Connecting the Upper Hudson and the Western Harbor

A multi-contaminant geochemical perspective

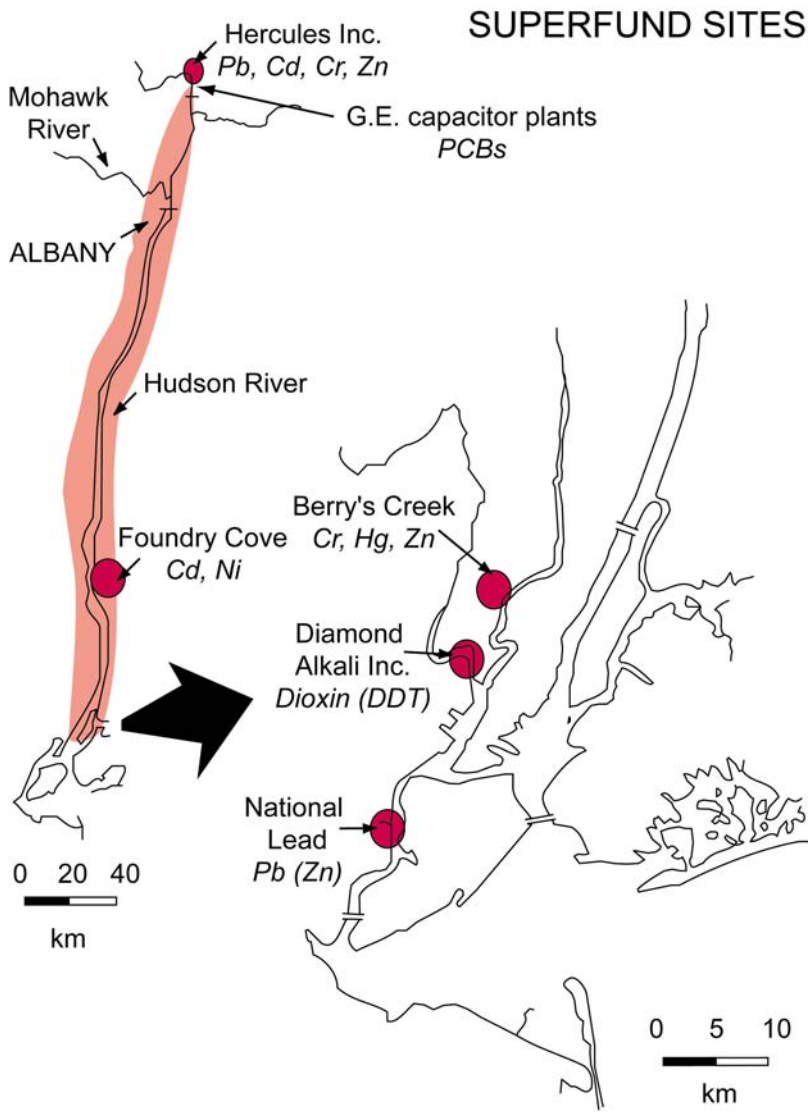
Dr. Richard Bopp
Rensselaer Polytechnic Institute
Mount Sinai Superfund Basic Research Program

SBRP Annual Meeting
January, 2006

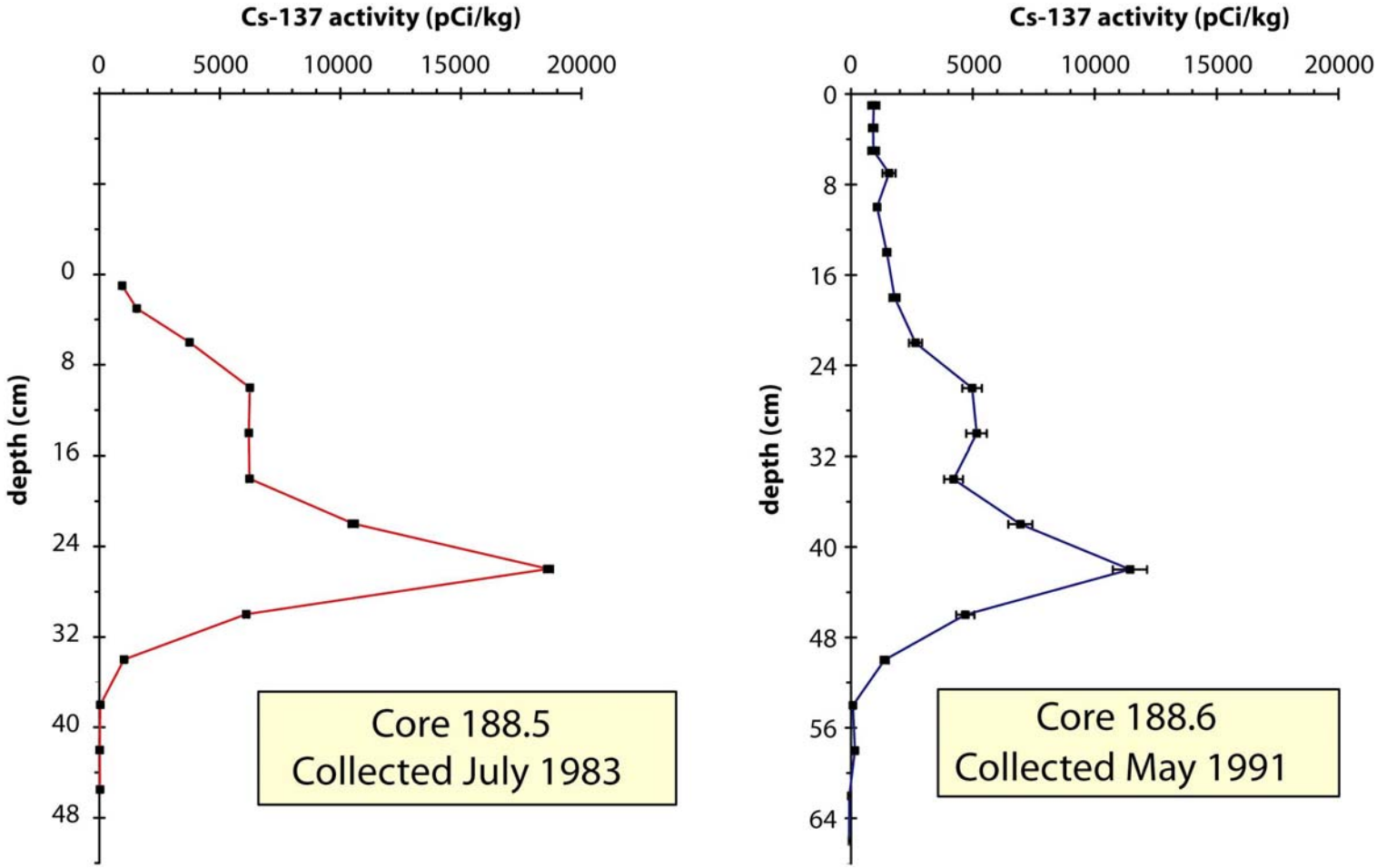
Acknowledgements

- **NIEHS (SBRP)**
- Hudson River Foundation
- NYSDEC
- NJDEP
- USEPA
- Collaborators – Steve Chillrud, Damon Chaky, Ted Shuster, Luci Benedict, Jennifer Tatten, Kelly Robinson, Anne McNulty, Erika Zamek, Frank Estabrooks, Jim Swart, Bruce Garabedian, Ron Sloan, Rick Kulzer, Bruce Brownawell, Lee Ferguson, Curtis Olsen, Joe Smith, Art Goeller…….

