BATTELLE 2023 SEDIMENTS CONFERENCE

Sediment PCB Cleanup Remedy Effectiveness: Case Study Synthesis

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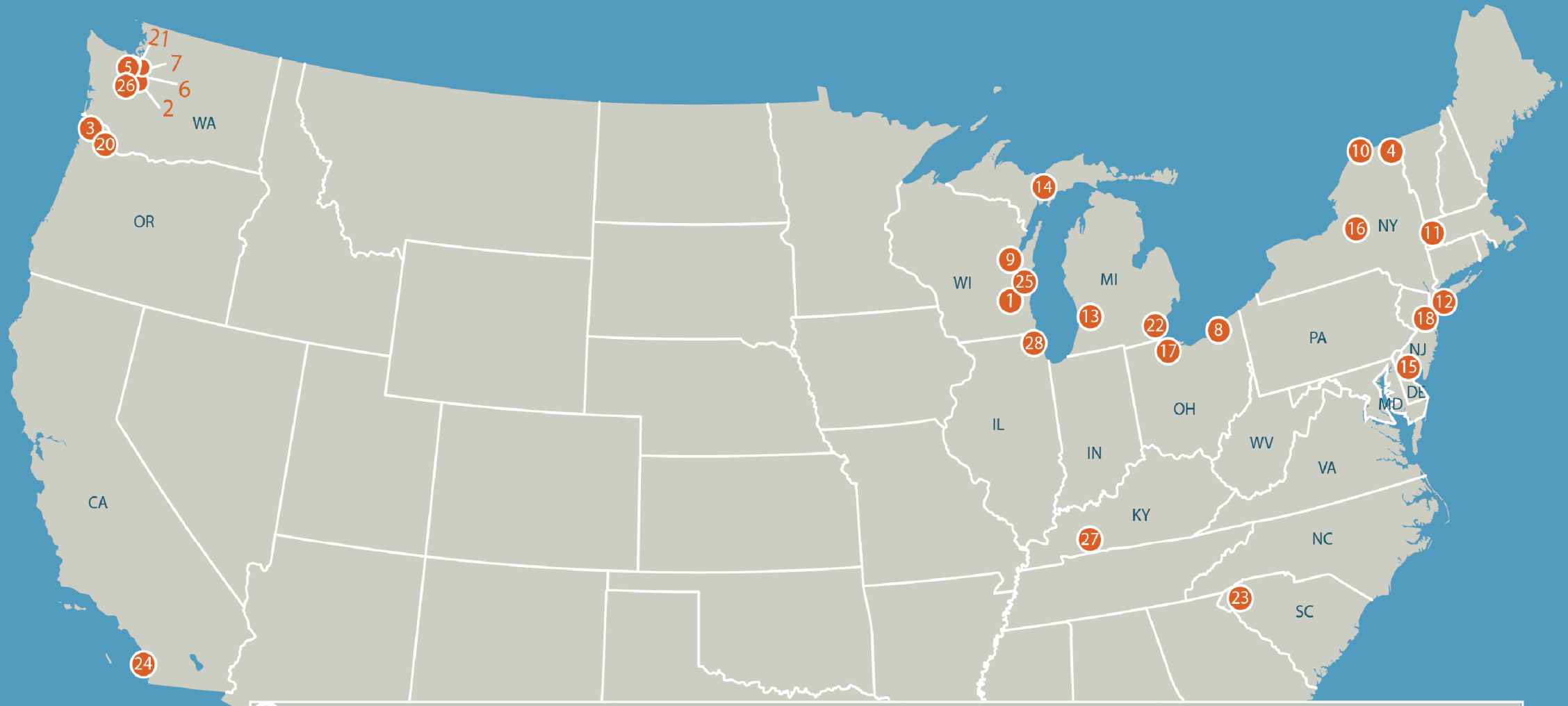
Suzanne Replinger, Windward

CHALLENGE

>15 million cubic yards dredged
>$10 billion spent (2022 dollars)

Was PCB sediment remediation successful?



Sediment PCB Cleanup Sites

1. Cedar Creek, WI	8. Field Brook/Ashtabula River, OH	15. Mirror Lake, DE	22. River Raisin, MI
2. Commencement Bay, WA	9. Fox River ,WI	16. Onondaga Lake, NY	23. Sangamo Weston/Lake Hartwell, SC
3. Columbia Slough, OR	10. Grasse River, NY	17. Ottawa River, OH	24. San Diego Bay, CA
4. Cumberland Bay, NY	11. Housatonic River, MA	18. Passaic River, NJ	25. Sheboygan River and Harbor, WI
5. Duwamish Waterway, WA	12. Hudson River, NY	19. Pearl Harbor, HI	26. Sinclair Inlet/Bremerton Naval Shipyard, WA
6. East Waterway, WA	13. Kalamazoo River, MI	20. Portland Harbor, OR	27. Town Branch Creek/Mud River, KY
7. Elliott Bay, WA	14. Manistique River and Harbor, MI	21. Puget Sound, WA	28. Waukegan Harbor, IL

