Loading Calculation Workshop
NOAA-GLERL, Ann Arbor, MI
April 5-6, 2017

Historical Perspectives and the Lake Ere Loading Estimation Work Group

Russell G. Kreis, Jr. (US Co-Chair) Retired
Sandra George (Canadian Co-Chair)
Environment and Climate Change Canada
Jeffrey M. Reutter (US Co-Chair, Emeritus)
THE Ohio State University/Ohio Sea Grant

Historical Aspects of Mass Loading and Mass Balance modeling Relationships

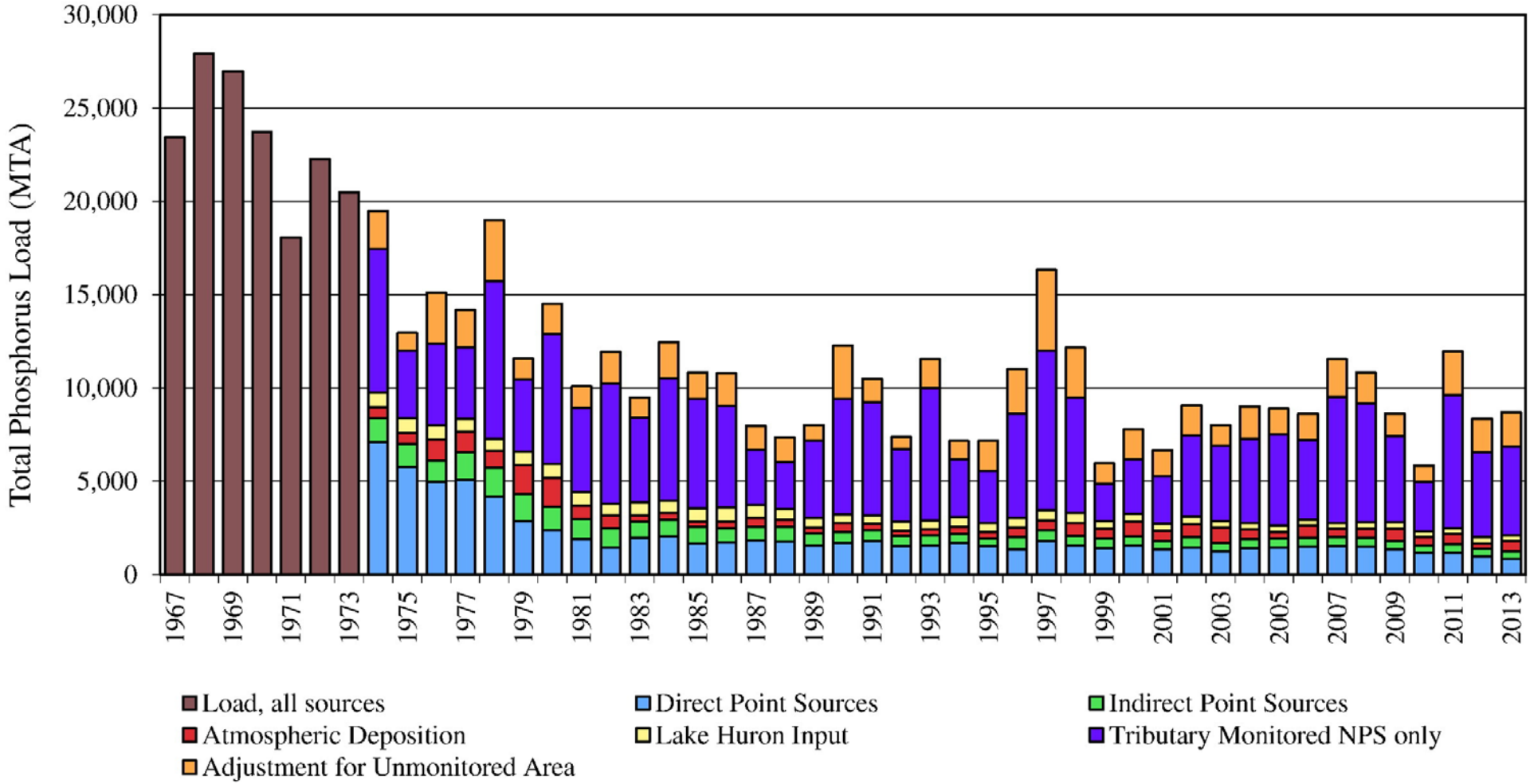
New York Bight, Long Island Sound, Tomahawk River, Sacramento-San Joaquin Delta, Lake Washington, Delaware Estuary, Potomac River

Lake Erie and Lake Ontario

EPA and NOAA applied this scientific concept to the Great Lakes fairly early on in the overall history

++ Einstein, Albert. 1905. Ist die Traghirt eines Korpers von seinem Energieinhalt abhangig?
Annalen der Physik 18: 639-643.

