Boundary Condition Sensitivity Analysis

- A summary of the discussions on this topic will be presented by Dr. Namsoo Suk.

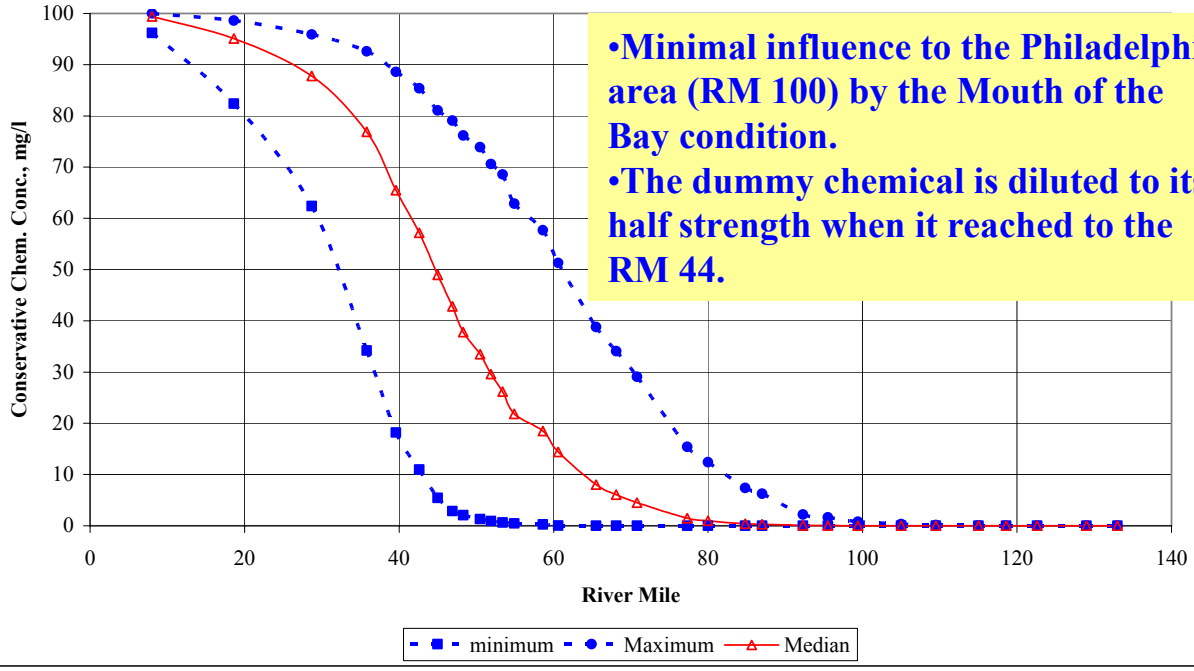
Relative Impact of the Four Boundaries: Delaware Trenton, Schuylkill, C&D, and the Mouth of the Bay

- Objectives: To understand the relative temporal and spatial impacts of the four major boundaries on water quality in the main channel.
- Simulation Period: 8/1/01 to 11/29/02 (486 days)
- Four Boundaries, mouth of the Bay, C&D Canal, Schuylkill River, and Delaware Trenton, were considered.
- No loadings were assigned other than 100 mg/l of conservative chemical at four boundaries at a time (4 simulations) plus all four boundaries (1 simulation)
- Considered water column only.
- Initial concentrations for the chemical were set to zero.
- Conservative simulation setup: no decay, no diffusion, no volatilization and no resuspension or settling

Figure 1

Spatial Plot: Relative Impact of Boundary Conditions

During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundary @ Mouth of the Bay

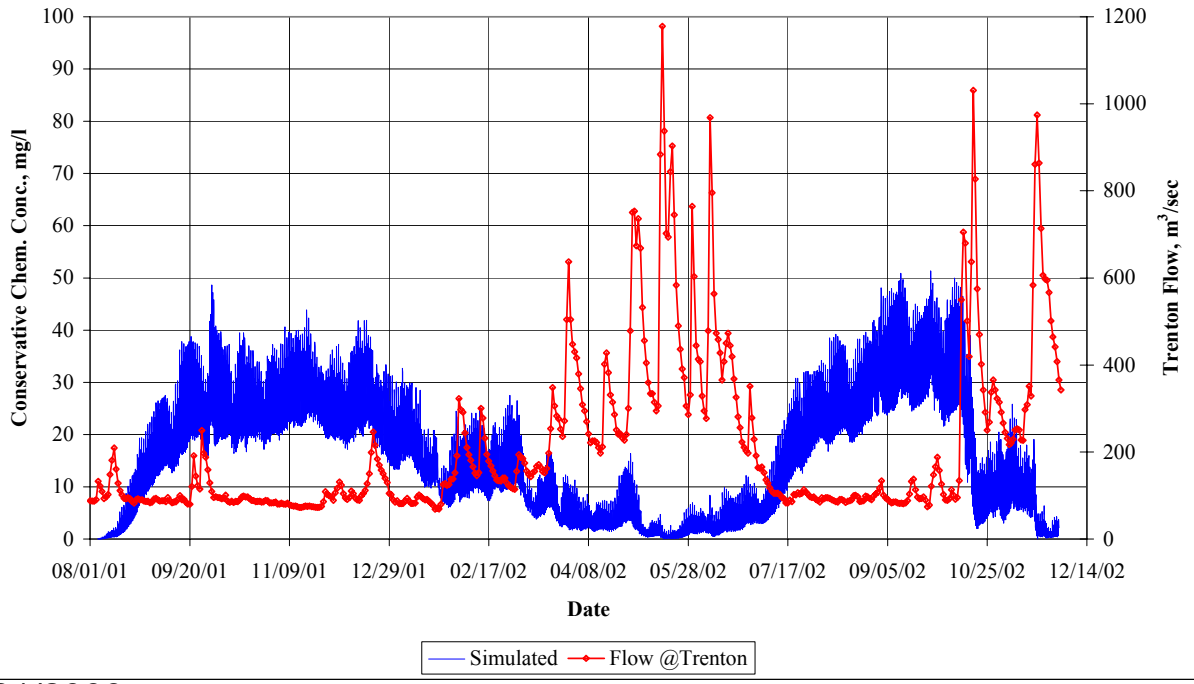


•Minimal influence to the Philadelphia area (RM 100) by the Mouth of the Bay condition.
•The dummy chemical is diluted to its half strength when it reached to the RM 44.

Figure 2A

Temporal Plot: Relative Impact of Boundary Conditions

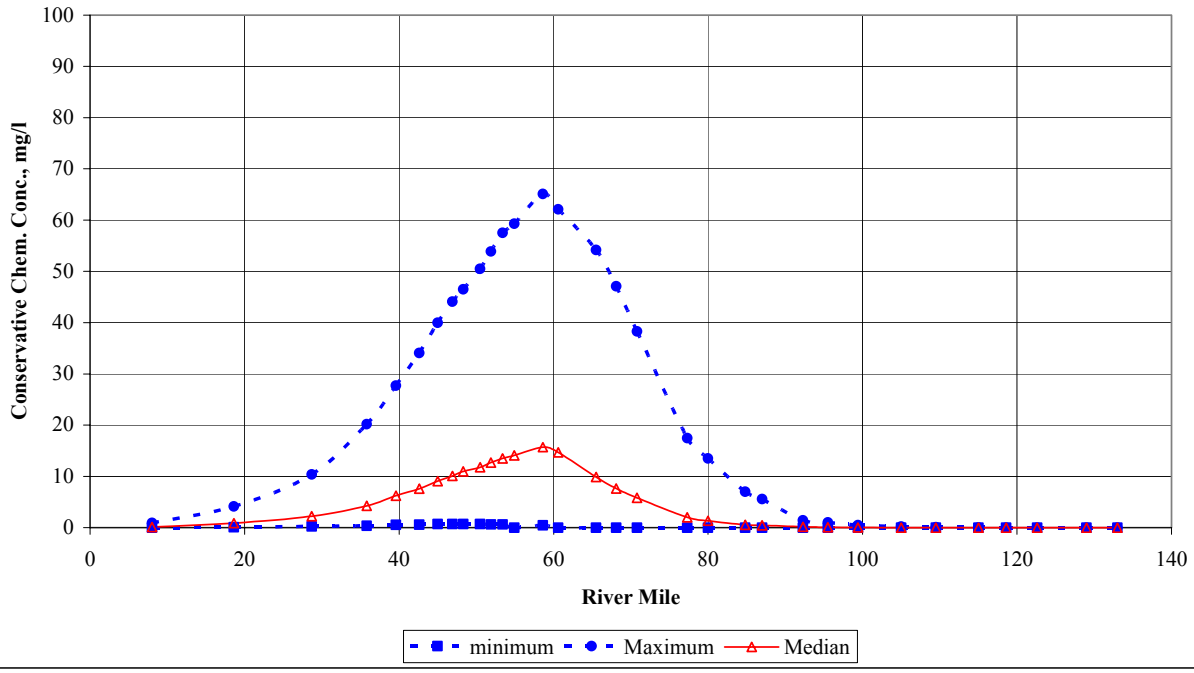
During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundary @ Mouth of the Bay @Node 20 (RM 60.6)



Spatial Plot: Relative Impact of Boundary Conditions

During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;

100 mg/l for Boundary @ C&D



Spatial Plot: Relative Impact of Boundary Conditions

During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;

100 mg/l for Boundary @ Schuylkill R.

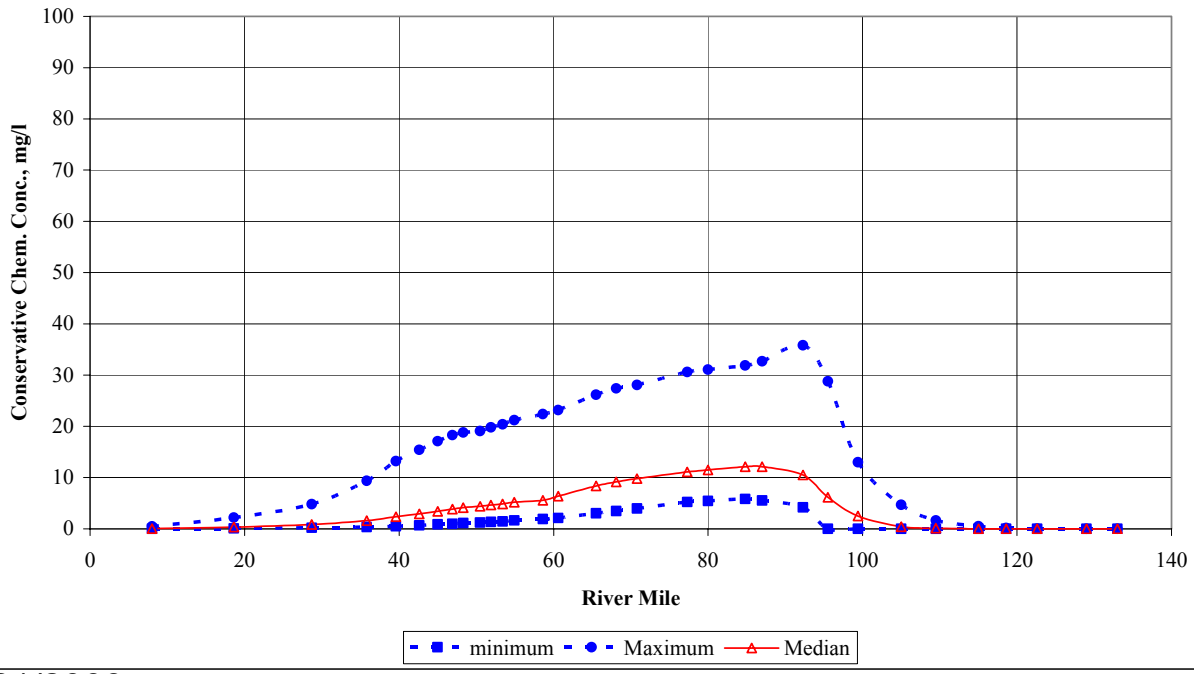


Figure 7

Spatial Plot: Relative Impact of Boundary Conditions

During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundary @ Trenton

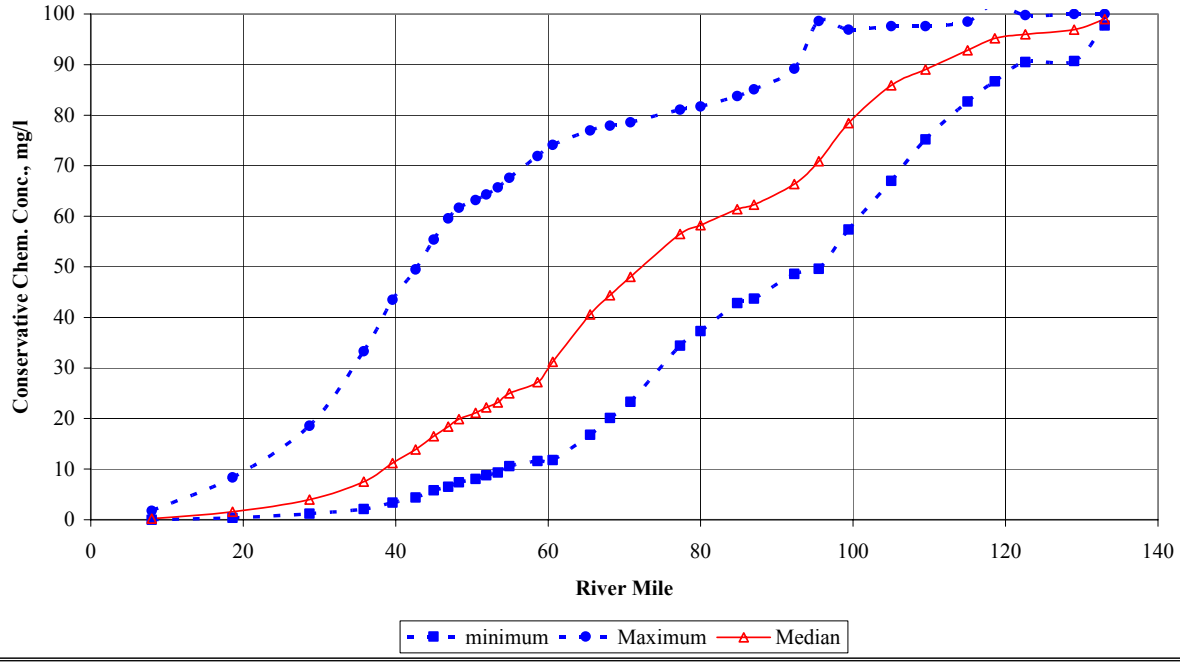


Figure 8A

Temporal Plot: Relative Impact of Boundary Conditions

During the simulation period of 08/01/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundary @ Trenton @Node 20 (RM 60.6)