APPROACH

Sediment Remediation Case Study Reviews

- Retrospective reviews of completed projects with robust monitoring
  - More broadly developed knowledge to inform future sediment cleanup remedies
- June 2019 Anchor QEA Seattle Workshop
  - 12 case study presentations (many Pacific Northwest sites; https://www.smwg.org/)
  - 66 participants (industry and federal, state, and local agencies)
- October 2022 SMWG Detroit Symposium
  - 12 case study and 4 summary presentations (https://www.smwg.org/)
  - 150 participants (industry and federal/state agencies)

APPROACH

Eight Common Topics for Each Case Study

1. Objectives of remediation
2. Summary of completed early actions and/or final remedy
3. Significant remedy scope or schedule deviations
4. When were external sources characterized and addressed?
5. Primary pre- and post-remedy effectiveness monitoring elements
6. Did the remedy achieve remediation objectives for surface sediment?
7. Is the remedy on track to achieve water/biota remediation objectives?
8. Key take-home messages on overall lessons learned

LESSONS

Common Case Study Themes

- Cooperative partnerships are more efficient
- Source control in urban settings is difficult but critical
- Remedy flexibility and adaptive management improve success
- Remediation successfully reduces sediment concentrations
- Mixed remedy success reducing PCB bioaccumulation exposures
  - Robust baseline and >7 years postconstruction monitoring needed for evaluation
  - Only a subset of case studies currently have sufficient robust monitoring data

APPROACH

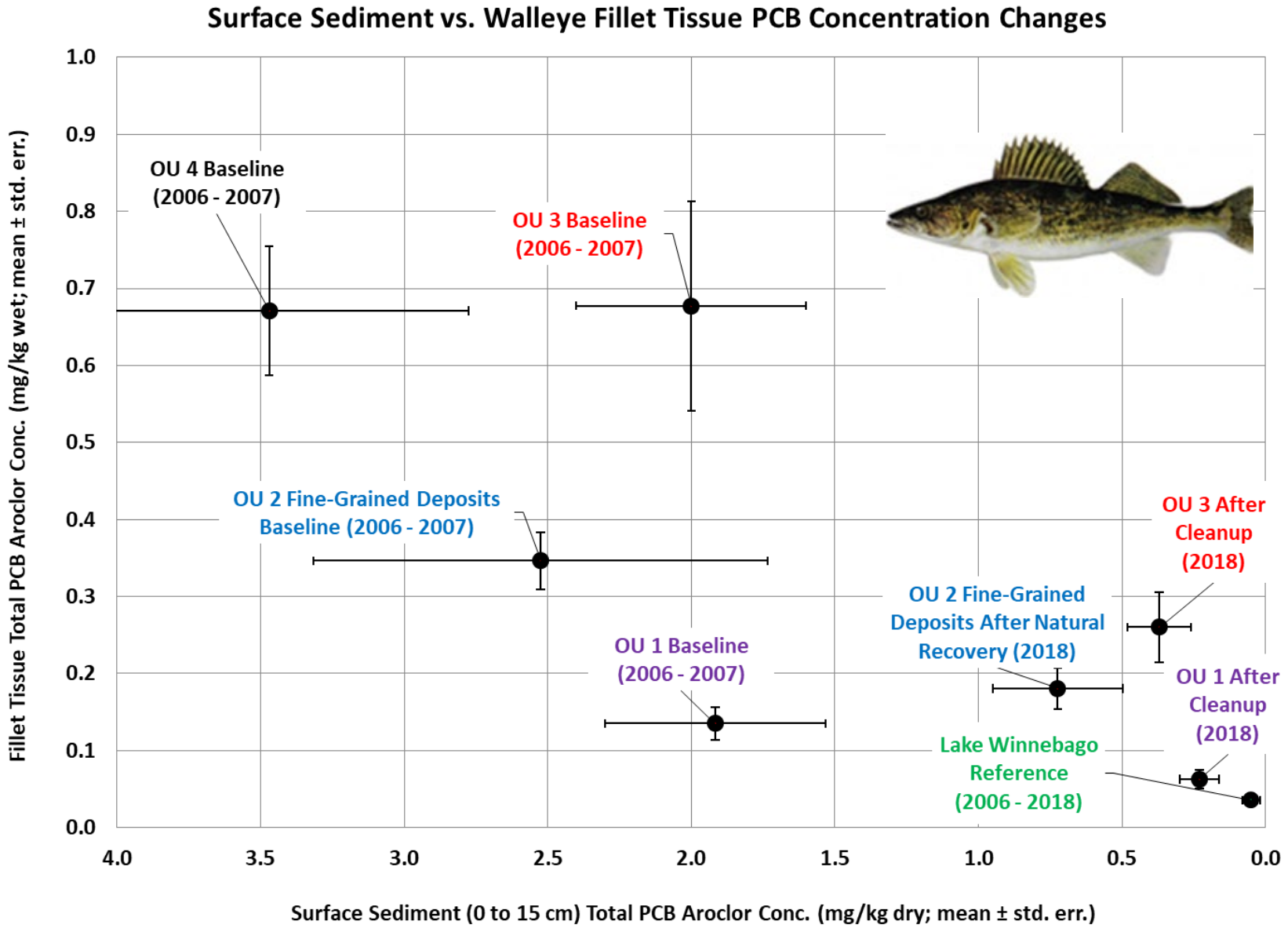
Robust PCB Remedy Effectiveness Case Studies