TOTAL PHOSPHORUS LOADING TO LAKE ERIE, 1967-2013

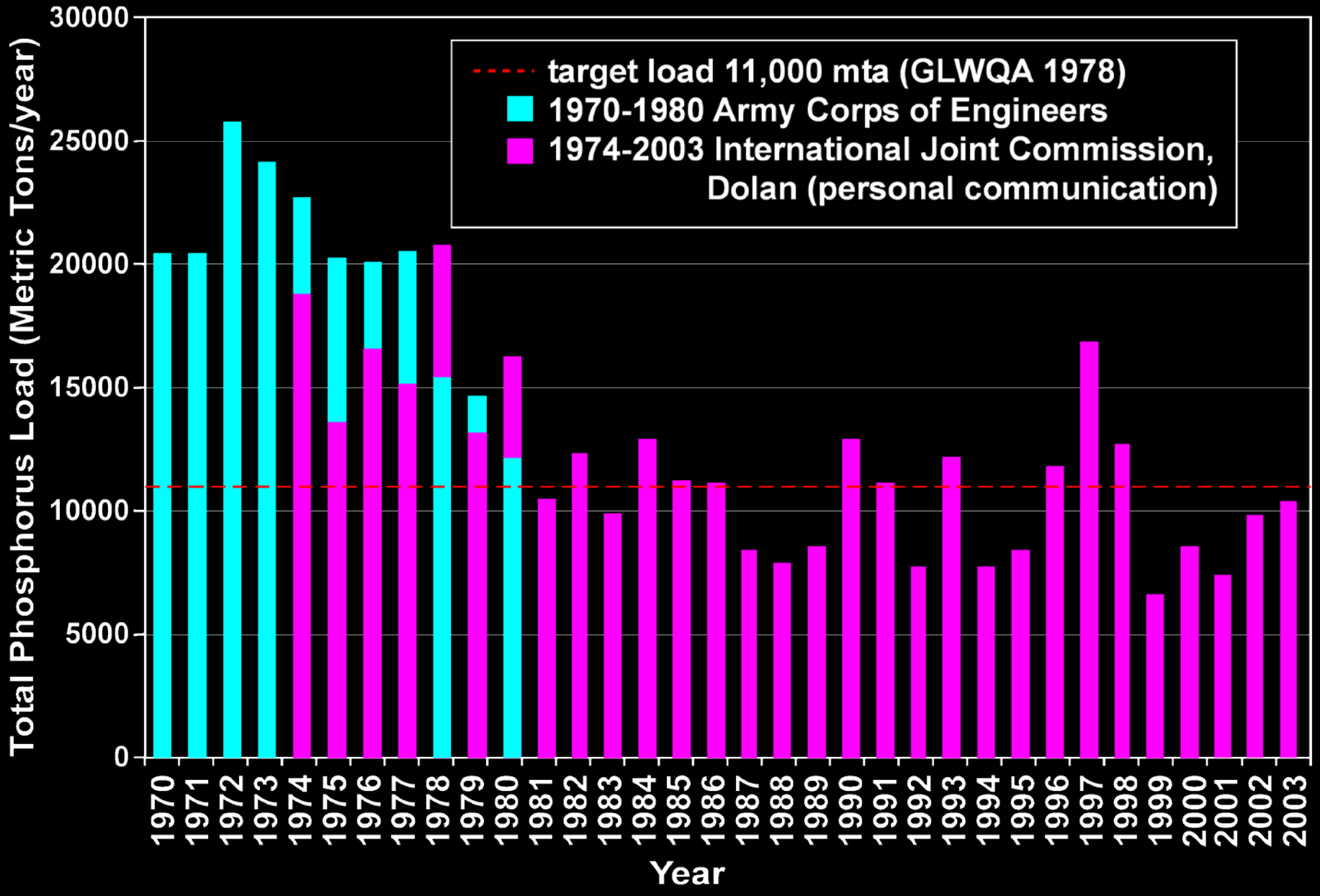


Environment and Climate Change Canada

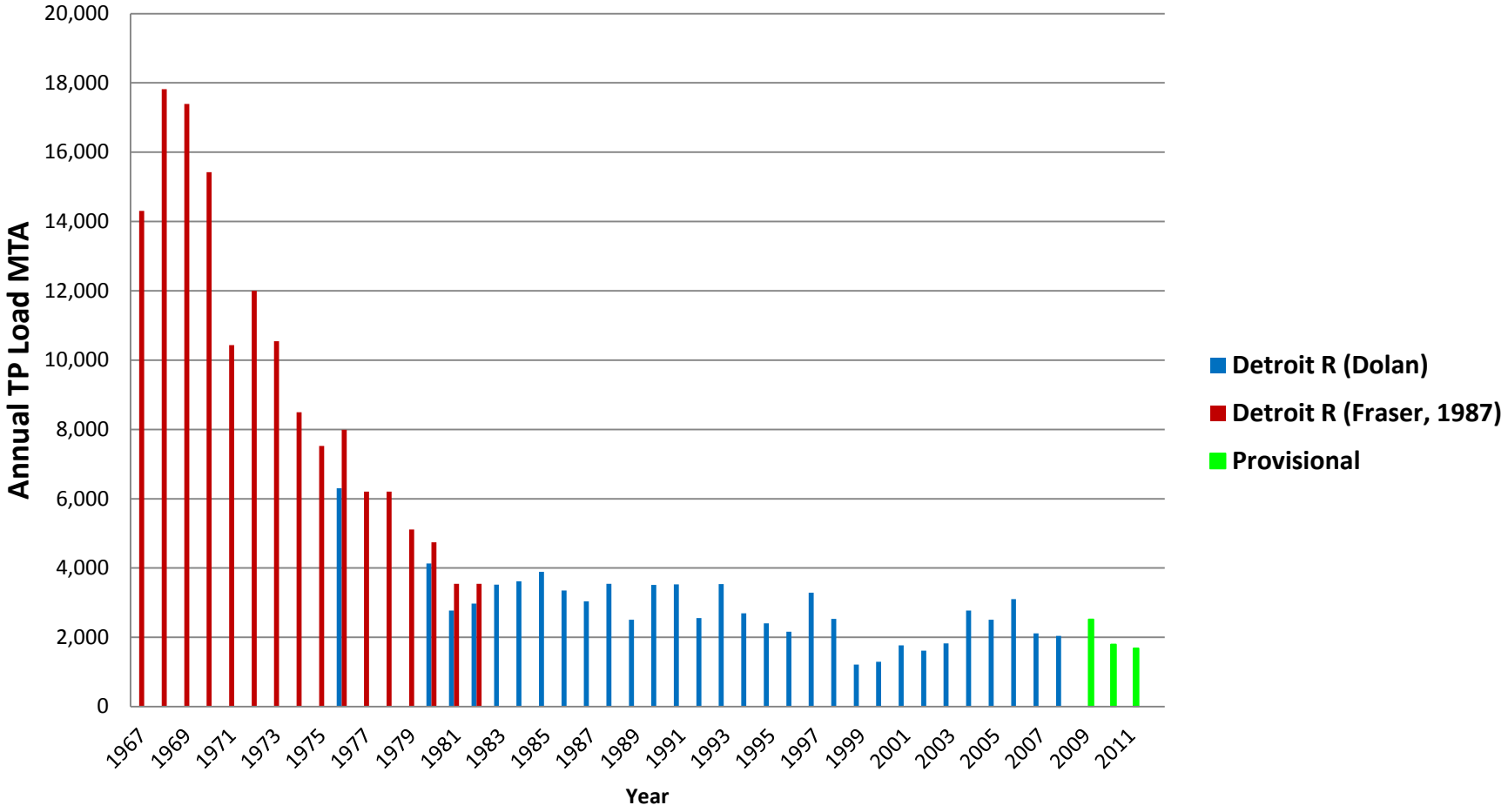
Environnement et Changement climatique Canada

