Water Quality Assessment of the Tidal Freshwater Schuylkill River, Philadelphia, PA: Understanding Sources and Fate of Nutrients and Trace Metals in an Urban Stream

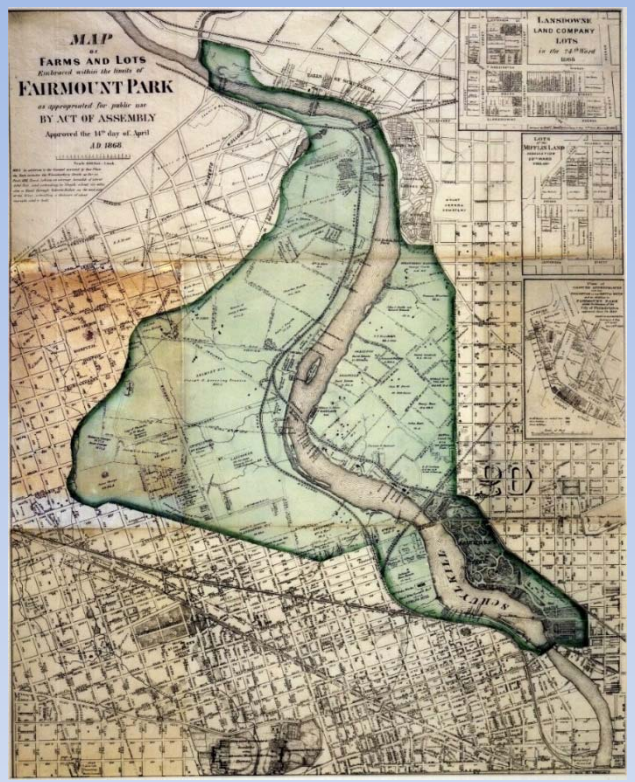
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Drexel University

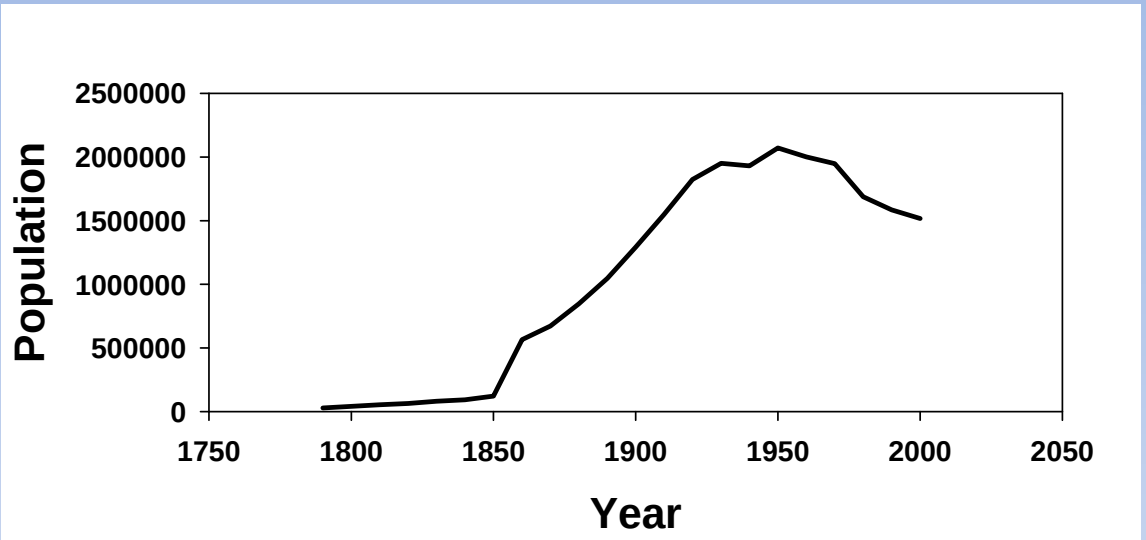
February 3, 2017

THE ACADEMY OF NATURAL SCIENCES of DREXEL UNIVERSITY

DREXEL UNIVERSITY College of Arts and Sciences
Biodiversity, Earth & Environmental Science

Population Growth Over Time in Philadelphia

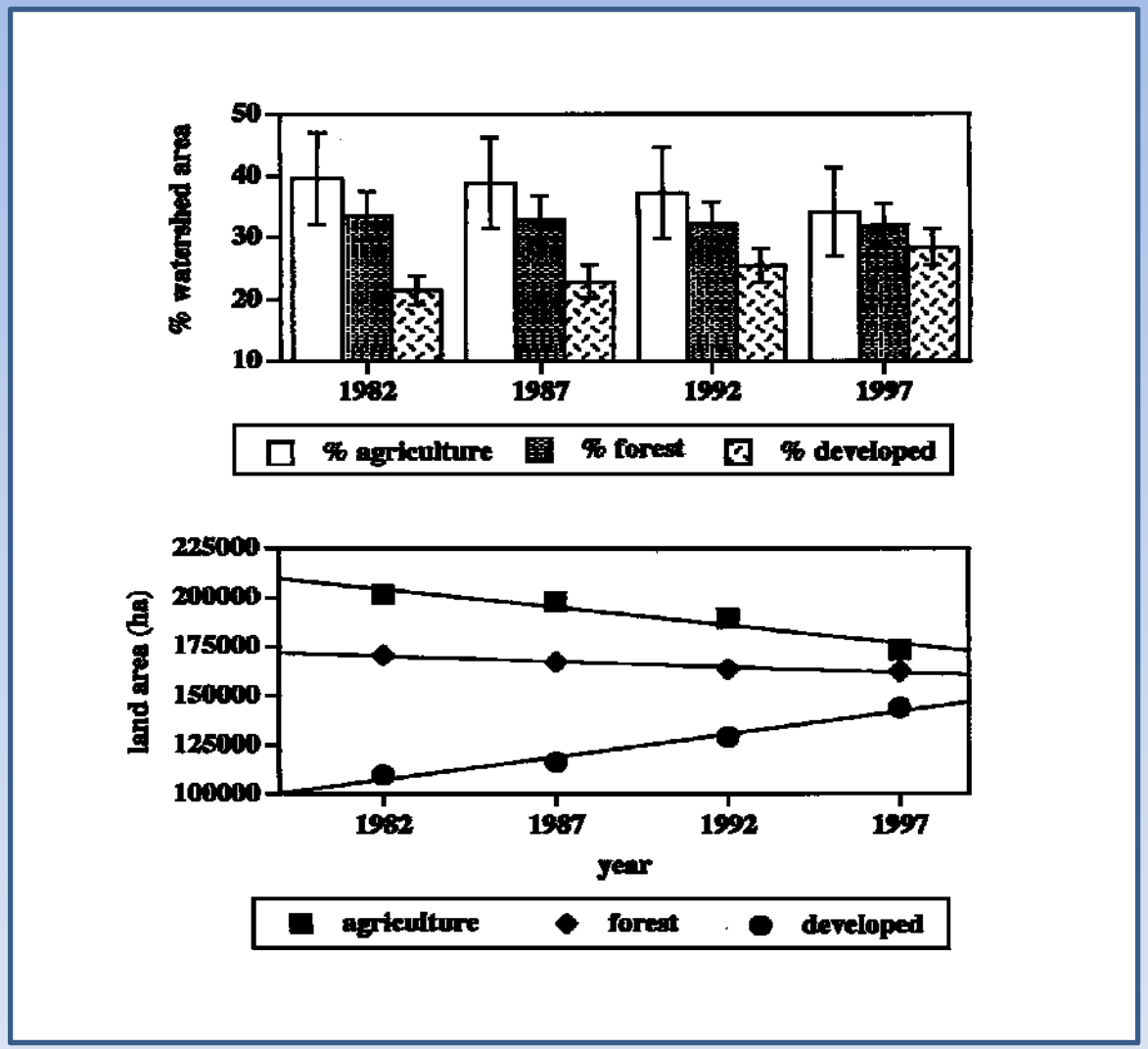






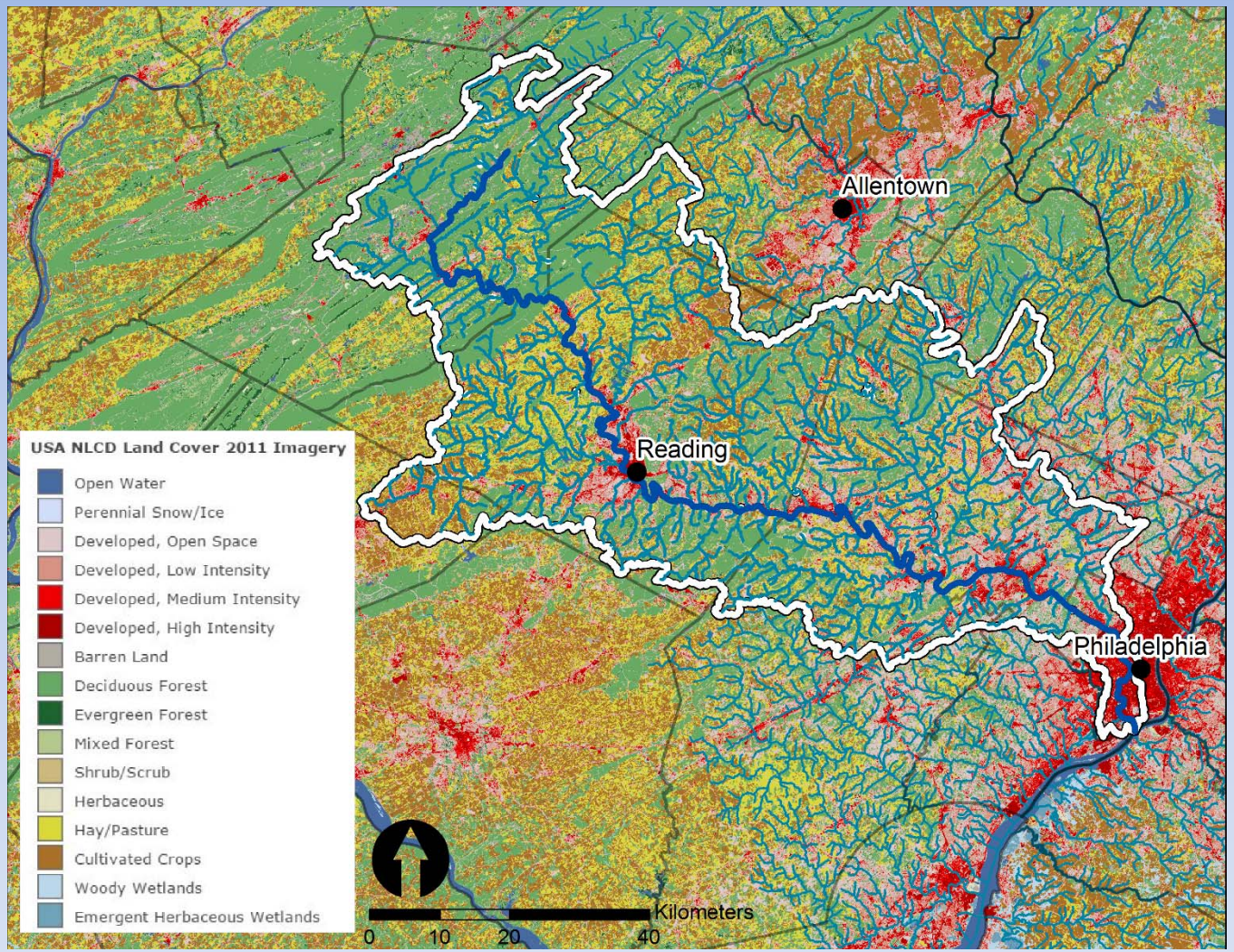


Land Use in the Schuylkill River Watershed

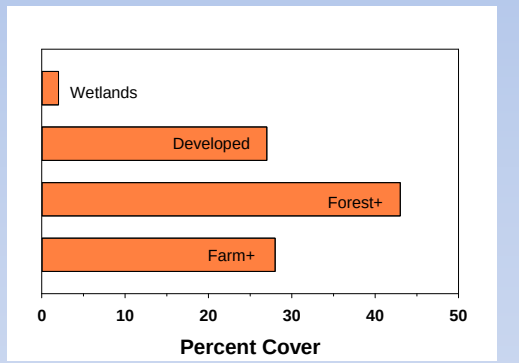


Data were obtained from the NRI, and are estimates based on specific site assessments and statistical averaging (Interlandi and Crockett, 2003).