- Fox River, Wisconsin (Tara Van Hoof's presentation earlier in this session)
- Hylebos Waterway, Washington
- Sinclair Inlet, Washington
- San Francisco Bay, California

Fox River, Wisconsin

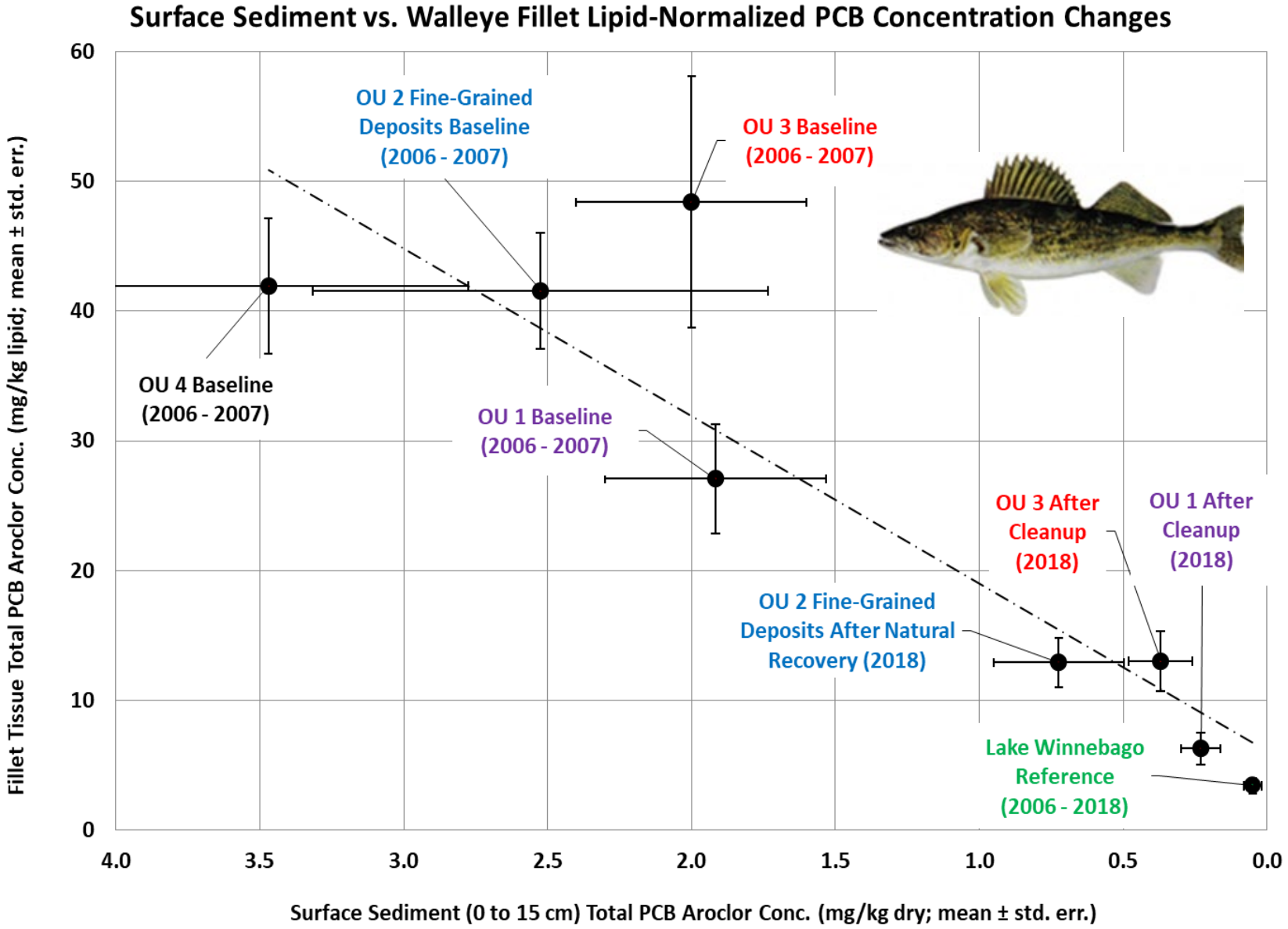
- PCBs from carbonless copy paper discharged from 1954 to 1971
- Operable Unit (OU) 1: 2004 to 2009
  - Dredge (370,000 cy), cap, and cover
- OU 2: natural recovery subareas
- OU 3: 2009 to 2011
  - Dredge (240,000 cy), cap, and cover
- OU 4: 2007 to 2020
  - Dredge (5,880,000 cy), cap, and cover

Fox River Remedy Effectiveness: Wet Weight Tissue



Sources: Anchor QEA (2007); Foth (2019); and Tetra Tech, Inc. et al. (2021)

Fox River Remedy Effectiveness: Lipid Normalized



Sources: Anchor QEA (2007); Foth (2019); and Tetra Tech, Inc. et al. (2021)

