Assessment of Arsenic and Trace Metal Contaminations in Riverine Water and Sediments Resulted from the Coal Ash Spill in Kingston, Tennessee

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Photo: EPA

America’s Largest Coal Ash Spill

December 22, 2008…

- 4.1 million cubic meters of ash
- 300 acres of land inundated
- ±7 miles up and down river

Remediation from 2009-2011

- Recover ash, line ash landfill and construct concrete retaining wall
- Removed ~60% coal ash contaminants

Trace Metal Composition of Coal Ash

- Coal ash is the by-product of the combustion of coal in coal-fired power plants
  - Types of by-products include:
    - Fly Ash
    - Bottom Ash
    - Cenospheres
- Elevated concentrations of trace metals relative to local sediment
  - Al, As, Ba, Cr, Cu, Li, Ni, Sr, and V

(Ruhl et al., 2009)

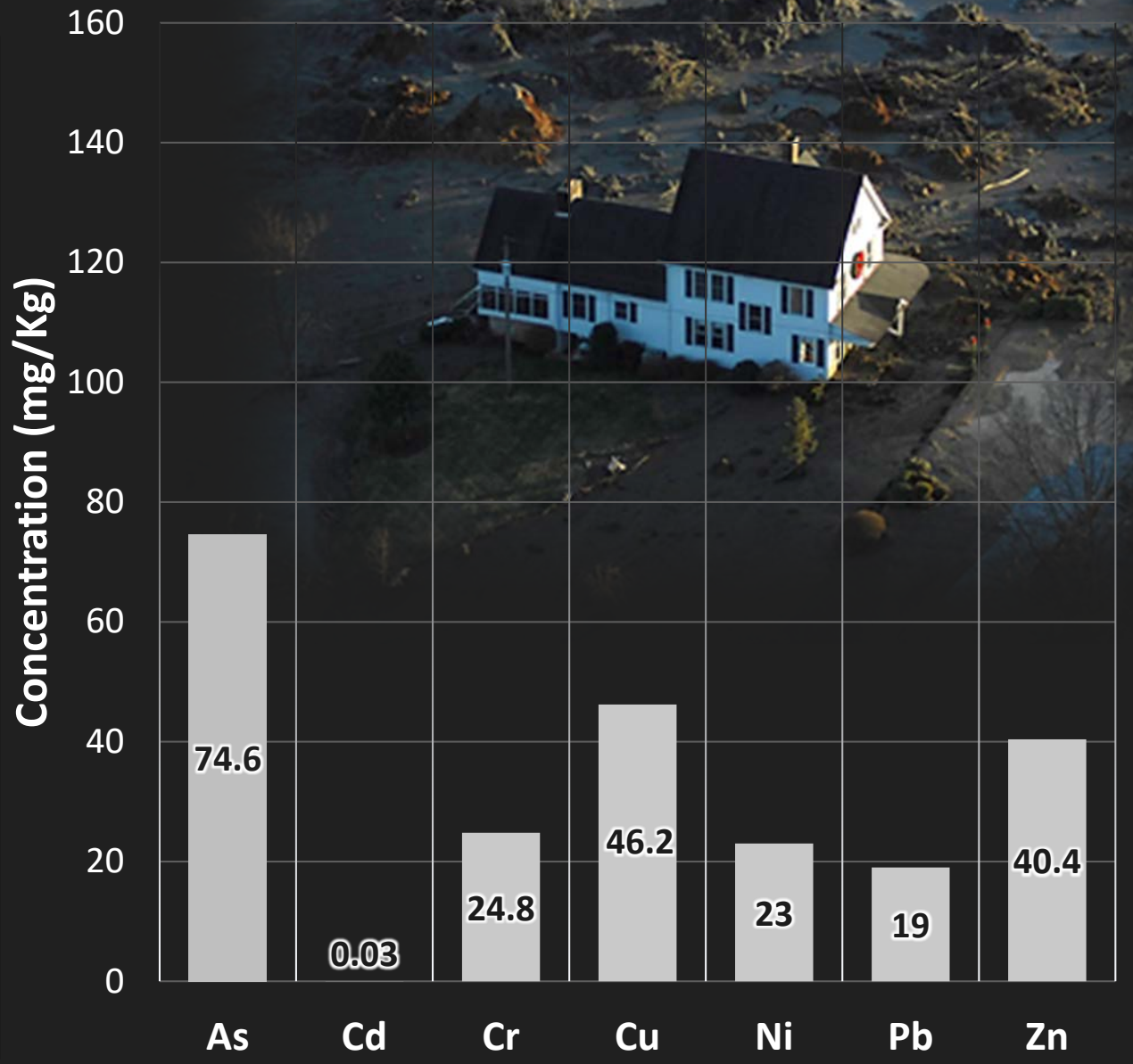


Photo: J. Miles Cary

Trace Metal Guidelines and Methods for Comparison

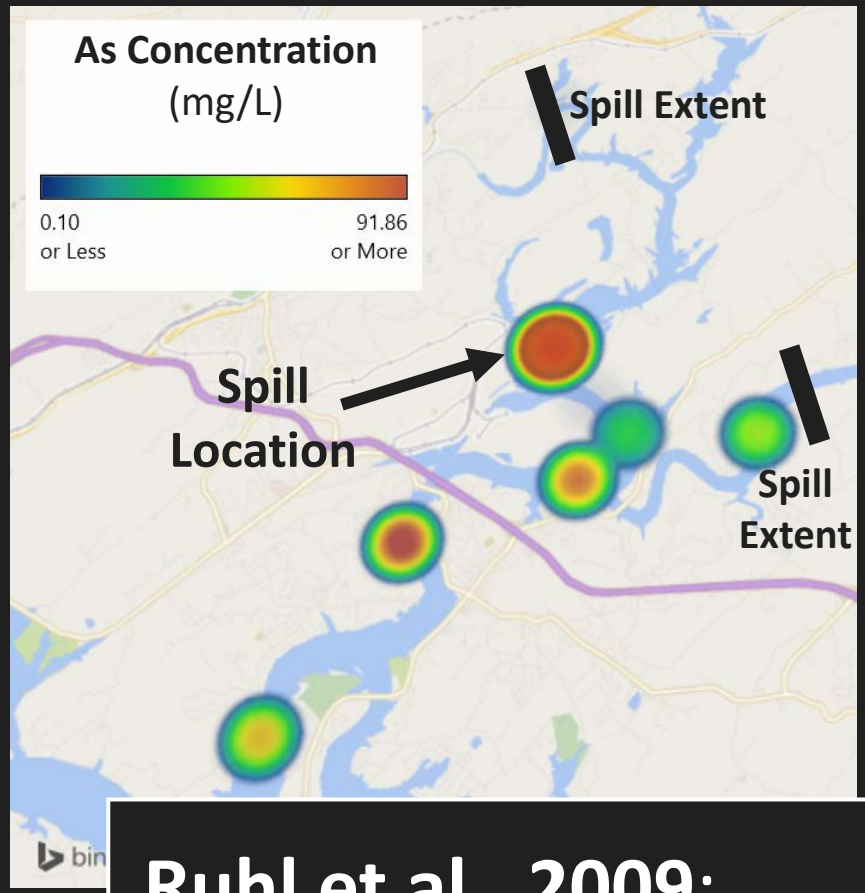
WATER

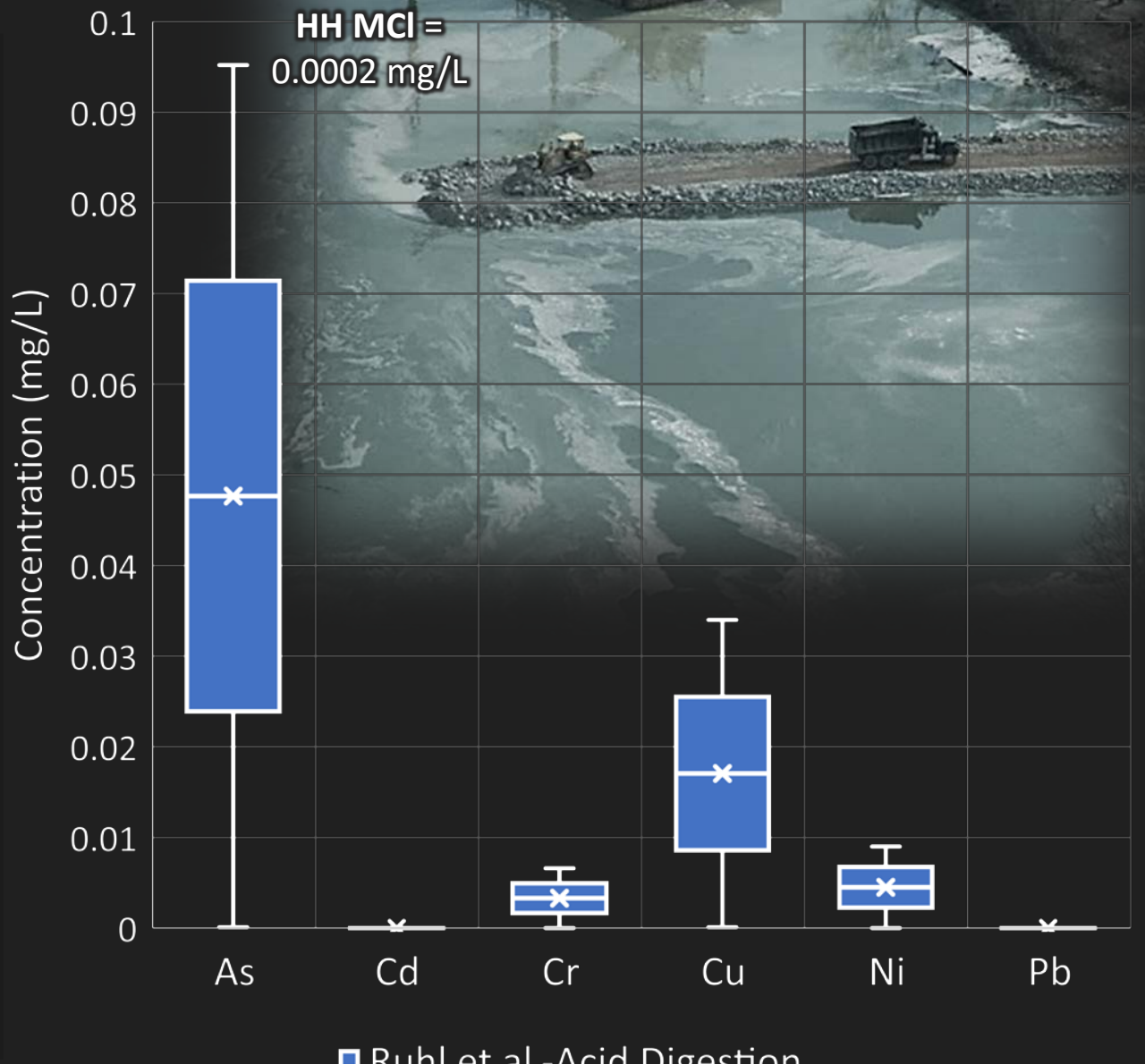
- **EPA Aquatic Life Max Contamination Limit**
  - Harm to plant and animal life
  - Al, As, Cd, Cr, Ni, Pb, Zn
- **EPA Human Health Max Contamination Limit**
  - Harm to human health
    - Drink water or Eat seafood
  - As, Ba, Cr, Cu, Mn, Ni, Se, Tl, Zn

SEDIMENT

- **Sediment Quality Guidelines**
  - Consensus-based
  - predict toxicity in freshwater sediments
    - Low potential for toxicity
    - Medium potential for toxicity
  - As, Cd, Cr, Cu, Ni, Pb, Zn