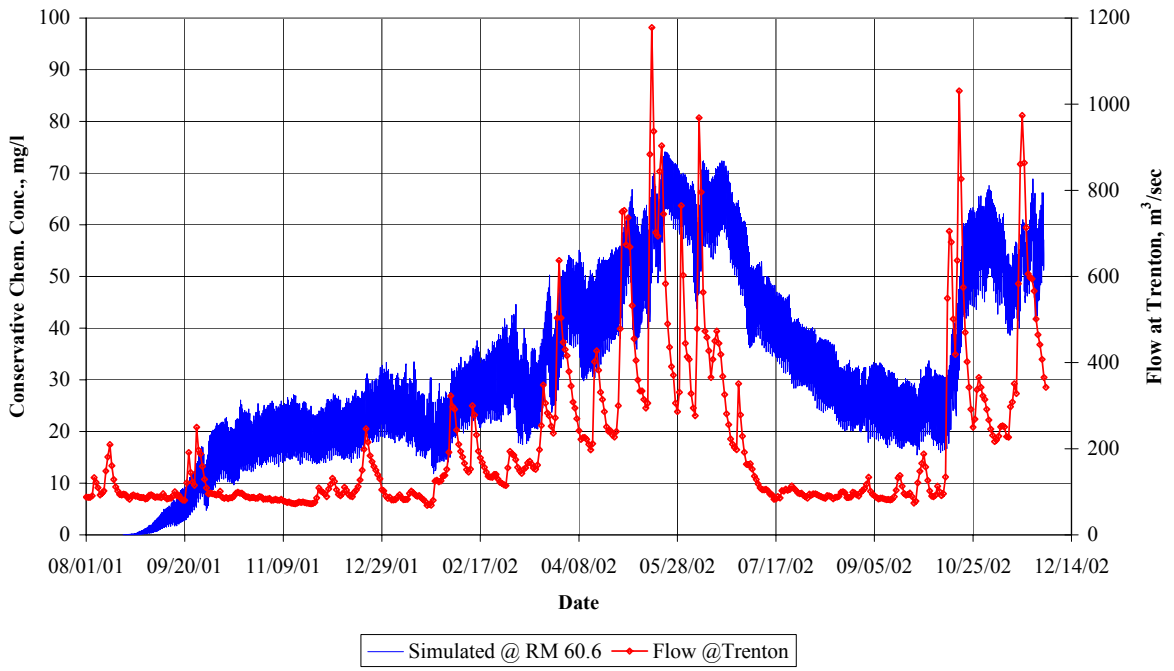


Figure 9

Spatial Plot: Relative Impact of Boundary Conditions

During the simulation period of 10/30/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundaries @ Mouth, C&D, Schuylkill, and Trenton

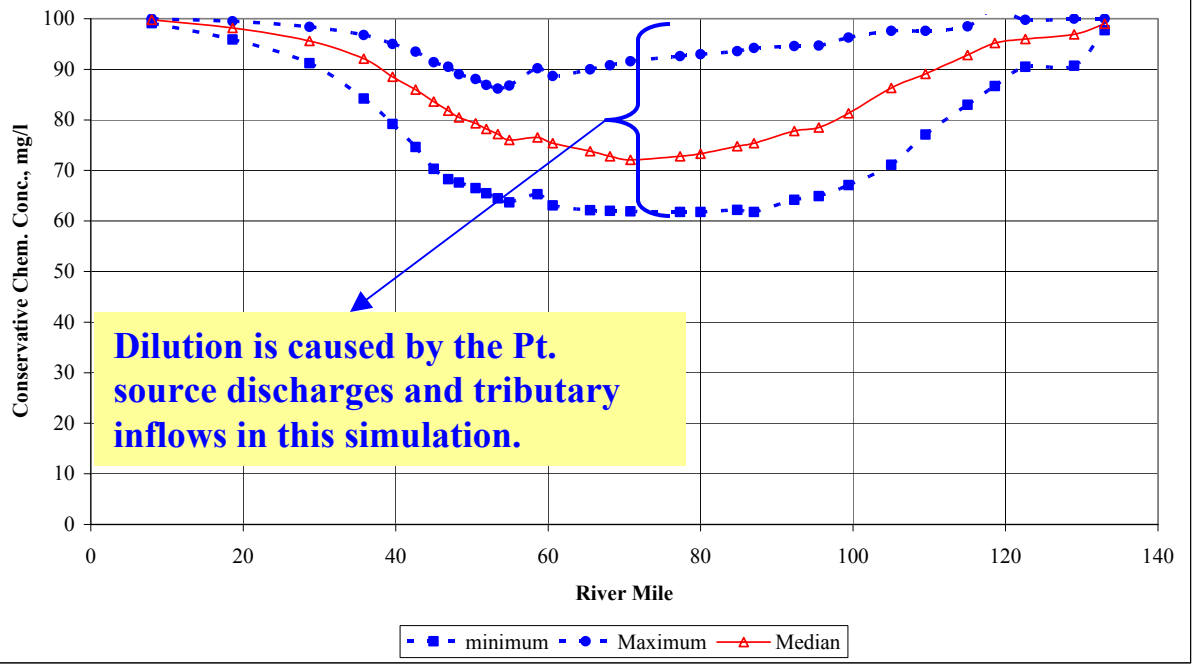


Figure 10

Temporal Plot: Relative Impact of Boundary Conditions

During the simulation period of 08/01/01 through 11/29/02; Conservative; Zero loadings;
100 mg/l for Boundaries @ Mouth, C&D, Schuylkill, and Trenton @Node 20 (RM 60.6)

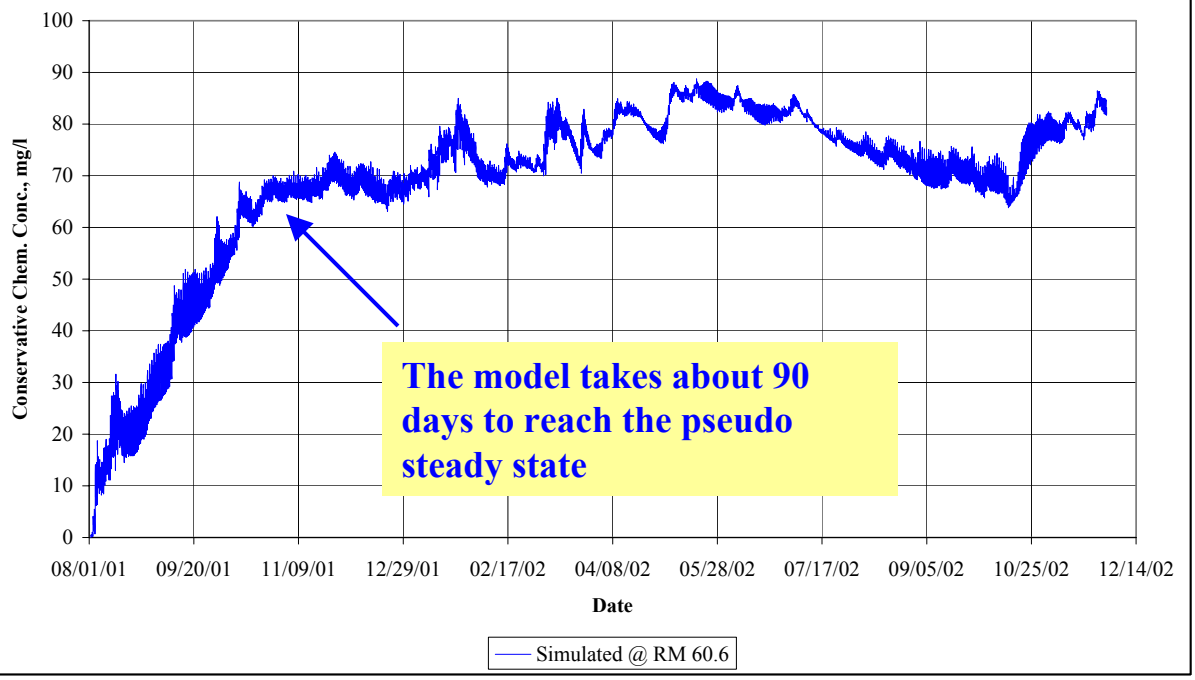


Figure 11

Spatial Plot: Relative Impact of the Boundary Conditions

During the Simulation period of 10/30/01 through 11/29/02: Median Values:

B.C. = 100 mg/l @ Mouth of the Bay, C&D, Schuylkill, and/or Trenton

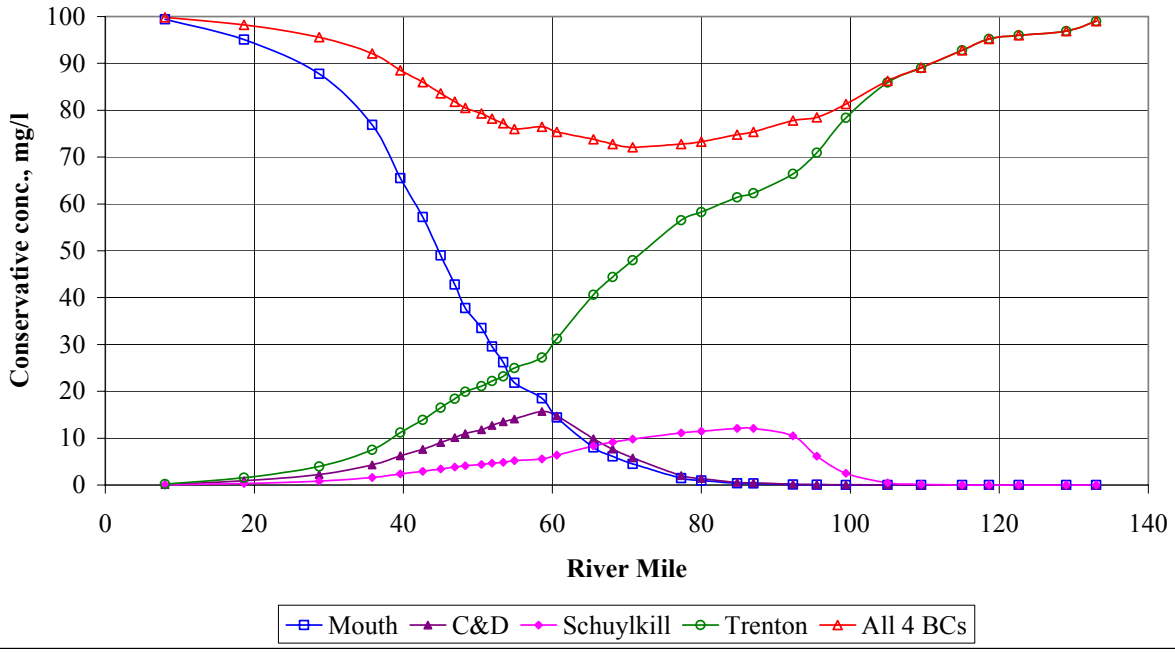
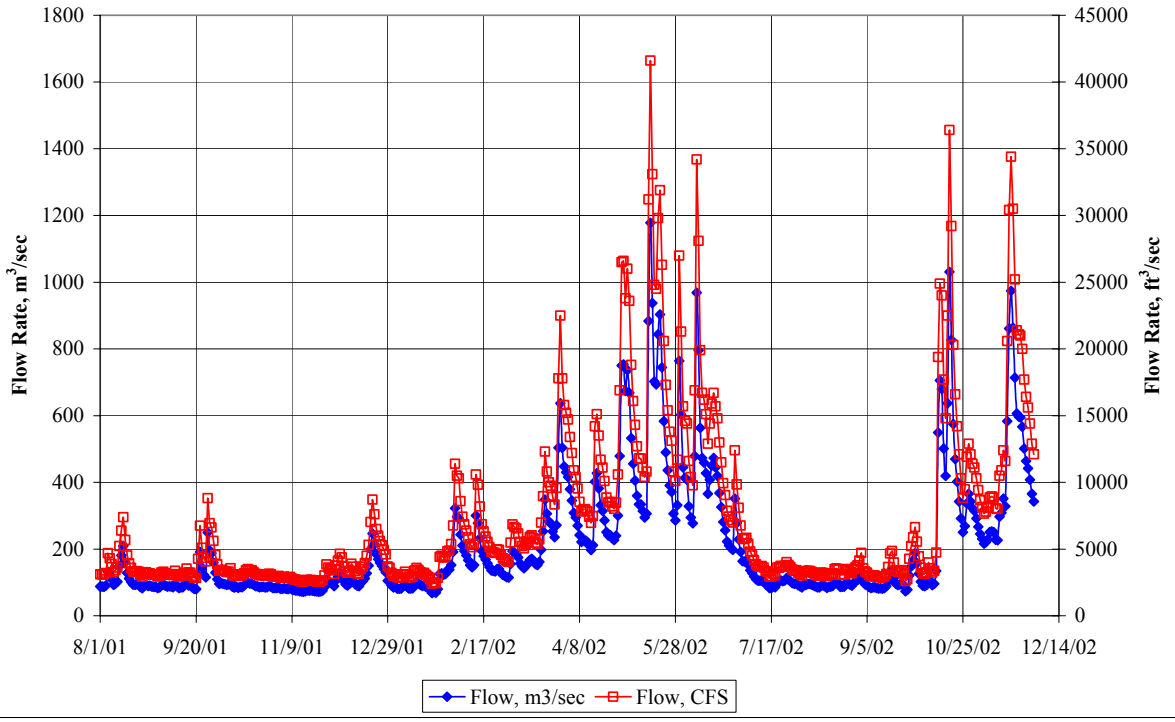


