MIRROR LAKE, DE

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SEDIMENT MANAGEMENT WORK GROUP
2022 SMWG Remedy Effectiveness Symposium
Oct 6, 2022

Mirror Lake, DE

- Mirror Lake (~3.5 acres, 3’ deep) is part of the Saint Jones watershed ~90 mi^2 (empties to Delaware Bay)

- It’s located at the gateway to historic Dover, DE. It’s impacted by sedimentation, stormwater runoff, chemical contaminants, excess nutrients, invasive plant species and bacteria

Drivers

- Mirror Lake/St. Jones River CoCs include PCBs, dioxins & furans, OC pesticides, mercury, and PAHs
  - *Fish consumption advisories have existed in this area of the St. Jones River since 1988*
  - *Listed as an impaired waterway*
  - *Old industrial sources upstream*
  - *Lacked ecological diversity and functionality*
  - *Radioisotope-dated sediment cores collected downstream of Mirror Lake indicated conditions improving; however, model forecasts indicated decades for recovery*
  - *In-place contaminated sediments controlled the recovery time*

1. Objectives of Remediation

- Remediate the sediments in place to prevent contaminants from entering the food chain, allowing the fish advisory to be lifted or reduced in a matter of years, not decades

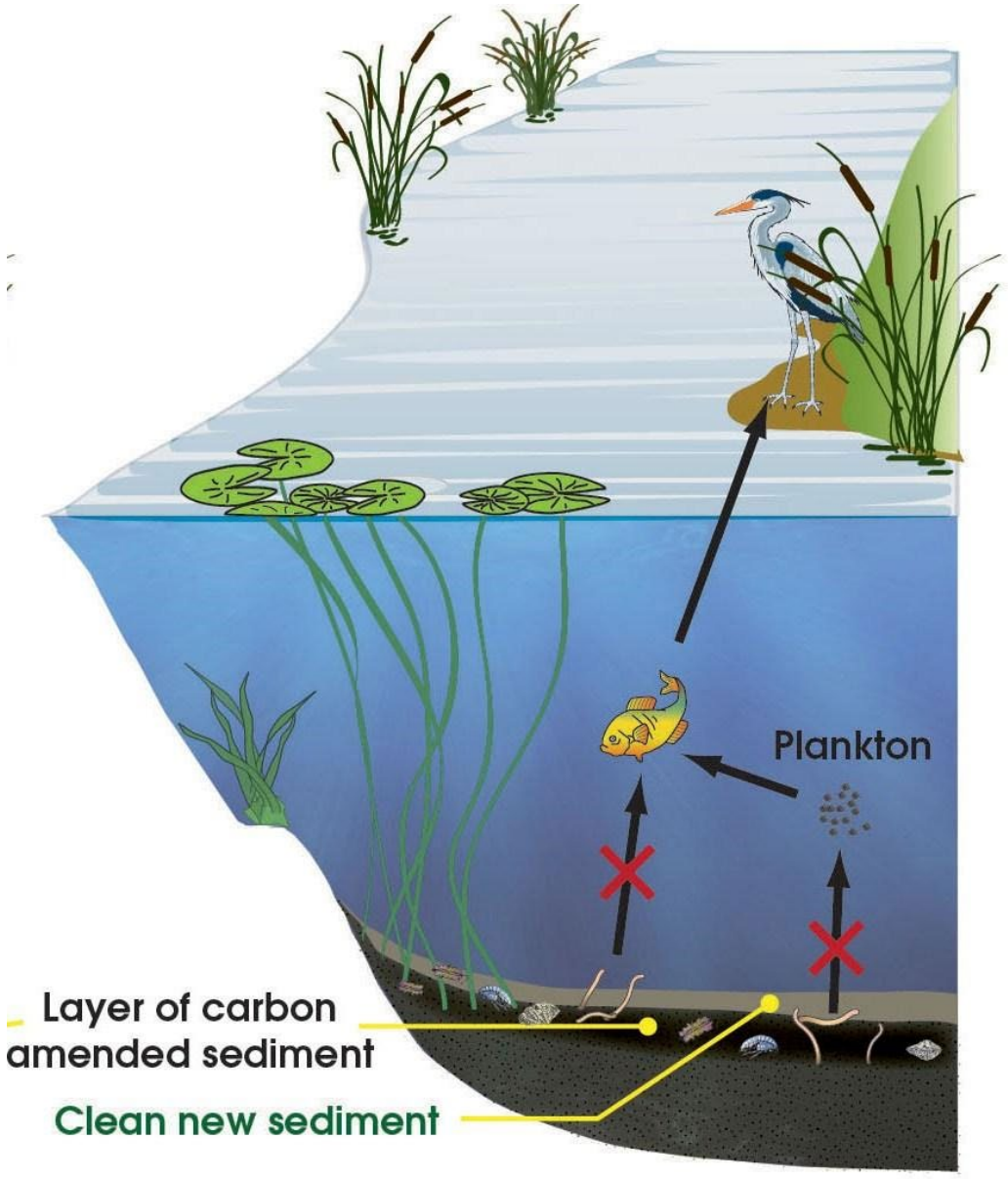
- Restore habitat and improve the visual appeal of the lake