Superfund Sites in the Hudson Basin



“Near ideal” dated sediment cores



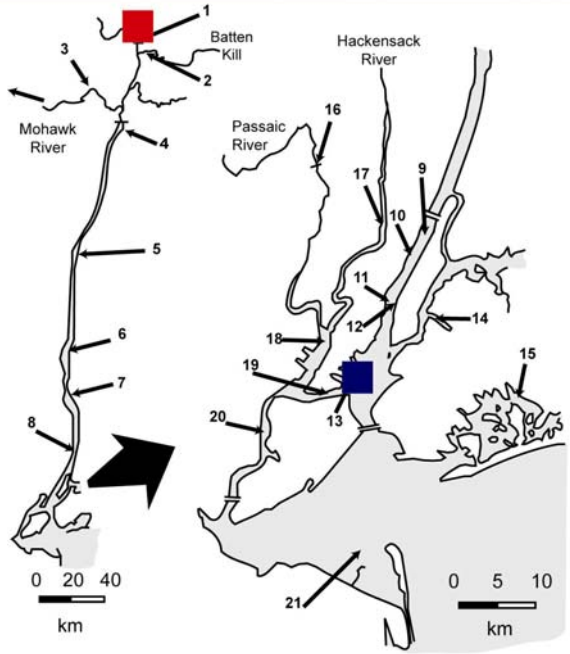
Sampling Site Information

Core Designation	Location/Significance	Use
SOURCE TRACERS		
Site 1 188.5 (1983) 188.6 (1991)	Downstream of the largest single discharger of pulp and paper waste in the Hudson basin	- PCB Chronology - Metals Chronology - Paired-Core PCB degradation studies - Dioxin time horizon samples - Characterization of of Pulp & Paper APEOs - Paired-Core APEO transformation studies
Site 2 Batt 5 (1993)	Downstream of Pulp & Paper Discharges on the Batten Kill	- Metals Chronology - Dioxin time horizon samples - Characterization of of Pulp & Paper APEOs
Site 3 Moh 7 (1993)	Downstream of Leather Tannery on the Mohawk R. (Gloversville)	- PCB time horizon samples - Metals Chronology - Dioxin time horizon samples - Cr tracer of tannery waste - Characterization of of Tannery APEOs
Site 14 Be-7 Bearing Coretops (1982, 87, 90, 92, 96, 98)	Discharge of Major Sewage Treatment Plant (Newtown Creek)	- PCB time horizon samples - Dioxin time horizon samples - DDT and chlordane time horizon samples - Characterization of Sewage-Derived APEOs
Site 15 JB 13 (1988) JB 16 (1996)	Discharge of Major Sewage Treatment Plants to Jamaica Bay	- PCB, DDT, chlordane, and metals chronologies - Dioxin time horizon samples - Characterization of Sewage-Derived APEOs - Paired-Core APEO transformation studies
Site 16 Pass 6	Downstream of Major Textile Manufacturing Center on the Passaic R. (Paterson, NJ)	- DDT and chlordane time horizon samples - Dioxin time horizon samples - Characterization of Textile APEOs
MAINSTEM HUDSON RIVER		
Site 4 152.7	Downstream of the Hudson/Mohawk Confluence	- Dioxin time horizon samples - Metals Chronology - Mixed Mohawk/Upper Hudson ' signal'
Site 5 91.8 (1977) 88.6 (1986) 88.6H (1996)	Mid-Hudson Estuary near Kingston	- PCB and DDT Chronology - Metals Chronology - Paired-Core PCB degradation studies - Dioxin time horizon samples - geographic and temporal distribution of APEO - Paired-Core APEO transformation studies
Site 6 59.55 (1992)	Lower Hudson Estuary, near Newburgh	- PCB Chronology - geographic and temporal distribution of APEO
Site 7 43.2 (1997) 43.3 (1992)	Lower Hudson Estuary, near Indian Point	- PCB Chronology - geographic and temporal distribution of APEO
Site 8 Hast 1 (1999)	Lower Hudson Estuary, near Hastings	- Currently being analyzed for PCBs in collaboration with NYSDEC (through CARP) - Mainstem Hudson Inputs to NY Harbor
Sites 9-12 Be-7 Bearing Coretops (1984, 89, 94, 96, 98)	NY Harbor, mainstem Hudson	- PCB time horizon samples - DDT and chlordane time horizon samples - Metals time horizon samples - geographic and temporal distribution of APEO
Site 13 -1.7W (1979) -1.68 (1984) Be-7 Bearing Coretops (1989, 94, 96, 98)	NY Harbor, mainstem Hudson	- PCB Chronology - DDT and chlordane chronologies - Metals chronologies - geographic and temporal distribution of APEO
WESTERN NY HARBOR/RARITAN BAY		
Site 17 Hack 14 (1987) Hack 14B (1995)	Hackensack River	- Metals Chronology - geographic and temporal distribution of APEO - Paired-Core APEO transformation studies
Site 18 NB 13 (1985) NB 20 (1986) NB 13B (1995)	Newark Bay	- Dioxin and DDT Chronology - PCB and chlordane time horizon samples - geographic and temporal distribution of APEO
Site 19 Be-7 Bearing Coretops (1985, 96, 98)	Kill Van Kull	- PCB, dioxin, DDT and chlordane time horizon samples - geographic and temporal distribution of APEO
Site 20 Kill 14 (1982) Kill 21 (1996)	Arthur Kill	- Metals Chronology - geographic and temporal distribution of APEO
Site 21 RB 17 (1981) RB 19 (1989)	Raritan Bay	- PCB and DDT chronology (unpublished data) - Dioxin time horizon samples (unpublished data) - geographic and temporal distribution of APEO

Site 1
188.5 (1983)
188.6 (1991)

Downstream of the largest single discharger of pulp and paper waste in the Hudson basin

- PCB Chronology
- Metals Chronology
- Paired-Core PCB degradation studies
- Dioxin time horizon samples
- Characterization of of Pulp & Paper APEOs
- Paired-Core APEO transformation studies

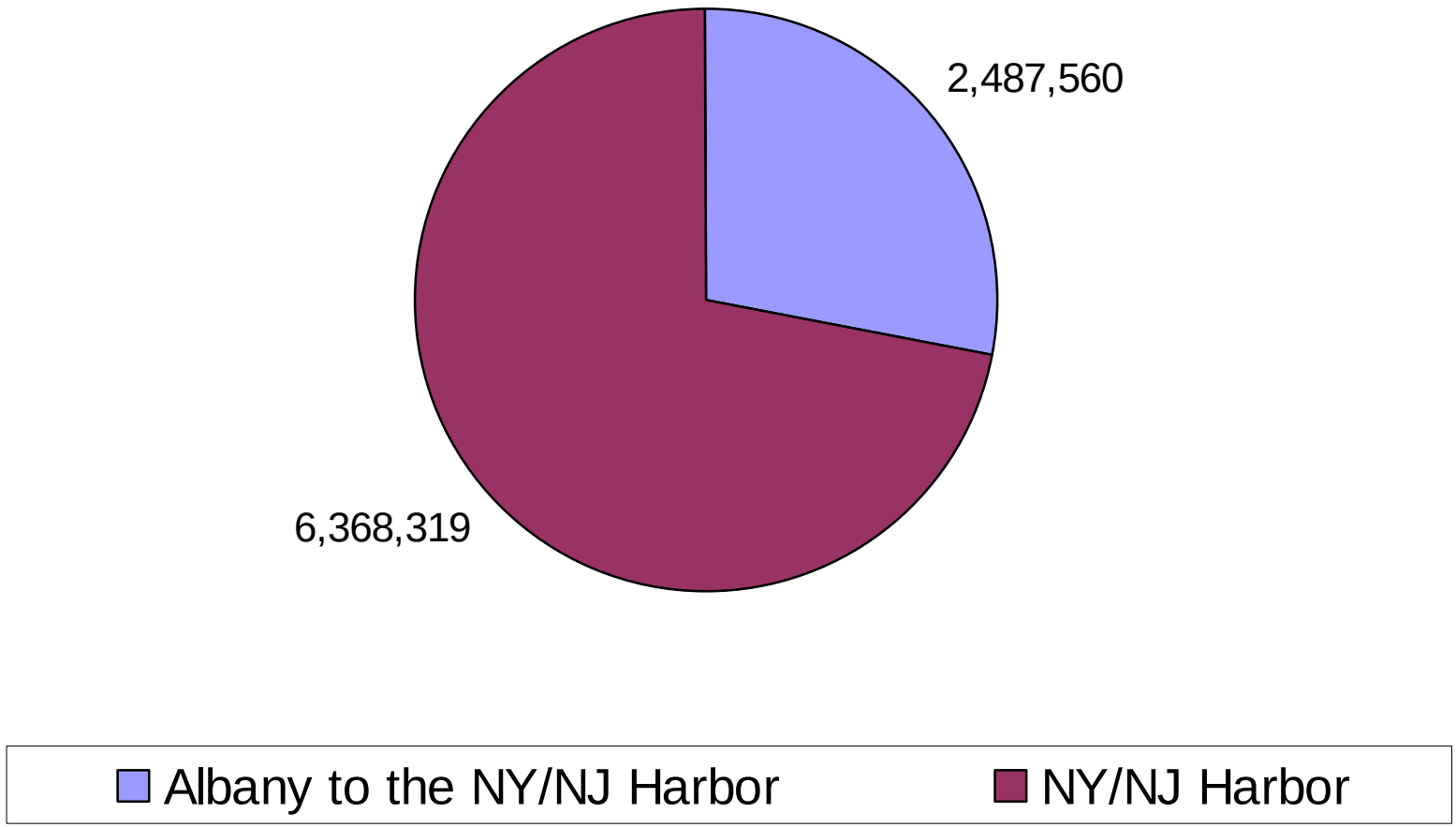


Site 13
-1.7W (1979)
-1.68 (1984)
Be-7 Bearing Coretops
(1989, 94, 96, 98)

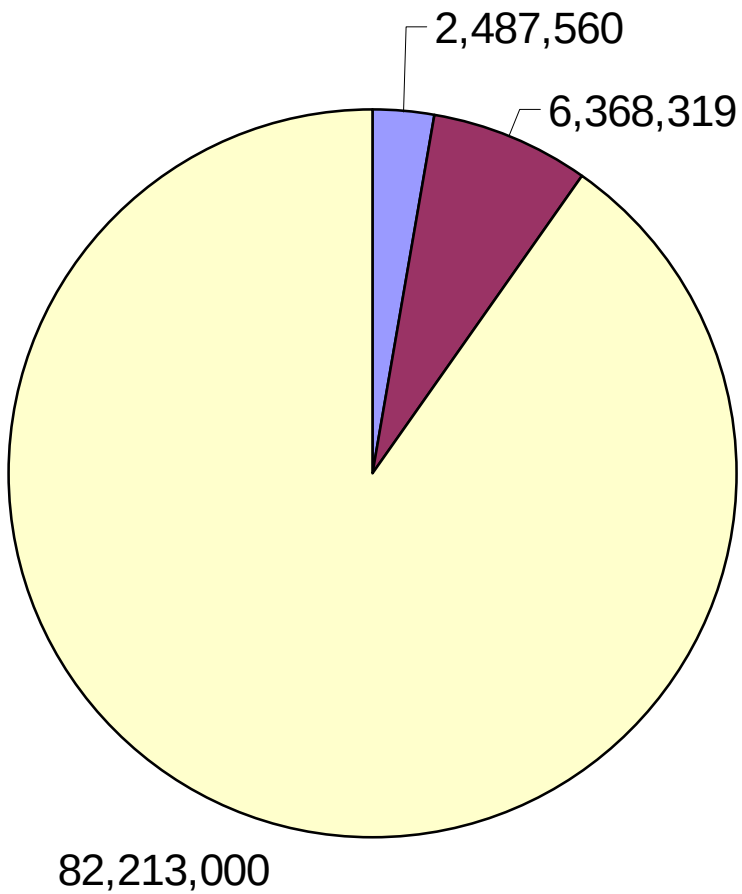
NY Harbor, mainstem Hudson

- PCB Chronology
- DDT and chlordane chronologies
- Metals chronologies
- geographic and temporal distribution of APEO

PCB Purchases (pounds) Main Stem Tidal Hudson 1958-1977

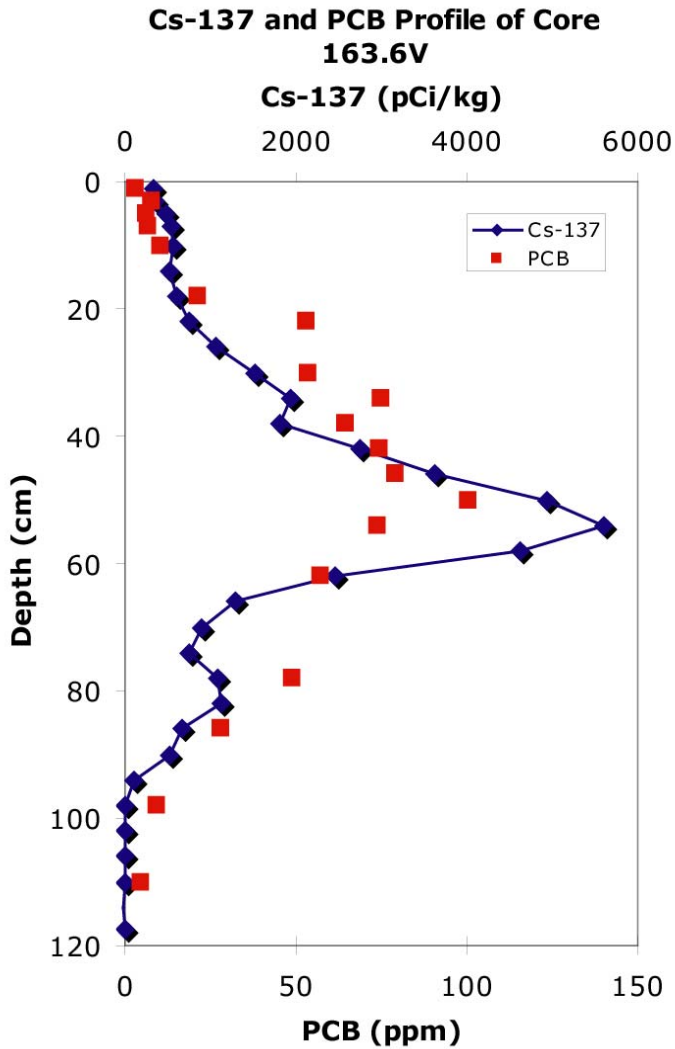


Adding in GE.....


