Pennsylvania Lake Erie Phosporus Reduction Domestic Action Plan (DAP)

Water Resources Advisory Committee
Rachel Carson State Office Building
9/19/18

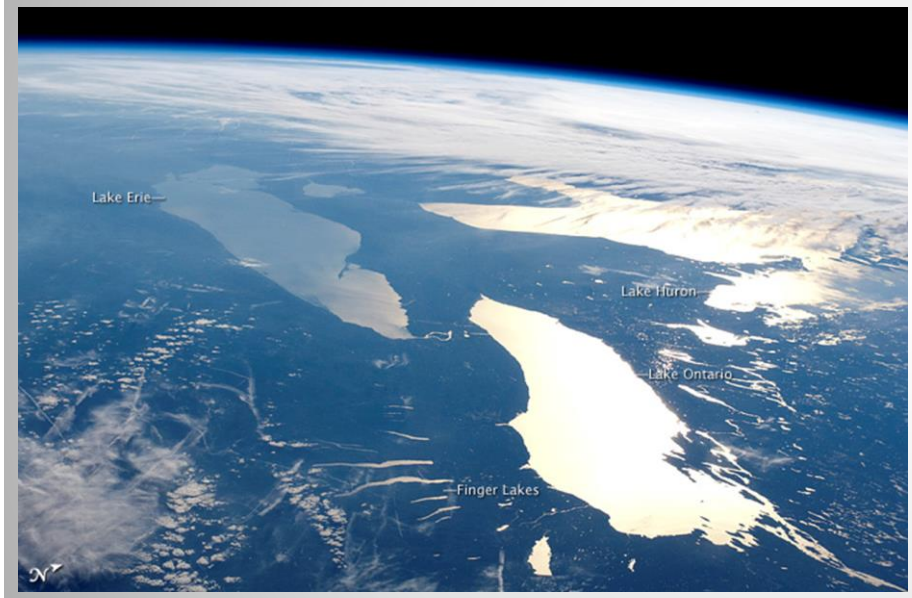
PA DEP Office of the Great Lakes

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

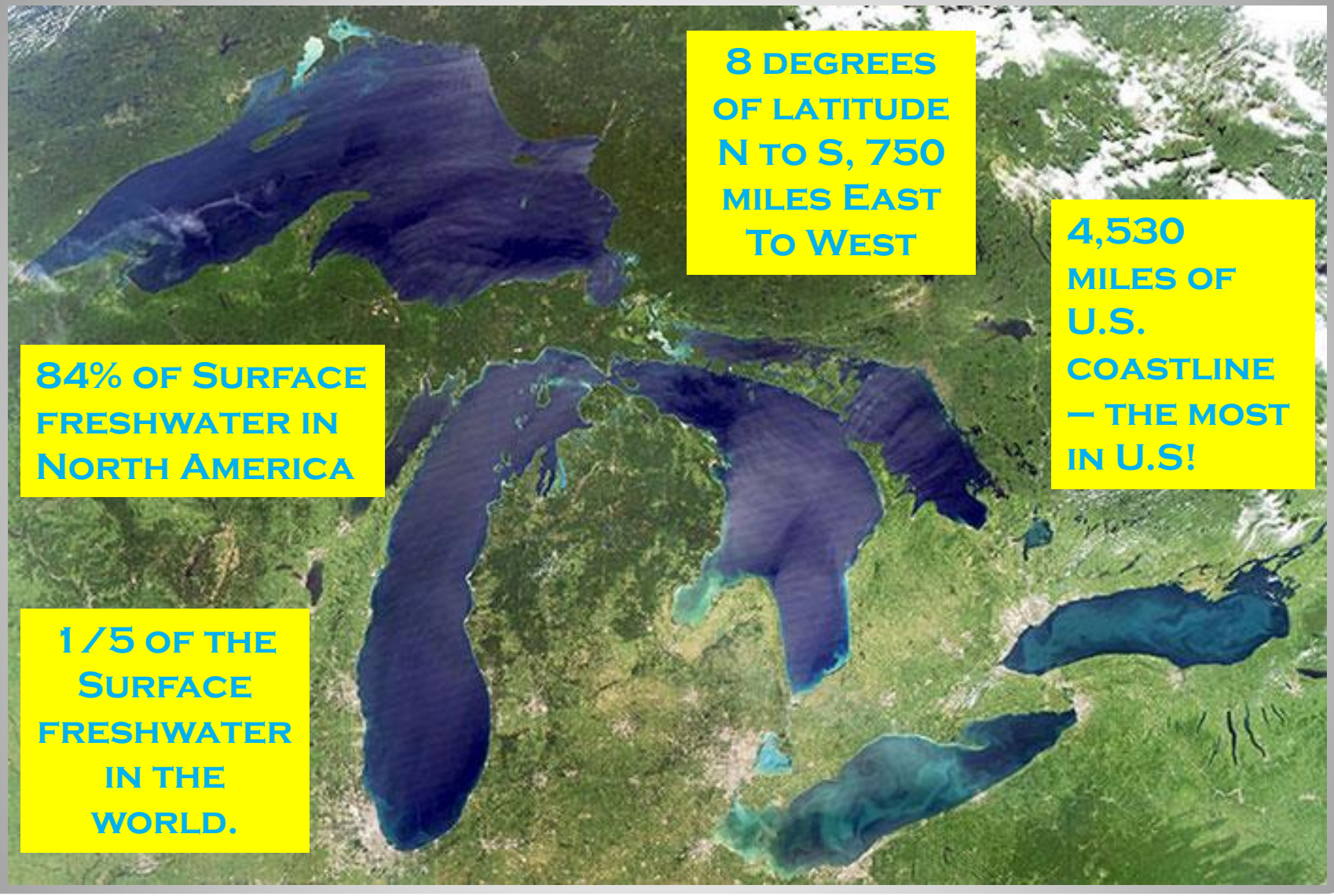
DEP Office of the Great Lakes

- Located at the Tom Ridge Environmental Center at Presque Isle State Park.
- Multi-disciplinary staff covering wide array of environmental technical and policy areas.
- A focus on Great Lakes water quality and linking the community with the resource.
- Forming community partnerships to encouraging municipal and county cooperation and protect the environment.