Initial Trace Metal Contamination in Water



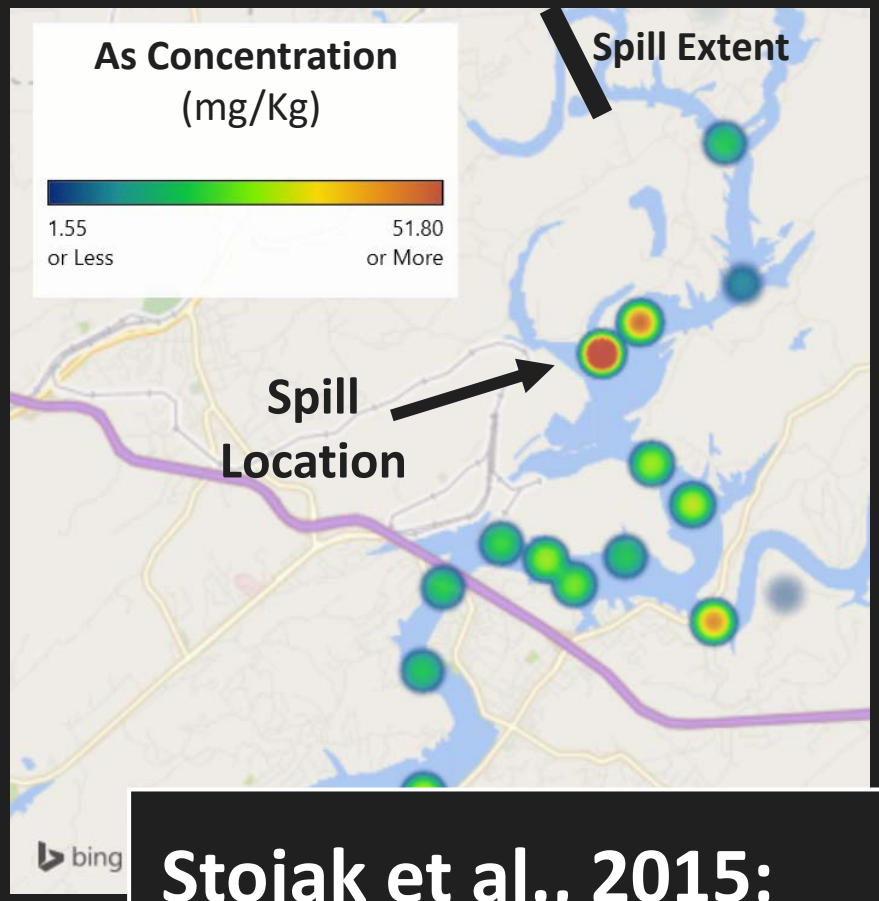


Ruhl et al., 2009:

- Most water samples had no trace metal concentrations above EPA MCLs
- Exceeding human health MCL: **As**

Photo: TVA

Initial Trace Metal Contamination in Sediment



Stojak et al., 2015:

- Samples collected in 2011
- Exceeding ERL: **As, Cu, Ni**
- Exceeding ERM: **As**