2,487,560
6,368,319
82,213,000
Albany to the NY/NJ Harbor
NY/NJ Harbor
GE, Upper Hudson 1966-75

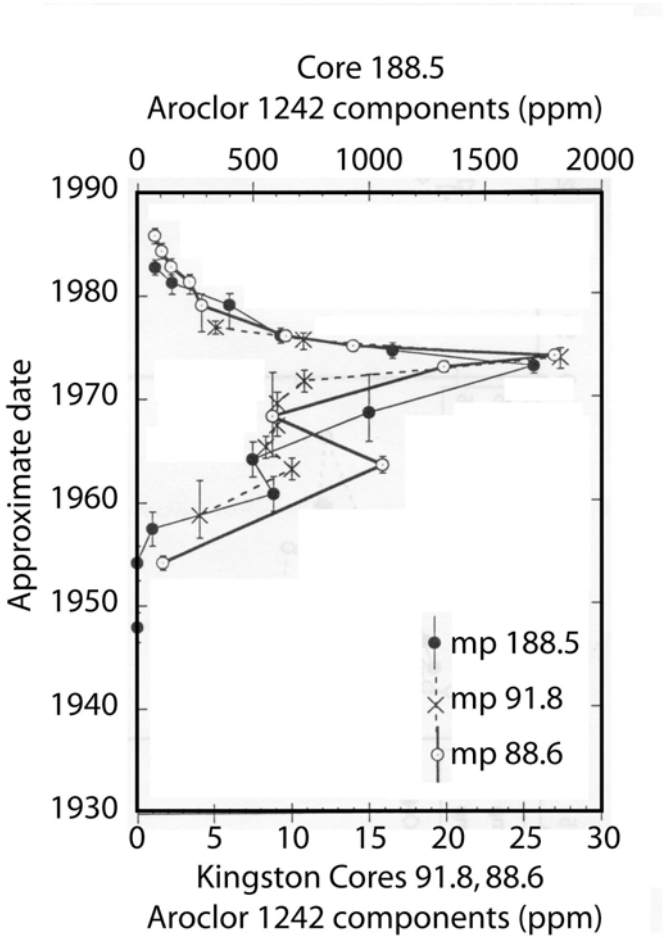
“Average” PCB levels in “recent, fine-grained” Hudson Sediments

> mp 200 and all tributaries*	<1 ppm
mp 180 to 193	a few hundred ppm
mp 157 to 166	several tens of ppm
mp 140 to 150	a few tens of ppm
mp 80 to 110	about 10 ppm
mp 40 to 60	about 5 ppm
mp 10 to -2	about 2 ppm

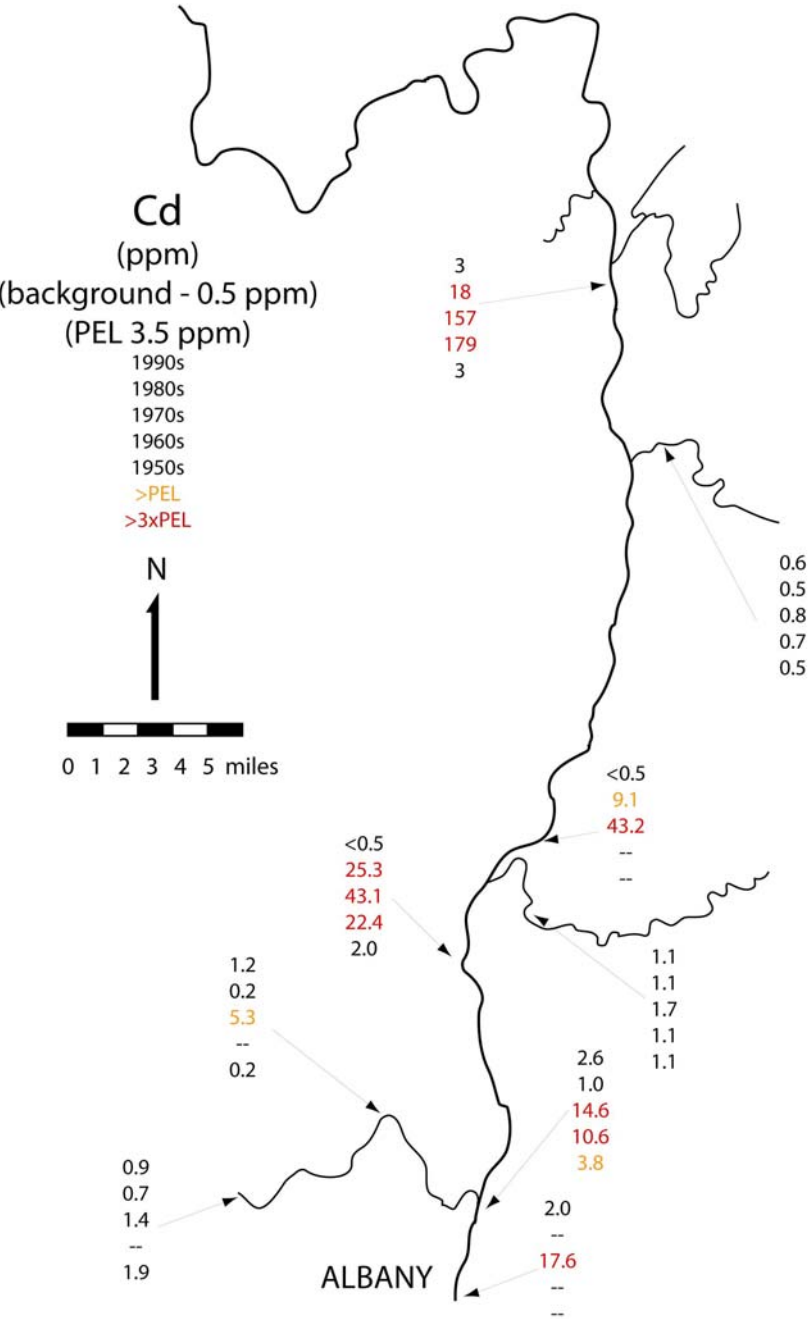


Cs-137 and PCB profile of a core from mile point 163.6.

Tracing the Upper Hudson PCB influence



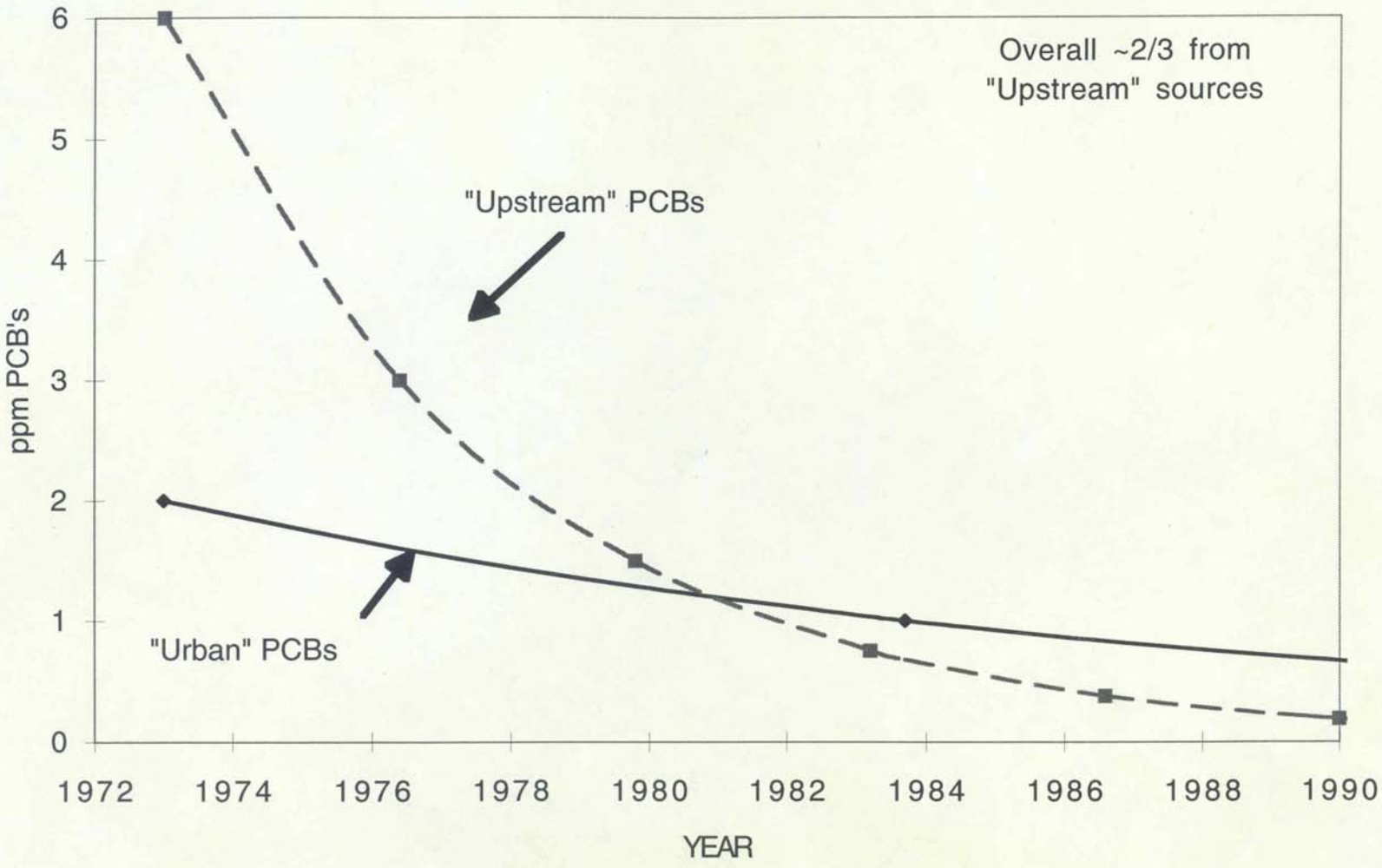
- Upper Hudson has dominated downstream historical PCB loadings