Land Use in the Schuylkill River Watershed



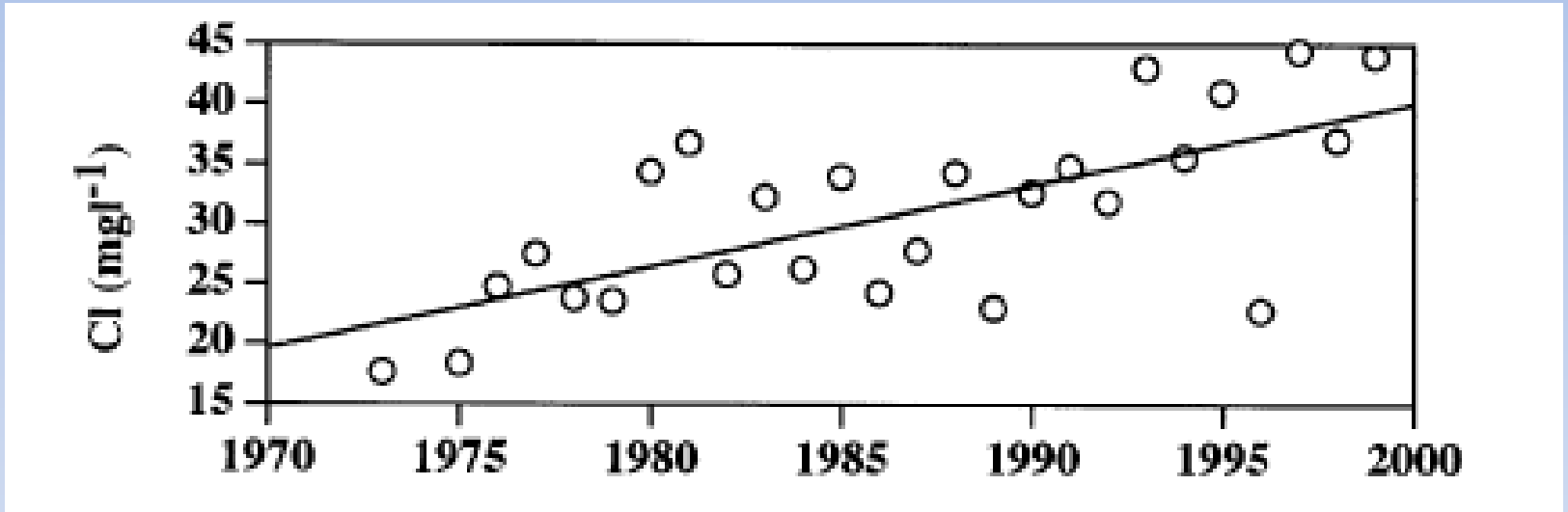
Current Land Use Summary



Total Area = 1.24M acres

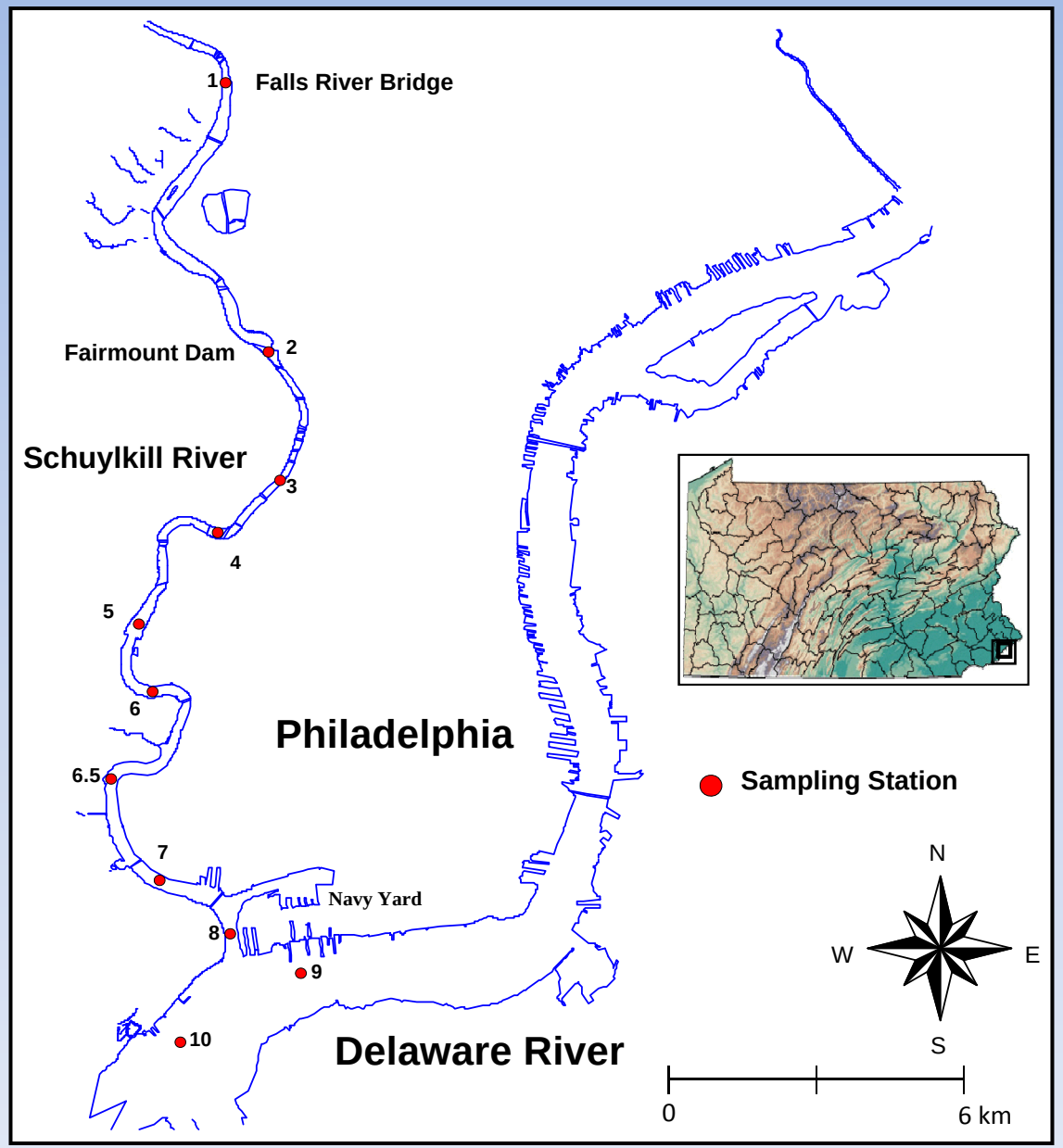
Population = 1.66M

Dissolved Chloride in Schuylkill River 1970-2000



(Interlandi and Crockett, 2003)

Sampling Locations: 1999-2000



Sampling and Analytical Methods

Sampling was accomplished using the Academy's RV Discovery in the tidal river at high tide during maximum ebb.

- Trace Metal Clean sampling and sample preparation techniques were used throughout the monitoring project, including:
- Sampling from upstream of boat using plastic pole
- Extensive cleaning procedure for trace metal system (i.e., conc HNO_3 and HCL bath)
- All Teflon pump system including tubing and bottles.
- Trace Metal Clean acids (Ultrex) were for sample preservation/preparation.
- A laminar flow clean bench was used during trace metal sample preparation and analysis.
- Dissolved(< 0.45 μm) and Total Recoverable Trace Metals: Pre-concentration of sample for trace metals via evaporation then analysis using Optima 3000 XL ICP-OES with ultrasonic nebulizer (EPA, 1992).
- Chlorophyll *a* and various inorganic and organic forms of C, N and P were analyzed using standard methods (Parsons et al., 1984; EPA, 1992; D'Elia et al., 1997)

Parameters:

In the Water

Basic Water Quality

Dissolved Oxygen
Temperature
Conductivity
Total Suspended Solids
Chlorophyll *a*

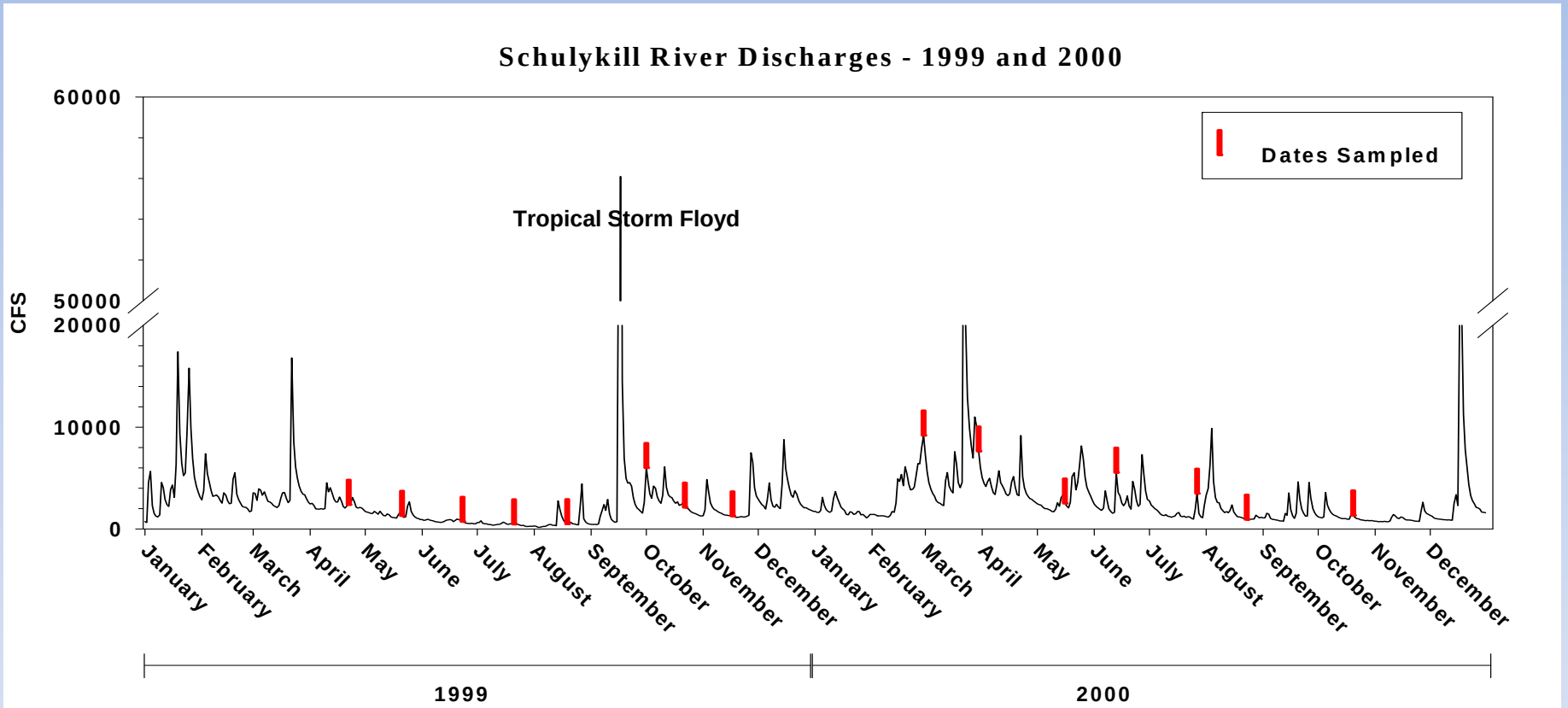
Nutrients (dissolved and particulate forms)

