



# Natural Recovery of Contaminated Sediments



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# MNR Definition

Monitored Natural Recovery (MNR) involves *leaving contaminated sediments in place* and allowing ongoing aquatic, sedimentary, and biological processes to reduce the bioavailability of the contaminants in order to protect receptors

It must be the result of a deliberate, thoughtful decision-making process following careful site assessment and characterization

NRC, 1997. *Contaminated Sediments in Ports and Waterways*



# Past Sites that Identified and Selected Natural Recovery their RODs

- Kepone, James River (VA)
  - Active remediation estimated at \$3 to \$10 billion
  - Active remediation would disturb existing habitat
  - Sediments likely to be buried, or diluted by flushing and mixing
- Lead, Interstate Lead Company Superfund site (AL), 1995 ROD
  - Historical trends indicated a general decline in sediment lead concentrations, attributed to dispersal, dilution, and burial
  - No evidence of damage to existing ecosystem
  - In situ capping and sediment removal would damage existing ecosystem
  - Natural recovery would result in minimal environmental disturbance
- PCBs, Lake Hartwell Superfund site (SC), 1994 ROD
  - Active remediation technically impracticable or too costly
  - EPA and public agreed that fishing advisories and education could adequately reduce risk
  - Simple 1-D model predicted recovery to 1 mg/kg within a reasonable time, once terrestrial PCB source was removed



## Current Direction of MNR:

### Develop a more rigorous approach to evaluate and demonstrate MNR efficacy

- Advances in environmental science & engineering
  - Computers and modeling capability
  - Analytical chemistry
  - Understanding of sediment transport and contaminant mass transport processes
- Time: Decades since original releases
- EPA acceptance of MNR
- Efforts to establish principles to evaluate MNR
  - RTDF
  - SMWG
  - EPA & DoD

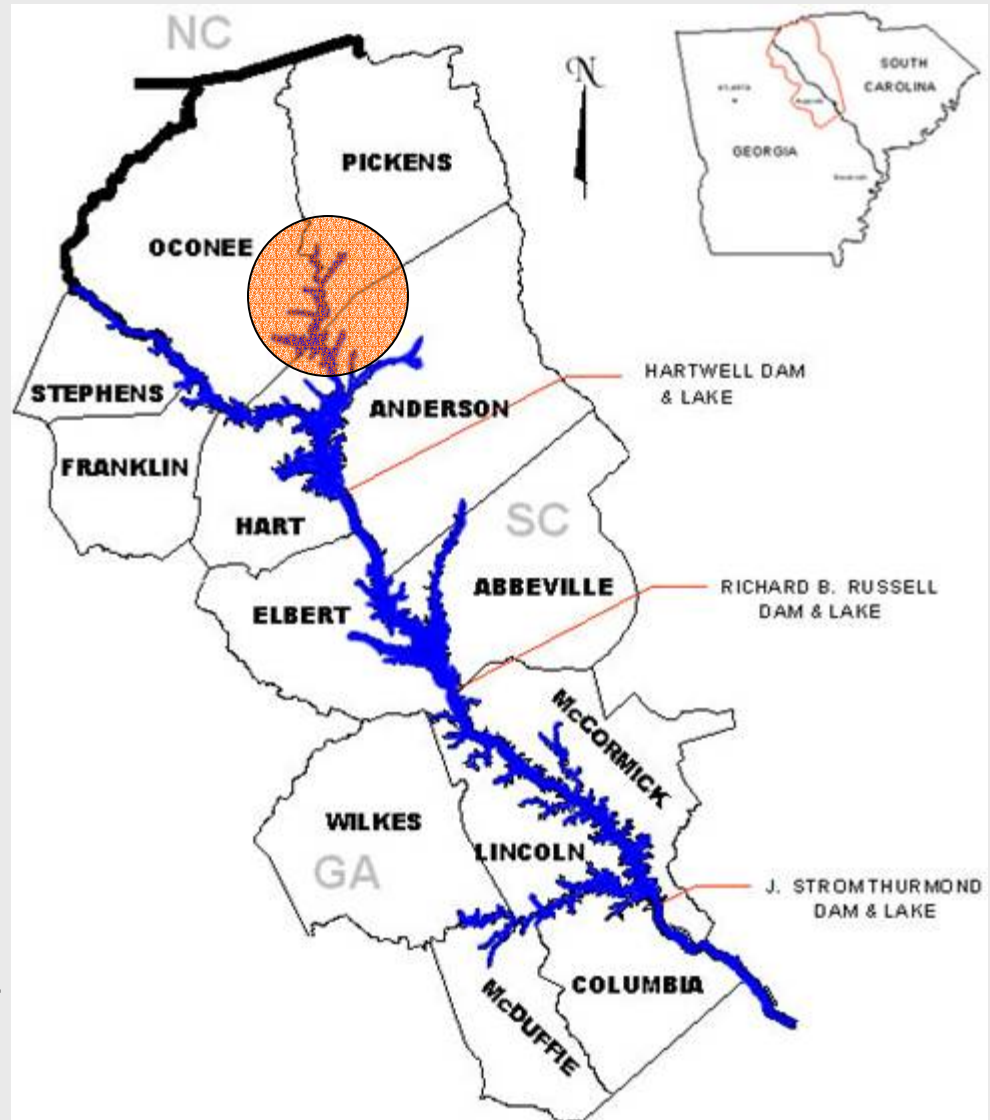


# MNR Principles

1. **Containment** through natural capping  
(deposition of increasingly clean sediment)
  - Requires net depositional areas
  - Provides natural barrier to aquatic environment
  - Largest contributor to natural recovery
2. Contaminant **weathering**
  - Biodegradation/Dechlorination
  - Other physical/chemical processes
  - Contaminant sorption/sequestration
3. Assess **sediment stability** to determine the potential for resuspension of buried contaminants
4. Modeling to predict **long-term sediment recovery**
5. Demonstrate **ecological recovery**, or potential recovery

