

Ohio River Methyl Mercury Bioaccumulation Study

Agenda Item 13

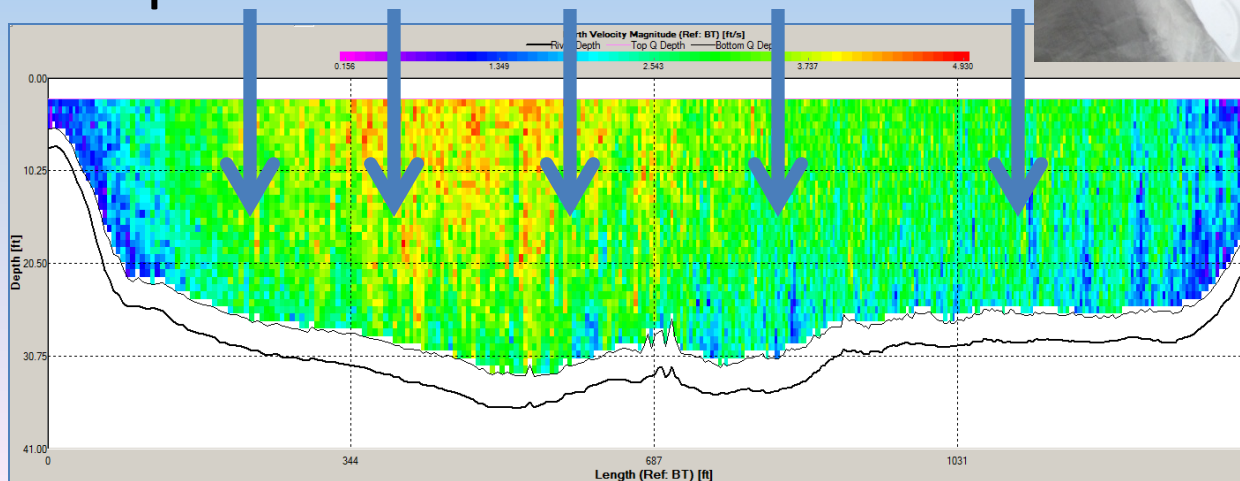
205th ORSANCO Technical Committee Meeting
June 10-11, 2014 Evansville, Indiana,

Methylmercury in the Ohio River

- 45 Ohio River Aqueous MeHg samples collected since 2010
 - 3 completed projects, no currently scheduled sampling
- Fish tissue MeHg analysis began in 2009 will continue
- 195 tissue results, most 3-fish composites

Water Sampling for Methyl Mercury Equal Discharge Increment (EDI) Method

- Clean Hands Technique (USEPA Method 1669)
- Fluoropolymer Equipment
- Composite of 5 EDI, isokinetic, depth-integrated vertical samples

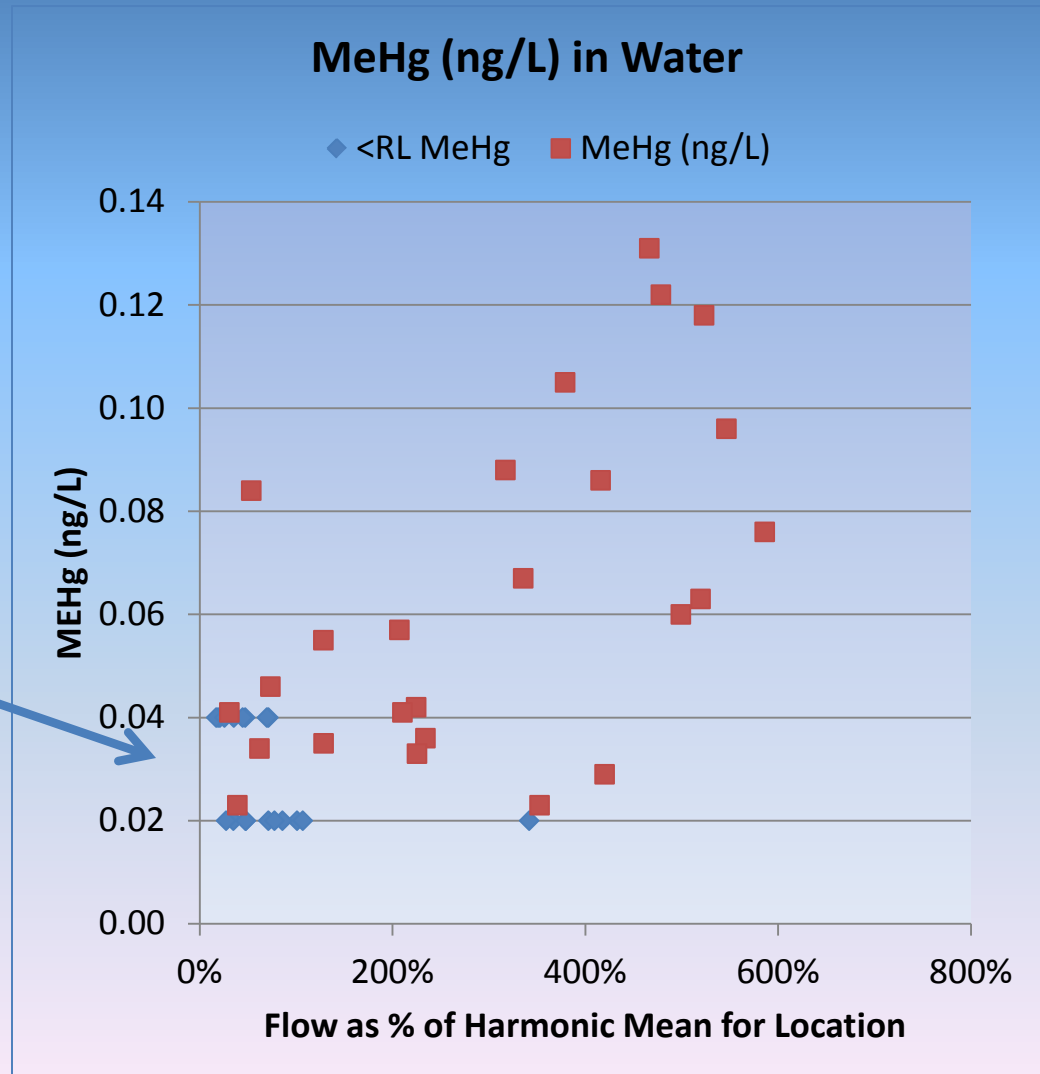


MeHg in Water

- Ohio River Aqueous MeHg

- 45 samples, 26 detections
- Median unfiltered MeHg Concentration **0.034 ng/L**