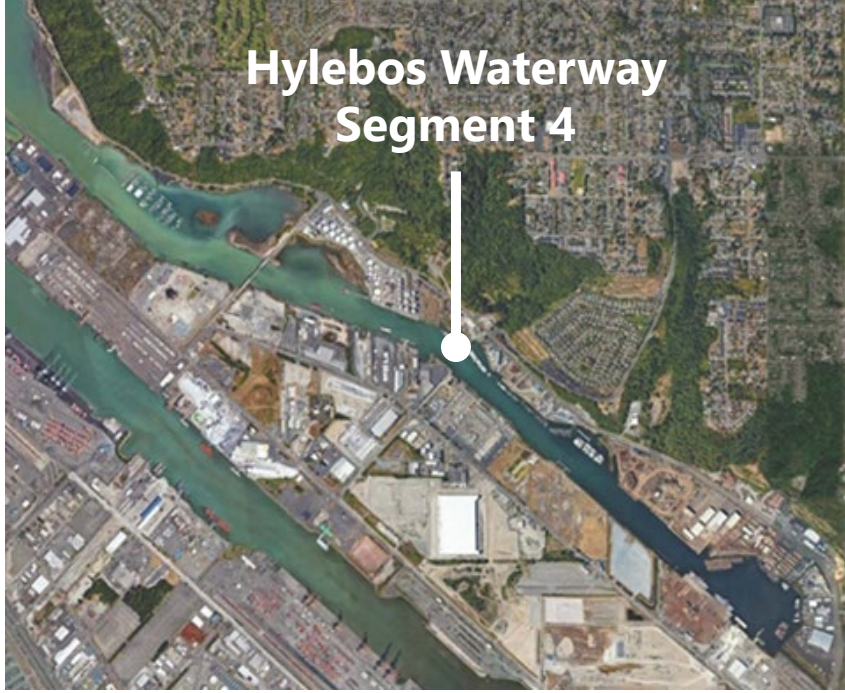
LESSONS

Fox River PCB Recovery

- Natural recovery and remedial actions (dredging, capping, and cover) all contributed to recovery
  - Similar reductions in surface sediment, fish tissue, and water column PCBs
    - Important covariates (e.g., fish lipid content)
    - Diminishing linkage between surface sediment and fish tissue PCB at lower levels

