2015 Toxicity Testing of Bear Creek Sediment

Sparrows Point Meeting

Sollers Pt / Dundalk Public Library

December 16th, 2015

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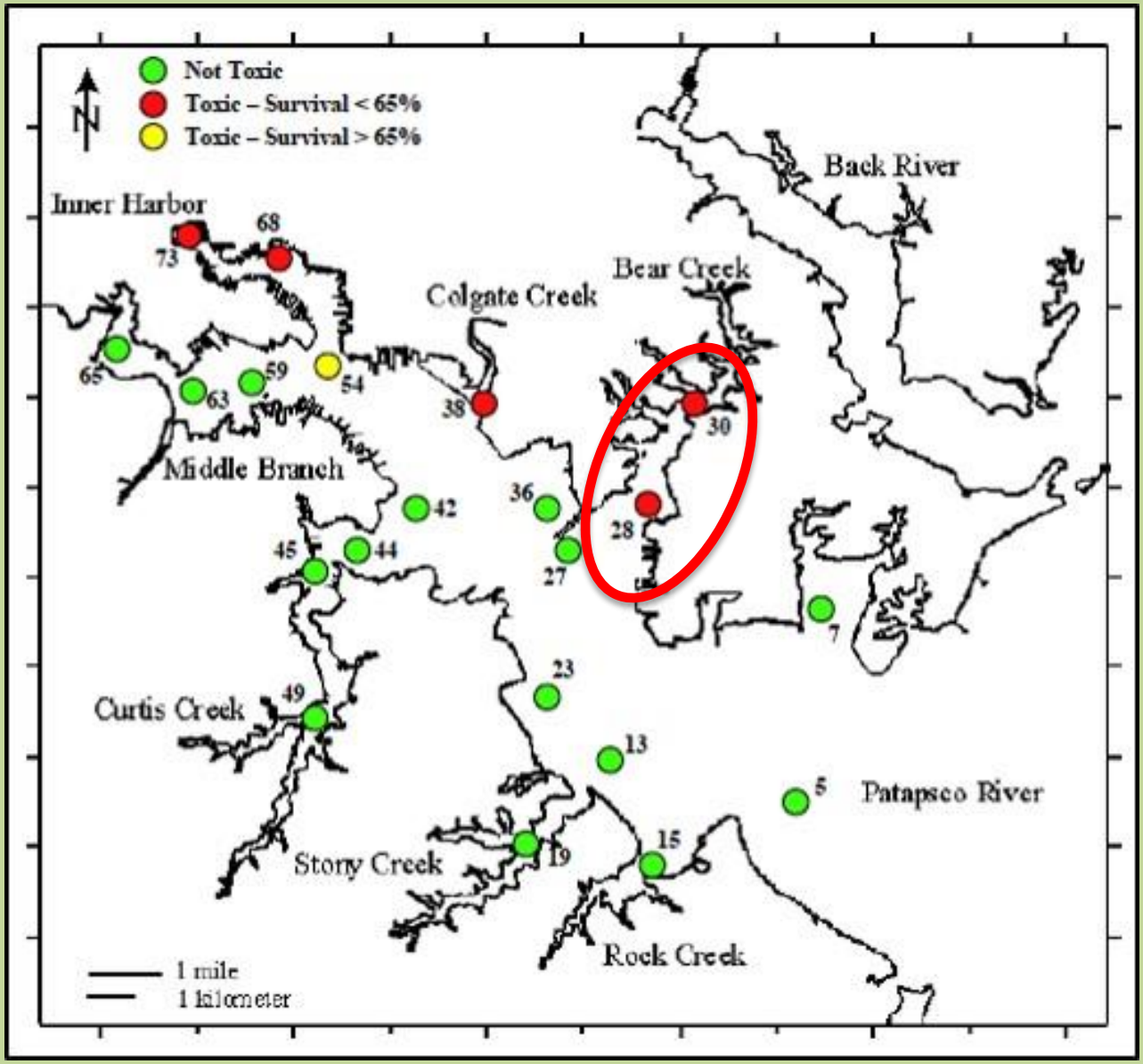
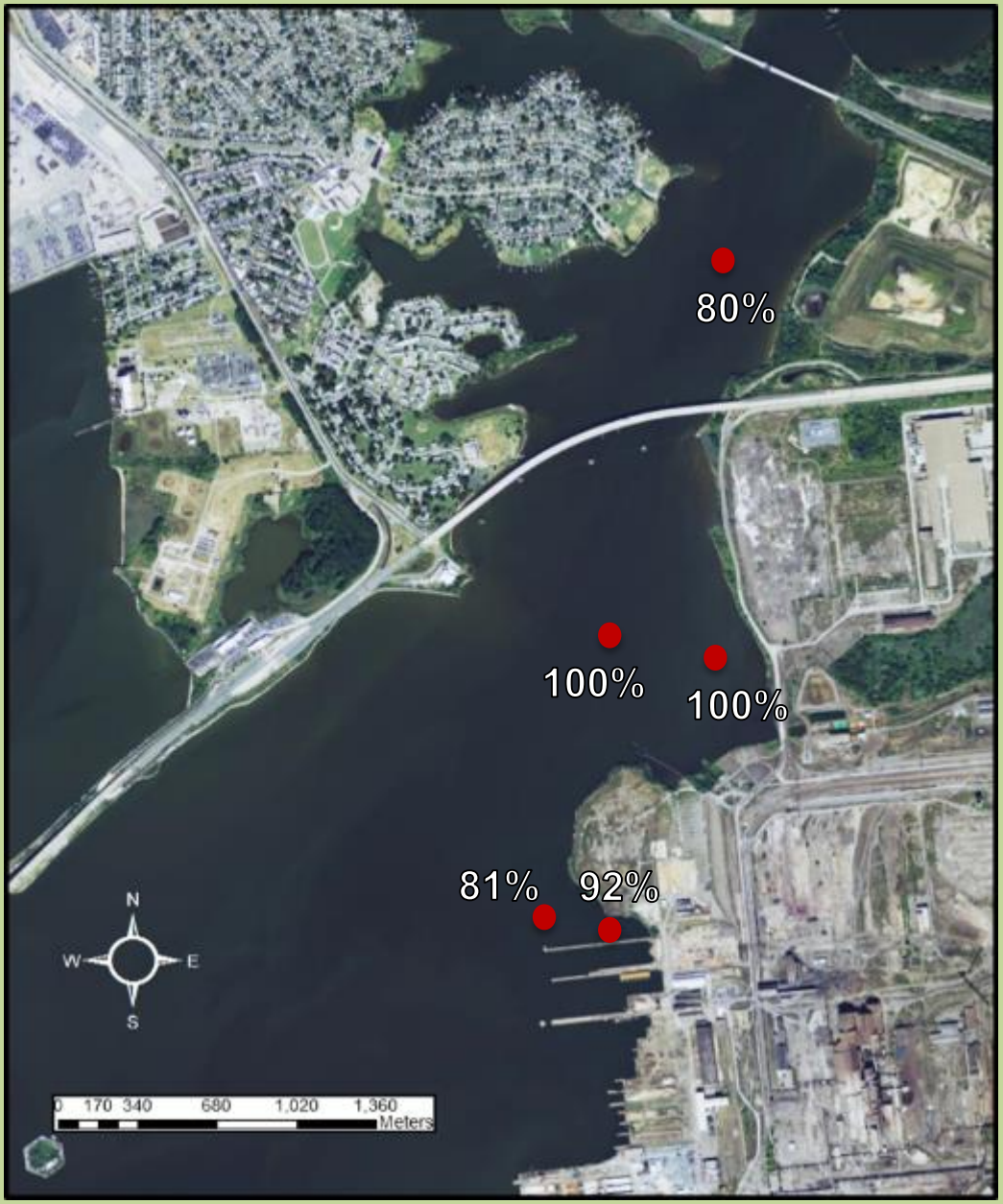
PAST INVESTIGATIONS: 2004



- Reported toxicity in limited # of sites within Bear Creek
- Correlated toxicity results with PAH & metal contamination at sites offshore of Sparrows Point

Klosterhaus & Baker, 2006

Past Investigations: December 2011



- Small study supported by CBF
- Performed by UMD Aquatic Toxicology Facility
- All five sites very toxic (≥80% lethality)