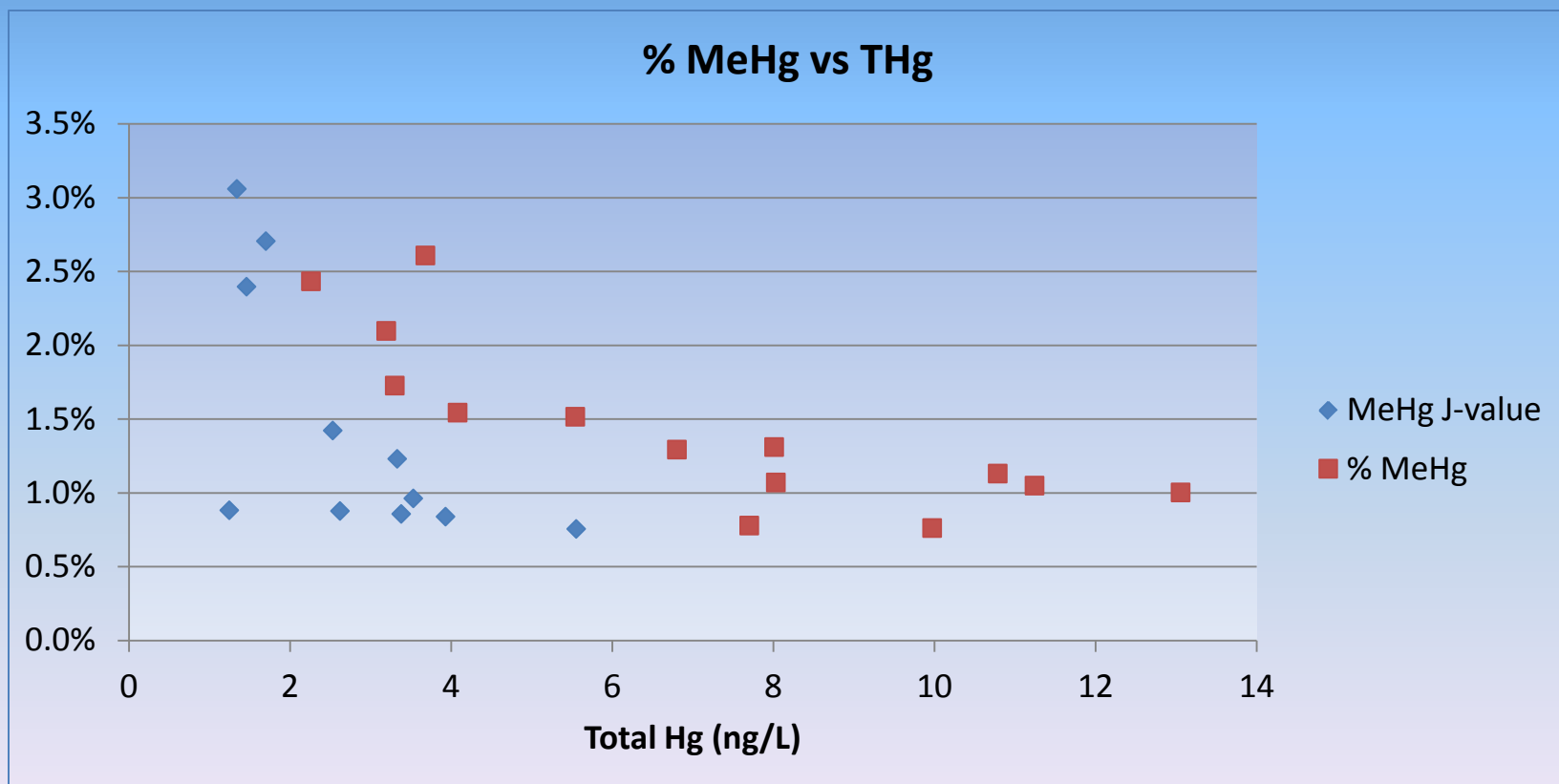
- Kaplan-Meier Estimate



MeHg as Percent of Total Hg

Percent MeHg of THg (25 paired detections)