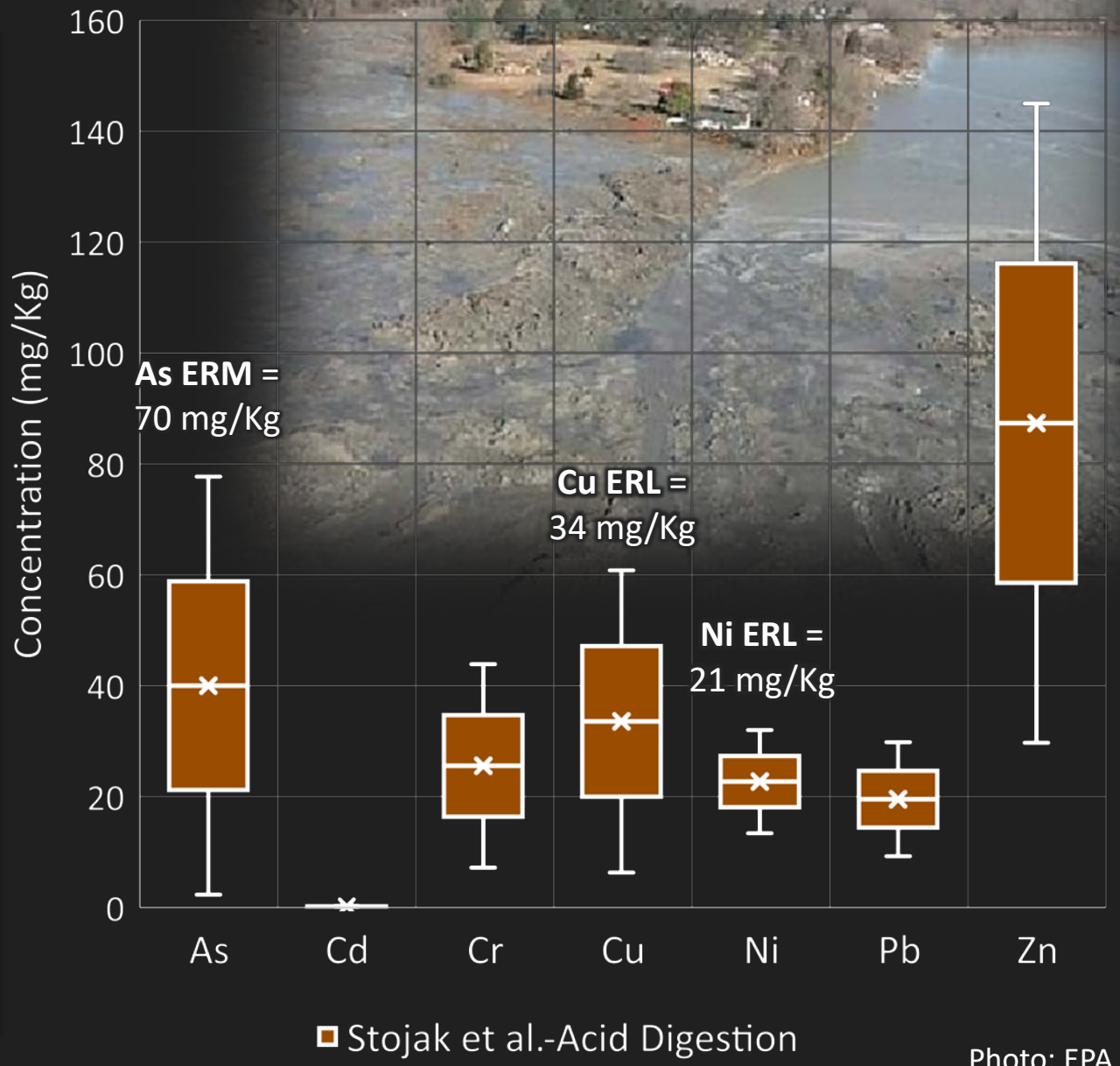


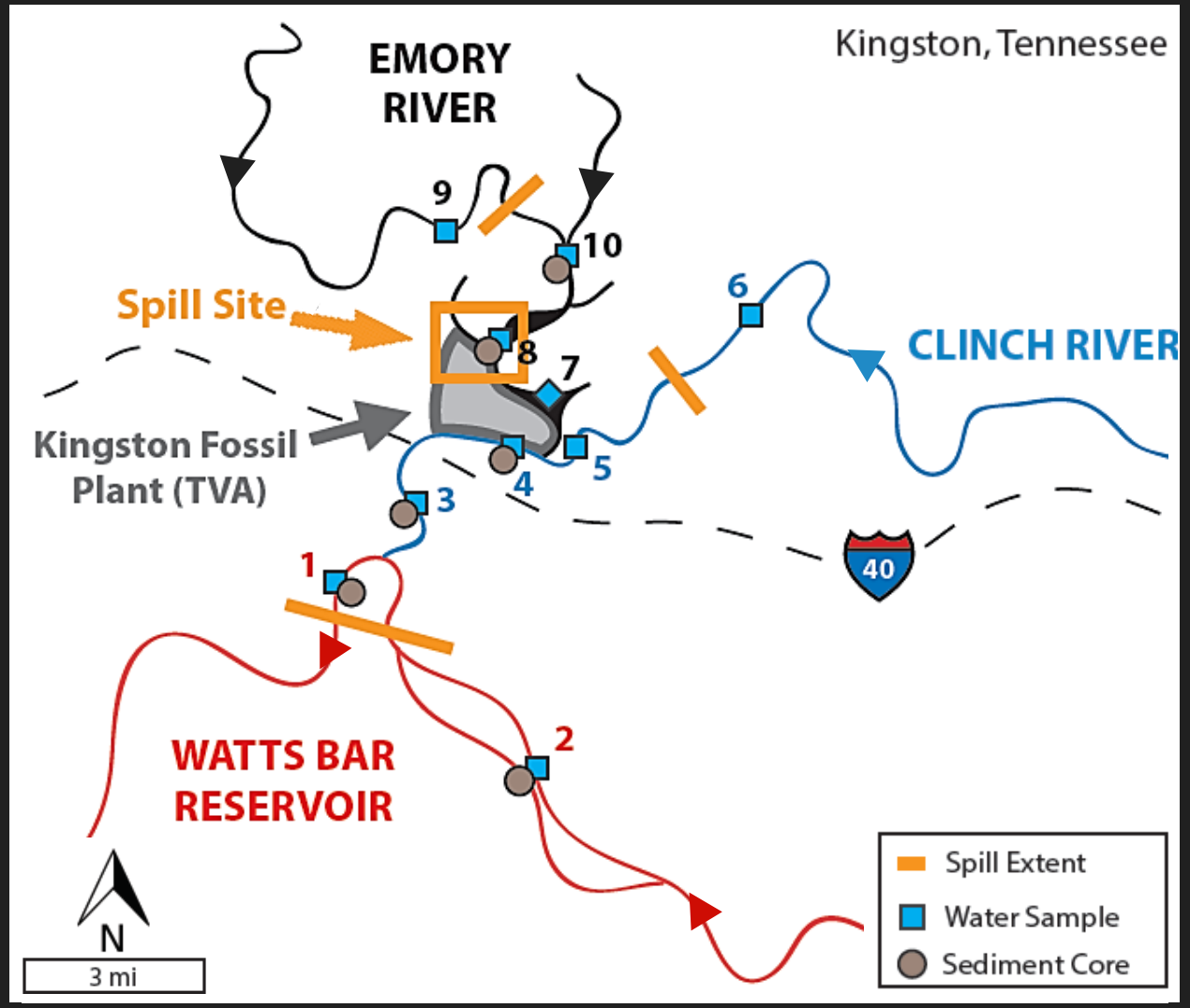
Photo: EPA

Water and Sediment Sampling

8 years later…

April 28, 2016:

- Surface water
  - at all locations