Yonkos et al., 2012

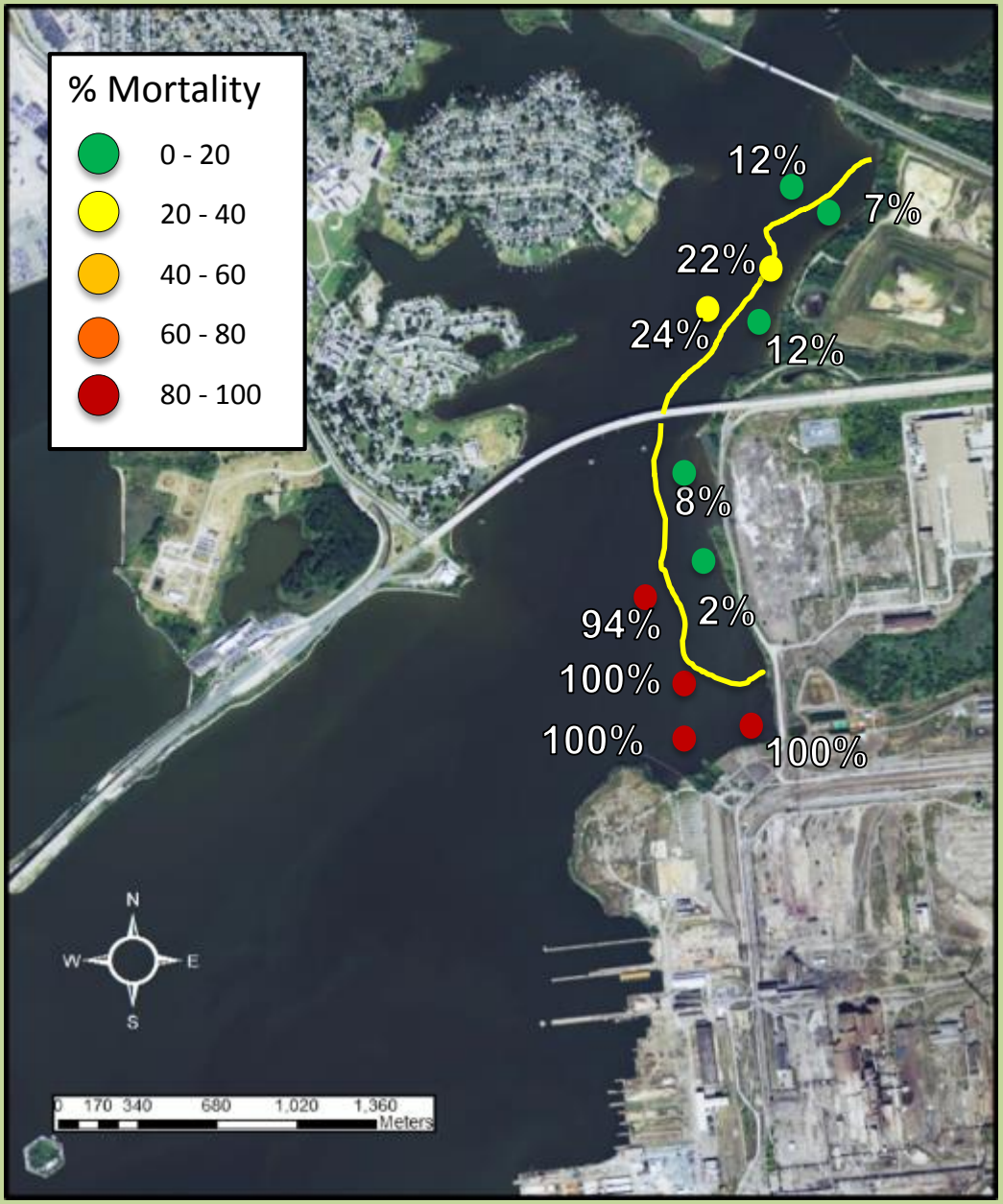
Past Investigations: December 2014

- EA Engineering - Round 1 Investigation of “Near-Shore” contamination
- 20 sites identified for analysis of sediments for metal and organic contaminants
- Yellow line indicates margin between coarse/sandy and fine “depositional” region
- Most sites were near-shore in sandy region
- Fine sediments are known to hold more contaminants

Past Investigations: December 2014

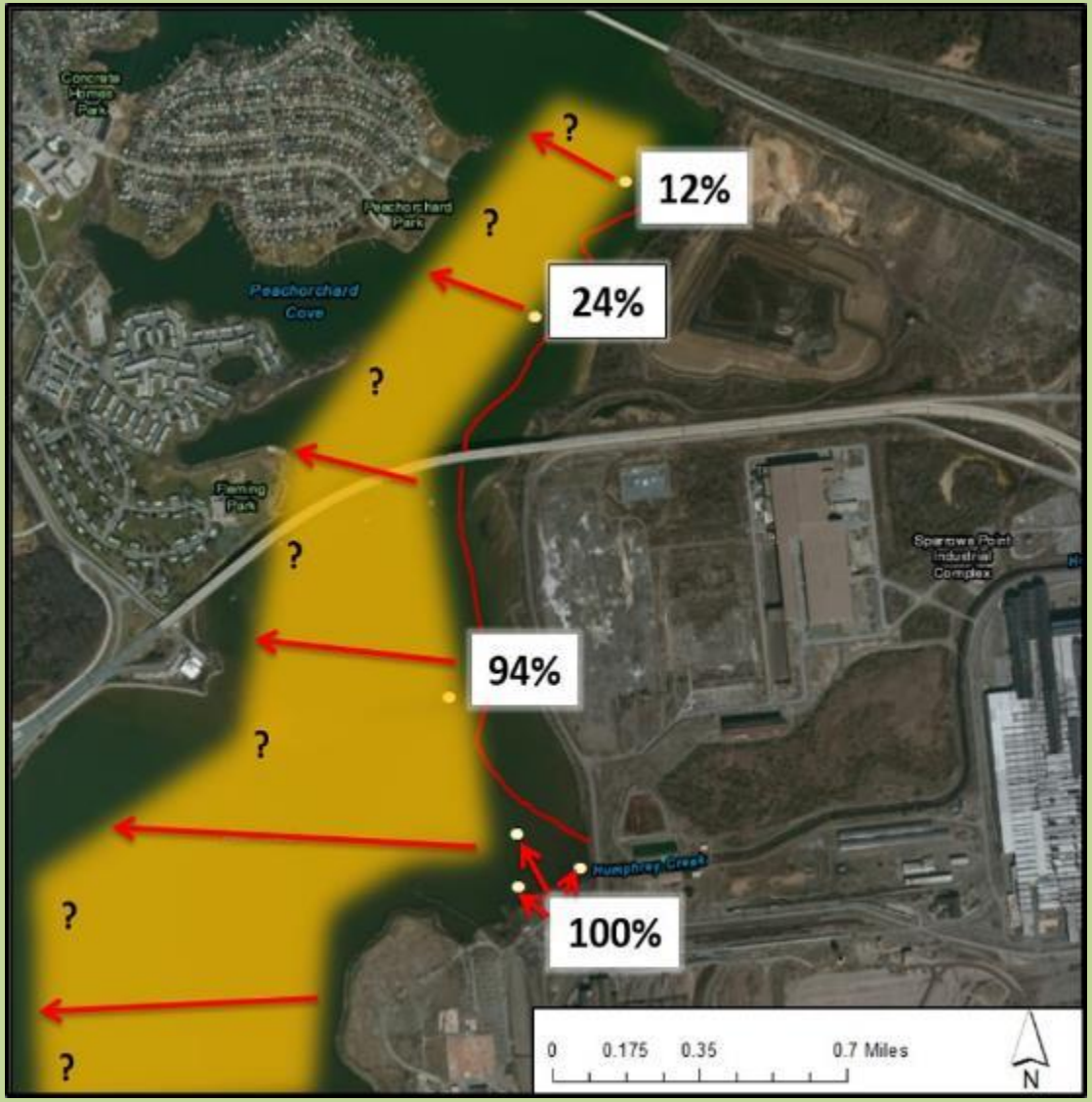
- We split samples from 11 of the sites including all 6 that were in depositional zones
- Results showed:
  - Minimal toxicity in sandy region
  - Substantial toxicity in depositional region
  - Obvious south – north toxicity gradient