Max 3.1%, Min 0.8%, **Geometric Mean 1.3%**,



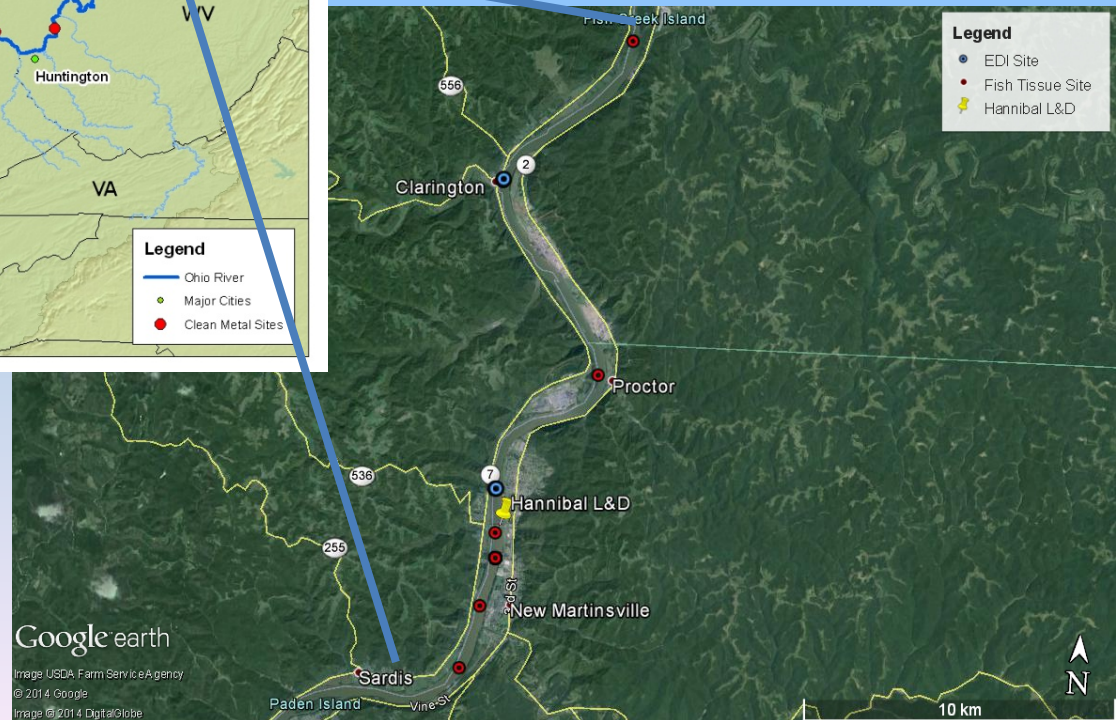
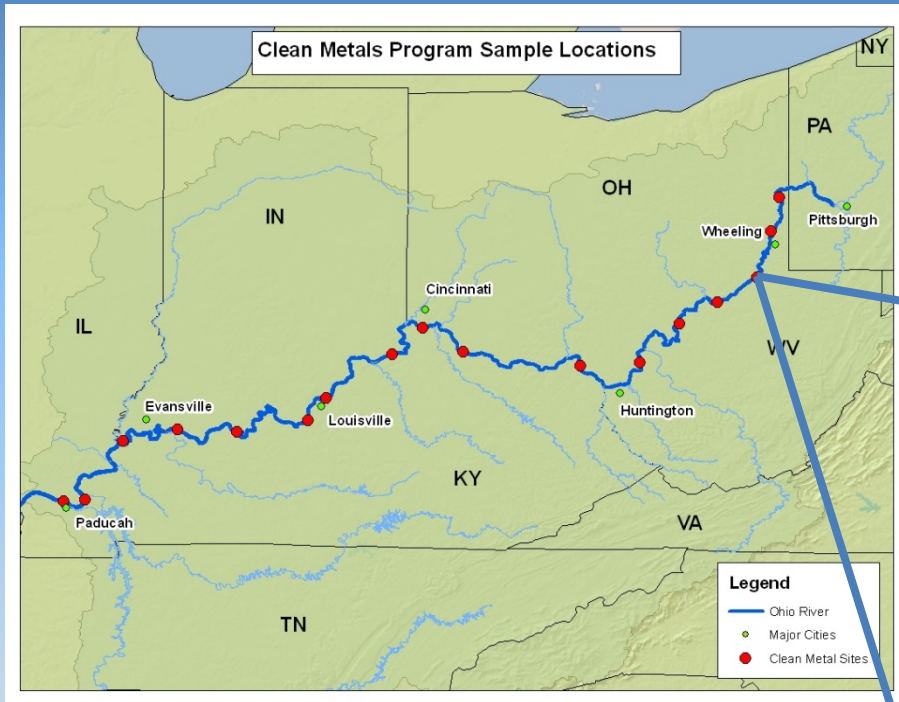
MeHg Bioaccumulation Factor BAF Project

- Variance requested by chlor-alkali facility near Hannibal L&D, **Ohio River mile 126**