- Water column, 3-4 m intervals
  - Sites 2, 6, 7, 8, 9, and 10

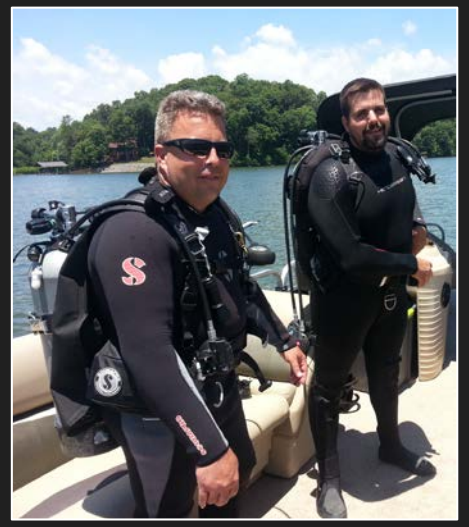


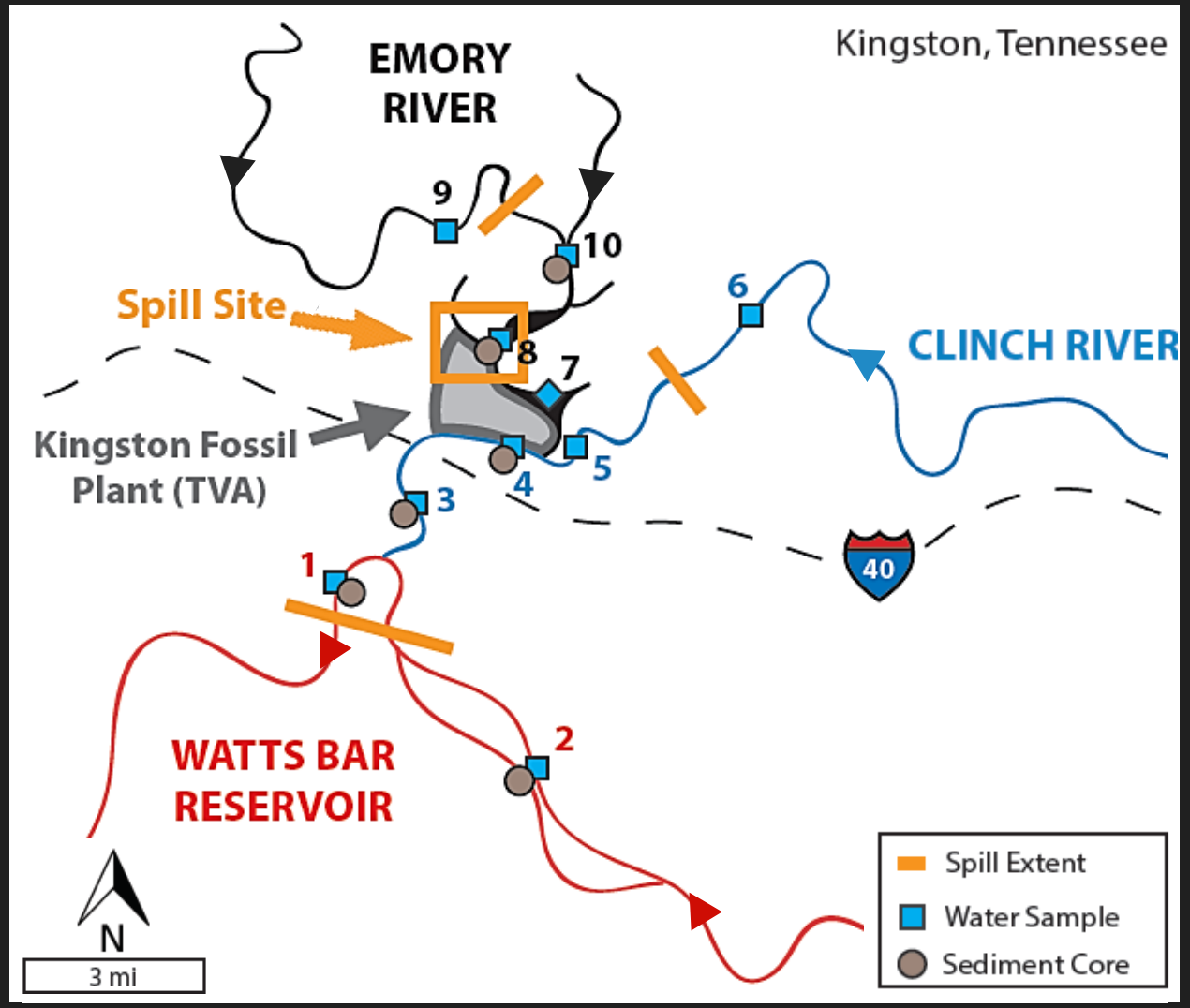
Water and Sediment Sampling

8 years later…

June 15 and 16, 2016:

- 6, 26-30 cm long sediment cores
  - Sites 1, 2, 3, 4, 8, and 10





Laboratory Analysis

Water Processing:

- Samples were acidified and filtered upon collection

Sediment Processing:

- Water-soluble
  1. 1 g of sediment
  2. ultra-pure DI water
- Acid-soluble
  1. 1 g sediment after DI process
  2. 2% HCl

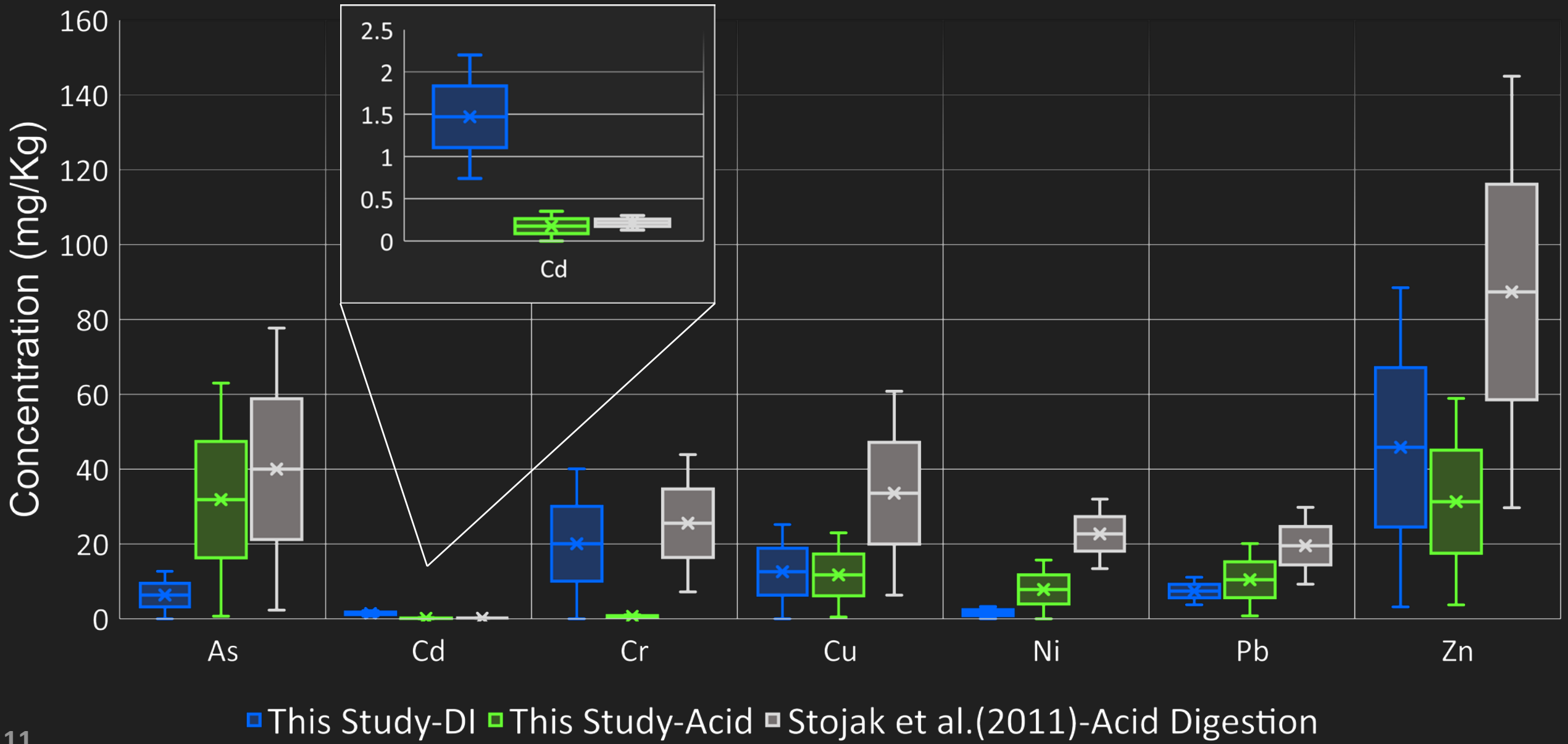
Trace Metal Ion Analysis:

- Thermo Scientific iCAP 7000 Series ICP spectrometer
  - Analytical precision was ± 0.002 mg/L.

Healthy Riverine Waters at Present

- Significantly lower concentrations of all dissolved trace metals
  - Trace metals below detection limit (0.002 mg/L) include:
    - Al, As, Cd, Cu, Cr, Be, Li, Ni, and PbB,
  - B, Fe, Se, and Zn concentrations detectable (<0.1 mg/L)
    - Concentration below established EPA MCL guidelines.