  (Not discussed in this presentation)

2. Summary of Completed Early Remedy

- DNREC, in cooperation with several partners, implemented the Mirror Lake Remediation & Restoration Project in Fall 2013
- In-situ amendment with activated carbon was chosen as the preferred remedial alternative
- SediMite™ technology was chosen as the mode of delivery
- SediMite™ is a pellet made up of activated carbon (binds contaminants), sand (aids sinking), and clay (temporarily holds the pellet together)
- 79 tons of SediMite™ were incorporated into 5 acres of lake bottom and downstream channel sediments over 10 days; three main application methods were used
- This was the largest application of SediMite™ in the U.S. at that time
- This was the first State-led project of its kind in the nation
- Construction of an intertidal wetland, flow diversion, bank stabilization, and native plants

2. Summary of Completed Early Remedy



AC amendment reduces exposure to food web through:

1) Reduced bioaccumulation in benthic organisms

1) Reduced flux into water column and uptake in the pelagic food web

1) Gradual deposition of clean sediment over the AC amended layer in the long-term


ENVIRONMENTAL Science & Technology

FEATURE

pubs.acs.org/est

In-situ Sorbent Amendments: A New Direction in Contaminated Sediment Management†

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Environ. Sci. Technol. 2011, 45, 1163–1168

2. Summary of Completed Early Remedy: SediMite™ Application Methods

- Majority of the application using a Telebelt
- First such application of SediMite™ at that time
- Brightfields Inc. performed the application in the field

Air Horn from Land

Air Horn from Boat

And even a few fistfuls!

3. Significant Remedy Scope or Schedule Deviations from What Was Originally Envisioned?

- Work was completed within schedule and on budget
- No injuries during the project
- No permit violations
- No complaints from adjacent landowners

4. When Were External Sources Characterized and Addressed?

- Mirror Lake is part of the St. Jones river
- The lake is influenced by both upstream sources and tidal inputs
- DE has been characterizing and remediating adjacent land sources over several decades
- The WATAR program has combined RCRA/CERCLA and CWA programs
- Historically, Mirror Lake had shown higher PCB concentrations in sediment