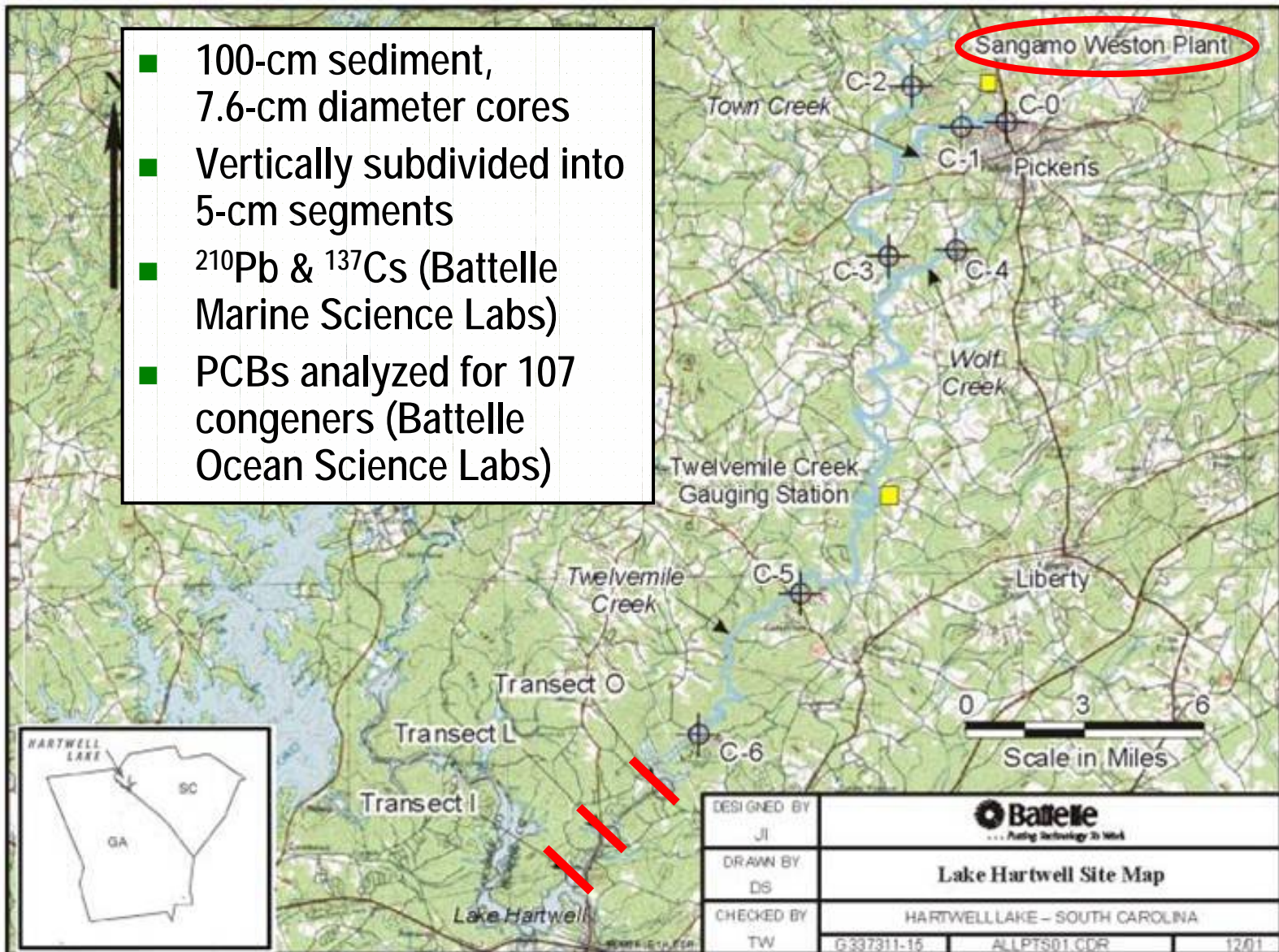
# Lake Hartwell Site

- Fresh water lake
- Sangamo-Weston Capacitor Manufacturing (1955 – 1978)
- Aroclors 1016, 1242, 1254
- Terrestrial PCB sources removed in mid-90s
- MNR selected by Region 4 (EPA/ROD/R04-94/178)

