Nutrient Load Estimates for Lake Erie in 2005

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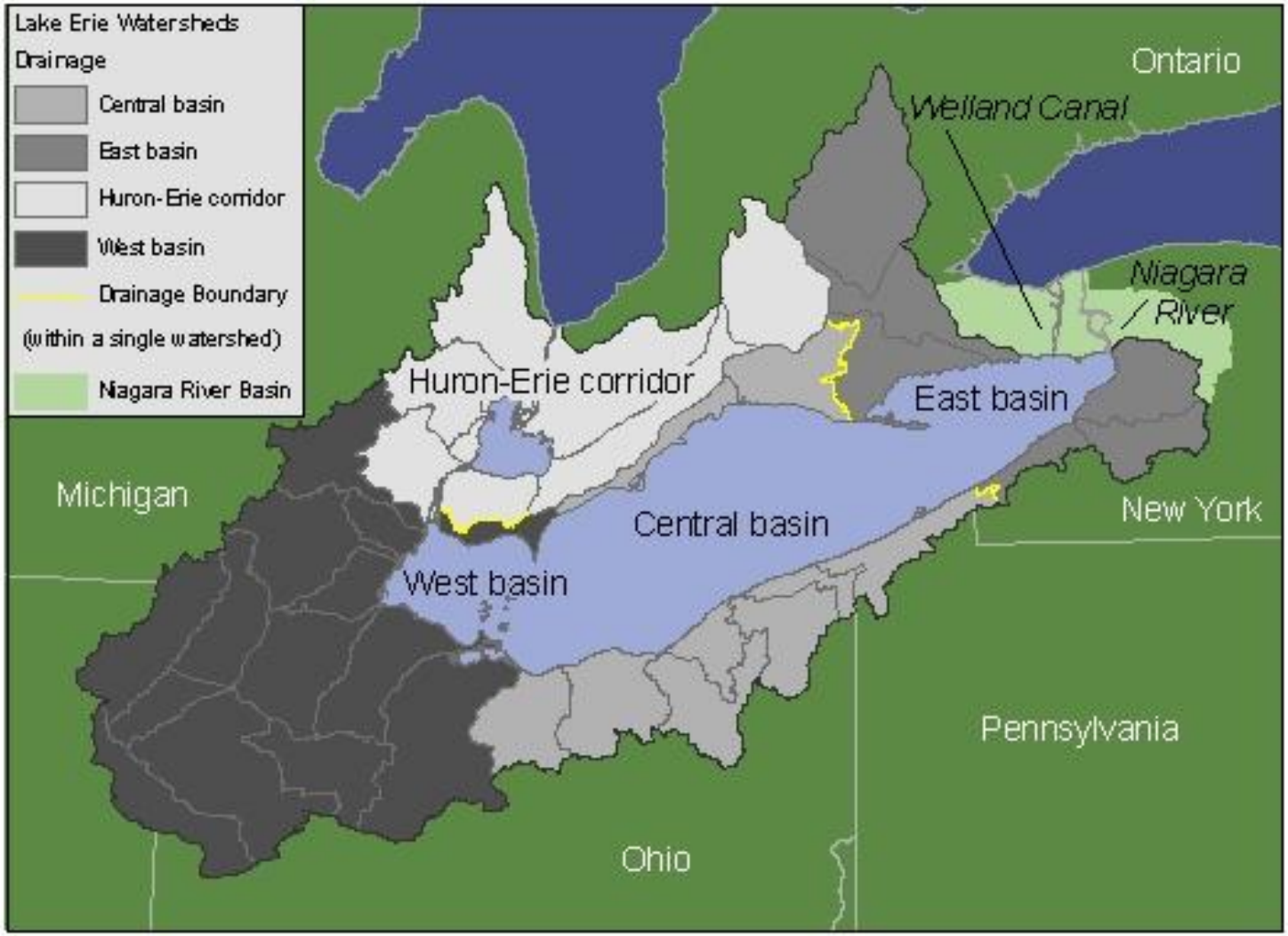
Background

- Ecological Forecasting (ECOFORE 2006): Hypoxia Assessment in Lake Erie
- Ecological Effects Team
- Hypoxia Team
- Watershed Loadings Team

ECOFORE Nutrient Loading Objectives

- Develop a comprehensive assessment of past, present, and projected future nutrient inputs to Lake Erie by:
  - Estimating Nutrient Loads for all tributaries
  - Quantifying Watershed Mass Balances
  - Evaluating Conservation Practices
  - Developing Models of Hydrology and nutrient Export for Back-Casting and Forecasting


Lake Erie Watersheds
Drainage
Central basin
East basin
Huron-Erie corridor
West basin
Drainage Boundary
(within a single watershed)
Niagara River Basin
Ontario
Welland Canal
Niagara River
Huron-Erie corridor
East basin
Michigan
Central basin
New York
West basin
Pennsylvania
Ohio

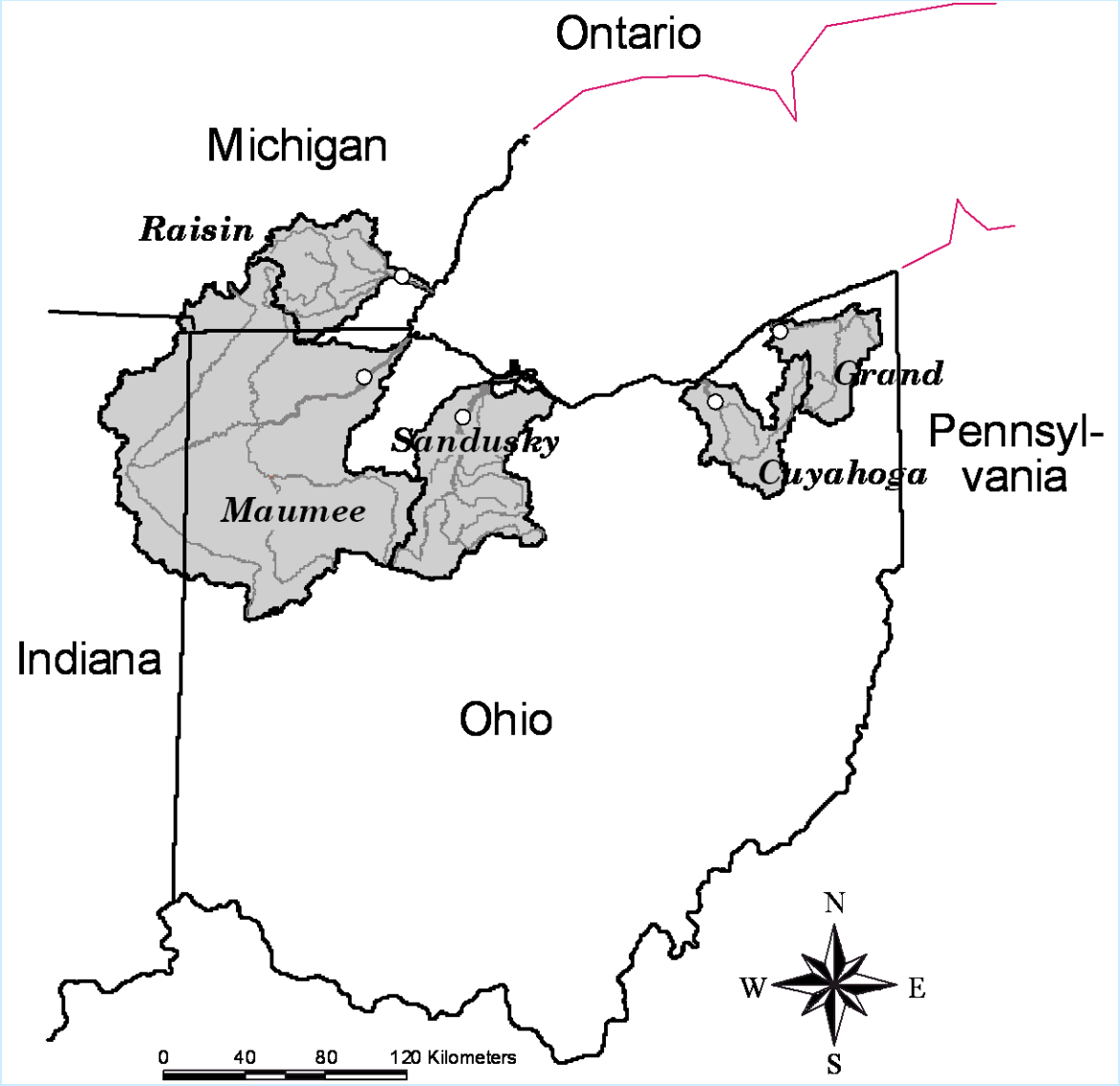
UWGB Objectives

- Continue Total Phosphorus Load Estimates for 2003-2007
- Collate Data from Diverse Sources into Common Formats
- Provide Spatially and Temporally Detailed Estimates for 1976, 2005, and 2007
- Estimate Loads for SRP, Suspended Solids, and other nutrients as needed

Six Lake Erie Tributaries

- From Ohio Tributary Monitoring Network
- Sampled One to Three Times Daily for Flow, Nutrients, and Suspended Solids
- Basis for Detailed Spatial and Temporal Total Phosphorus Loads
- Maumee*, Sandusky*, Grand, Raisin, Cuyahoga, Vermilion Rivers

* Sampling began October 1, 1975



The locations of the sampling stations are indicated with dots.

Data Sources

- U.S. Point Sources: Permit Compliance System (PCS)
- U.S. Tributary Flow: U.S.G.S.
- U.S. Tributary Concentrations: STORET
- Canadian Point Sources: MOE
- Canadian Tributary Flow: Water Survey
- Canadian Tributary Concentrations: MOE
- Atmospheric Flux: Environment Canada

