EPA
United States
Environmental Protection
Agency

Long Term Measures of Remedy Effectiveness

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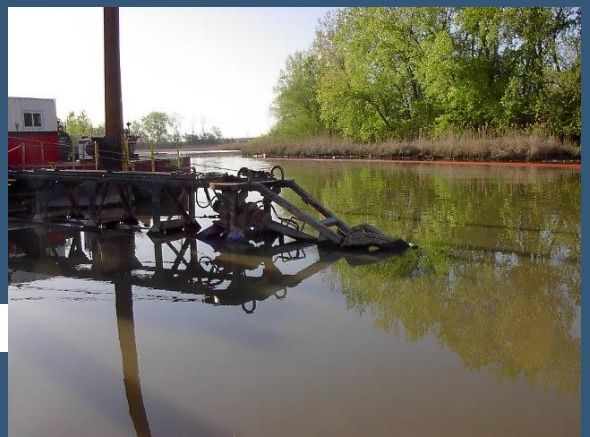


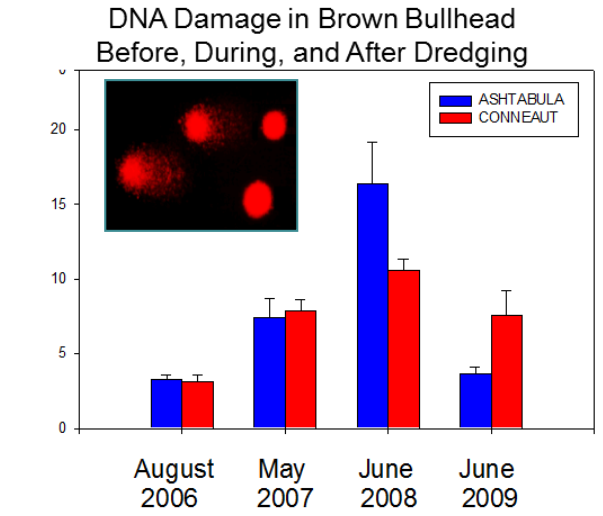
Weight of Evidence Approach using Multiple Lines of Evidence

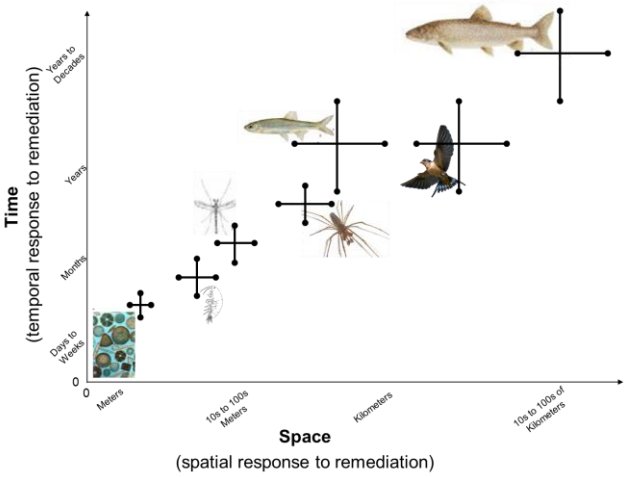
- Biological LOE – assesses biological endpoints, e.g., fish reproduction, diversity of species, toxicity
- Chemical LOE – measures that relate to contaminant concentrations, e.g., post-remedial surface weighted concentrations, reductions in fish tissue levels
- Physical LOE – volume and mass removed, e.g. pounds of PCBs dredged
- Modeling - physical and hydrodynamic modeling, performance modeling, food web modeling

Biological lines of evidence

Current

Innovative





<u>Current practice</u>

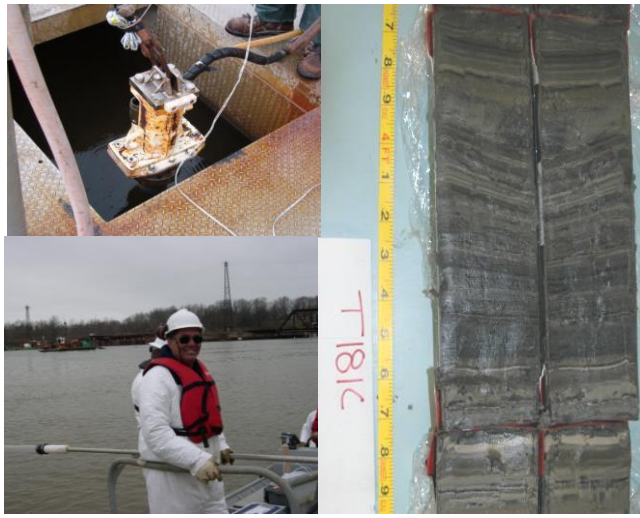
- Fish tissue for human consumption
- Standard sediment tox. and bioacc. testing
- Benthic survey
- Histopathology, common endpoints for biota

<u>Innovative (examples)</u>

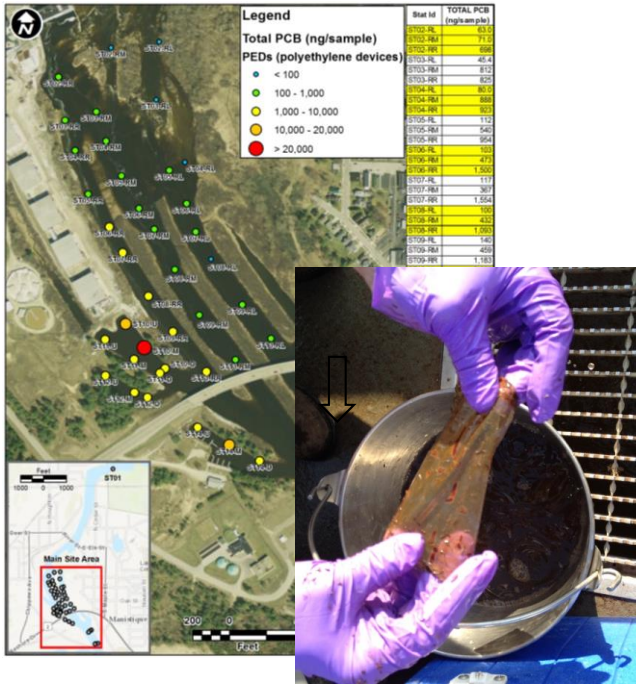
- Benthic body burden
- Short lived fish
- Bioaccumulation – alternative biological and surrogate measures (Tenax, SPMEs, etc)
- Fish (IBI)/habitat quality/Genetic damage
- Benthic survey (e.g. L-ICI)
- Bivalve uptake
- Riparian indicators (avian, spiders, etc)
- SOP (performance based)/QAQC/Interlab comparisons
- Reference locations

Chemical lines of evidence

Current



Innovative



Current practice

- Sediment chemistry – surface and segmented core sampling
- Water Chemistry

Innovative (examples)

- Passive samplers (e.g., PEDs, SPMEs)
- Porewater (direct and passive)
- Groundwater intrusion
- Legacy contaminants versus CECs
- Rapid screening – direct analysis techniques
- Qualitative level screening for additional contaminants (legacy and CECs)
- Advanced Chemical Forensics
- Common SOPs/QA

Physical lines of evidence

Current practices

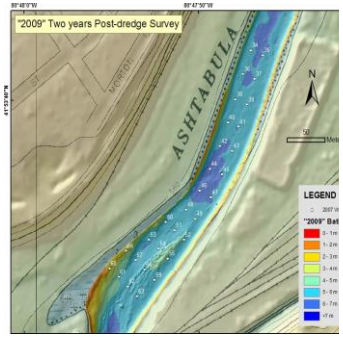
- Single-beam Bathymetry
- Turbidity
- Sediment transport modeling

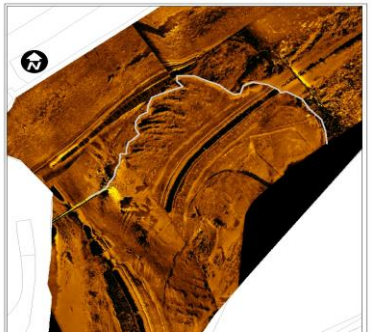
Innovative (examples)

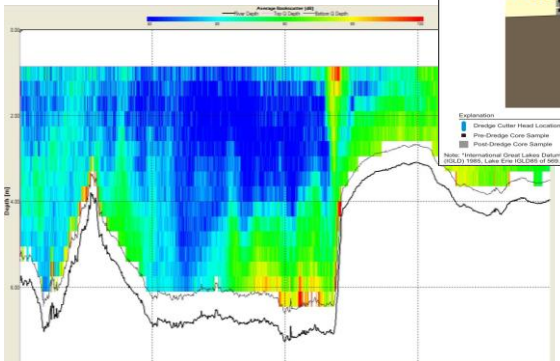
- Grain size analyses of dredge materials and “residuals”
- Particle tracking
- Hydrodynamics & plume monitoring
- GW-surface water interactions
- Sediment traps for transport of sediment and COCs
- Multi-beam Bathymetry/side scan sonar
- Diver assisted probing and SPI camera for residuals