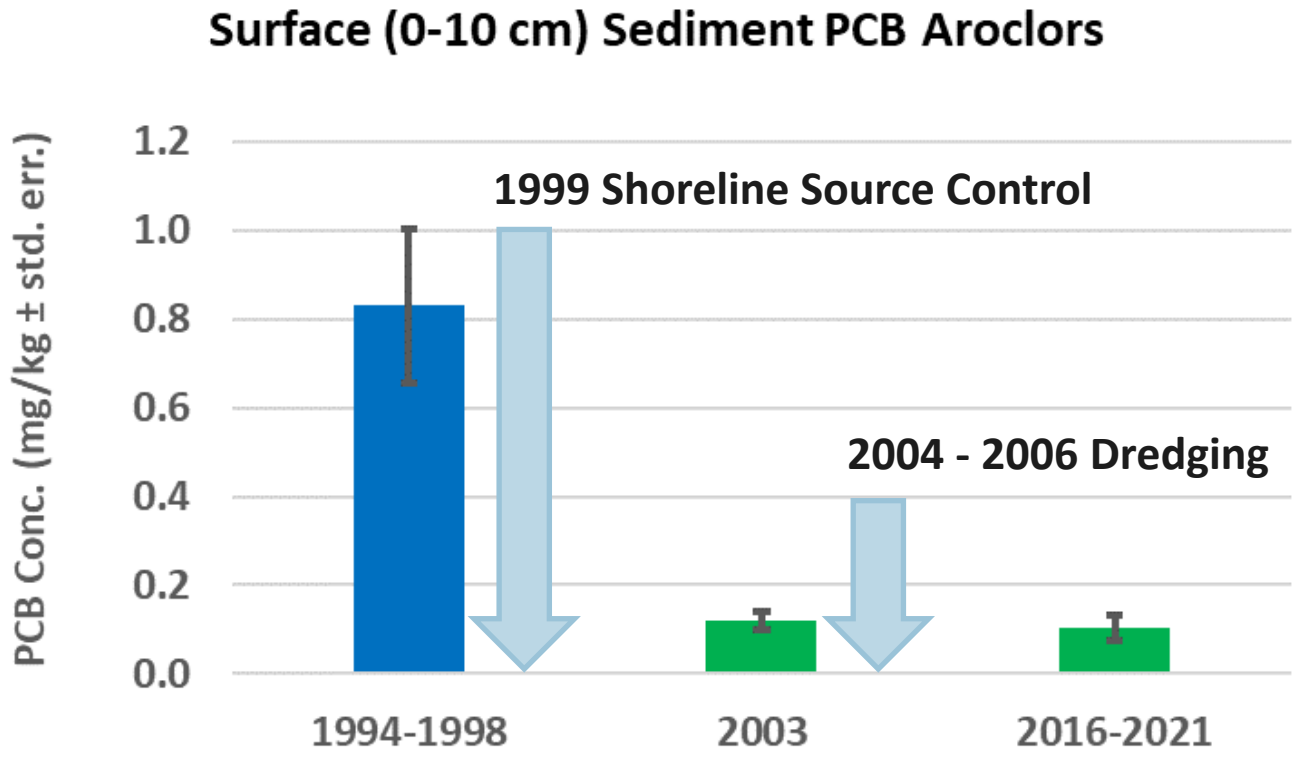
Hylebos Waterway, Washington

- Part of Commencement Bay Site
- Numerous historical PCB sources
  - Extensive wastewater/stormwater controls and upland/shoreline cleanup actions: 1985 to 1999
  - Source control verified in 2001
- Sediment remediation: 2001 to 2006
  - 24 acres dredged (1,500,000 cy)
  - 8 acres monitored natural recovery
  - 3 acres capped



Hylebos Waterway Segment 4 Sediment Monitoring

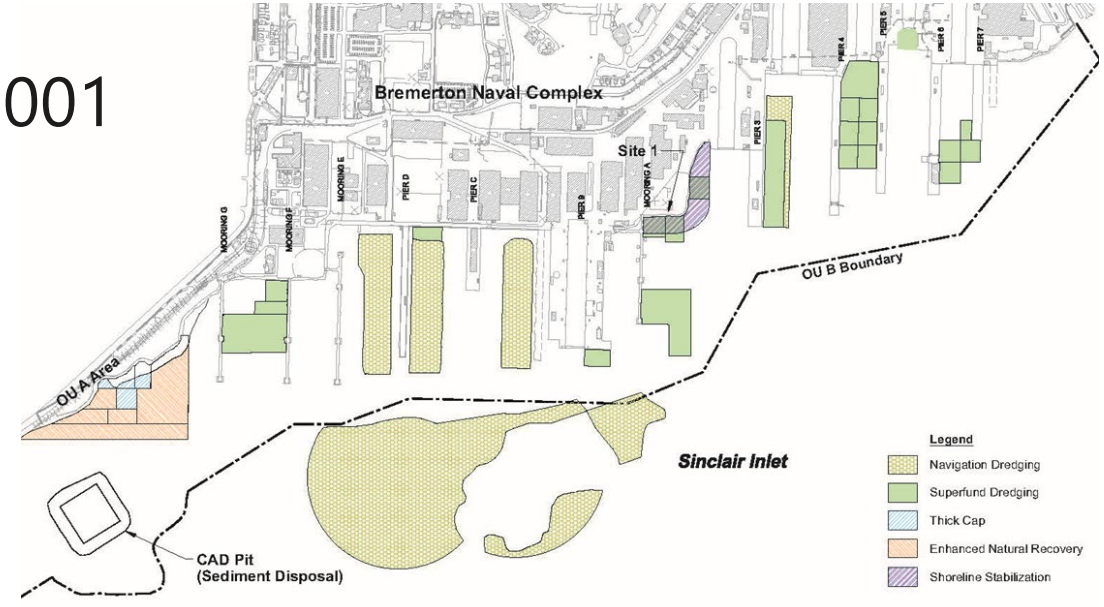
- 1999 remediation of larger shoreline PCB source
- Offshore surface sediment recovered 5 times faster than simple model projections
  - Dynamic/rapid equilibrium; more flux than net deposition
- Source control most effective reducing sediment PCB levels



Sources: Hylebos Cleanup Committee (1999) and Anchor QEA (2003, 2021)