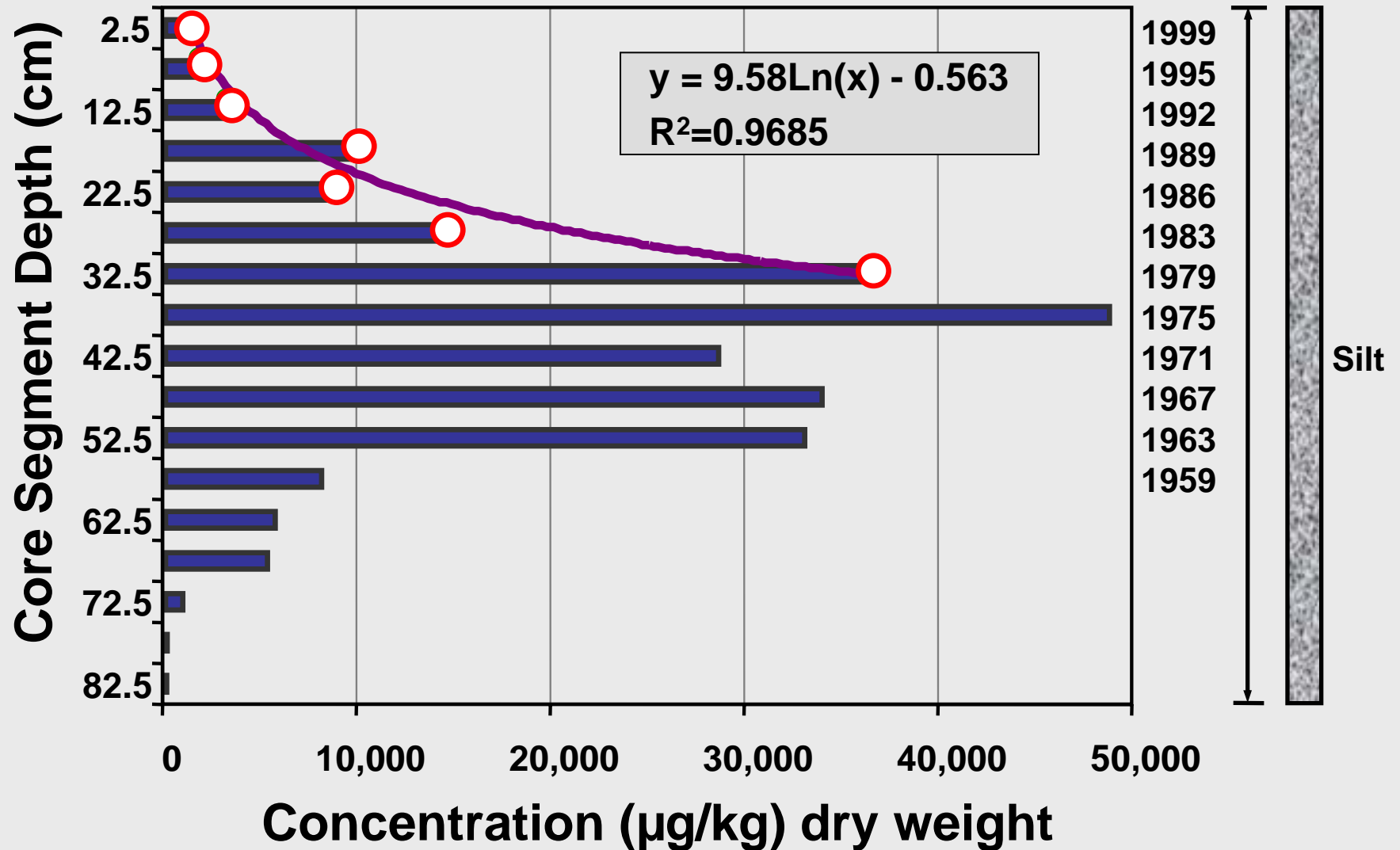


# Sediment Coring and Profiling

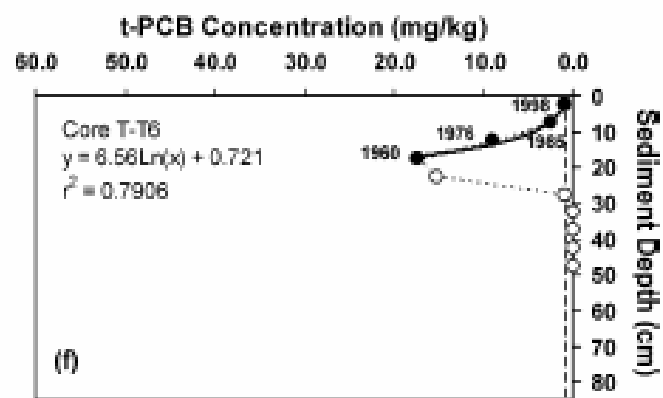
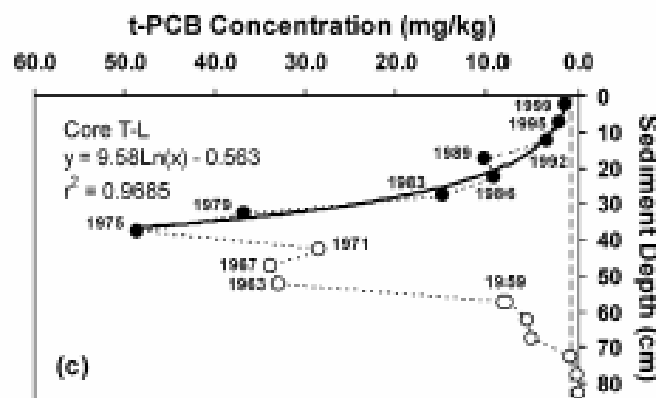
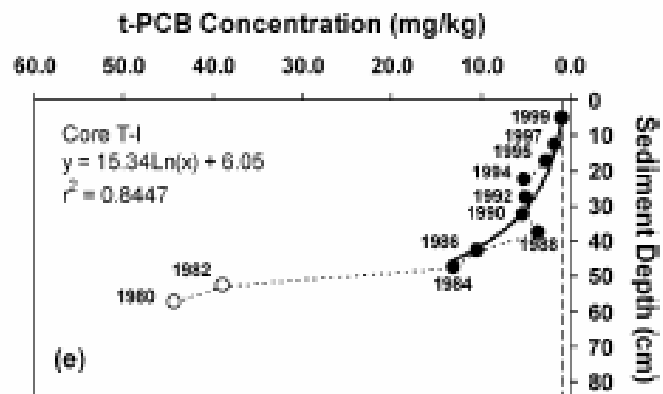
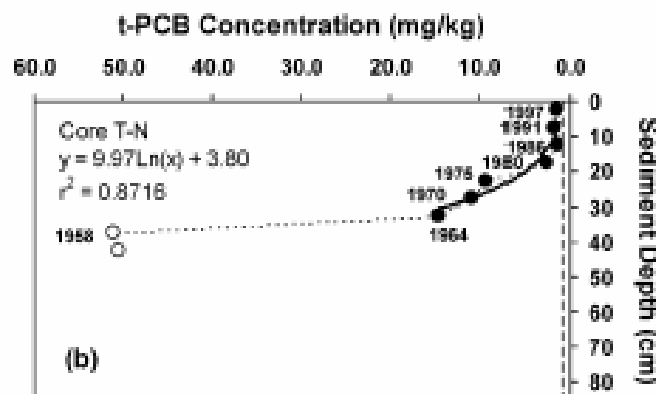
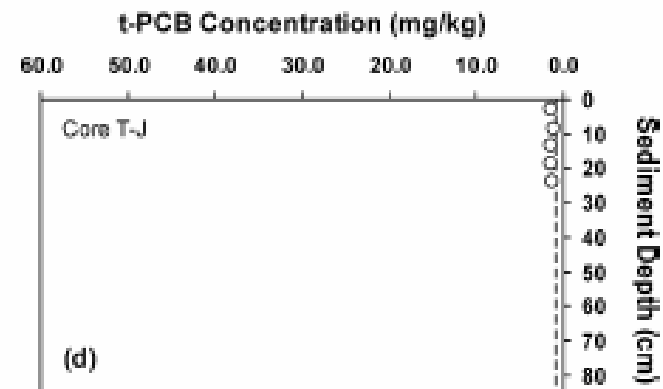