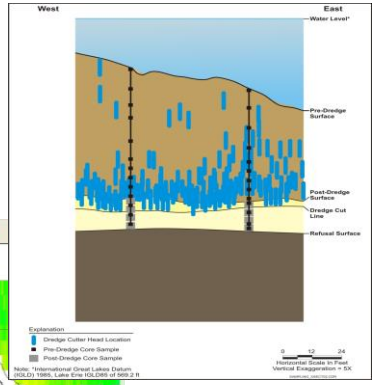
Current

Innovative







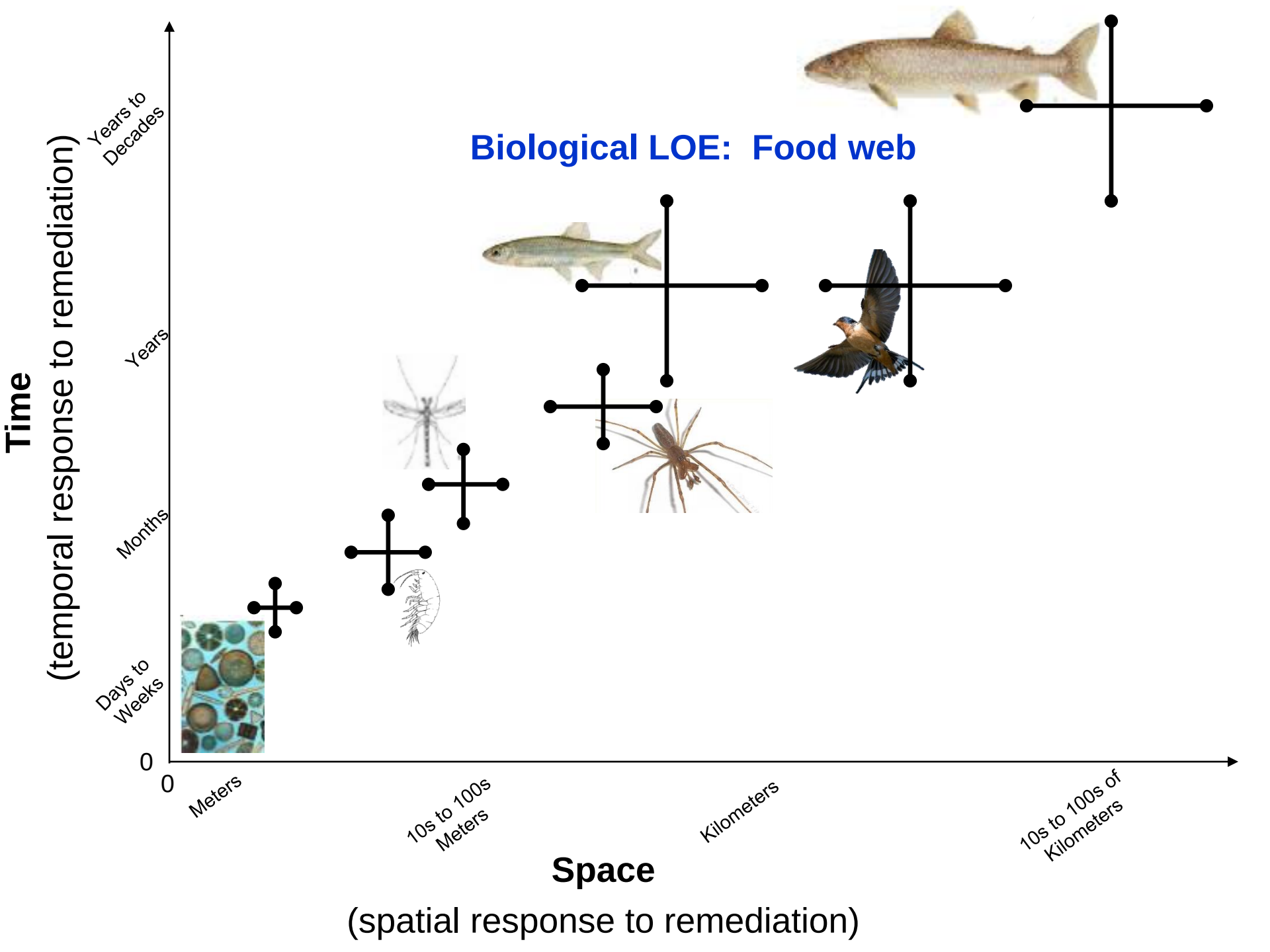


GLLA Ottawa River remediation project (Maumee River AOC)

- The 2009-2010 GLLA remediation project was over 5 miles in Reaches 2-4.
- The primary Contaminants of Concern (COC) at the site were PCBs, PAHs, inorganics (principally lead), and oil/grease.
- ~ 260,000 yd^3 of contaminated sediments were removed from the project area.
- Removal was through dredging in targeted areas within Reaches 2-4 of the river where COCs exceeded a threshold level.

ORD Monitoring Stations

EPA United States Environmental Protection Agency

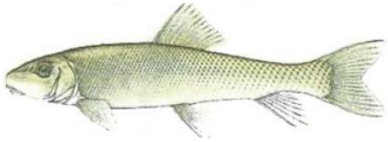

Biological LOE: Food web
Time
(temporal response to remediation)
Years to Decades
Years
Months
Days to Weeks
0
0
Meters
10s to 100s Meters
Kilometers
10s to 100s of Kilometers
Space
(spatial response to remediation)

Biological LOE's: Food Web Tissue Sampled

Fish Composited Across Each of the 3 Reaches

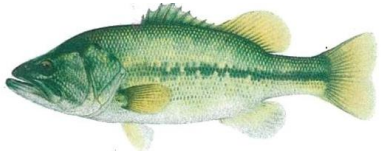
White Sucker (WS) Redhorse (RH)

3-5/Reach > 200 mm



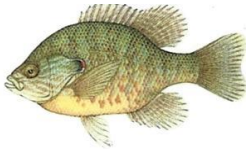
Large Mouth Bass (LMB)

3-5/Reach > 250 mm



Pumpkinseed (PS)

3-5/reach > 80 mm

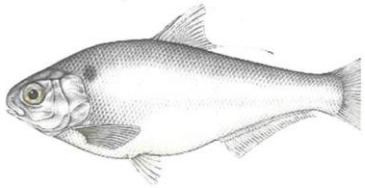


Brown Bullhead (BB)

> 10/reach > 250 mm

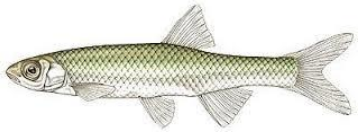
Gizzard Shad(GS)

3-5/Reach > 180 mm



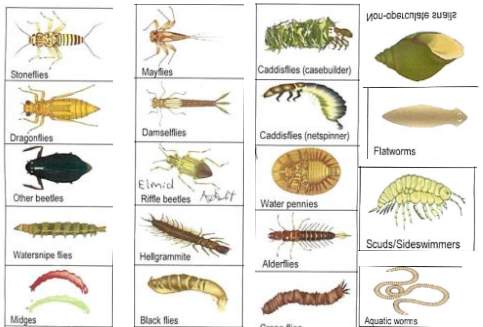
Emerald Shiner (ES)

2-3 reps >25 g/reach



Macroinvertebrates (Inv)

2 reps/Station > 1gm

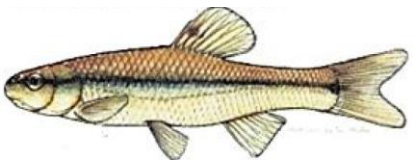


Spiders Tetragnathids (Sp)

4 Reps per station >2 gm

Bluntnose Minnow (BN)