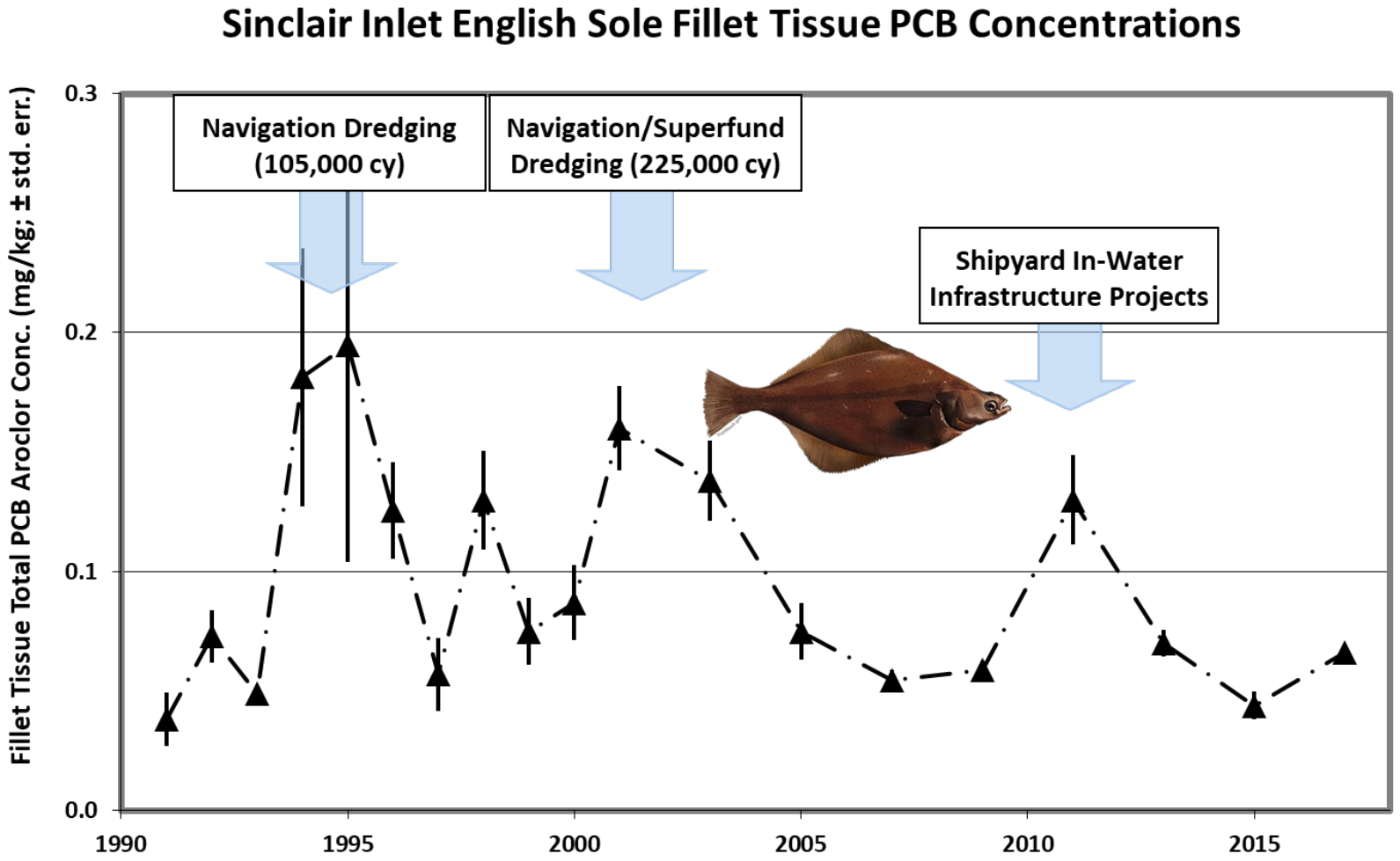
Sinclair Inlet, Washington

- Numerous historical shipyard PCB sources
  - Continuous process improvements and upland cleanup actions beginning in 1992
- Navigation dredging in 1994/1995
- Navigation/Superfund actions in 2000/2001
  - 32 acres dredged (225,000 cy)
  - 13 acres capped or sand covered
- Shipyard infrastructure projects in 2011
- Fish tissue sampling: 1991 to 2017



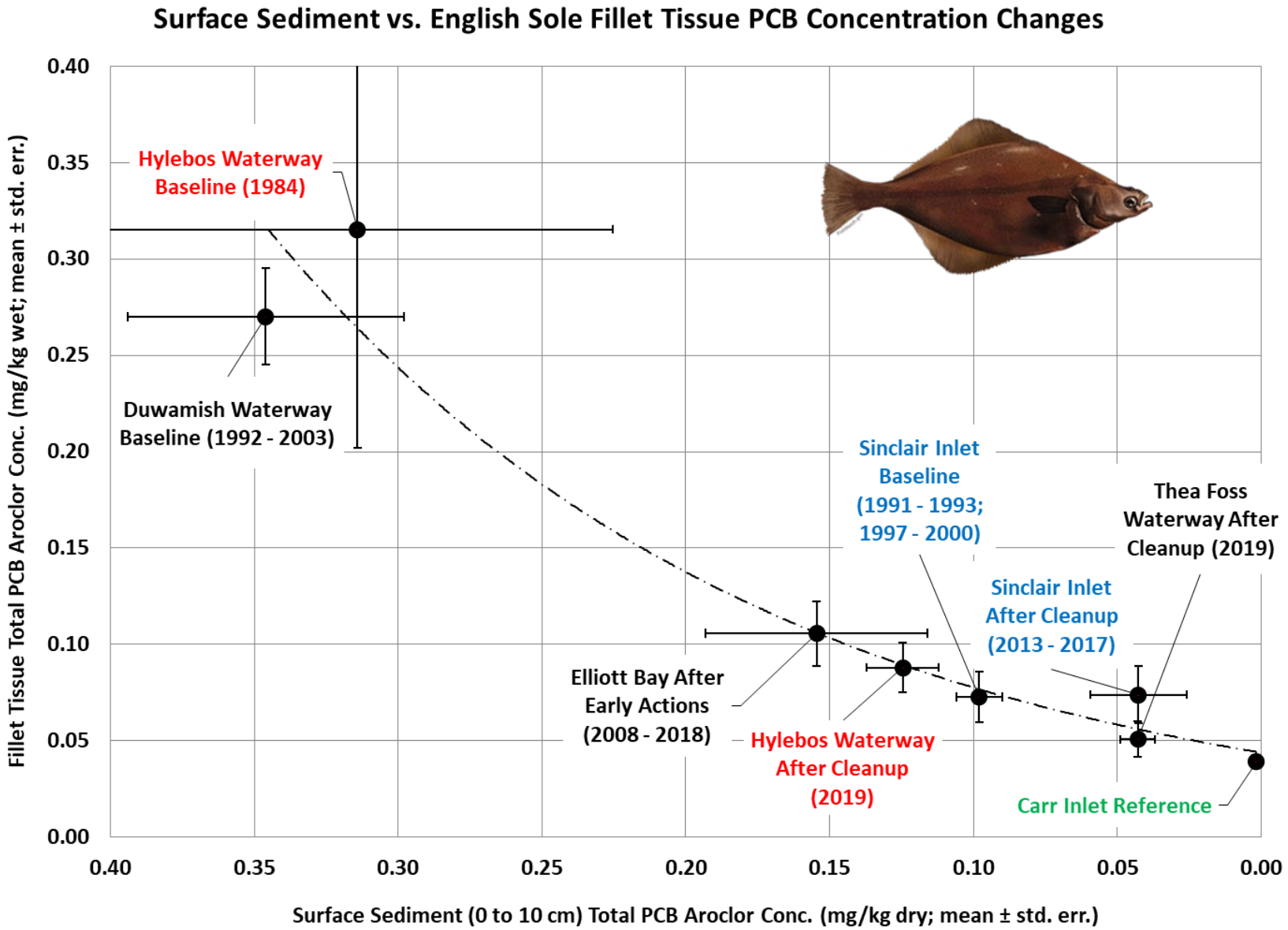
Sinclair Inlet Remedy Effectiveness Monitoring