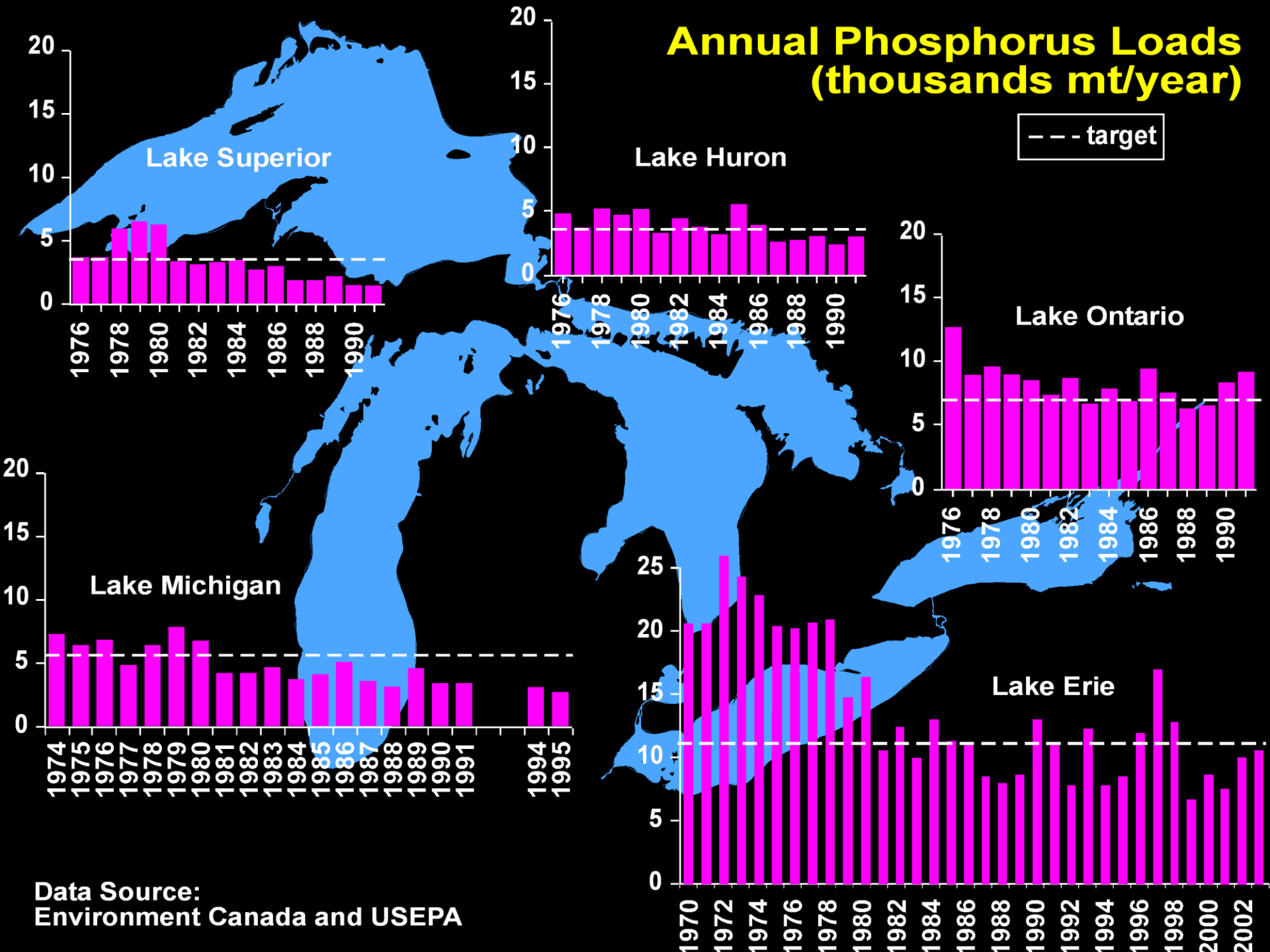
Methods

- Point Sources: Average of Monthly Loads
- Tributaries: Beale's Stratified Ratio Estimator
- Atmospheric: Average of Monthly Fluxes
- Unmonitored Areas: UAL adjusted for Indirect Point Sources

Data Availability Issues

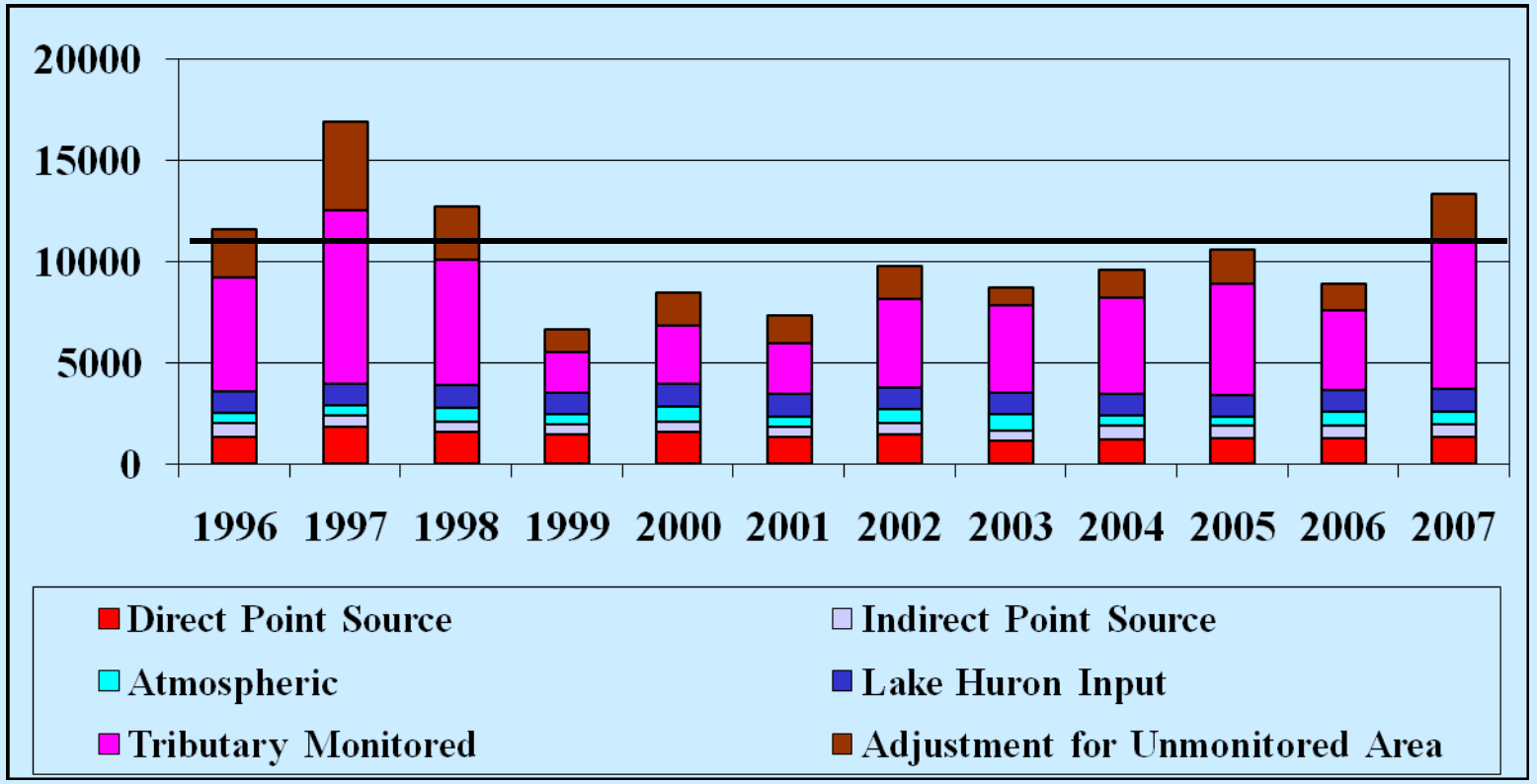
- Estimates are missing flows from Canadian point sources (2003 flows used instead)
- Estimates are missing measured atmospheric fluxes (except for TP)

Annual Phosphorus Loads (thousands mt/year)



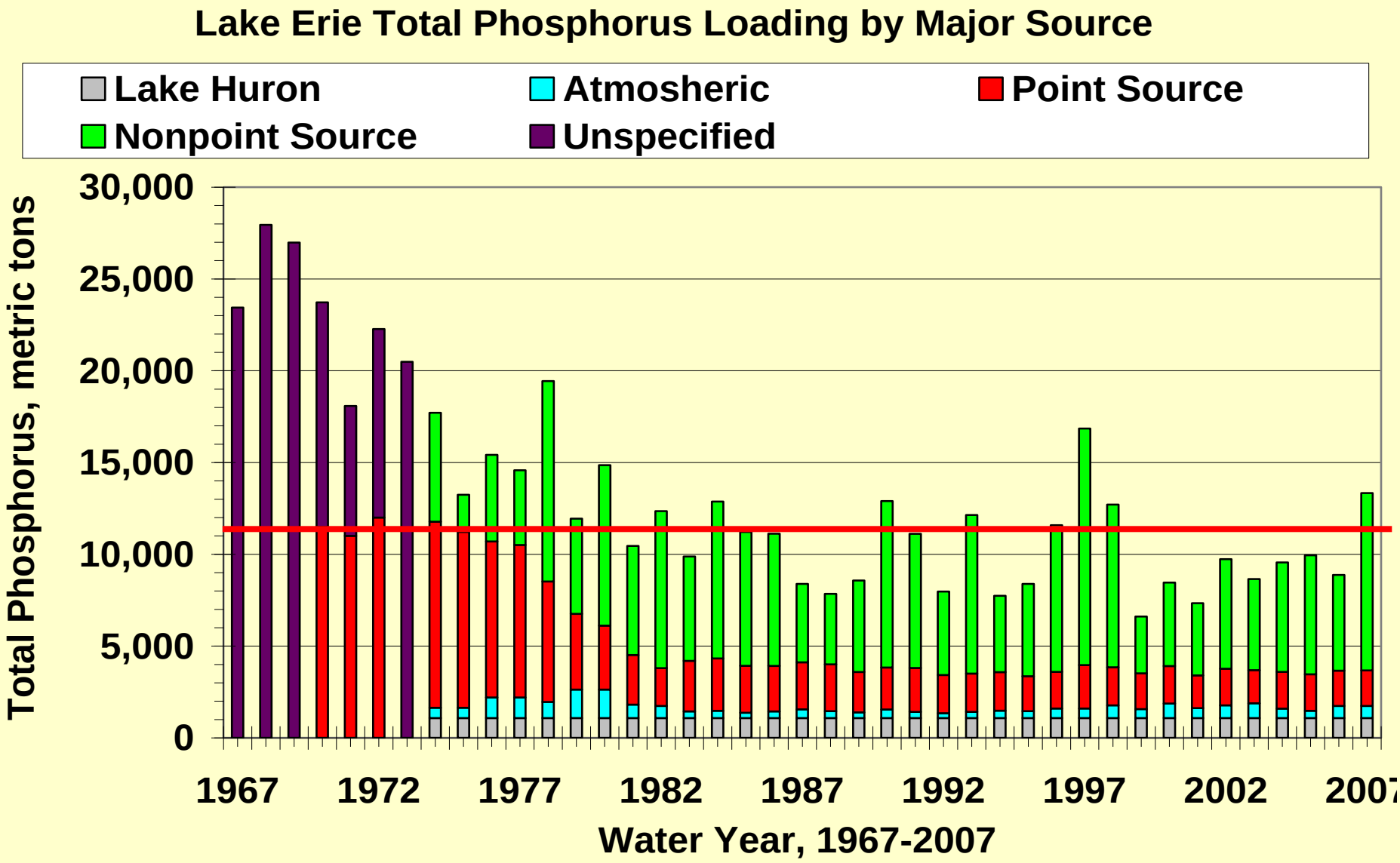
Data Source:
Environment Canada and USEPA

Total Phosphorus Loadings 1996-2007 (Draft)



Lake TP load and WQA Target

(data compilation from Dolan and Rockwell) **LTI-LimnoTech**



Lake Erie TP Load Summary

	2002	2003	2004	2005	2006	2007
Monitored Tributary	4,868	4,842	5,385	6,108	4,568	8,029
Unmonitored Area	1,635	855	1,354	1,734	1,297	2,279
Atmospheric	694	804	511	394	658	658
Direct Industrial	57	21	22	21	21	21
Direct Municipal	1,399	1,077	1,194	1,245	1,250	1,266
Lake Huron	1,080	1,080	1,080	1,080	1,080	1,080
Total	**9,733**	**8,679**	**9,546**	**10,582**	**8,874**	**13,333**
Target Load (GLWQA)	11,000	11,000	11,000	11,000	11,000	11,000
Upper 95% Conf. Lim.	10,513	9,111	9,894	-----	-----	-----
Lower 95% Conf. Lim.	8,953	8,247	9,198	-----	-----	-----