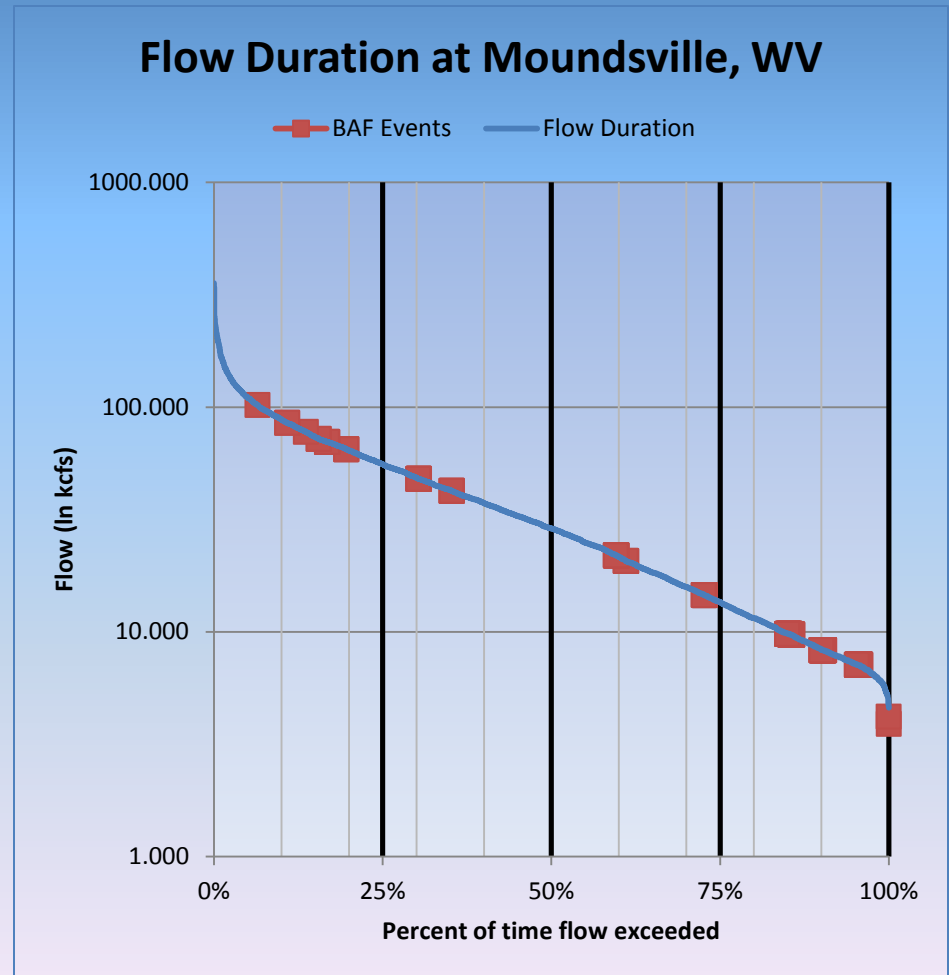
MeHg BAF Project Location

- Water Samples at Mile 126 and 118
- Tissue Samples from miles 112-131



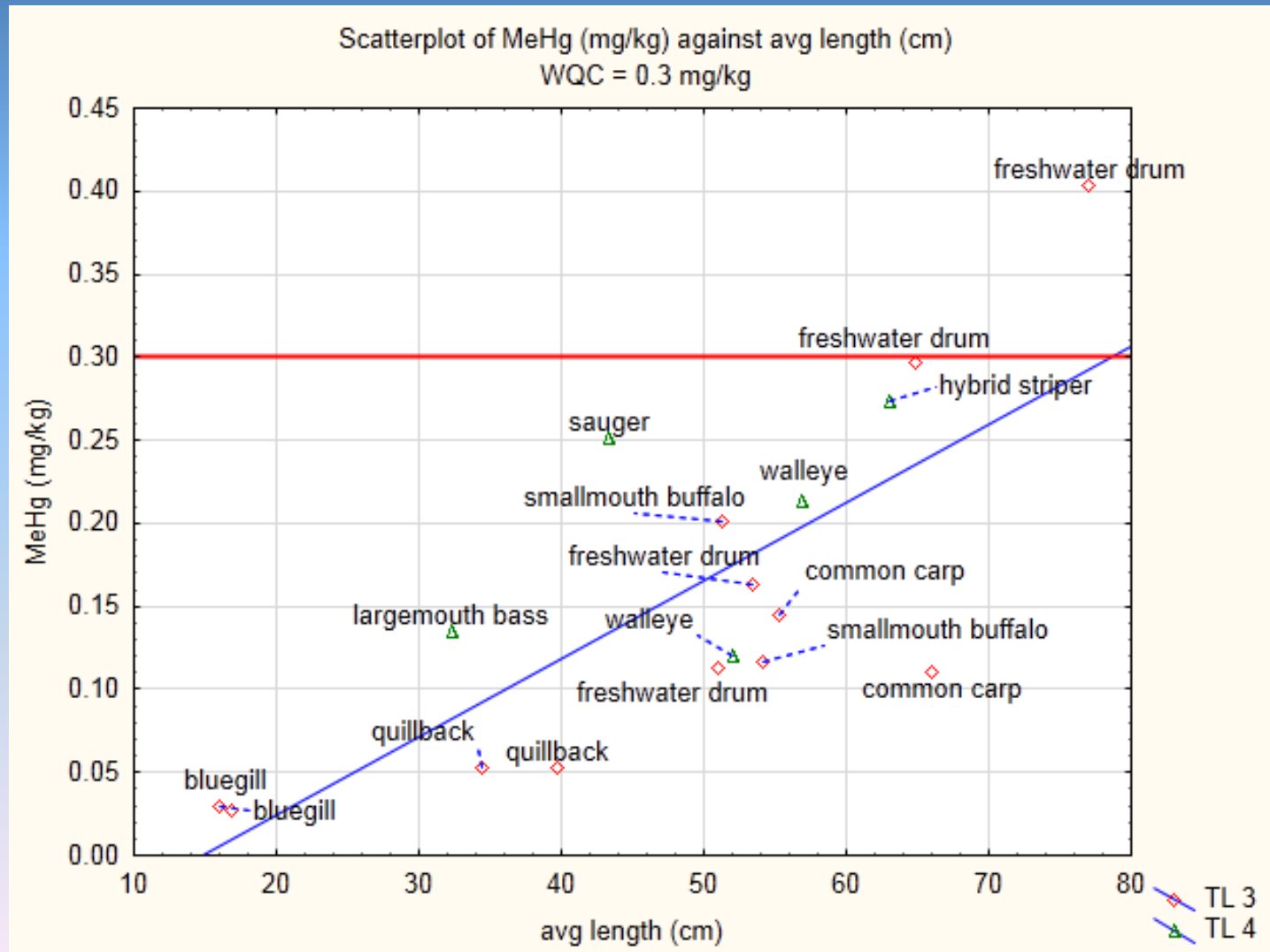
Data Collected for Mile 126 BAF

- MeHg and THg Water Data
 - 12 monthly EDI samples Aug 2012 – July 2013
 - 6 EDI Samples July-Sept 2010 (USGS Cooperative)
- MeHg and Total Hg Tissue Data
 - 17 composites collected 2010-2013
 - 12 Trophic Level 3
 - 5 Trophic Level 4