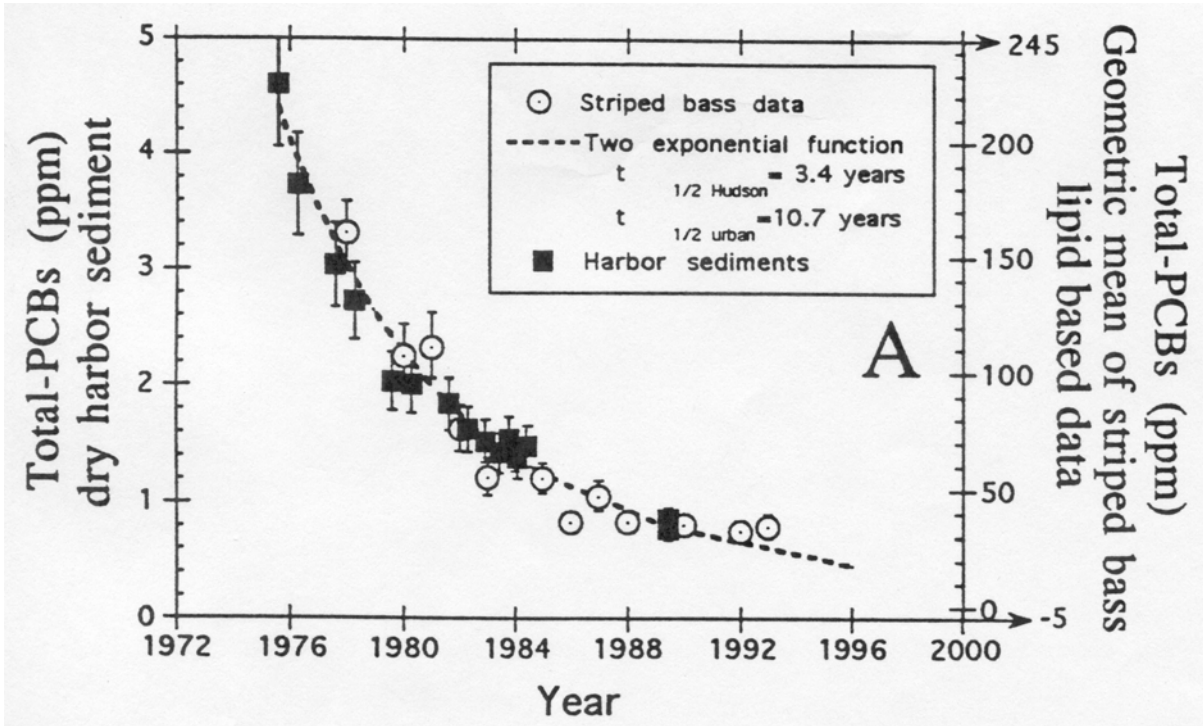


Other Particle Tracers - Metals

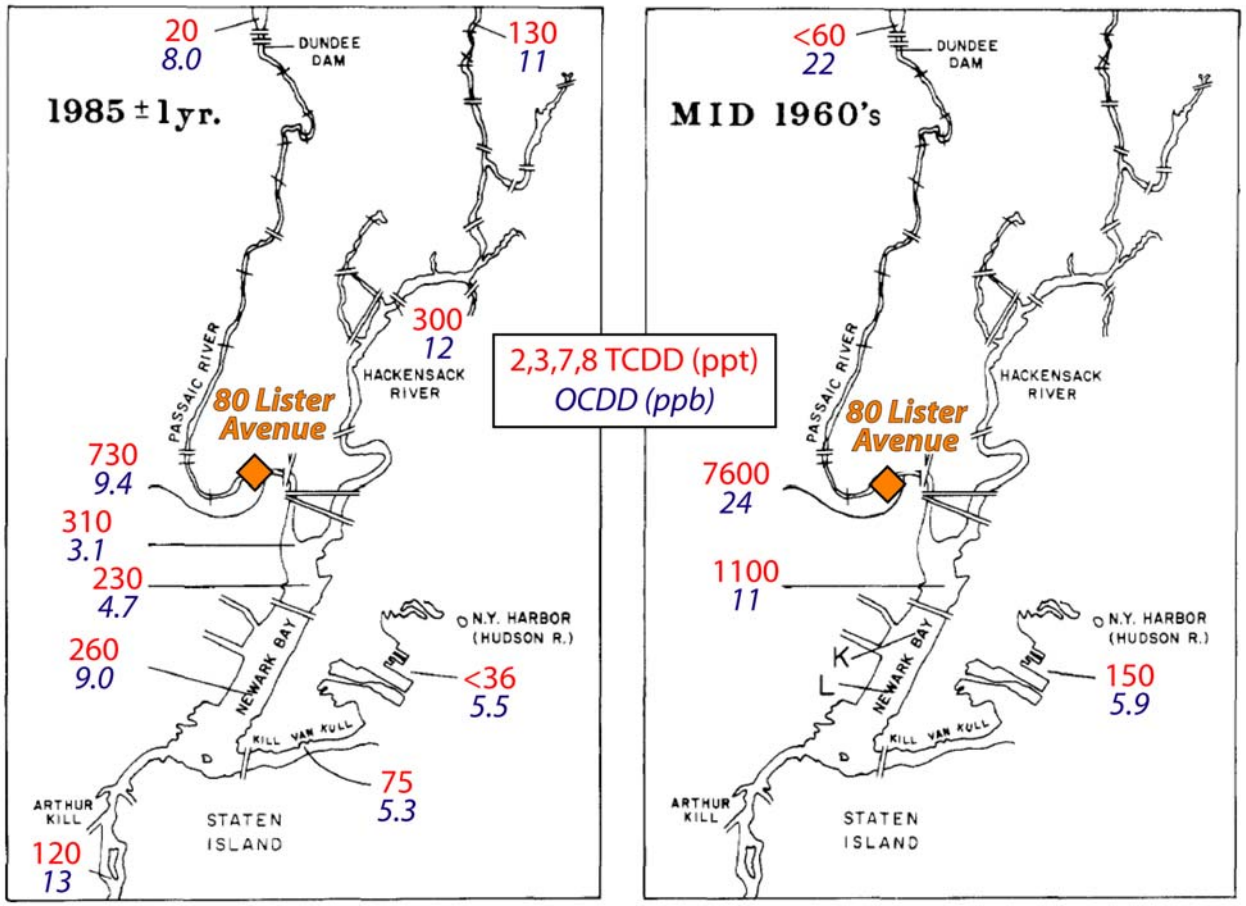
- Upper Hudson sources dominate Cd to Kingston (mp 90)
- Other metals:
  - Pb (& stable isotopes)
  - Cr
  - Hg
  - Zn

PCB SOURCES TO MAINSTEM NY HARBOR SEDIMENTS



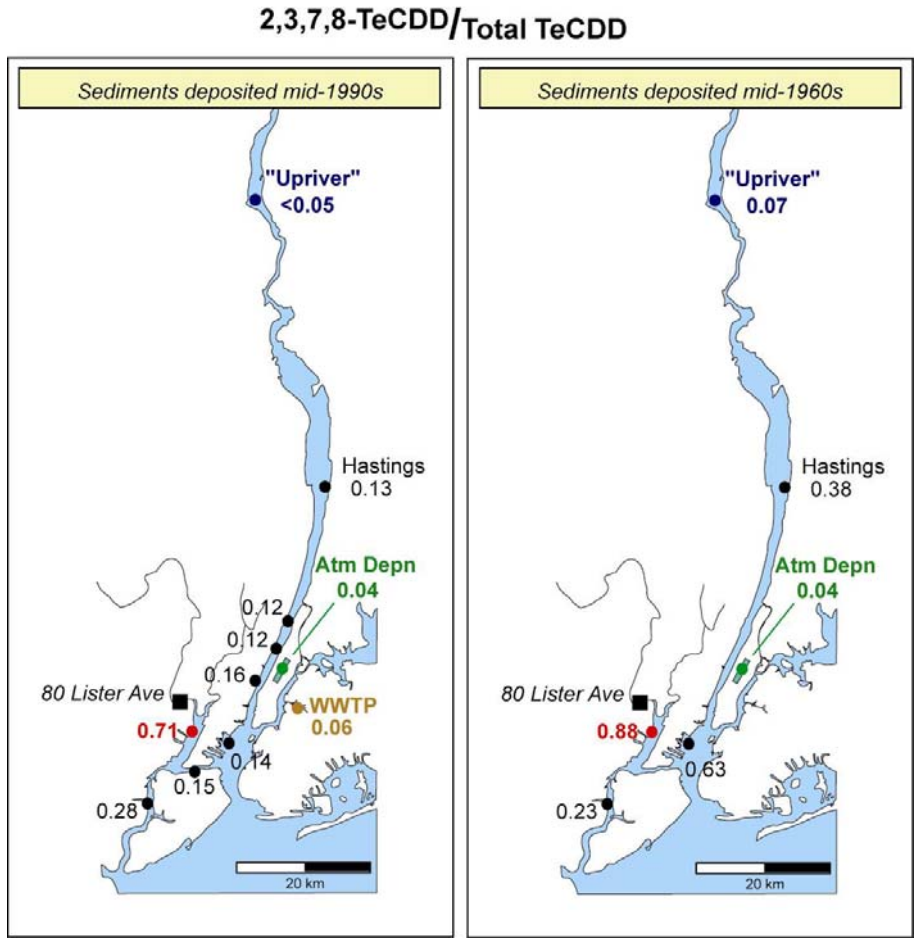

Total-PCBs (ppm)
dry harbor sediment
Total-PCBs (ppm)
Geometric mean of striped bass
lipid based data
Year
Striped bass data
Two exponential function
t 1/2 Hudson = 3.4 years
t 1/2 urban =10.7 years
Harbor sediments
A
0
1
2
3
4
5
-5
50
100
150
200
245
1972
1976
1980
1984
1988
1992
1996
2000