Elevated Concentrations of Trace Metals in Sediments



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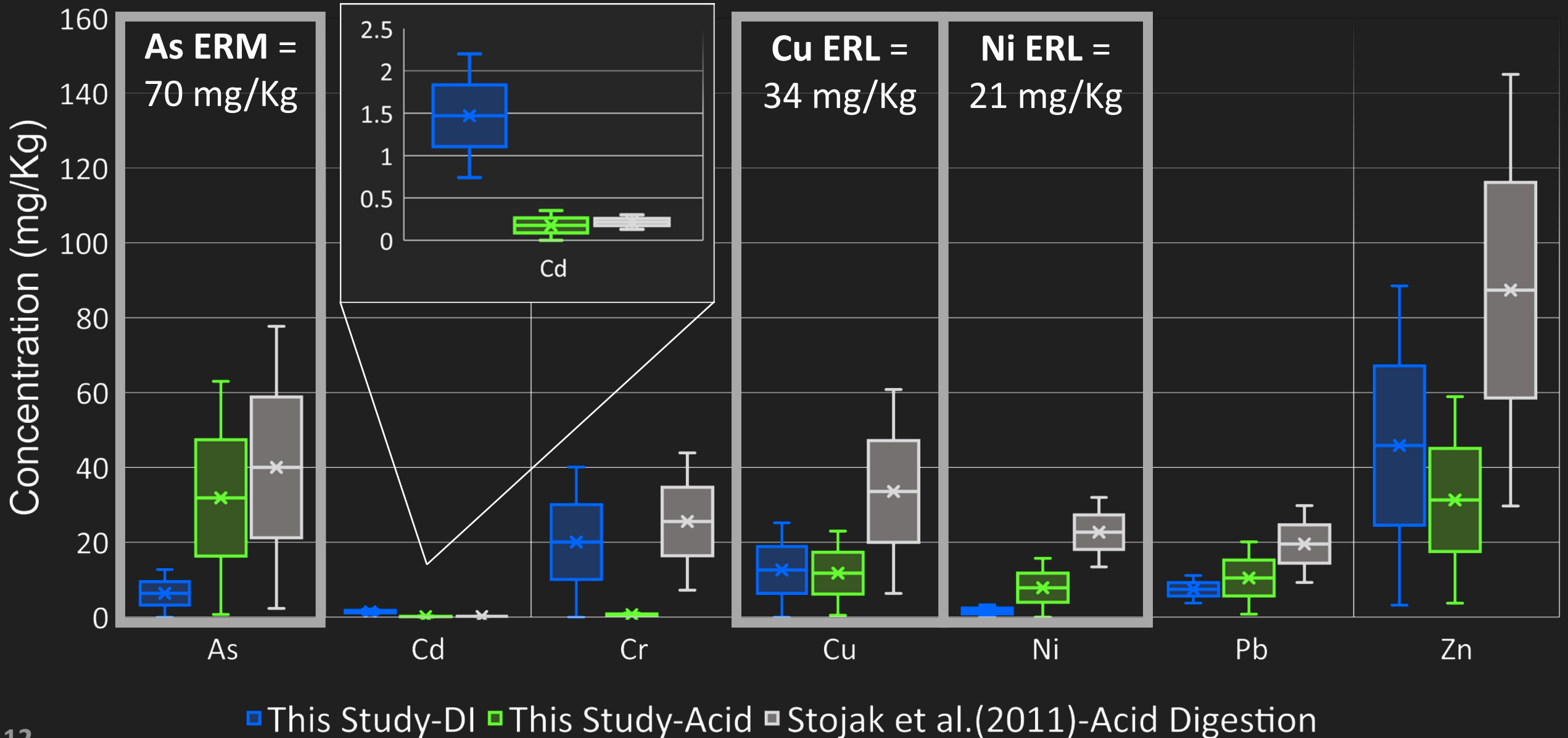

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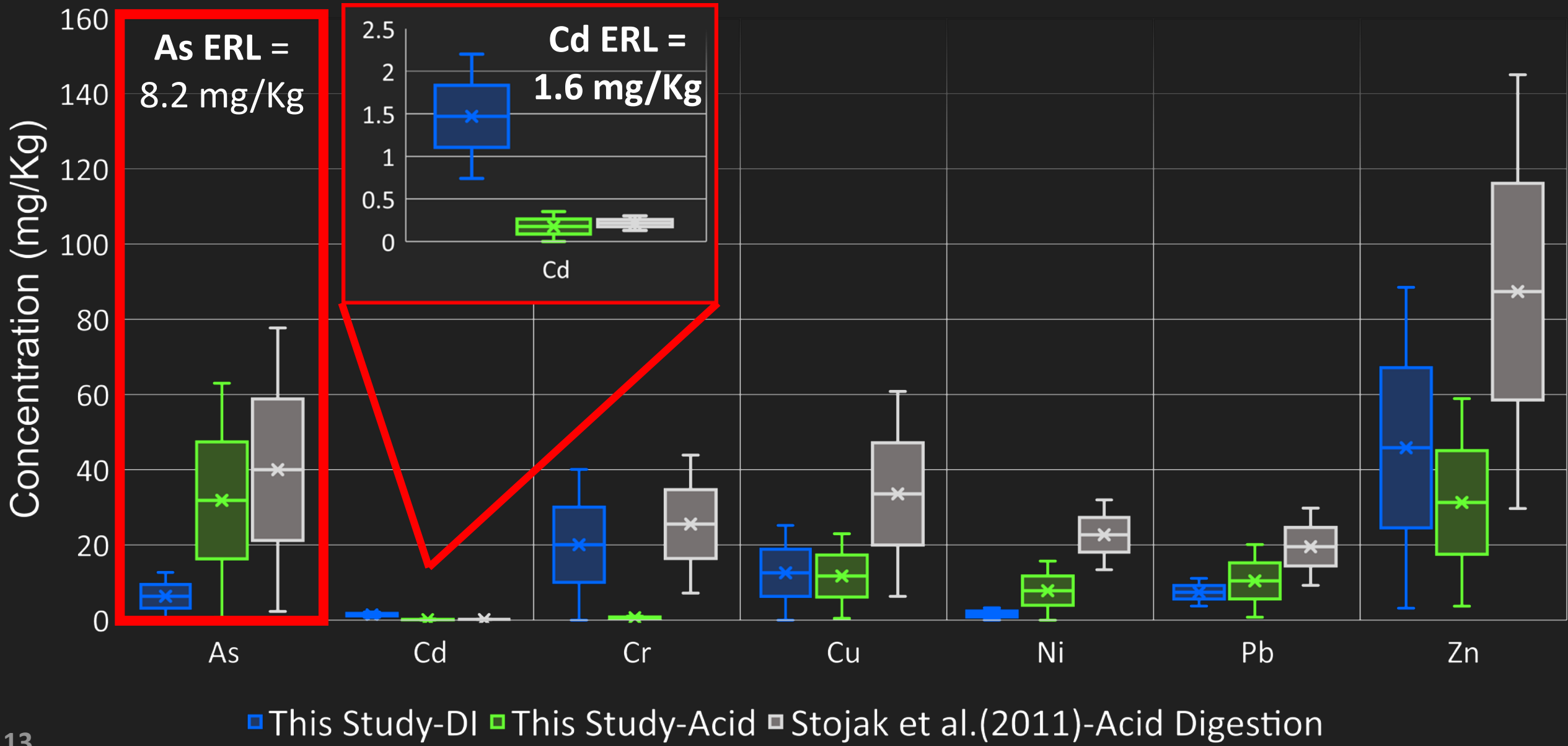
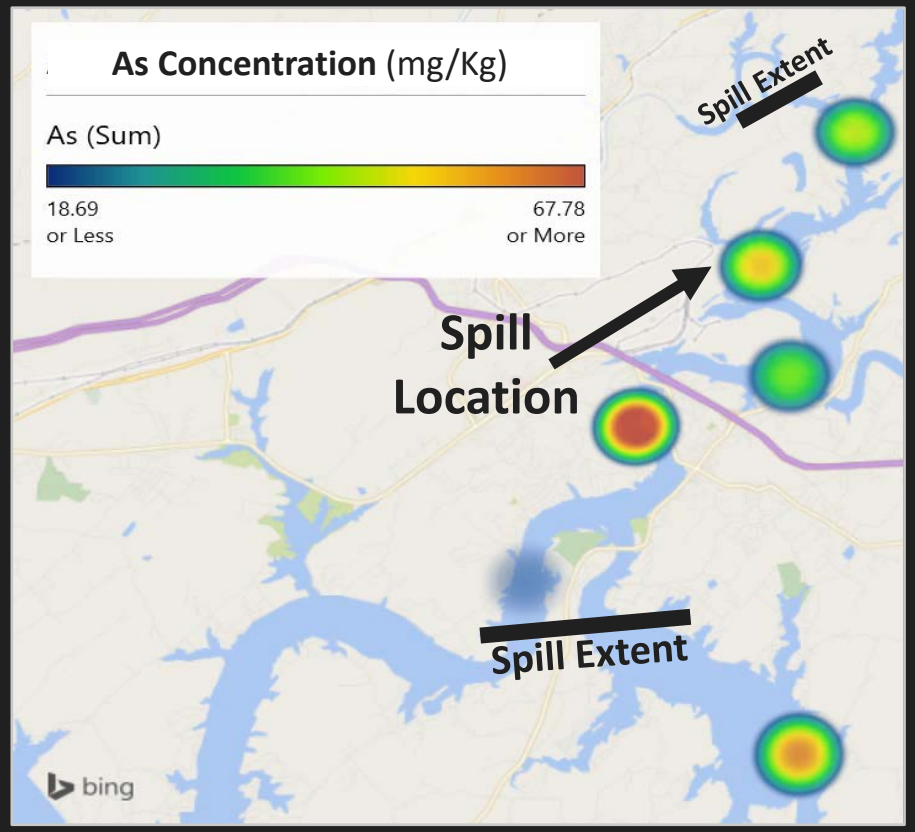