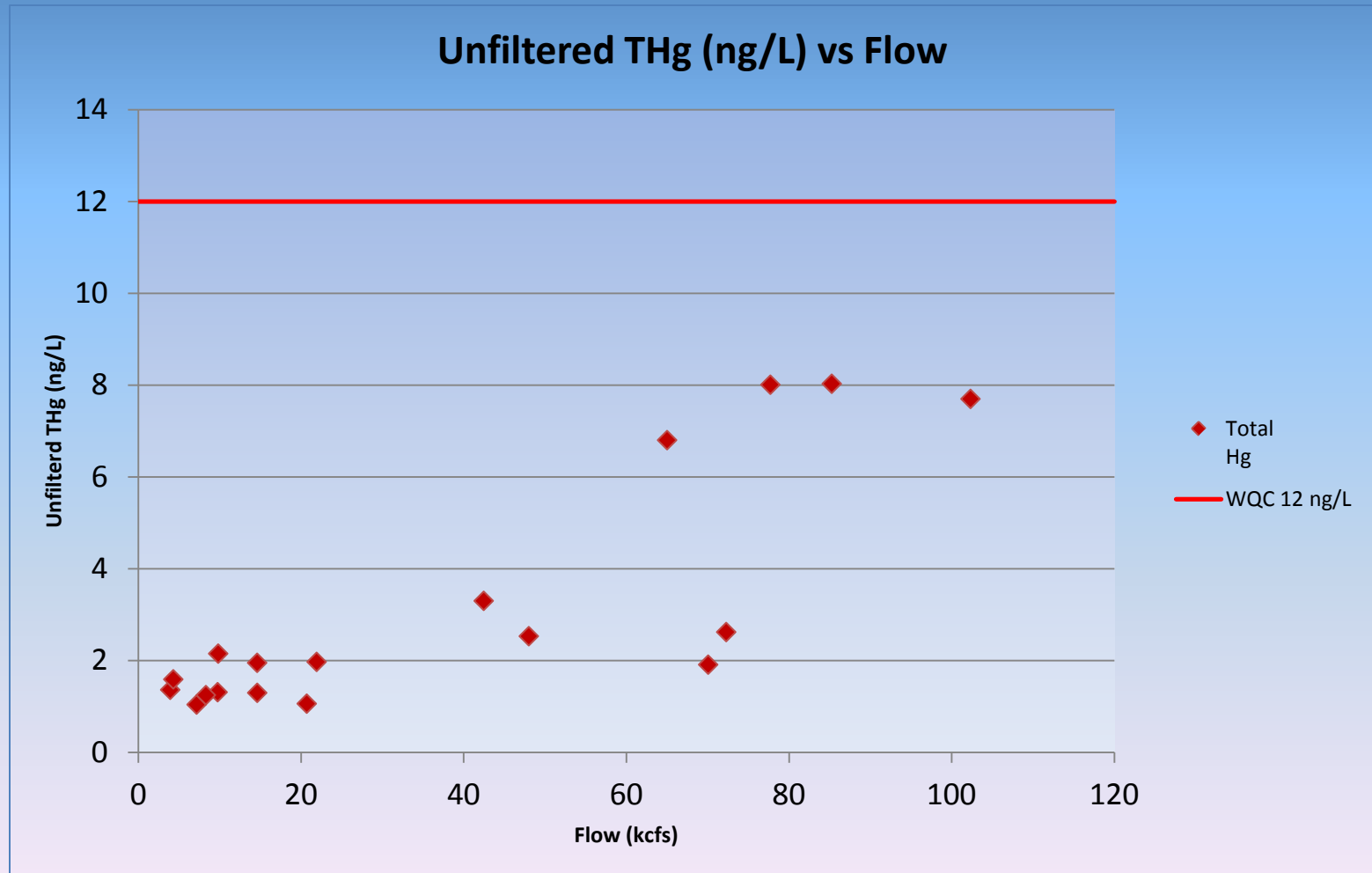
MeHg in Tissue Near Hannibal Dam

ORM 113-129, 2010-2013



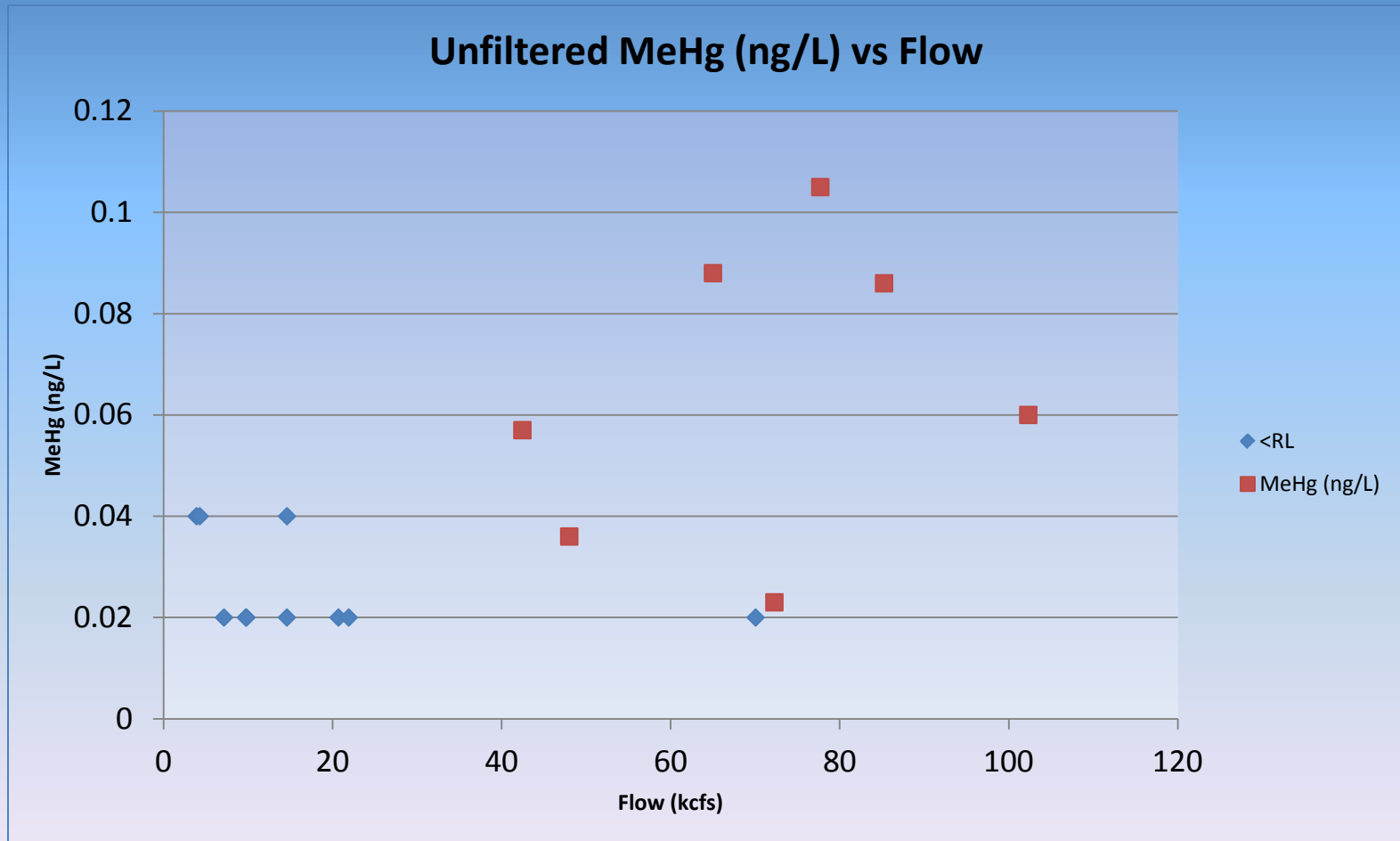
THg in Water near Hannibal Dam

Data collected for Mile 126 BAF 2010-2013



MeHg in Water near Hannibal Dam

Data collected for Mile 126 BAF 2010-2013



BAF Calculation $CW_{est.DMeHg}$

Project	Date	Flow	Total Hg	Methyl Hg	% MeHg	Est MeHg (1.3%)	Est DMeHg (49%)
BAF Project	Jul-12	<div><div></div></div> 7,144	<div><div></div></div> 1.04	<0.02		0.014	0.007
	Aug-12	<div><div></div></div> 9,800	<div><div></div></div> 2.15	<0.02		0.028	0.014
	Sep-12	<div><div></div></div> 14,591	<div><div></div></div> 1.95	<0.02		0.025	0.012
	Oct-12	<div><div></div></div> 9,731	<div><div></div></div> 1.31	<0.02		0.017	0.008
	Nov-12	<div><div></div></div> 20,689	<div><div></div></div> 1.06	<0.02		0.014	0.007
	Dec-12	<div><div></div></div> 47,995	<div><div></div></div> 2.53	0.036	1.4%	0.033	0.016
	Jan-13	<div><div></div></div> 102,310	<div><div></div></div> 7.7	0.060	0.8%	0.100	0.049