The “other” Superfund site – dioxins from 80 Lister Avenue

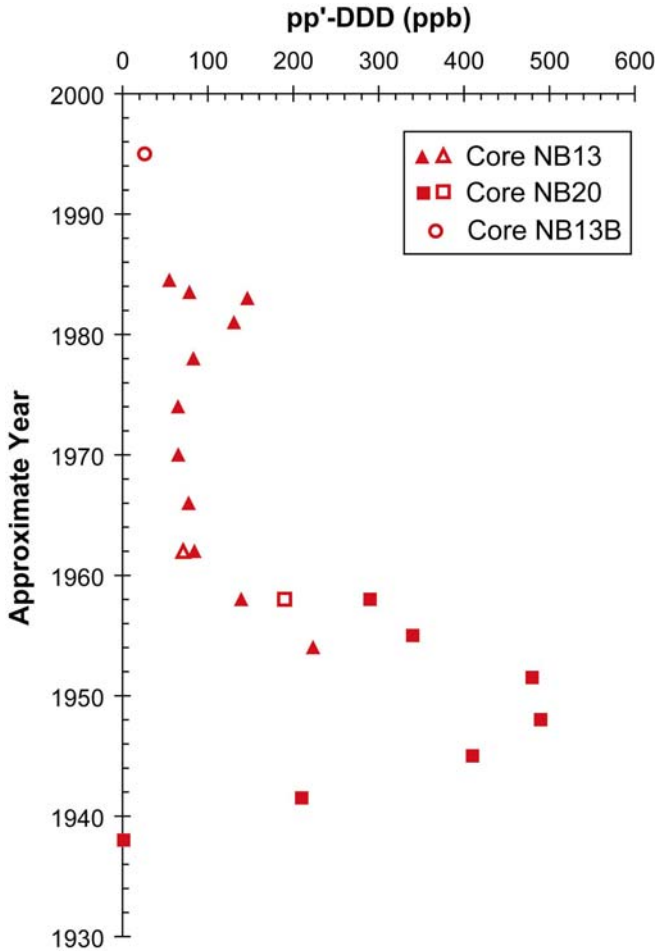


Bopp, *et al.* (1991) *Environ. Sci. Tech.* 25(5):951-956

Tracing Harbor Sources Upstream: 2,3,7,8-TCDD Ratio

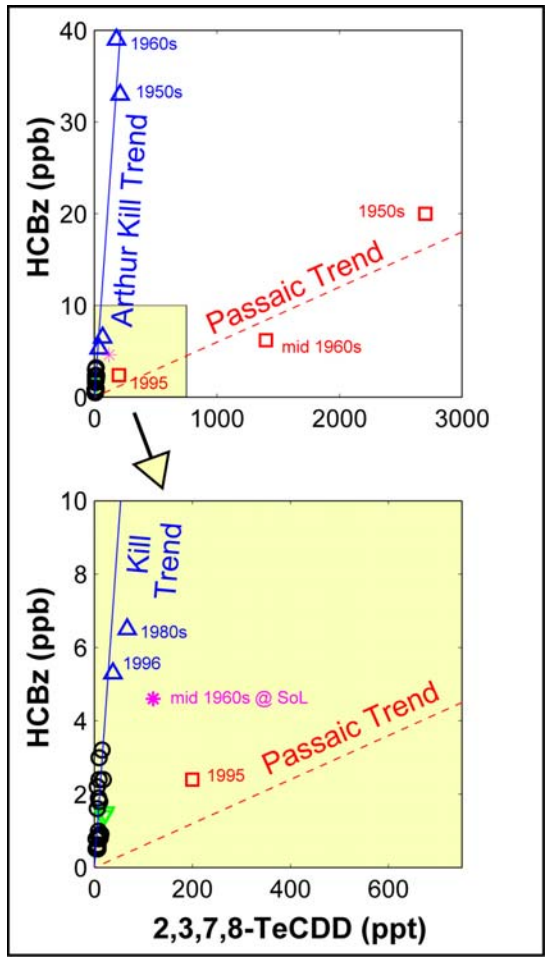


Same Source; Another Contaminant - DDT

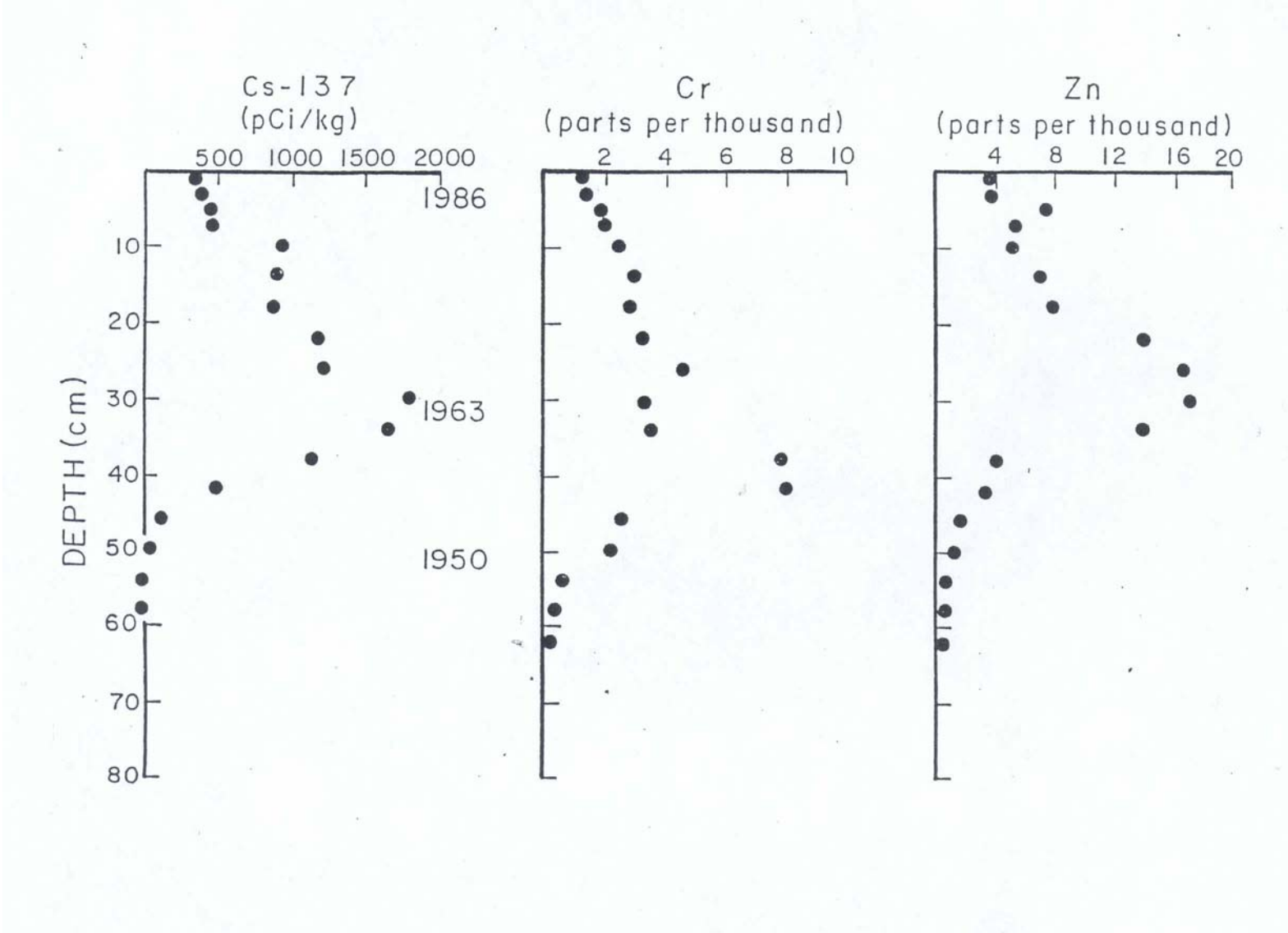


Hexachlorobenzene?

- Although produced at 80 Lister Avenue, a source near the Arthur Kill apparently dominates HCB loadings to the Harbor