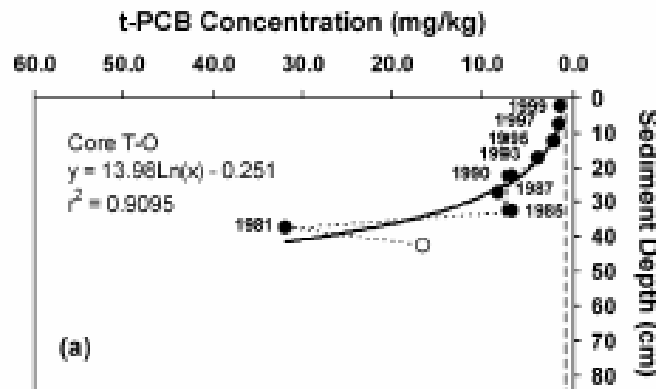
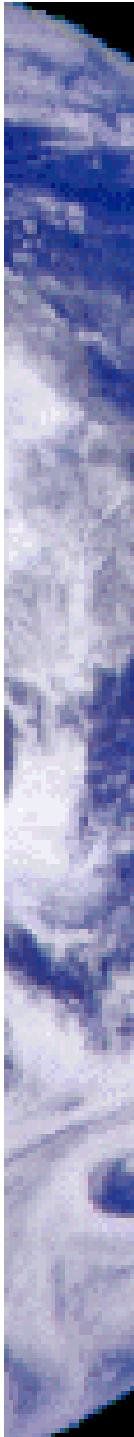
- 100-cm sediment, 7.6-cm diameter cores
- Vertically subdivided into 5-cm segments
- $^{210}\text{Pb}$  &  $^{137}\text{Cs}$  (Battelle Marine Science Labs)
- PCBs analyzed for 107 congeners (Battelle Ocean Science Labs)