	Feb-13	<div><div></div></div> 70,051	<div><div></div></div> 1.91	<0.02		0.025	0.012
	Mar-13	<div><div></div></div> 72,268	<div><div></div></div> 2.62	0.023	0.9%	0.034	0.017
	Apr-13	<div><div></div></div> 85,246	<div><div></div></div> 8.03	0.086	1.1%	0.104	0.051
	May-13	<div><div></div></div> 21,906	<div><div></div></div> 1.97	<0.02		0.026	0.013
	Jun-13	<div><div></div></div> 42450	<div><div></div></div> 3.3	0.057	1.7%	0.043	0.021
USGS Coop (118)	May-10	<div><div></div></div> 65,000	<div><div></div></div> 6.802	0.088	1.3%	0.088	0.043
	Jul-10	<div><div></div></div> 8,290	<div><div></div></div> 1.246	0.011	0.9%	0.016	0.008
	Sep-10	<div><div></div></div> 3,900	<div><div></div></div> 1.362	<0.04		0.018	0.009
USGS Coop (126)	May-10	<div><div></div></div> 77,700	<div><div></div></div> 8.009	0.105	1.3%	0.104	0.051
	Jul-10	<div><div></div></div> 14,600	<div><div></div></div> 1.296	<0.04		0.017	0.008
	Sep-10	<div><div></div></div> 4,280	<div><div></div></div> 1.59	<0.04		0.021	0.010
			Geometric Mean of Estimated MeHg				0.015