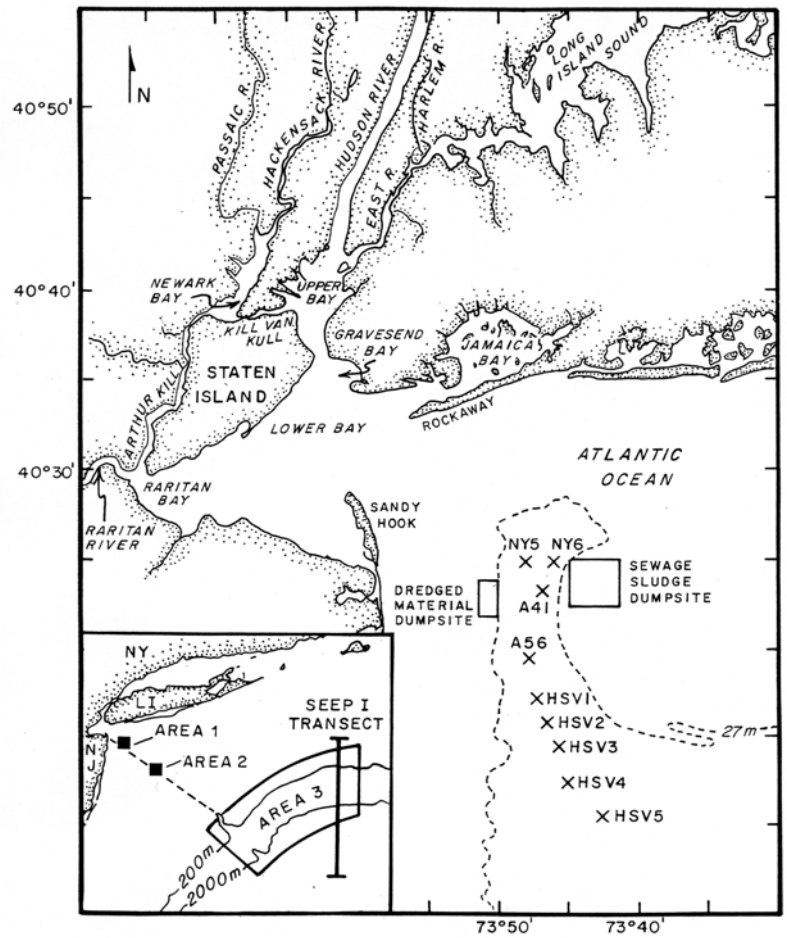


Other Sources; Other Contaminants



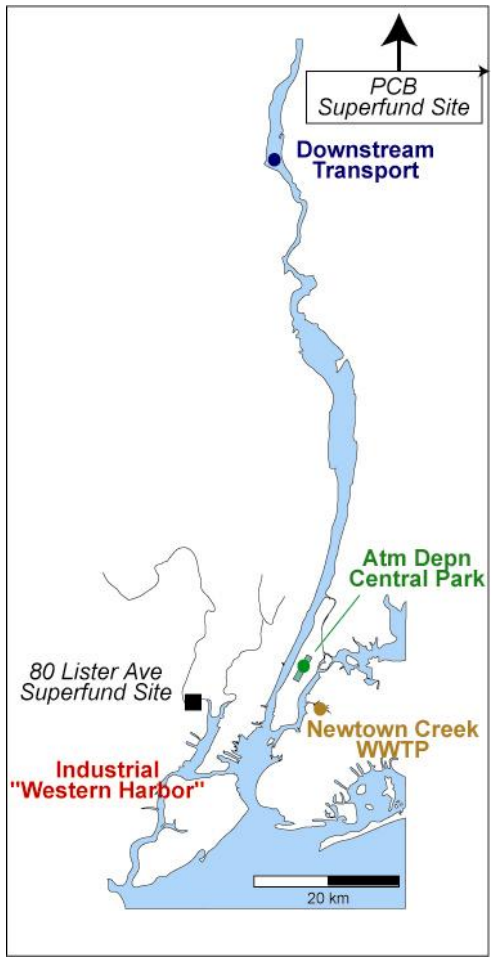
Other “distribution” of Western Harbor Contaminants

- Dredge spoil (upland)
- Offshore disposal



Other contaminant sources

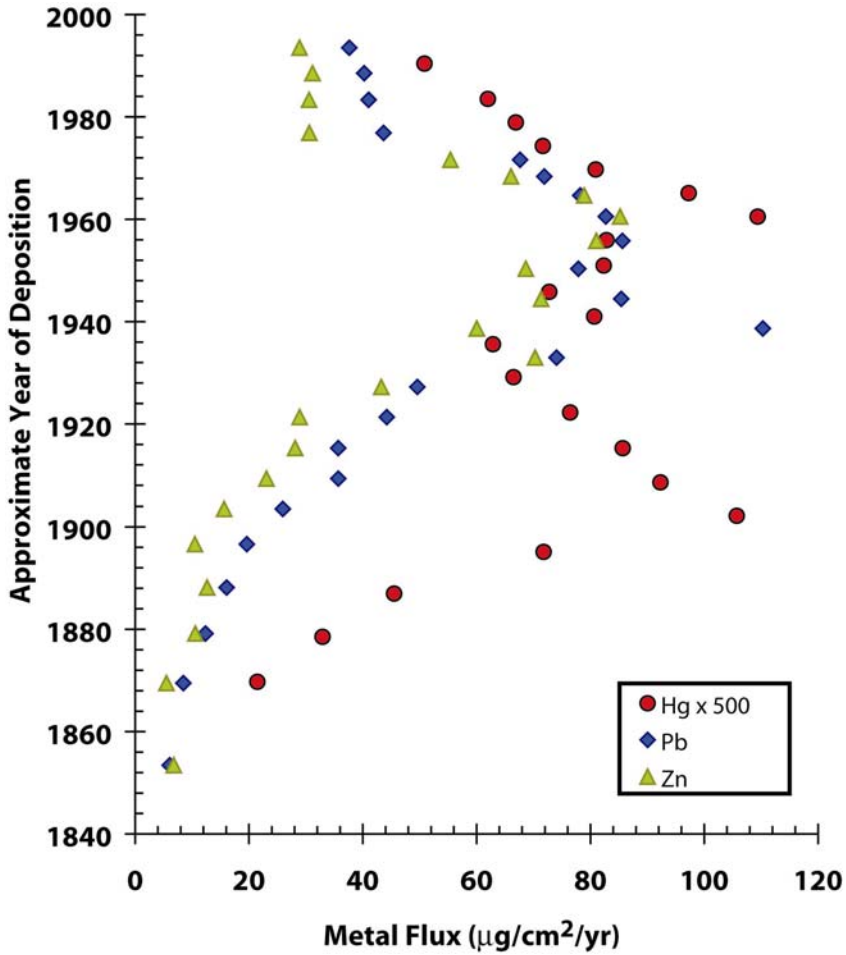
- Newtown Creek, Jamaica Bay WWTP
  - Sediment monitoring near discharge points
- Atmospheric deposition
  - Sediment cores from Central Park Lake, Prospect Park
- Local road runoff
  - Van Cortlandt Park