2-3 reps >25 g/reach



COCs in Biomass Methods

Fish

EPA & FWS Electroshocking

EPA Fyke Netting

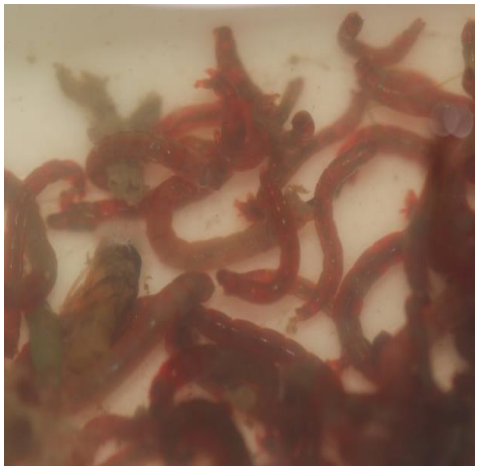
Logged and processed

Macrobenthos

20 HDs/rep 2 reps/site
18 sites over 3 reaches

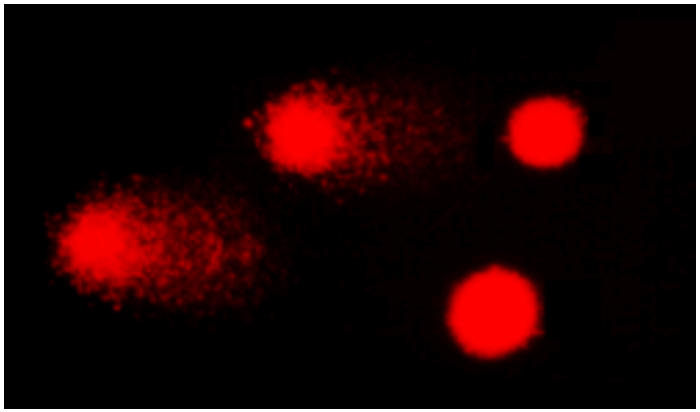
Deployed 6 weeks and processed in field

Time sorted to > 1gm wet wt



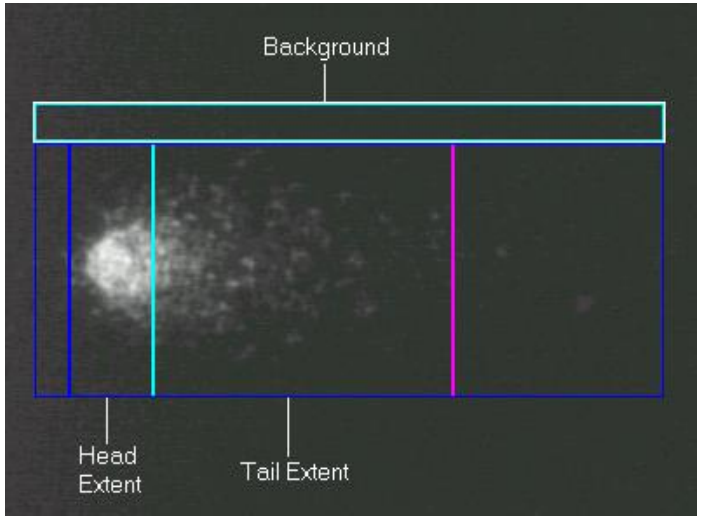
Biological LOE's: Comet Assay to evaluate genotoxic response

Collect Blood and Liver in Field



Fluorescence microscopy image of Comet Assay blood cells

Preserve samples in the field

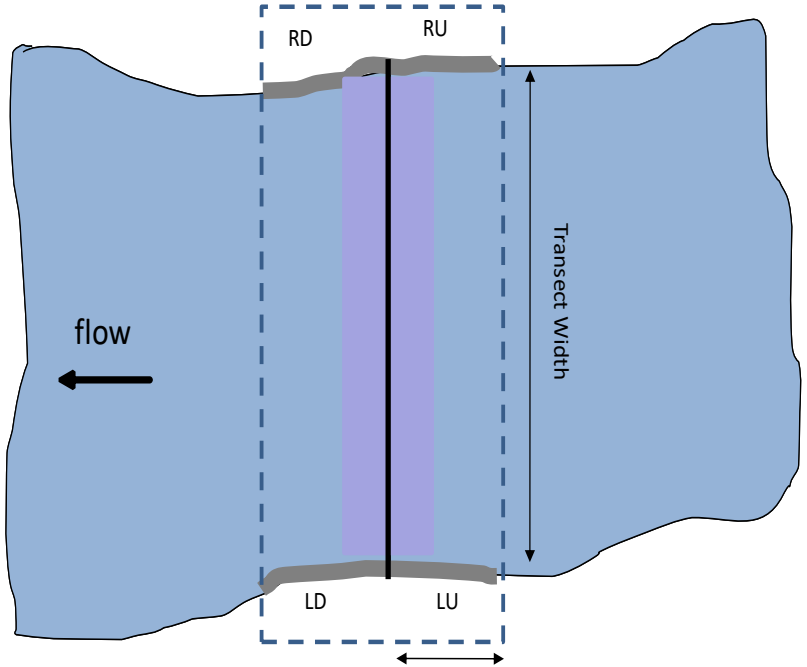


Measuring DNA damage parameters using image analysis

Biological LOE's: Riparian predators - Spiders

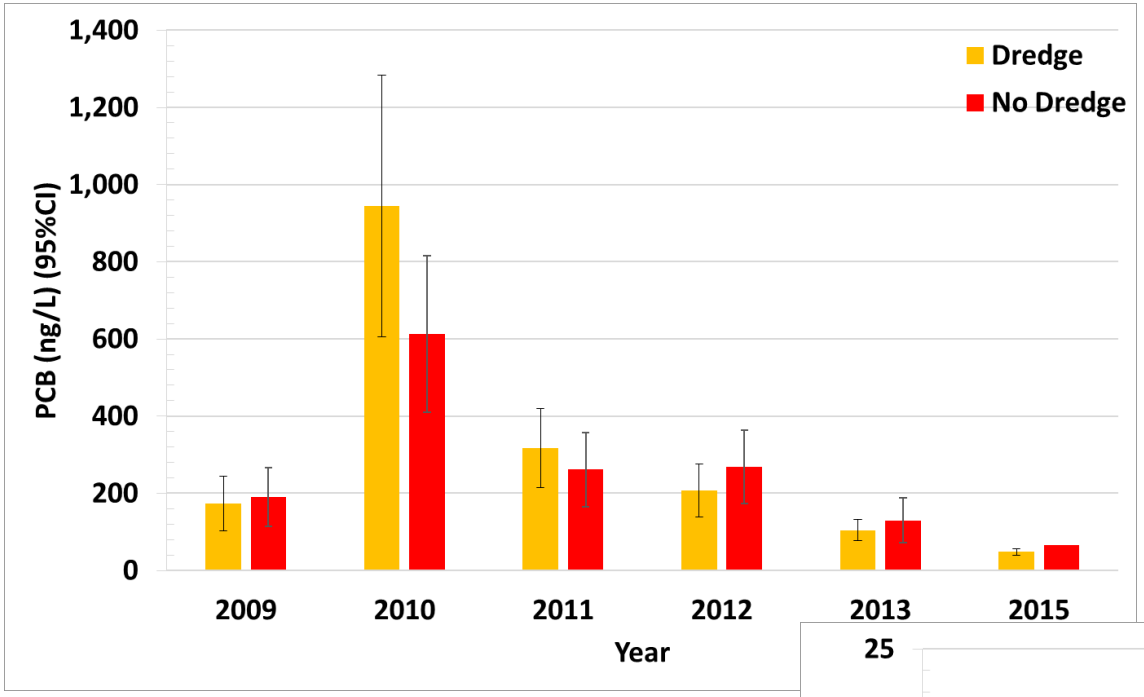
Tetragnathid (longjaw spider)

- riparian specialist
- aquatic insect specialist
- **riparian vegetation** and human structures