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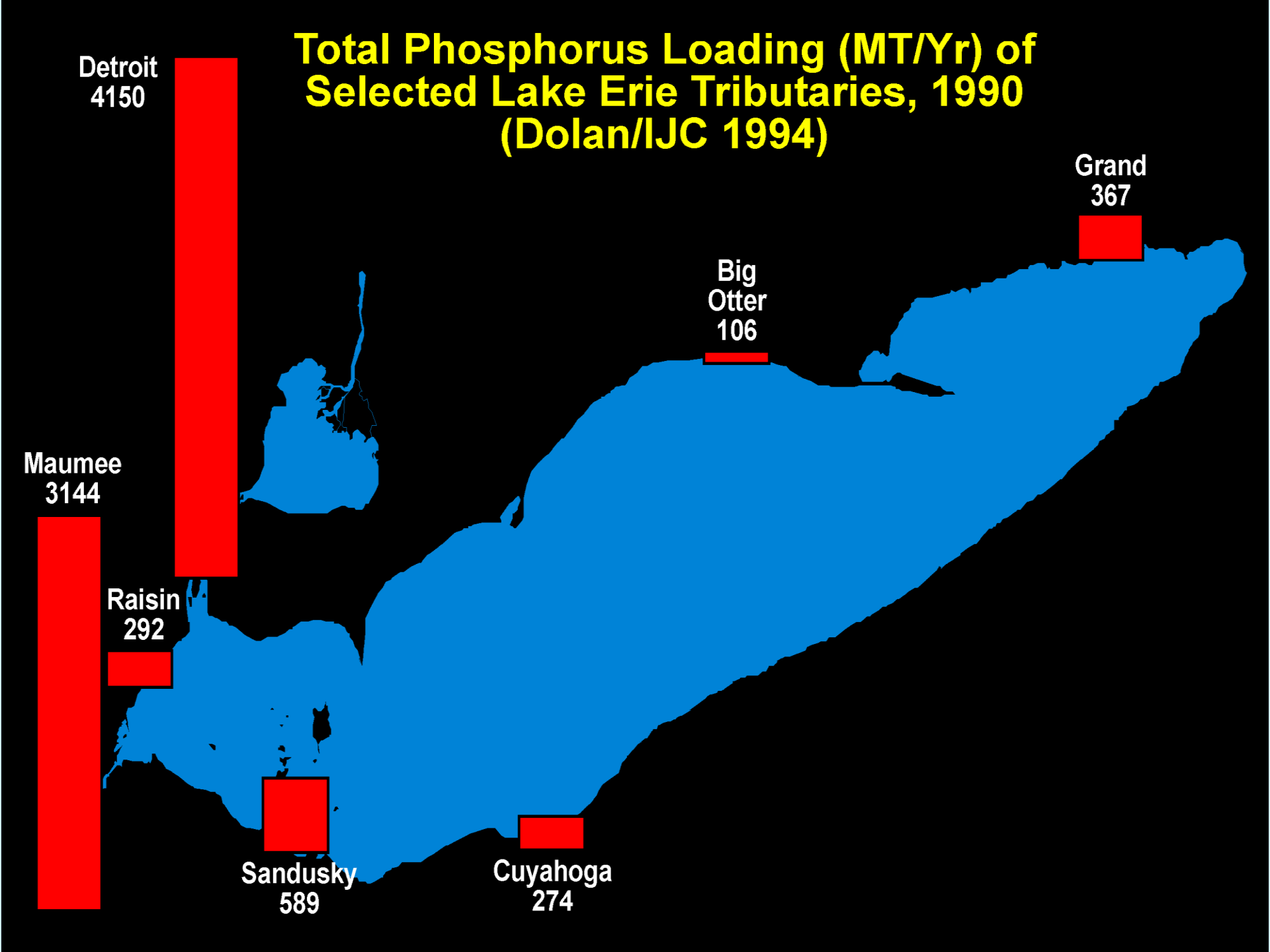
Relative Contributions to Lake Erie Phosphorus Loadings in 2005

Source	Load (MTA)	Percent of Total
Maumee River	3,115	31.1 %
Sandusky River	755	7.5 %
Detroit WWTP	619	6.2 %
Cuyahoga River	546	5.4 %
Atmospheric	394	3.9 %
Other Sources	4,575	45.7 %
TOTAL	10,004	100 %

Total Phosphorus Loading (MTA) to Lake Erie:
Detroit and Maumee Rivers, 2003-2005

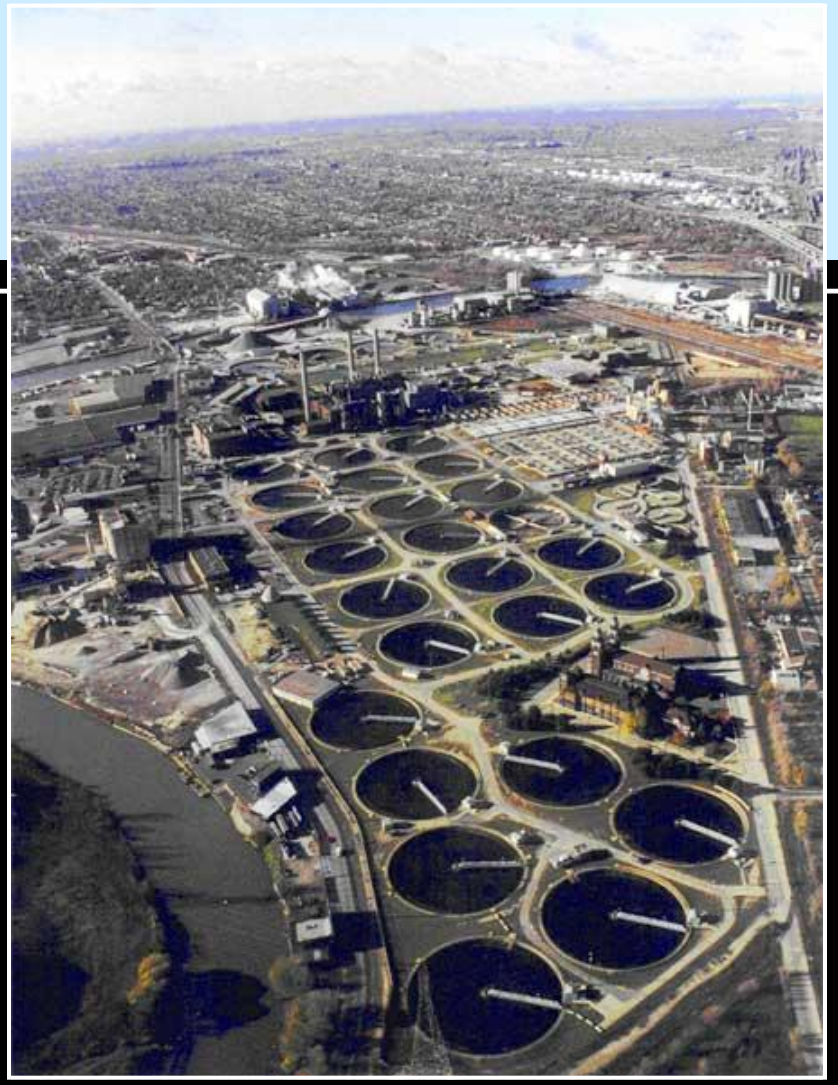
	2003	2004	2005
Detroit	2336	3282	3031
Maumee	2407	1949	3115
Lake Erie: Total P Load	8647	9567	10,004


Total Phosphorus Loading (MT/Yr) of Selected Lake Erie Tributaries, 1990 (Dolan/IJC 1994)
Detroit 4150
Maumee 3144
Raisin 292
Sandusky 589
Cuyahoga 274
Big Otter 106
Grand 367

Relative Contributions to Lake Erie Phosphorus Loadings in 1976

Source	Load (MTA)	Percent of Total
Detroit WWTP	3,055	20.1 %
Maumee River	2,569	16.9 %
Atmospheric	1,550	10.2%
Sandusky River	507	3.3 %
Cuyahoga River	406	2.7%
Other Sources	7,120	46.8 %
TOTAL	15,207	100 %

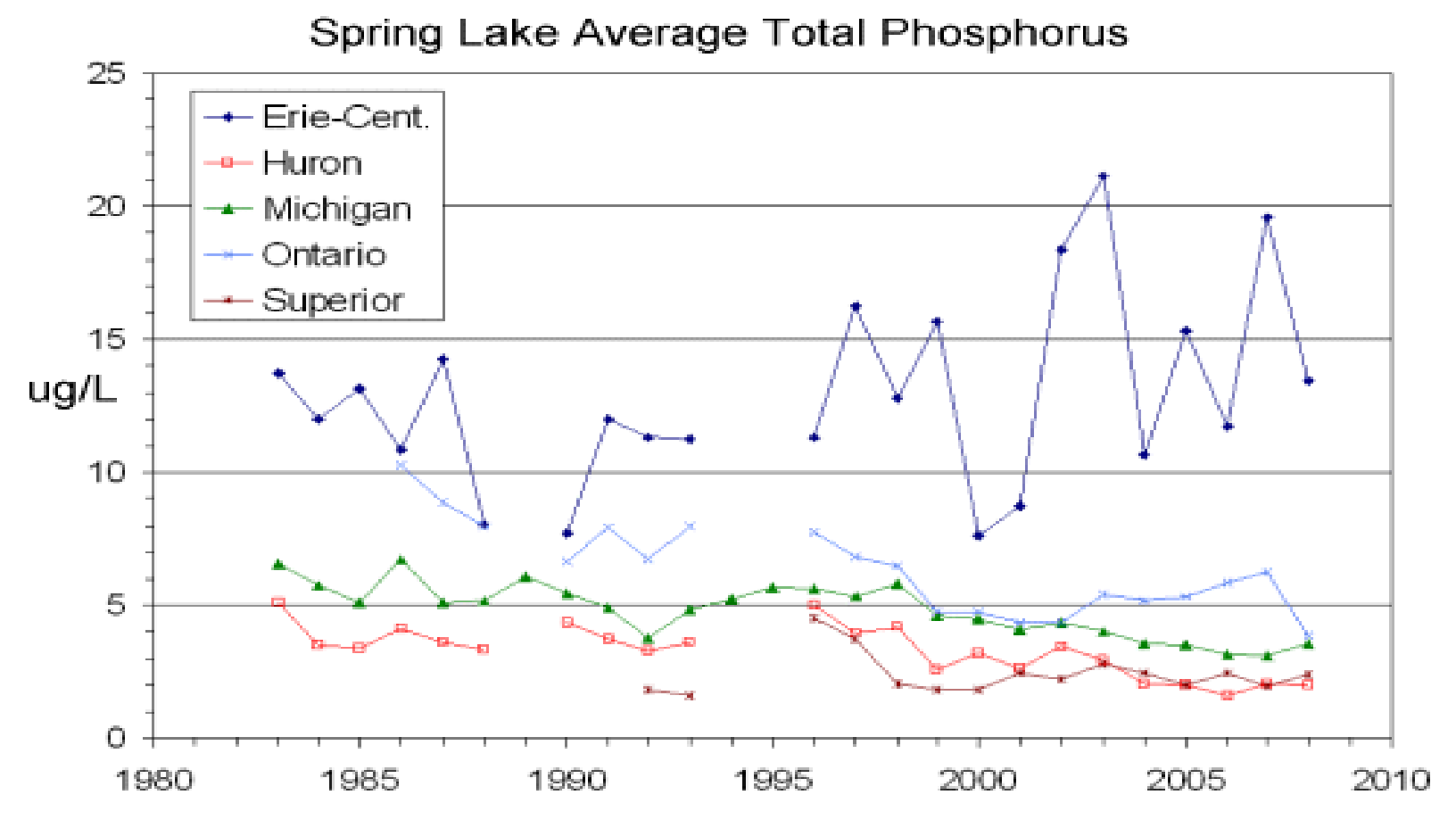
Total Phosphorus Loading from Detroit Wastewater Treatment Plant, 1966 – 2003