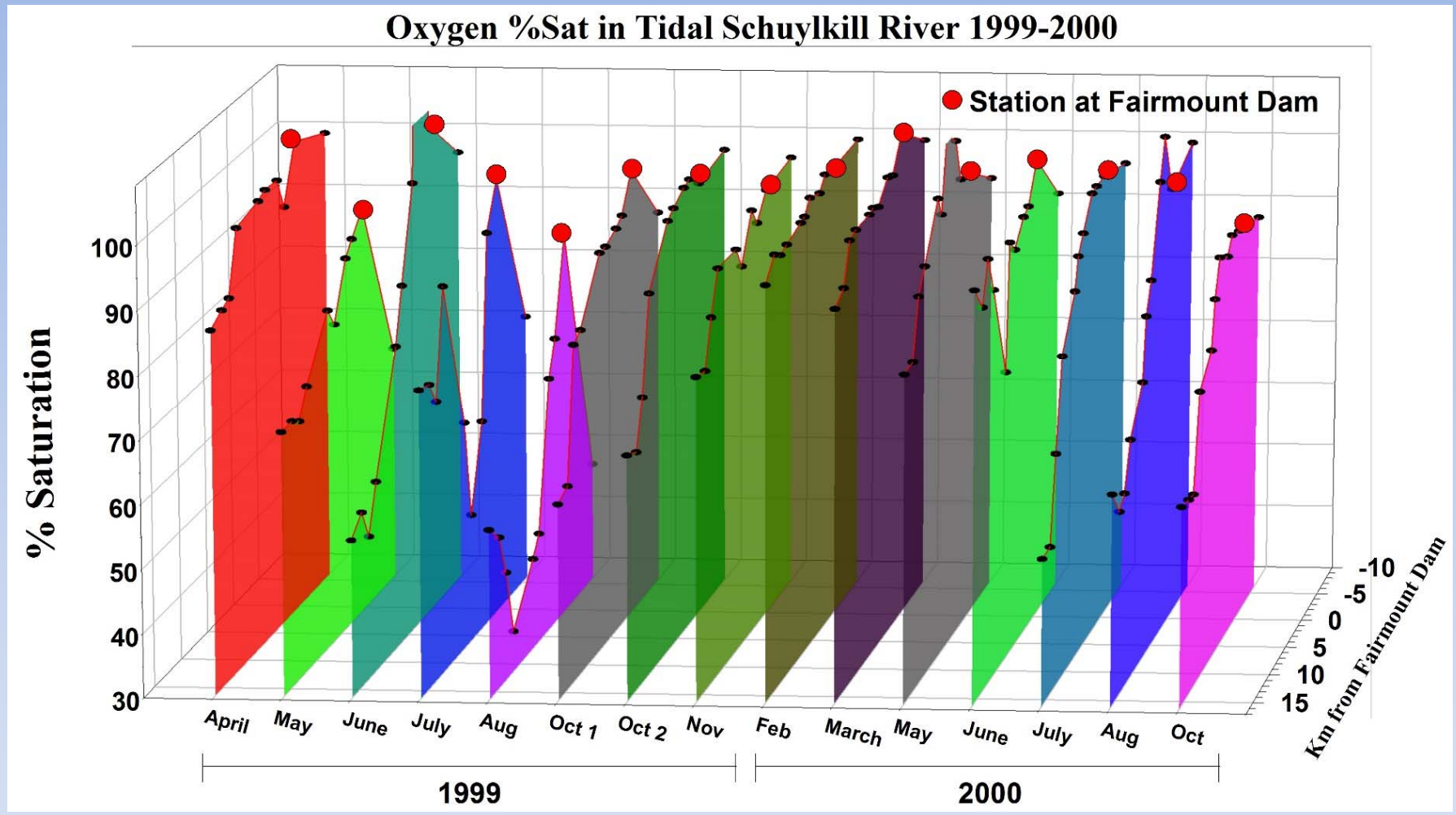
Nitrogen
Phosphorus
Carbon

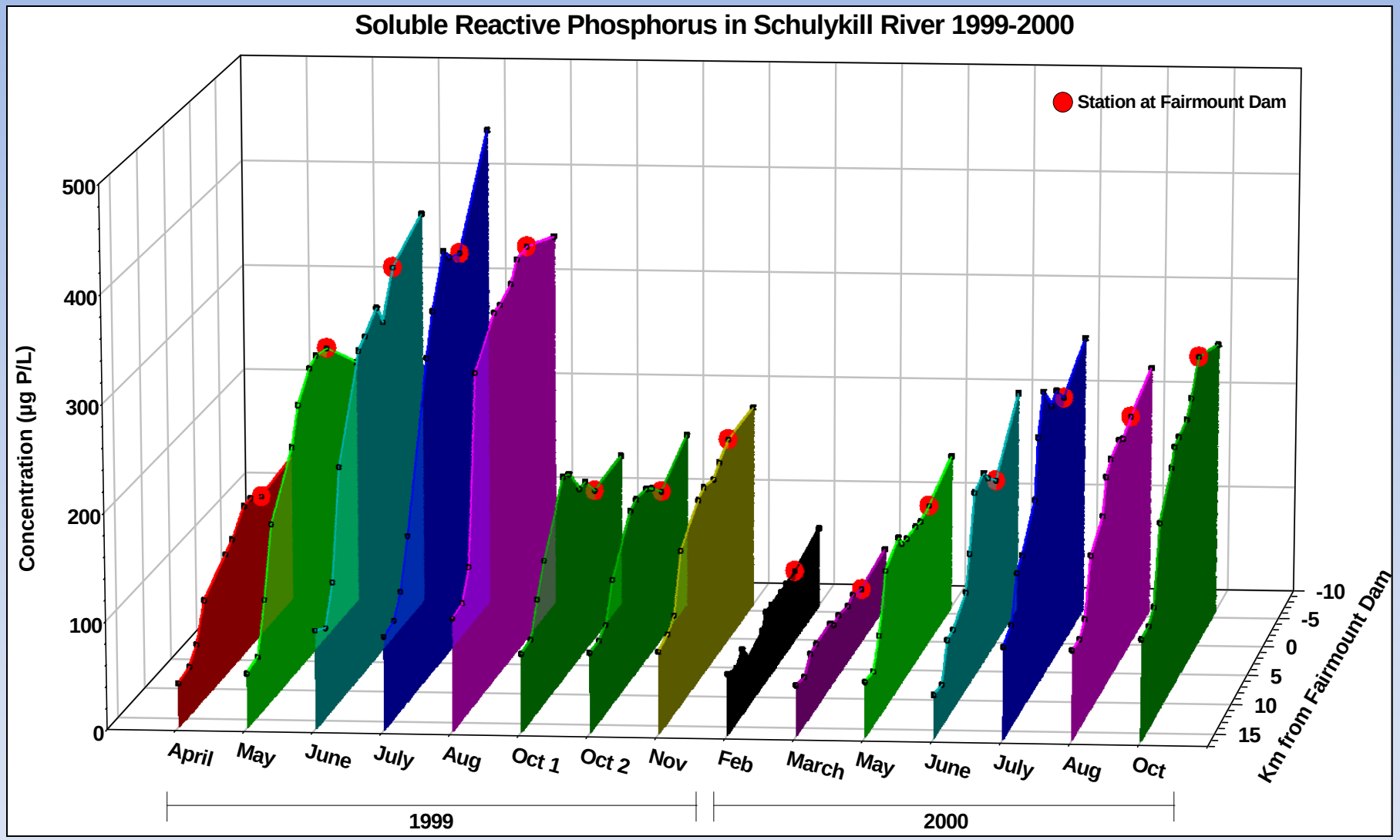
Trace Metals (total recoverable and dissolved)