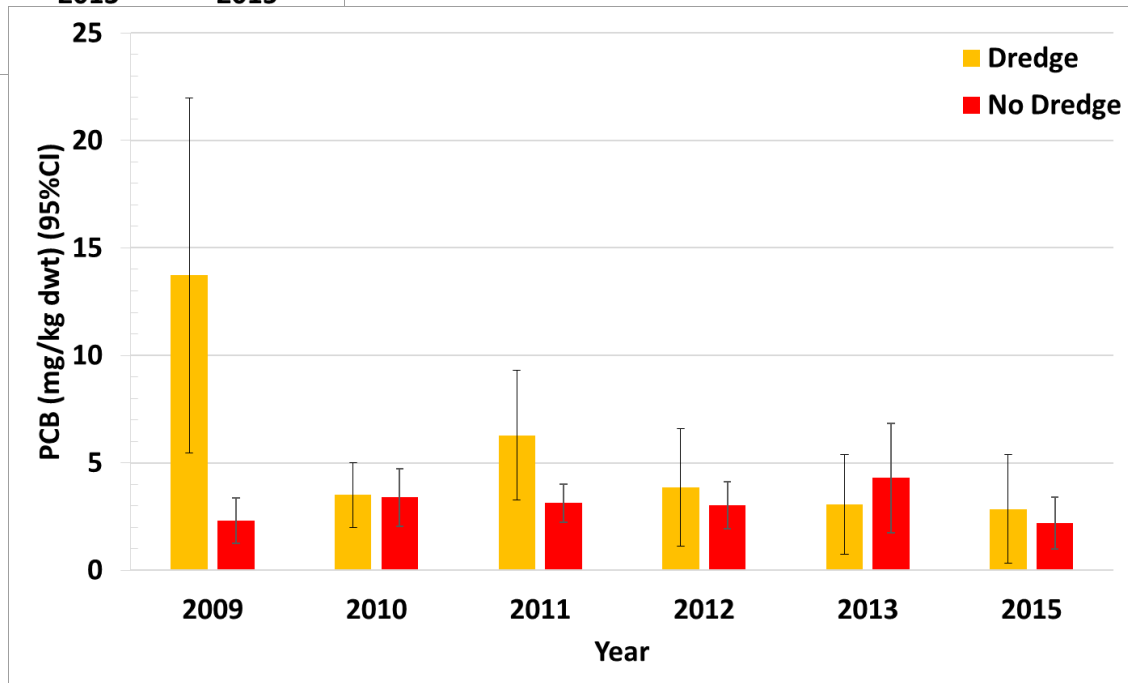


Chemical LOE's

PCBs in water

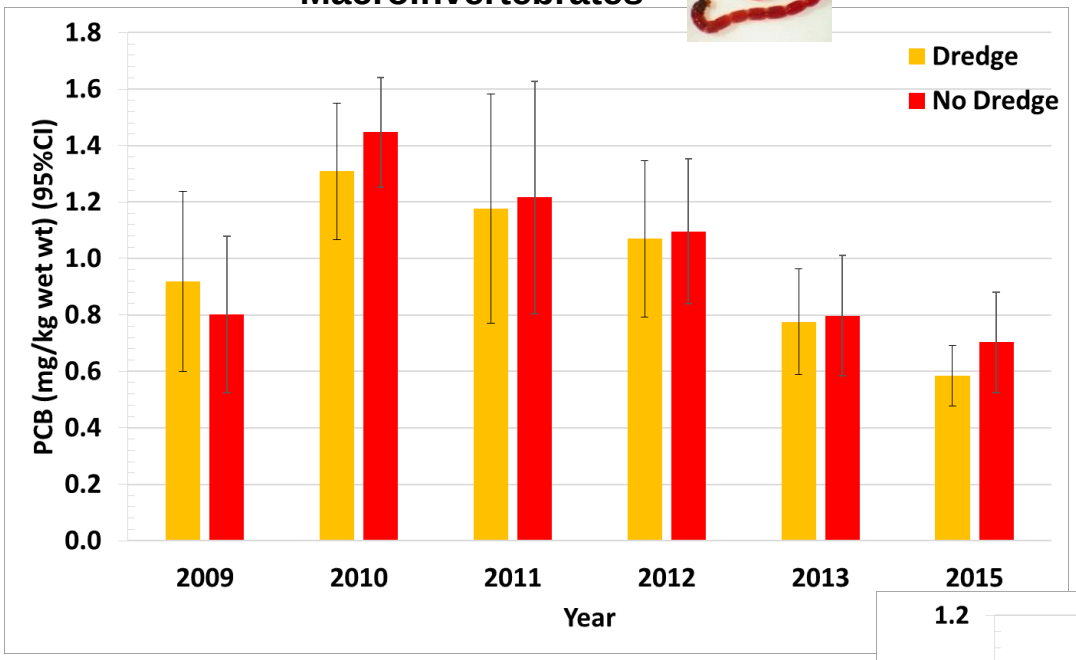


PCBs in sediment

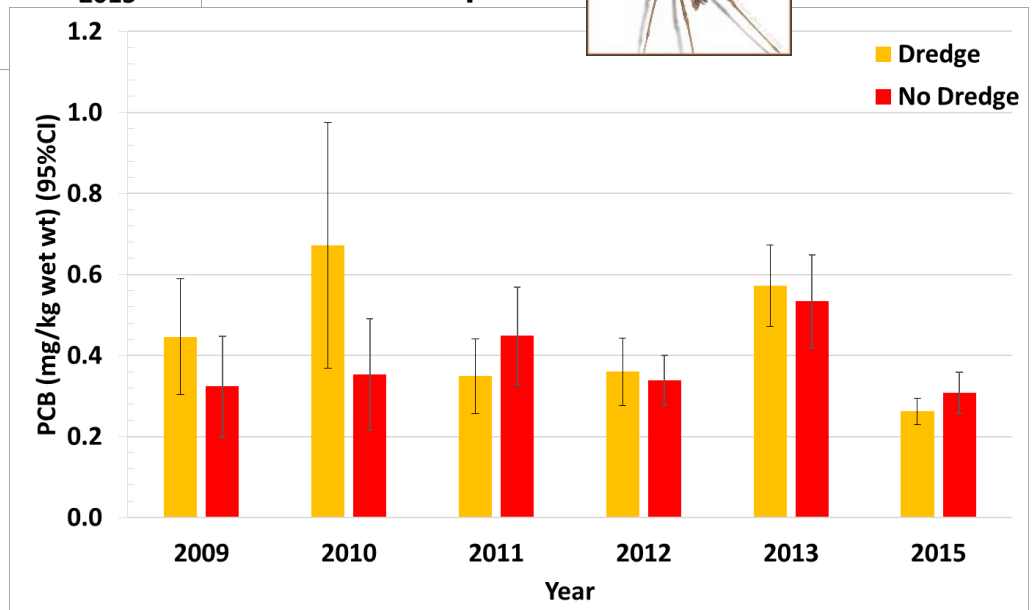


Biological LOE's: COCs in Macroinvertebrates & Spiders