Figure 12

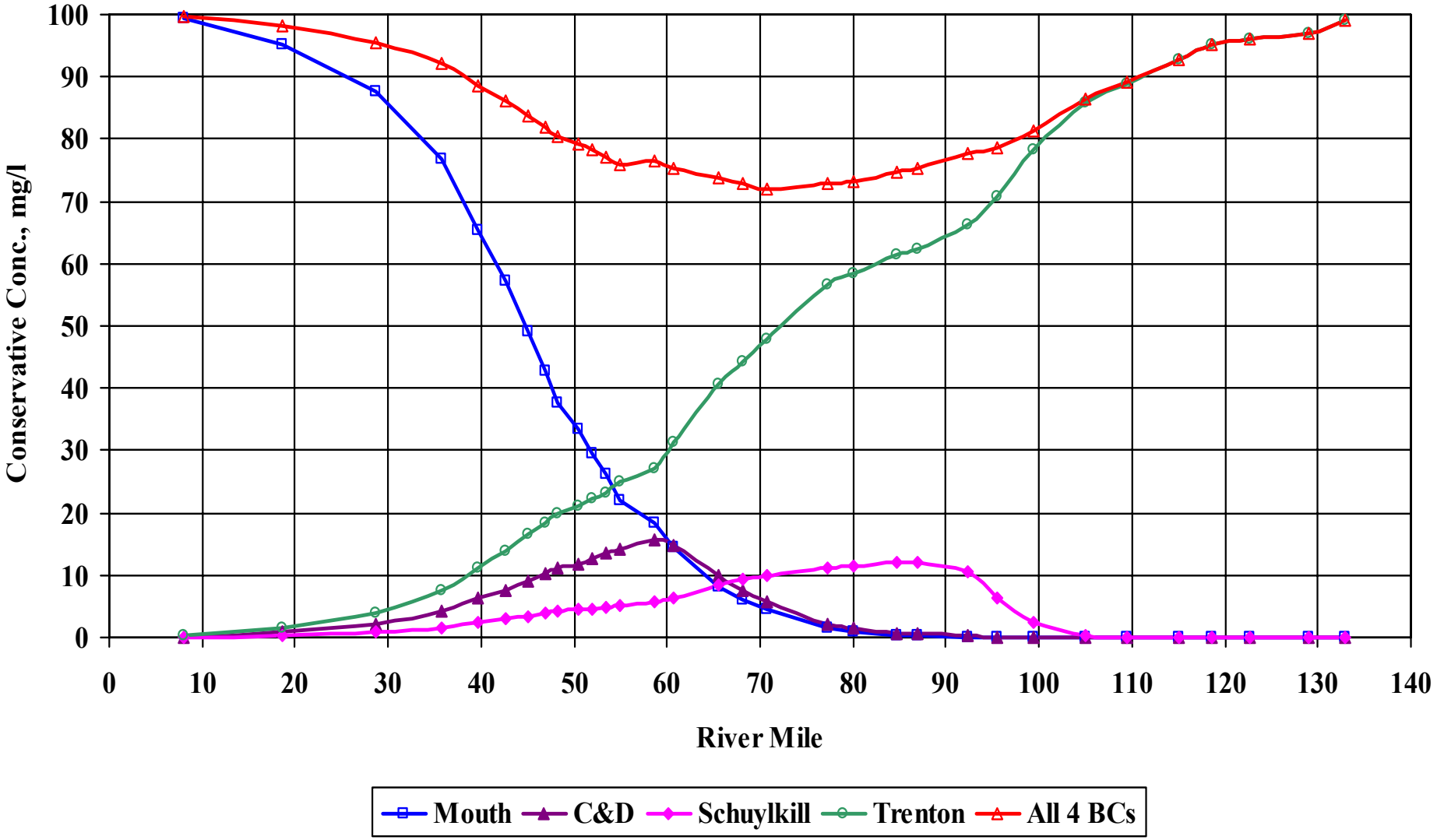
Average daily flow at Trenton during the simulation period



Spatial Plot: Relative Impact of the Boundary Conditions:

During the simulation period of 10/30/01 through 11/29/02: Median Values:

BC. = 100mg/l for Mouth of the Bay, C&D, Schuylkill, and/or Trenton



Boundary Condition Sensitivity Analysis

- A summary of the discussions on this topic will be presented by Dr. Namsoo Suk.
- Conclusions:
  - The downstream boundary appears to have a significant influence in the lower 1/3 of the estuary.
  - The Delaware River at Trenton appears to have a significant influence in the upper 2/3 of the estuary.

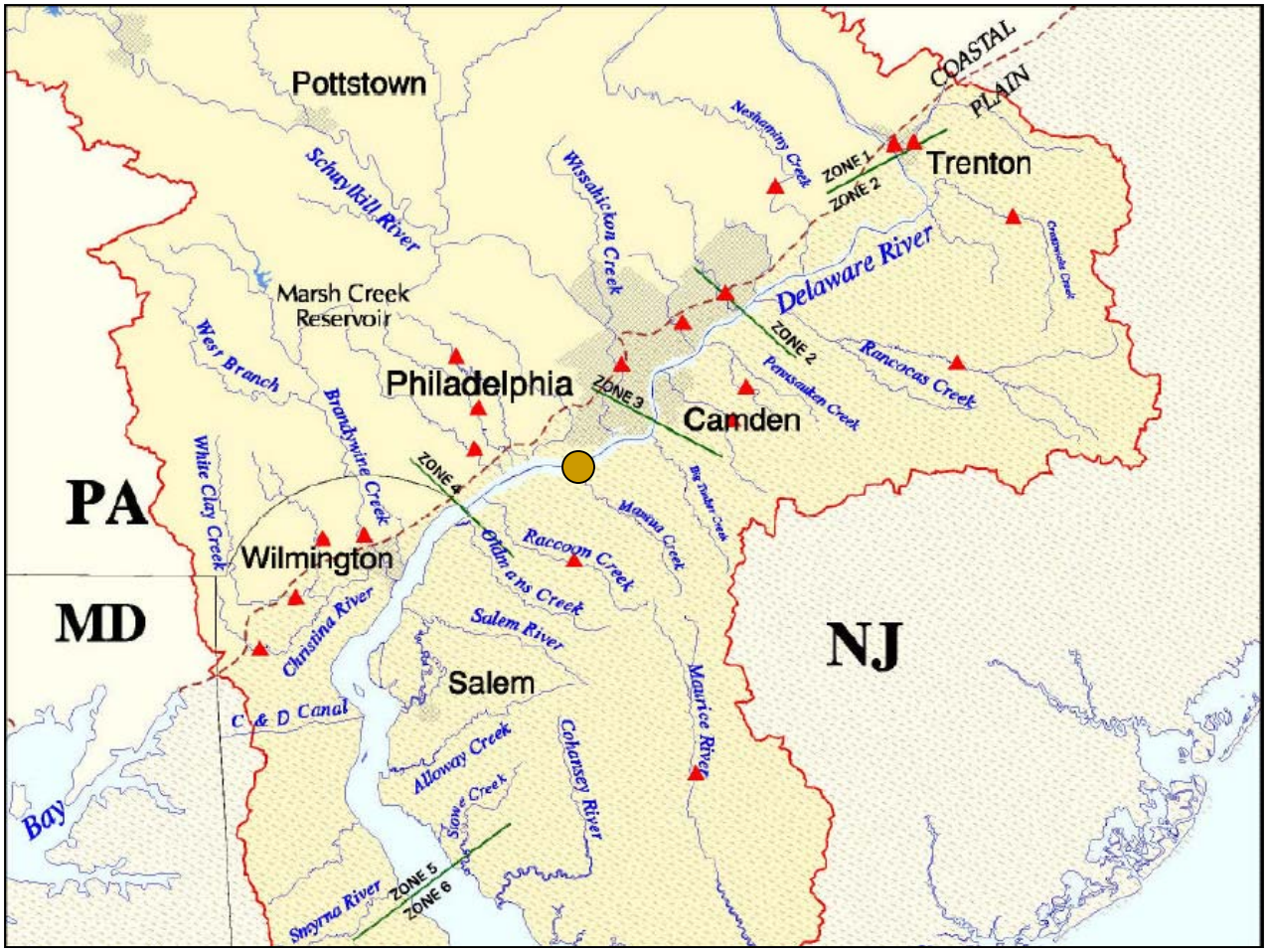
Boundary Condition Sensitivity Analysis

- Conclusions:
  - The influences of the C&D Canal and Schuylkill River are smaller and centered on the locations where they enter the Delaware Estuary.
  - The influence of wastewater discharges and minor tributaries is greatest in the central portion of the estuary.

Available data for Decadal Scale Consistency Check

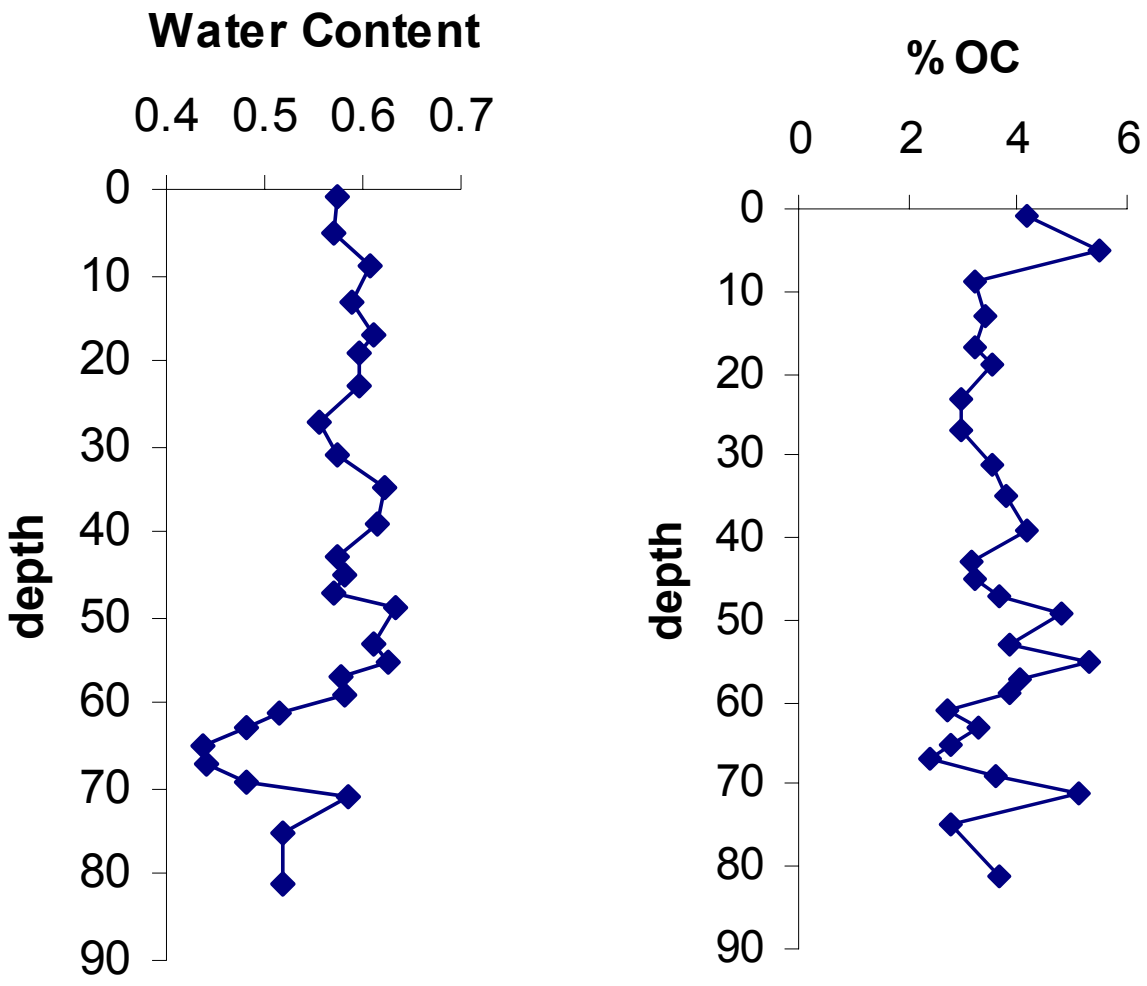
- Dr. Steven Eisenreich will present the results of chemical analyses of the sediment core collected in the Woodbury Creek marsh.

