PUGET SOUND SEDIMENT MANAGEMENT
ANNUAL REVIEW MEETING
MAY 2024

Puget Sound Sediment Cleanup Needs a Paradigm Shift

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APPROACH

Puget Sound Sediment Case Study Reviews

- Retrospective reviews of completed projects (e.g., https://www.smwg.org/)
  - To more broadly develop knowledge to inform future sediment cleanup remedies
- January 2024 journal manuscript
  - https://setac.onlinelibrary.wiley.com/doi/10.1002/ieam.4890

Critical Review

Puget Sound sediment cleanup remedy effectiveness retrospective

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[2]Port of Tacoma, Tacoma, Washington, USA

APPROACH

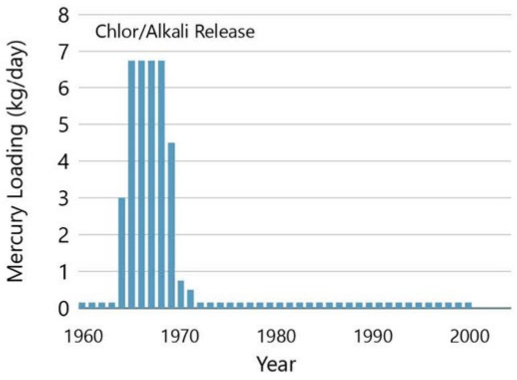
Puget Sound Sediment Cleanup Case Studies

- Particularly robust monitoring programs
  - Bellingham Bay (source control)
  - St. Paul Waterway (source control and cap)
  - Eagle Harbor (source control and cap)
  - Hylebos Waterway (source control and dredge)
  - Sinclair Inlet (source control and dredge)

- Post-construction monitoring data vs. model projections (SEDCAM)

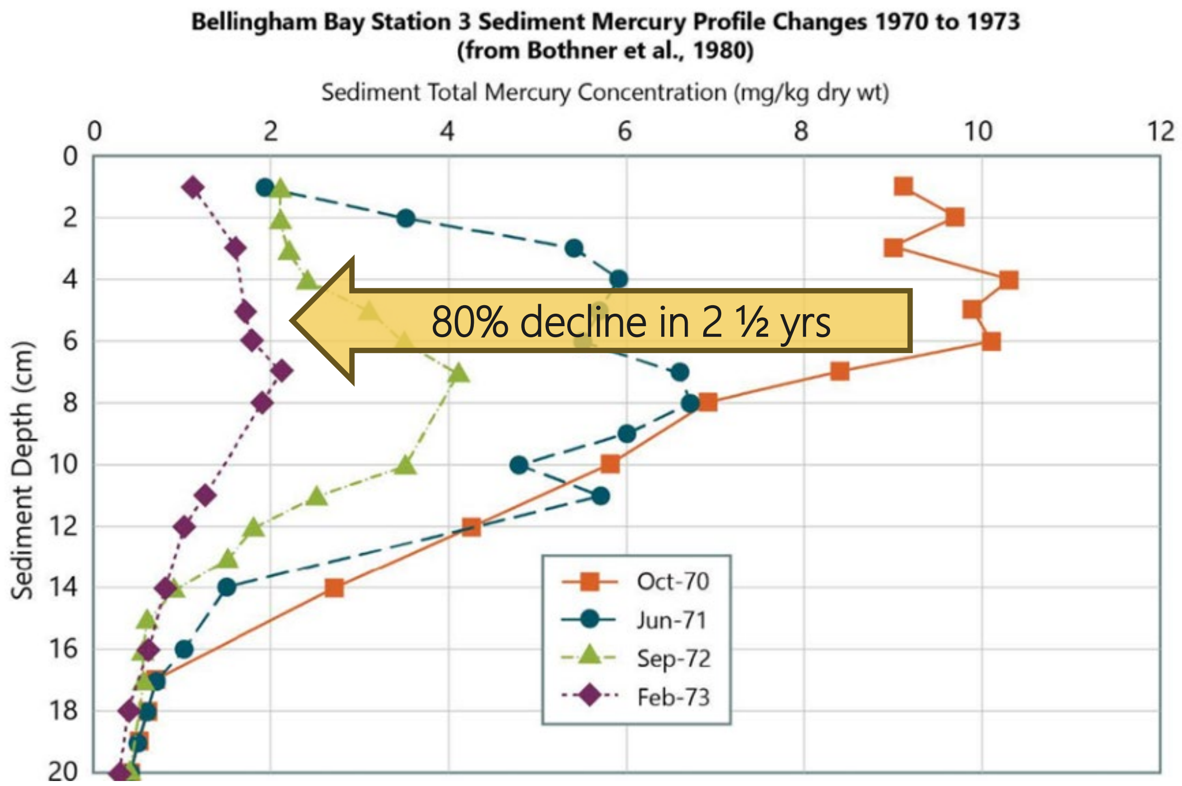
Bellingham Bay

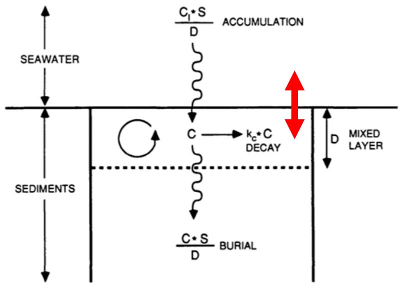
- 1965 - 1970 mercury release from former chlor-alkali facility
- 1970-1973 source controls and sediment monitoring
  - >95% mercury load reduction
  - Sediment sampling every 6 - 12 months
- Surface sediment recovery half-time projection: 6 ± 1 years (SEDCAM)



Bellingham Bay Sediment Mercury Recovery

- Observed surface sediment recovery half-time: 1.3 ± 0.2 years (5X faster)
- Concurrent porewater flux monitoring accounted for <5% of observed recovery
- Rapid recovery due to biological transfer across sediment-water interface (e.g., bioresuspension)