PAST INVESTIGATIONS: 2014



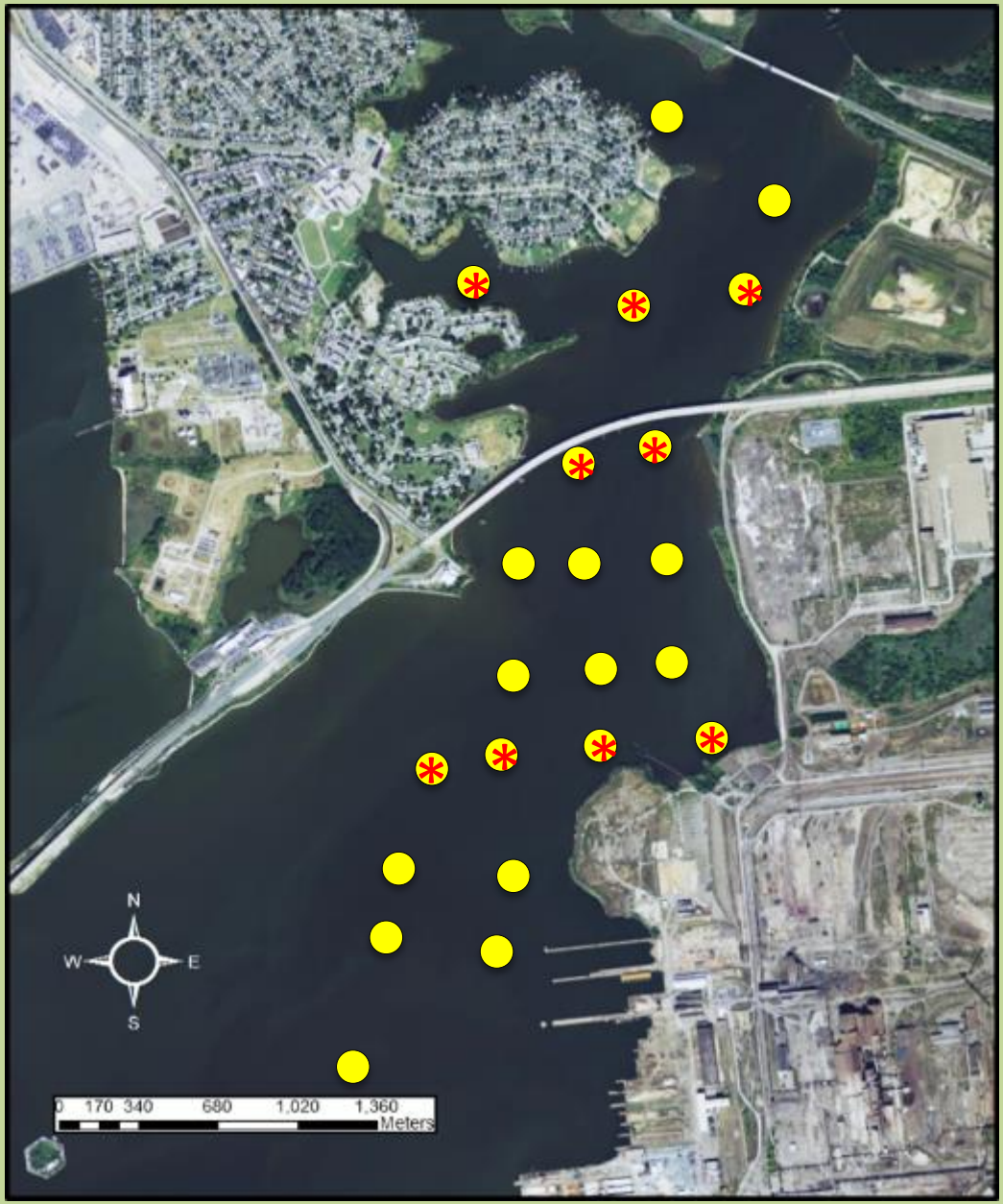
- We split samples from 11 of the sites including all 6 that were in depositional zones
- Results showed:
  - Minimal toxicity in sandy region
  - Moderate to severe toxicity in depositional region
  - Obvious south-to-north toxicity gradient

UNANSWERED QUESTION???



- WHAT'S GOING ON EVERYWHERE ELSE IN BEAR CREEK?

2015 Sediment Toxicity Tests



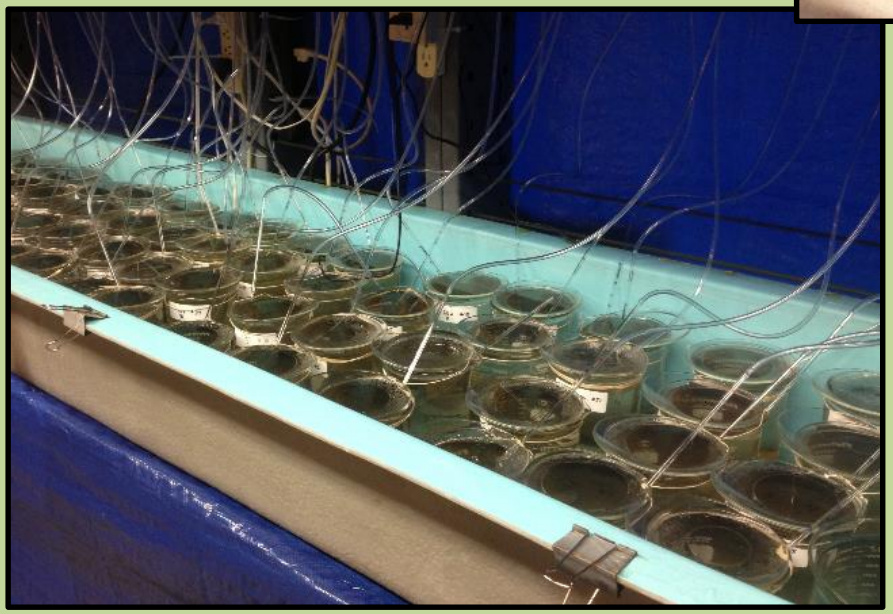
- **Objective:** Determine the spatial extent of sediment toxicity in the offshore area of Bear Creek in proximity to Sparrows Point
- **Methods**:
  - Investigate 22 sites arrayed within Bear Creek along Sparrows Point
  - Specifically target <u>depositional</u> regions
  - Collect surface sediment (top 2 cm) for toxicity testing and chemical analysis
  - * Collect 9 sediment cores to 80 cm depth for additional testing

What's a sediment toxicity test?

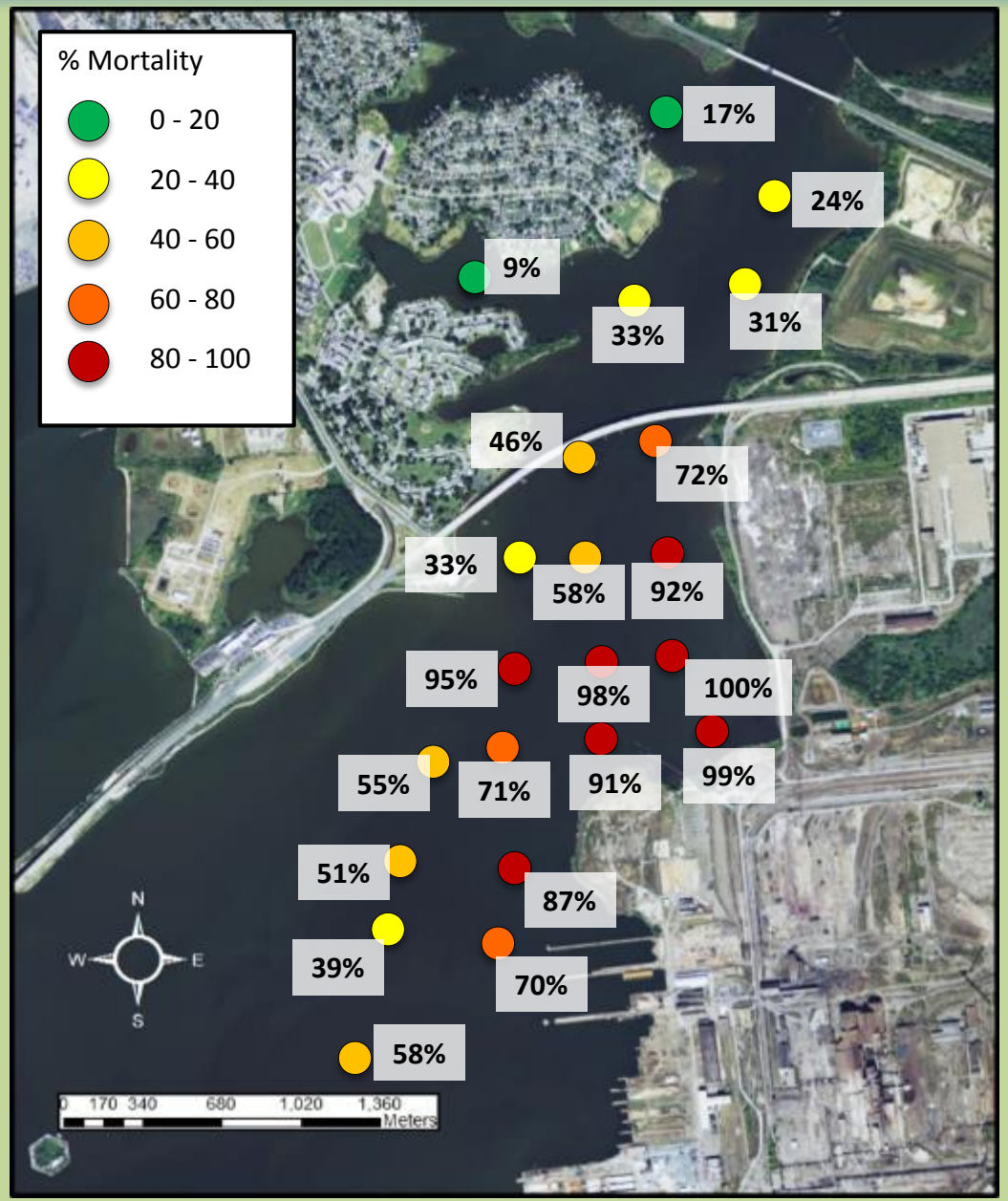
- Collect surface sediments using a Ponar sampler
- Collect top 2 cm (~1”) from multiple grabs
- Mix to make a homogeneous batch
  - Place portion in clean jars for chemistry
  - Return portion to lab for toxicity tests

What's a sediment toxicity test?