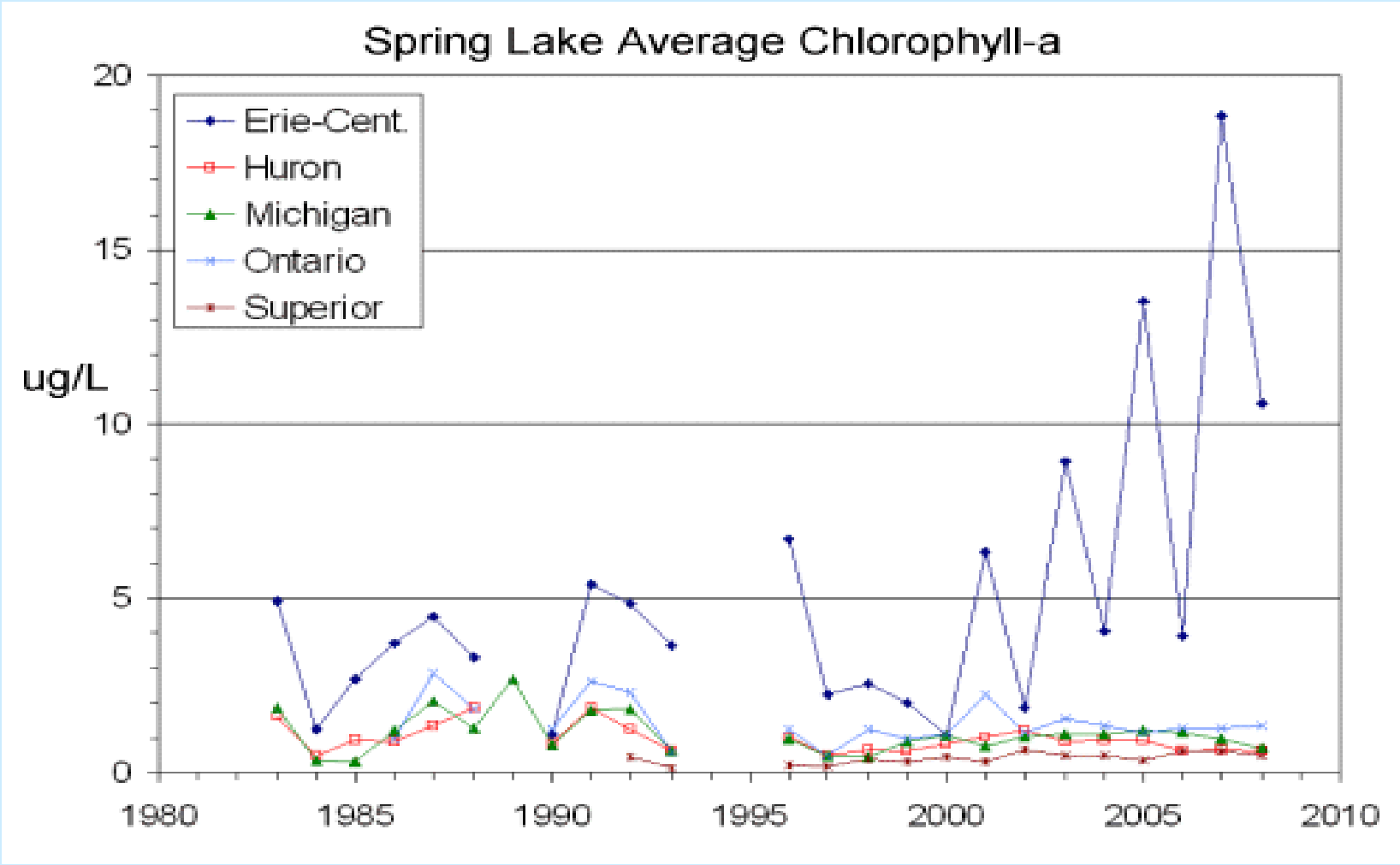
Relative Contributions to Lake Erie SRP Loadings in 2005

Source	Load (MTA)	Percent of Total
Maumee River	706	27.9 %
Detroit WWTP	433	17.1 %
Sandusky River	186	7.3 %
Cuyahoga River	104	4.1 %
Grand R. (ONT)	86	3.4 %
Other Sources	1,016	40.2 %
TOTAL	2,531	100 %

Great Lake Total Phosphorus Trends 1983-2008 (USEPA, GLNPO)



Great Lakes Chorophyll-a Trends 1973-2008 (USEPA, GLNPO)



Conclusions

- GLWQA Target was exceeded less during the past 10 years than the previous 10 years for Total P
- Non-point sources are the largest load by major category for Total P and SRP
- The Detroit and Maumee Rivers dominate total P loadings to Lake Erie
- Point Sources continue to be important for nutrients, especially SRP

Challenges:

Quantification for Nutrients, HABs and Hypoxia

- Carbon Cycle and Balance
- Nitrogen Cycle and Balance
- Carbon and Nutrients from CAFOs and CSOs
- Contribution of Glyphosate-Phosphonates
- Bioavailable P fractions in loads and within lake
- Reconciliation of Various P Loading Studies
- In-Lake Phosphorus Transformations/Processes

Acknowledgements

- EcoFore Project Director: Don Scavia, University of Michigan, The Cooperative Institute for Limnology and Ecosystems Research (CILER)
- Watershed Team Leader: Dave Allan, University of Michigan, School of Natural Resources & Environment
- Funding: NOAA, Center for Sponsored Coastal Ocean Research
- UWGB students: C. Piette and L. Eslinger

THANKS!

Any Questions?

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Relative Contributions to Lake Erie Nitrate Loadings in 2005

Source	Load (MTA)	Percent of Total
Atmospheric	48,000	24.5 %
Maumee River	34,200	17.5 %
Detroit WWTP	11,100	5.6 %
Sandusky River	9,000	4.6 %
Grand R. (ONT)	7,100	3.6 %
Other Sources	86,400	44.2 %
TOTAL	195,800	100 %

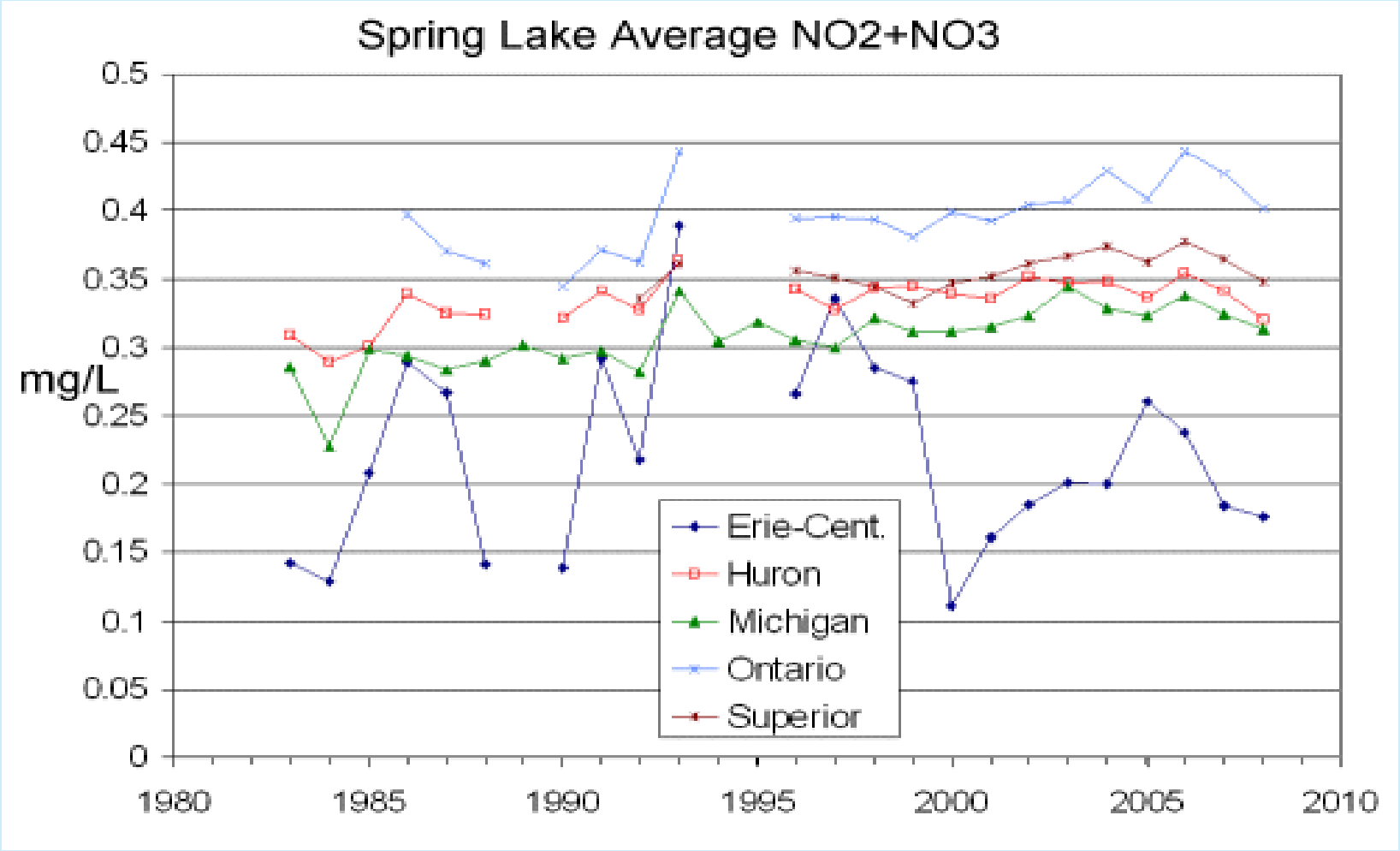
Relative Contributions to Lake Erie TKN Loadings in 2005

Source	Load (MTA)	Percent of Total
Atmospheric	51,300	45.4 %
Maumee River	10,900	9.6 %
Detroit WWTP	5,000	4.4 %
Sandusky River	3,500	3.1 %
Cuyahoga River	2,800	2.5 %
Other Sources	39,500	35.0 %
TOTAL	113,000	100 %

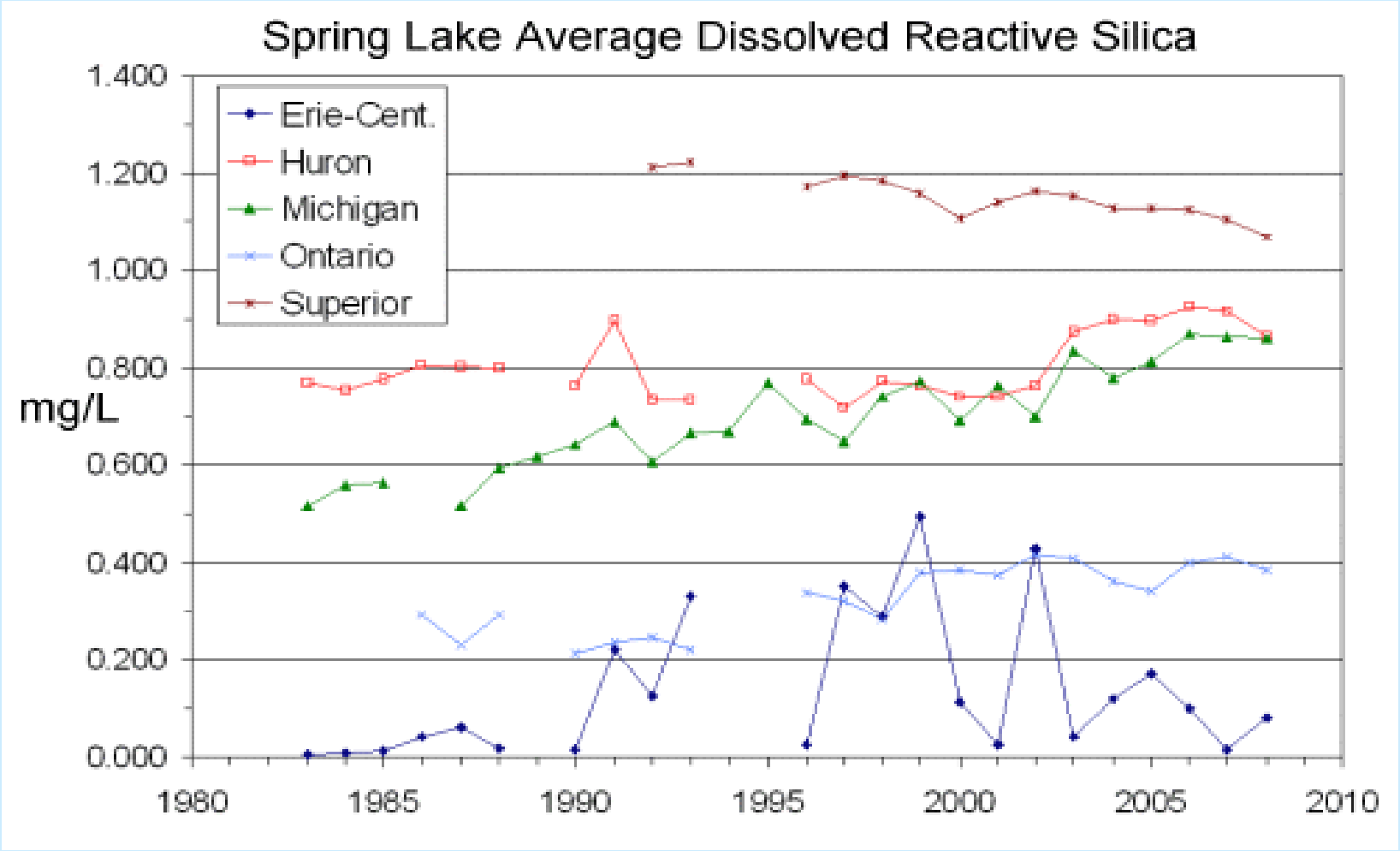
Relative Contributions to Lake Erie TSS Loadings in 2005