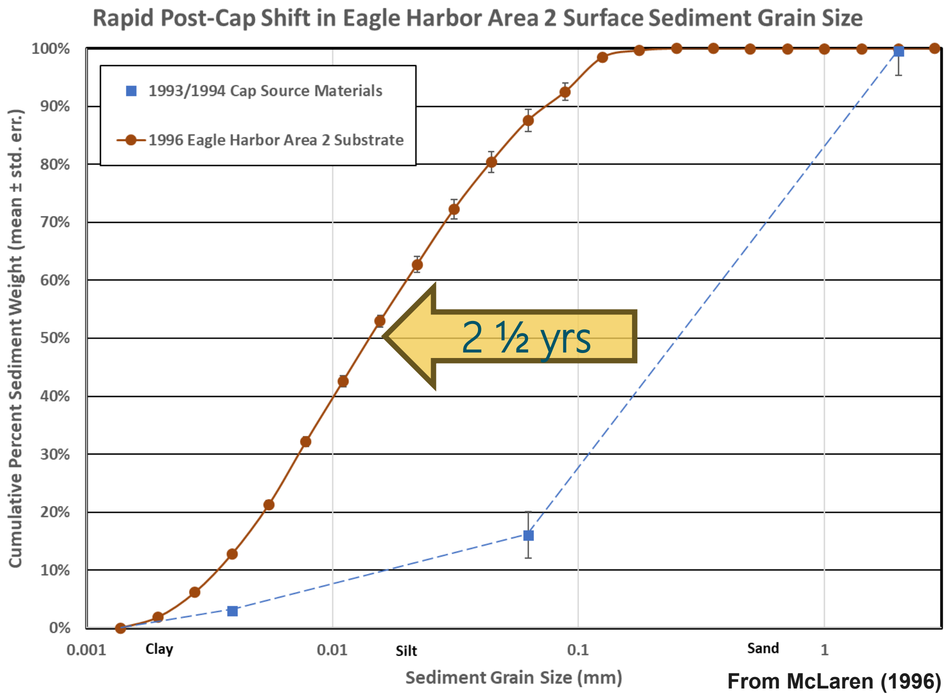
Eagle Harbor

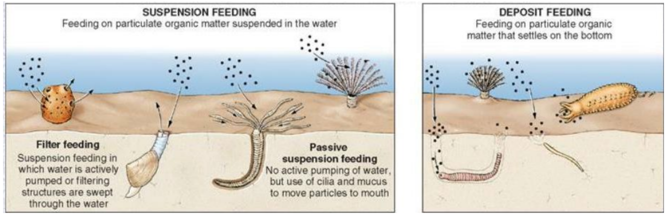
- Wood treatment (creosote) source controls since 1988 (facility closure)
- 1984 to 2010 flatfish monitoring
- 1993/1994 cap (54 acres; 3-ft-thick)
  - Area 1: sand cap placed over sand substrate
    - Primarily using bottom-dump barges
  - Area 2: sand cap placed over silt substrate
    - Sand slowly washed off flat deck barge with water jet to minimize substrate disturbance

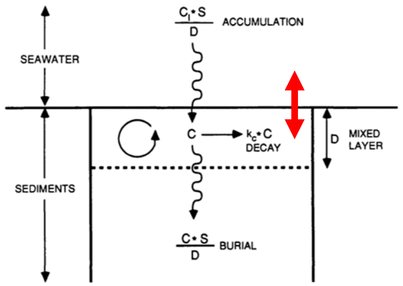
From Sumeri (1993) and Bottcher (2019)

Rapid Eagle Harbor Sediment Texture Recovery

- 1996 detailed surface sediment grain size survey (2 ½ years after cap placement)
- Rapid Area 2 surface sediment grain size recovery from sand cap to silt substrate
  - Observed half-time: 1.5 ± 0.8 years (>10X faster than SEDCAM projections)
  - Rapid recovery due to biological transfer across sediment-water interface (e.g., suspension and deposit feeding)



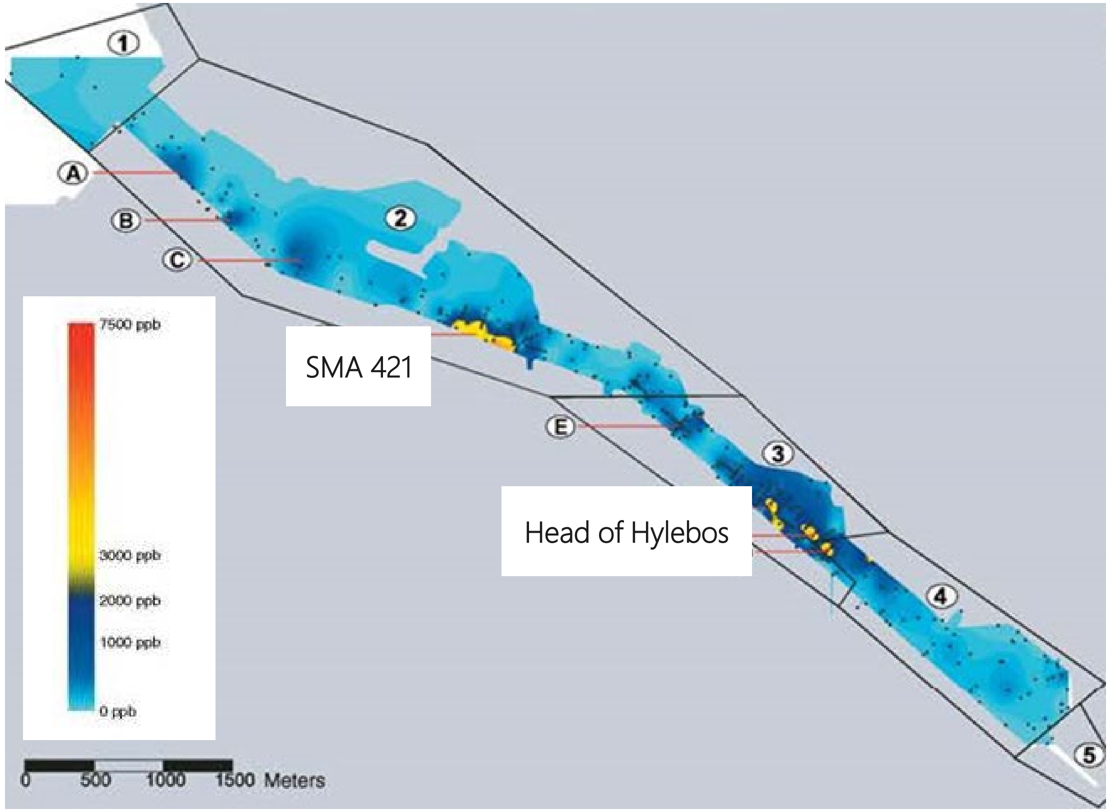




Hylebos Waterway

- 1990 - 1999 source controls
  - Extensive wastewater/stormwater controls and upland/shoreline cleanup
- 1994 - 1998 sediment PCB "hot-spots"
  - Sediment Management Area (SMA) 421
    - 1995 - 1999 shoreline source control
  - Head of Hylebos (several adjacent SMAs)
- 2004 - 2006 Waterway-wide remediation
  - 1.2 million cubic yards sediment dredged (24 acres)
  - 8 acres monitored natural recovery; 3 acres capped