- Sieve sediments (0.5 mm) to remove large debris and native organisms
- Place sediment in exposure beakers (5 replicate/sample)
- Add overlying water (15‰ salinity)
- Load test organism (benthic amphipod *Leptocheirus plumulosus)*
- Tabulate toxicity after 10 days

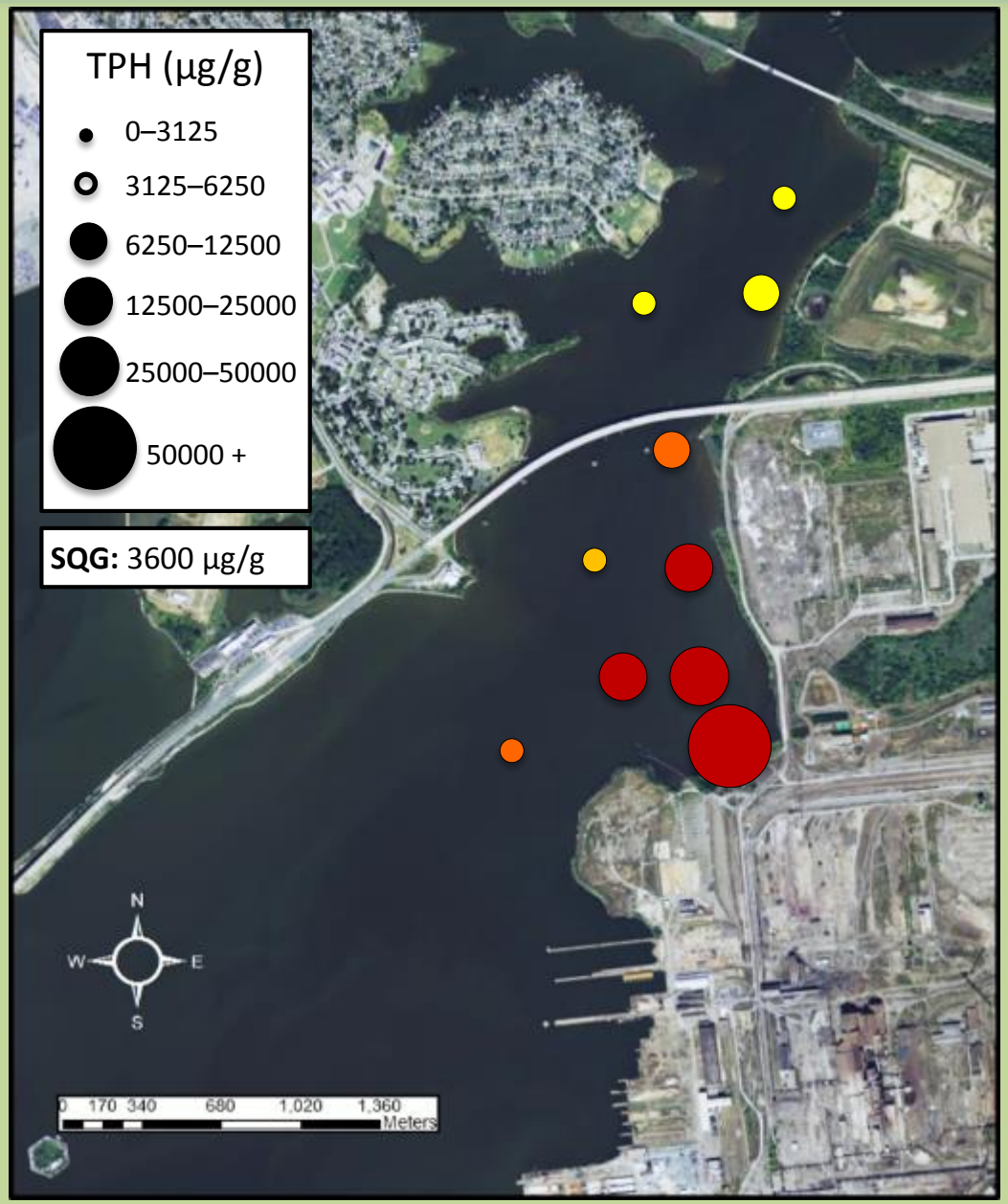


Toxicity Test Results



- 21 of 22 sites were toxic (statistically significant reduction in survival compared to control)
- Range from <10% to 100% lethality
- Lethality generally decreased with distance from the Tin Mill Canal discharge
  - Decreases from east-west
  - However, all depositional sediments below the 695 bridge were toxic
  - Decreases to north (margin defined?!)
  - Decreases to south (margin not defined)

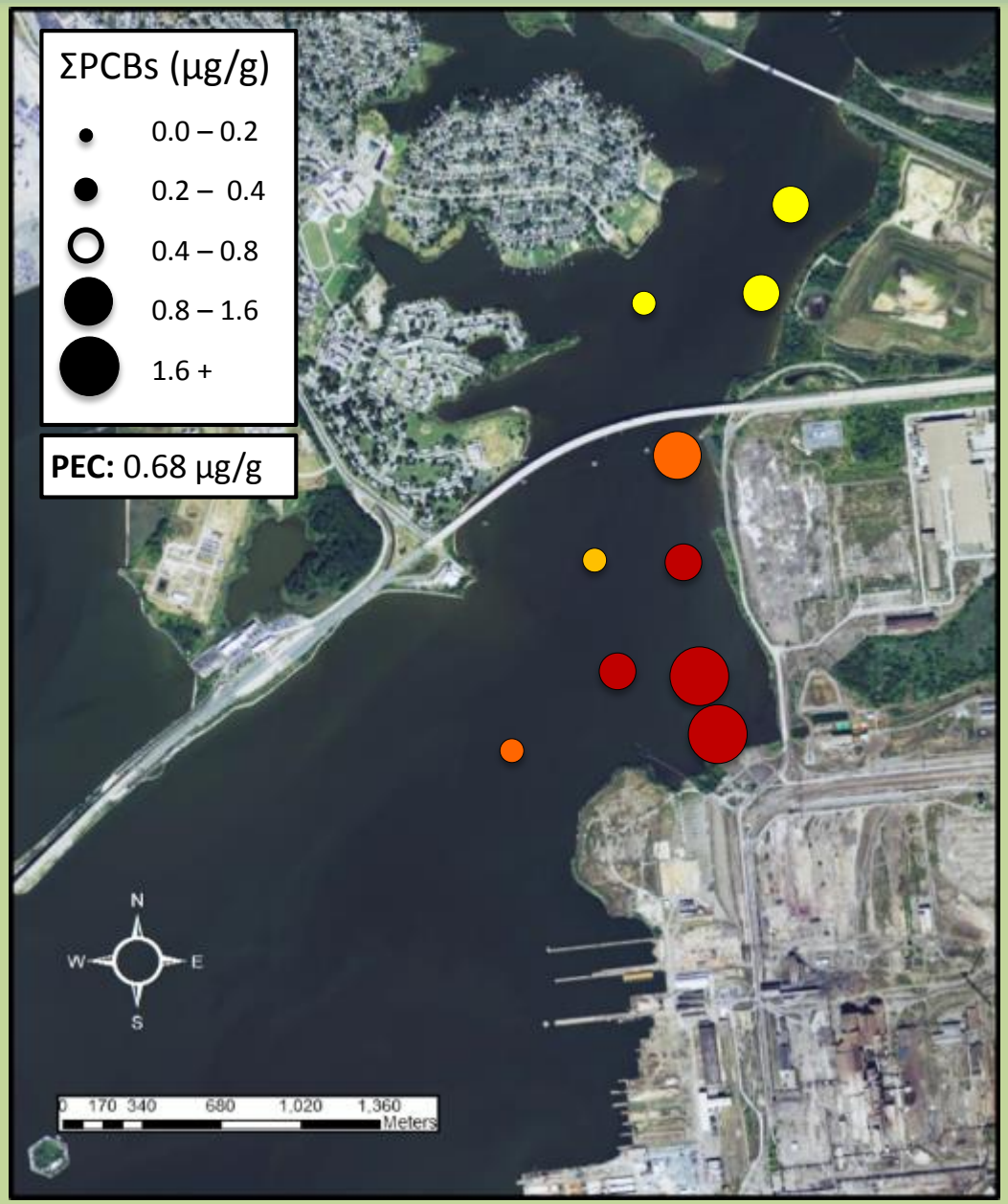
Chemistry Results: Organics



Total petroleum hydrocarbon (TPH)

- **Mixture of many chemicals originating from petroleum**
  - **Fuel oil distillates**
  - **Industrial greases & lubricants**
  - **Hydraulic fluids**
- **Range 5,680 – 54,684 µg/g**
- **Sediment Quality Guideline (SQG) is 3,600 µg/g**
- **All sites exceeded standard by 1.6X – 15X**
- **Correlates positively with observed toxicity**