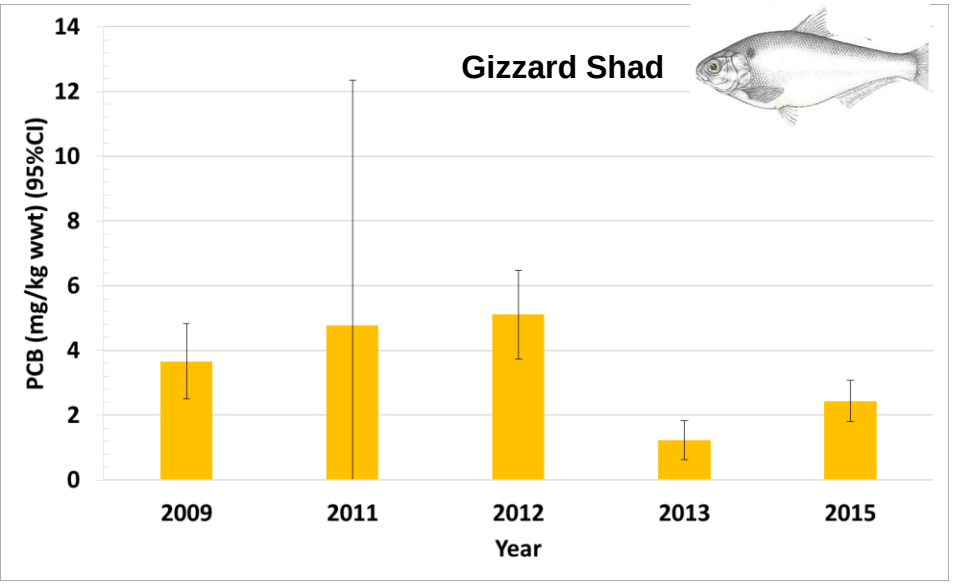
Macroinvertebrates

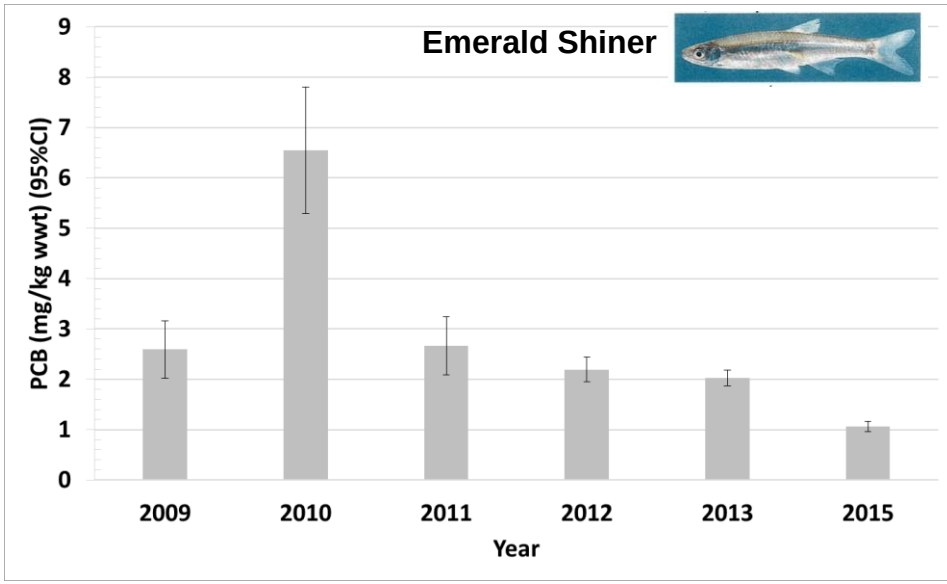


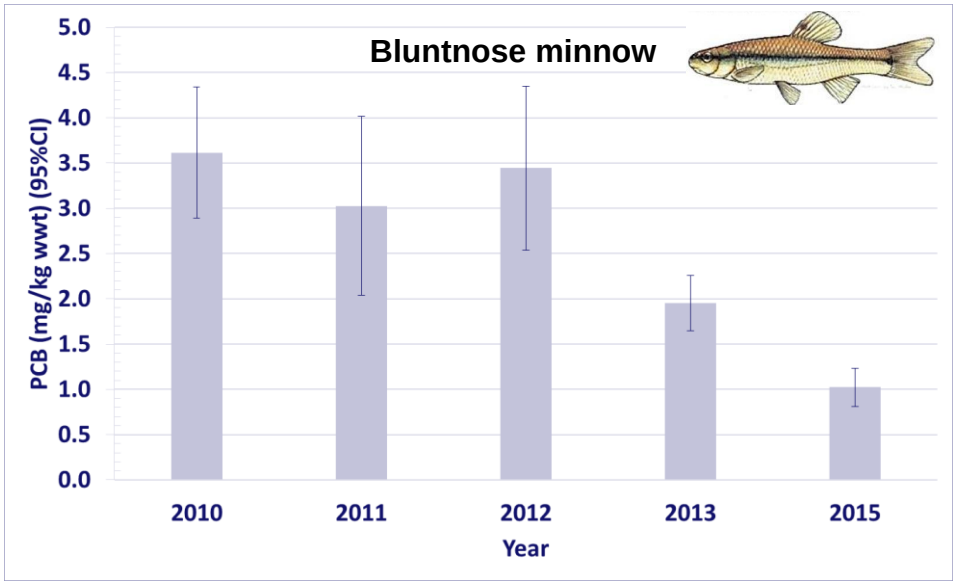
Spiders



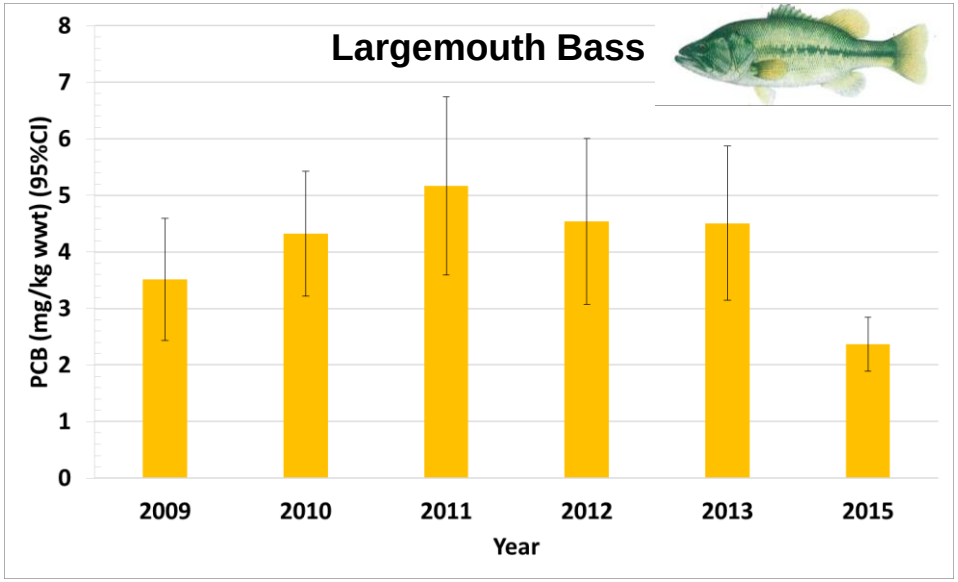
Biological LOE's: Small short lived fish