SEDIMENTOLOGICAL AND GEOPHYSICAL SURVEY OF THE UPPER DELAWARE ESTUARY



Sommerfield and Madsen, 2003

Core PC-15

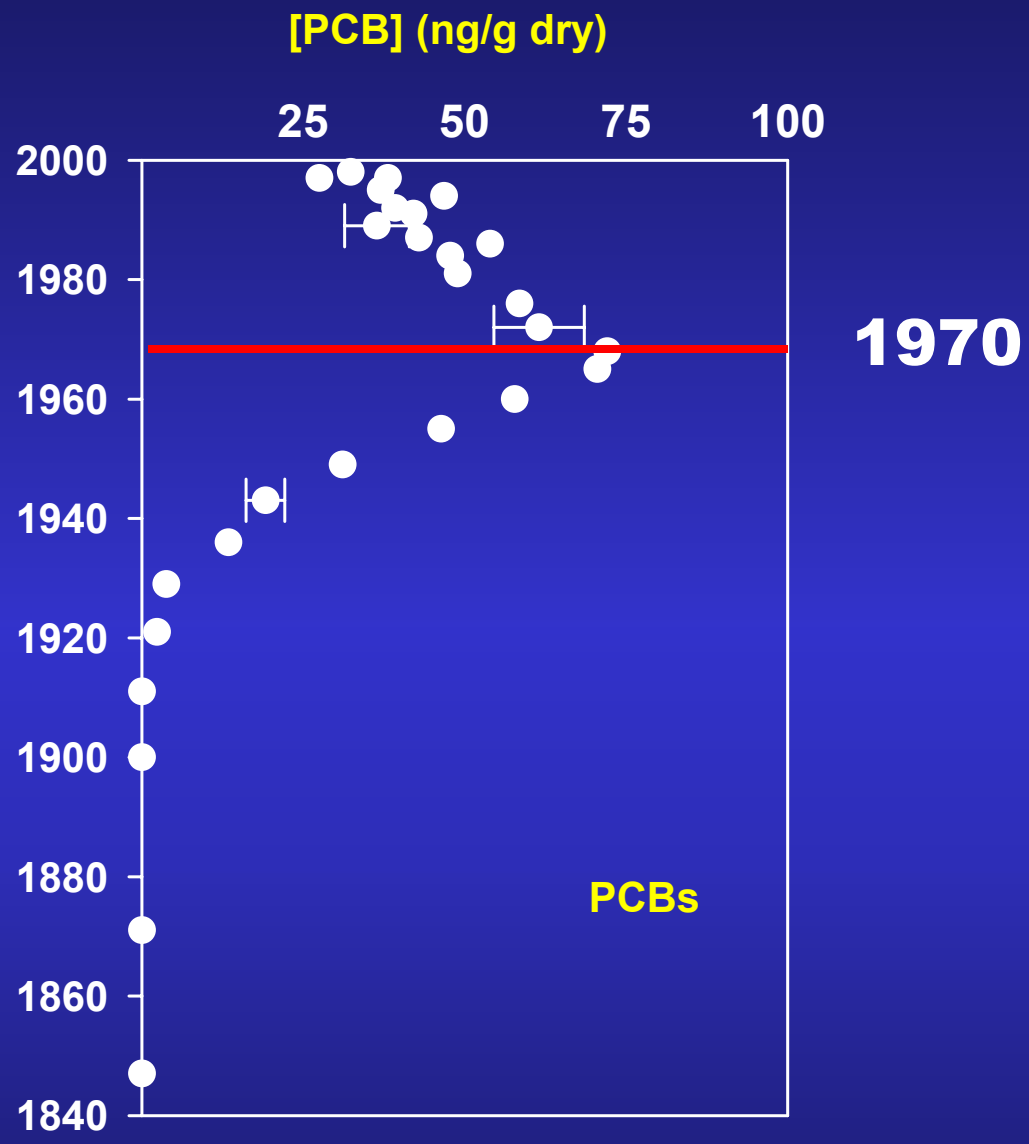

Water Content
0.4
0.5
0.6
0.7
depth
0
10
20
30
40
50
60
70
80
90
% OC
0
2
4
6
depth
0
10
20
30
40
50
60
70
80
90

Maximum Conc. 1970

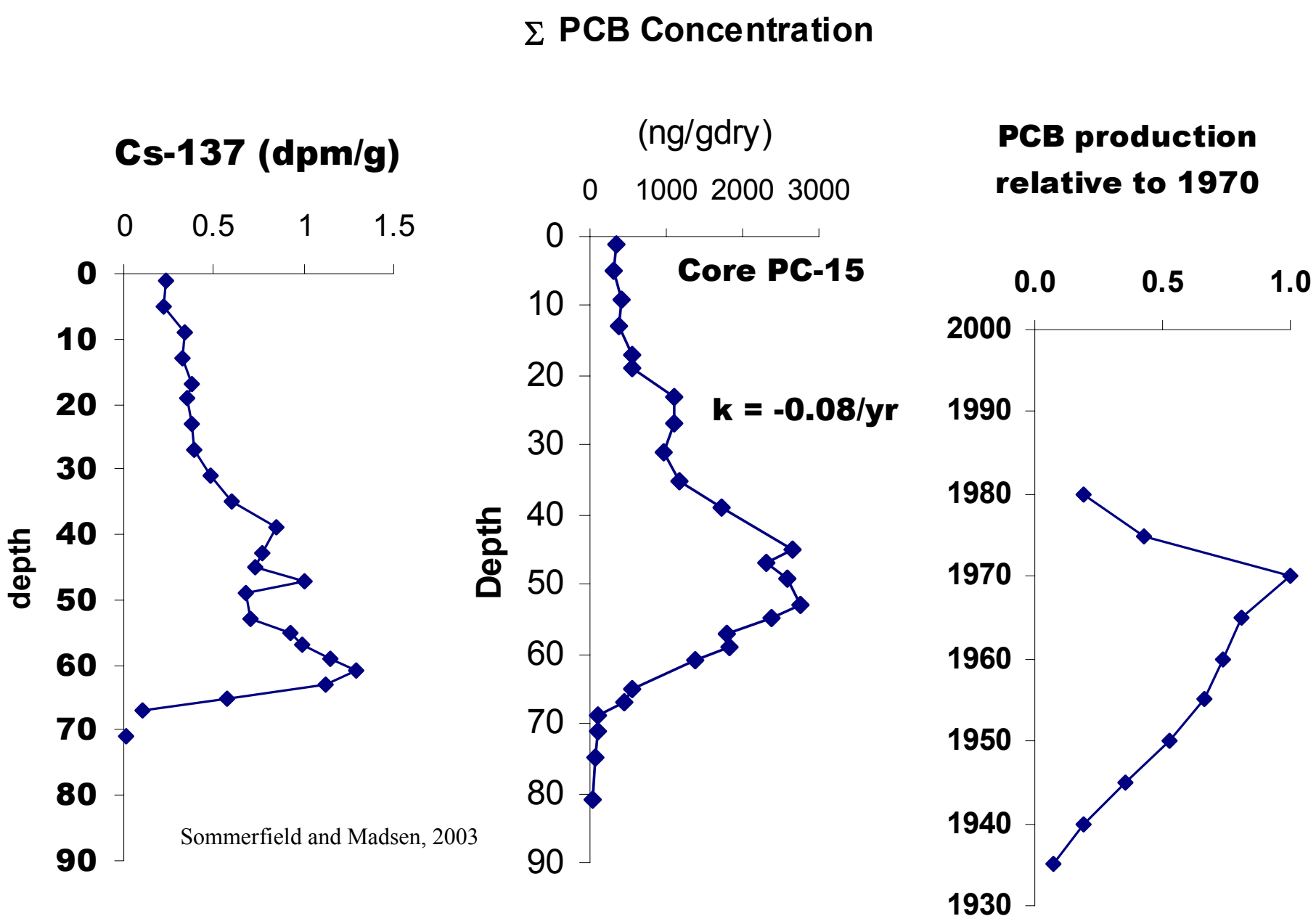
Rate of decline =
$-0.027 yr^{-1}$

Half Life ~ 26 years

(Schneider et al., 2001)



Lake Michigan


Σ PCB Concentration
Cs-137 (dpm/g)
0
0.5
1
1.5
depth
0
10
20
30
40
50
60
70
80
90
Sommerfield and Madsen, 2003
(ng/gdry)
0
1000
2000
3000
Depth
Core PC-15
k = -0.08/yr
PCB production
relative to 1970
0.0
0.5
1.0
2000
1990
1980
1970
1960
1950
1940
1930

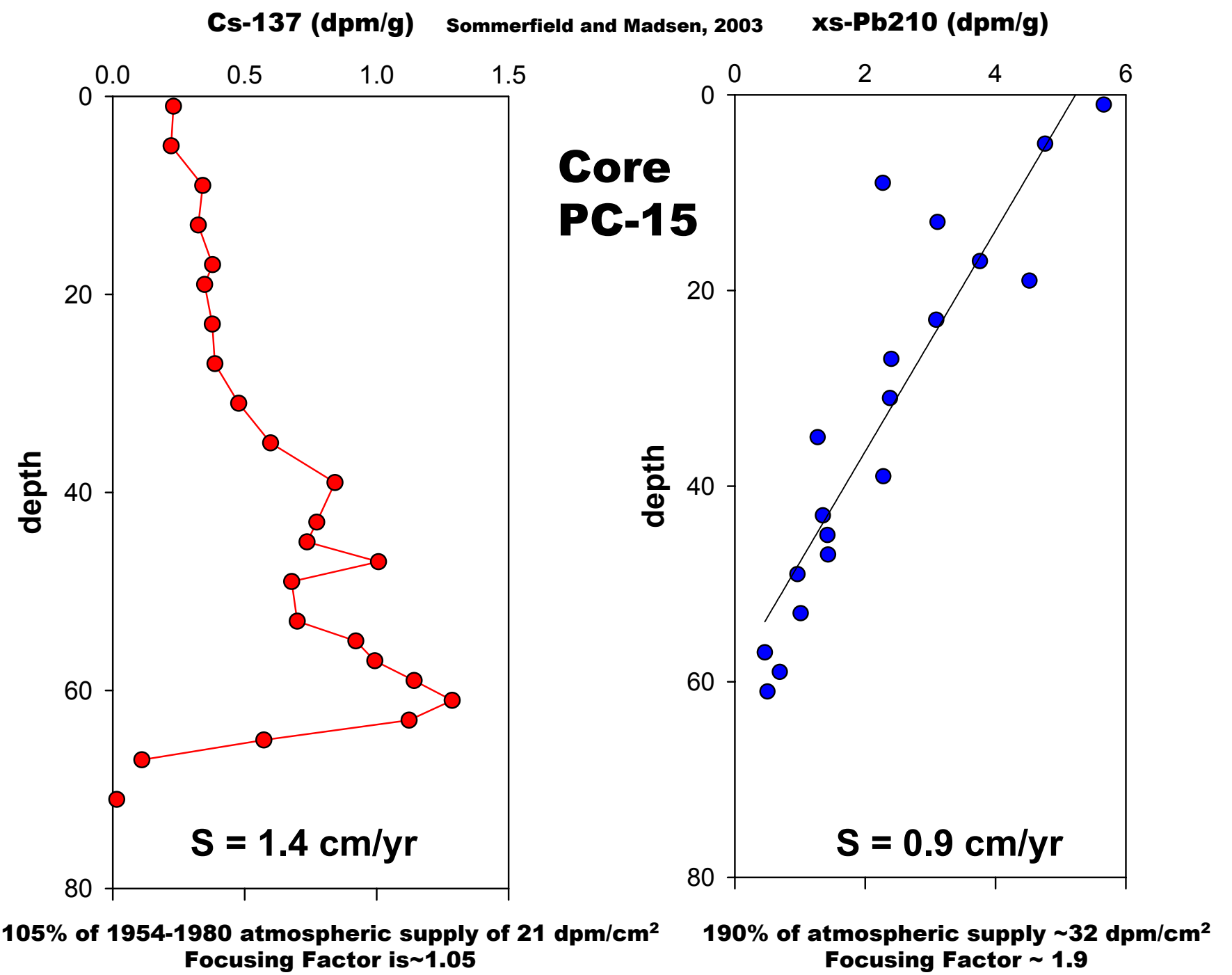
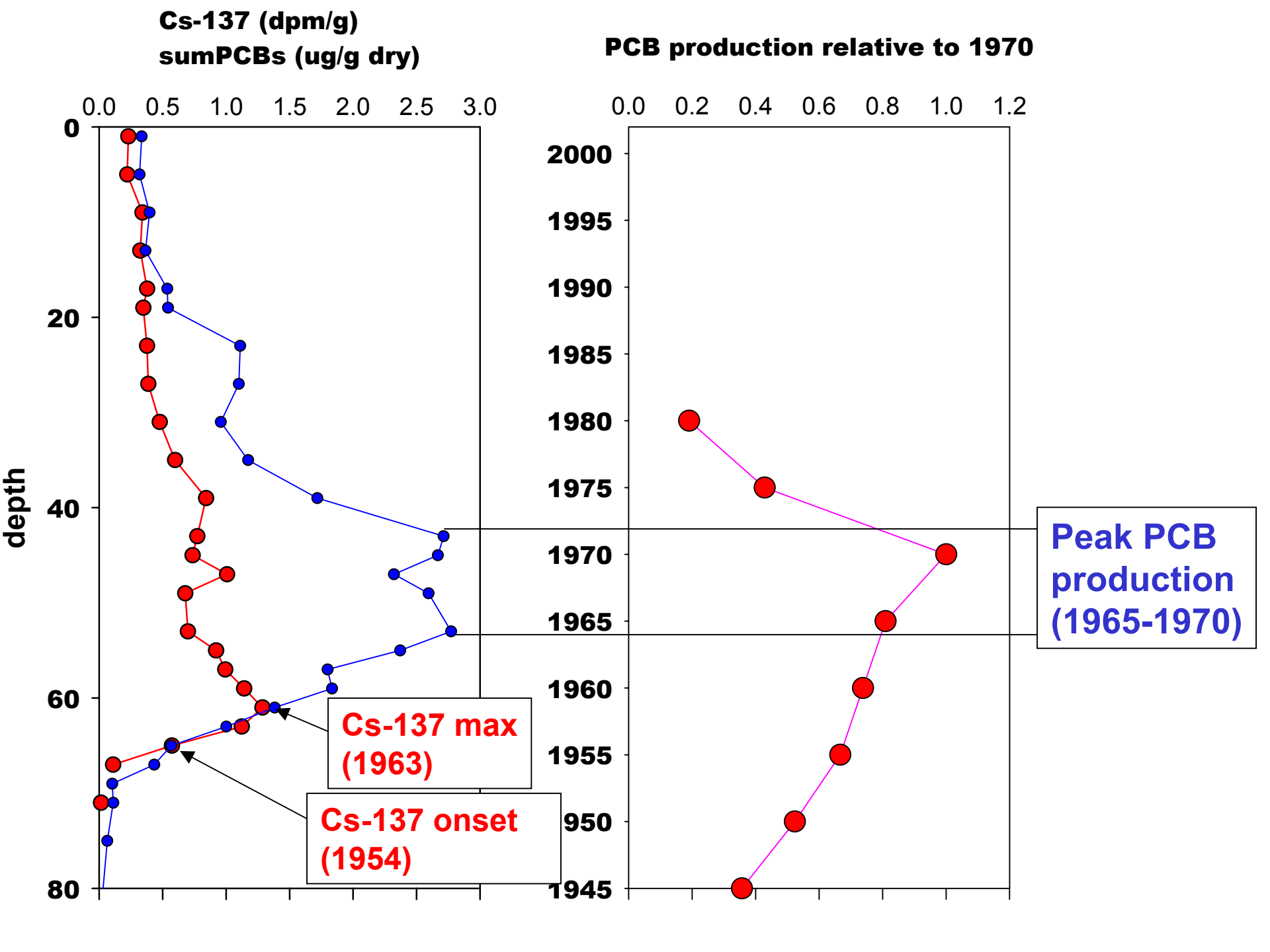

Cs-137 (dpm/g)
Sommerfield and Madsen, 2003
xs-Pb210 (dpm/g)
0.0
0.5
1.0
1.5
0
2
4
6
0
20
40
60
80
depth
Core
PC-15
S = 1.4 cm/yr
S = 0.9 cm/yr
105% of 1954-1980 atmospheric supply of 21 dpm/cm²
Focusing Factor is~1.05
190% of atmospheric supply ~32 dpm/cm²
Focusing Factor ~ 1.9