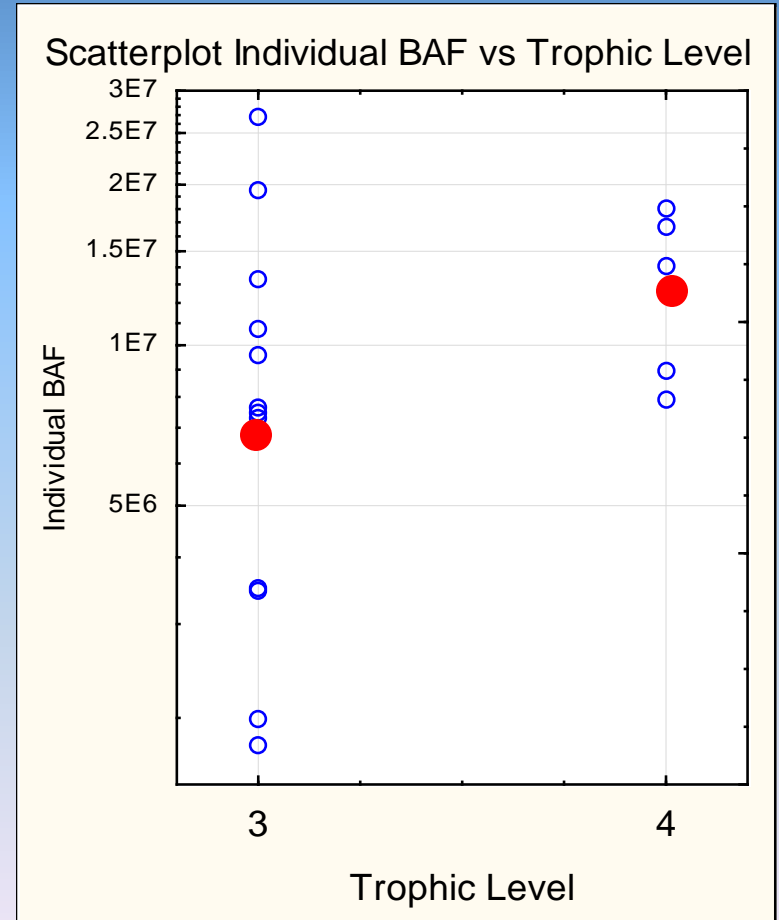
BAF Calculation CT_{MeHg}

Date Collected	Sample Mile	Common Name	Trophic Level	avg length (cm)	Hg (mg/kg)	MeHg (mg/kg)	% MeHg
4/22/2010	113.8	freshwater drum	3	64.83	0.464	0.297	64%
4/22/2010	129.3	freshwater drum	3	77	0.431	0.404	94%
11/7/2012	127	freshwater drum	3	51	0.229	0.113	49%
11/7/2012	127	bluegill	3	16.9	0.0531	0.027	51%
11/7/2012	127	quillback	3	34.5	0.0841	0.0532	63%
11/7/2012	127	common carp	3	66	0.173	0.111	64%
11/7/2012	127	smallmouth buffalo	3	54.2	0.172	0.116	67%
4/2/2013	127	bluegill	3	16	0.0488	0.03	61%
4/2/2013	127	quillback	3	39.67	0.0831	0.0524	63%
4/2/2013	127	freshwater drum	3	53.5	0.226	0.163	72%
4/2/2013	127	smallmouth buffalo	3	51.3	0.261	0.201	77%
4/2/2013	127	common carp	3	55.3	0.163	0.145	89%
Trophic Level 3 GeoMetric Mean						0.105	
5/12/2010	128	hybrid striper	4	63	0.496	0.273	55%
6/1/2010	126.5	largemouth bass	4	32.33333	0.149	0.135	91%
11/7/2012	127	walleye	4	56.8	0.309	0.214	69%
4/2/2013	127	walleye	4	52	0.162	0.12	74%
7/17/2013	122.2	sauger	4	43.3	0.3	0.252	84%
Trophic Level 4 GeoMetric Mean						0.189	

BAF Calculation

$$BAF = \frac{CT_{MeHg}}{CW_{est.DMeHg}}$$

- TL3 $CT_{MeHg} = 0.105 \text{ mg/kg (GM)}$
- TL4 $CT_{MeHg} = 0.189 \text{ mg/kg (GM)}$
- $CW_{est.DMeHg} = 0.015 \text{ ng/L (GM)}$
 $= CW_{est.DMeHg} = 1.51 \times 10^{-8} \text{ mg/L}$
- TL3 BAF = 7.0×10^6
- TL4 BAF = 1.2×10^7



Compared MeHg BAF

Water Est. DMeHg Hg to Tissue Methyl Hg Ohio River Mile 126

- USEPA Draft BAF used converted (estimated) data
- USEPA Translator $\text{MeHg}_d/\text{Hg}_t = 0.014$ (1.4%)
- ORSANCO DMeHg concentrations estimated by observed percent methyl mercury (1.3%) $\times F_D =$ (49%)

ORSANCO Converted (est.)
DMeHg in Water BAF

TL	ORSANCO BAF
TL3	7.0E+06
TL4	1.2E+07

Draft National BAF
*USEPA Methylmercury Water Quality
Criterion 1/3/01*

TL	Draft Nat.
TL3	6.8E+05
TL4	2.7E+06

EPA BAF Comparison

- ORSANCO BAFs
 - TL3 $7.0E+6$
 - TL4 $1.2E+7$
- January 2001 Water Quality Criterion for the Protection of Human Health: Methylmercury, EPA-823-R-01-001
 - Nearly all USEPA BAF data from the Everglades and Great Lakes

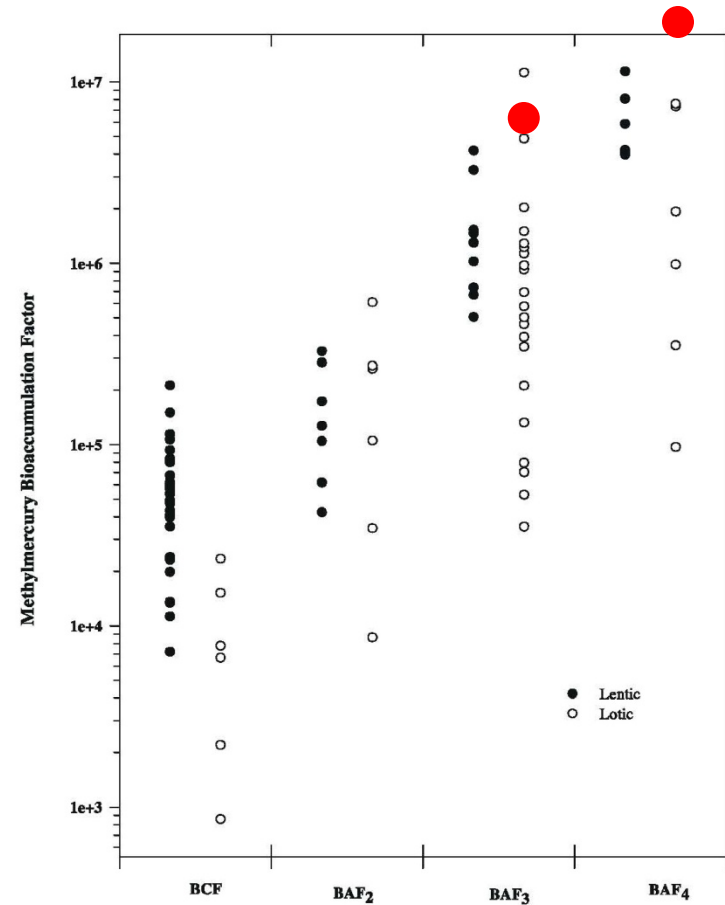


Figure A-3. Comparison of lentic and lotic methylmercury BAFs. Data includes both direct field-measured BAFs and converted field-measured BAFs.

Utilization of USEPA Recommended Methodology for Determining Fish Consumption Use Impairment

Averaging across trophic levels, weighted by national default fish consumption rates.

$$C_{\text{avg}} = \frac{8.0 * C_3 + 5.7 * C_4}{(8.0 + 5.7)}$$

Where:

C_2 = average mercury concentration for trophic level 2

C_3 = average mercury concentration for trophic level 3

C_4 = average mercury concentration for trophic level 4

**Calculation is based on apportioning the 17.5 grams/day national default consumption rate for freshwater fish by trophic level