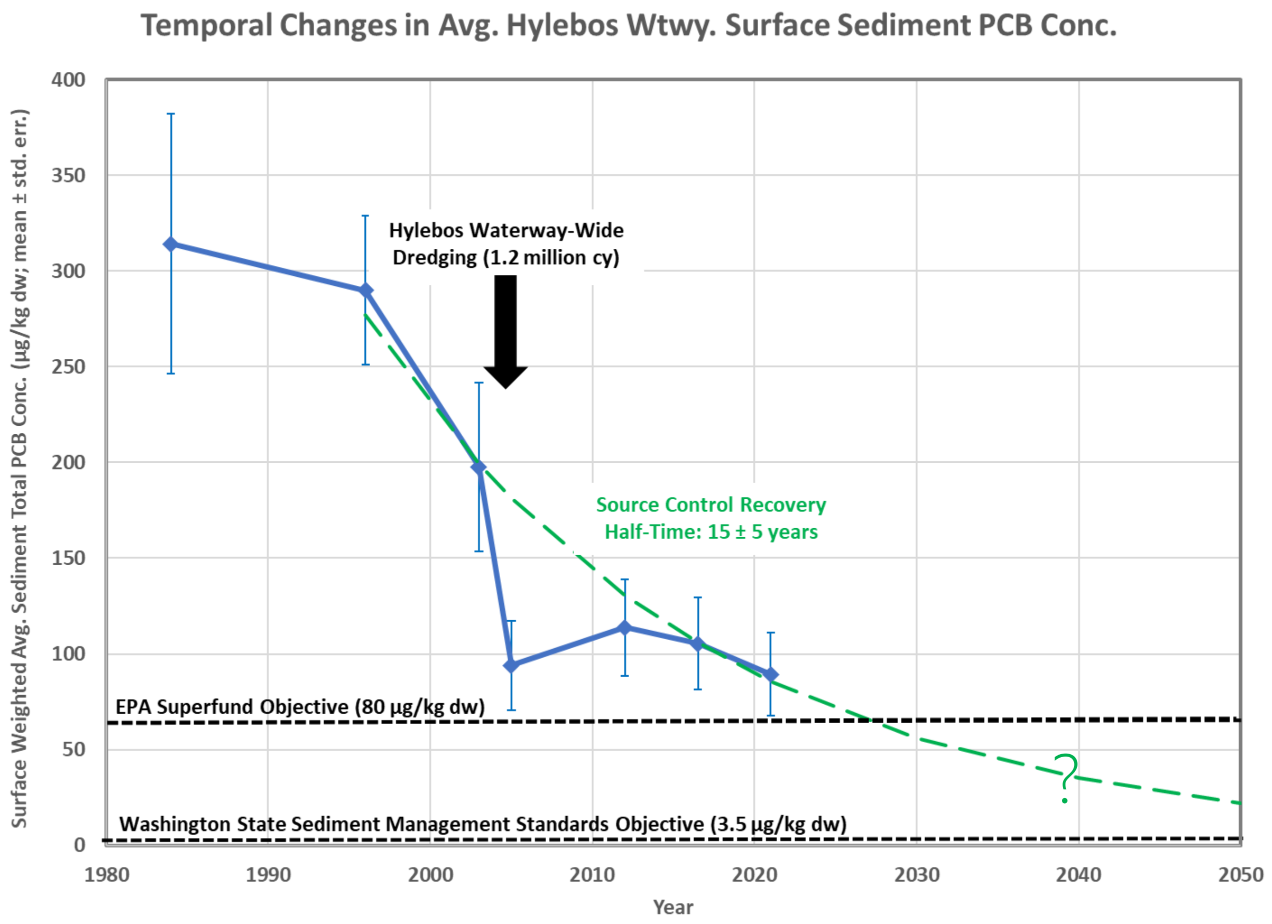
1994 - 1998 Surface Sediment Total PCB Concentrations in Hylebos Waterway

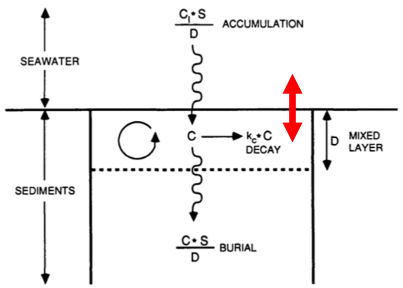


From McLaren and Beveridge (2006)

Hylebos Waterway Sediment PCB Recovery

- SMA 421 recovery half-time: 1.5 ± 0.8 years (1998 to 2003)
  - Rapid recovery due to biological transfer across sediment-water interface (e.g., bioresuspension)
- PCB recontamination after 2004 to 2006 dredging
- Waterway-wide PCB source recovery half-time: 15 ± 5 yrs
- Watershed PCB source controls continuing





Why are English Sole Tissue Concentrations Not Declining?

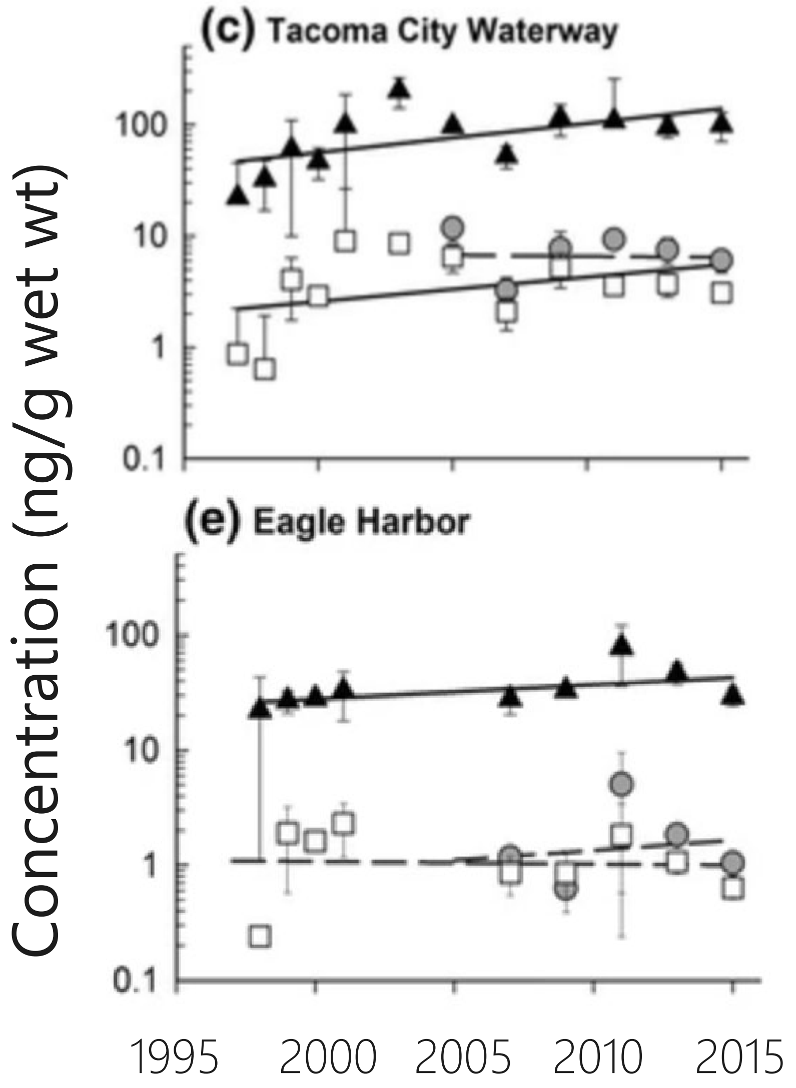
Arch Environ Contam Toxicol (2017) 73:207–229
DOI 10.1007/s00244-017-0383-z