COURTESY OF MACCOUX et al 2016

Annual Phosphorus Loading – Lake Erie



Total Phosphorus Load (MTA) from the Detroit River to Lake Erie, 1967-2011



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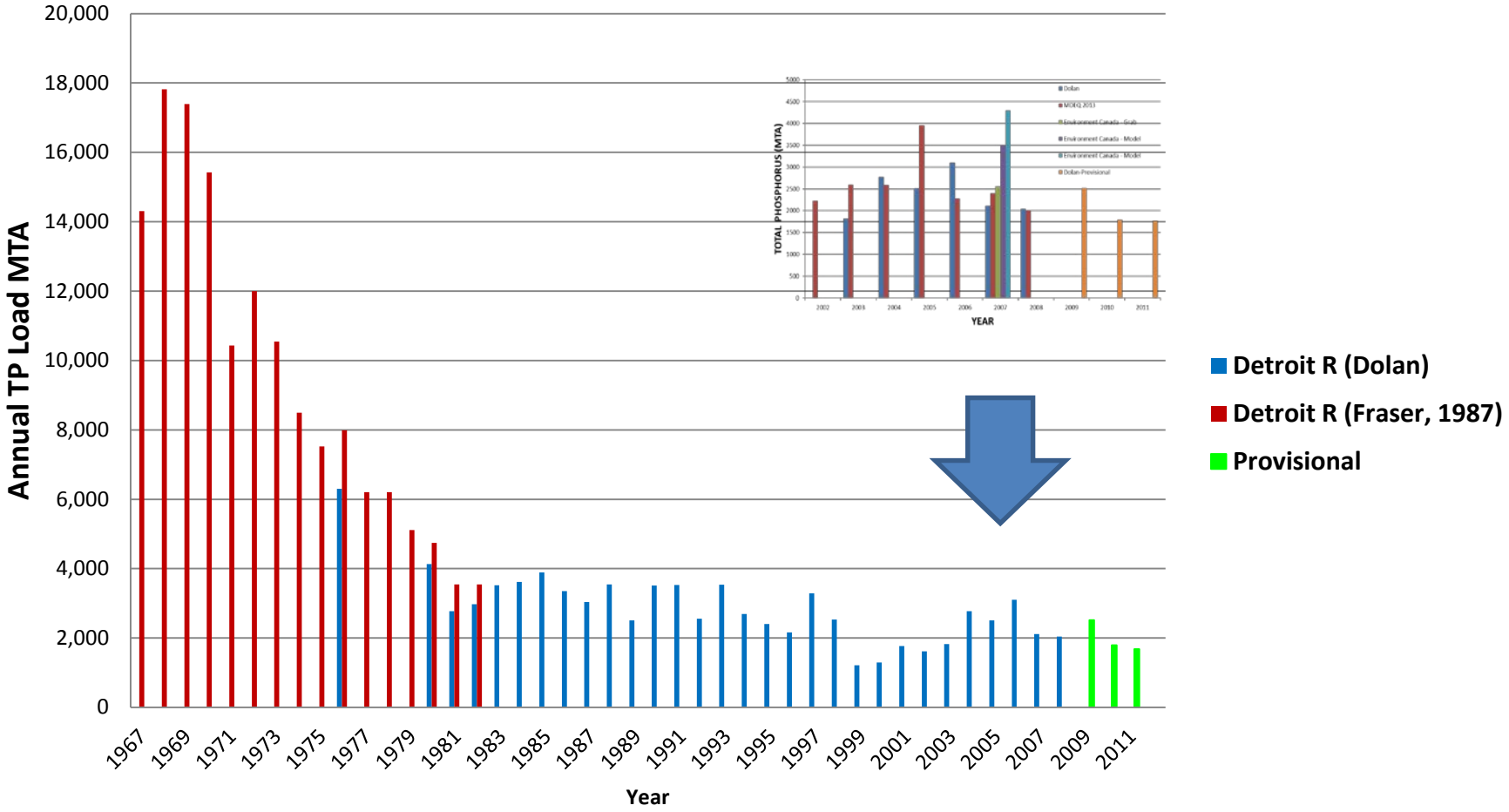