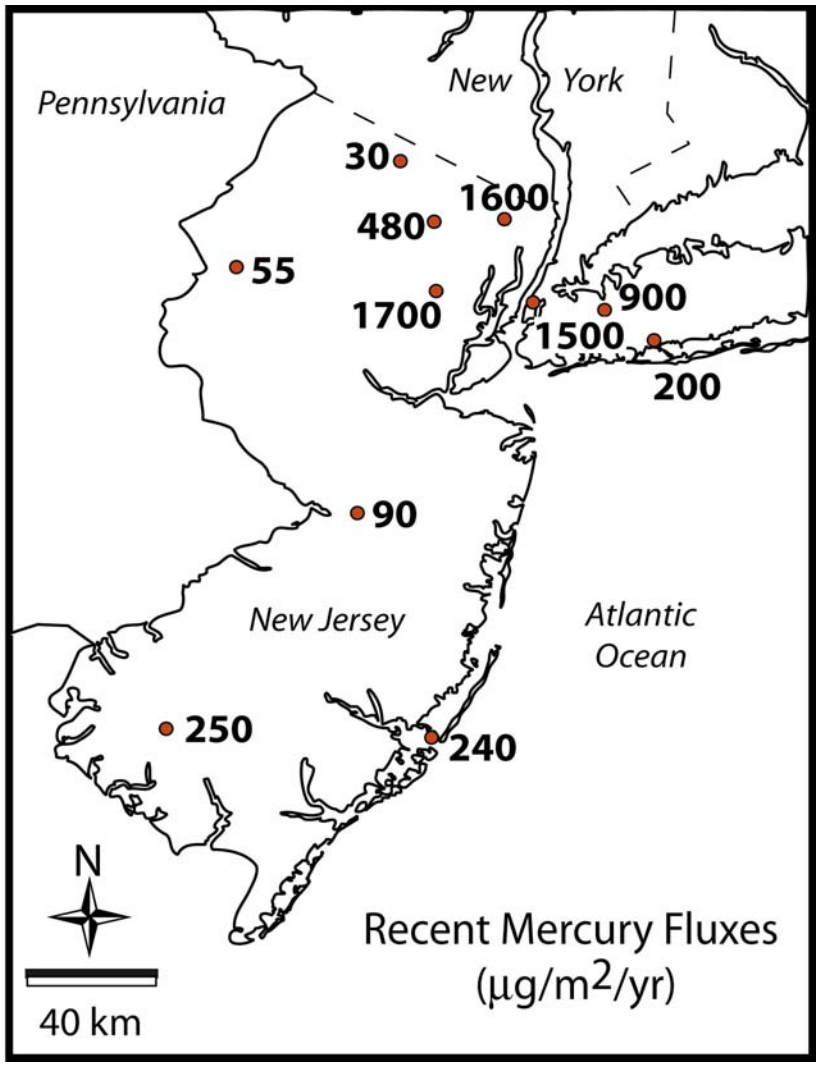
“Re-emerging” and Emerging Contaminants

- Mercury
- APEOs
- PBDEs

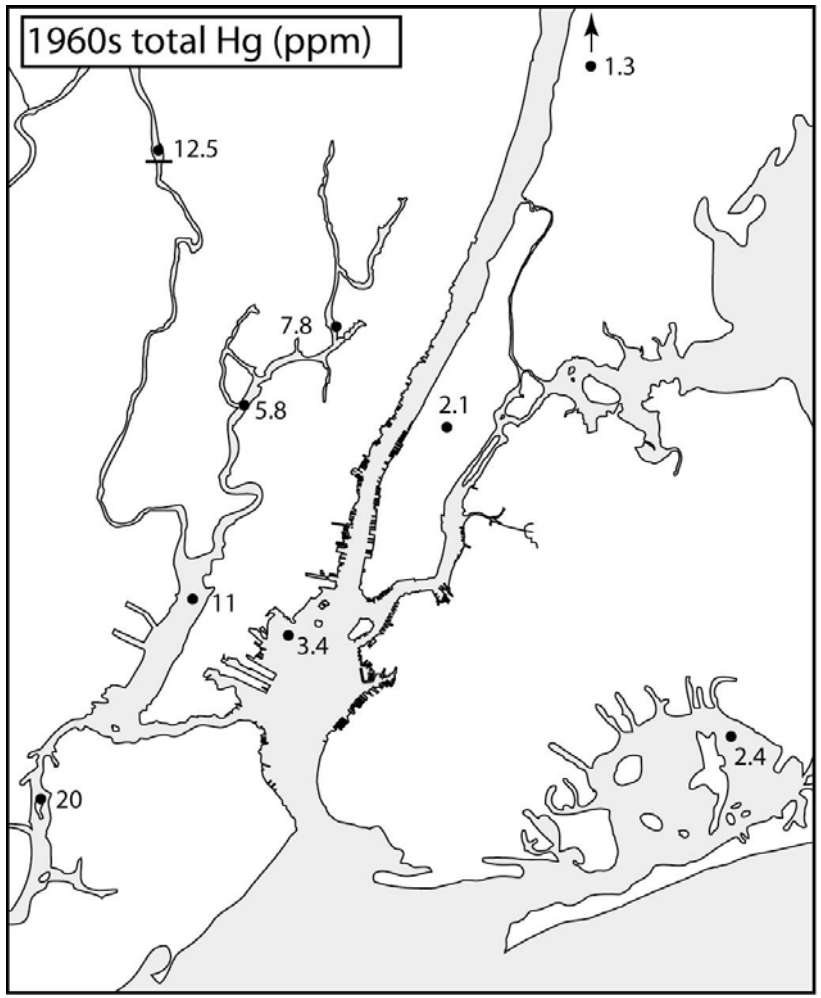
Mercury deposition in Central Park Lake

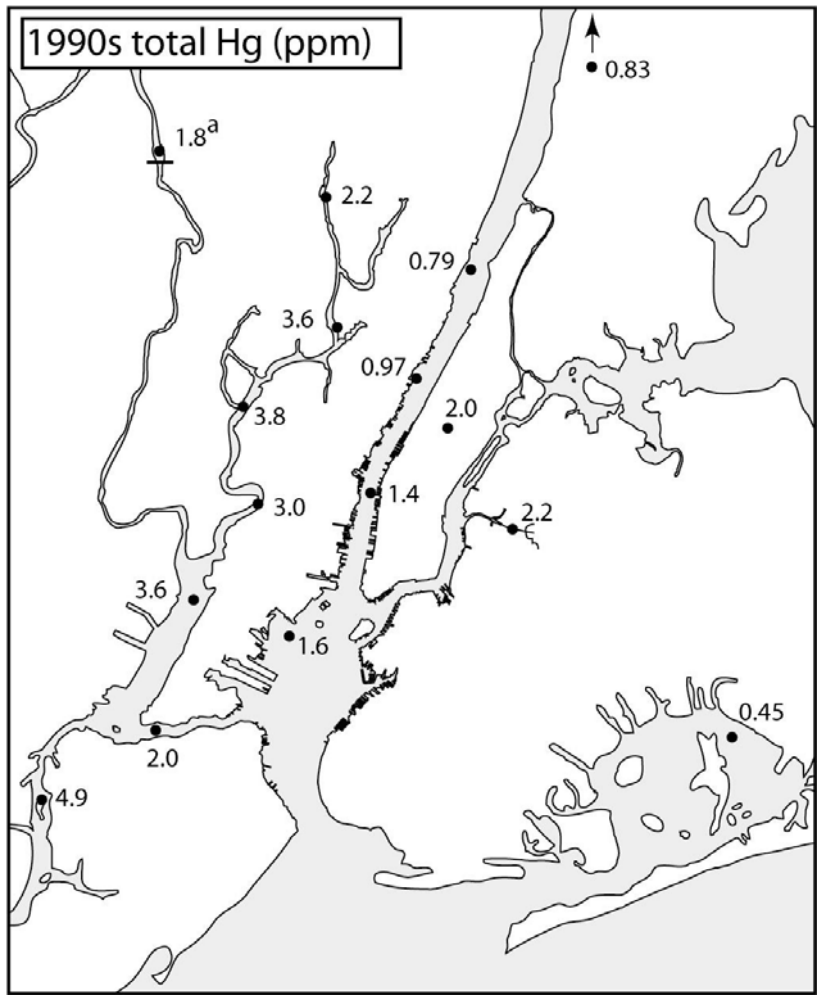


Regional Atmospheric Hg Flux

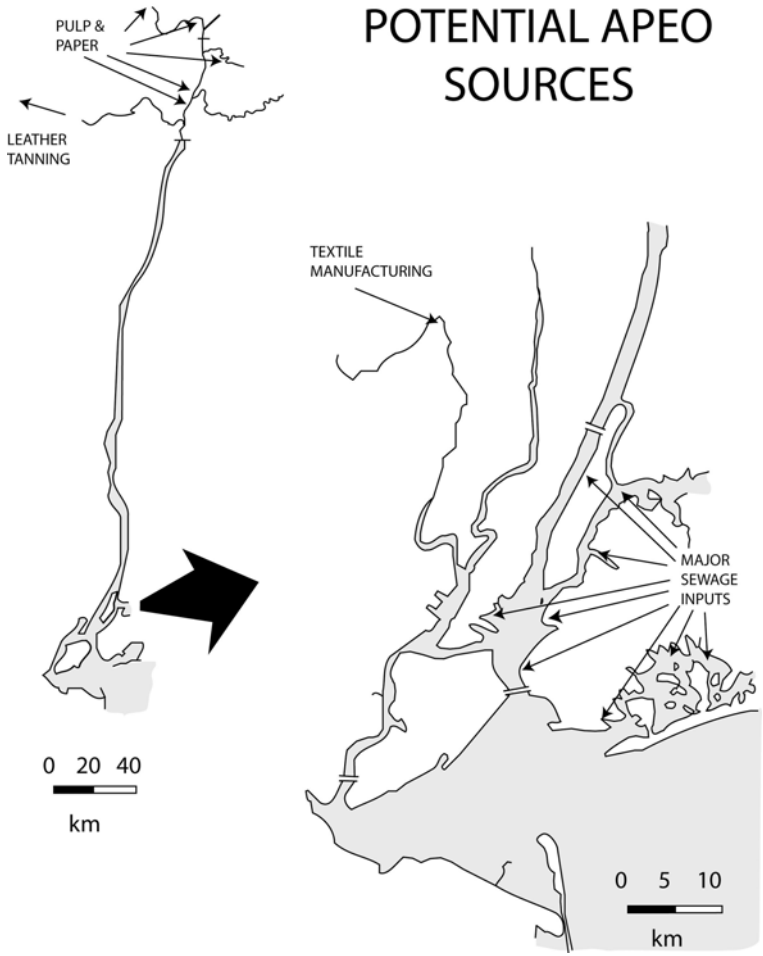


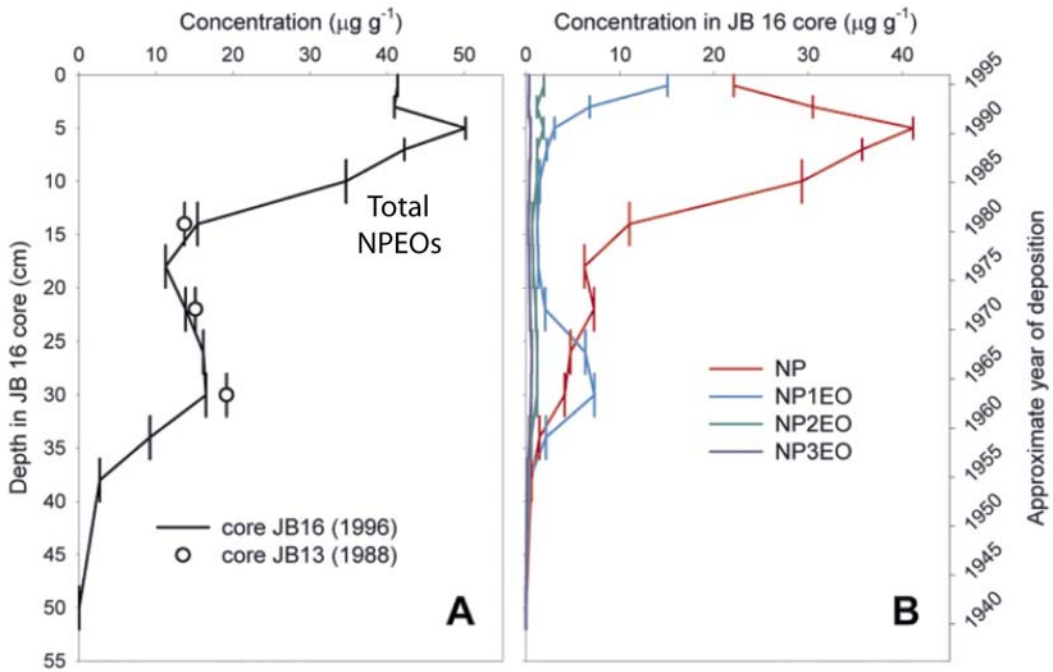
Hg flux to Harbor Sediments



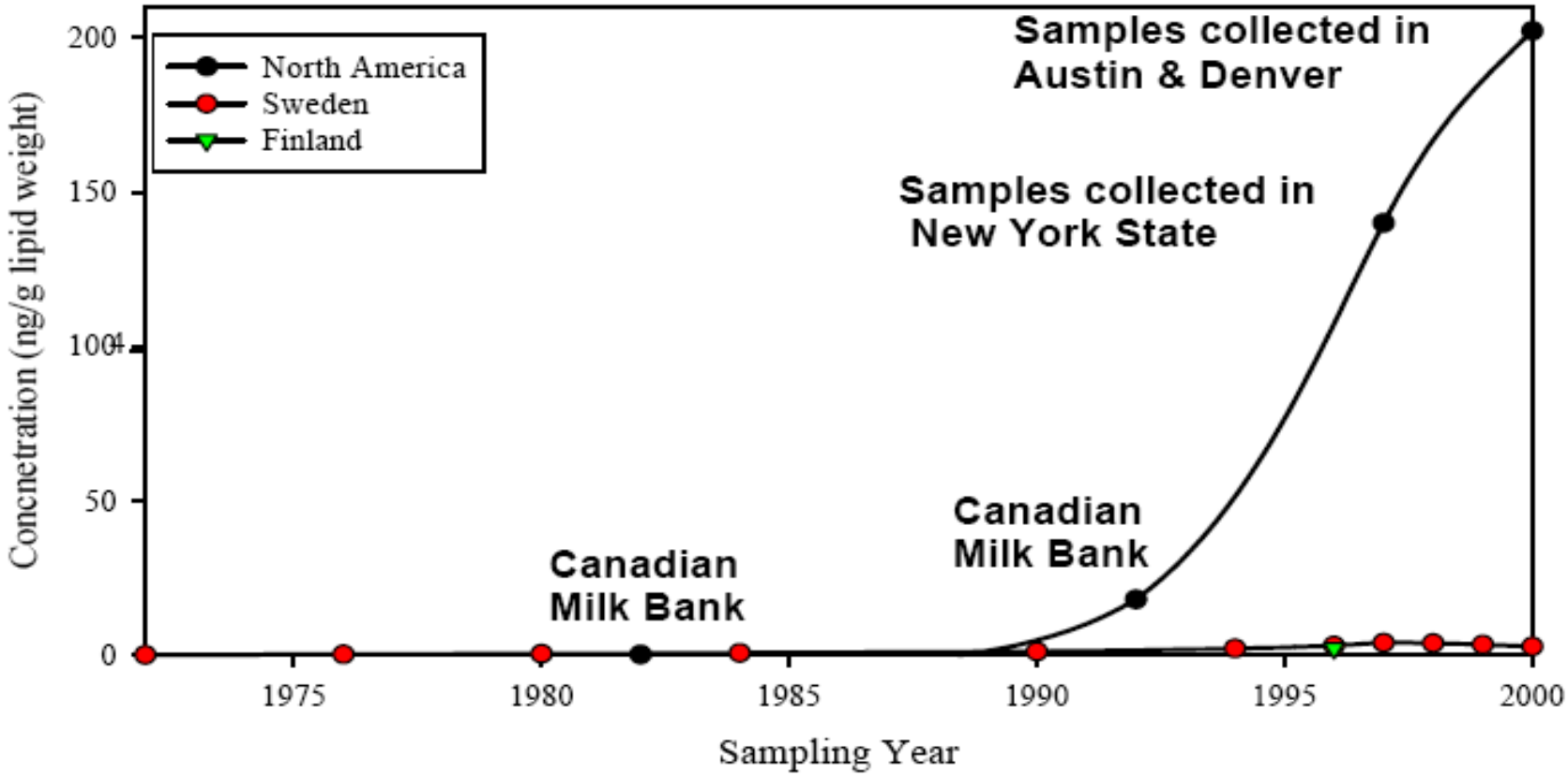


APEOs


POTENTIAL APEO SOURCES
PULP & PAPER
LEATHER TANNING
0 20 40
km
TEXTILE MANUFACTURING
MAJOR SEWAGE INPUTS
0 5 10
km