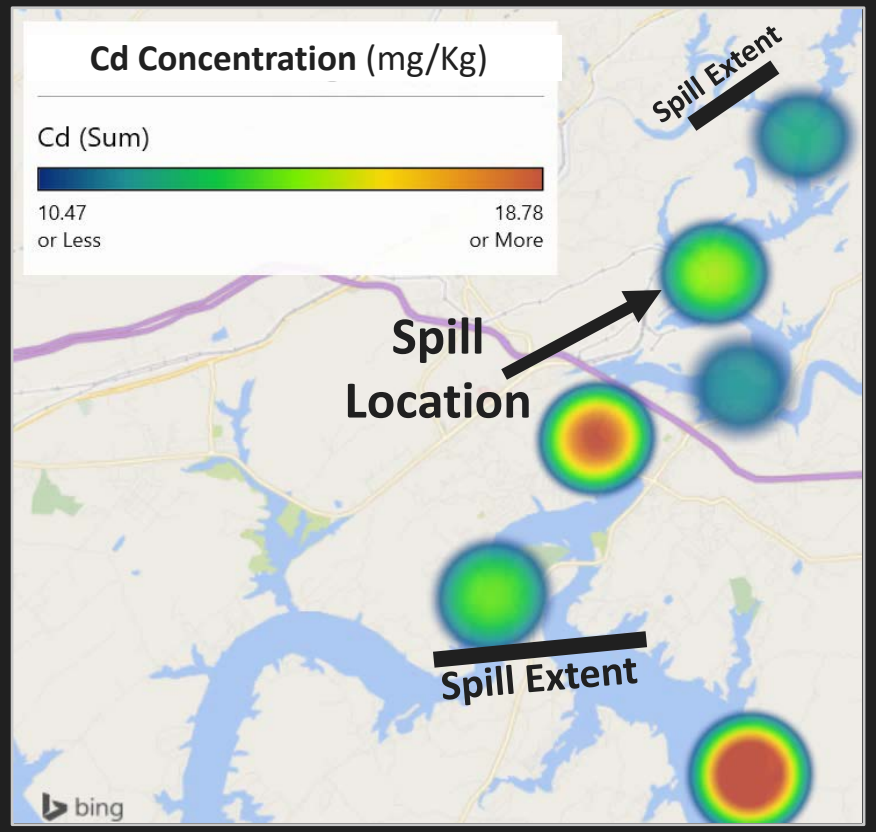
More Than One Trace Metal Source…

High concentrations both inside and outside spill region

Trace metals also sourced by other contaminants

Additional sampling Necessary





Take-Home Message

People and organisms interacting with the water should be safe from potential trace metal caused illness

Interaction with sediment or consumption of seafood increases risk of toxic side effects

More in-depth analysis of the region is necessary

Photo: TVA

Acknowledgements

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Jared Malone-Scuba Diver

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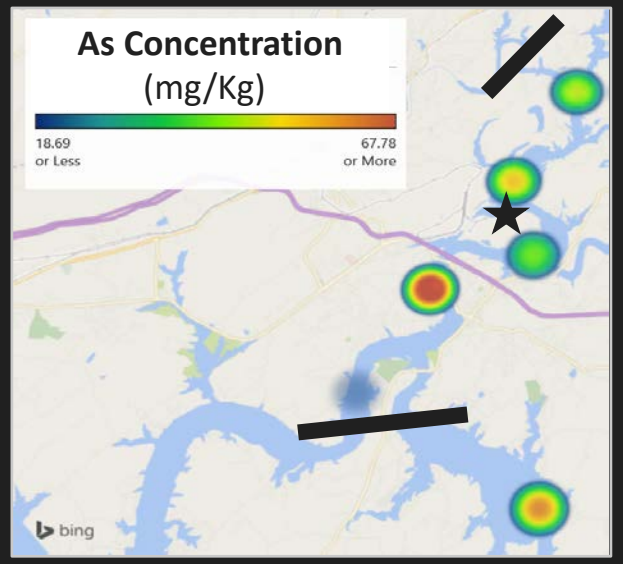