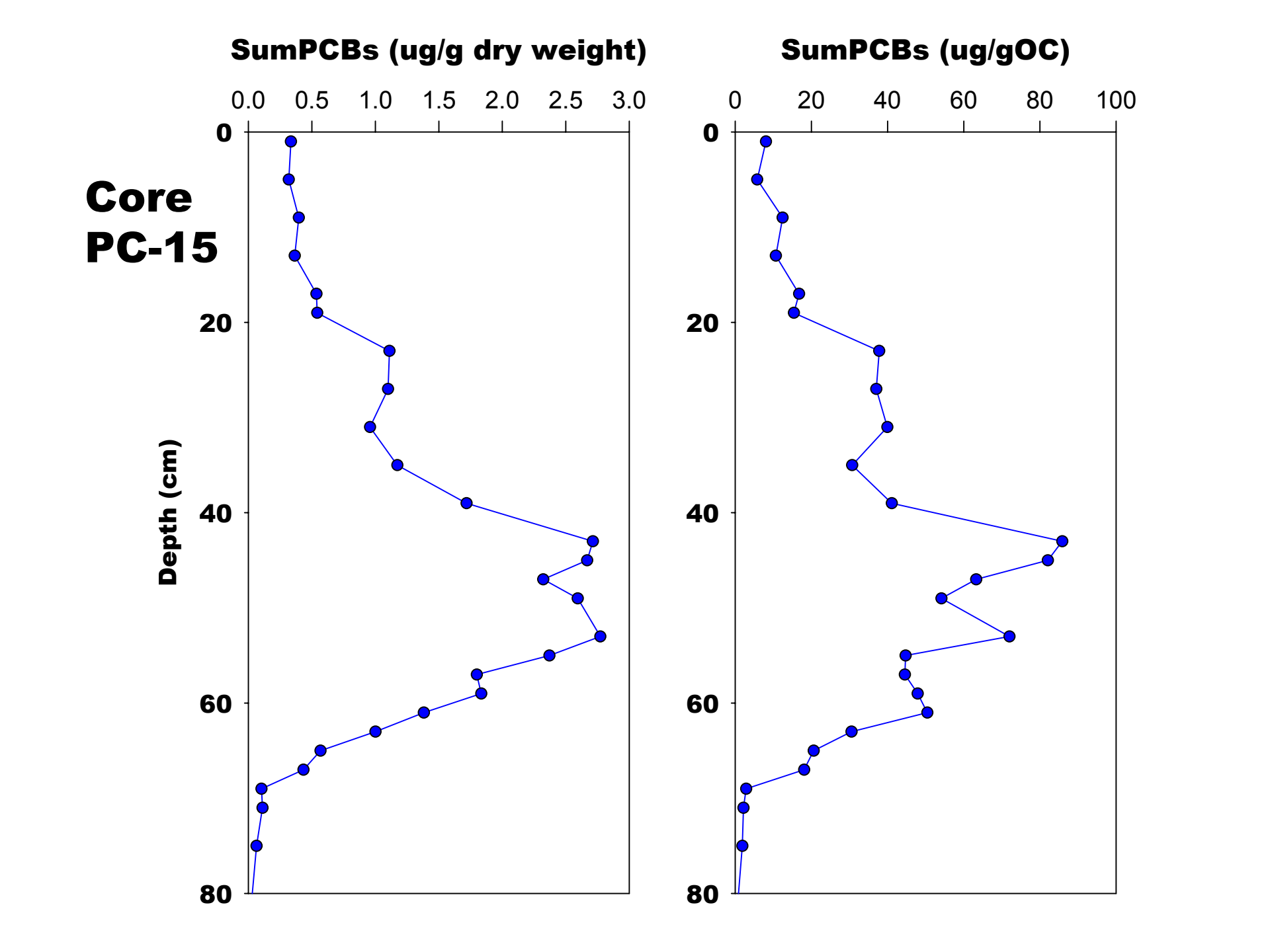
Table 5. Sediment accumulation rates and radioisotope inventories

Site	Cs-137 penetration (cm)	Cs-137 maximum (cm)	Cs-137 sed. rate (cm/yr)	Cs-137 inventory (dpm/cm^2)	Pb-210 sed. rate (cm/yr)	xsPb-210 inventory (dpm/cm^2)
C-1	nd[b]	NM	-	-	-	-
C-2	nd	NM	-	-	-	-
C-4	nd	NM	-	-	-	-
C-7	nd	NM	-	-	-	-
C-14b	55	NM	>1.0	3.0	-	-
C-15b	68	NM	-	-	-	-
C-16A	55	43	≥1.0	3.5	-	-
MHE	54	NM	≥1.0	2.0	-	-
PC-4	19	51	>1.0	4.4	2.0	60
PC-7	37	NM	0.8	2.4	-	27
PC-13	40	29	1.0	4.0[c]	0.8	28
PC-14	32	NM	0.7	11.5	0.7	52
PC-15	70	61	1.5	22.0	0.7	78
PC-16	14	NM[a]	0.3	12.0	-	33

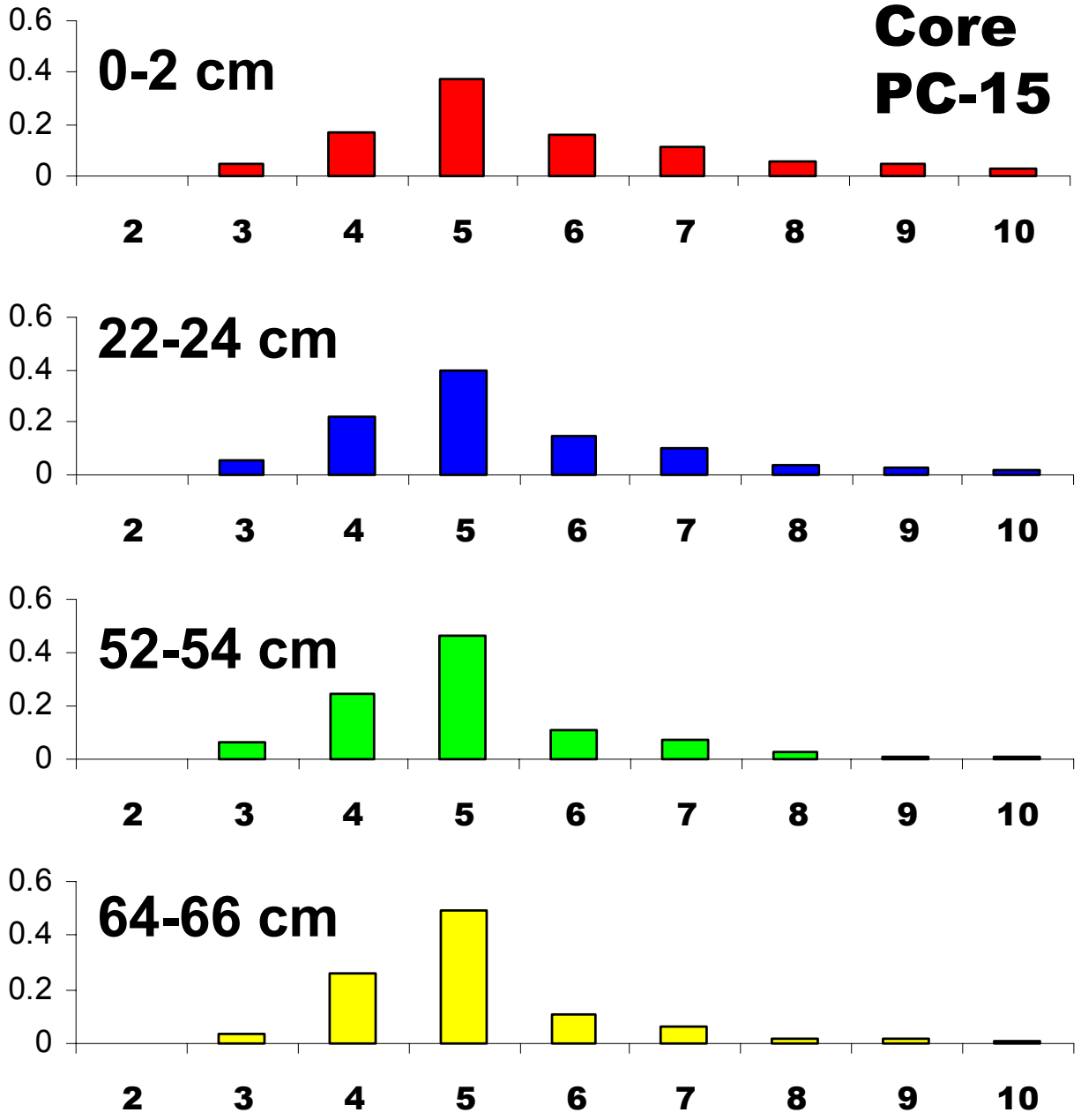
[a]nm, no Cs-137 maximum in core; [b]nd, non-detectable; [c]incomplete inventory (see text)

Sommerfield and Madsen, 2003


Cs-137 (dpm/g)
sumPCBs (ug/g dry)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
depth
0
20
40
60
80
PCB production relative to 1970
0.0
0.2
0.4
0.6
0.8
1.0
1.2
2000
1995
1990
1985
1980
1975
1970
1965
1960
1955
1950
1945
Peak PCB production (1965-1970)
Cs-137 max (1963)
Cs-137 onset (1954)

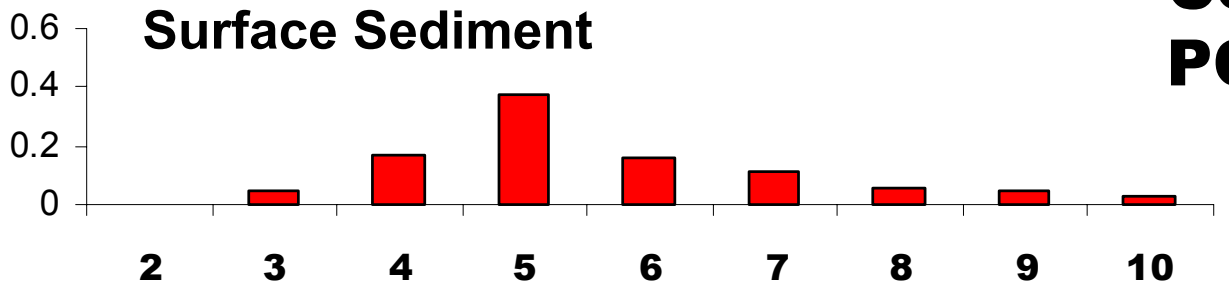

Core
PC-15
SumPCBs (ug/g dry weight)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
SumPCBs (ug/gOC)
0
20
40
60
80
100
Depth (cm)
0
20
40
60
80