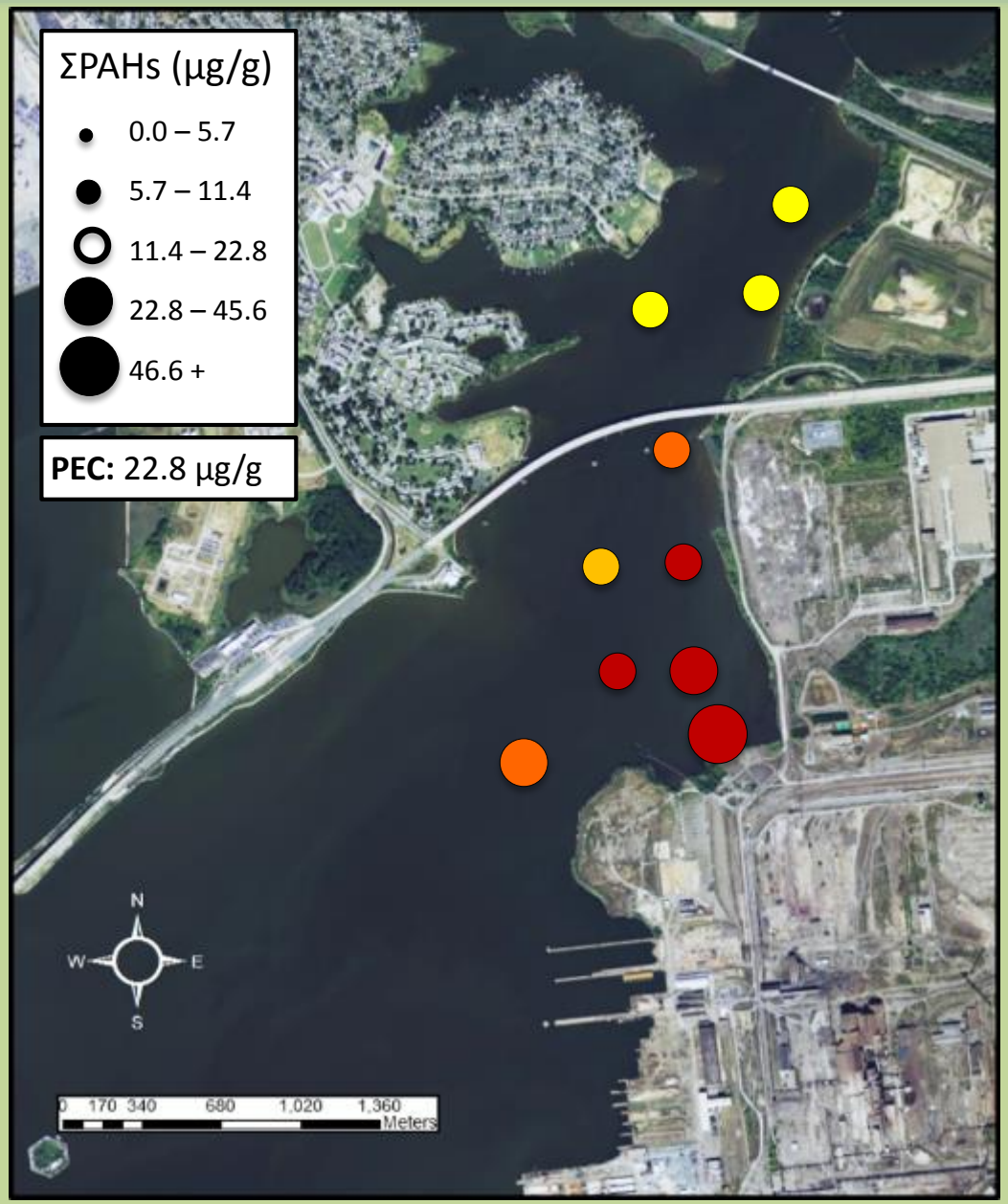
Chemistry Results: Organics



Total PCBs

- Lubricants and thermal insulators
- Very environmentally persistent
- Able to accumulate in fish
- Human carcinogen
- Concentrations not particularly high (range 0.38 – 1.16 µg/g)
- However, 3 of 10 sites exceed Predicted Effects Concentration (PEC)
- Correlates positively with observed toxicity

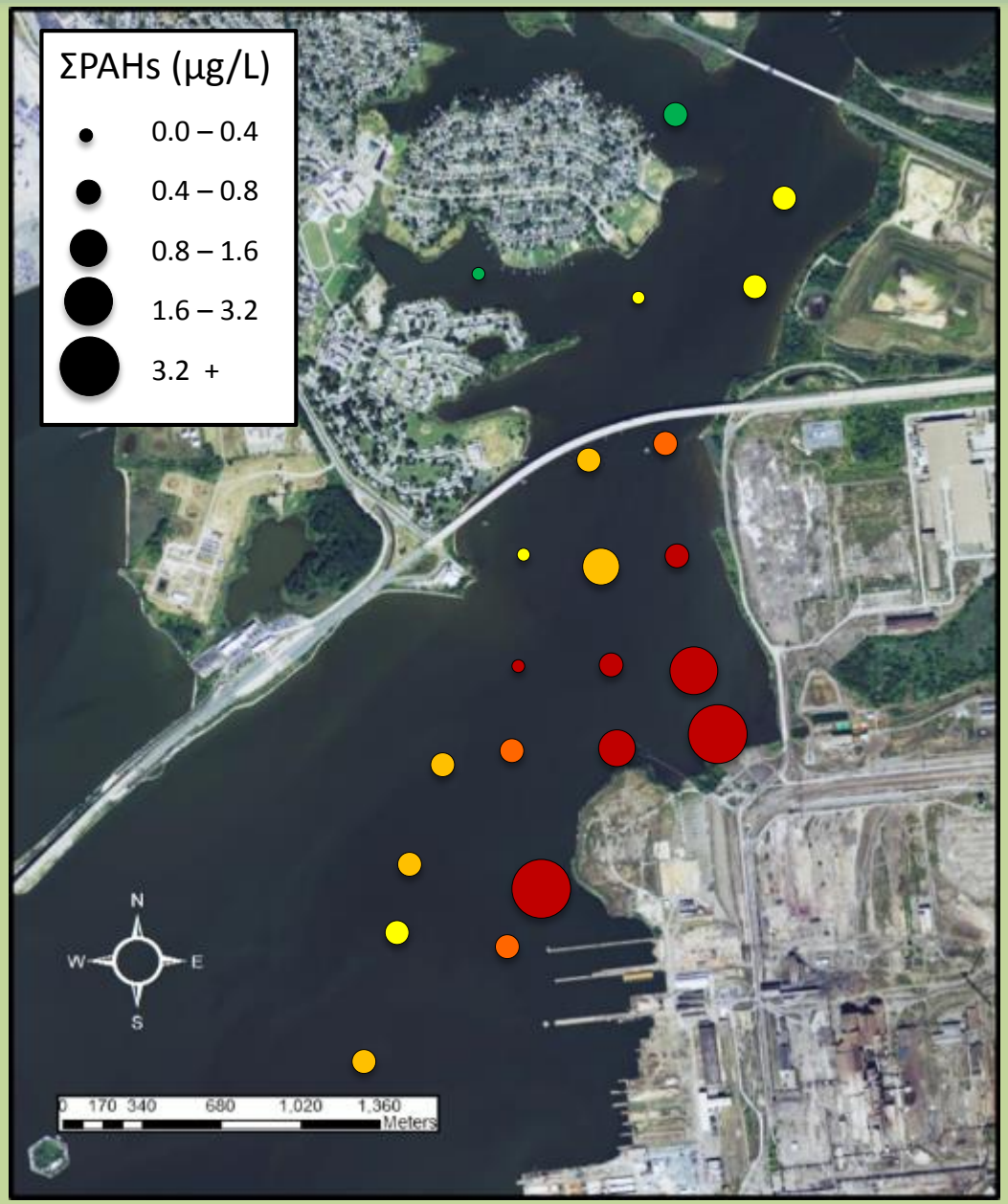
Chemistry Results: Organics



Polycyclic Aromatic Hydrocarbons (PAHs)

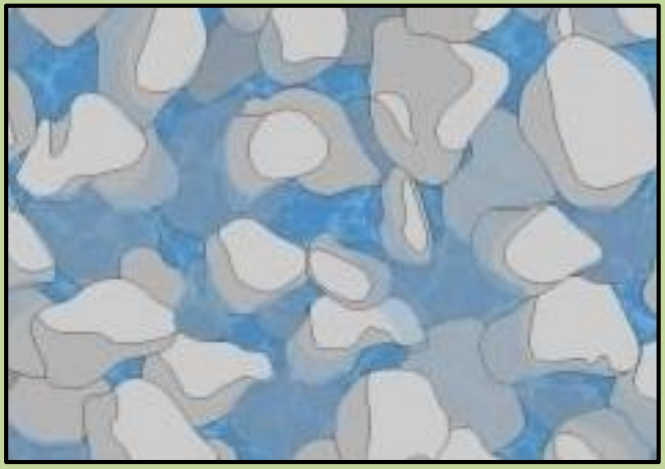
- **Incomplete combustion of coal and oil**
- **Concentrations not particularly high (12.3 – 49.9 µg/g)**
- **However, 3 of 10 sites exceed (PEC)**
- **Correlates positively with observed toxicity**