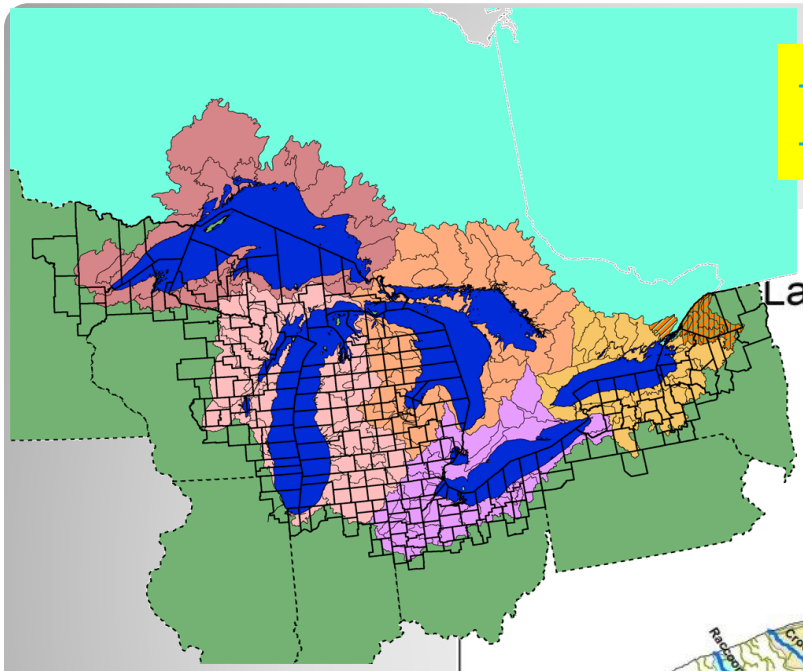
Meeting Our Regional Commitments

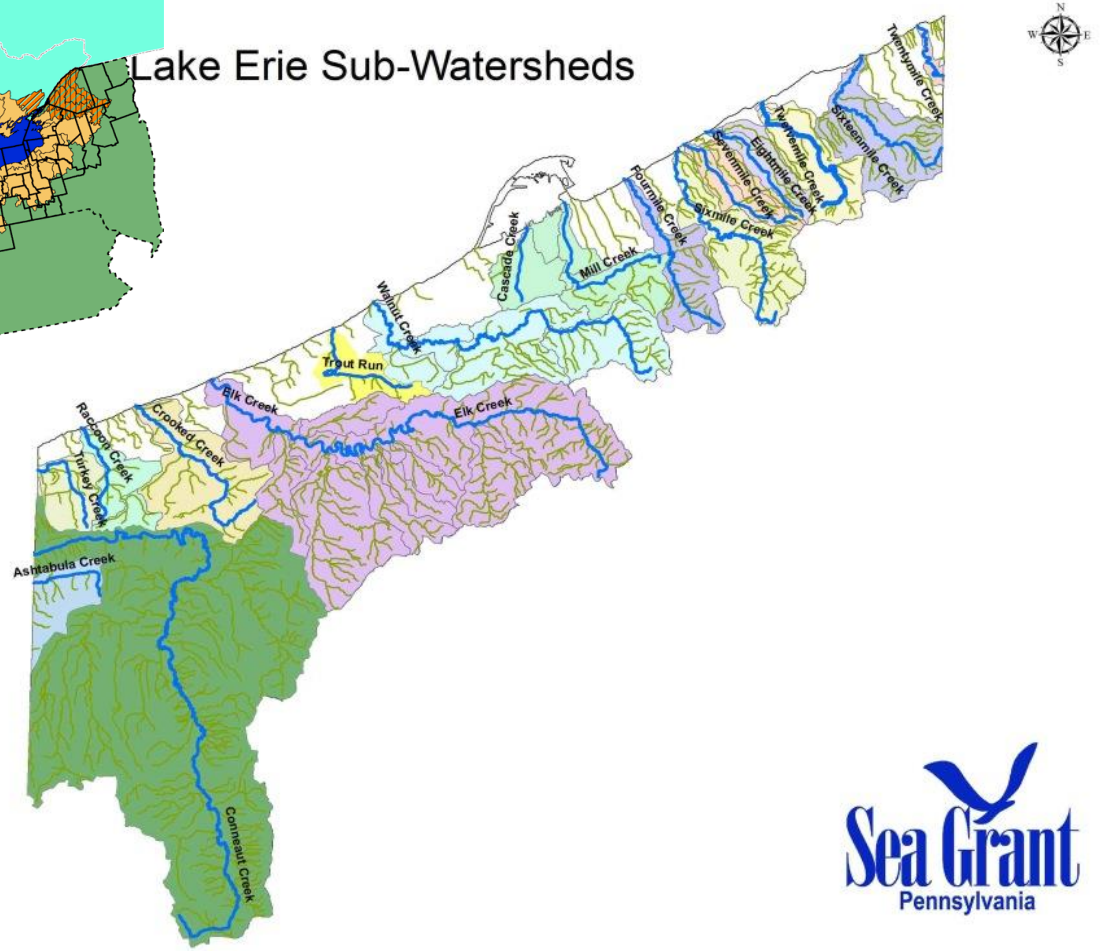


- Coordinate with U.S. and Canadian federal agencies, other states and provinces to address water use and water quality challenges.
- Working within the Great Lakes governance structures to assure PA has a strong voice.
- Developing water and land protection programs and prioritizing funding.
- Fulfilling a role in the continued development of stronger communities both now and in the future.


8 degrees of latitude N to S, 750 miles East To West
4,530 miles of U.S. coastline – the most in U.S!
84% of Surface freshwater in North America
1/5 of the Surface freshwater in the world.

- 77 miles of coastline.
- 2% of the total Great Lakes watershed area.