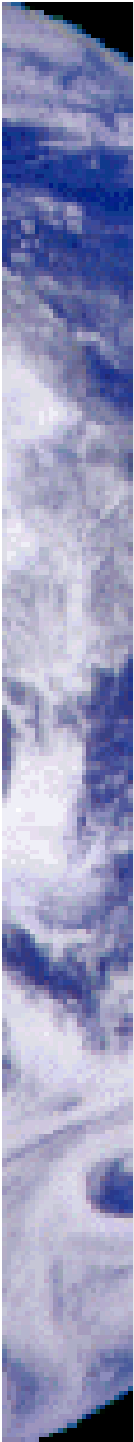


# Containment: Vertical contaminant profiling and age dating ( $^{210}\text{Pb}$ & $^{137}\text{Cs}$ )









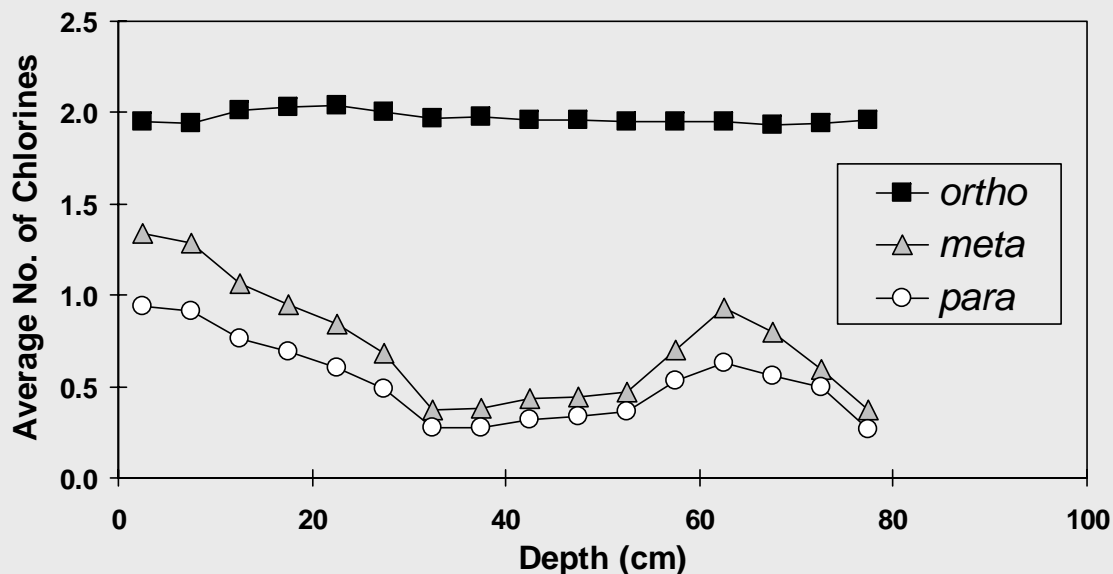
# Time to Achieve ROD (U.S. EPA 1994) Cleanup Goals

- ROD surface sediment cleanup goal (1 mg/kg)
- Mean site-specific sediment quality criteria (0.4 mg/kg)
- NOAA effects range-low (0.05 mg/kg)

Time to Achieve Cleanup Goals		
1 mg/kg t-PCB	0.4 mg/kg t-PCB	0.05 mg/kg t-PCB
1 – 5 yrs	2 – 10 yrs	10 – 30 yrs

95% confidence levels increased the time frame up to 95 yrs

# Relative *meta* and *para* Dechlorination Rates



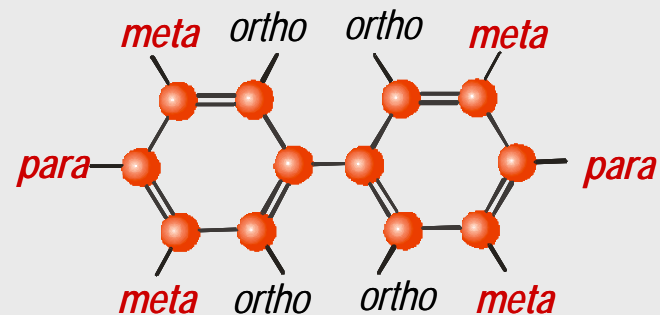
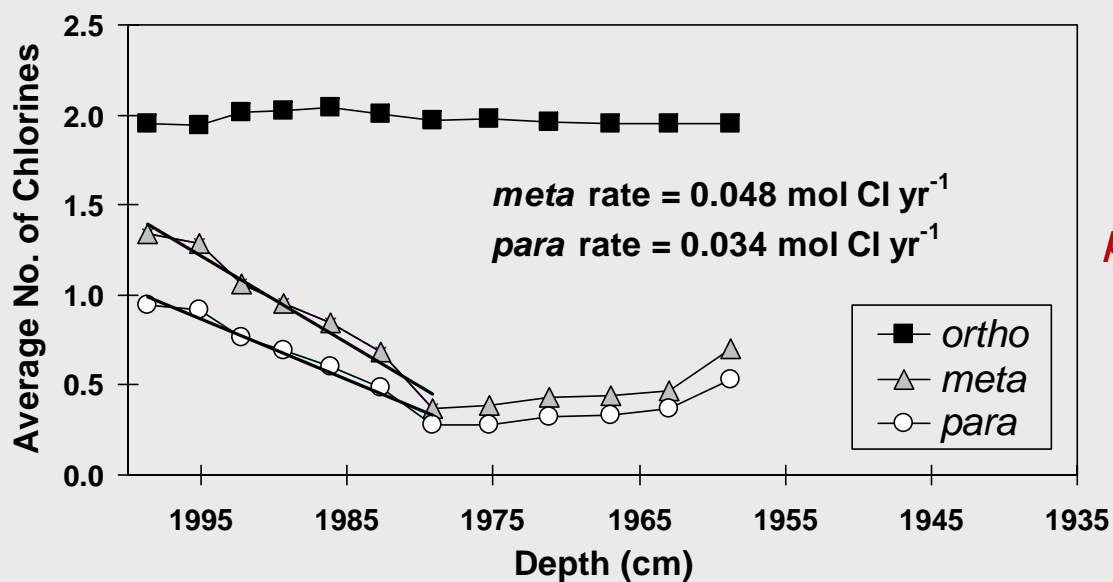
Average Rates (n = 11)