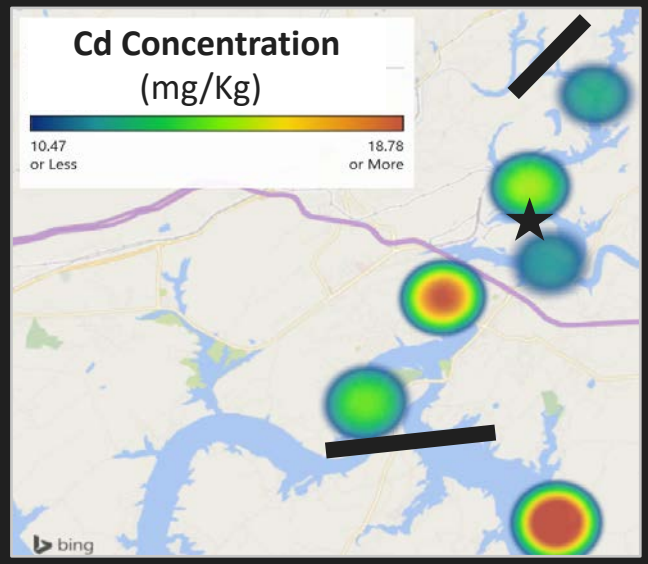

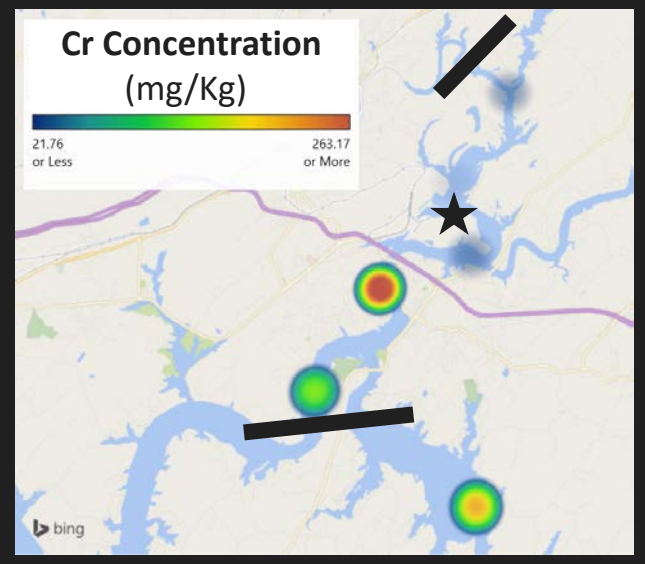

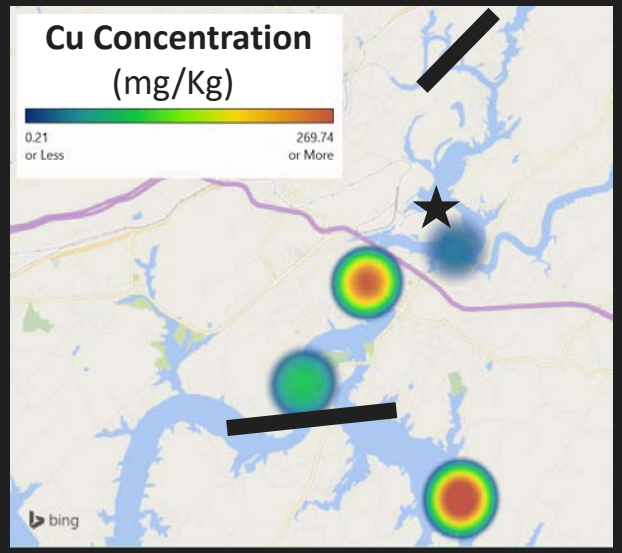

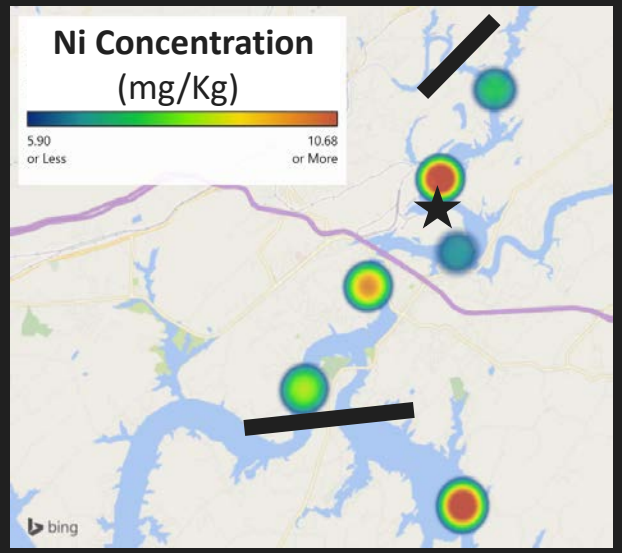

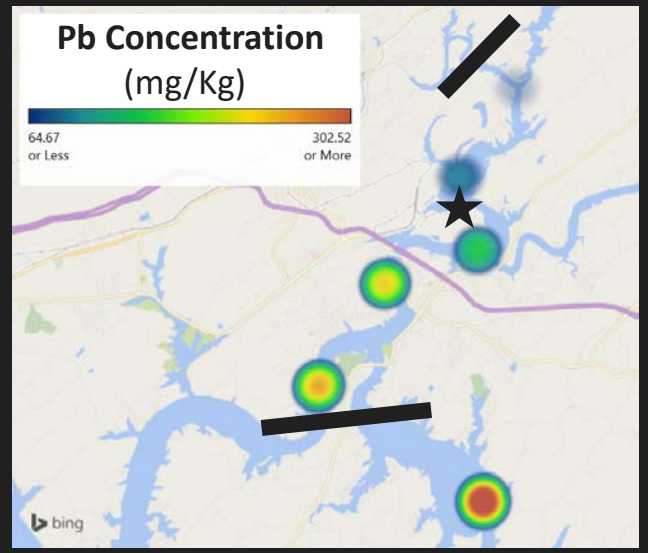

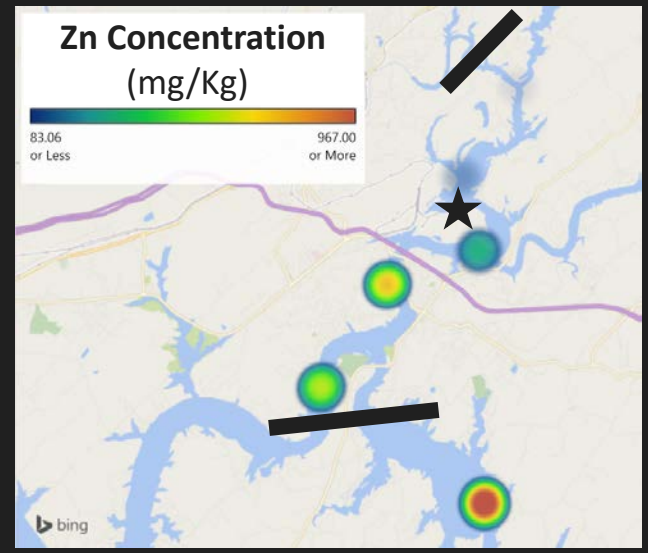

Total Leached Trace Metals Relative to Stojak et al.