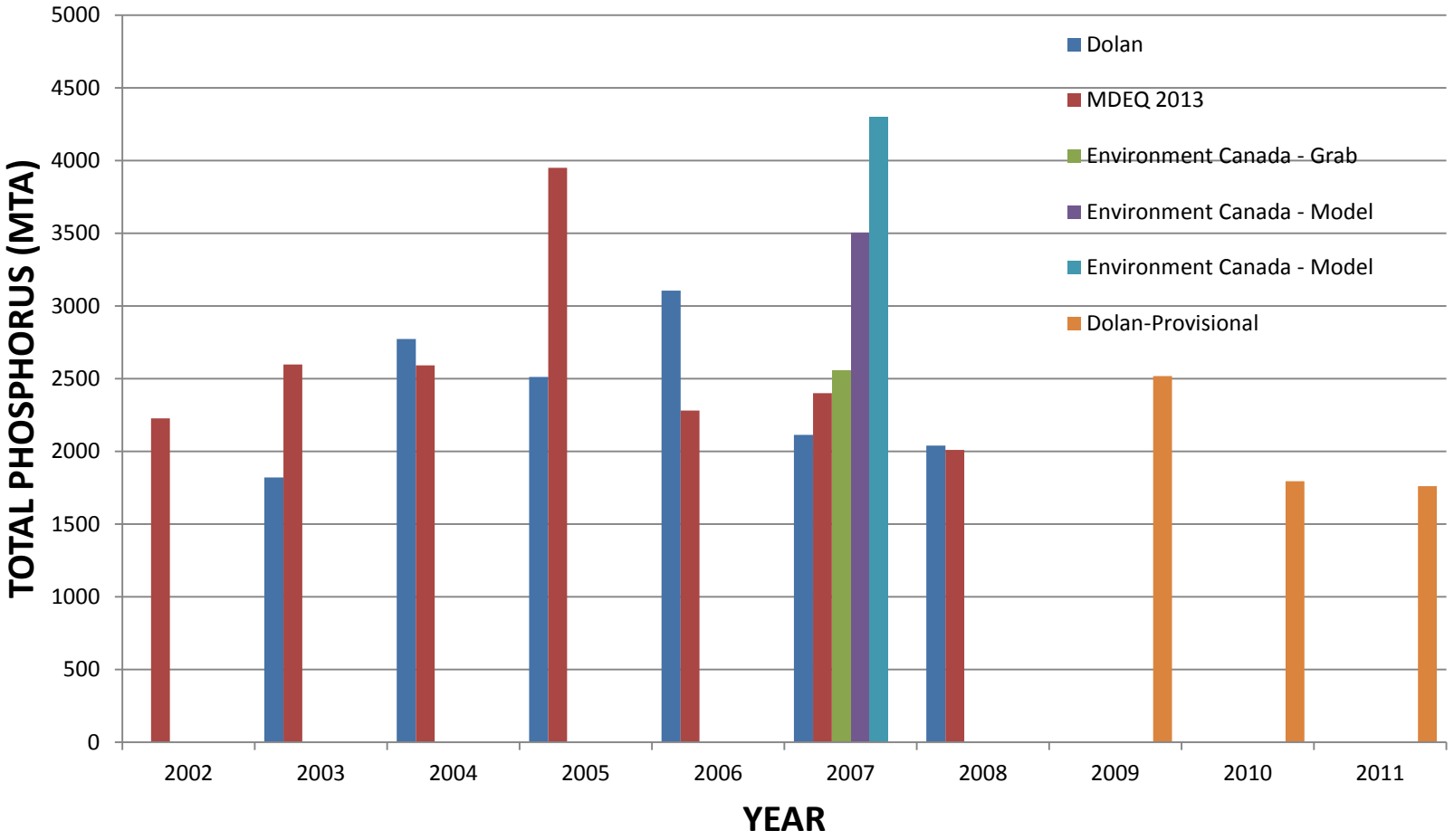
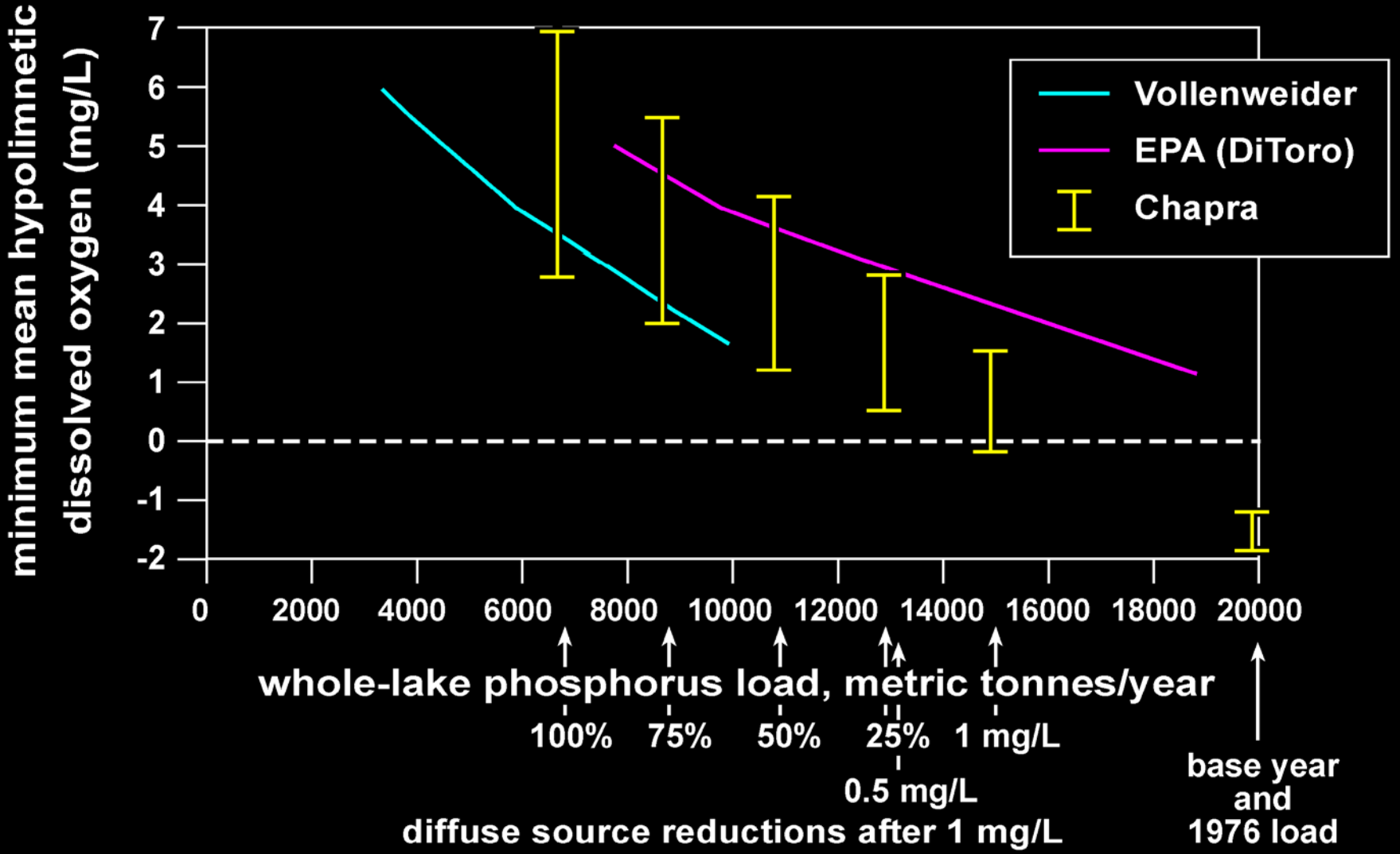


TOTAL PHOSPHORUS LOAD (MTA) FROM THE DETROIT RIVER TO LAKE ERIE, 2002-2011 (MULTIPLE SOURCES)



Phosphorus Load vs. Predicted Minimum Mean Hypolimnetic Dissolved Oxygen Lake Erie Central Basin