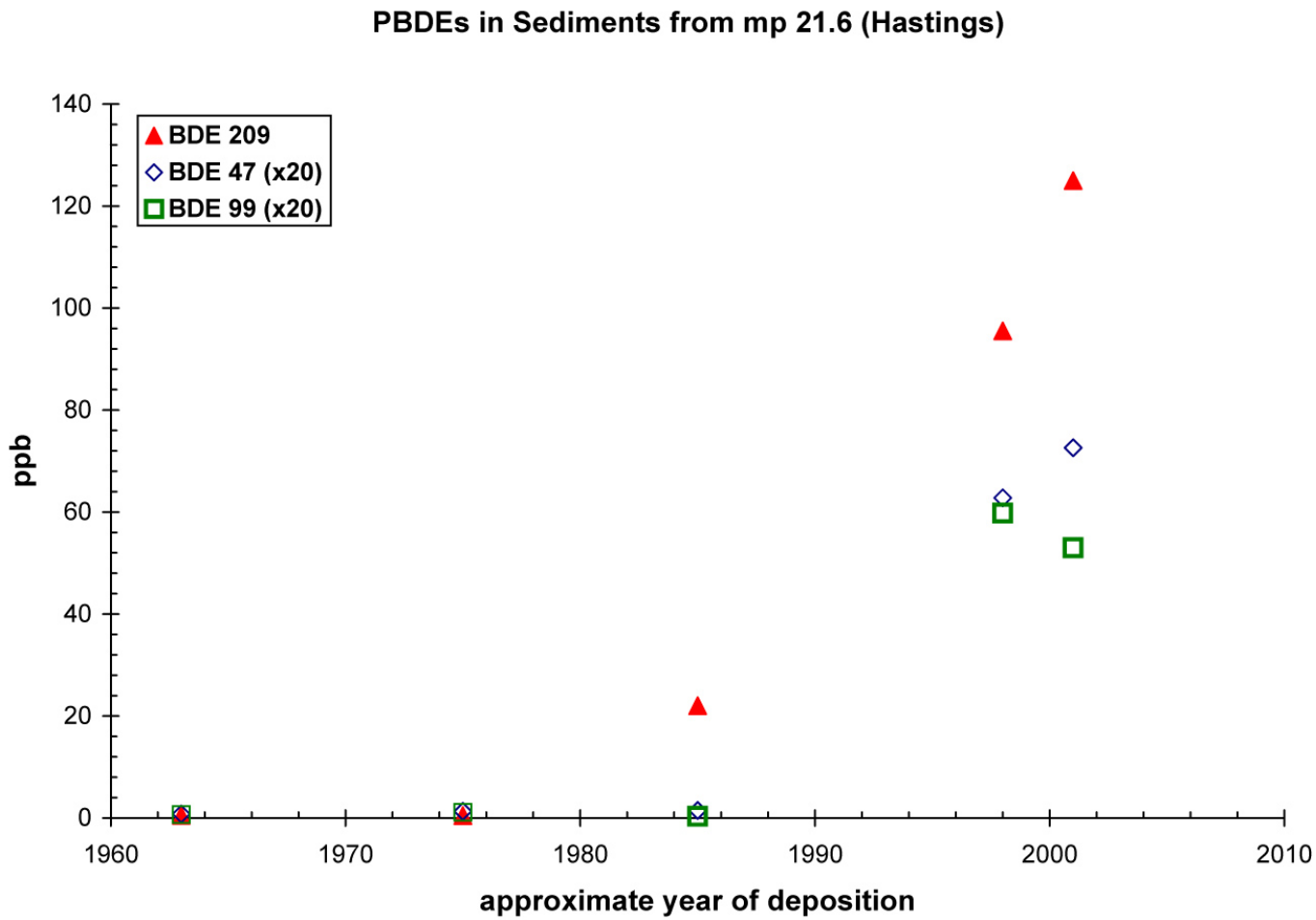

Concentration (μg g-1)
Concentration in JB 16 core (μg g-1)
Depth in JB 16 core (cm)
Approximate year of deposition
Total NPEOs
core JB16 (1996)
core JB13 (1988)
A
NP
NP1EO
NP2EO
NP3EO
B

Comparison Between Concentrations of PBDEs in Breast Milk from North America and Europe

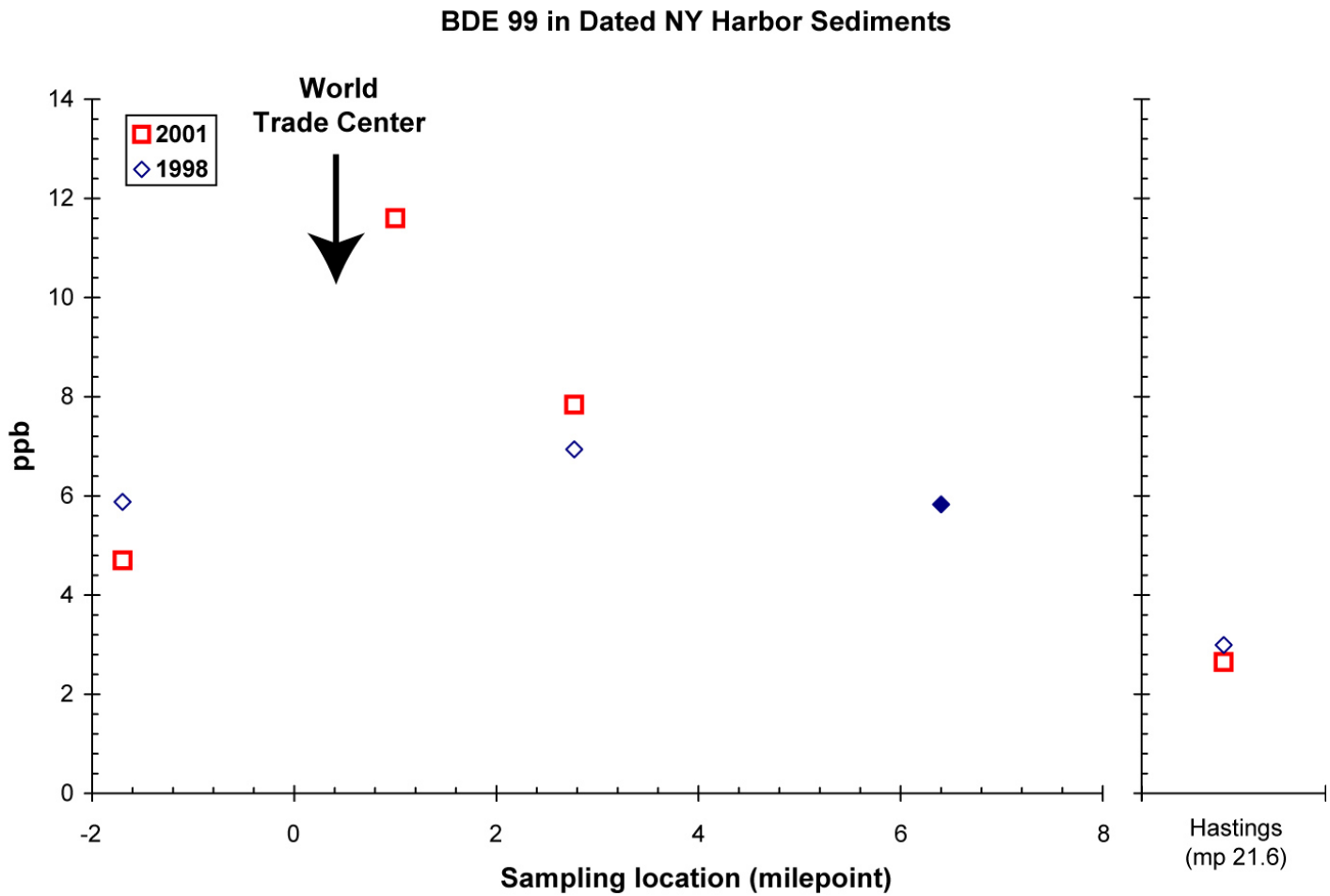


Betts, K.S., 2001. Rapidly rising PBDE levels in North America. *Environmental Science and Technology Online News, December 7, 2001.*

PBDEs in Hudson Sediments - Long term trends



The WTC influence




MIT
CREW