5.7 grams/day of TL 4 fish

8.0 grams/day of TL 3 fish

3.8 grams/day of TL 2 fish



Calculating Protective WQC from BAF

$$BAF = \frac{C_{TMeHg}}{C_{WThg}}$$



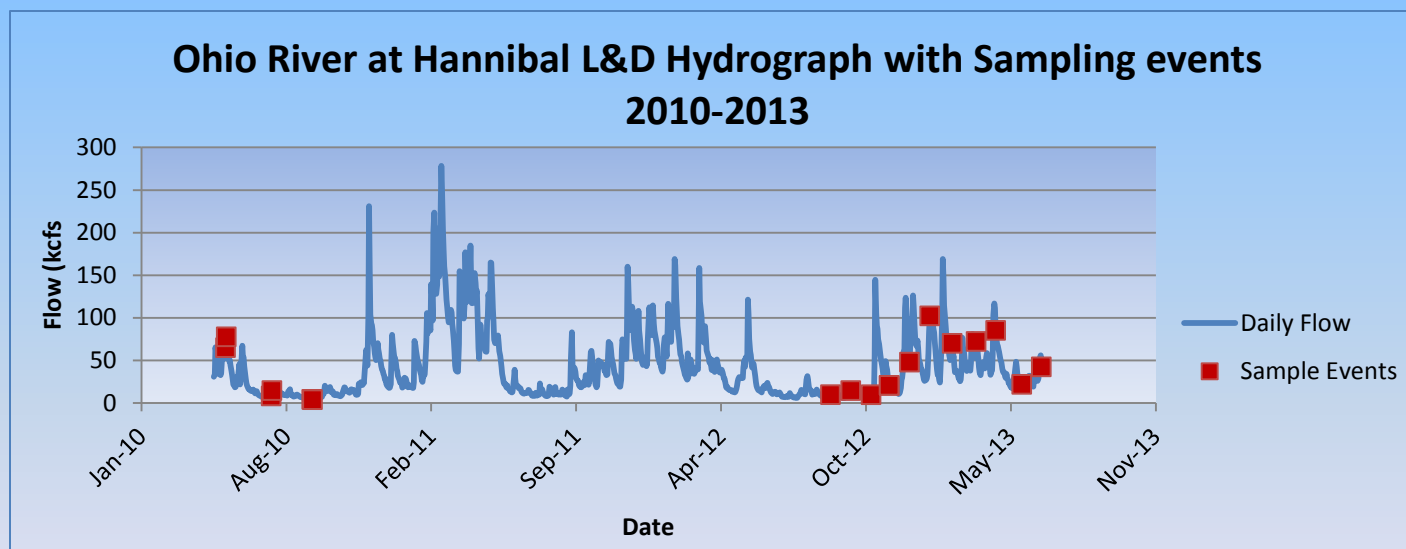
$$C_{WThg} = \frac{0.3mg / kg_{TMeHg}}{BAF}$$

BAF	Target Tissue 0.3 (mg/kg)	MeHg GM (ng/L)	Translator (1.3%x49%)	Critical Value (ng/L THg)
ORSANCO TL3 BAF	7.0E+06	0.04	0.0064	6.8
ORSANCO TL4 BAF	1.2E+07	0.02	0.0064	3.8
Draft Nat. TL2 BAF	1.2E+05	2.50	0.014	178.6
Draft Nat. TL3 BAF	6.8E+05	0.44	0.014	31.5
Draft Nat. TL4 BAF	2.7E+06	0.11	0.014	7.9
Draft Nat Average BAF	1.7E+06	0.18	0.014	12.7
ORSANCO Average BAF	9.7E+06	0.03	0.0064	4.9
Consumption Weighted (CW) Average				
Draft Nat CW BAF	1.2E+06	0.25	0.014	17.6
ORSANCO CW BAF	9.2E+06	0.03	0.0064	5.1

- Consumption weighting of TL3 and TL4 BAFs yields the necessary THg geometric mean (GM) to protect against fish tissue > 0.3mg/kg **5.1 ng/L**

Relating Tissue to Ambient Conditions

- Tissue Geometric Means TL3 (0.105)and TL4 (0.189)
 - **Average 49% of WQC (0.3 mg/kg)**
- Estimated Daily THg - Geometric Mean = 2.7 ng/L
 - 22% of WQC (12 ng/L)
 - **53% of BAF-derived Critical Value (5.1 ng/L)**



- THg estimated for each day based on Flow/THg regression ($R^2=0.69$)

2010 Emery/Spaeth BAF Study

- Hybrid Striped Bass

– Larger individuals, Average 59.9 cm TL

Location	Mile	GM Thg (ng/L)	GM Thg (mg/L)	Avg TL (cm)	Tissue THg (mg/kg)	BAF (L/kg)	Critical Value* (ng/L THg)
Pike Island	84.2	3.89	3.89E-06	61.4	0.23	5.9E+04	6.8
Willow Island	161.8	4.43	4.43E-06	59.8	0.28	6.3E+04	6.3
Belleville	203.9	3.33	3.33E-06	60.3	0.28	8.4E+04	4.8
RC Byrd	279.2	2.83	2.83E-06	55.1	0.20	7.1E+04	5.7
Greenup	341.1	3.99	3.99E-06	57.0	0.26	6.5E+04	6.1
Meldahl	436.2	4.1	4.10E-06	61.0	0.29	7.1E+04	5.7
Markland	531.5	4.71	4.71E-06	56.8	0.20	4.2E+04	9.4
McAlpine	606.8	5.32	5.32E-06	61.9	0.40	7.5E+04	5.3
Cannelton	720.7	7.08	7.08E-06	56.5	0.33	4.7E+04	8.6
Newburgh	776	7.82	7.82E-06	58.6	0.33	4.2E+04	9.5
JT Myers	846	7.25	7.25E-06	57.8	0.30	4.1E+04	9.7
Smithland	918.5	6.78	6.78E-06	59.9	0.34	5.0E+04	8.0
Summary		5.06	5.06E-06		0.28	5.5E+04	7.2

* Critical value based on 0.4 mg/kg using 75% MeHg in tissue from current study TL4 composites

Direct Calculation THg Bioaccumulation

Water Total Hg to Tissue THg Ohio River Mile 126

- THg geometric mean of 17 composites
 - TL3 **0.158** mg/kg THg
 - TL4 **0.256** mg/kg THg
- THg geometric mean of 18 water samples
 - **2.38** ng/L

$$BAF = \frac{C_{TTHg}}{C_{WTHg}}$$

TL	BAF
TL3	6.6E+04
TL4	1.1E+05

Final Points

- Only one site-specific study for MeHg BAF
- A long-term average concentration (GM) of ~ 5 ng/L THg might protect human health from fish tissue >0.3 mg/Kg MeHg