5. Primary Pre- and Post-Remedy Effectiveness Monitoring Elements

A. Sediment Cores for AC analysis

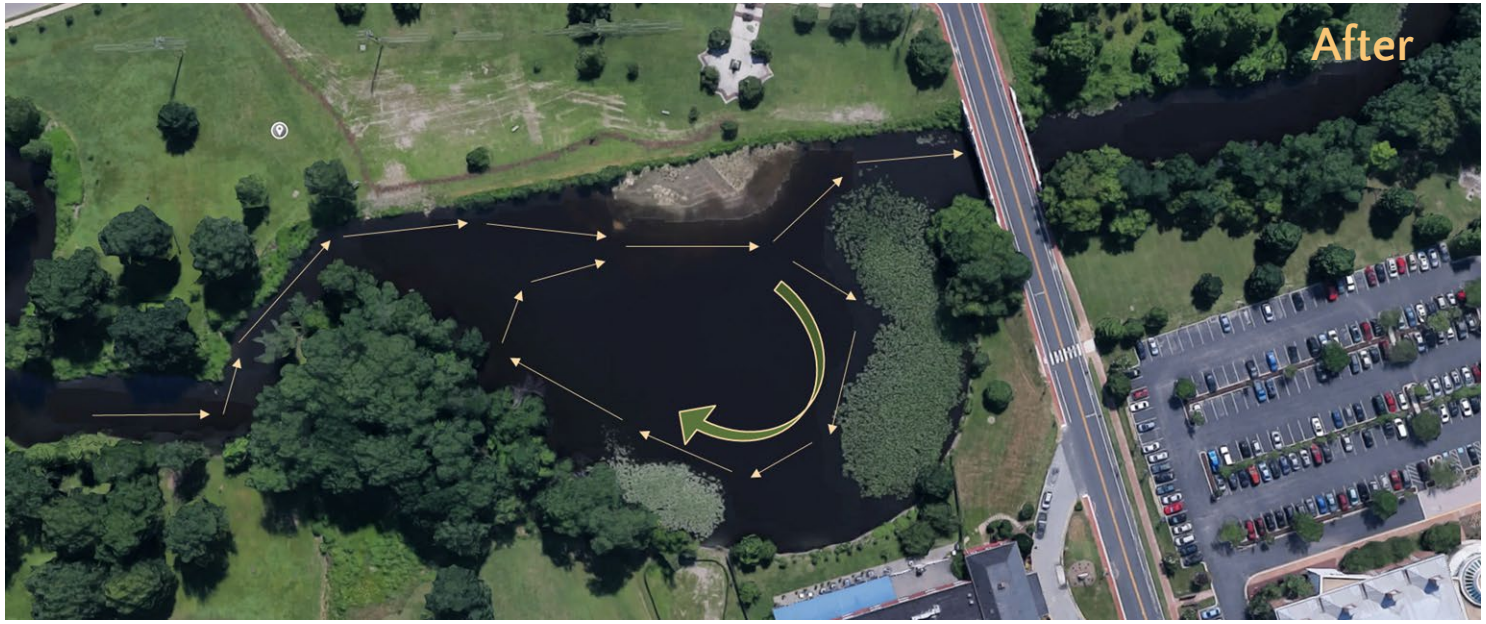
Carbon in sediment during low tide

After 1 month

After 1 month

After 1 year

Monitoring Locations & Flow



Natural sand bar in the upper area

Restoration effort created a new intertidal wetland (photo below)