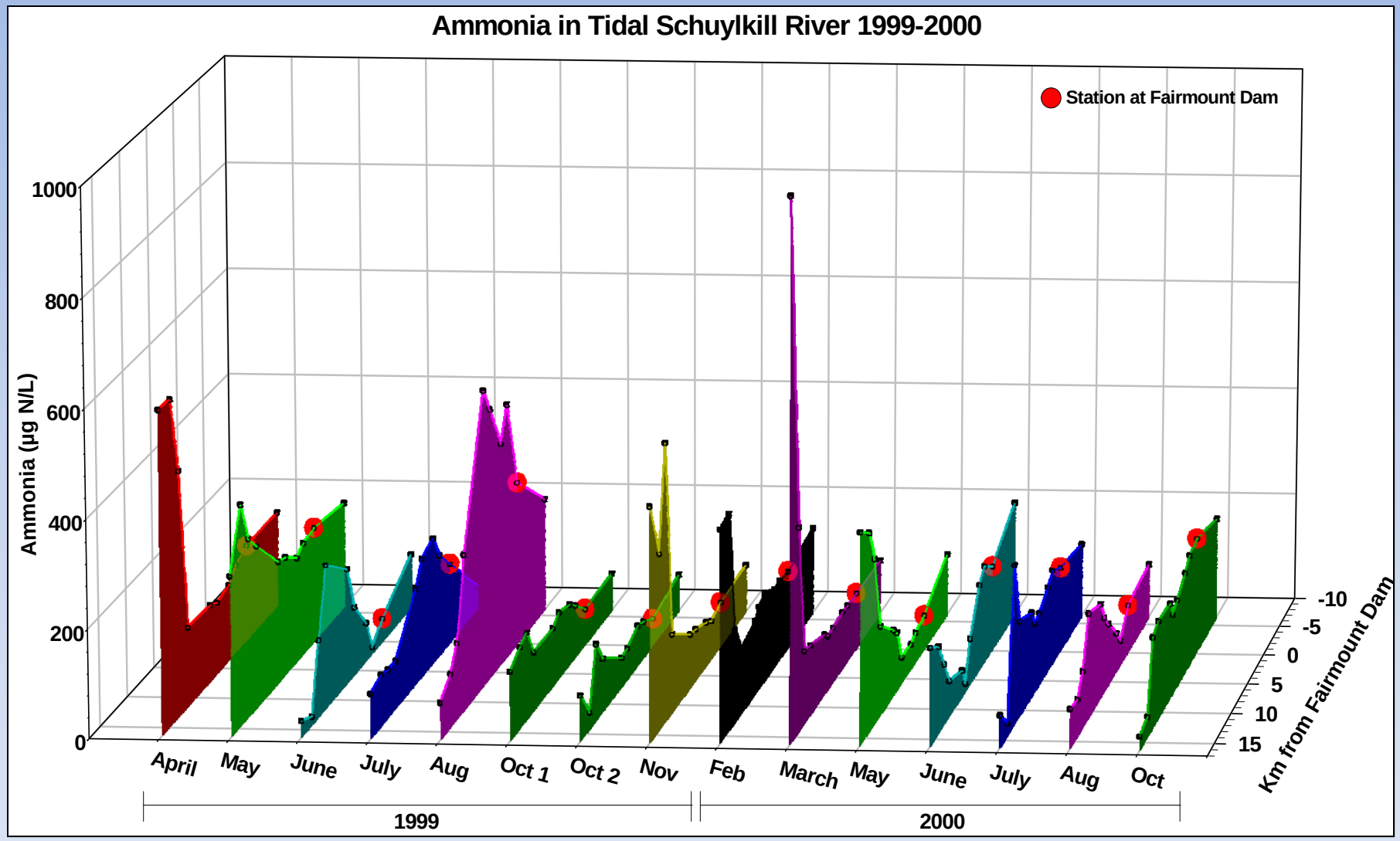
Copper, Cadmium, Lead, Nickel, Zinc, Chromium

