Sediment Monitored Natural Restoration Initial Case Studies

Presented to
RTDF Sediment Remediation Action Team

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Washington State Monitored Natural Restoration Case History Examples

- Bellingham Bay
- Spokane River
- Eagle Harbor
**Case Study Site Comparisons**

**Chemicals of Potential Concern**
- **Bellingham Bay**: Mercury & Wood Waste
- **Spokane River**: PCBs & Metals
- **Eagle Harbor**: PAHs & Mercury

**Source Control Implementation**
- **Bellingham Bay**: Mercury - ‘70, Wood - ‘78
- **Spokane River**: PCB - ‘72, Metals - Ongoing
- **Eagle Harbor**: PAHs & Hg - ‘60

**Monitoring Record**
- **Bellingham Bay**: 30 Years RI/FS - ‘00
- **Spokane River**: 15 Years RI/FS - ‘02
- **Eagle Harbor**: 20 Years RI/FS - ‘91

- Capping in ‘94 to Accelerate Recovery
Mercury Release and Source Control: Bellingham Bay

![Bar chart showing mercury loading (kg/day) over time from 1960 to 2000. The highest loading occurred around 1970.](image-url)
Sediment Deposition and Stability: Bellingham Bay
Decline in Surface Sediment Mercury Following Source Control: Bellingham Bay

Station 3A (Log Pond; near release)

Station 3 (Inner Bay)

Sediment Cleanup Level
Temporal Change in Core Profiles: Inner Bellingham Bay Station 3

Sediment Mercury (mg/kg)

Sediment Depth (cm)

0 2 4 6 8 10 12

1970
1975
1996
Bellingham Bay Sediment Recovery Modeling

• Initial Model Development in 1980
  • Radioisotope Dating

• Model Refinements in 1989 and 1996
  • Sediment Traps; Resuspension Rates

• Several Models Used
  • Officer and Lynch; WASP

• Model Validation
  • Predicted Changes in Core Profiles
Biological Endpoint Recovery: Reduction in Bellingham Bay Surface Sediment Toxicity
Biological Endpoint Recovery: Reduction in Bellingham Bay Crab Tissue Mercury Levels

- Sediment Mercury (mg/kg) vs. Crab Muscle Mercury (mg/kg)
- Risk-Based Protection Level
- 1974
- 1997

Graph showing the correlation between sediment mercury levels and crab muscle mercury levels, indicating a reduction in mercury levels from 1974 to 1997.
PCBs and Metals Release & Control: Spokane River

- **PCB Releases:**
  - Sources Not Well Documented Before 1990
  - Restricted Use After 1972
  - Source Control Complete by 1993

- **Metals Releases:**
  - Initial Control Efforts Began in 1977
  - Significant Ongoing Mine Tailings Release
Sediment Deposition and Stability: Spokane River
PCB Core Profile: Spokane River Stable Deposit

Sediment PCBs (mg/kg OC)

Depth (cm)

-70 -60 -50 -40 -30 -20 -10 0 50 100 150 200 250 300

2000 1980 1960 1940

Sediment Cleanup Level
Zinc Core Profile: Spokane River Stable Deposit

![Graph showing sediment zinc levels over time. The x-axis represents depth in cm, ranging from 0 to 70 cm. The y-axis represents sediment zinc levels in mg/kg, ranging from 0 to 6000 mg/kg. Key years marked include 1940, 1960, 1980, and 2000, with corresponding sediment zinc levels at each depth.]
Decline in Surface Sediment PCB Levels Following Source Control: Spokane River

Sediment PCB (mg/kg OC)

Minimum Cleanup Level

Sediment Cleanup Goal
Decline in Fish Tissue PCB Levels Following Source Control: Spokane River
Predicted Recovery of Zinc Following Future Source Controls: Spokane River

![Graph showing predicted recovery of zinc in Spokane River over time.]
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West Harbor Mercury Capping Area - 1997

East Harbor PAH Capping Area - 1994 & 2001

Eagle Harbor Sediment Cap Areas
Barge Wash-Off Cap Placement - 1994 & 2001
Biological Endpoint Recovery: Fish Histopathology

Liver Lesion Prevalence

Eagle Harbor: 1993
Puget Sound Background
Eagle Harbor: 1997 to 1999

Sediment PAH Conc (ug/kg dry wt)