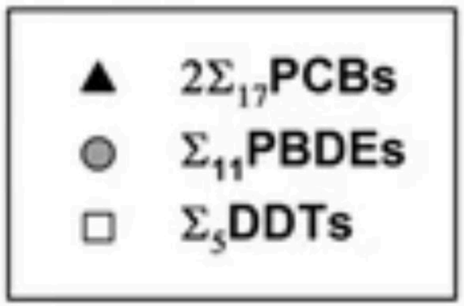
CrossMark

SPECIAL ISSUE: INDICATORS OF OCEAN POLLUTION

Time Trends of Persistent Organic Pollutants in Benthic and Pelagic Indicator Fishes from Puget Sound, Washington, USA

James E. West[1] · Sandra M. O'Neill[1] · Gina M. Ylitalo[2]





Where are the Pollutants in Fish Coming From?

$$\frac{d\nu_i}{dt} = k_{u_i} C_{dis} - k_{b_i} \nu_i + \sum_j \alpha_{i,j} I_{i,j} \nu_j \left[\frac{f_{dry\ wt_j}}{f_{dry\ wt_i}}\right] - \left(k_e + k_m + k_g\right)\nu_i$$

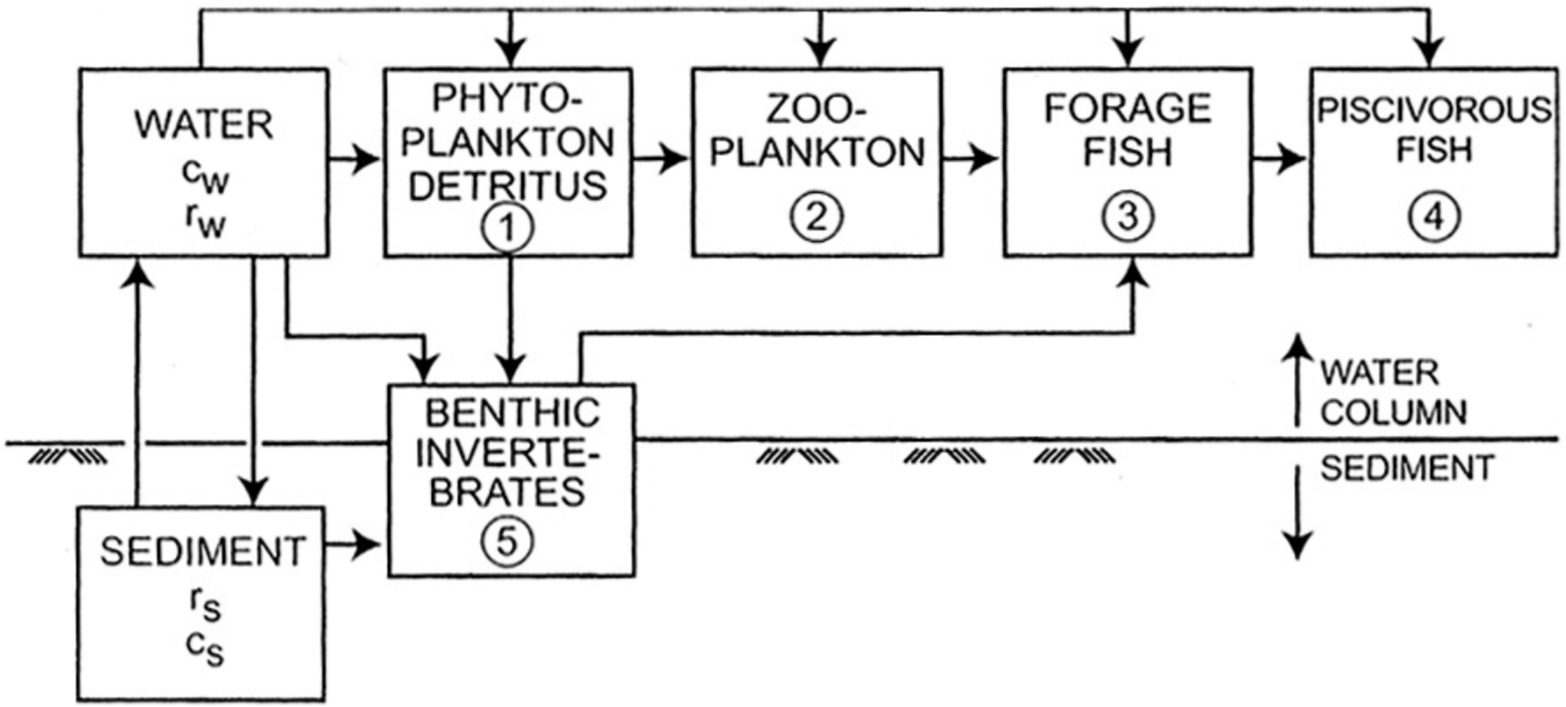
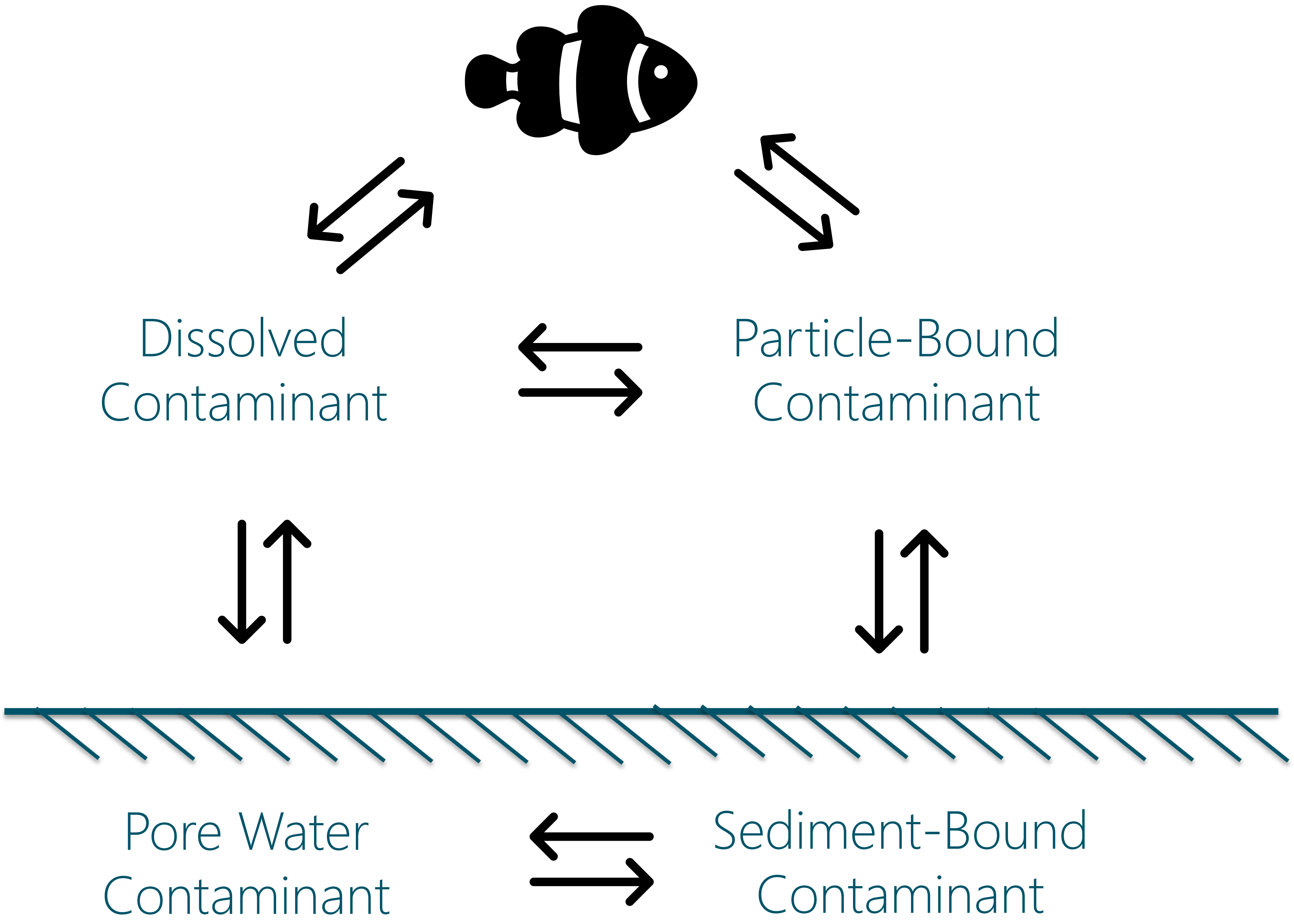
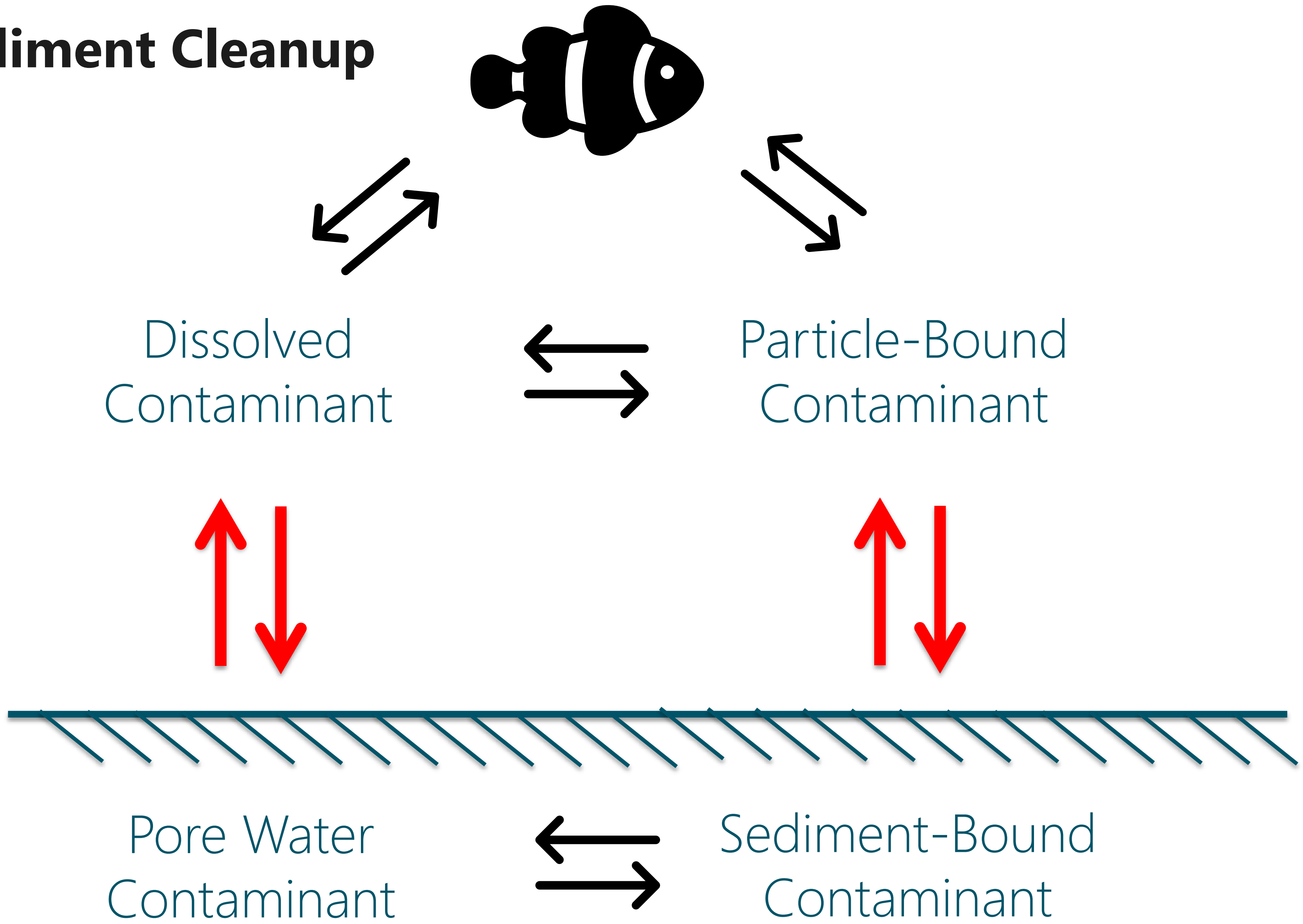
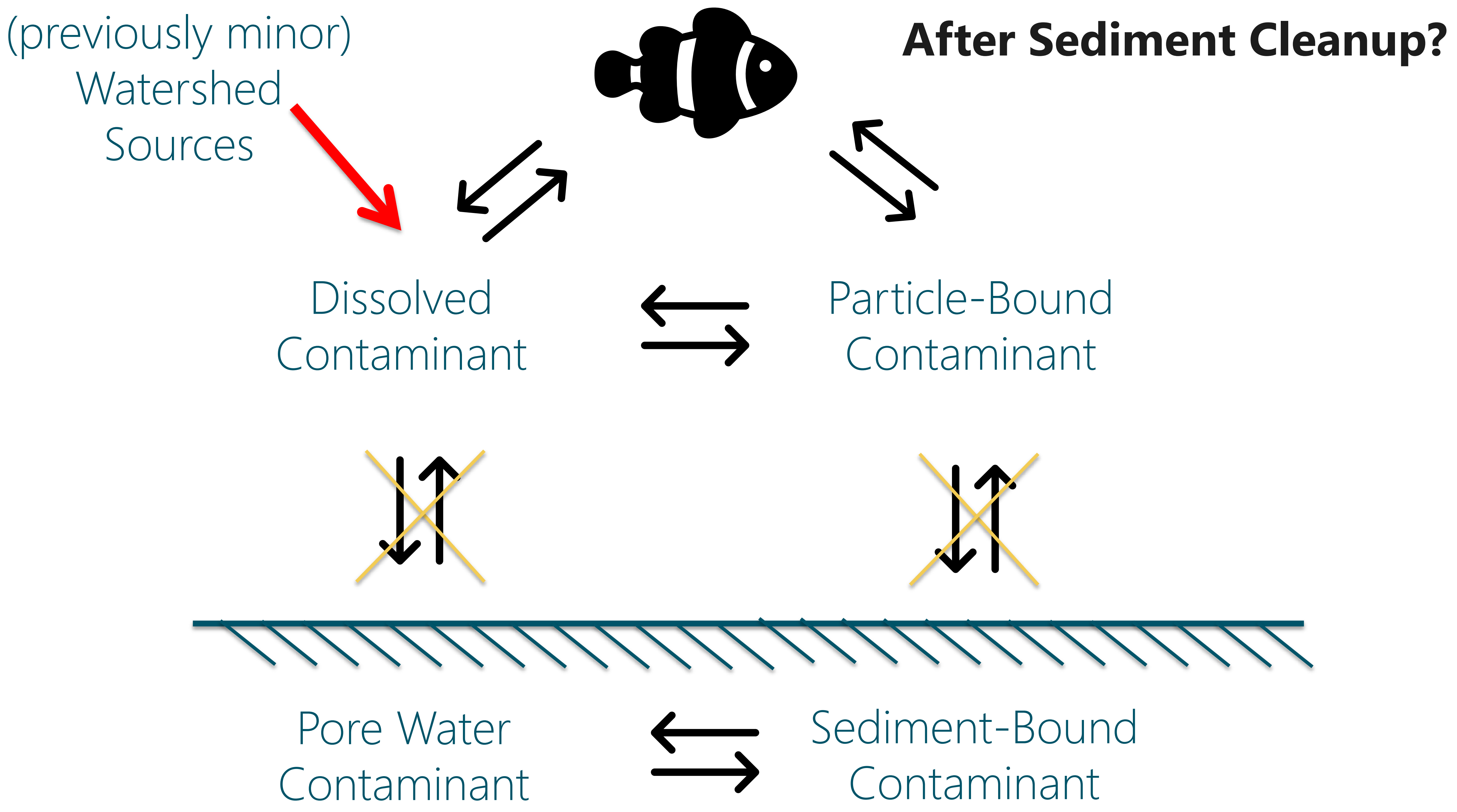