- Tissue peaks associated with in-water construction releases
  - Similar data from Commencement Bay
- Little net change in tissue PCB levels over 26 years



Source: West et al. (2017)

Puget Sound Remedy Effectiveness Monitoring

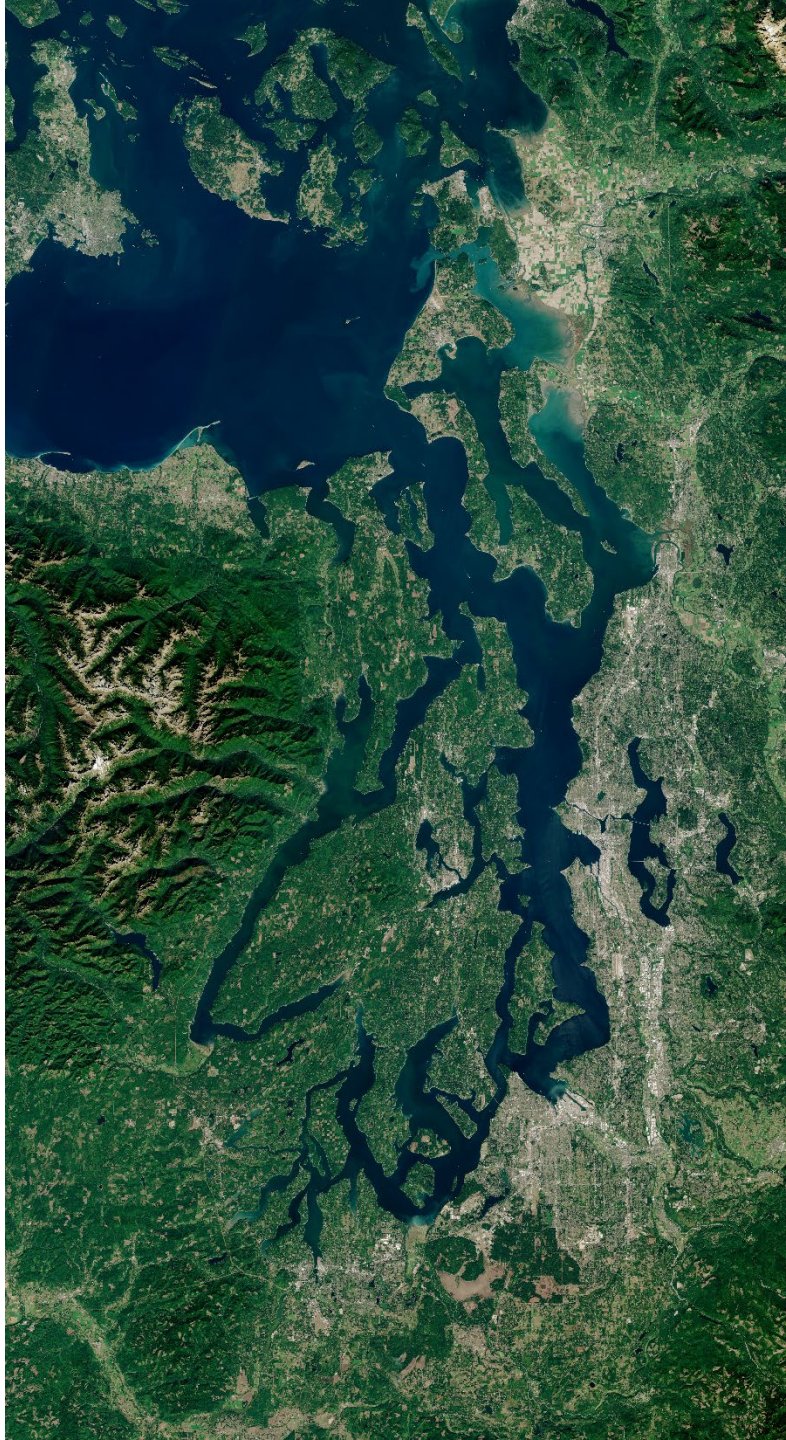


Sources: Tetra Tech (1985), West et al. (2017), EPA (2020), Windward (2020), and Anchor QEA (2022)