Source	Load (MTA)	Percent of Total
Maumee River	1,359,000	32.4 %
Cuyahoga River	582,000	13.9 %
Sandusky River	343,000	8.2 %
Chagrin River	317,000	7.6 %
Detroit River	249,000	5.9 %
Other Sources	1,343,000	32.0 %
TOTAL	4,193,000	100 %

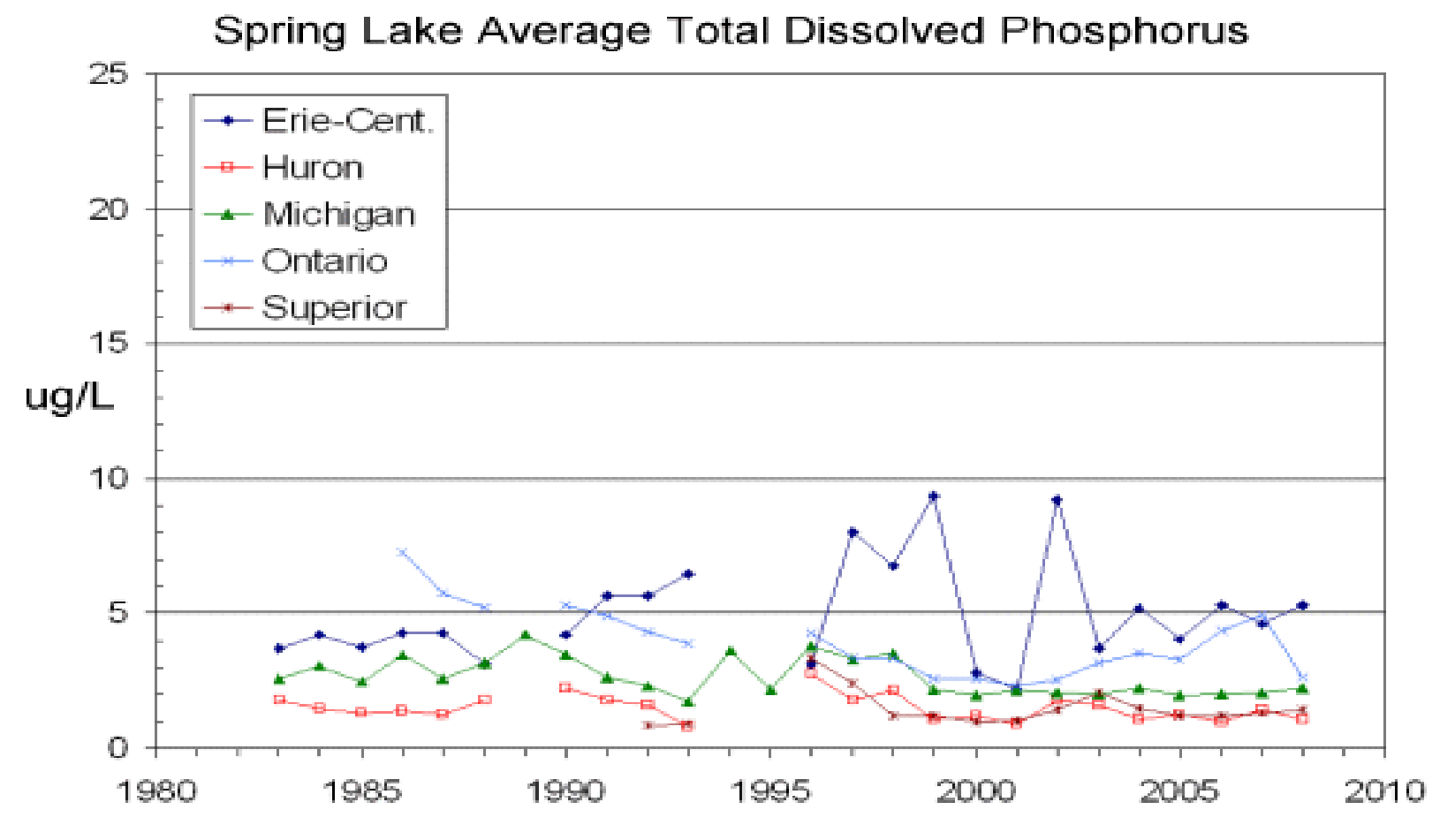
Great Lakes Nitrate/Nitrite Trends 1973-2008 (USEPA, GLNPO)



Great Lakes Silica Trends 1973-2008 (USEPA, GLNPO)



Great Lakes Dissolved P Trends 1973-2008 (USEPA, GLNPO)