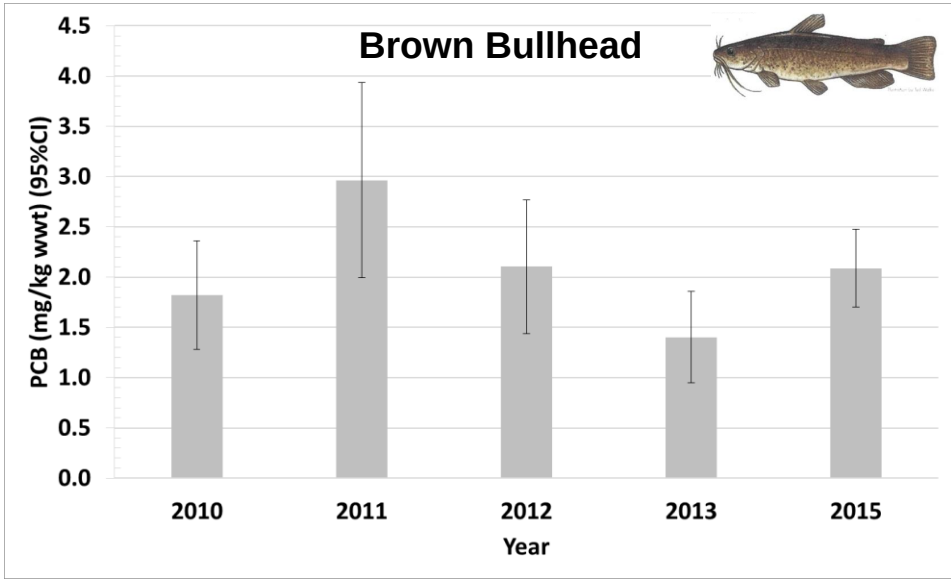


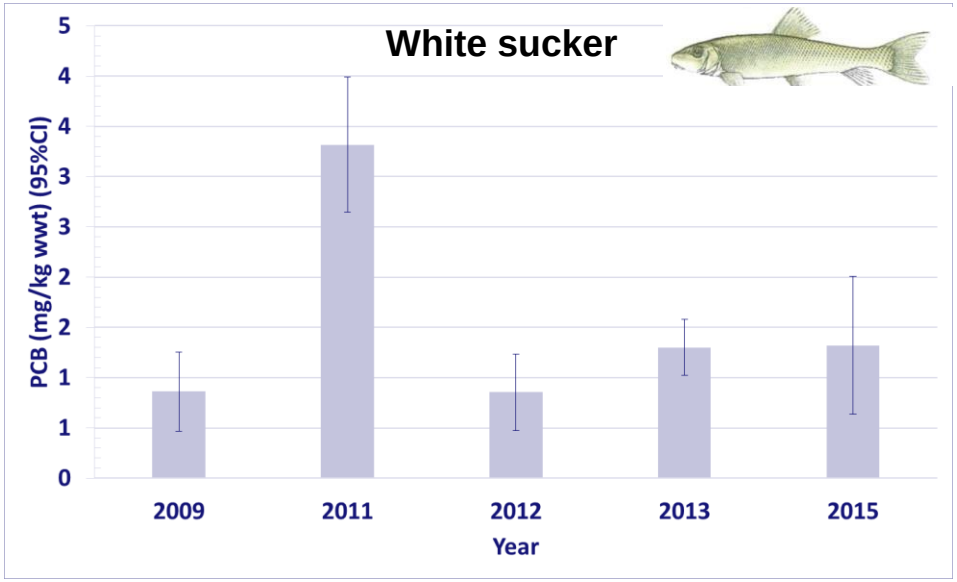


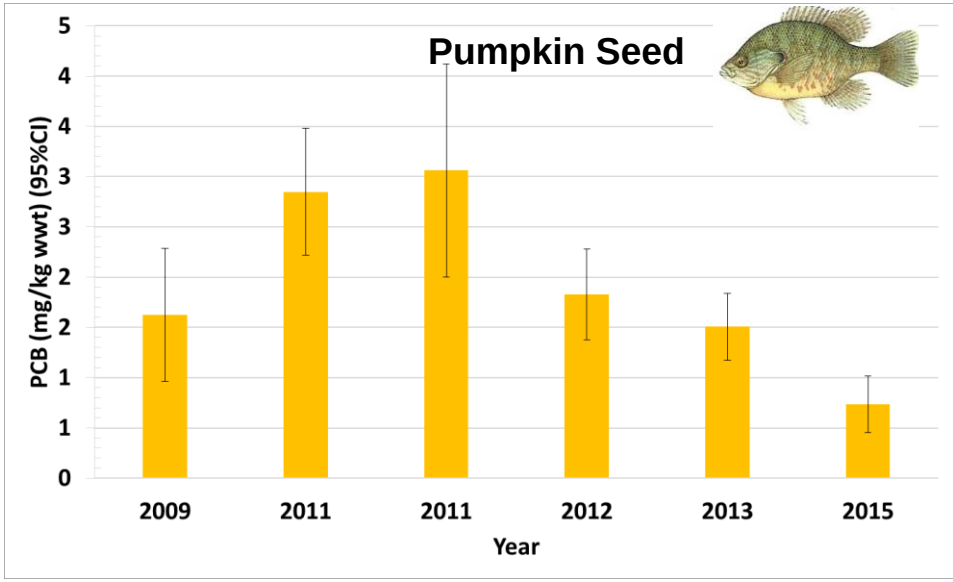


Biological LOE's: Higher trophic fish



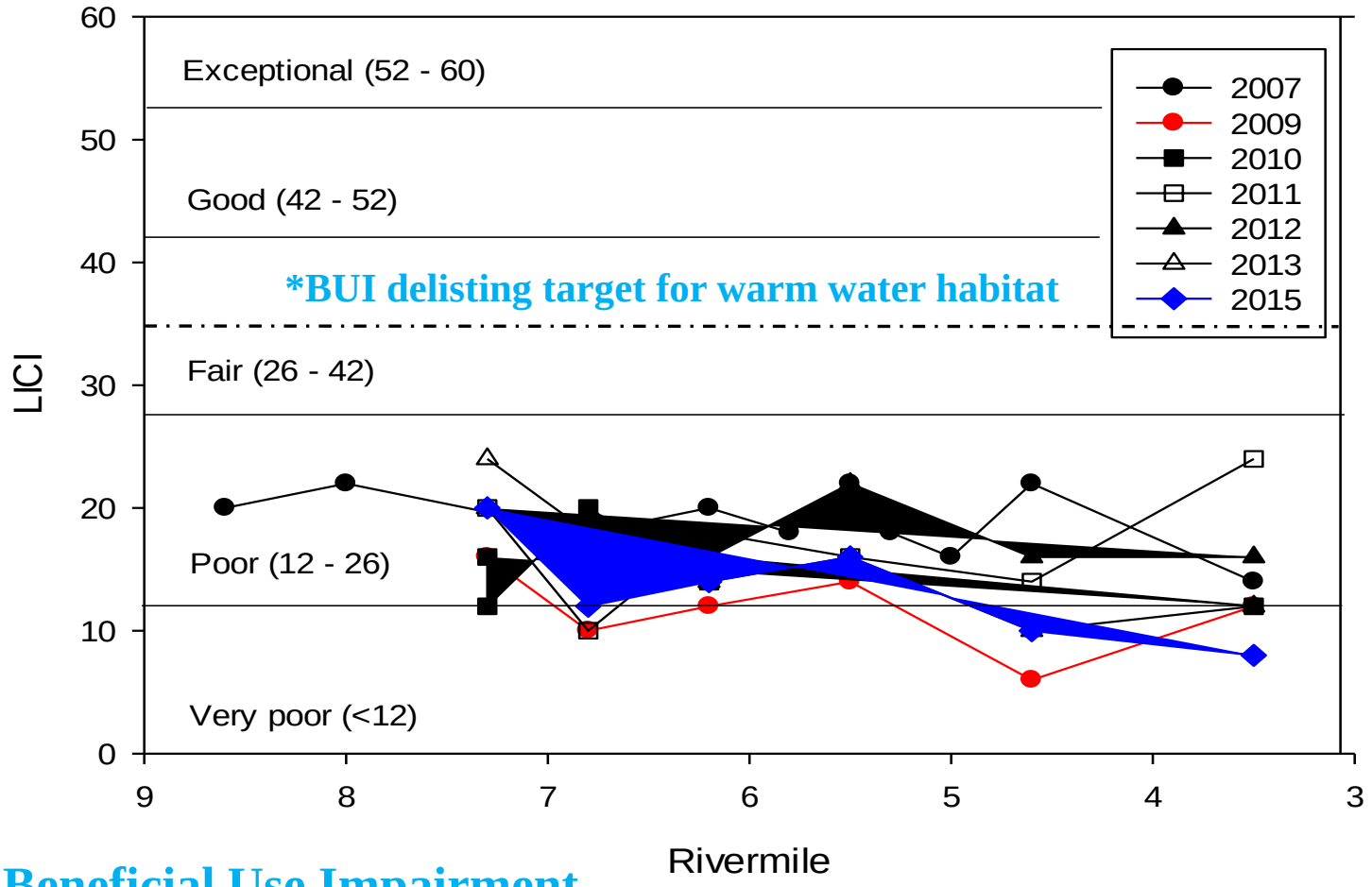






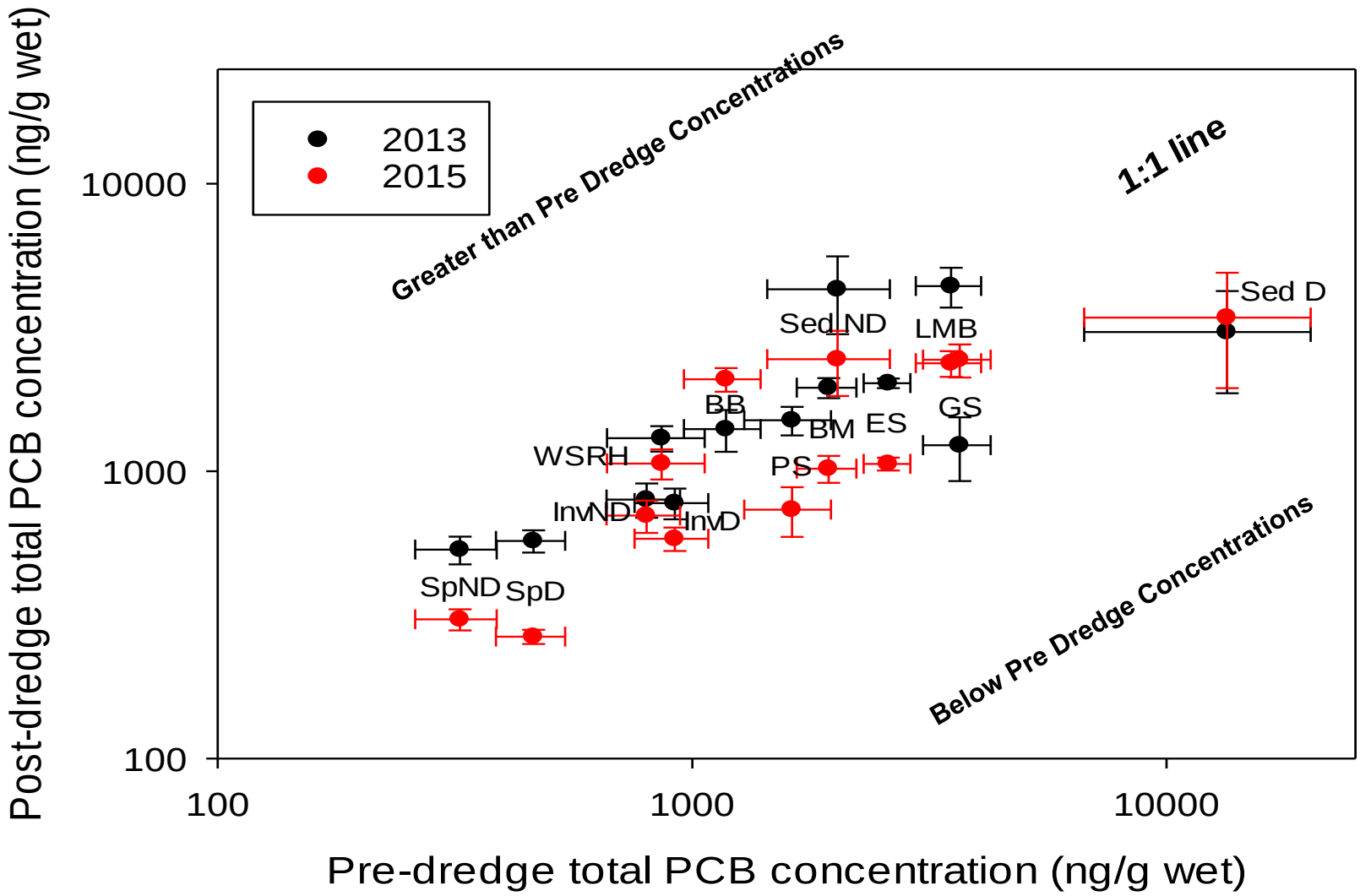
Biological LOE: Macroinvertebrates Lacustuary Invertebrate Community Index (LICI)

Ottawa River 2007-2015



*BUI Beneficial Use Impairment

Biological and Chemical LOE's: Trophic Level PCB Concentrations 2009 v 2013 & 2015



Preliminary Findings

- Sediment concentrations decreased after remediation
  Water concentrations unchanged/slightly decreased after remediation

- **Macroinvertebrate and Spider tissue levels were lower than pre dredge conditions**

- Despite the large physical disruption associated with remediation (dredging) there was no decline in the LICI score.

- **Brown bullhead showed a trend toward a decrease in DNA damage across all reaches from the 2011 high (data not presented)**

- **2015 Gizzard Shad, Emerald Shiners, Bluntnose Minnows, Largemouth Bass, tissue levels were lower than pre dredge conditions**