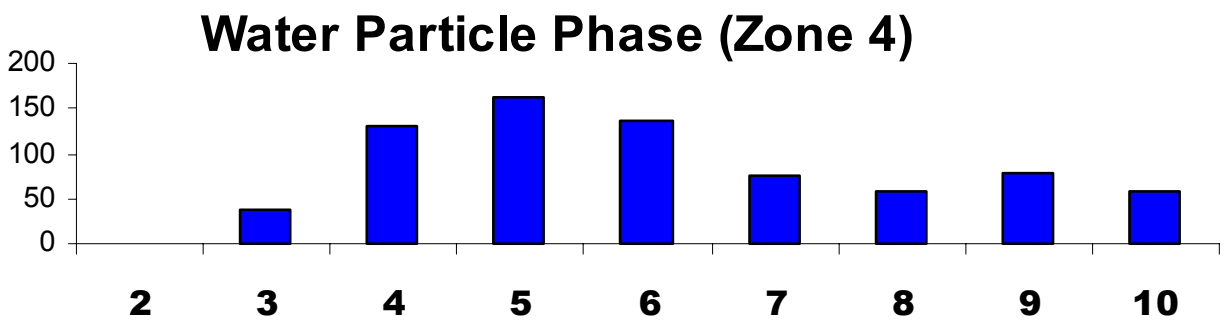
PCB Homolog profiles

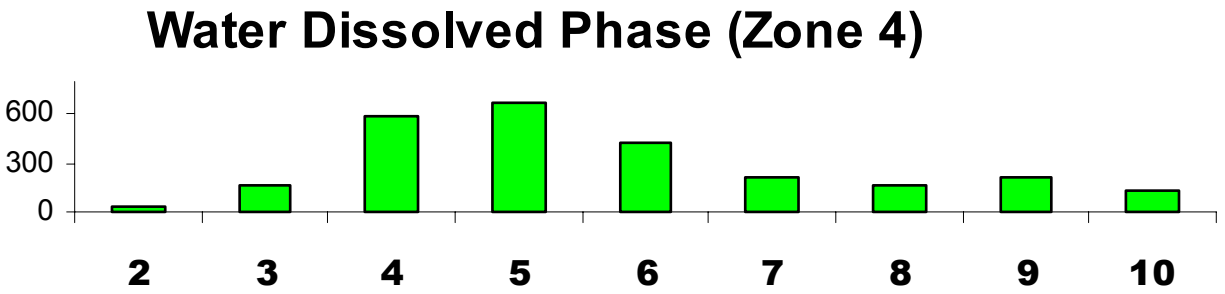


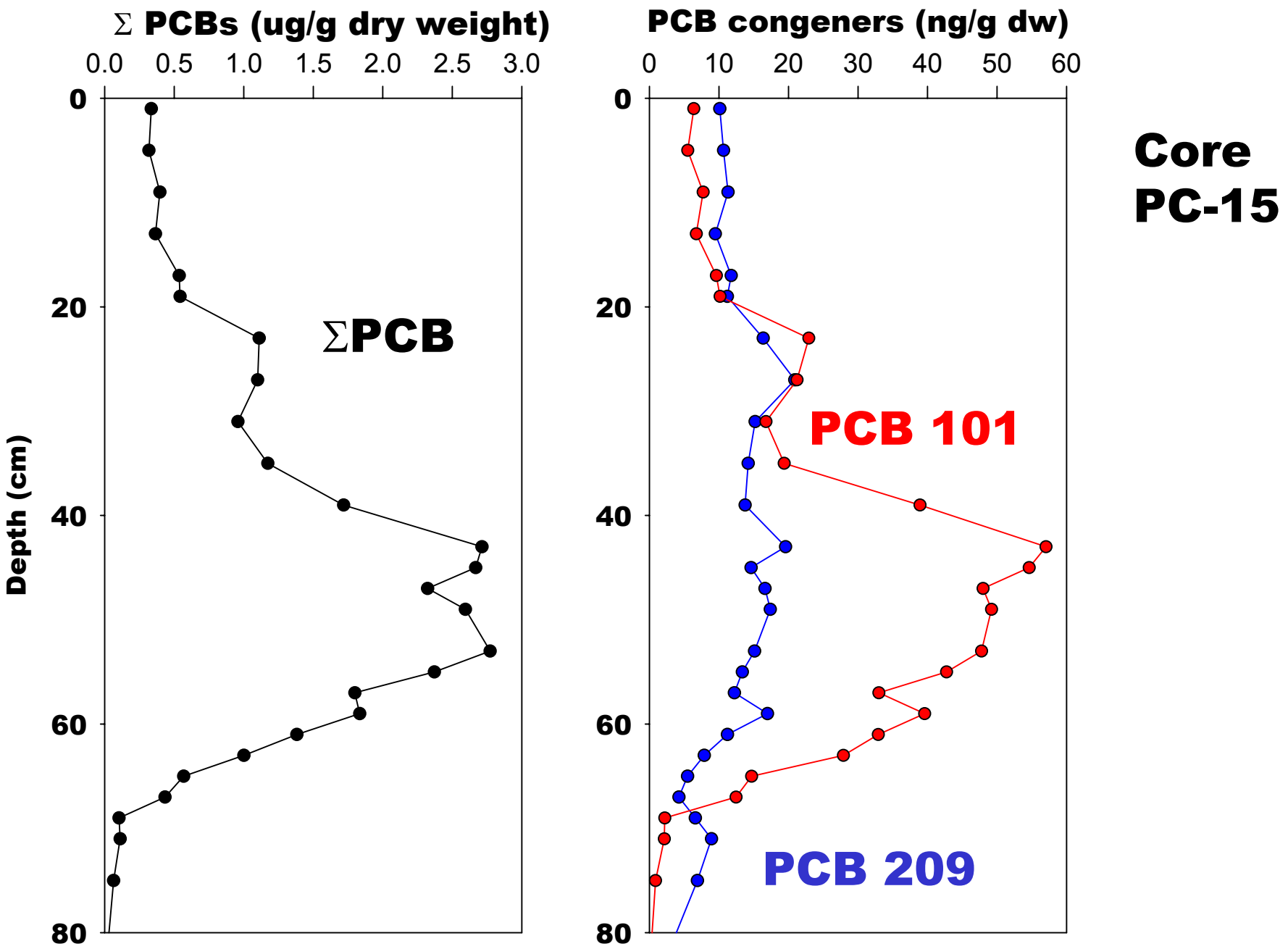
PCB Homolog Profiles

Core PC-15








Σ PCBs (ug/g dry weight)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
20
40
60
80
Depth (cm)
ΣPCB
PCB congeners (ng/g dw)
0
10
20
30
40
50
60
PCB 101
PCB 209
Core
PC-15

SEDIMENTOLOGICAL AND GEOPHYSICAL SURVEY OF THE UPPER DELAWARE ESTUARY

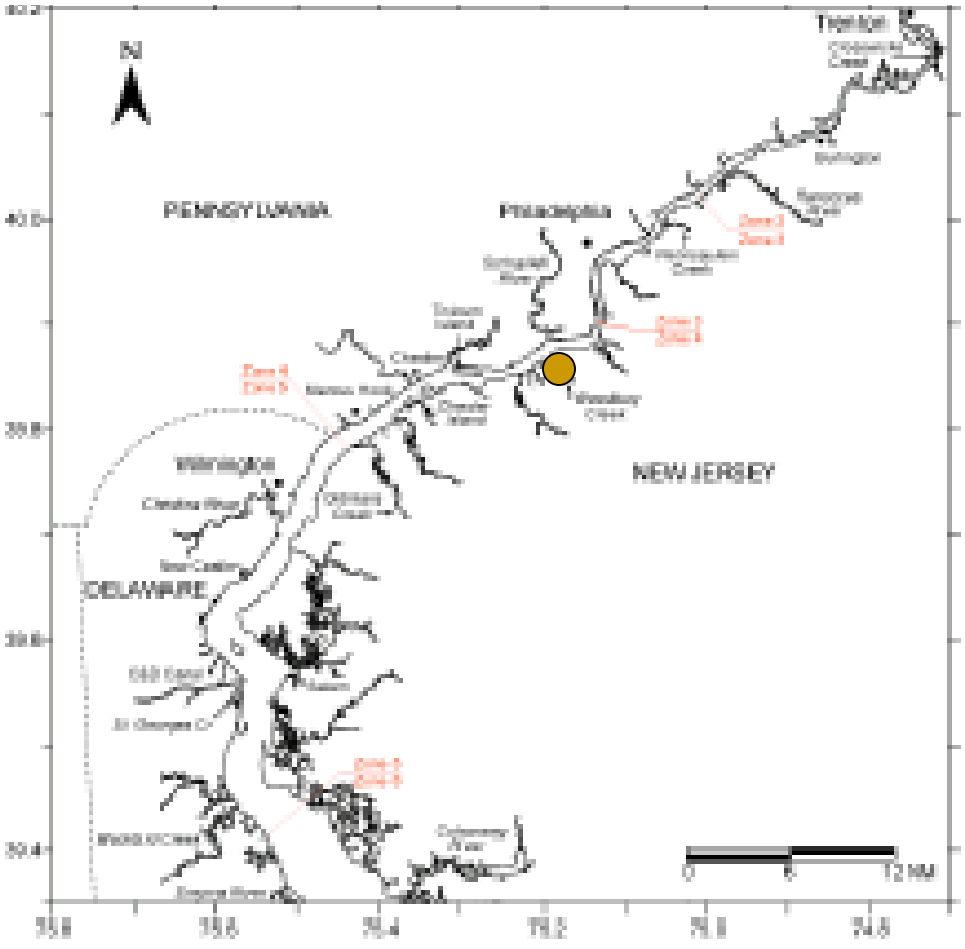
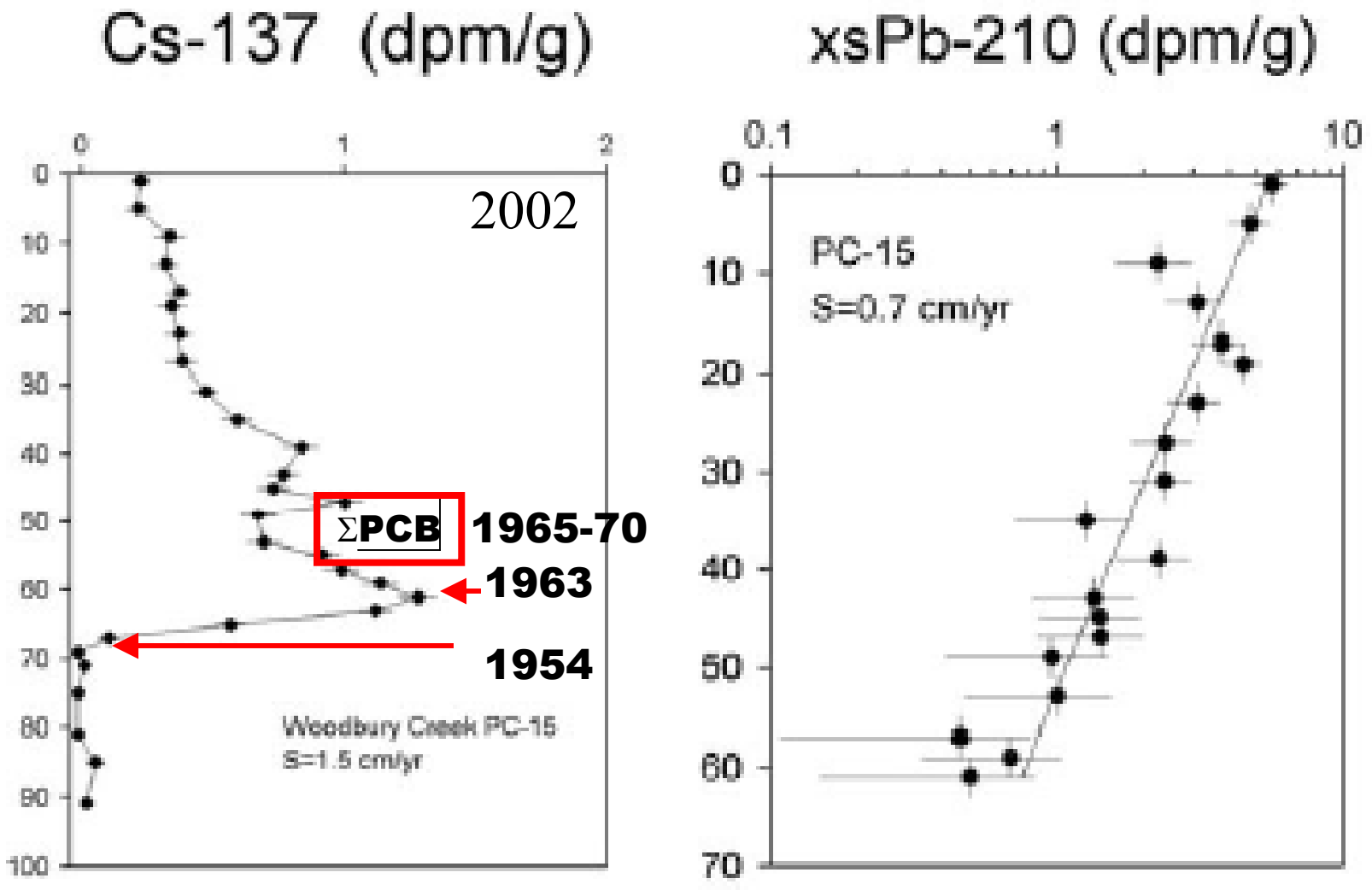


Figure 1. Location map of the study area showing geographic features and DRBC zones.

Sommerfeld and Madson, 2003

Sommerfield and Madsen, 2003



105% of 1954-1980 atmospheric supply of 21 dpm/cm²
Focusing Factor is~1*

190% of atmospheric supply ~32 dpm/cm²
Focusing Factor is 2.4

APPENDIX D. WATER CONTENT AND POROSITY DATA

Cruise	Sample ID	Interval (cm)	Water Content (%)	Porosity (%)
MARSH	PC15	0-2	60.2	79.9
MARSH	PC15	4-6	61.8	80.9
MARSH	PC15	8-10	59.4	79.3
MARSH	PC15	12-14	62.1	81.2
MARSH	PC15	16-18	62.9	81.6
MARSH	PC15	18-20	64.9	82.9
MARSH	PC15	22-24	60.3	79.9
MARSH	PC15	26-28	56.2	77.1
MARSH	PC15	30-32	60.8	80.3
MARSH	PC15	34-36	59.3	79.2
MARSH	PC15	38-40	62.8	81.6
MARSH	PC15	42-44	57.4	78.0
MARSH	PC15	44-46	58.0	78.4
MARSH	PC15	46-48	58.6	78.8
MARSH	PC15	48-50	61.3	80.6
MARSH	PC15	52-54	61.3	80.6
MARSH	PC15	54-56	59.5	79.4
MARSH	PC15	56-58	59.8	79.6
MARSH	PC15	58-60	57.2	77.8
MARSH	PC15	60-62	56.7	77.5
MARSH	PC15	62-64	49.2	71.8
MARSH	PC15	84-86	38.8	62.5
MARSH	PC15	90-92	39.2	62.9
MARSH	PC15	68-70	46.2	69.3
MARSH	PC15	70-72	61.7	80.9
MARSH	PC15	74-76	55.4	76.5
MARSH	PC15	80-82	50.4	72.7

Sommerfield and Madsen, 2003

Loading Inventories

- A summary of the discussions on this topic will be presented by Mr. John Yagecic.