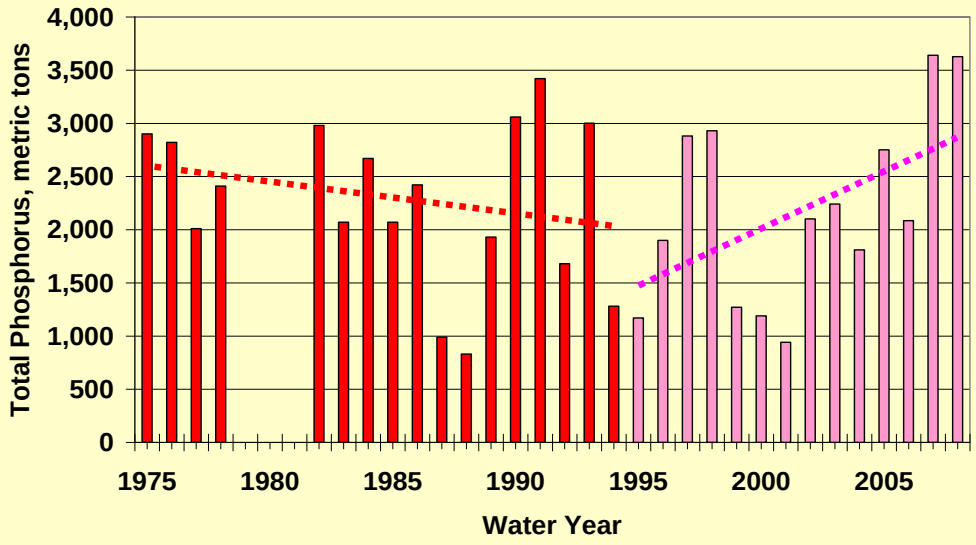


Land Use

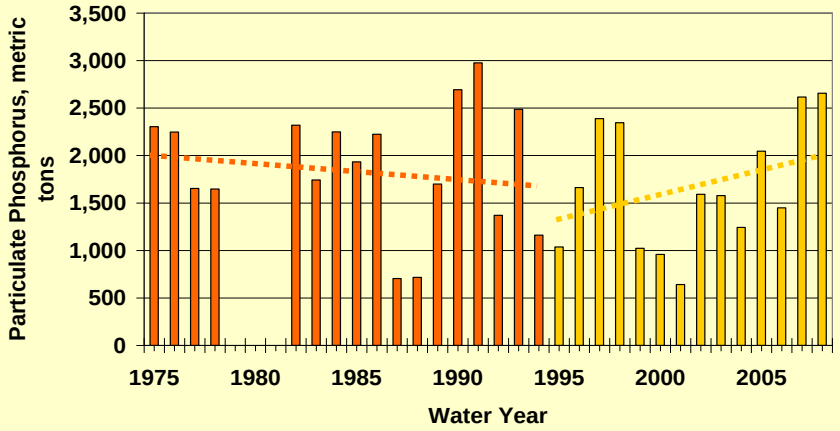
Row Crops, 73.6%

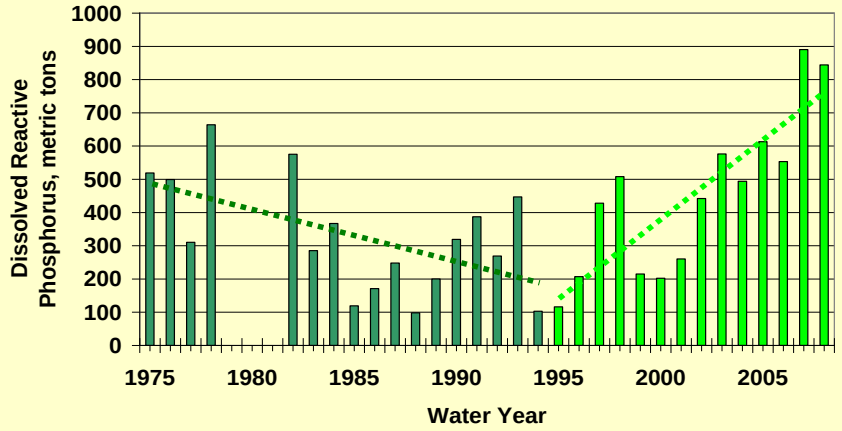
Urban/Resid. 10.4%

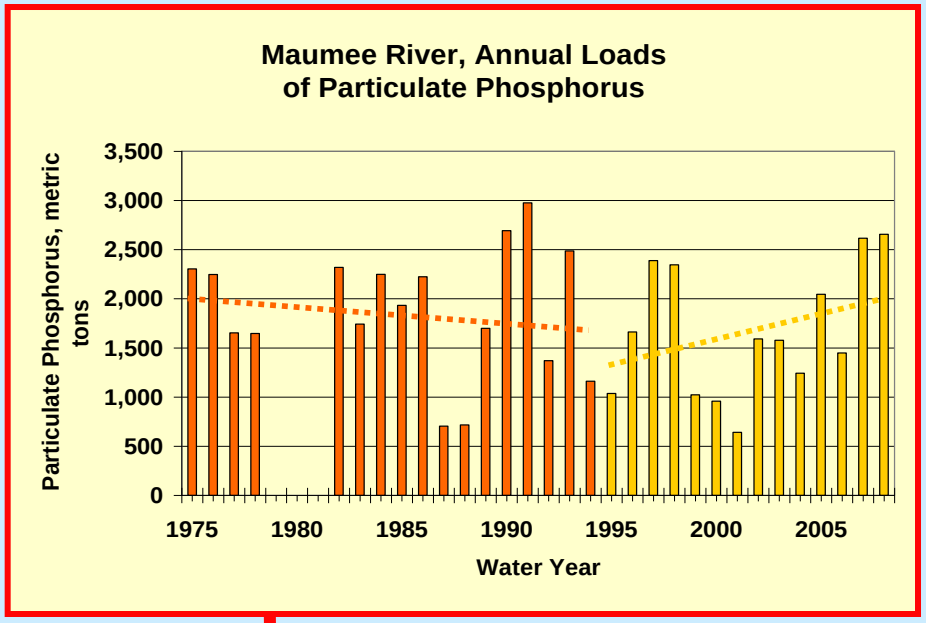
Forests, 6.4%

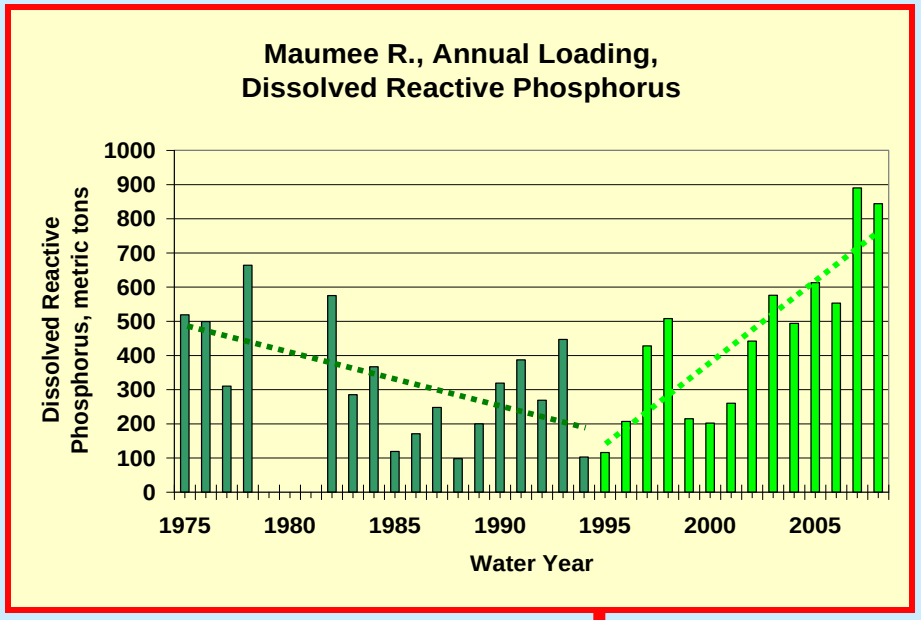


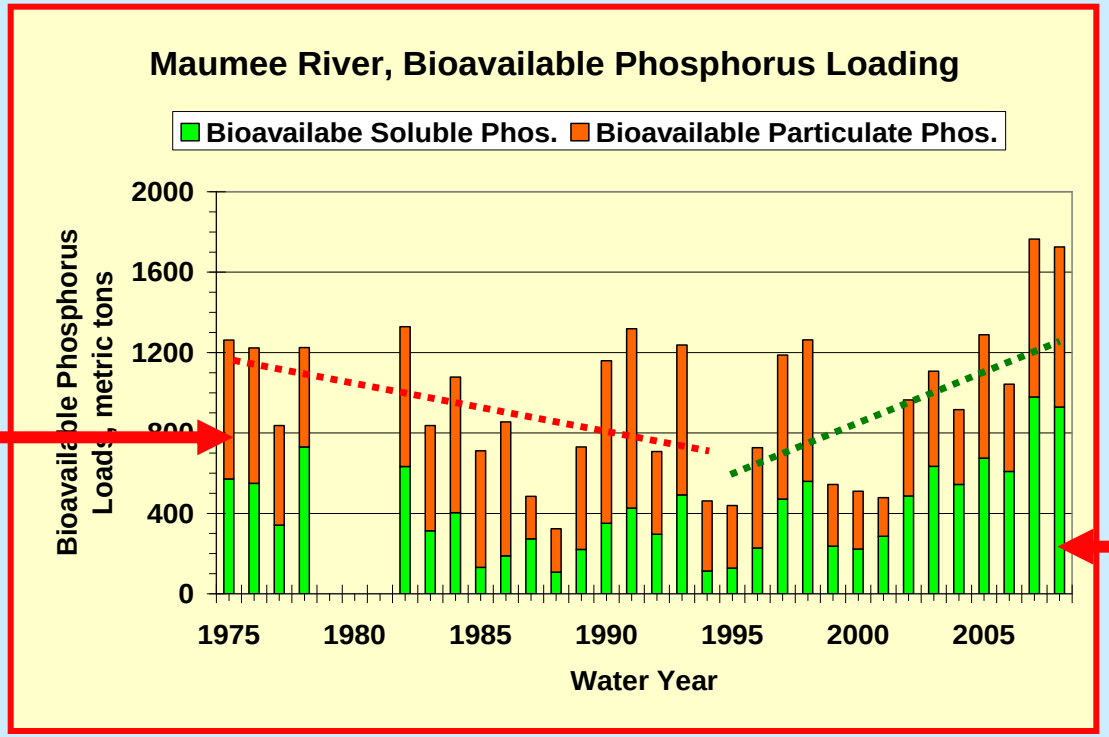
Up-stream Point Source TP Inputs Equal 4.9% of Average TP export for 2004-2008.





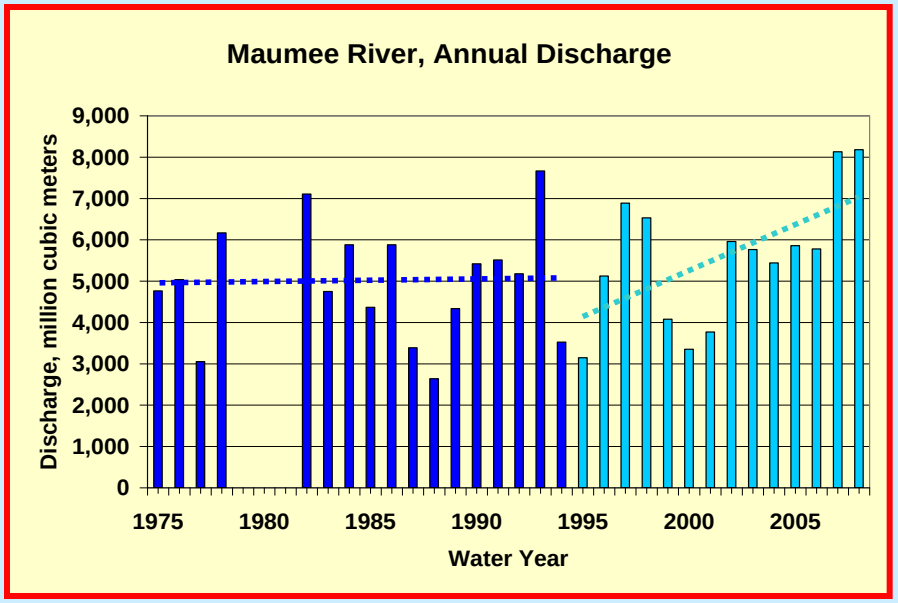






30% bioavailable

Dissolved bioavailable equals 110% of DRP



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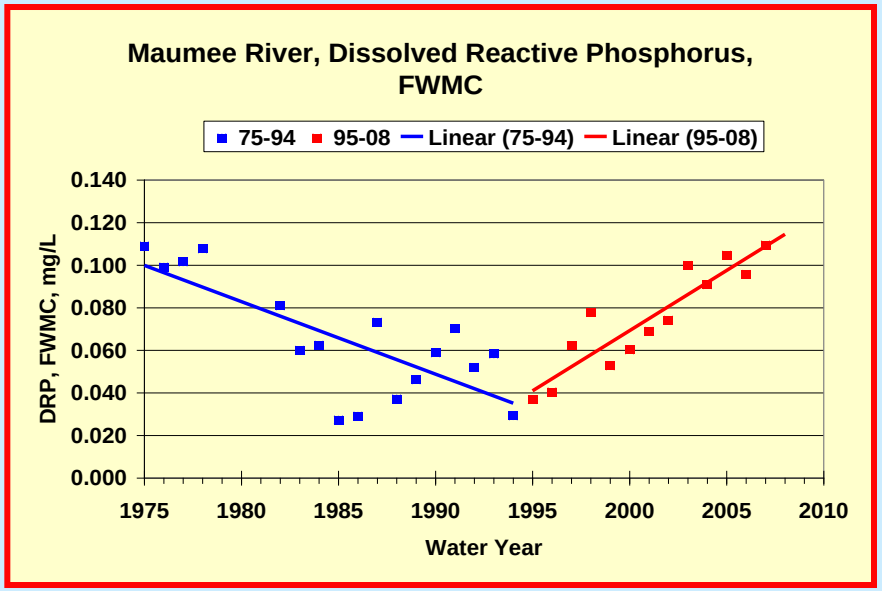
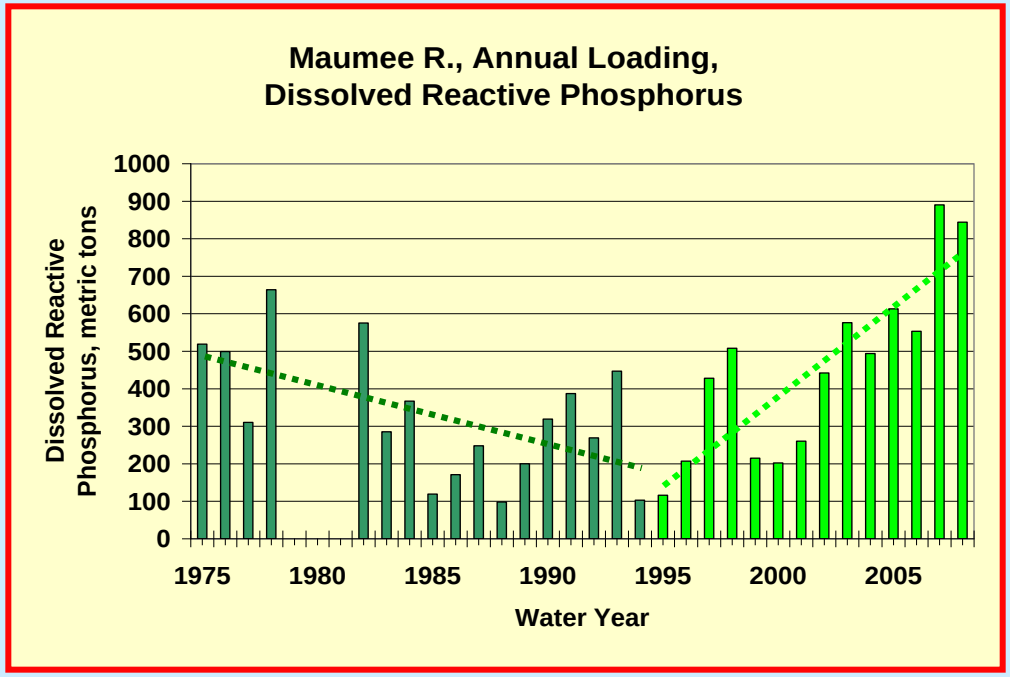
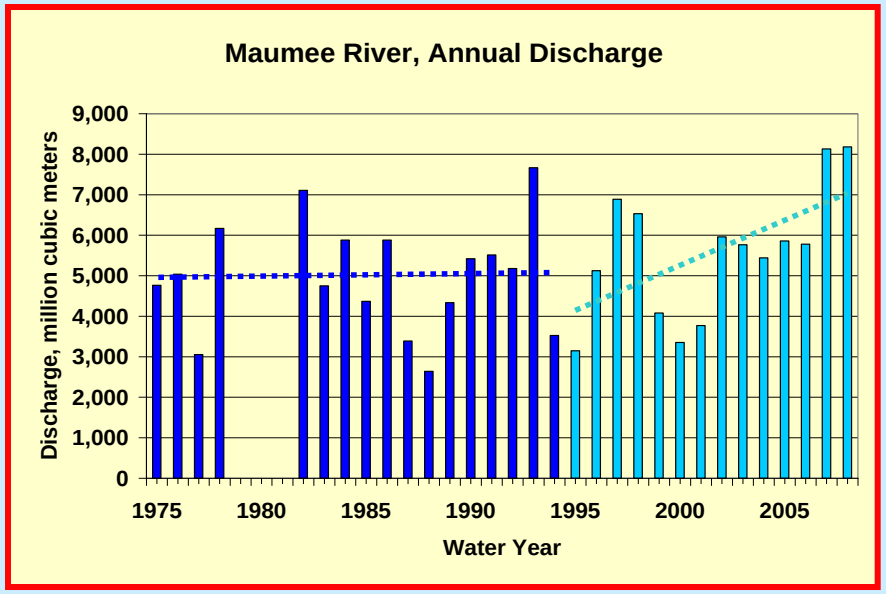


Annual discharges are variable but have increased during the study period.