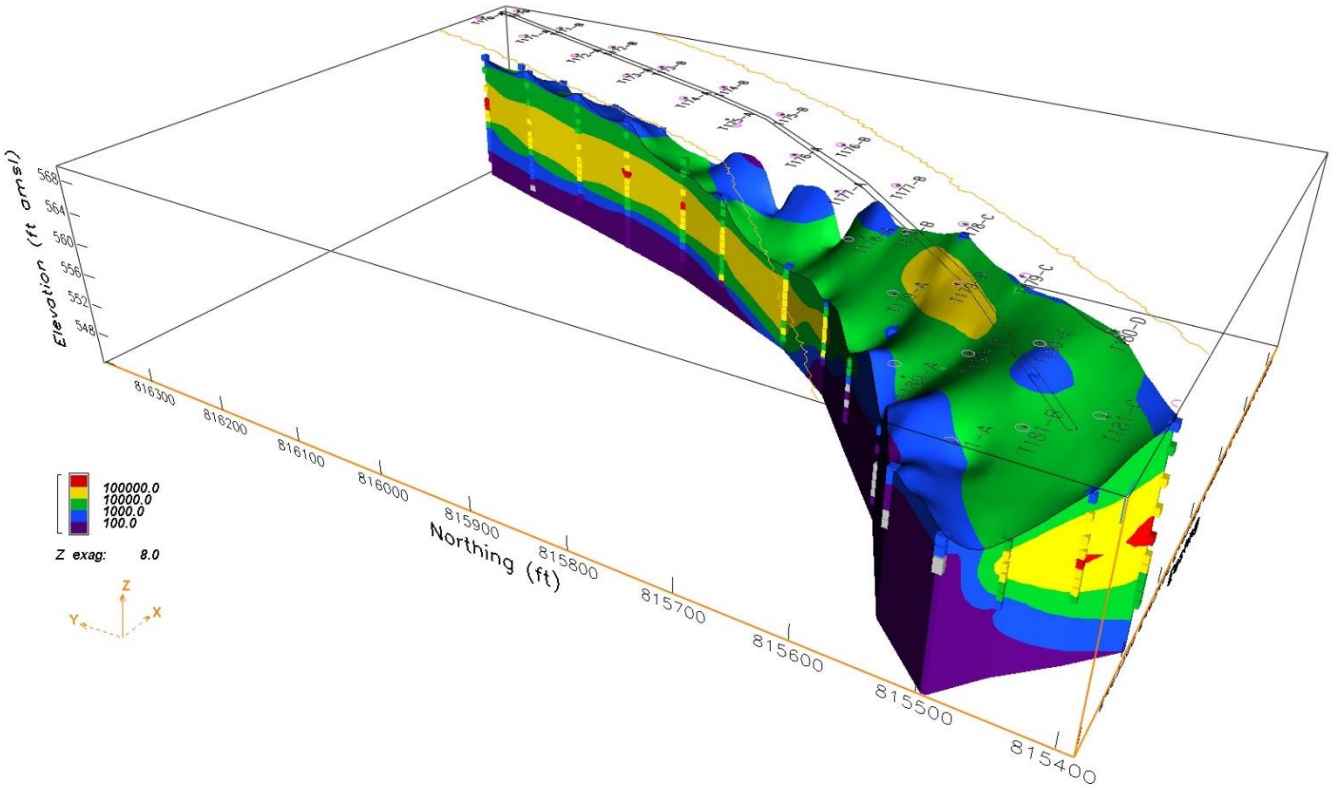
- **Based on modeling performed during the design phase, it was anticipated that the long-term clean up goals would be met approximately 10 years (2020) after the completion of dredging activities**

QUESTIONS

Chemical LOE's

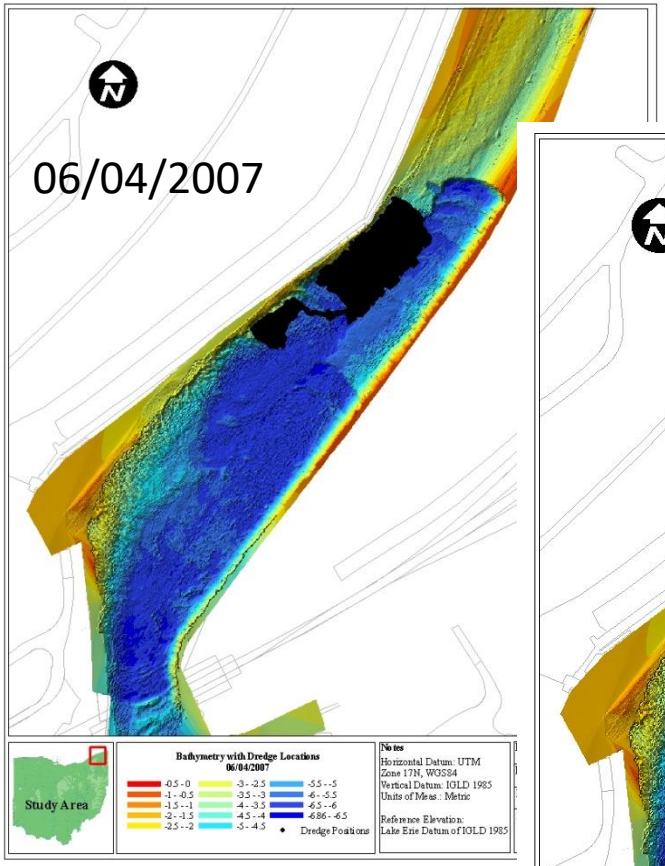
Deep coring to characterize COC distributions