Estimated Particulate Carbon Loads to the Delaware Estuary

Delaware River Basin Commission

March 21, 2003

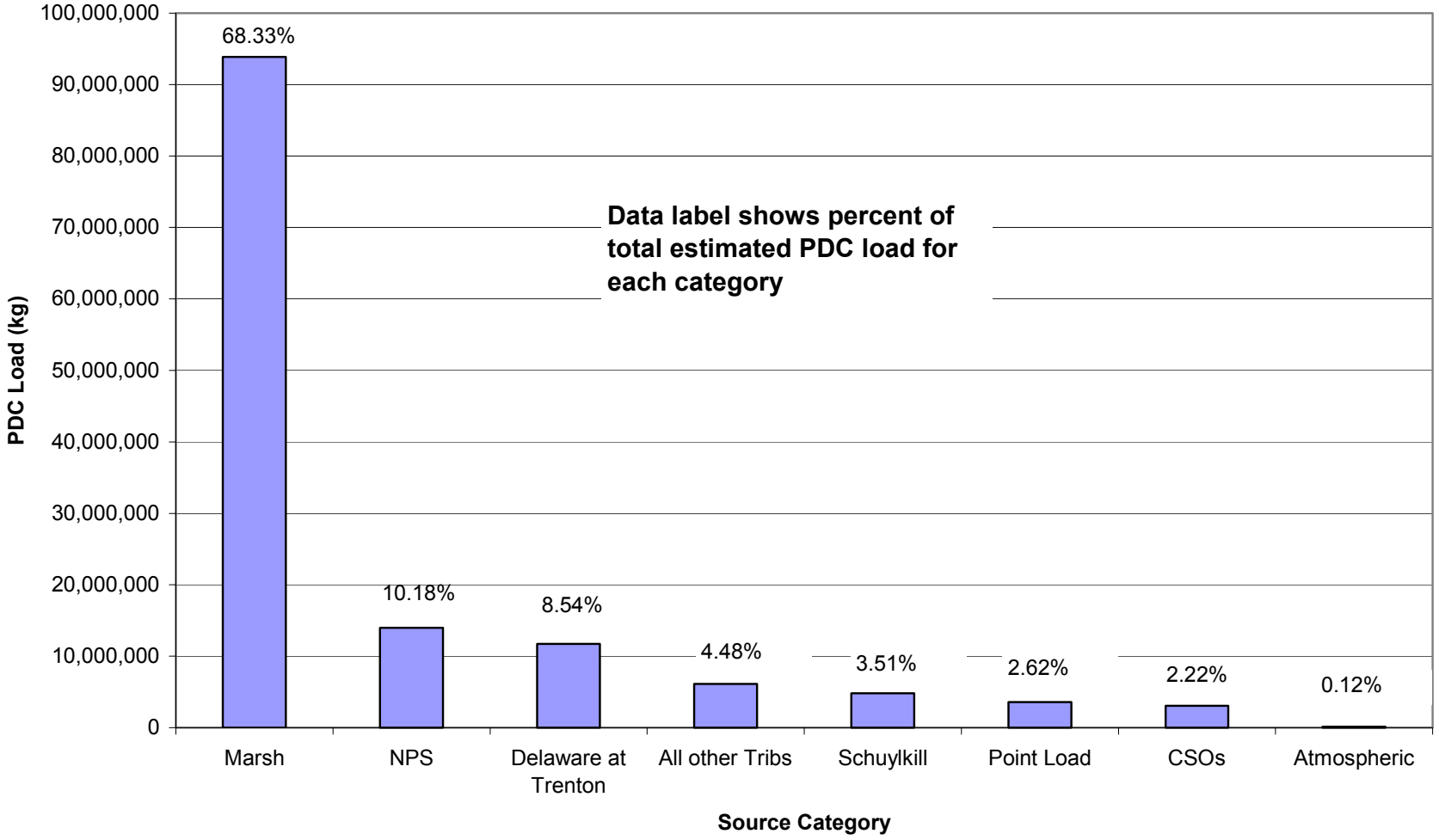
Estimated Particulate Carbon Loads to the Delaware Estuary

- Estimated loads of particulate detrital carbon (PDC) and biotic carbon (BIC)
- Daily loads (kg) for the first portion of the continuous simulation period (September 1, 2001 through December 31, 2002)

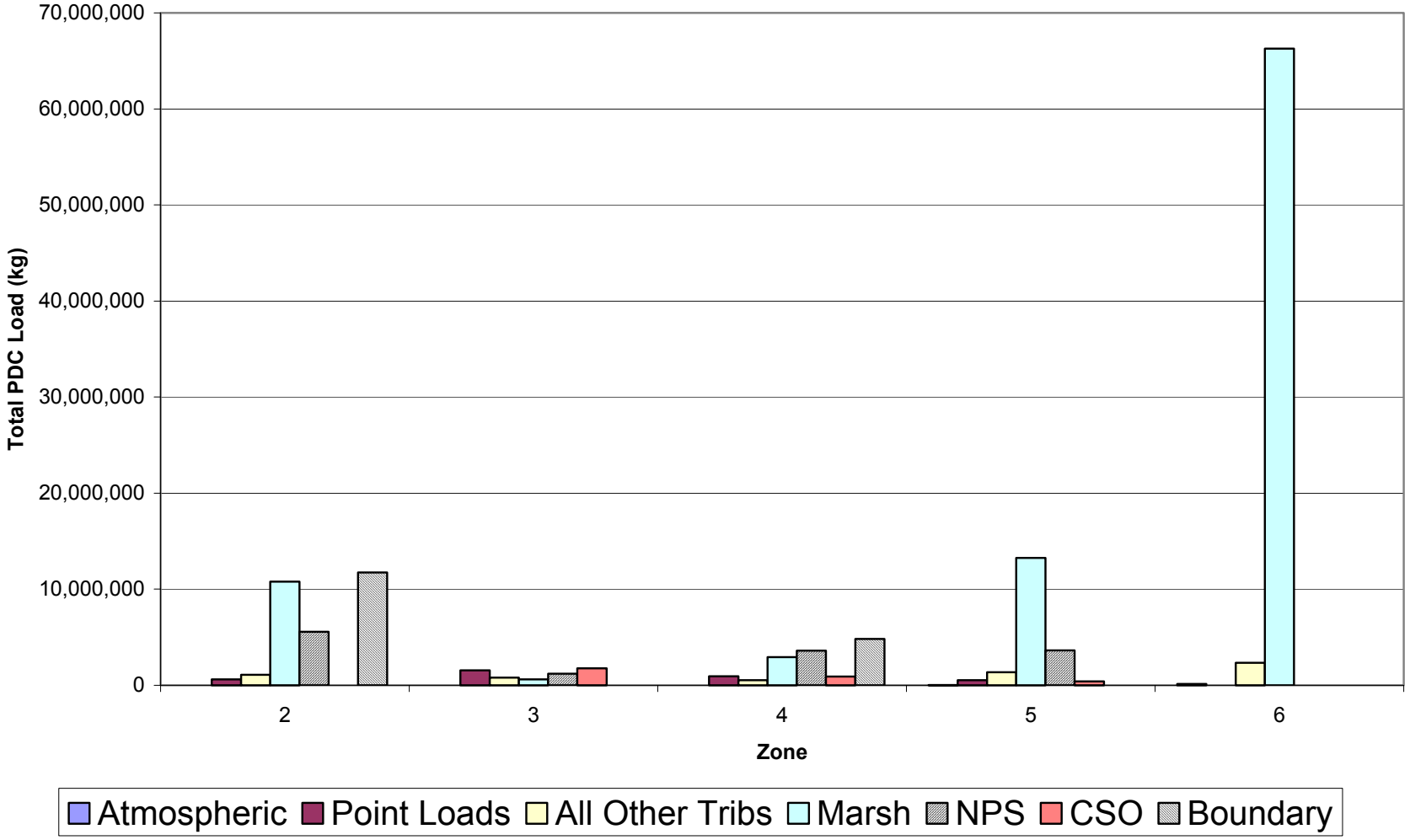
External Sources of Particulate Carbon Considered

- Sources of PDC
  - Boundaries
  - Tributaries
  - Point Discharges
  - CSOs
  - Marshes
  - Atmospheric Deposition
  - Non-point sources
- Sources of BIC
  - Boundaries
  - Tributaries
  - Internal Production

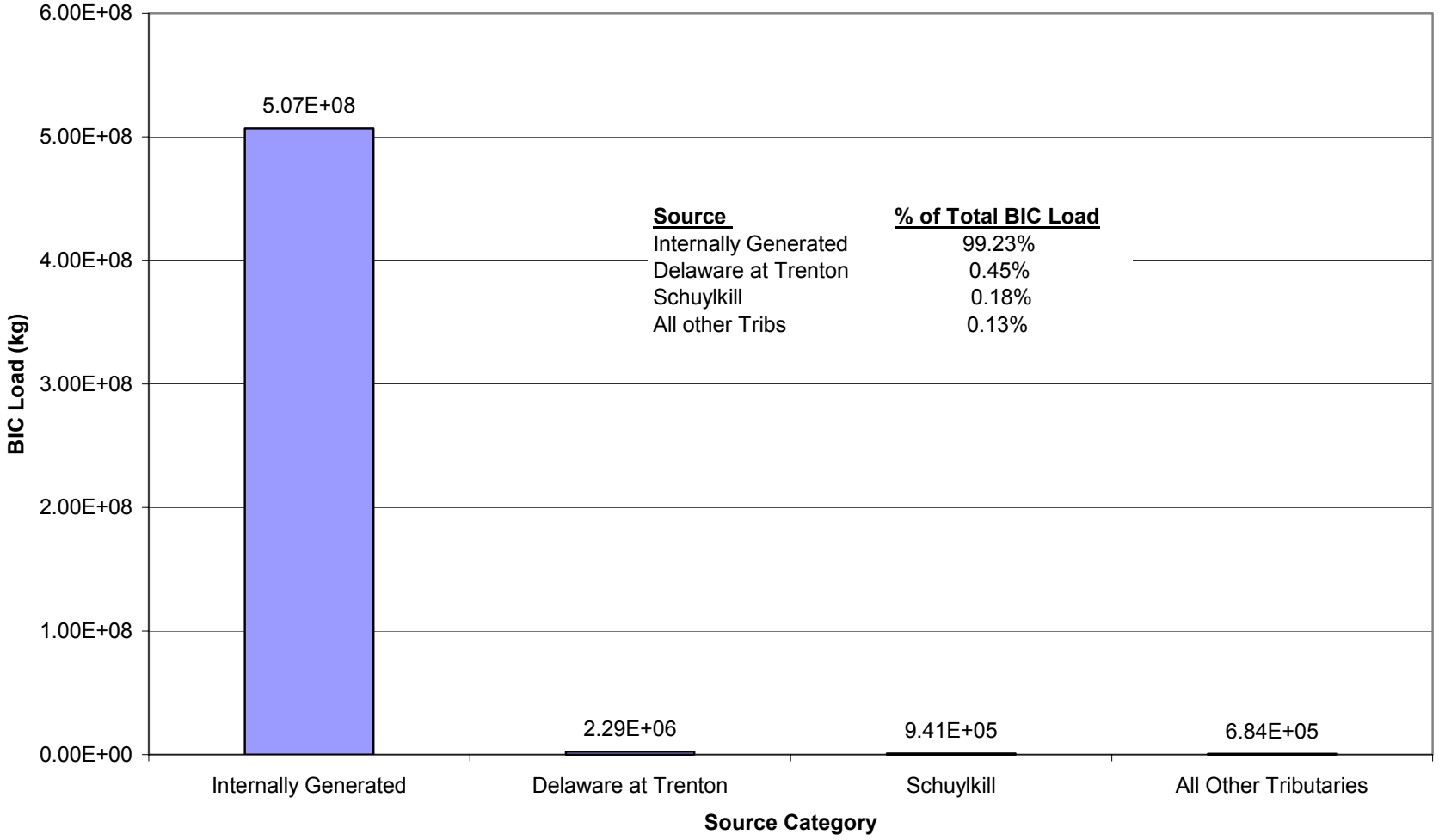
Estimated Total PDC Load to the Delaware Estuary by Category
During the Continuous Simulation Period (September 1, 2001 through December 31, 2002)



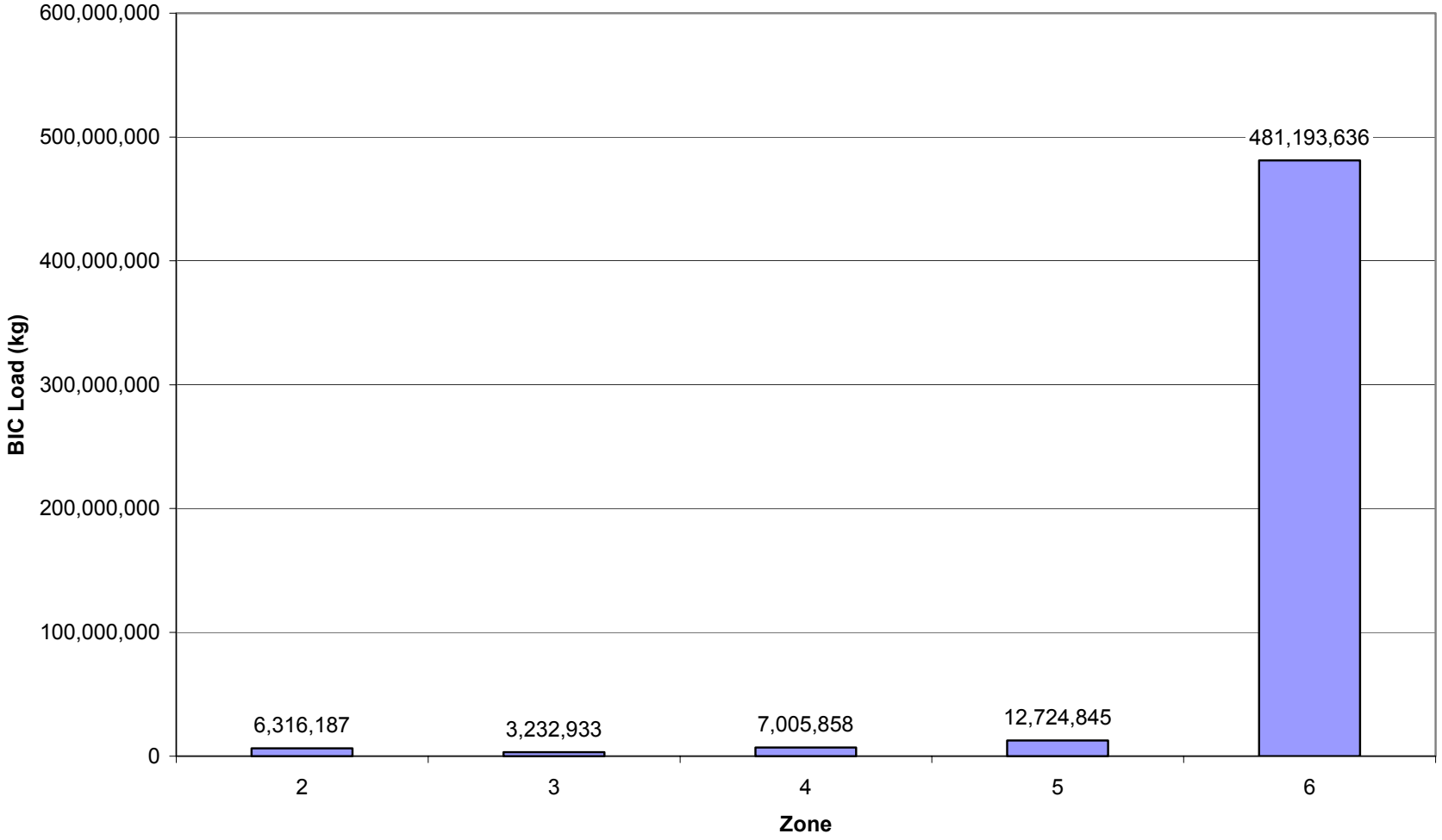
Estimated Total PDC Load to the Delaware Estuary by Category for each Zone
During the Continuous Simulation Period (September 1, 2001 through December 31, 2002)



Estimated Total BIC Load to the Delaware Estuary by Category
During the Continuous Simulation Period (September 1, 2001 through December 31, 2002)