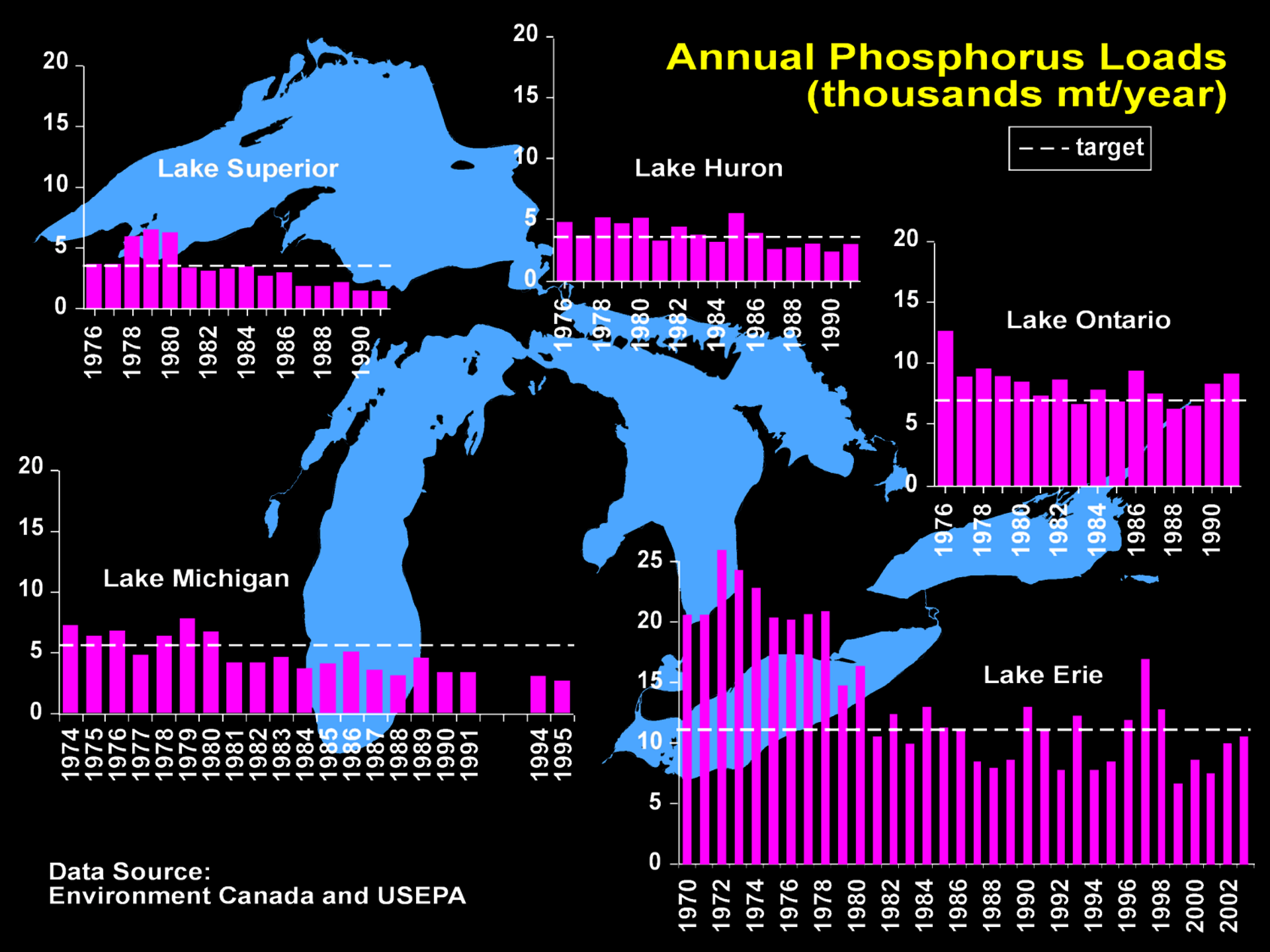
Target Phosphorus Loads and Associated Endpoints for the Great Lakes

	Target P* Load (MTA)	Target P** Concentration (µg/L)	CHL A** Concentration (µg/L)	Secchi (m)	Trophic Status
Lake Superior	3400	5	1	8	oligo
Lake Michigan	5600	7	1 - 3	9 - 12	oligo/meso
Lake Huron	2800	5	0.5 – 1.5	8	oligo
Georgian Bay	620	5			
North Channel	520	5			
Saginaw Bay	440	15	5 - 10	1 - 3	eutro
Lake Erie	11000				
Western Basin		15	5 - 10	1 - 3	eutro
Central Basin		10	3 - 6	4 - 8	meso
Eastern Basin		10	1 - 3	6 - 9	oligo/meso
Lake Ontario	7000	10	1 - 3	6 - 9	oligo/meso