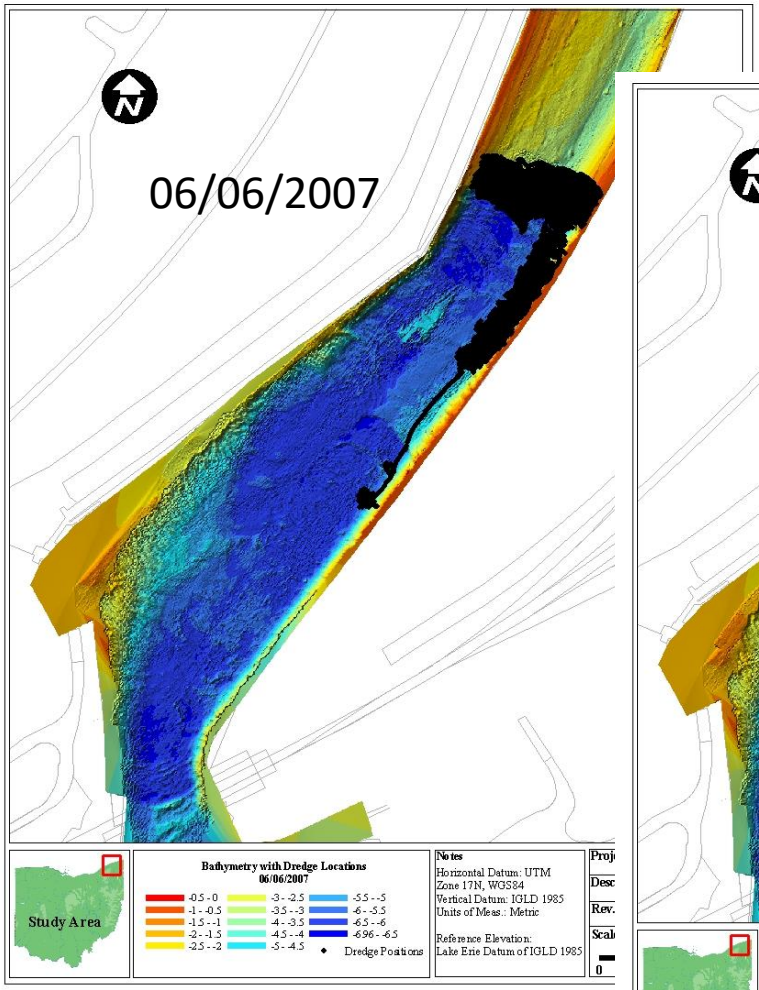
PCB Contaminant profiling

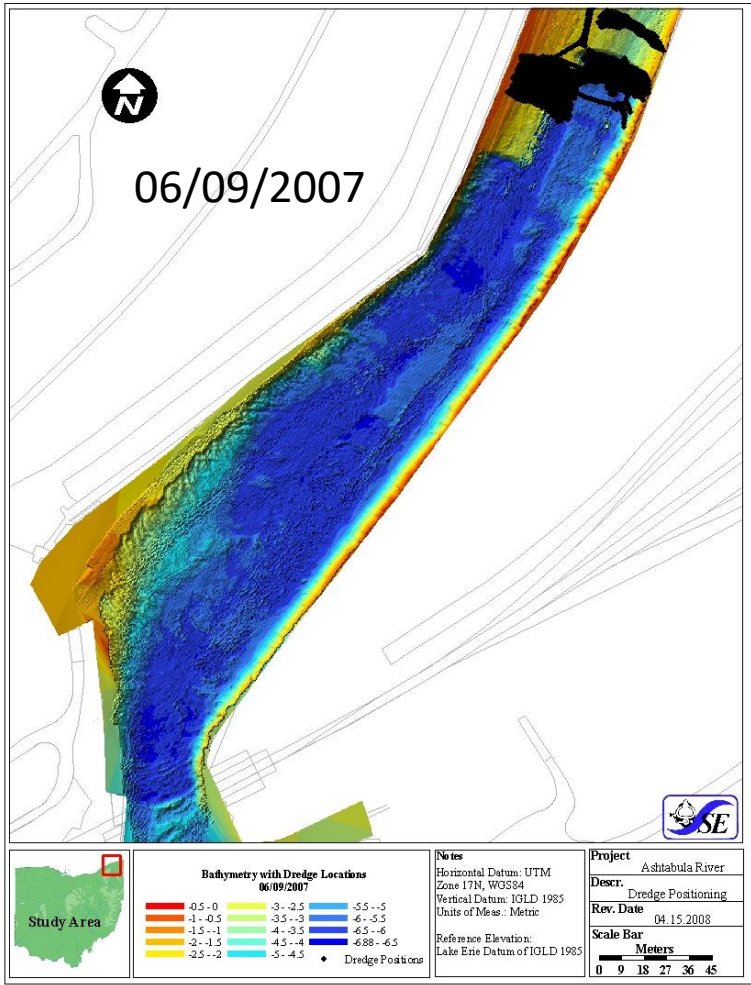


Physical LOE: High resolution bathymetry to evaluate mechanism for residuals

Daily dredge progress



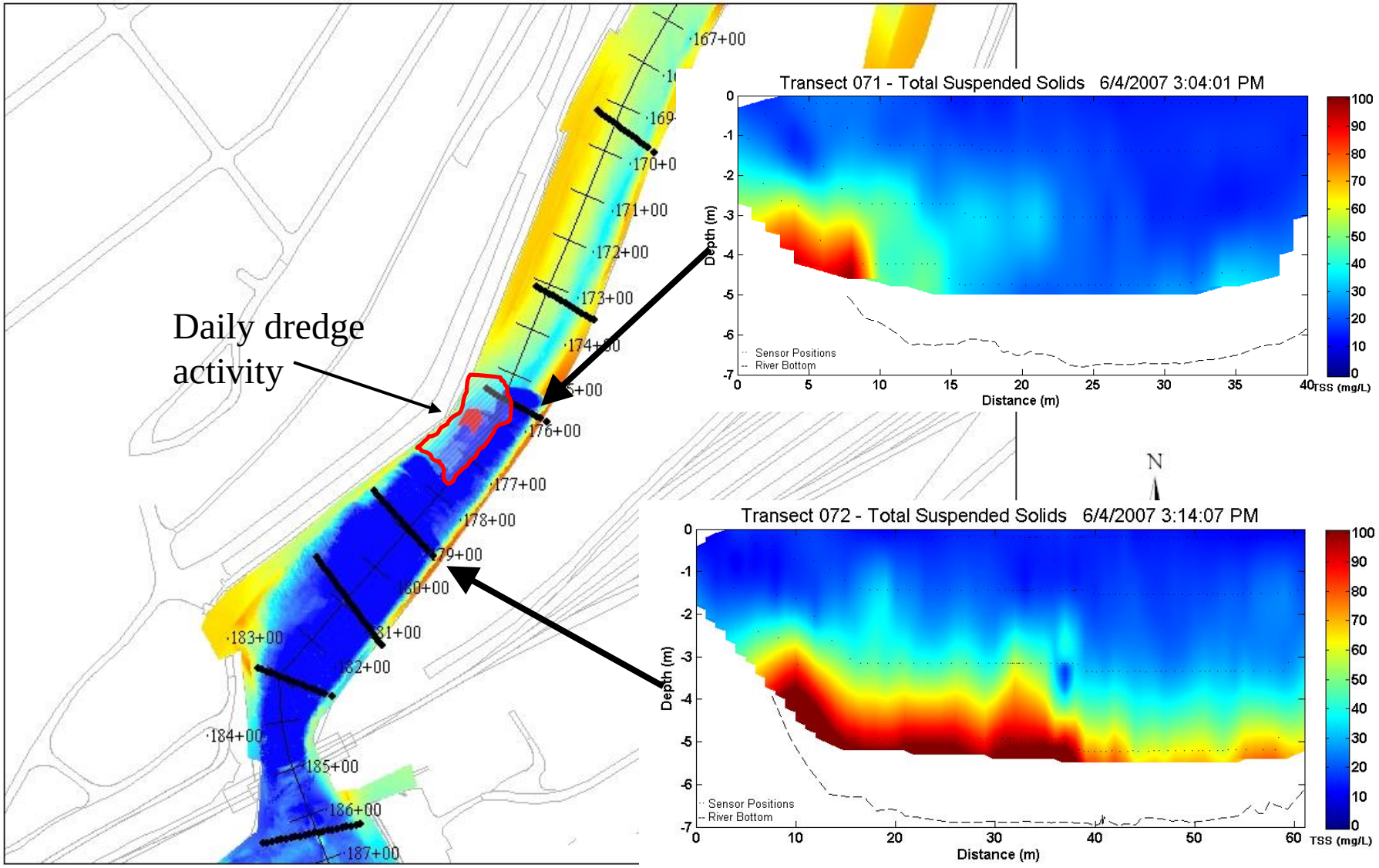




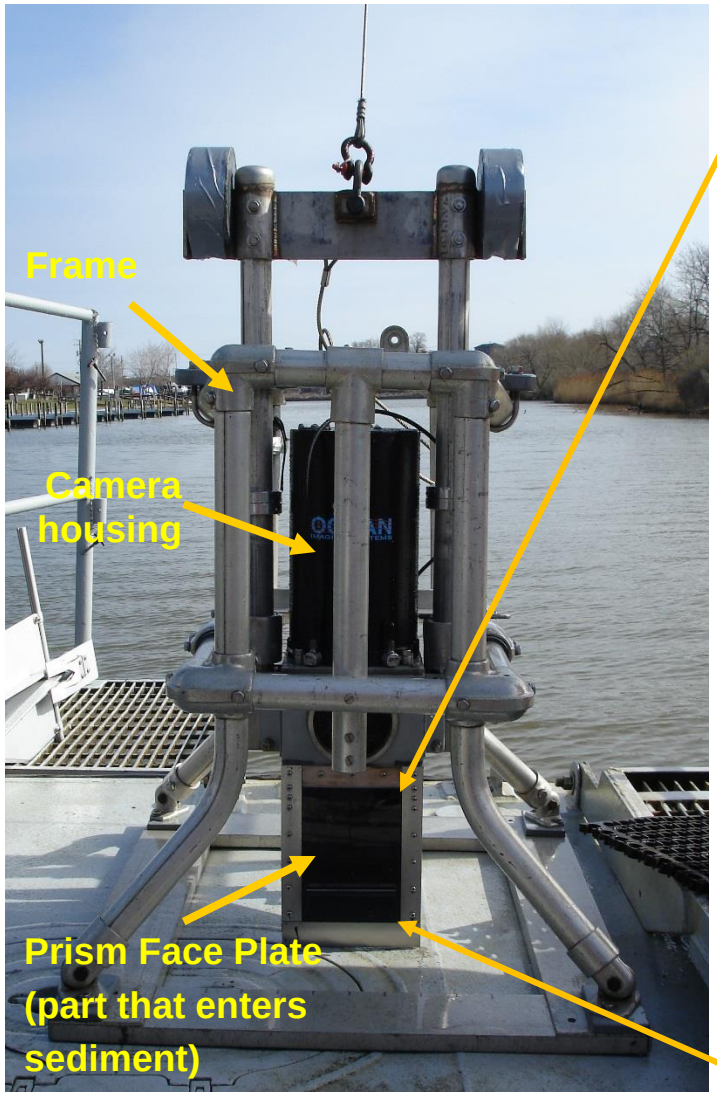
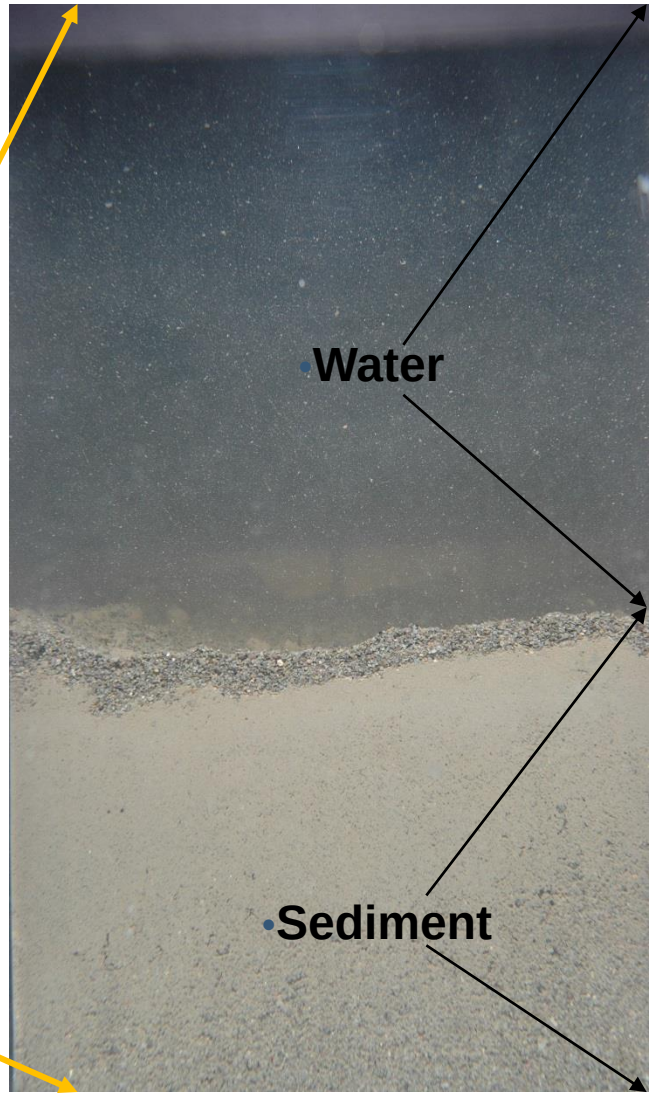
Physical LOE: Side scan sonar to evaluate mechanism for residuals

Side scan sonar surveys conducted to identify near-bed dredging features.

Physical LOE: TSS Measurements to evaluate resuspension of sediment



Physical LOE: Characterizing sediment (pre-dredge) and residuals (post-dredge)

Lithography

Subsurface profile imaging (SPI) to characterize residuals (NHEERL-Narr and NRMRL-Cinc)