Chemistry Results: Organics

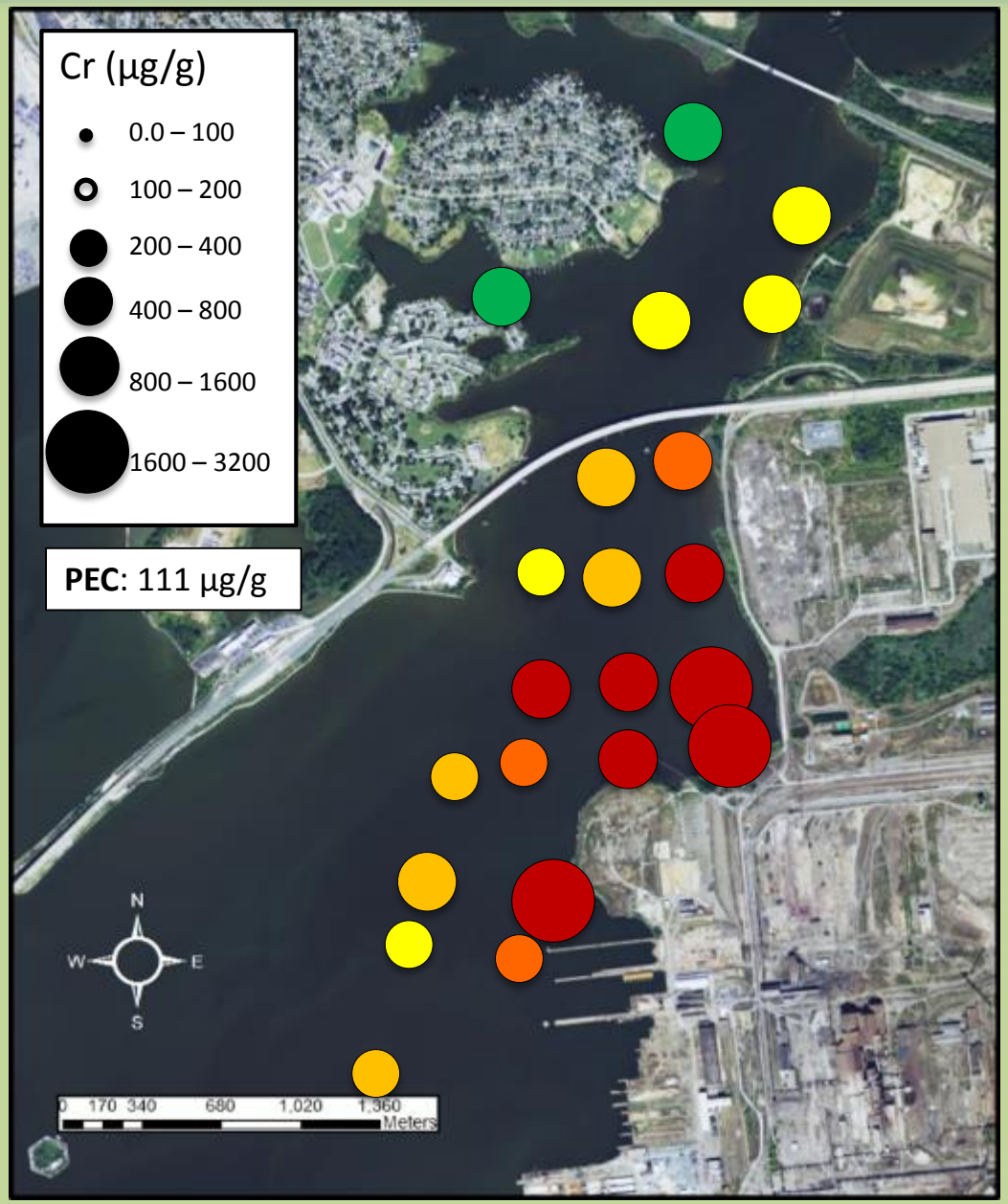


Porewater PAHs

- **Novel method – so no Sediment Quality Guideline**
  - **Reflects available fraction (not bound to sediment)**
  - **Correlates with PAH conc. in shellfish**
- **Correlates positively with observed toxicity**



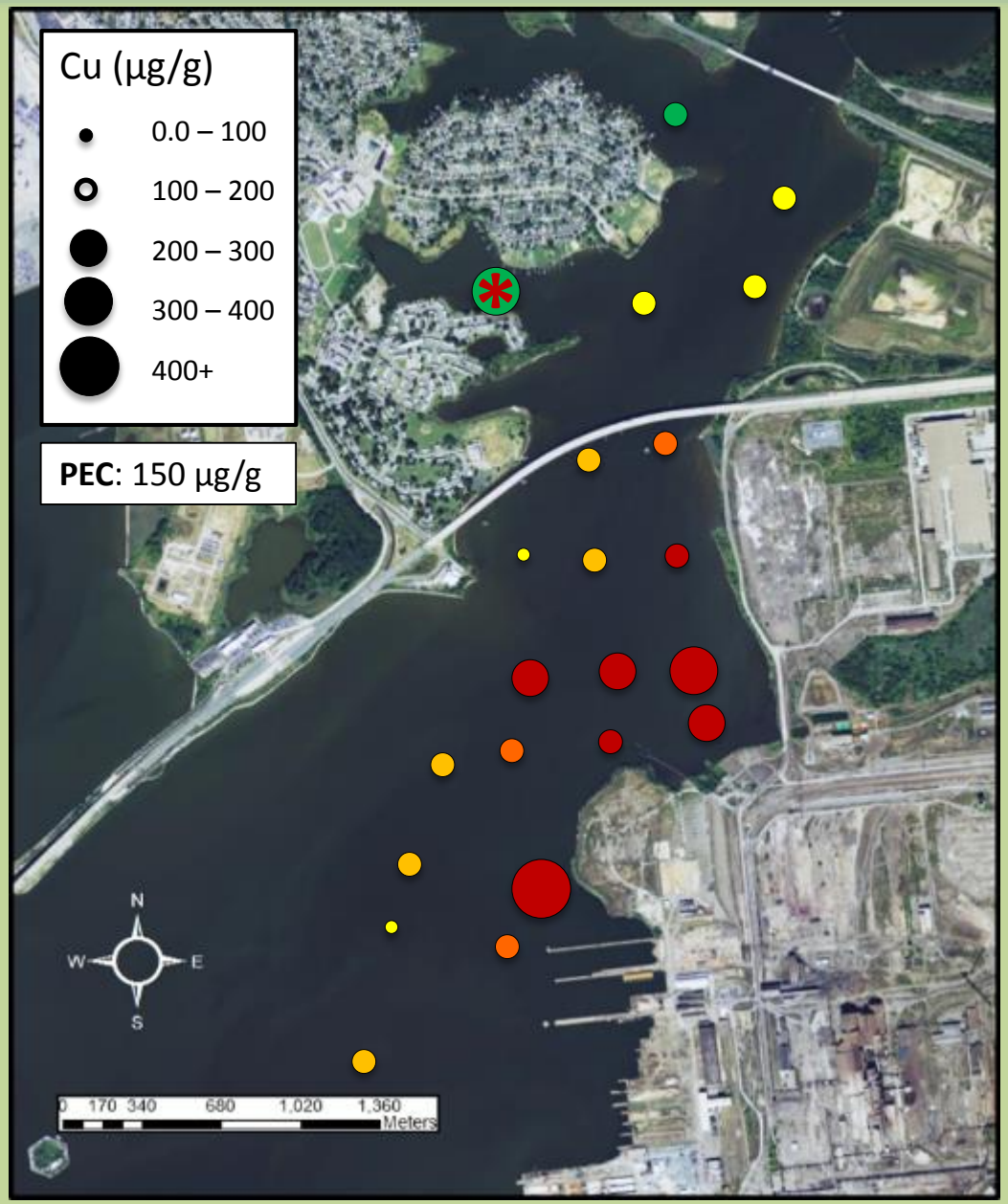
Chemistry Results: Metals



Chromium (Cr)

- **Range 467 – 2685 µg/g (PEC: 111 µg/g)**
- **All sites at least 4X PEC**
- **Highest sites > 28X PEC**
- **Correlates positively with observed toxicity**