$$meta = 0.053 \pm 0.04$$

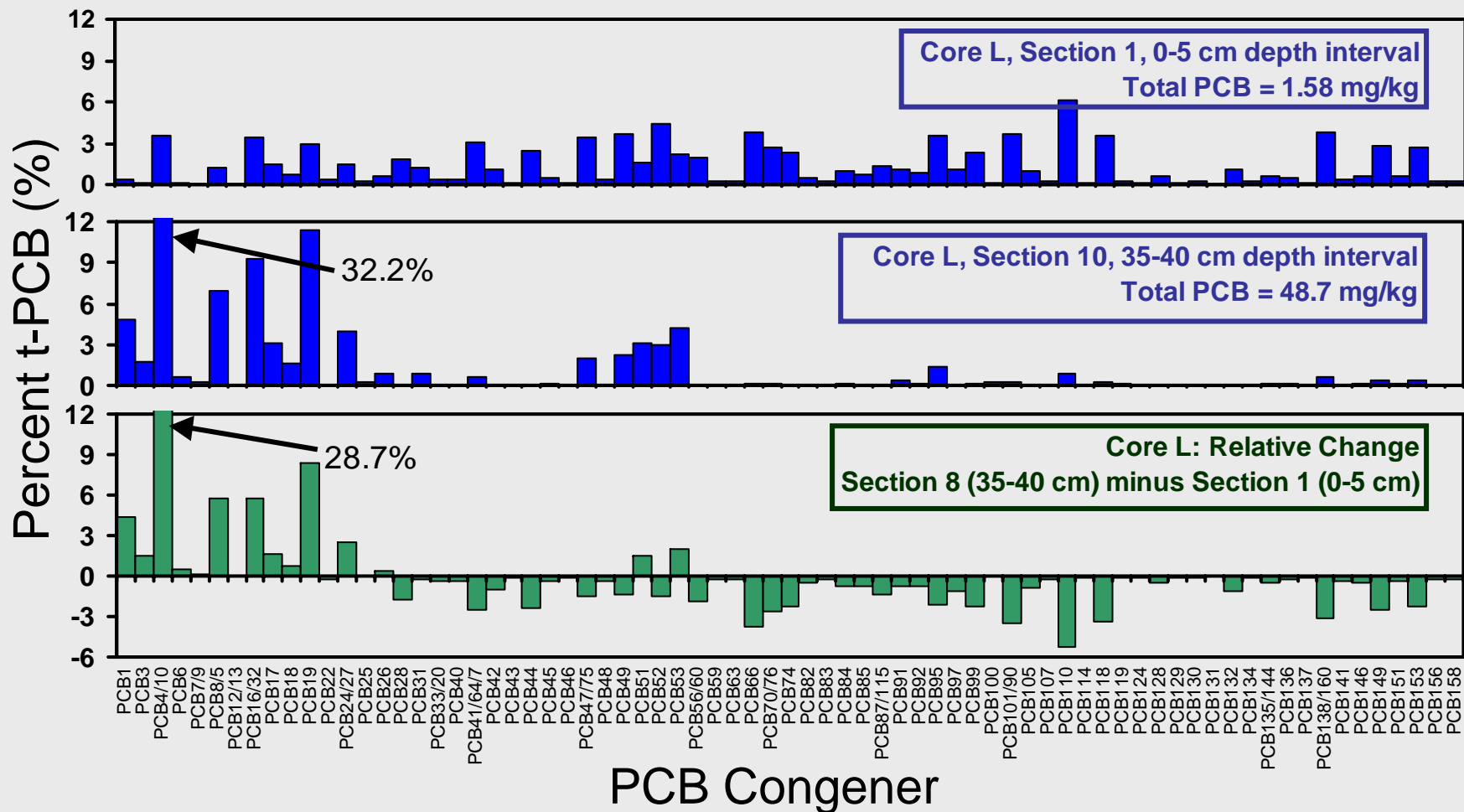
$$para = 0.037 \pm 0.03$$

18 yr per *meta* Cl

27 yr per *para* Cl



# PCB Dechlorination



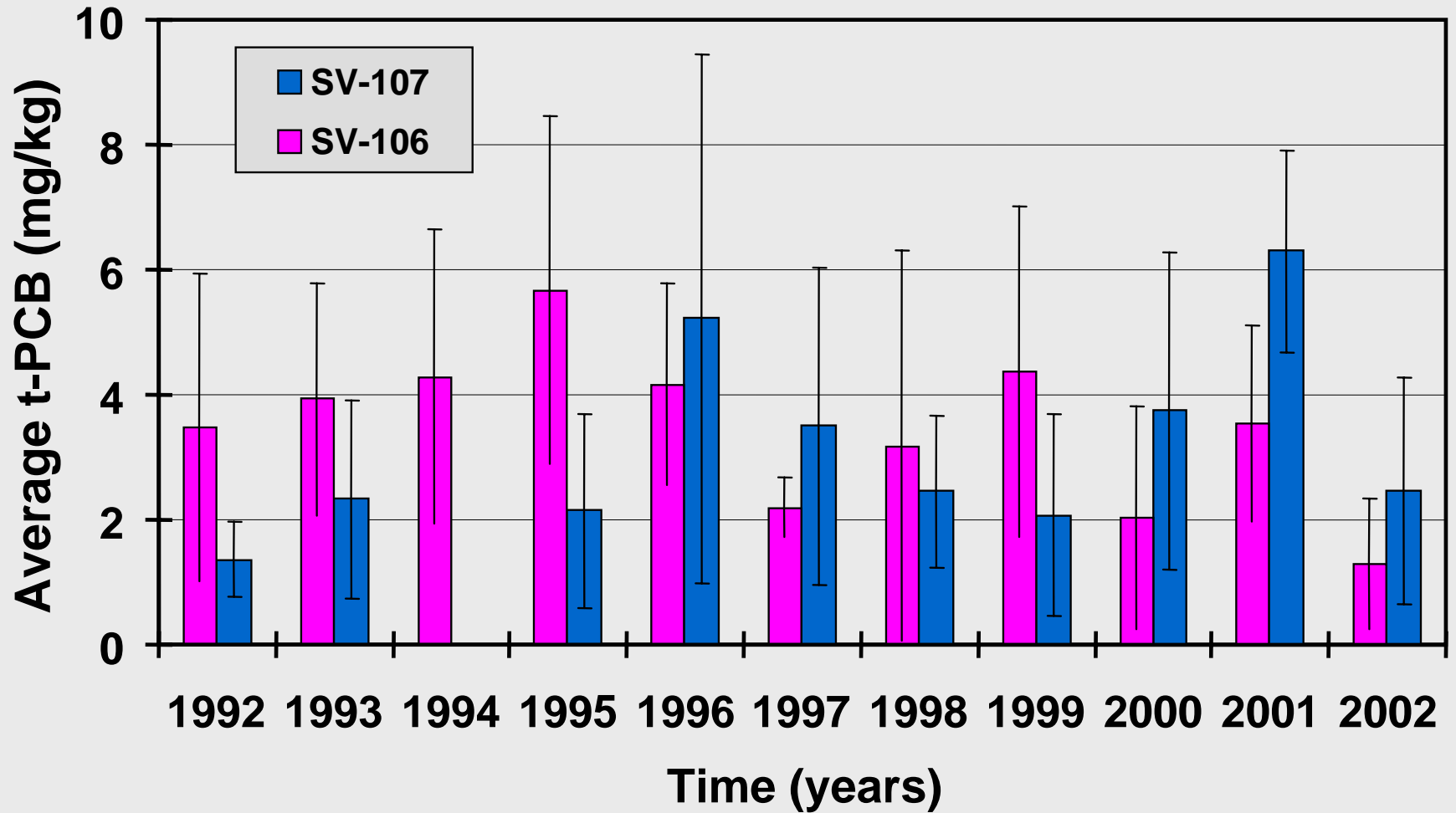
Less Cl<sup>-</sup>

