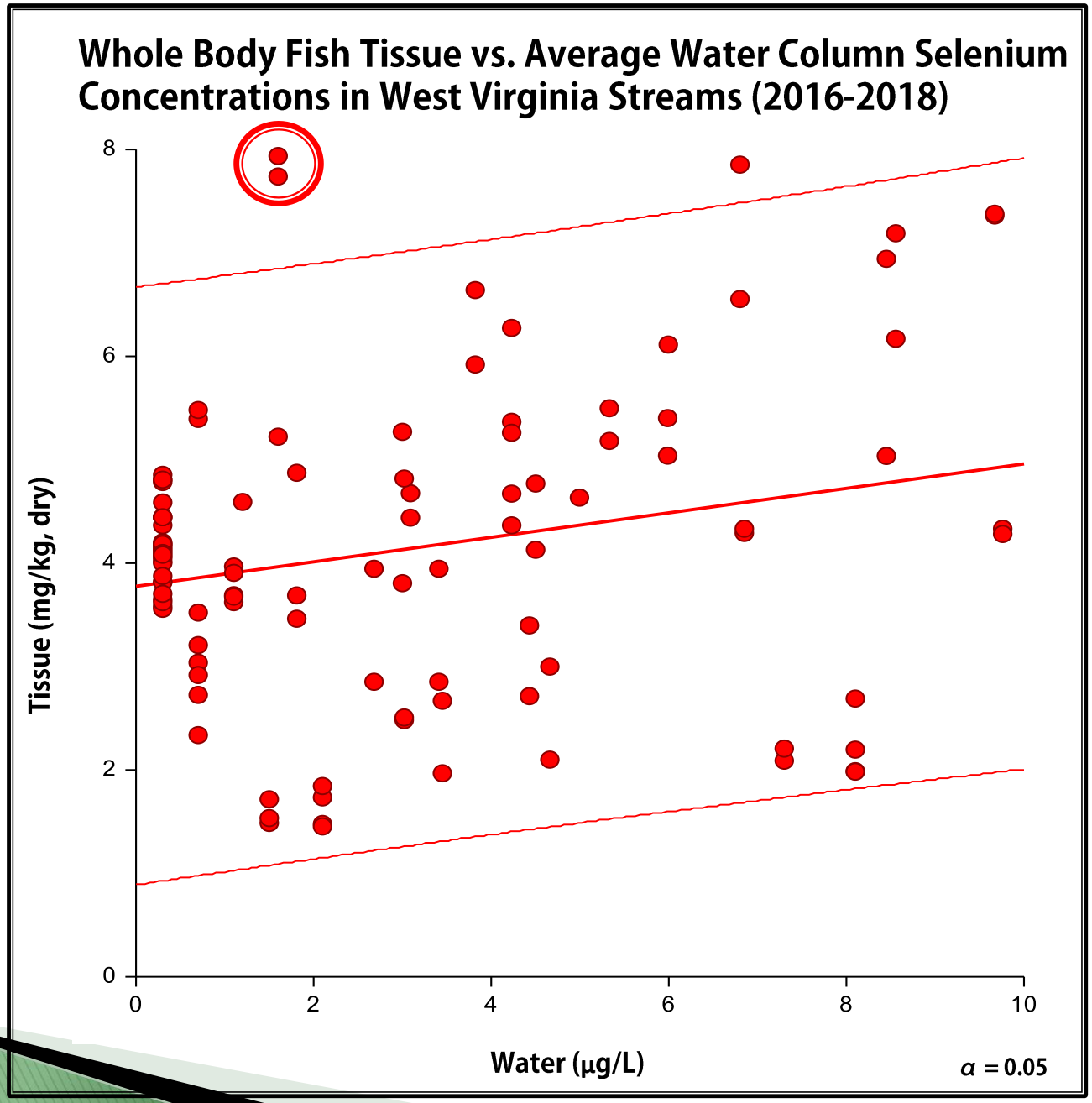
BAF (L/kg)
6000
7333.333333
8333.333333

	Column (mg/L)
Species 1	0.001333333
Species 2	0.001090909
Species 3	0.00096

Protective Se Water Column Concentration (mg/L)
0.00096


Upton Branch
Mud River
Bear Branch
Slab Creek
Dog Pool Branch
Carpers Branch
Right Fork Upton Crk
Messinger Rd
Bulger Rd
Bear Branch
Steve Branch
Frank Frk
Bee Branch
Nightingale Rd
Upper Mud River Rd
Dotson Branch
Stonecoal Branch
Sengina Br Sengina Branch
1214 ft
100 Miles
0 2 4 8 Miles
N
W
E
S
Legend
Exposure Tissue Site
Mobility Tissue Site
Mud River (Exposure)
Unexposed Tributaries
Mining Permit Boundaries
0 0.5 1 2
S500207
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase,