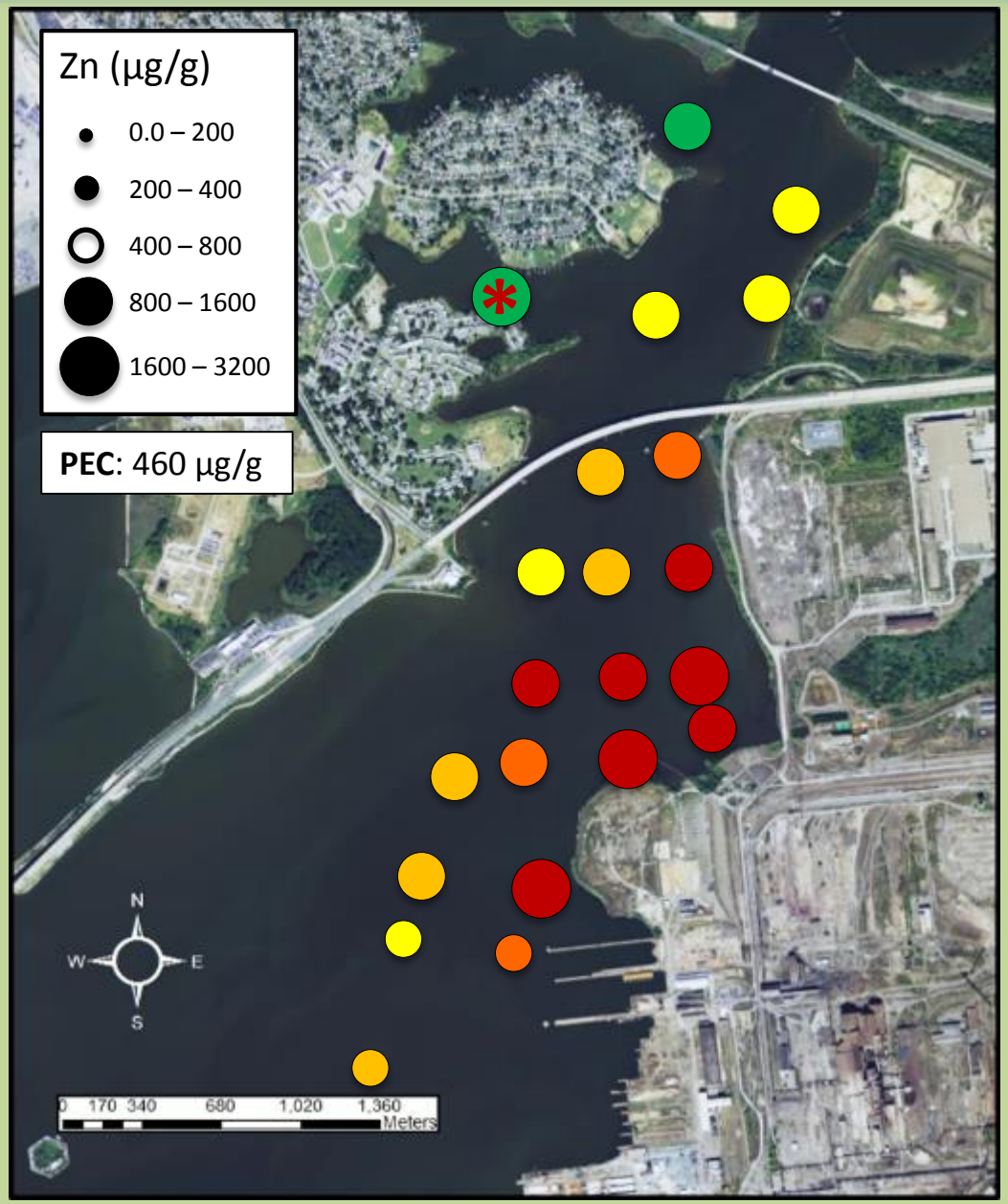
Chemistry Results: Metals



Copper (Cu)

- **Range 99 – 343 µg/g (PEC: 149 µg/g)**
- **13 of 22 sites exceed PEC**
- **Reasonable correlation with toxicity (with one exception*)**

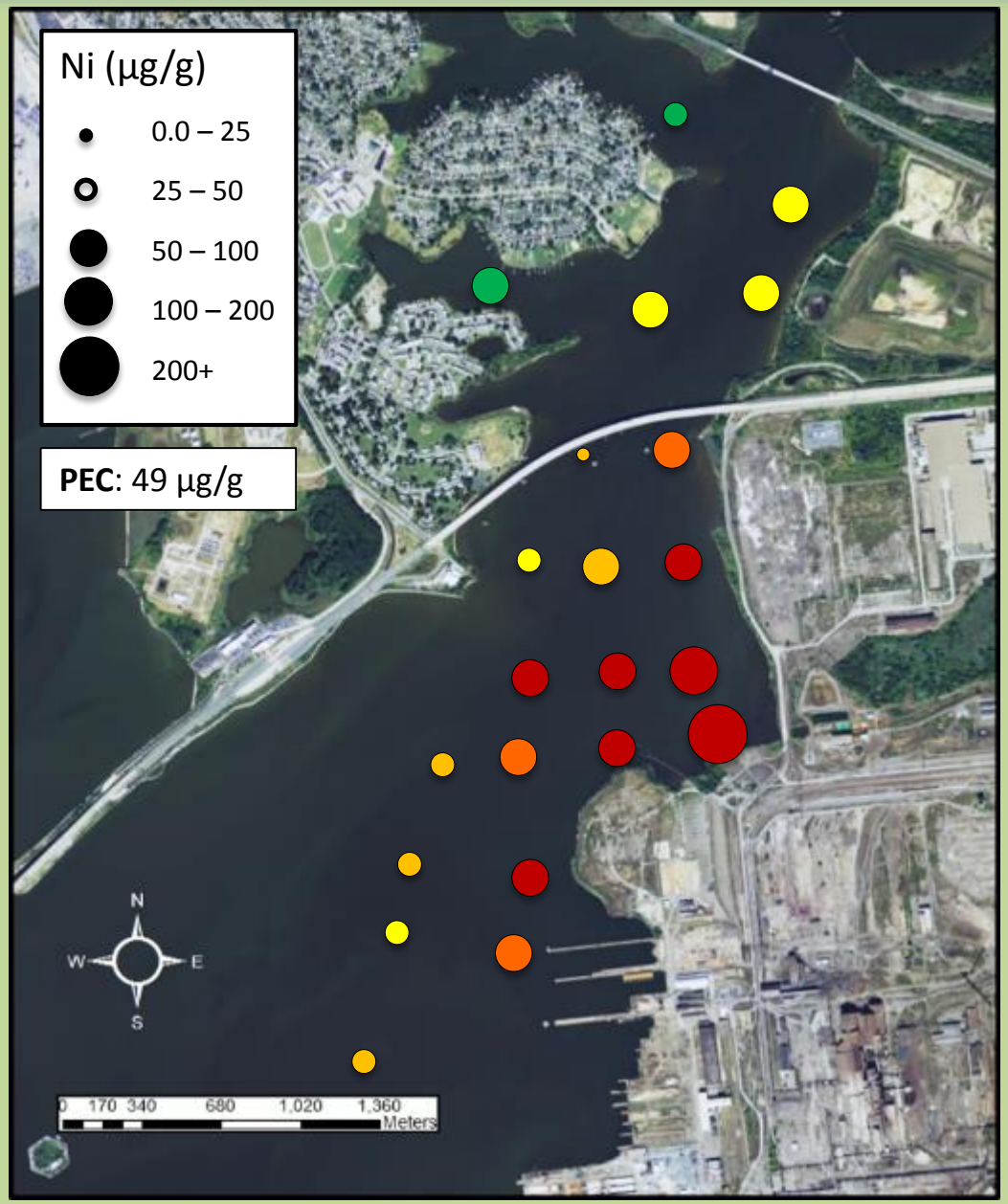
Chemistry Results: Metals



Zinc (Zn)

- **Range 705 – 2295 µg/g (PEC: 460 µg/g)**
- **All sites exceed PEC by 1.7X – > 5X**
- **Does not correlate with observed toxicity**

Chemistry Results: Metals



Nickel (Ni)

- **Range 21 – 127 µg/g (PEC: 49 µg/g)**
- **14 of 22 sites exceed PEC**
- **Correlates positively with observed toxicity**

Conclusions: Surface Sediments

- Significant toxicity was observed in surface sediments throughout the depositional region of Bear Creek (especially below the Interstate 695 Bridge)
- Total PAHs, PCBs, and TPH all correlated positively with observed toxicity
- Zn, Cr, Ni and Cu were elevated above PEC levels throughout the system - Cr and Ni showed the strongest correlations with observed toxicity
- Organic contaminants tended to co-occur (with one-another) and with metals, especially Cr, Cu, & Ni.