Annual FWMCs of DRP decreased through the mid-1990s but then increased.



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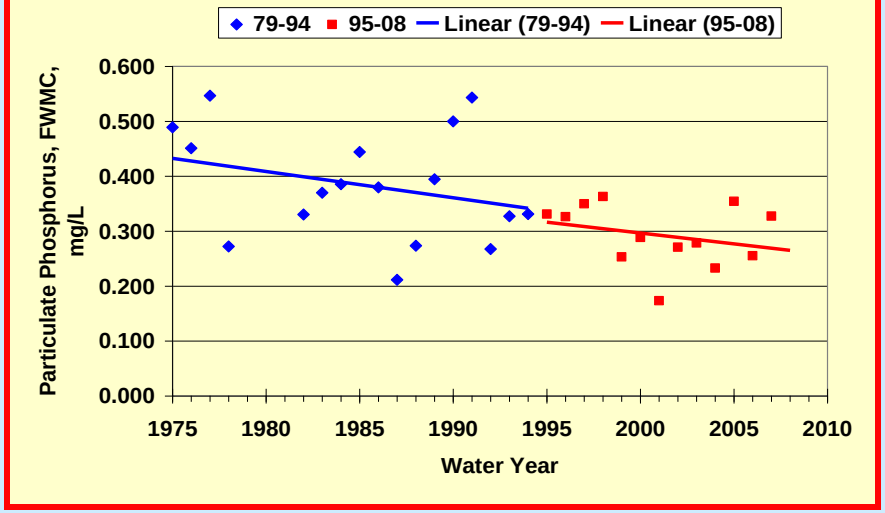
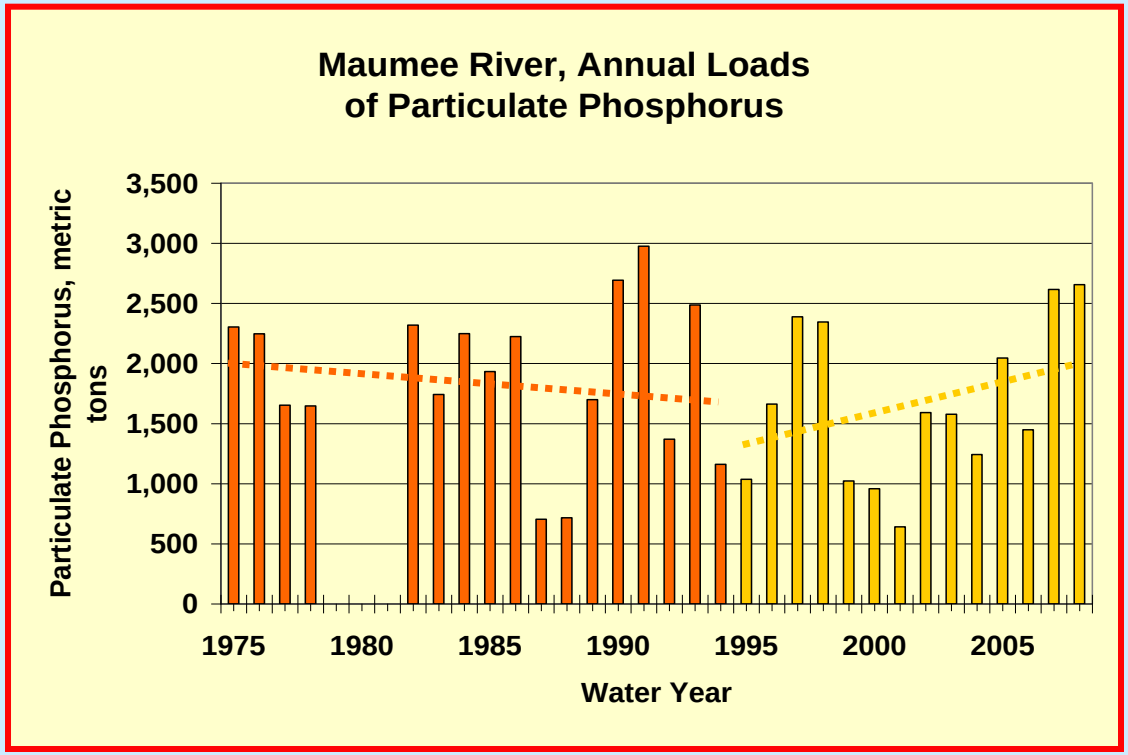
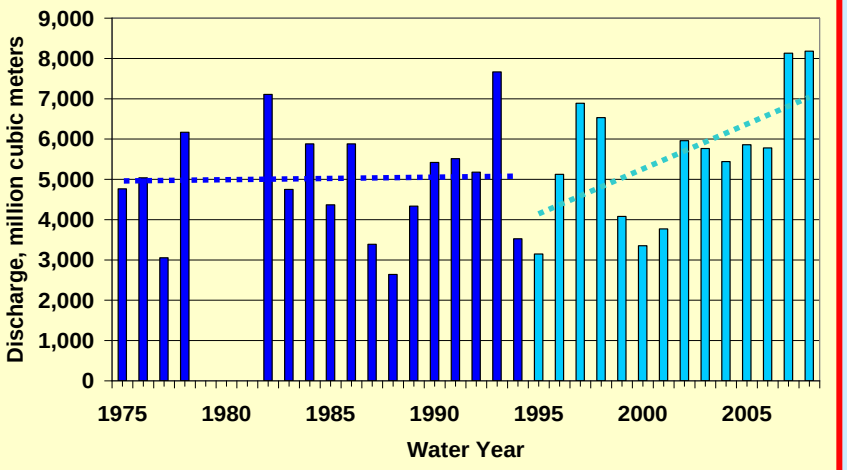




Annual particulate phosphorus FWMCs are variable but have generally decreased throughout the study period.



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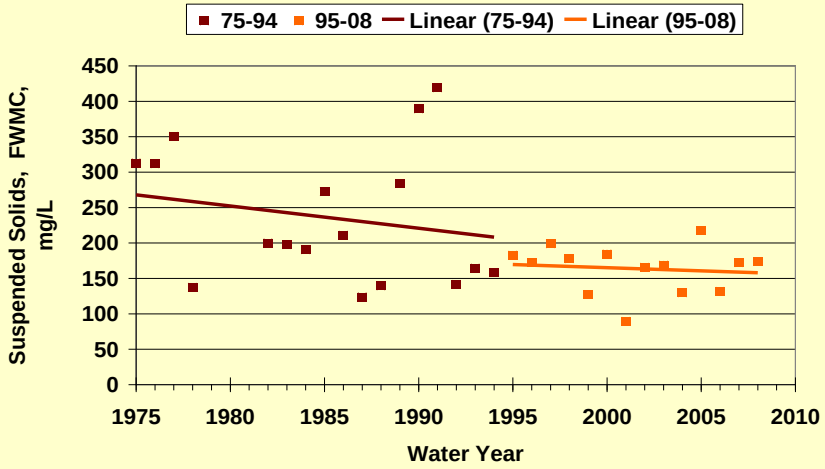
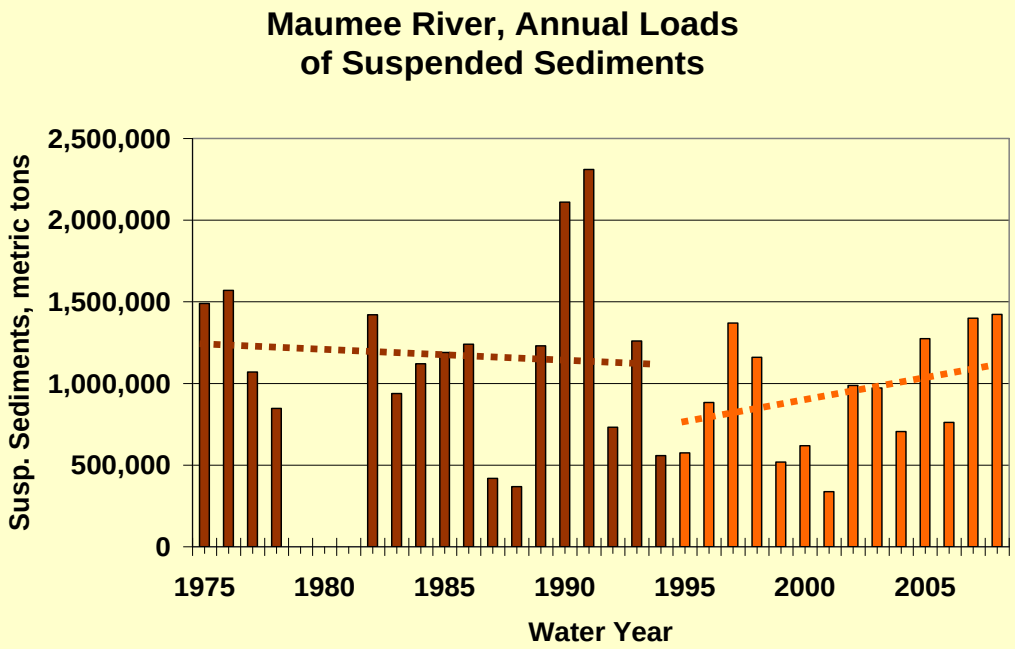


The decreasing suspended sediment FWMCs attest to the effectiveness of agricultural BMPs, such as no-till.



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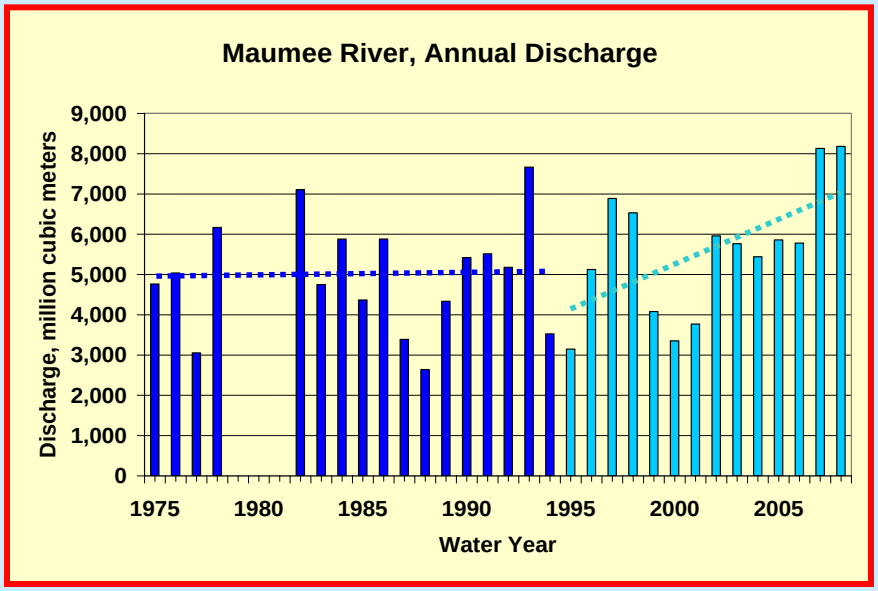