* Great Lakes Water Quality Agreement, 1972; 1978; 1983; 1987

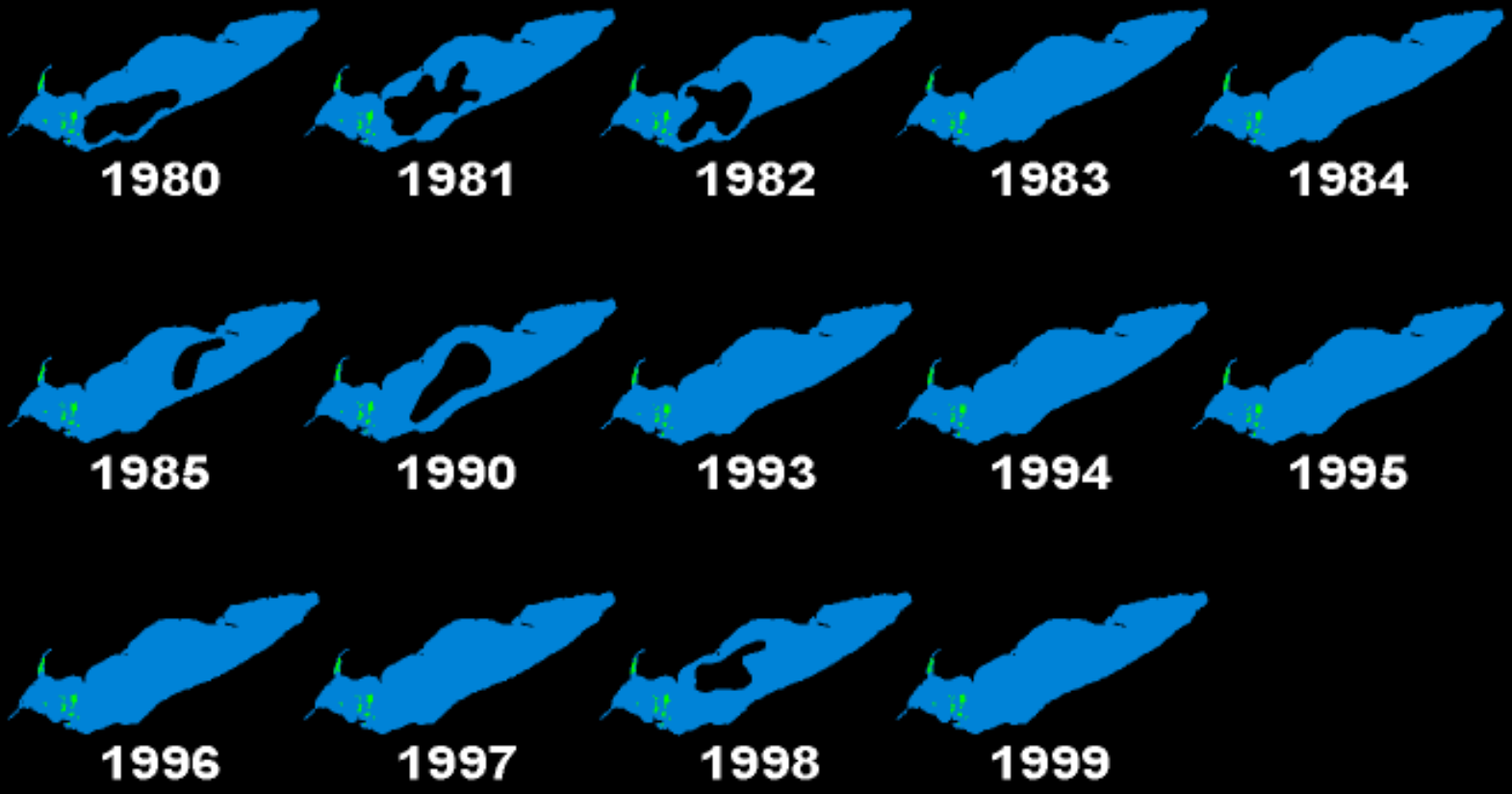
** Great Lakes Water Quality Board, IJC, 1978

Annual Phosphorus Loads (thousands mt/year)