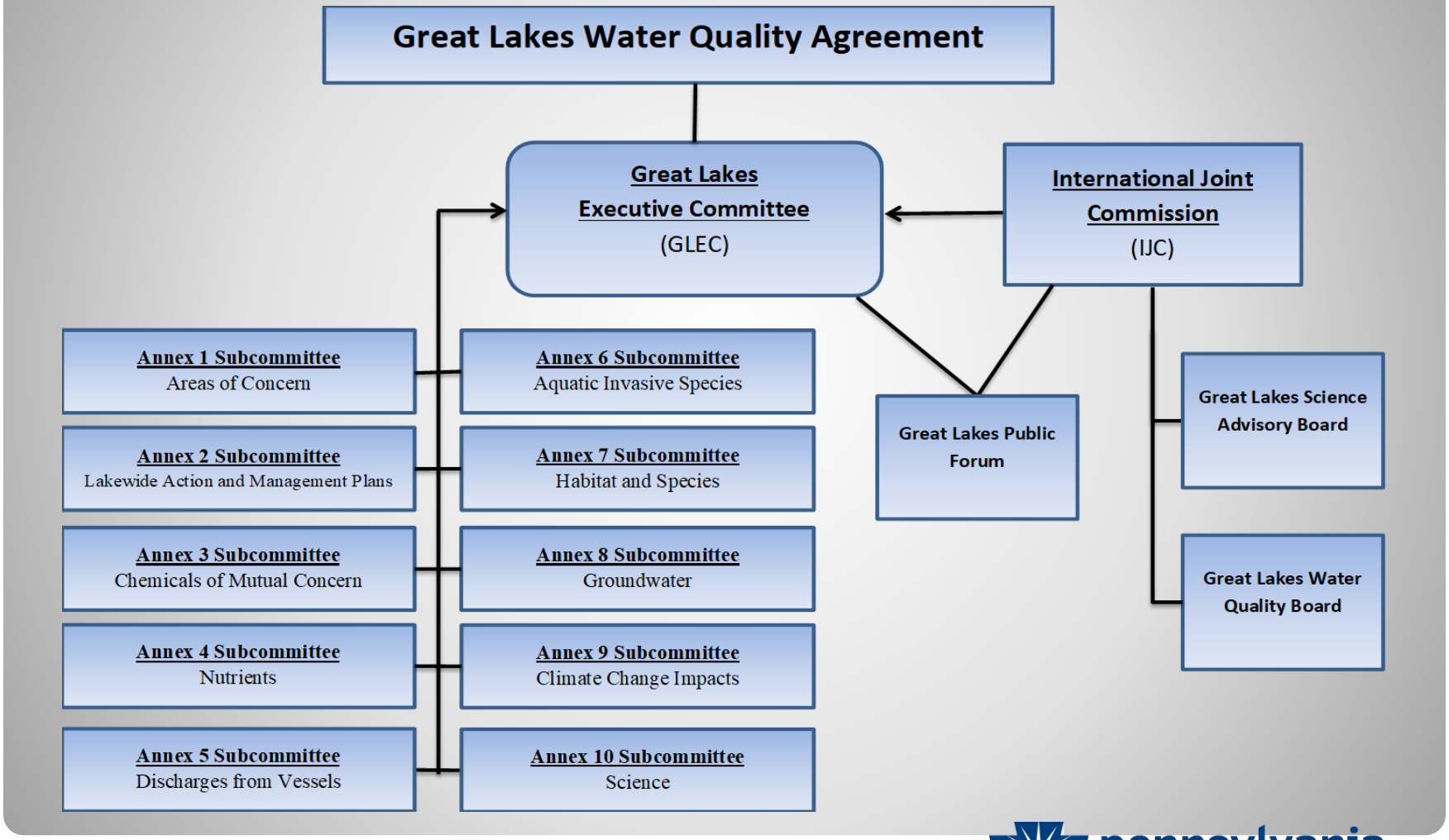
Sea Grant
Pennsylvania

Great Lakes Water Quality Agreement

- The Great Lakes Water Quality Agreement (GLWQA) is a commitment between the United States and Canada to restore and protect the waters of the Great Lakes.
- First signed in 1972, the Agreement provides a framework for identifying binational priorities and implementing actions that improve water quality.
- It enhances water quality programs that ensure the "chemical, physical, and biological integrity" of the Great Lakes.
- EPA coordinates U.S. activities that fulfill the Agreement. States participate in GLEC, Lake Partnerships, Annex Subcommittees, and Work Groups.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