Lower dioxin equivalents

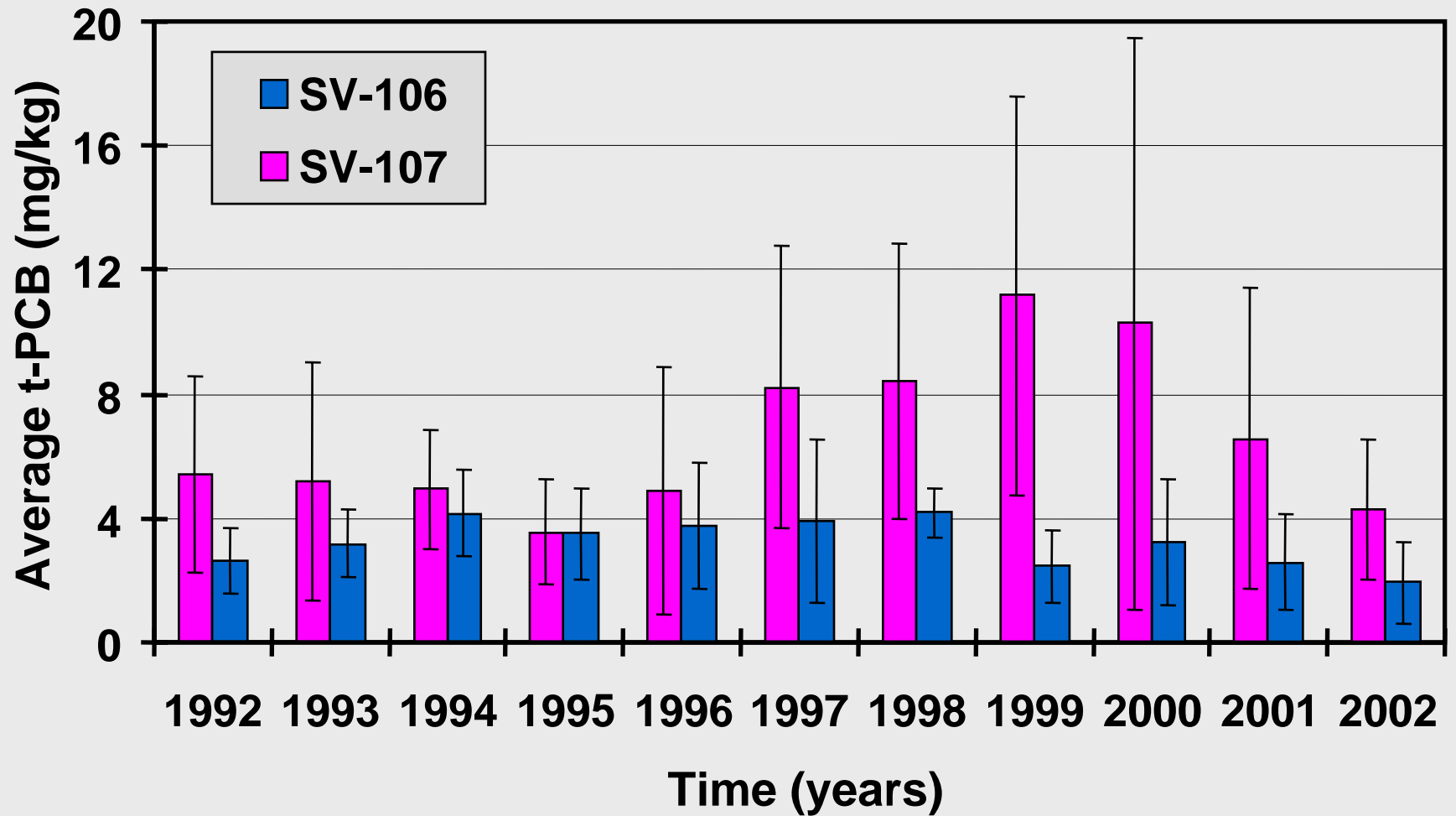
More Cl<sup>-</sup>

Higher dioxin equivalents

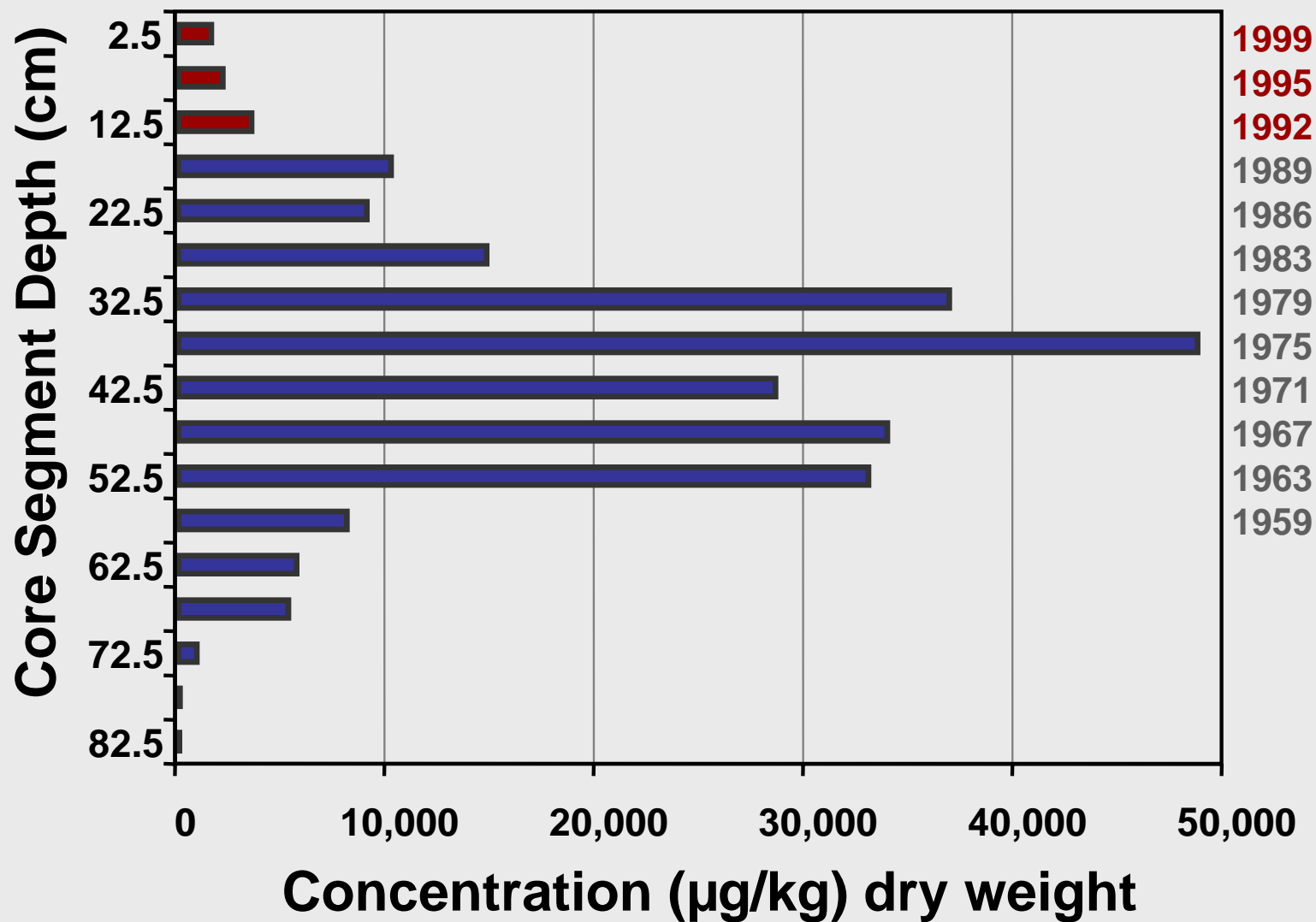
# Ecological Recovery Hybrid Bass



# Largemouth Bass



# Do fish PCB concentrations over time reflect reduced surface sediment concentrations?



# Sediment Stability

- Lake Hartwell Site
  - Historical storms
  - Drought conditions
- Hunters Point Shipyard
  - Sedflume
  - Hydrodynamic studies