Altered water flow/recirculation changed depositional environment

Check for updates

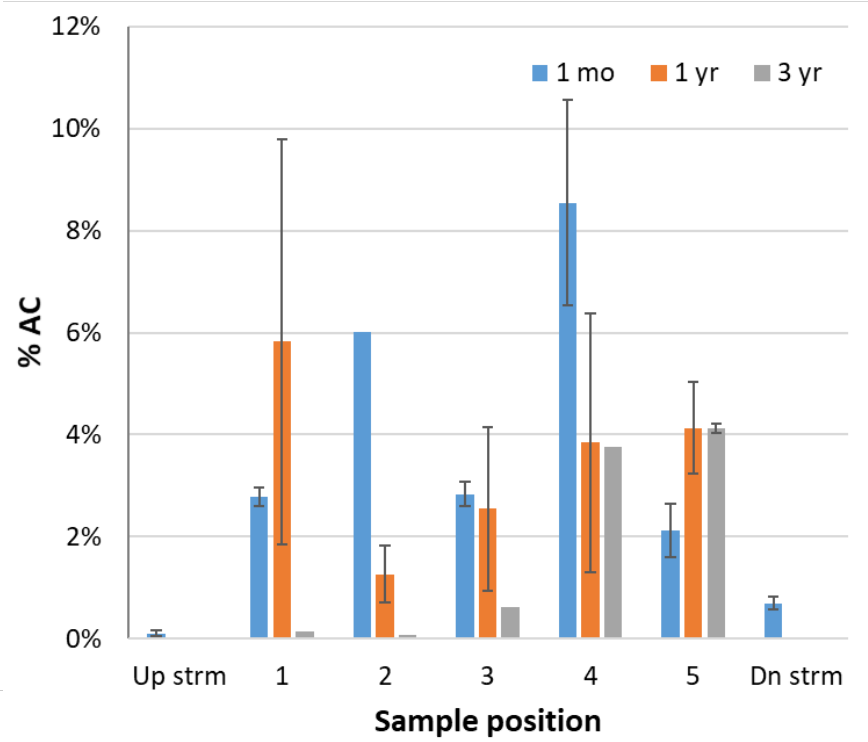
ASCE

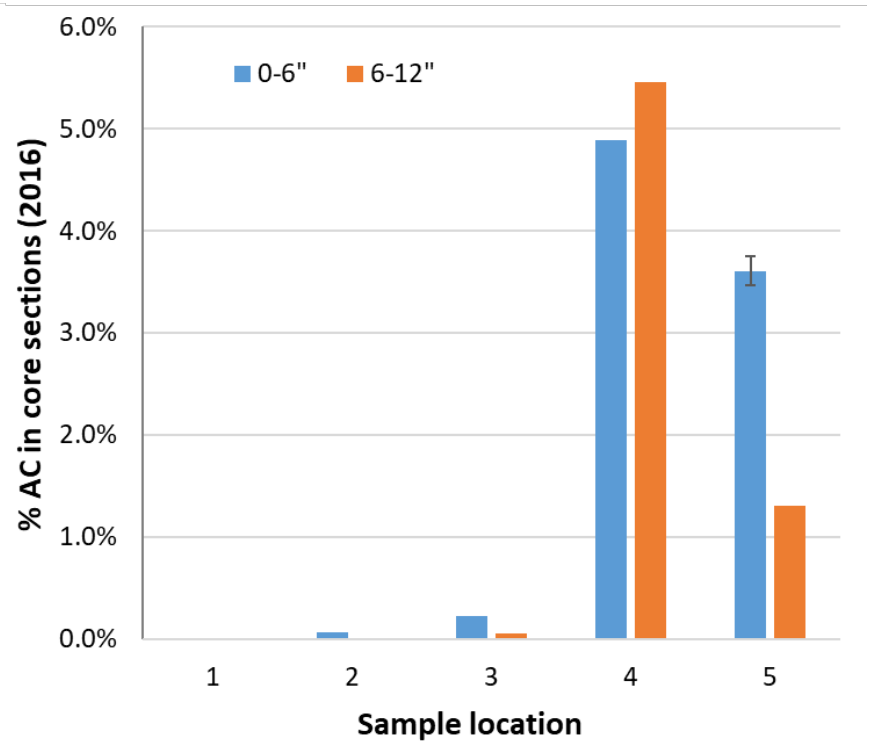
Full-Scale Application of Activated Carbon to Reduce Pollutant Bioavailability in a 5-Acre Lake