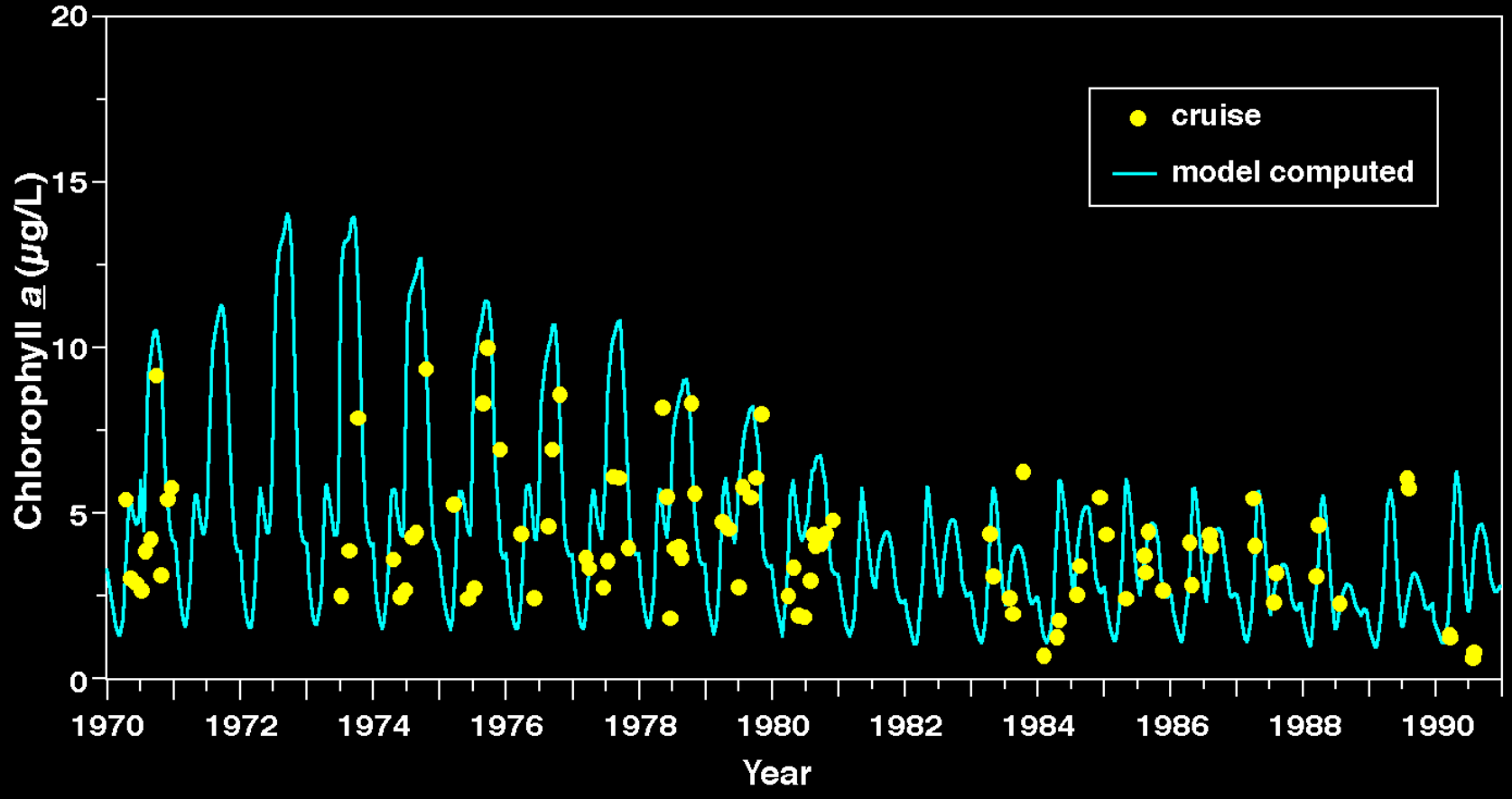


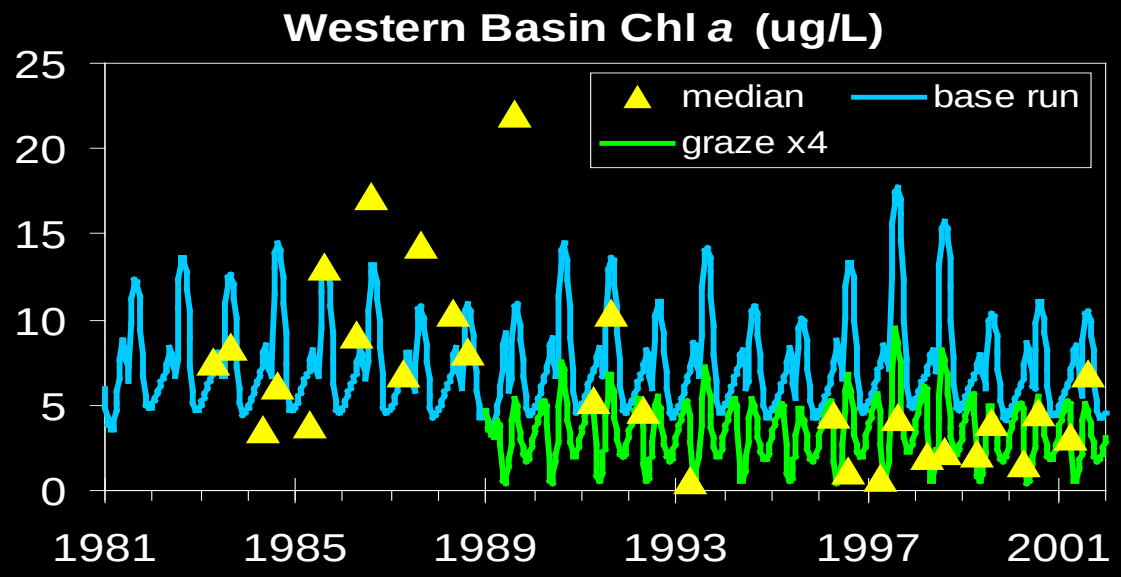
Data Source:
Environment Canada and USEPA

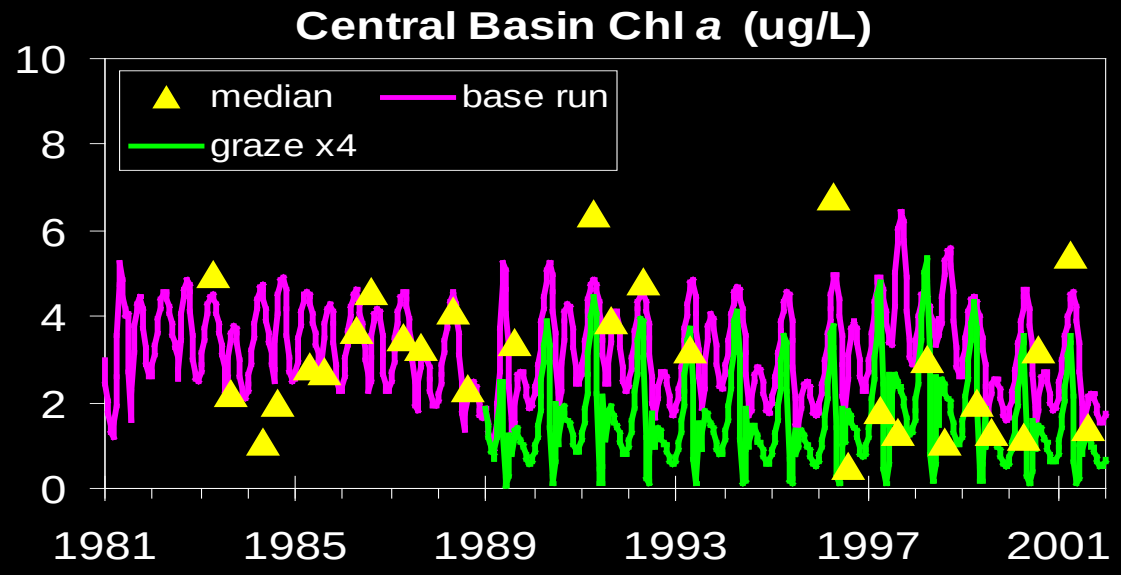
Distribution of Hypolimnion Anoxia in Central Lake Erie, 1980 - 1999
(Charlton, CCIW)



Model Simulation of Chlorophyll *a* Concentrations in Central Lake Erie (1970 - 1991)