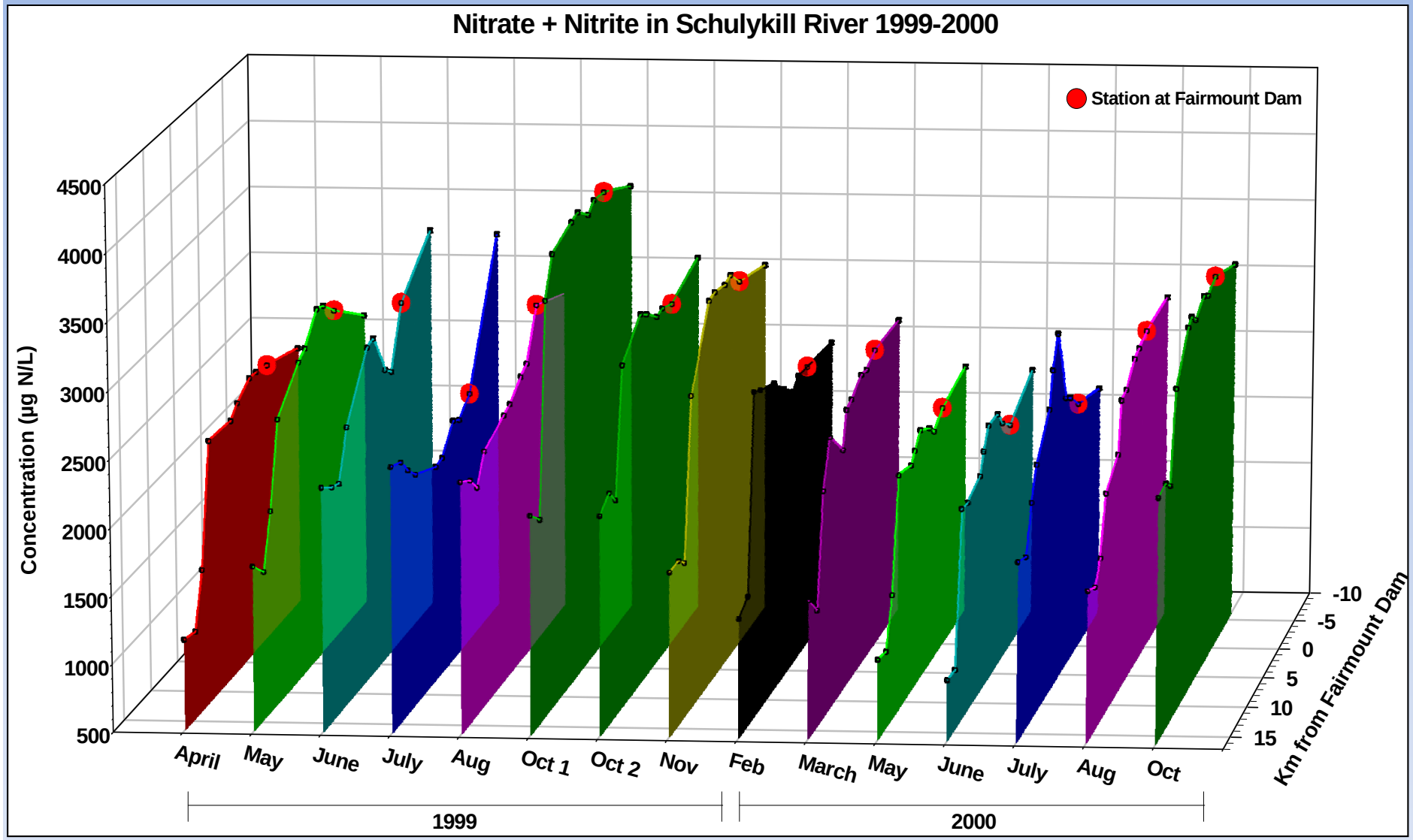
USGS Discharge Data

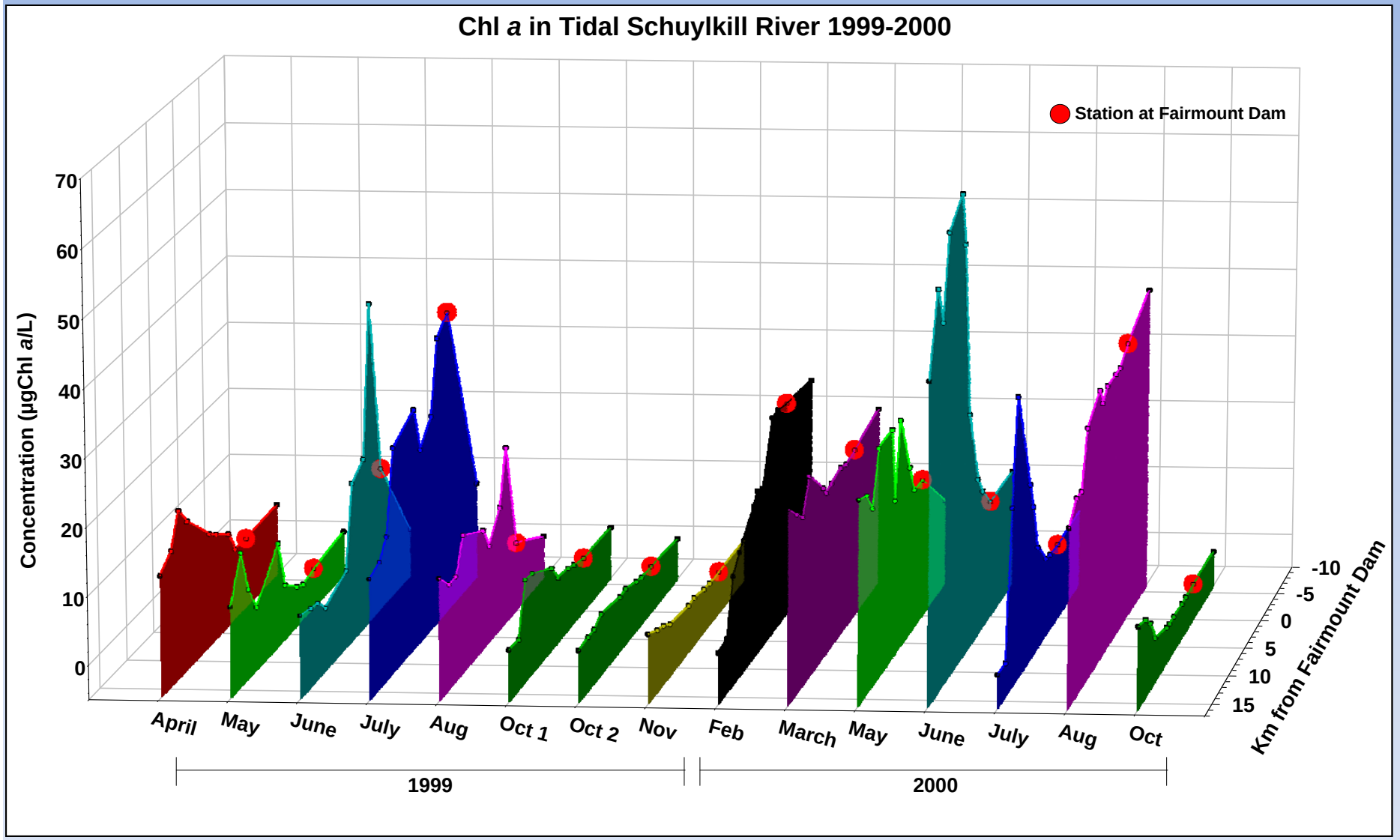


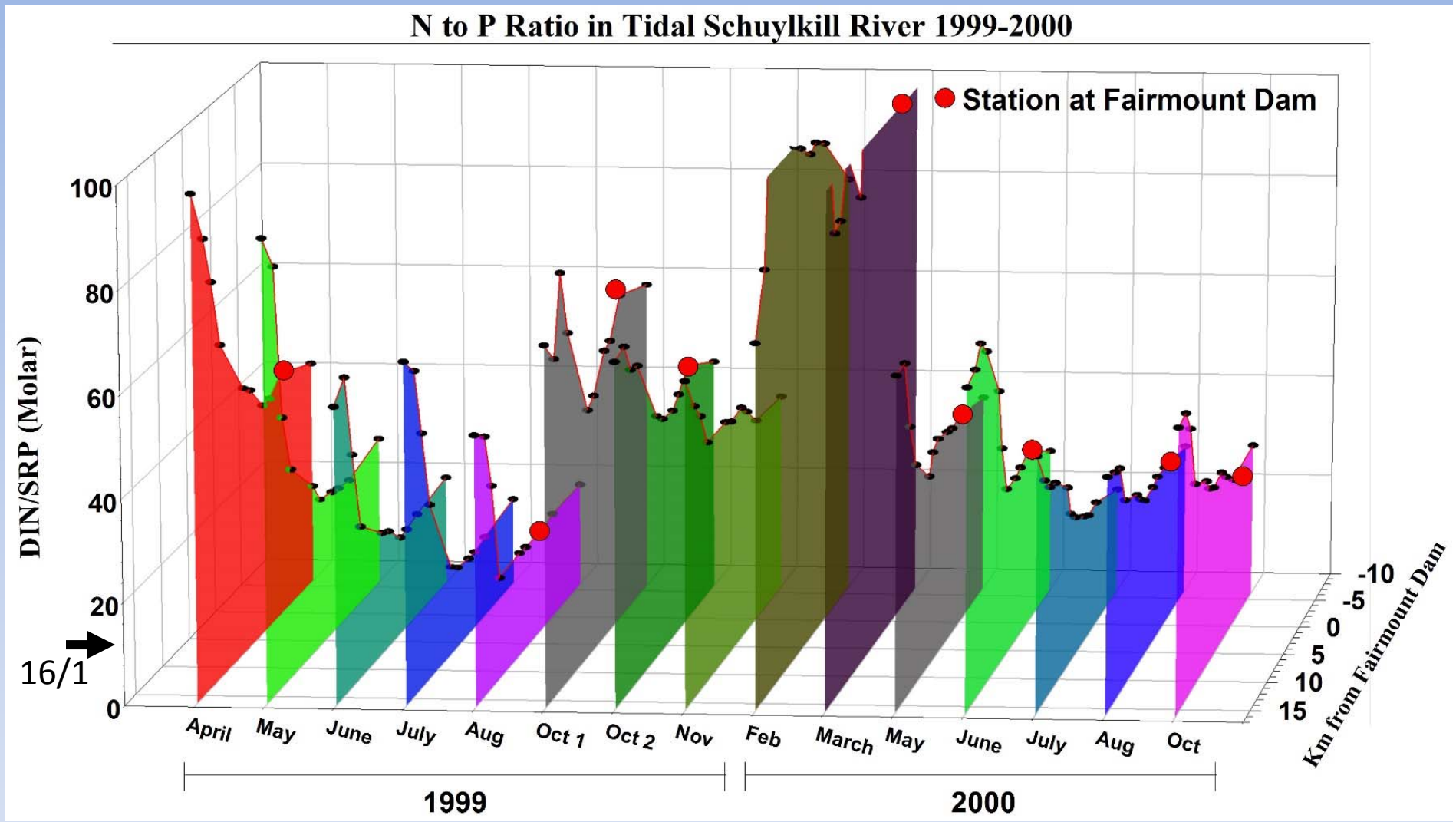

Oxygen %Sat in Tidal Schuylkill River 1999-2000
Station at Fairmount Dam
% Saturation
100
90
80
70
60
50
40
30
April
May
June
July
Aug
Oct 1
Oct 2
Nov
Feb
March
May
June
July
Aug
Oct
1999
2000
-10
-5
0
5
10
15
Km from Fairmount Dam


Soluble Reactive Phosphorus in Schulykill River 1999-2000
Station at Fairmount Dam
Concentration (µg P/L)
0
100
200
300
400
500
April
May
June
July
Aug
Oct 1
Oct 2
Nov
Feb
March
May
June
July
Aug
Oct
1999
2000
-10
-5
0
5
10
15
Km from Fairmount Dam


Ammonia in Tidal Schuylkill River 1999-2000
Station at Fairmount Dam
Ammonia (µg N/L)
0
200
400
600
800
1000
April
May
June
July
Aug
Oct 1
Oct 2
Nov
Feb
March
May
June
July
Aug
Oct
1999
2000
-10
-5
0
5
10
15
Km from Fairmount Dam

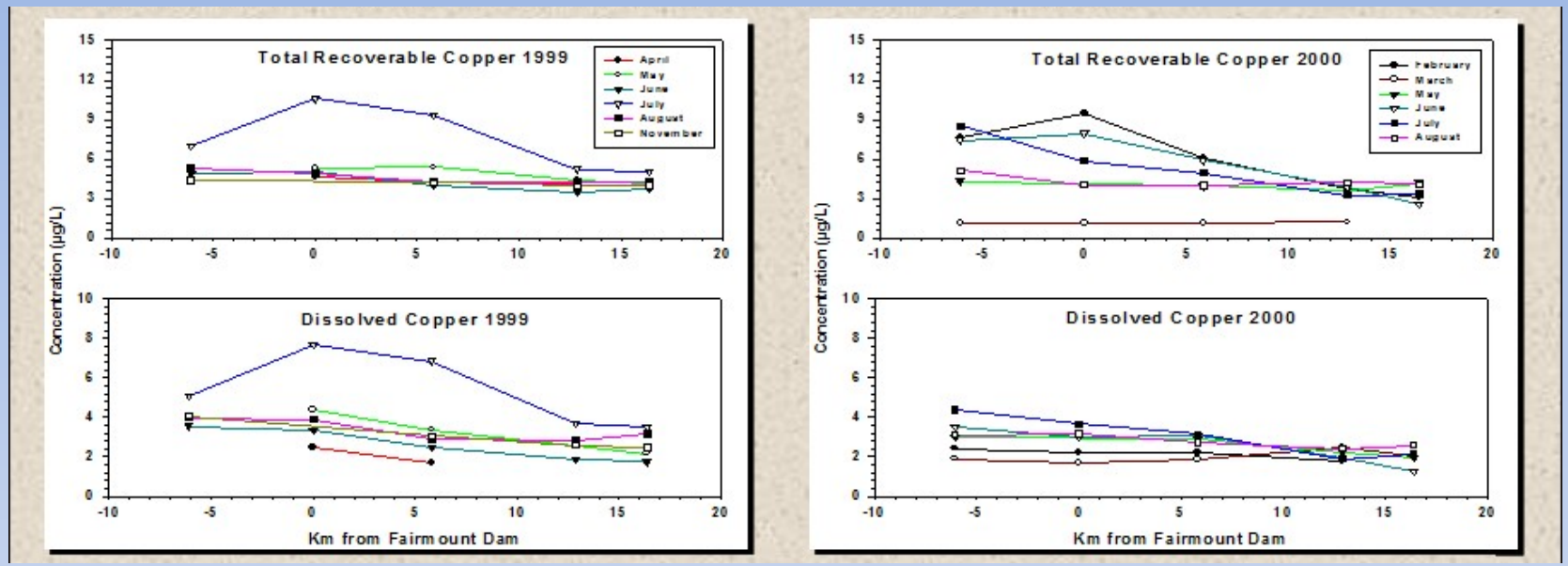

Nitrate + Nitrite in Schulykill River 1999-2000
Station at Fairmount Dam
Concentration (µg N/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
April
May
June
July
Aug
Oct 1
Oct 2
Nov
Feb
March
May
June
July
Aug
Oct
1999
2000
-10
-5
0
5
10
15
Km from Fairmount Dam

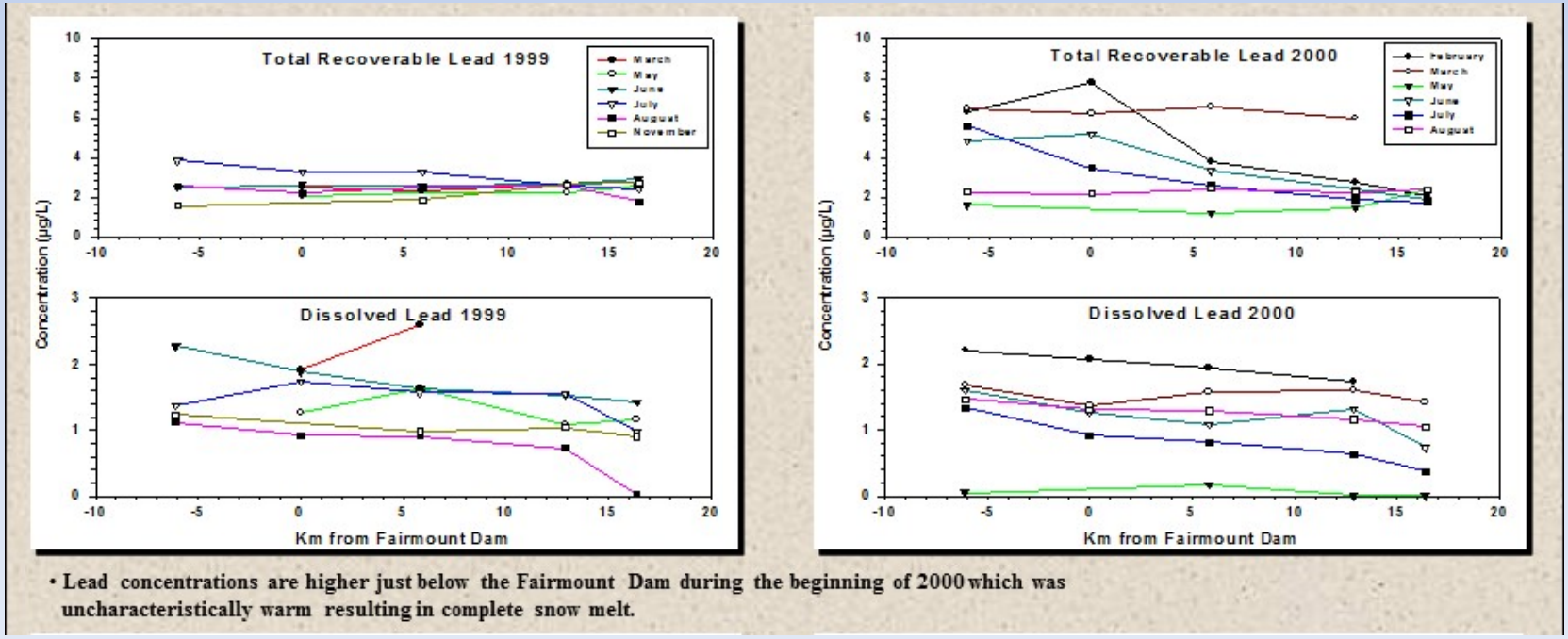

Chl a in Tidal Schuylkill River 1999-2000
Station at Fairmount Dam
Concentration (µgChl a/L)
70
60
50
40
30
20
10
0
April
May
June
July
Aug
Oct 1
Oct 2
Nov
Feb
March
May
June
July
Aug
Oct
1999
2000
-10
-5
0
5
10
15
Km from Fairmount Dam



Generally high N/P values indicate P limitation for the growth of algae in the river

Distribution of Selected Trace Metals in the Tidal Schuylkill River





- Lead concentrations are higher just below the Fairmount Dam during the beginning of 2000 which was uncharacteristically warm resulting in complete snow melt.