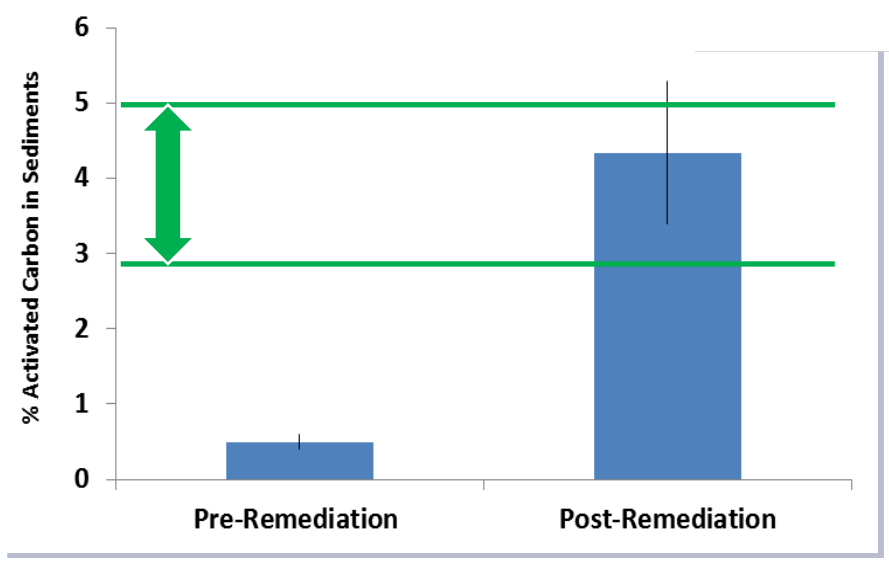
Eli Patmont[1]; Mehregan Jalalizadeh[2]; Mandar Bokare[3]; Trevor Needham[4]; Jeff Vance[5]; Richard Greene[6]; John Cargill[7]; and Upal Ghosh, A.M.ASCE[8]

ASCE J. of Environmental Engineering, 2020, 146 (5)