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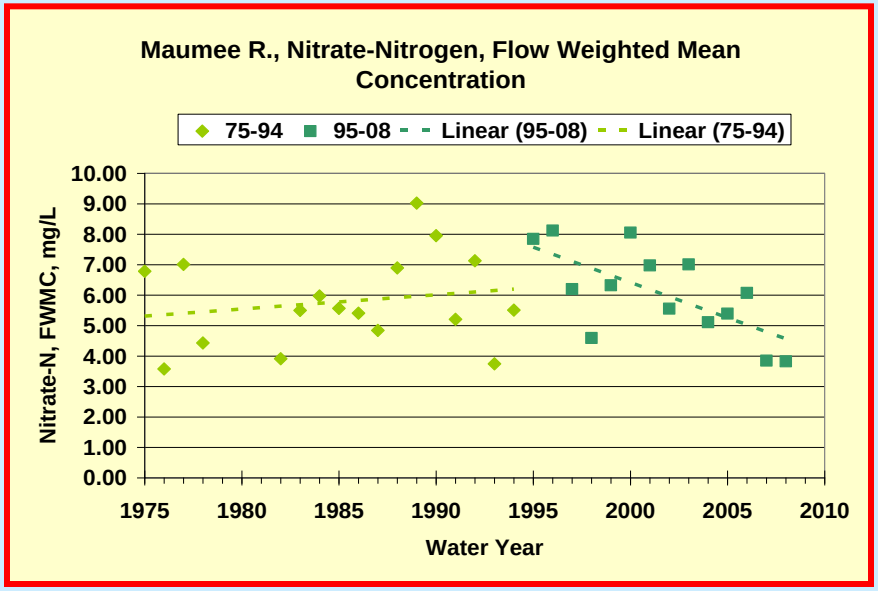
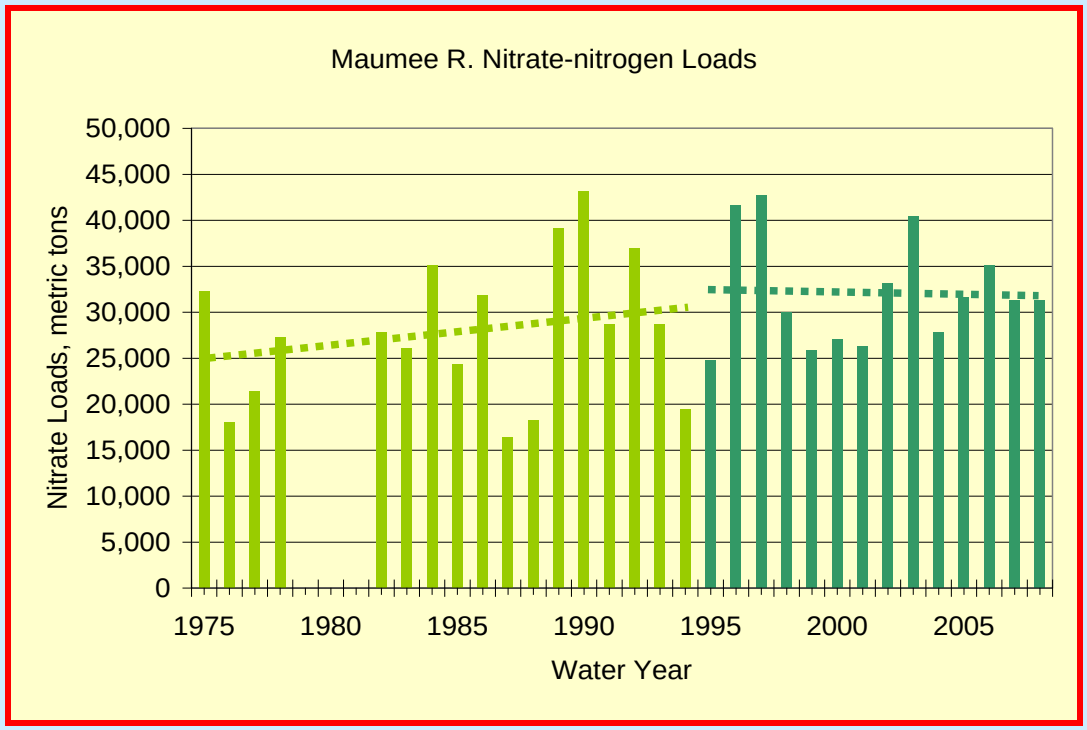
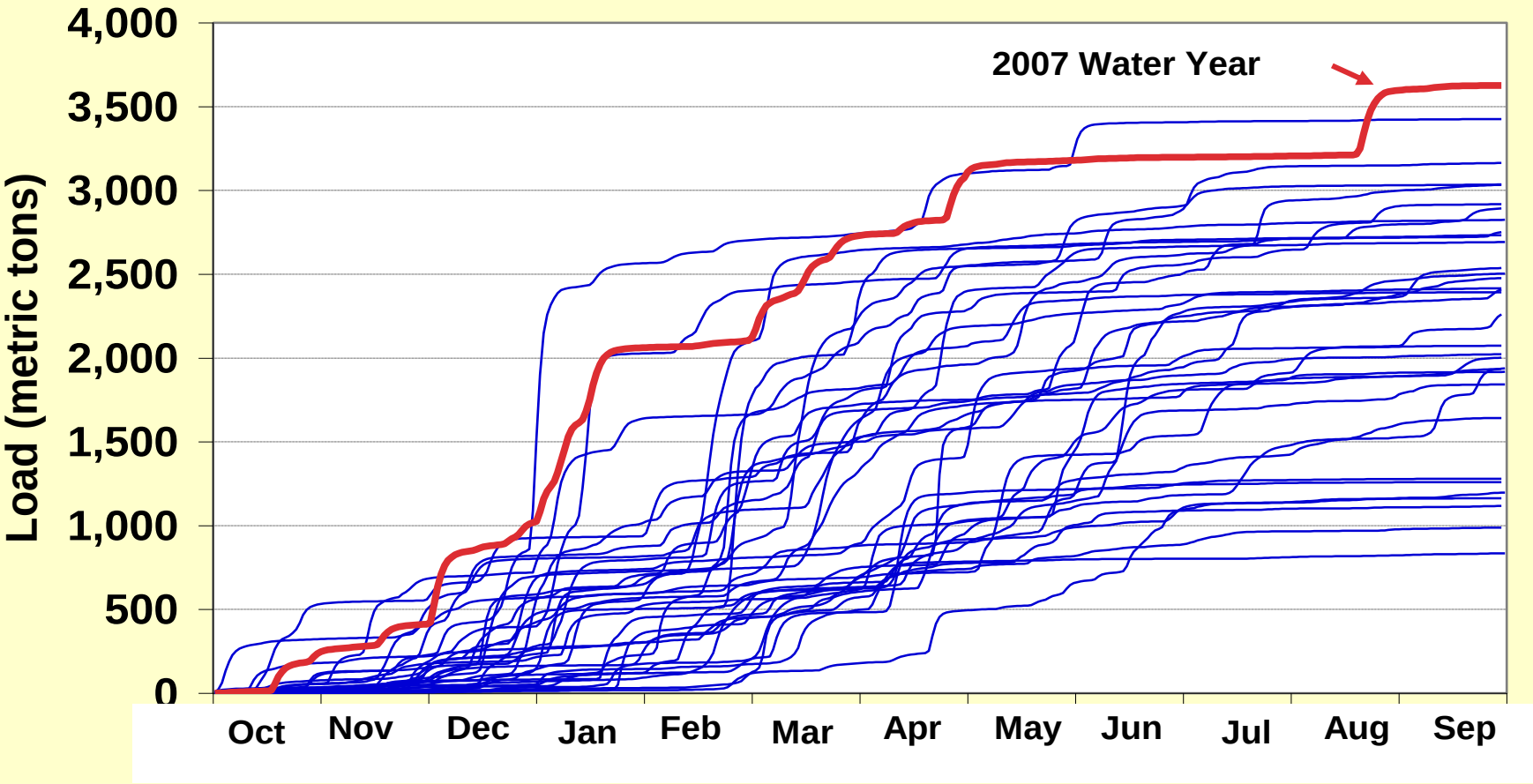
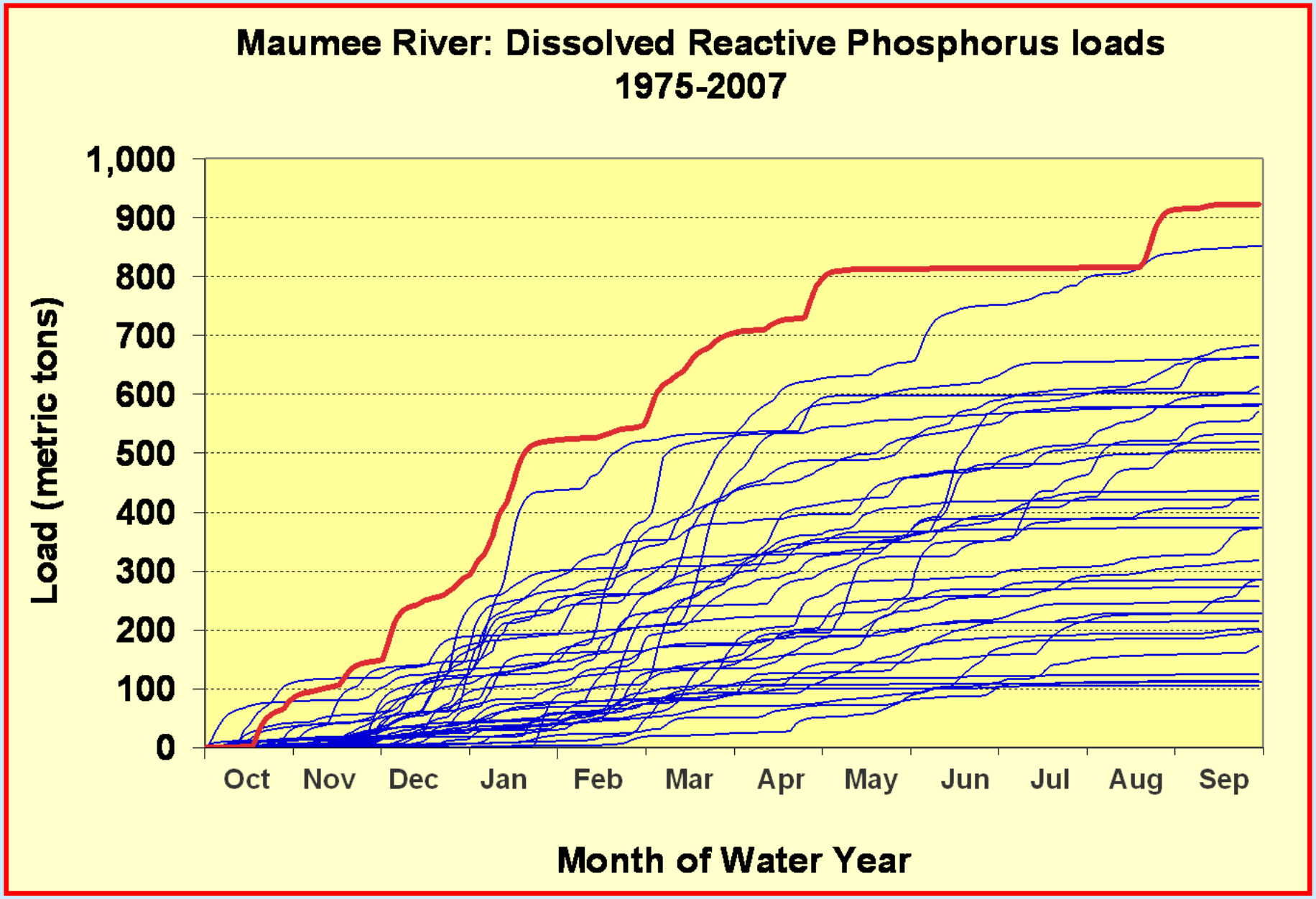




There is a complex relationship between nitrate FWMCs and annual discharge. Years of large discharge may dilute a finite supply of nitrate for export. The size of that supply hinges of the corn yields of the previous year.

Maumee River: Cumulative Annual PhosphorusLoads, 1975-2007




Maumee River: Dissolved Reactive Phosphorus loads
1975-2007
Load (metric tons)
1,000
900
800
700
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month of Water Year