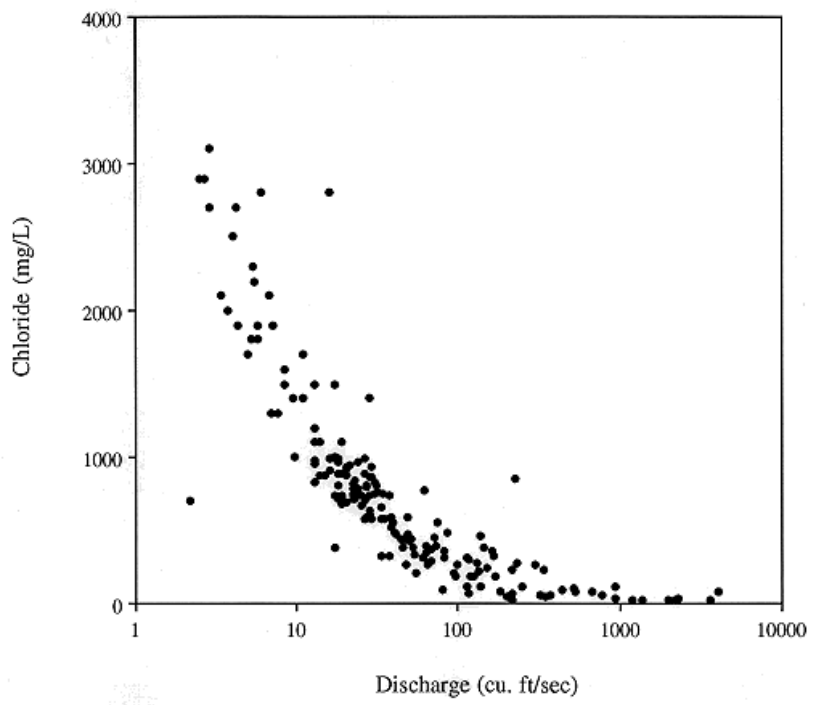
Metal Concentrations and Water Quality Criteria on Tidal Schuylkill River 1999 and 2000

Metal	Form	Range (Mean)[1] 1999	n	Range (Mean) 2000	n	WQC Acute[2]	WQC Chronic
Cadmium	Total Rec.	0.11 - 0.39 (0.19)	25	0.18 - 1.14 (0.46)	27	5	1.3
	Dissolved	0.03 - 0.20 (0.09)	25	0.02 - 0.22 (0.10)	27		
Chromium	Total Rec.	0.42 - 2.60 (0.88)	25	0.58 - 3.48 (1.50)	27	2,016	240
	Dissolved	0.07 - 0.84 (0.30)	25	0.01 - 0.52 (0.23)	27		
Copper	Total Rec.	3.46 - 10.6 (5.01)	25	2.99 - 9.44 (5.28)	27	21	14
	Dissolved	1.72 - 7.70 (3.42)	25	1.24 - 4.39 (2.53)	27		
Lead	Total Rec.	1.54 - 3.84 (2.52)	25	1.19 - 7.76 (3.23)	27	48	16
	Dissolved	0.02 - 2.59 (1.34)	25	0.05 - 2.21 (1.24)	27		
Nickel	Total Rec.	1.79 - 6.21 (3.27)	25	1.66 - 6.67 (3.30)	27	1,654	184
	Dissolved	1.48 - 4.86 (2.92)	25	0.49 - 5.01 (1.94)	27		
Zinc	Total Rec.	8.70 - 17.7 (11.6)	25	6.19 - 26.8 (12.1)	27	136	124
	Dissolved	4.27 - 10.0 (7.37)	25	1.20 - 6.62 (3.33)	27		

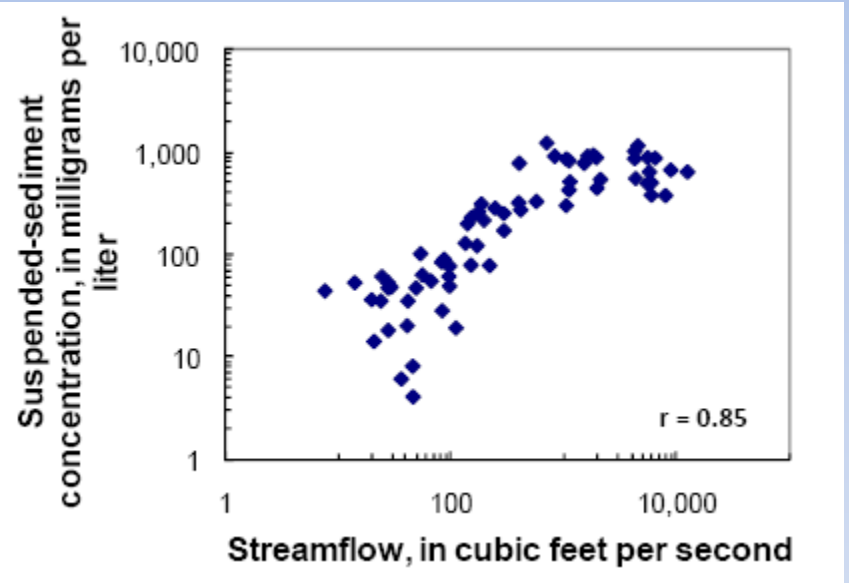
[1] All units are in µg/L

[2] Water Quality Criteria (units = µg/L) - Calculated from Delaware River Basin Commission Water Quality Regulations 1996 as Total Recoverable metal. Using a average hardness of 120 mg/L. Chromium is the trivalent form.