Activated Carbon in Sediments





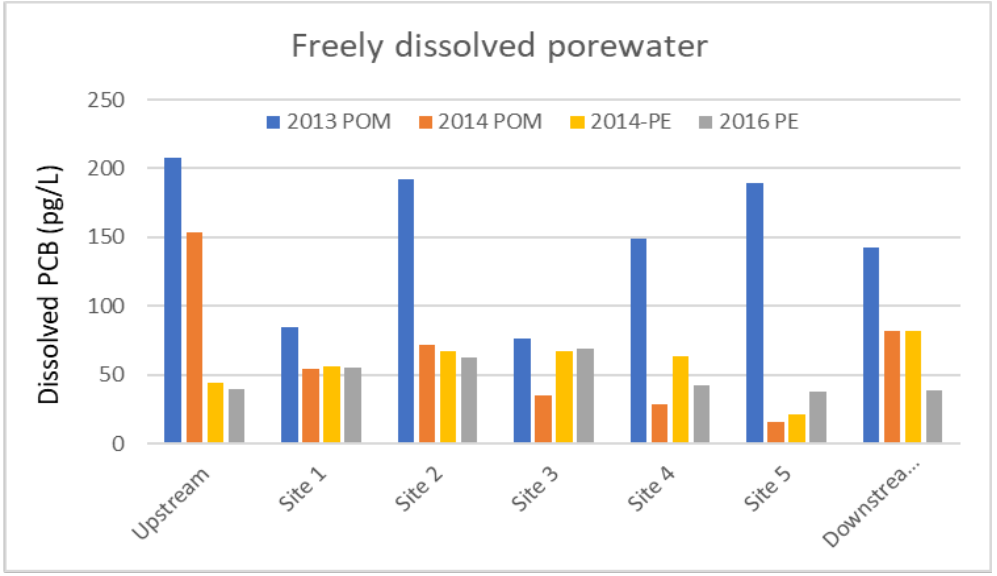


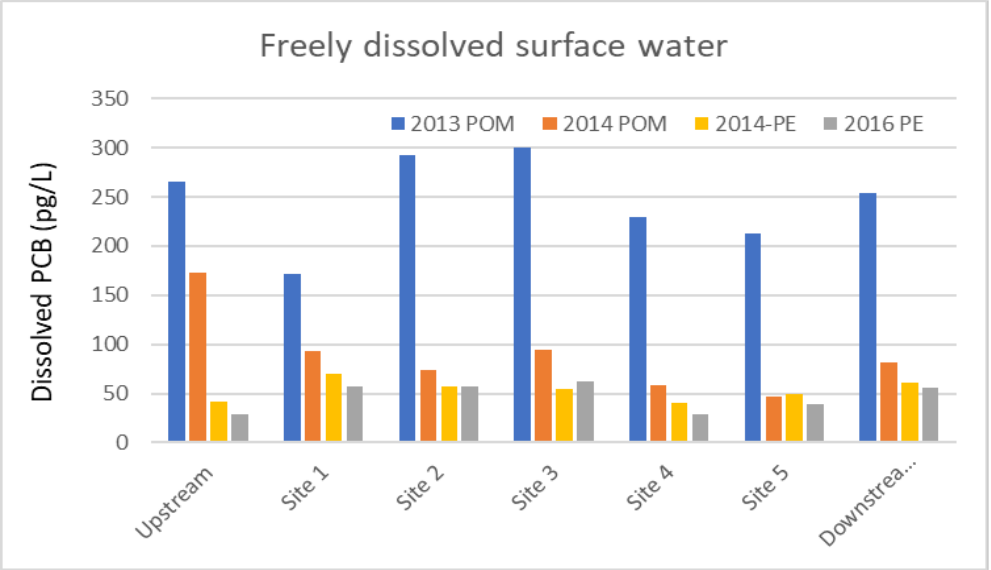
- Target dose of 3 – 5% met
- Sediment/AC deposited into thicker layer in low flow region of lake
- 83% of AC applied could be accounted for within Mirror Lake after 3 years, predominantly in the west side of the lake

5. Primary Pre- and Post-Remedy Effectiveness Monitoring Elements

A. Dissolved PCBs – Passive Samplers

- Freely dissolved PCB in the sediment pore water dropped ~ 61% over 3 years
- Freely dissolved PCB in the water column dropped ~80% over the same period
- Station-to-station variability explained by pond hydrogeomorphology
- Delaware & EPA human health water quality criterion = 64 pg/L





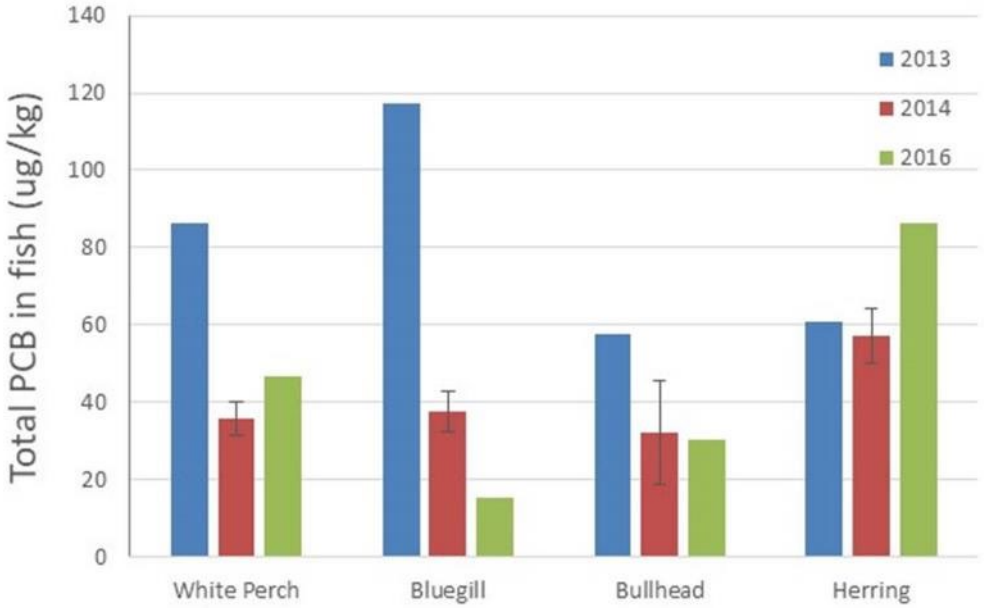
5. Primary Pre- and Post-Remedy Effectiveness Monitoring Elements