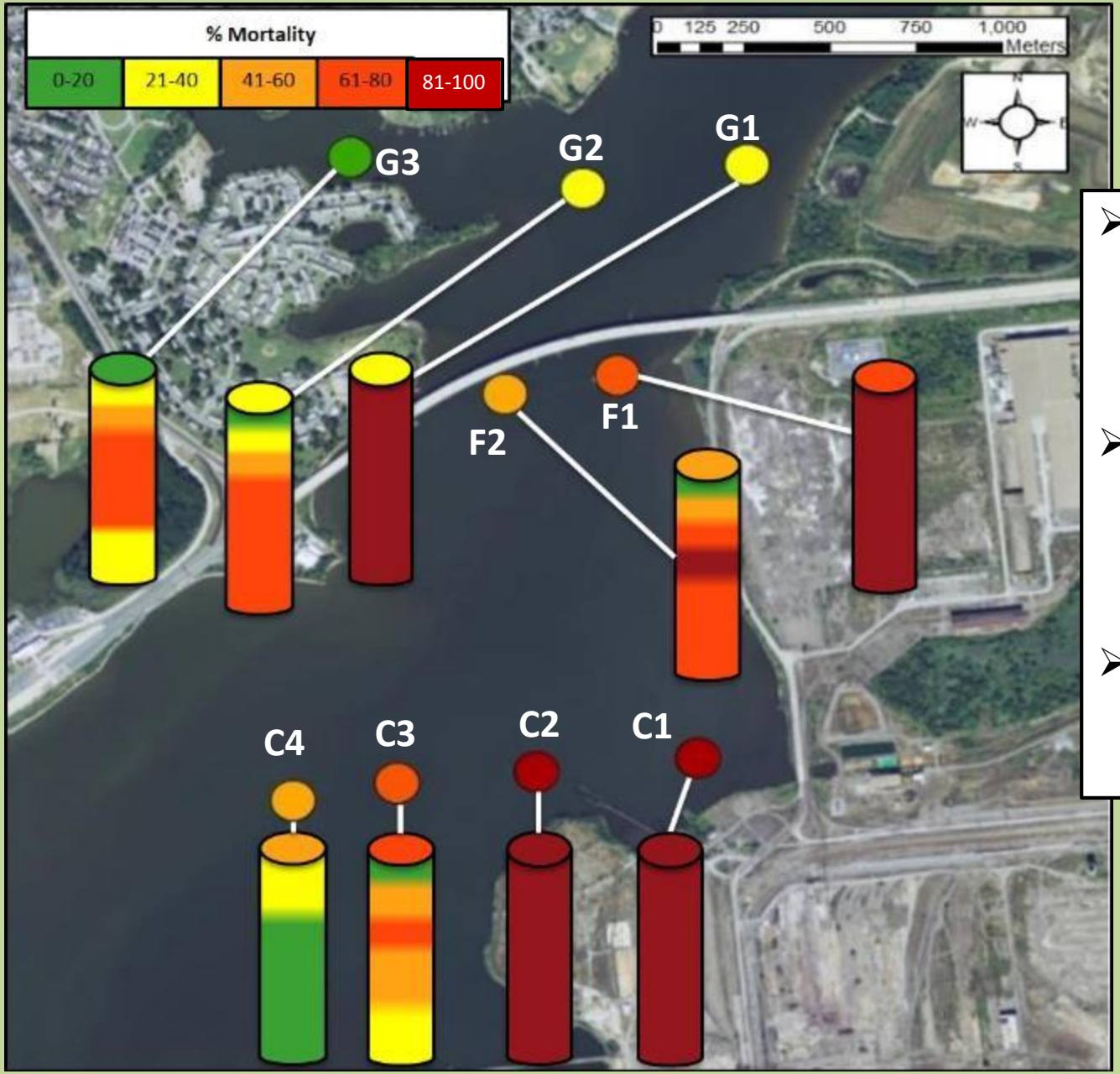
Coring methods

- 4” sediment cores were collected at 9 sample sites
- Cores were segmented (10-cm increments to 40 cm; 20-cm from 40 - 80 cm)
- Acute 10-day toxicity tests and limited chemistry run on core segments



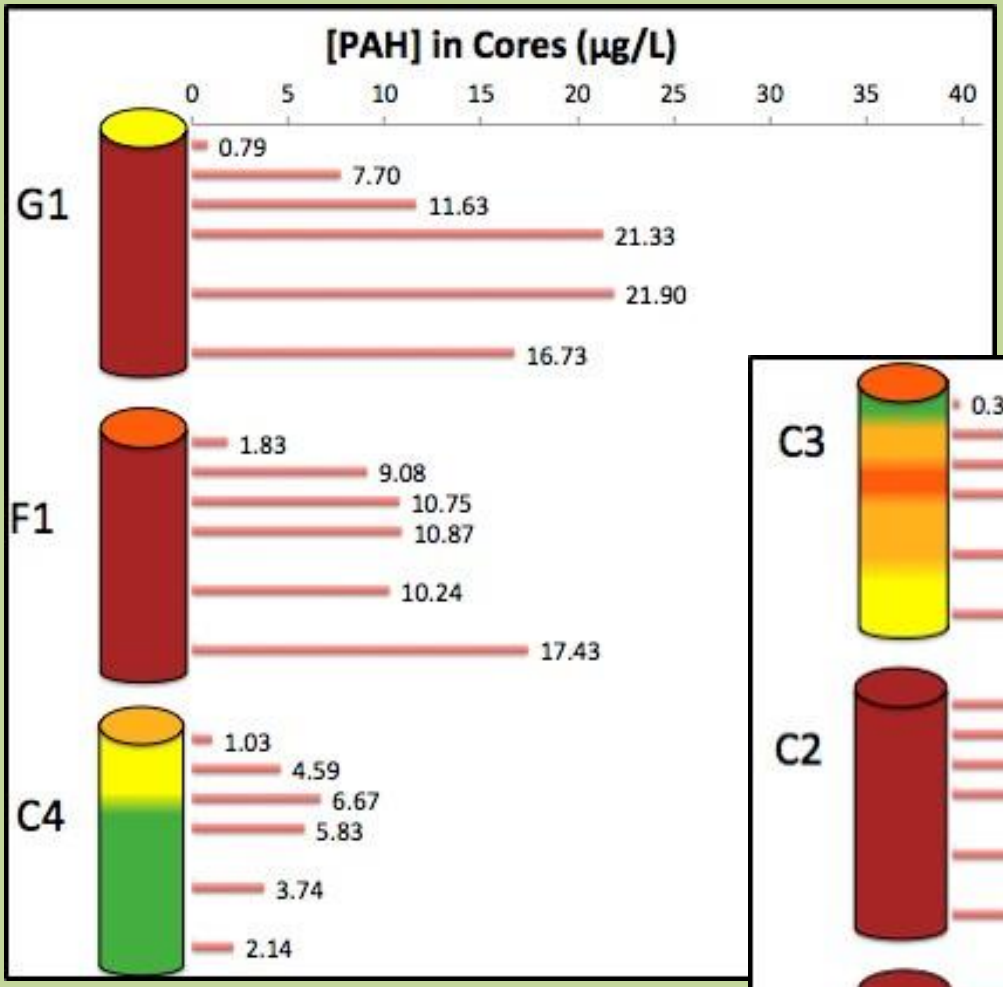


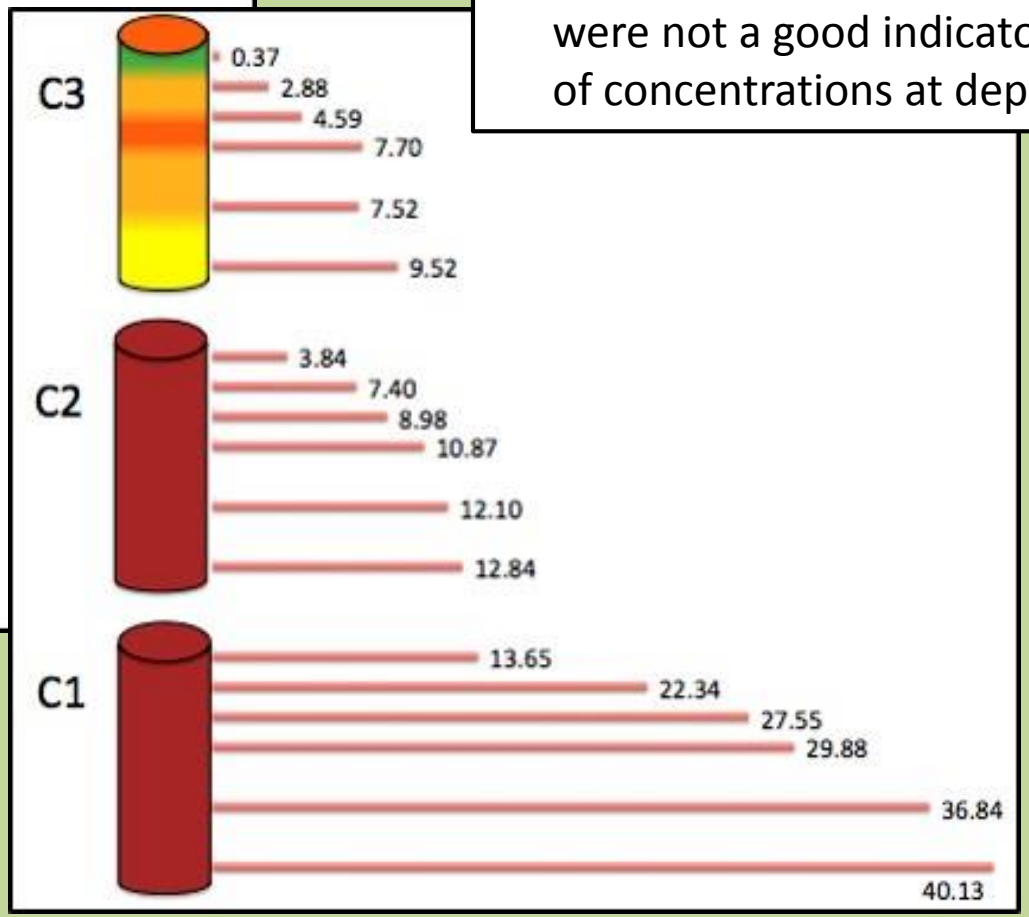
Coring Results: Toxicity



- Cores closest to Sparrows Point produced near total lethality at all depths
- Surface sediments (2 cm) were often less toxic than the underlying sediment
- Occasionally surface was more toxic than underlying sediment

Coring Results: Porewater PAH





- Porewater PAH concentrations generally increased with depth
- Surface concentrations were not a good indicator of concentrations at depth

Conclusions: Sediment Cores

- Within north–south transects of depositional sediments:
  - Toxicity reduced modestly from south to north (but was still severe)
  - porewater PAH concentrations generally reduced from south to north
- Within east–west transects of depositional sediments:
  - Toxicity generally reduced from east to west
  - porewater PAH concentrations generally reduced from east to west
- Toxicity in top 2 cm was not necessarily predictive of toxicity at depth, with many sites showing increased toxicity below the surface

ACKNOWLEDGMENTS

Dr. Lance Yonkos

Dr. Michael Unger

Dr. Beth McGee

Dr. Andrew Heyes

Mary Ann Vogelbein

George Vadas

Allison Satterfield

Elizabeth Friedel

Amy Wherry

Wenqi Hou

Alex MacLeod

Barret Wessel

University of Maryland 1856 — Department of Environmental Science & Technology

Save the Bay

Superfund Research Program

University of Maryland Center for Environmental Science

William & Mary VIMS — Virginia Institute of Marine Science, School of Marine Science