Relationship with discharge of the river: Point and non point sources

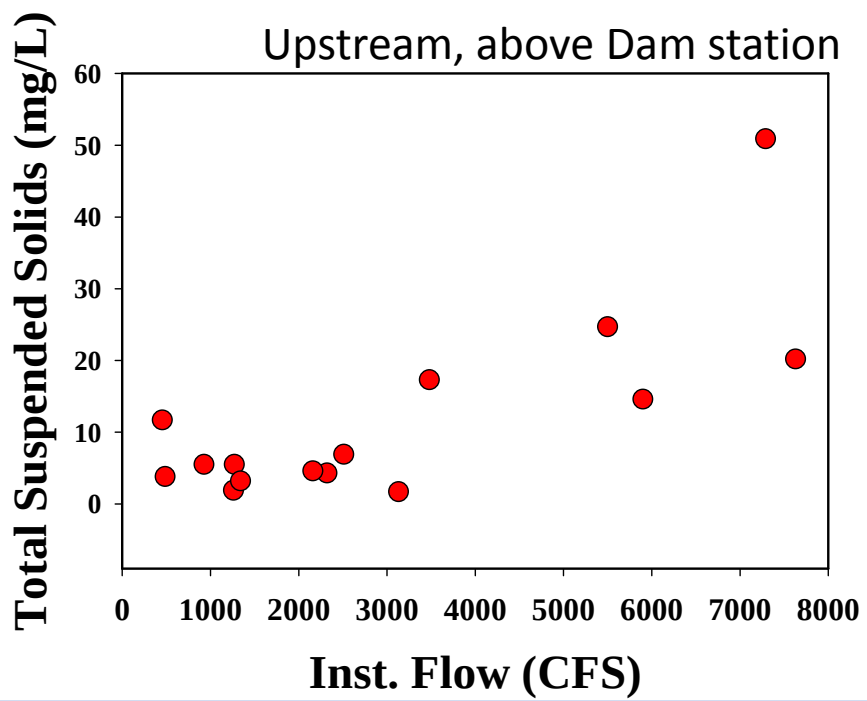


Example of a point source dominated river: dilution

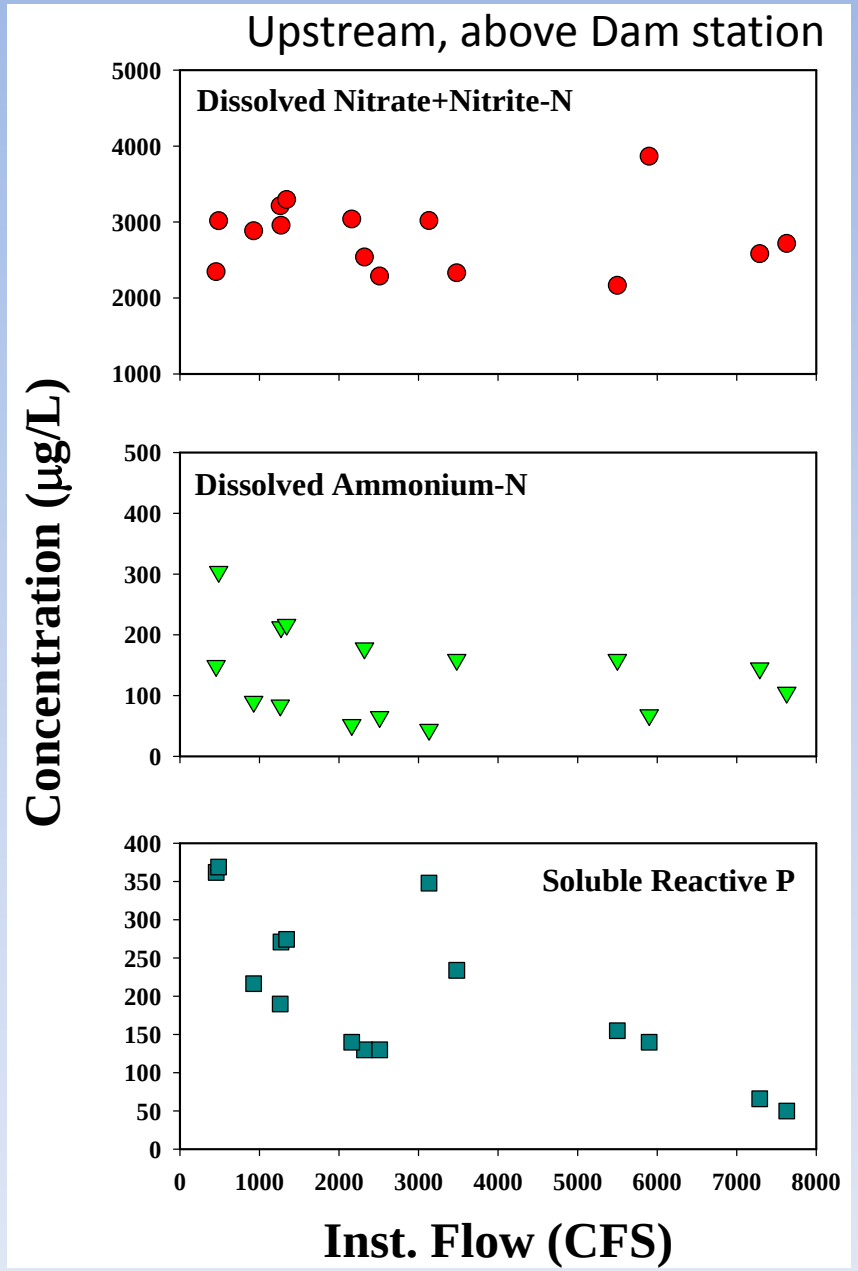


Example of a non-point source dominated river: increase with discharge

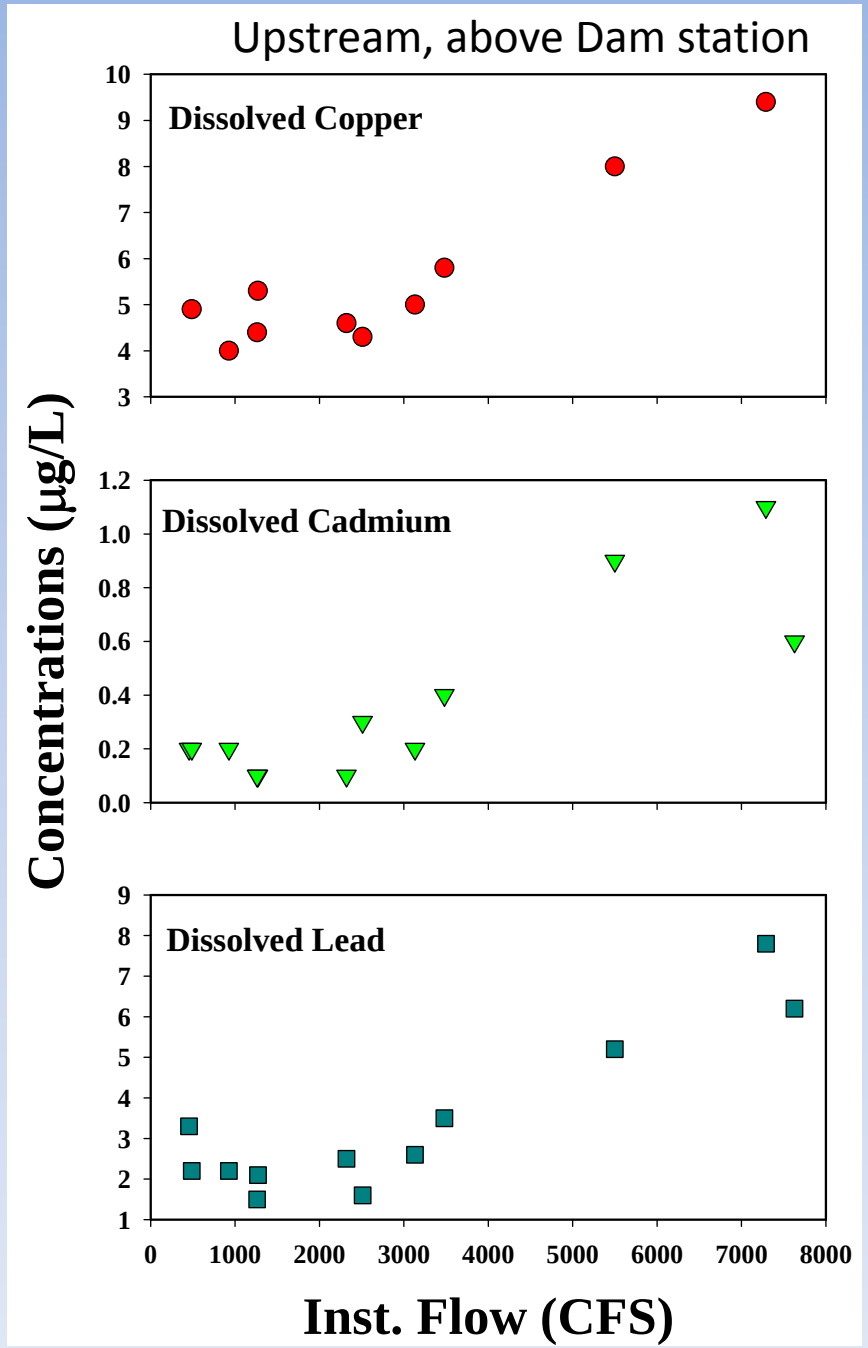
Was there a relationship with flow of the river?



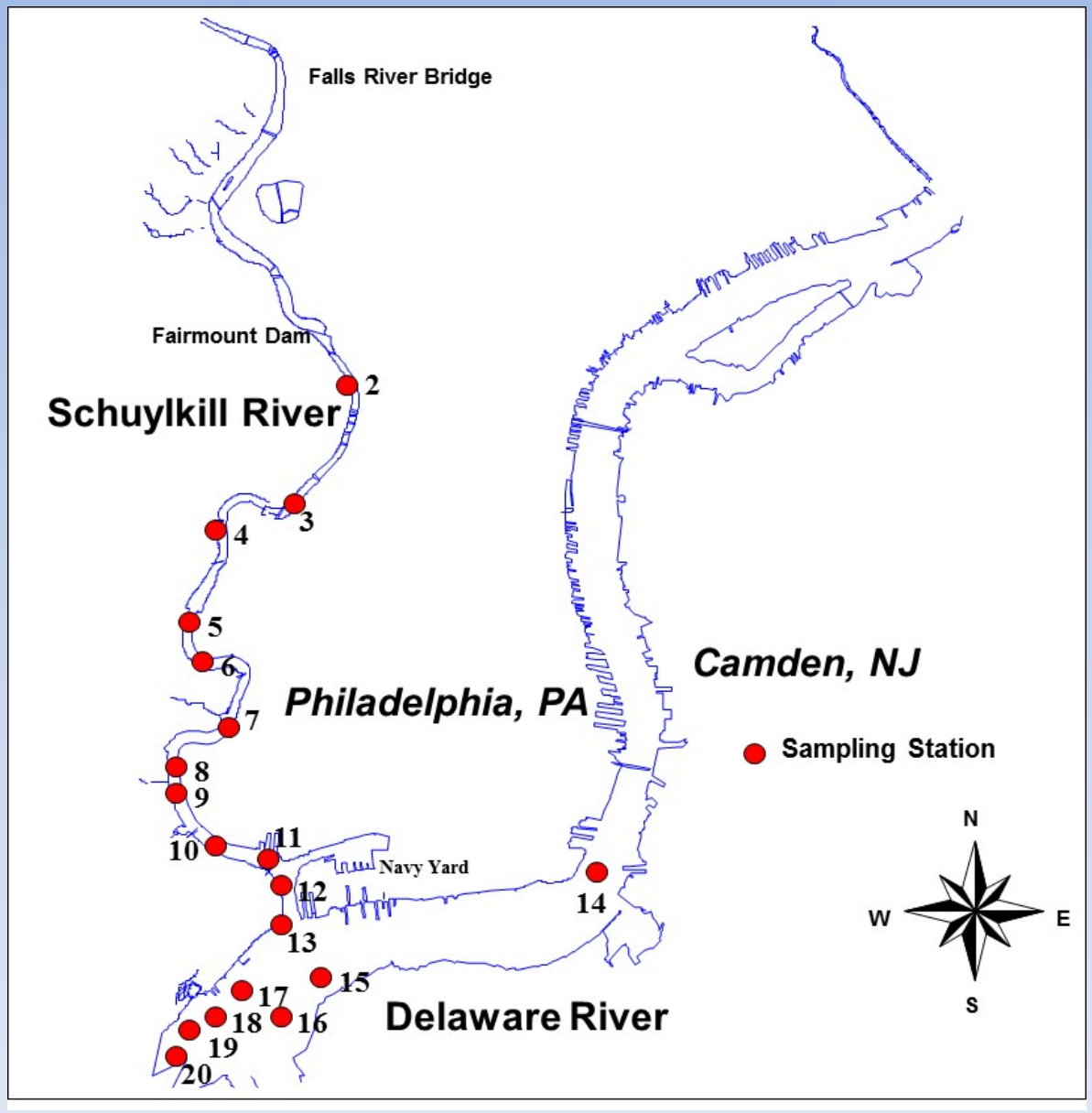
…higher discharge mobilized sediment and diluted dissolved phosphorus