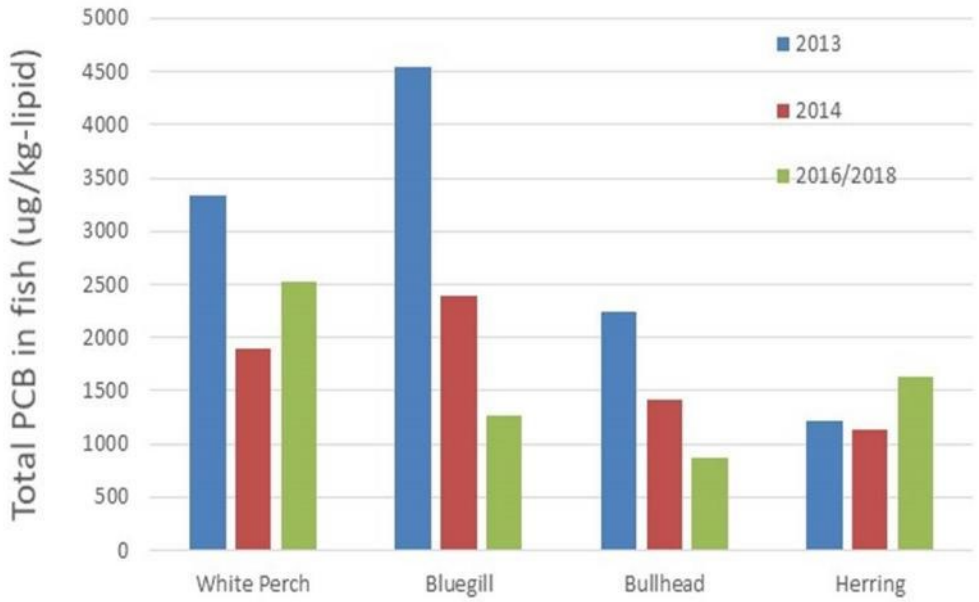
B. PCBs in Fish Tissue

48% – 87% reduction in resident fish (brown bullhead and bluegill, respectively)

27% reduction in migratory white perch

43% increase in migratory blueback herring





6. Did the Remedy Achieve Short- and/or Long-Term Remediation Objectives for Surface Sediment?

- Reductions observed in surface water and porewater dissolved PCBs
- Potentially 10-year monitoring coming up in 2024
- Key remediation objective was to reduce PCB concentration in fish tissue
  - Project was successful in reducing PCB concentrations in resident fish

7. Is the Remedy on Track to Achieve Long-Term Remediation Objectives for Water and/or Biota?

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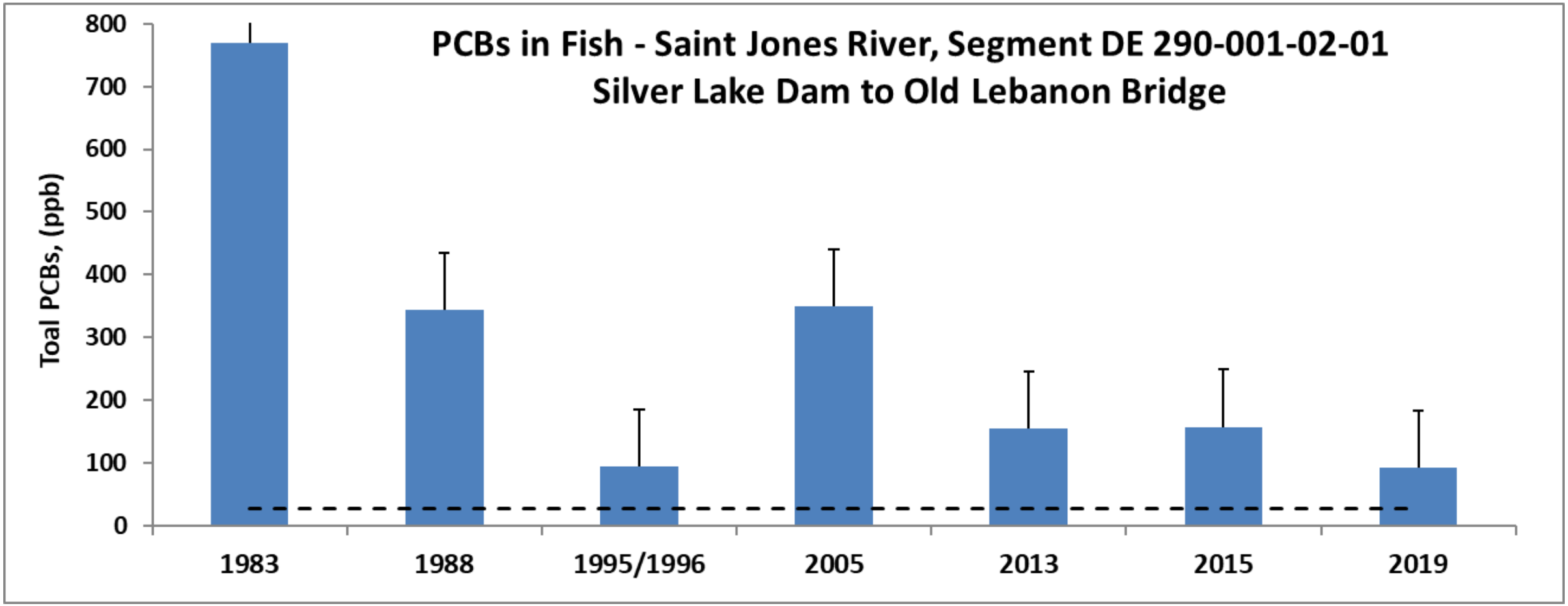