Figure 8-1. Generic Food Web Model (Thomann et al., 1992)


Dissolved Contaminant
Particle-Bound Contaminant
Pore Water Contaminant
Sediment-Bound Contaminant

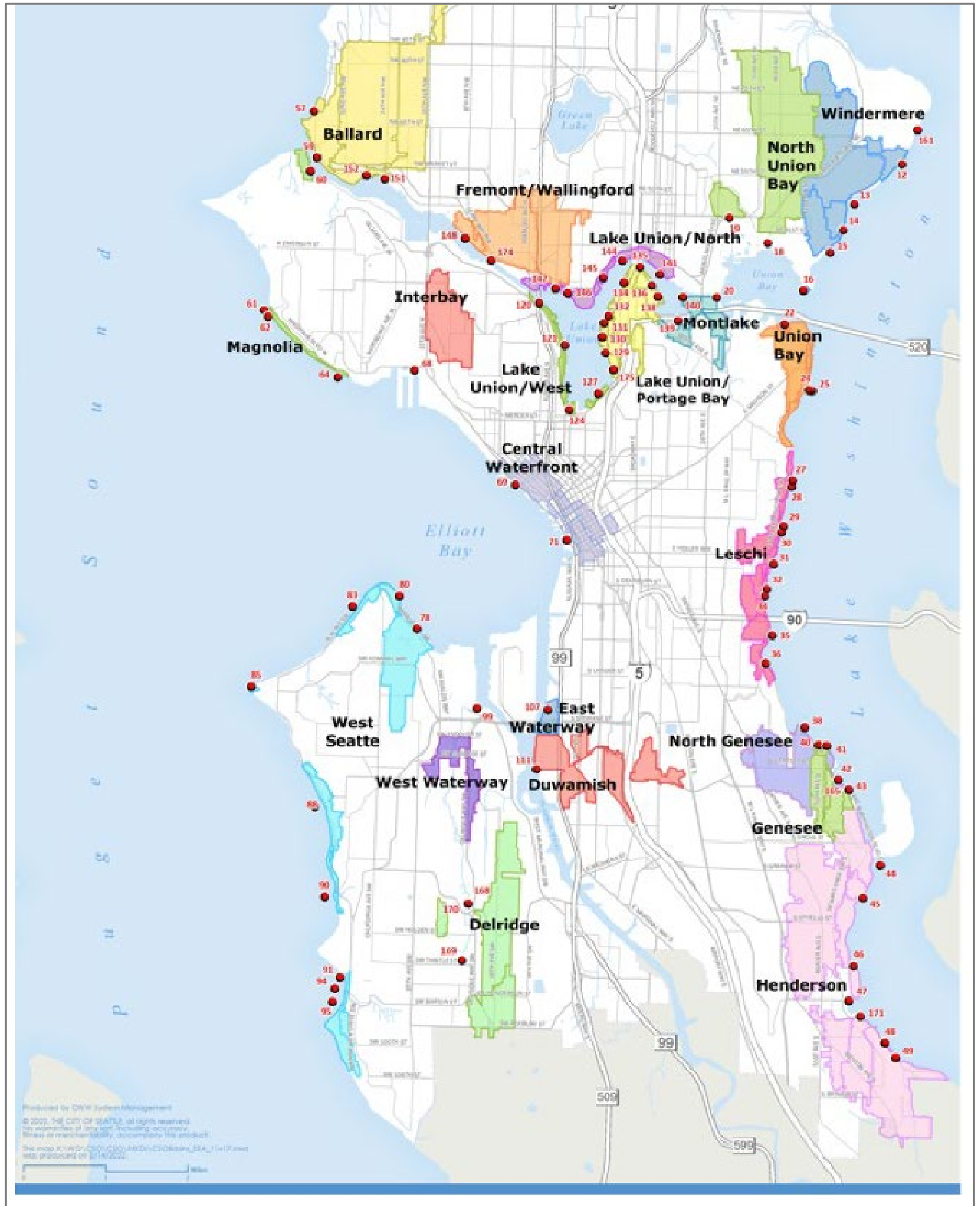
Before Sediment Cleanup





After Sediment Cleanup?
(previously minor) Watershed Sources
Dissolved Contaminant
Particle-Bound Contaminant
Pore Water Contaminant
Sediment-Bound Contaminant