Estimated Total BIC Load to the Delaware Estuary by Zone
During the Continuous Simulation Period (September 1, 2001 through December 31, 2002)



Estimated Penta PCB Loads to the Delaware Estuary

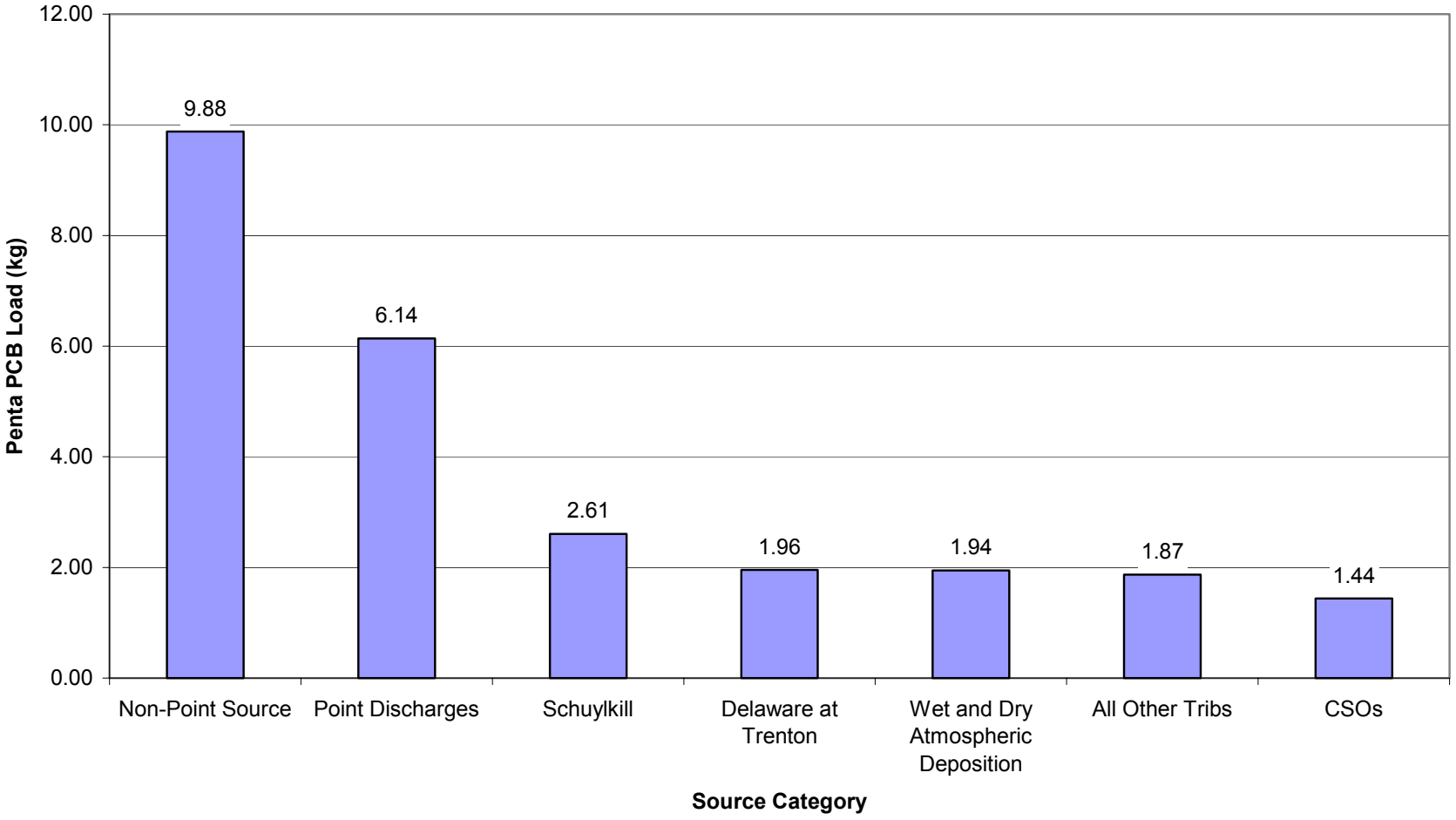
Delaware River Basin Commission

March 21, 2003

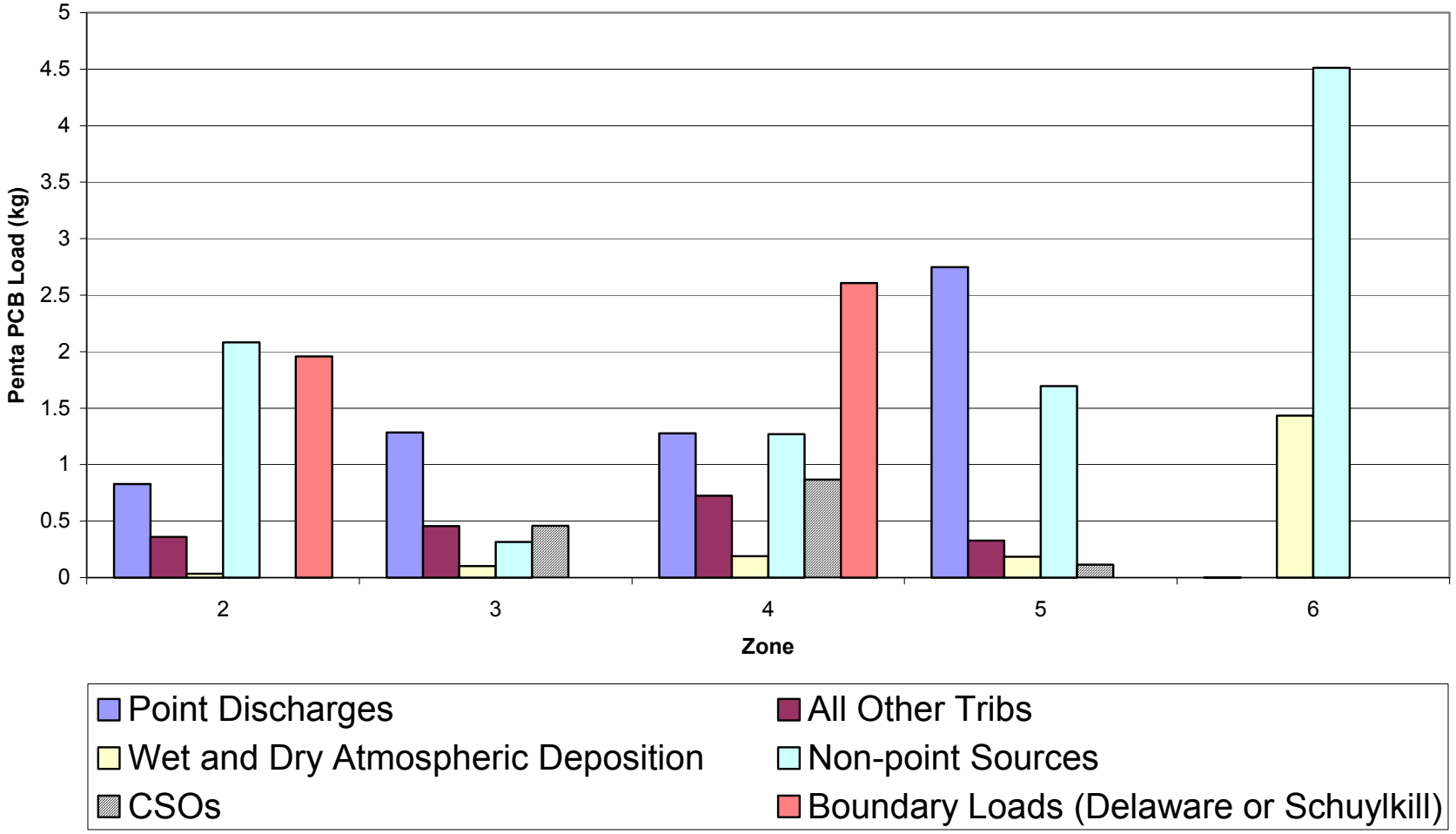
Penta PCB sources considered

- Boundaries
- Tributaries
- Point Discharges
  - WWTP
  - industrial wastewater
  - industrial stormwater
  - non-contact cooling water
- CSOs
- Atmospheric deposition
- Non-point sources
- Contaminated Sites

Estimated Total Penta PCB Load by Source Category to the Delaware Estuary During the Simulation Period (September 1, 2001 through December 31, 2002)
Excluding Contaminated Sites and Non-Contact Cooling Water

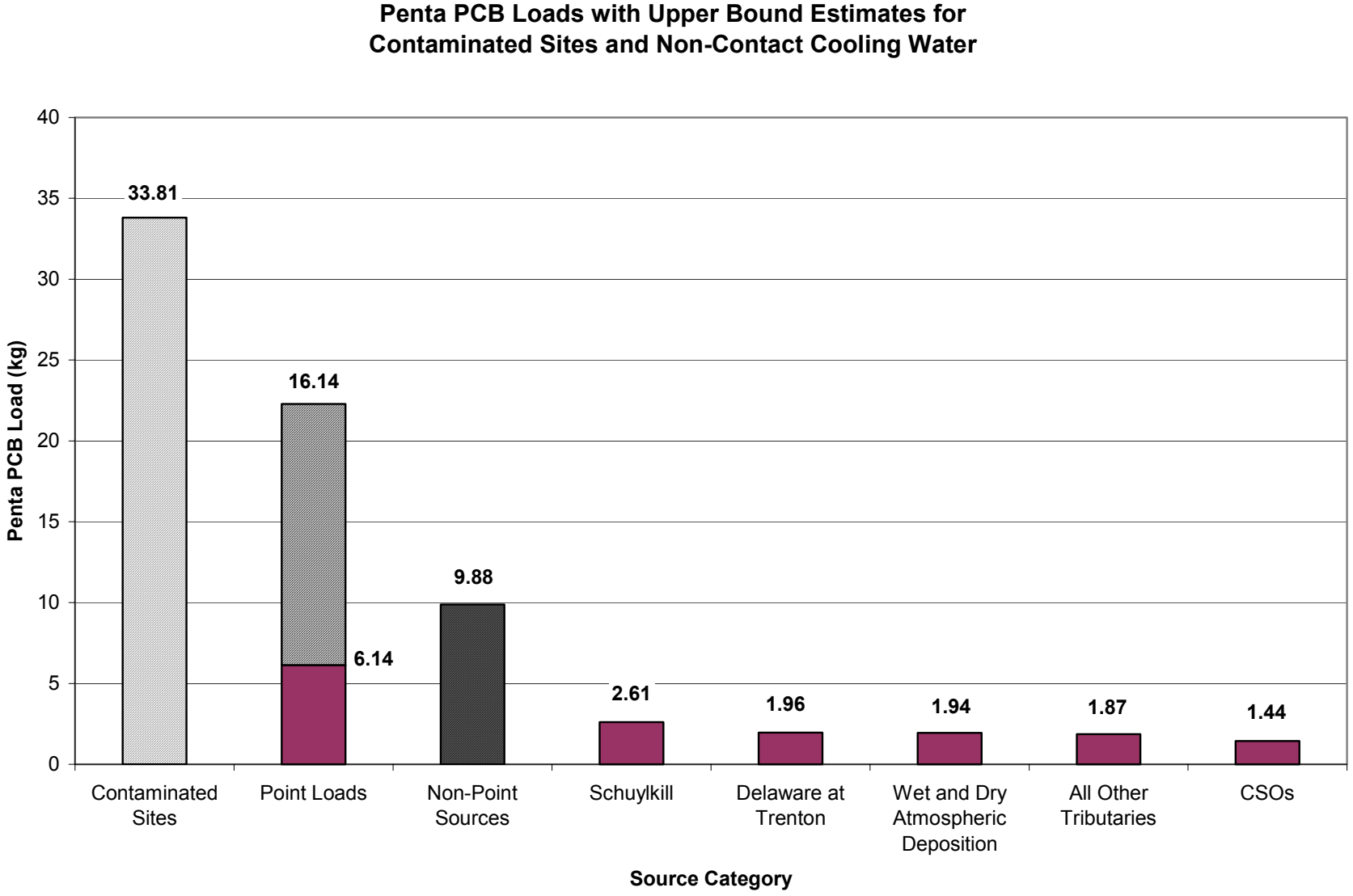


Estimated Total Penta PCB Load to the Delaware Estuary by Category for each Zone
During the Simulation Period (September 1, 2001 through December 31, 2002)
Excluding Contaminated Sites and Non-Contact Cooling Water



Contaminated Sites

- Federal Sites (NPL, Superfund)
  - Not yet available
- State Sites (DE, PA, NJ)
  - Delaware submitted a draft **upper bound** estimate
  - PA and NJ not yet available


Penta PCB Loads with Upper Bound Estimates for
Contaminated Sites and Non-Contact Cooling Water
Penta PCB Load (kg)
40
35
30
25
20
15
10
5
0
33.81
16.14
6.14
9.88
2.61
1.96
1.94
1.87
1.44
Contaminated Sites
Point Loads
Non-Point Sources
Schuylkill
Delaware at Trenton
Wet and Dry Atmospheric Deposition
All Other Tributaries
CSOs
Source Category

Loading Inventories

- A summary of the discussions on this topic will be presented by Mr. John Yagecic.
- Recommendations/Conclusions:
  - The marshes provide ~70% of the loadings of particulate detrital carbon to the estuary.
  - Most of the loadings of PDC from the marshes enters the lower portion of the estuary in Zone 6.
  - While further evaluation of the loading estimates should continue, organic carbon loads are sufficiently characterized.

Loading Inventories

- Recommendations/Conclusions:
  - Significant sources of penta PCBs include tidewater non-point sources, point source discharges and the two major tributaries.
  - Current loading estimates for contaminated sites and non-contact cooling water discharges suggest that these categories are also significant.
  - Each of the source categories for PCBs should be characterized as accurately as possible and include estimates of uncertainty.

Loading Inventories

- Recommendations/Conclusions:
  - Contaminated site loads are potentially important. **Complete estimates for USEPA, NJ, and PA are needed.**
  - Estimates for non-contact cooling water sources were not based upon reanalyzed data with lower detection limits. Should this source category prove to be significant, additional data collection should be conducted in Stage 2 to refine the net loading of PCB homologs.