Whole Body Selenium Concentrations for Target Species In Unexposed Tributaries ≥ 200m from Mud River
Selenium (mg/kg, dry)
22.0
16.5
11.0
5.5
0.0
Green sunfish
Stoneroller
Blacknose dace
Creek chub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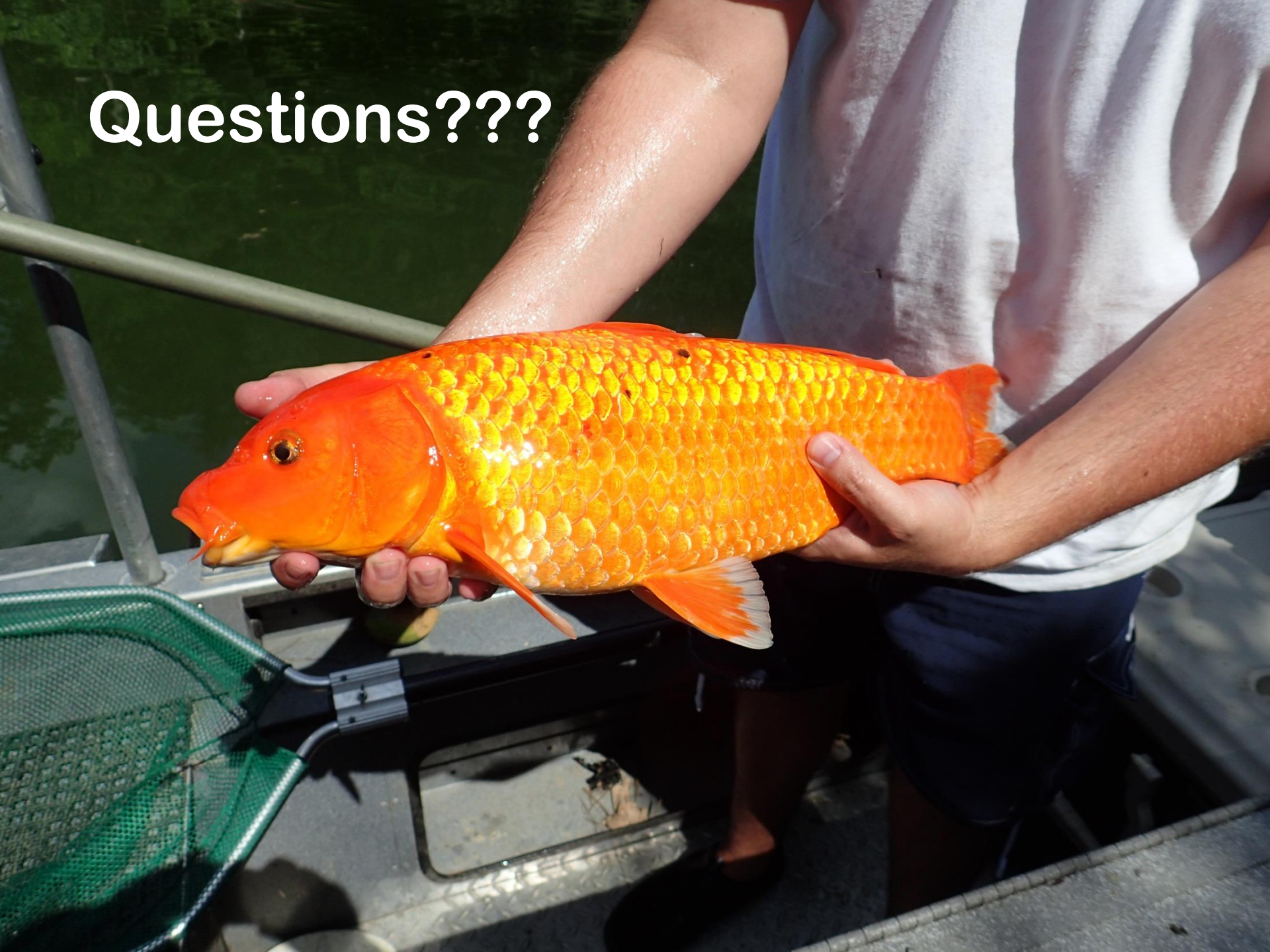
dep


Questions???