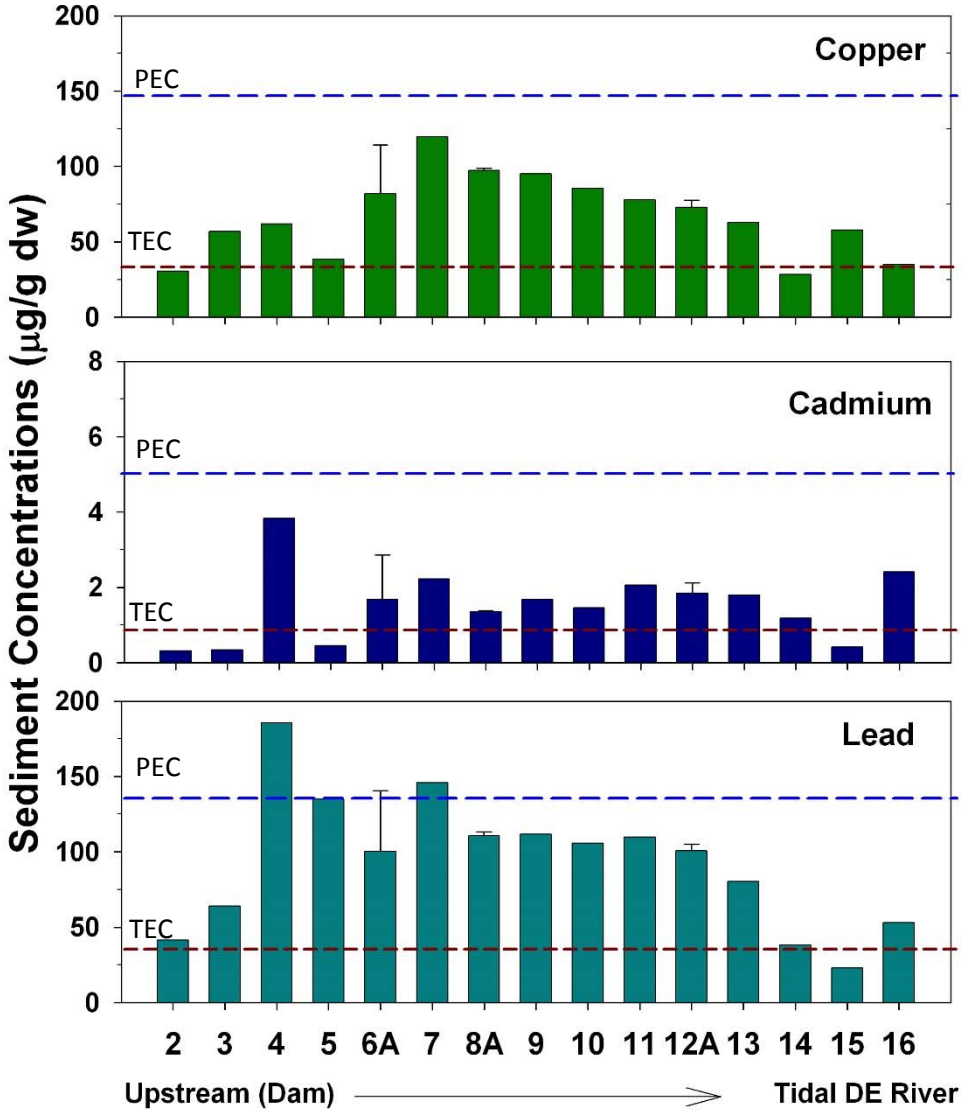
Dissolved Trace Metals

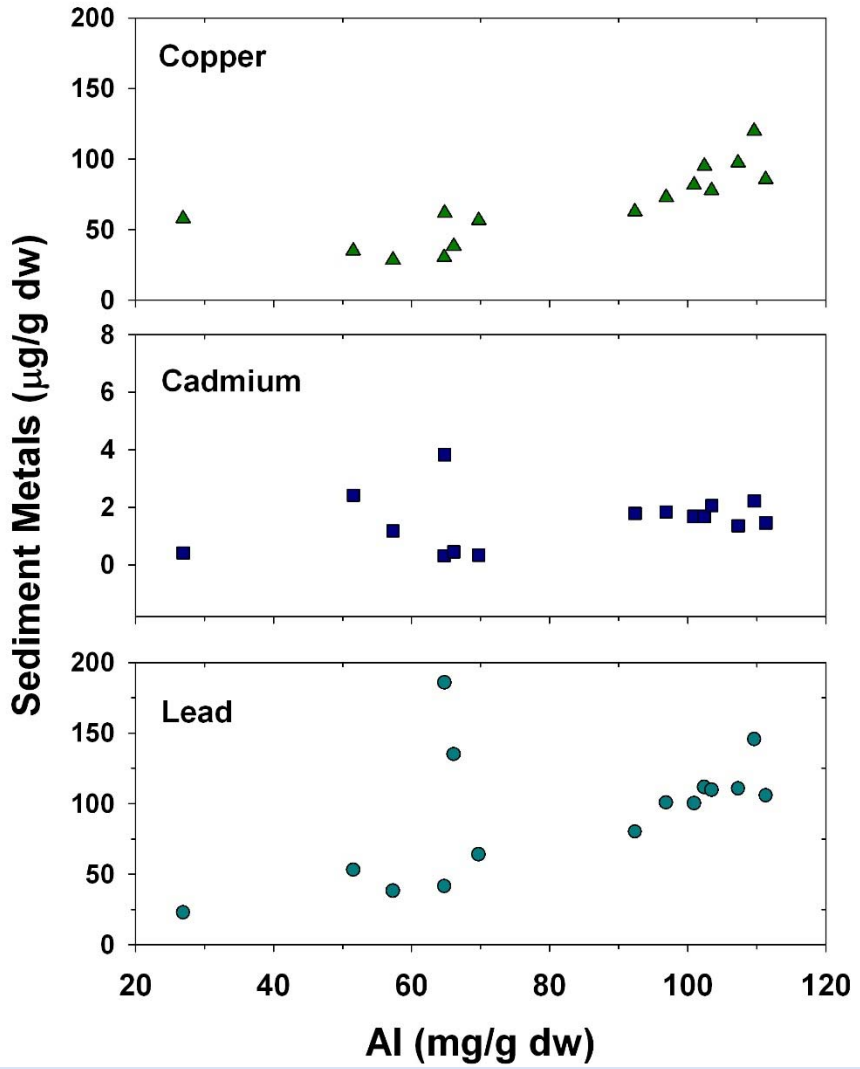


Sediment Sampling in Tidal River



Distribution of Selected Trace Metals in the Bottom Sediments of the Tidal Schuylkill River



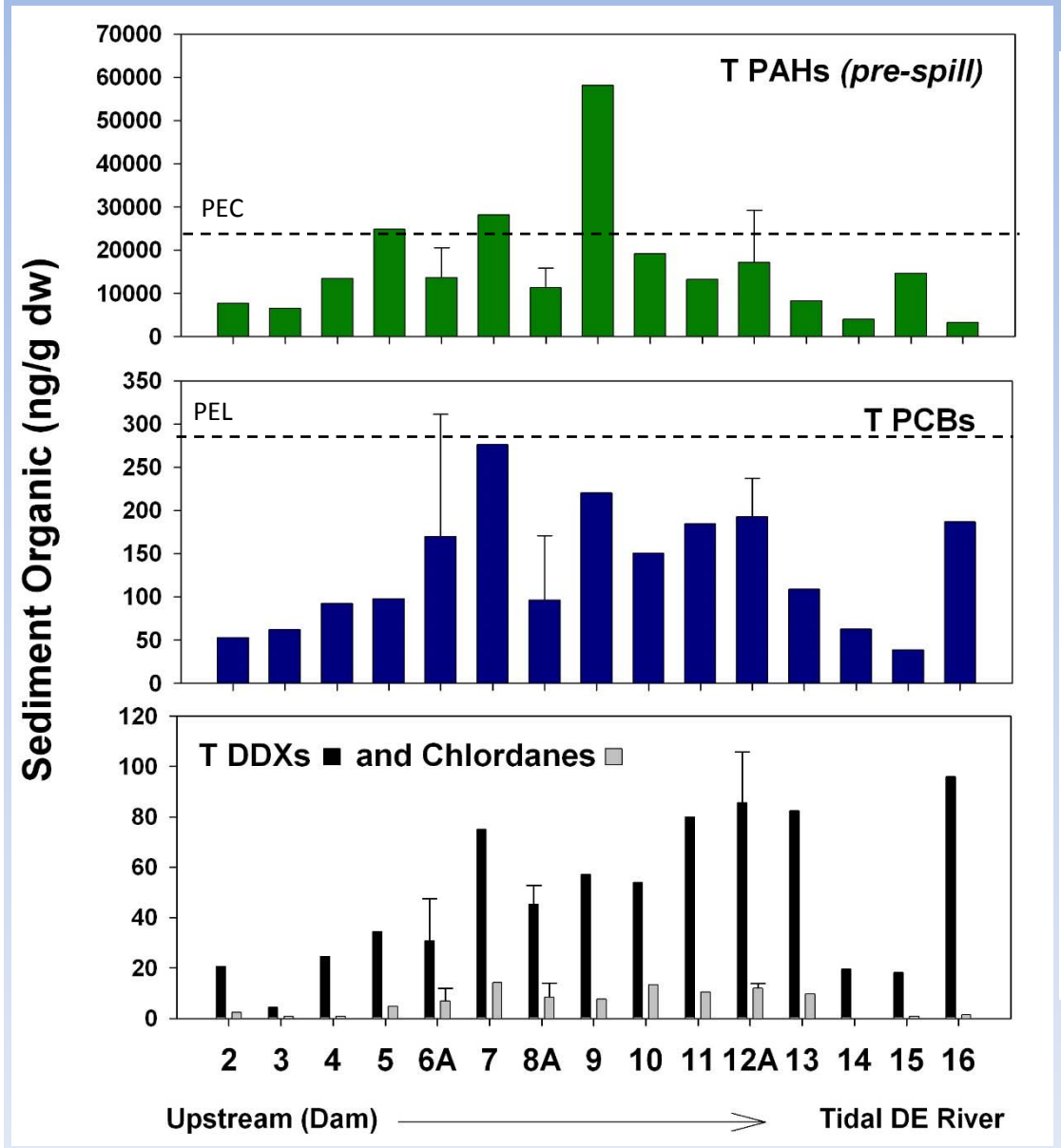


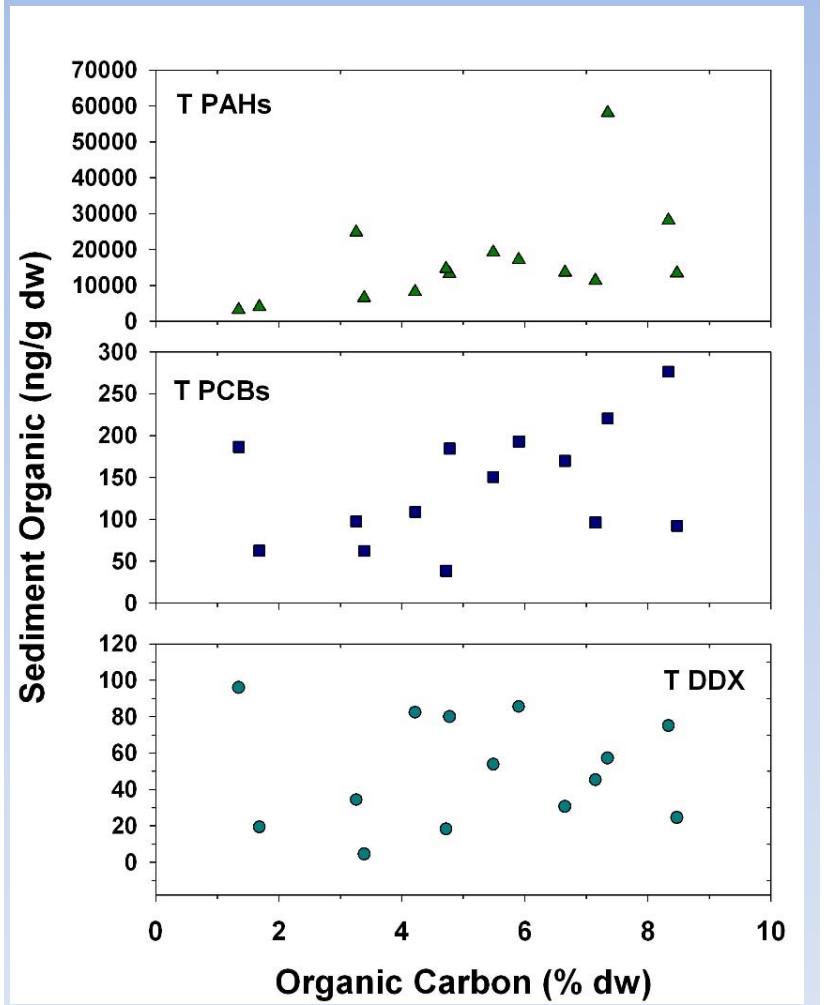
TEC – Threshold Effect Concentration

PEC – Probable Effect Concentration

EPA 905/r-0007 (June 2000)

Distribution of Selected Organic Contaminants in the Bottom Sediments of the Tidal Schuylkill River





Summary

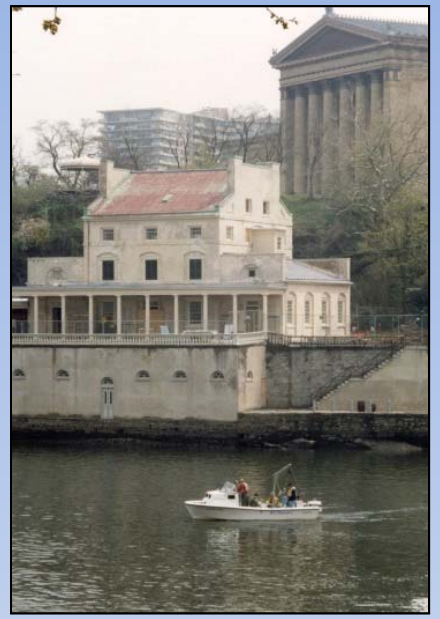
- The monitoring of the tidal Schuylkill River has revealed substantial biogeochemical reactions are modifying the flux of material to the mainstem tidal Delaware River.

- The distribution of specific trace metals indicate a source downstream of the main urban core of Philadelphia; some sediment contaminants are near or above published effects level guidelines.

- The data generated from this effort will be used for a dynamic model of the entire Delaware Estuary and allow a better understanding of the sources of nutrients and trace metals.



Questions?



Thank you to A.R. Boettner (ANS DU), T. Fikslin (DRBC), P. Kiry (ANS DU), J. DeAlteris (ANS DU), A.M. Compton (ANS DU), R.T. Thomas (ANS DU) and A. Wilson-Finelli (ANS DU)

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