CSO Basins



Stormwater Basins

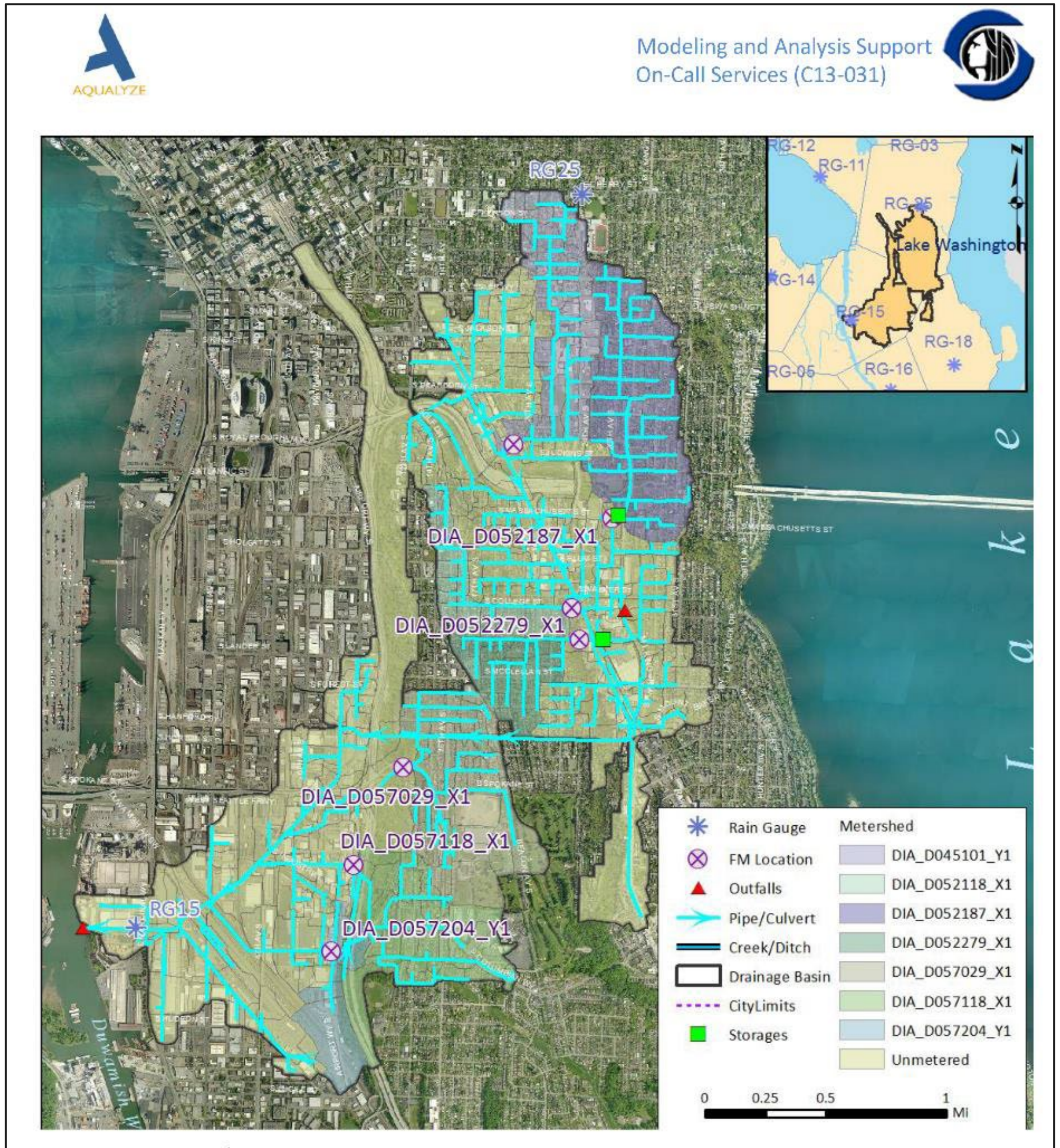
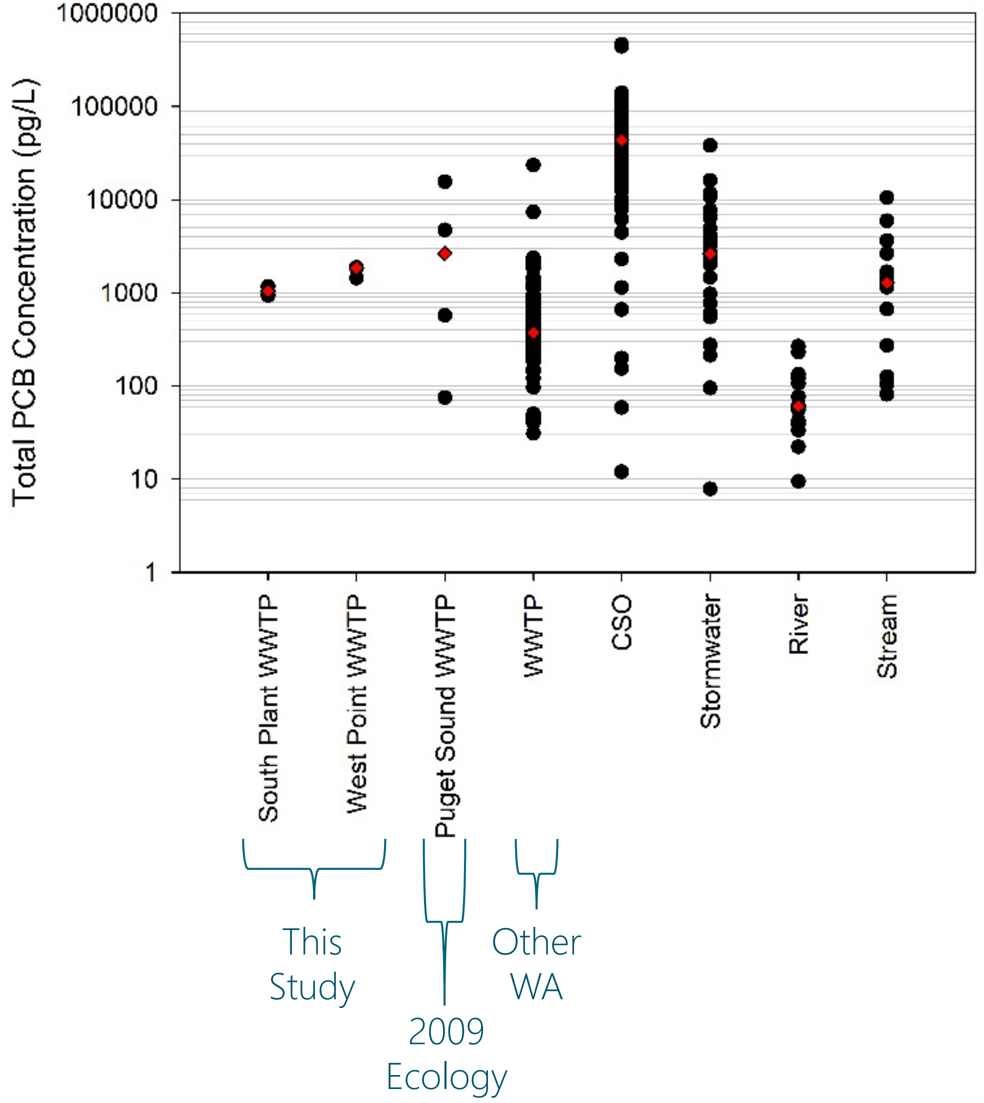
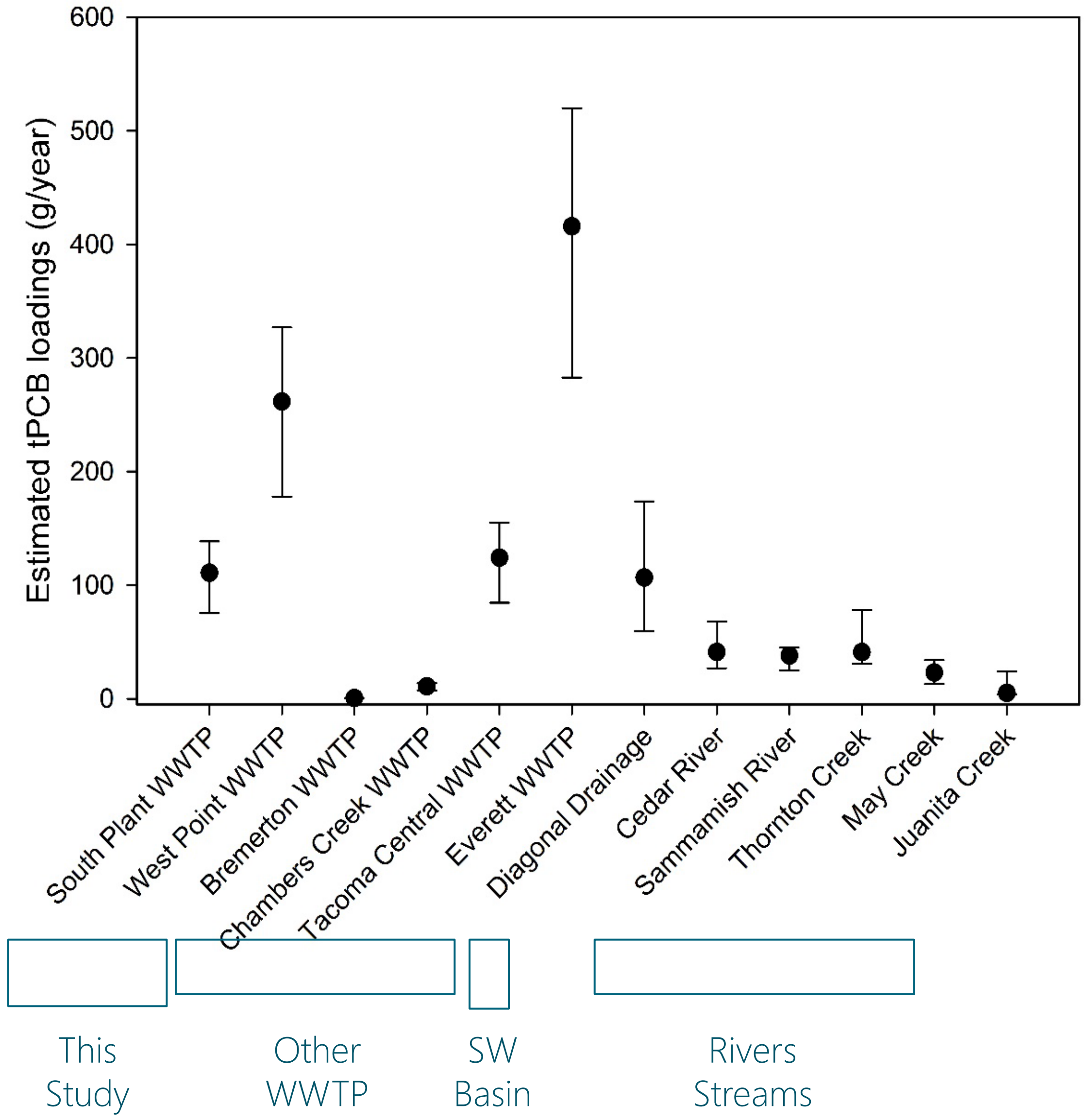


Figure 5-1: Diagonal Drainage Basin

Total PCB Concentrations



Total PCB Loadings



A. James, UW PSI

LESSONS

Summary

OLEM Directive Number 9200.1-166

EPA United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation, and Office of Research and Development

Sediment Assessment and Monitoring Sheet (SAMS)

Adaptive Site Management – A Framework for Implementing Adaptive Management at Contaminated Sediment Superfund Sites

- Rapid equilibration of Puget Sound surface sediments
  - Revealed by timely monitoring of source controls and capping
  - Recovery rates 5 ± 2 times faster than original model projections (SEDCAM)
  - Biological processes (e.g., feeding/movement) result in rapid sediment equilibration
- Diminishing linkage between fish and sediment at lower PCB levels
- Going forward, source control in an adaptive management framework is the most efficient way to achieve protective remediation goals
  - Paradigm shift needed from broad-scale sediment remediation