LESSONS

Puget Sound PCB Recovery

- Diminishing linkages between surface sediment and fish tissue at lower PCB levels
  - Non-sediment factors such as water column exposures become predominant
- Source control and natural recovery have generally been more effective than remediation
  - Particularly after higher PCB sediments are addressed
  - Dynamic/rapid equilibrium of surface sediment
  - Unavoidable short-term dredging releases

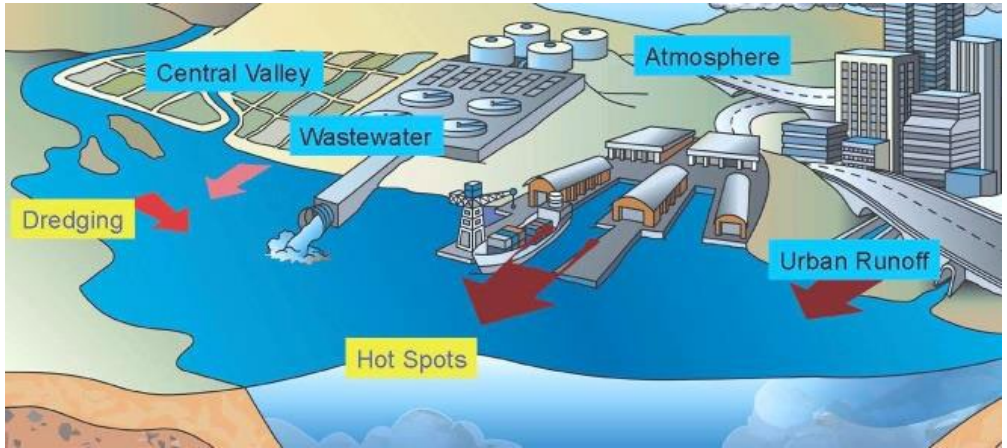


San Francisco Bay PCB Exposure Control Strategy

- Reduce stormwater sources in watershed to achieve 0.01-mg/kg fish tissue criterion

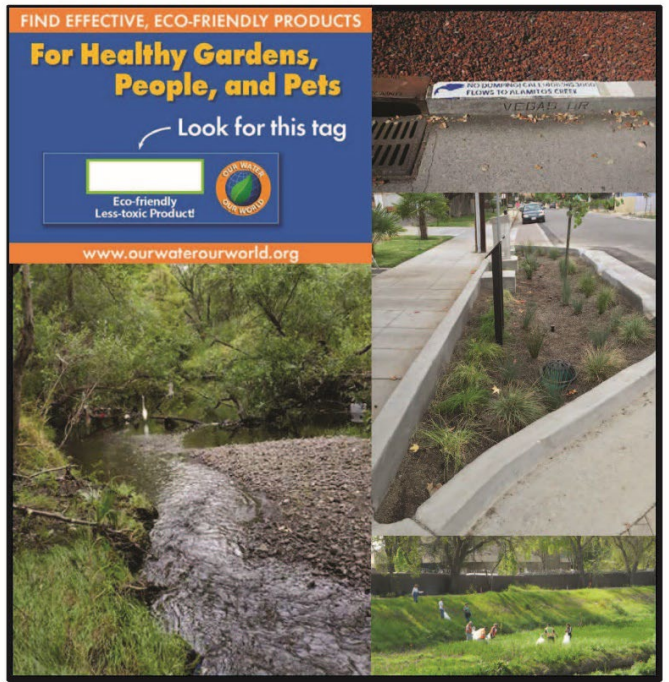
Source Category	PCB Loading (kg/yr)
Stormwater runoff	20
Central Valley drainage	11
Municipal dischargers	2.3
Industrial discharges	0.035
Navigation dredging	Net Loss
Sediments	Net Sink

Source: California Regional Water Quality Control Board (2008)



California Regional Water Quality Control Board
San Francisco Bay Region
Municipal Regional Stormwater NPDES Permit

Order No. R2-2015-0049
NPDES Permit No. CAS612008
November 19, 2015



LESSONS

Summary

- As sediment concentrations decrease, sediment linkages with fish tissue PCB concentrations diminish
  - Non-sediment factors such as water column exposures become predominant
- Source control in urban settings is difficult but critical
  - Source control has generally been more effective than sediment remediation, particularly after higher PCB sediments (hotspots/early actions) are addressed
  - Site-specific dynamic equilibrium of surface sediments with ongoing sources
- Additional case studies with robust baseline and >7 years postconstruction monitoring data pending

THANK YOU

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