Remediation of on-land sources and contaminated sediments collectively helping reduce PCBs in fish

8. Key Take-Home Messages

- % reduction in porewater and water column dissolved phase PCB (61% and 80%, respectively) is very similar to % reduction in PCB in *resident* fish species (48% to 87%)
- % reduction was slightly less than anticipated (70% - 90%); likely due to residual transport of PCB into Mirror Lake from upstream and downstream
- Project was recognized locally, regionally and nationally for its innovative approach and demonstrated results
- Monitoring will continue periodically to track long term performance
- 11 yr monitoring in 2024: dissolved PCBs, fish species, overlap with scheduled watershed-scale monitoring

Concluding thoughts on In-situ AC amendment

Amendment with AC will be most effective at sites:

- That are depositional in nature and less prone to erosion
- Where native bioavailability of contaminants is high
- Where ongoing contribution from off-site sources have been controlled

AC amendment provides several advantages over traditional remediation:

- Less disruption to benthic habitats in sensitive systems
- Amenability to shallow or constricted locations
- Potential for lower cost
- Less concern about mobilizing buried contaminants

In-situ amendments can also be used in combination with other remedies:

- Possible to incorporate AC into sediment caps
- Apply AC during/after dredging to minimize aqueous contaminant release
- Can be applied in conjunction with bioaugmentation

Acknowledgements

Dr. Rick Greene, DNREC, Watershed Assessment Section (Ret.)
John G. Cargill, DNREC, Watershed Assessment Section
Eli Patmont, AnchorQEA, formerly UMBC

- AmeriCorps
- Biohabitats
- Brightfields
- City of Dover
- Colonial Investment & Management Company
- Delaware National Estuarine Research Reserve
- Delaware Office of Management and Budget
- Delaware Representative Darryl Scott
- Delaware Senator Brian Bushweller
- DNREC Office of the Secretary
- DNREC Division of Fish & Wildlife
- DNREC Division of Parks & Recreation
- DNREC Division of Waste & Hazardous Substances
- DNREC Division of Water
- DNREC Division of Watershed Stewardship (esp. the Shoreline and Waterway Section)
- Energizer Personal Care
- Frazier's Restaurant
- Interfaith Mission
- Meadville Land Services, Inc.
- Pinelands Nursery, Inc.
- Portadam, Inc.
- Ransome Rents
- Sediment Solutions
- Silver Lake Commission
- Sussex County Conservation District
- Sussex County Correctional Boot Camp
- US Army Corps of Engineers
- VOLUNTEERS, VOLUNTEERS, VOLUNTEERS!
- Wistar Equipment, Inc.

Questions ?