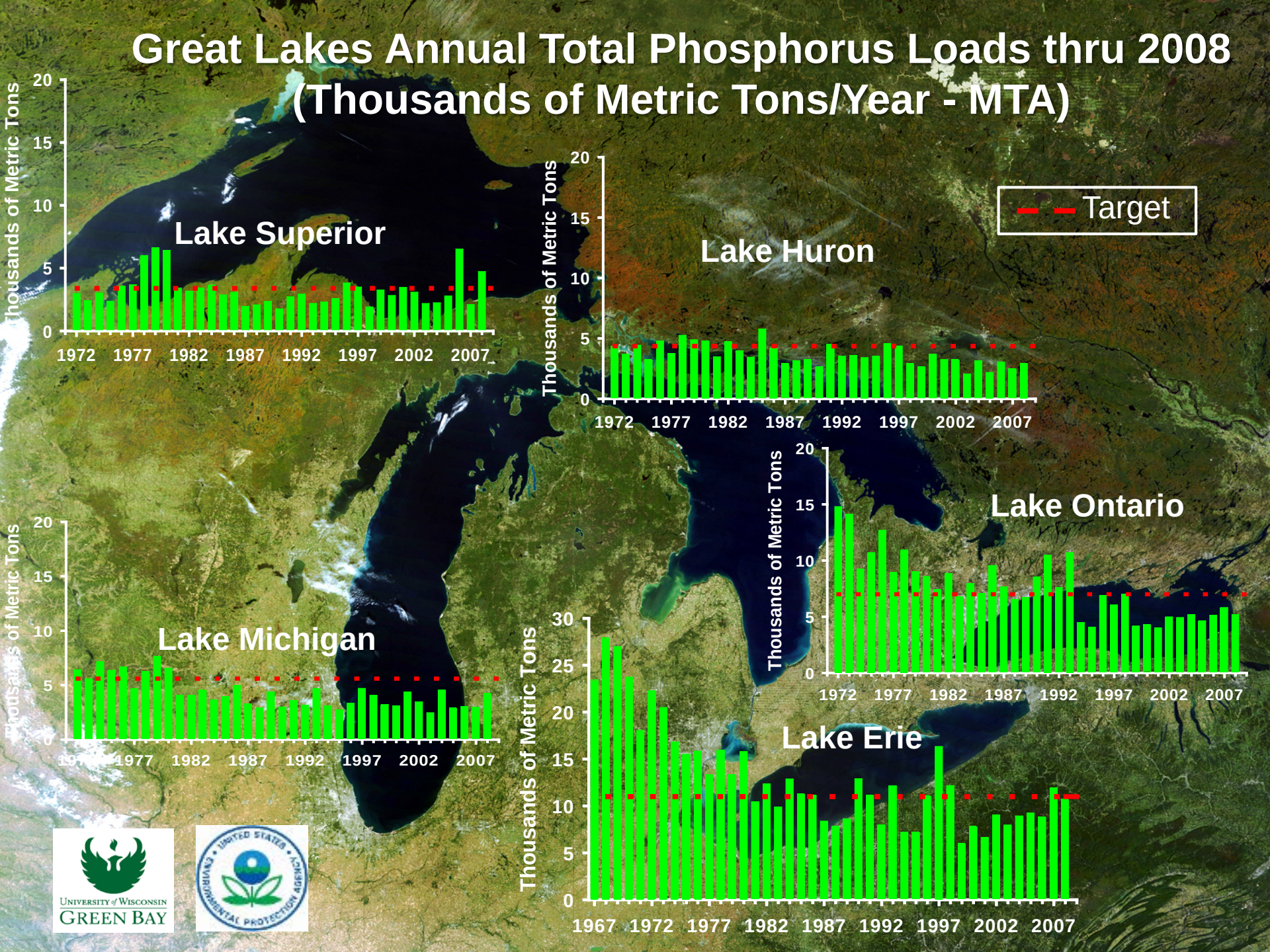






Model Results Sensitivity to Zooplankton Grazing Rates (simulation of zebra mussel feeding)

Great Lakes Annual Total Phosphorus Loads thru 2008
(Thousands of Metric Tons/Year - MTA)



Model	Lead Author, Institution	Eutrophication Response Indicators			
		Western Basin phytoplankton biomass	Western Basin cyanobacteria biomass	Central Basin Hypoxia	Eastern Basin Cladophora
Statistical HAB model	Stumpf, NOAA		X		
Statistical HAB model	Obenour, U-M/NOAA		X		
3-D WB Ecosystem Model	DePinto, LimnoTech	X	X		
TP Mass Balance Model	Chapra, Tufts Univ.	X			
1-D CB Model	Rucinski, LimnoTech/U-M			X	
2-D WB/CB Model	Zhang, U-M	X		X	
9-Box CB Model	Lam, Environment Canada (EC)			X	
3-D ELCD model	Bocaniov, U-M/EC	X		X	
Cladophora Model	Auer, Michigan Tech.				X

Loading Estimation Work Group

5 Conference Calls Held Since March, 2016

Approximately 15 WG Members

Connectivity/Interface with other WGs
-Tributaries, Modeling, and Adaptive Management

Rough 1st Draft Report Distributed to the WG

Primary Documents: Task Team Report;
Draft Modeling Report; M,M, R &R for AM Report;
IAGLR Special Publications

Loading Estimation Work Group
GOALS/CHARGE

- Review/Explain How Lake Erie Phosphorus Loads were Estimated in the Past and Present; as well as for the Entire Great Lakes Basin
- Explore Improved Strategies for Load Estimation for the Future
- Address other Objectives which lead to a Better Understanding of Managing Lake Erie Nutrients
- Provide Recommendations to the Annex 4 Objectives and Targets Task Team

General Findings

- The present method and system for calculating and tracking phosphorus loads in Lake Erie and the Great Lakes basin is well-know and well-documented.
- The method is the only international, lakewide method for Lake Erie and for the other 4 Great Lakes.
- The system has been in use spanning approximately 5 decades and is commonly known as the “Dolan Approach”.
- It has also been the only methodology used in various reporting venues, including under the Great Lakes Water Quality Agreement.
- This approach uses empirical data, additive loads, and mathematical modeling.
- The approach also uses the Beale Stratified Ratio Estimator, Maximum Likelihood Theory, and provides Error Estimates which appear appropriate.

Draft Loading Work Group Recommendations -1

- Establish a formal, non-proprietary, binational group of experts to provide management and oversight to the calculation of Lake Erie and Great Lakes Basin nutrient loadings.
- Coordinate and interact with the Tributary Monitoring, Modeling, In-lake Response, and Adaptive Management teams.
- Explore and examine additional systems, models, and algorithms for calculating nutrient loading.
- Reduce lake-wide loading uncertainty by enhancing the atmospheric monitoring program and determining in-lake nutrient loads governed by sediment dynamics.
- Reconcile the existing loading approaches and datasets from the outflow of Lake Huron, reducing uncertainty in Detroit River loading estimates; account for ecosystem dynamics in the St. Clair-Detroit River corridor.

Draft Loading Work Group Recommendations -2

- Continue existing daily monitoring for present operational models and load calculations and a minimum of 50 samples per year for other priority tributaries to reduce uncertainty and increase statistical robustness.
- Reduce the number of Unmonitored Areas through increased monitoring.
- Pursue collection of constituent phosphorus forms from all sources.
- Pursue collection of constituent nitrogen forms from all sources.
- Develop mass balances/budgets for all phosphorus and nitrogen constituent forms.
- Plan for additional operational, lake-wide models with time steps ranging from daily, weekly, monthly, to annual.
- Provide annual nutrient loading for the other Great Lakes using the present loading approach (2009-2016).