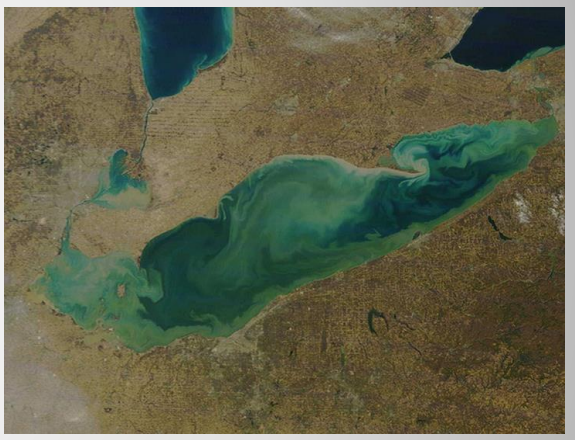
Great Lakes Water Quality Agreement



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Great Lakes Water Quality Agreement

- ***Annex 4: Nutrients***
  - Adopted new phosphorus reduction targets in February 2016.
  - Adopted Binational Phosphorus Reduction Strategy 2018
  - US and Canada each adopted a Domestic Action Plan 2018
    - States developed individual DAPs and were integrated into the umbrella US DAP.
  - Great Lakes Commission developed ErieSTAT website for tracking.



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

QLWQA 2012 – Annex 4: Nutrients

- Manages phosphorus concentrations and loadings.
- Establishes Lake Ecosystem Objectives.
- Establishes Substance Objectives for TP Concentrations and Loadings
- Requires program evaluation and enhancement.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Annex 4: Lake Ecosystem Objectives

- Minimize hypoxic zones.
- Maintain algae below nuisance.
- Maintain healthy algae species.
- Maintain cyanobacteria at levels below which are a threat to humans or ecosystem.
- Maintain oligotrophic/biomass/algal species in Superior, Michigan, Huron Ontario
- Maintain mesotrophic conditions in West/Central Erie and oligotrophic conditions in East Erie.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

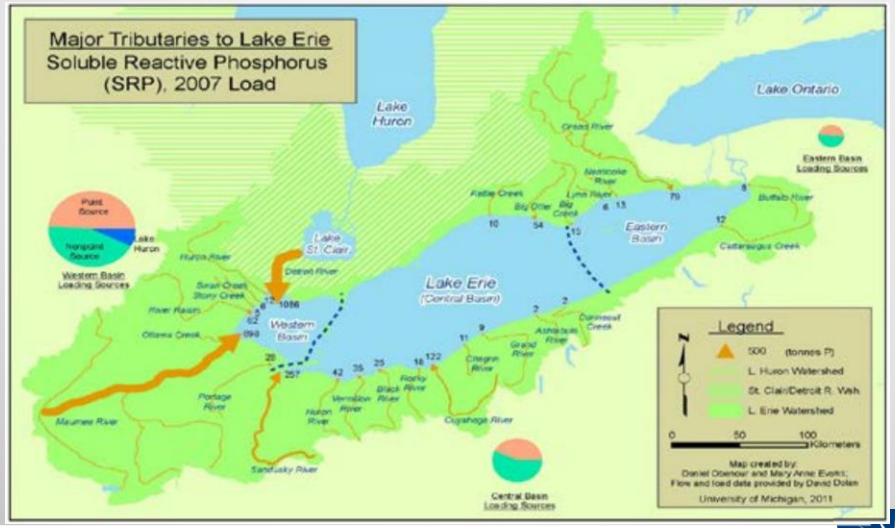
PA Applicable Phosphorus Targets

1. **West Basin Cyanobacteria: N/A**
2. **West & Central Basin Nearshore: N/A**
3. **To minimize the extent of hypoxic zones in the waters of the central basin of Lake Erie:** 40 percent reduction in total phosphorus entering the western and central basins of Lake Erie—from the United States and from Canada—to achieve an annual load of 6,000 metric tons to the central basin.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Establishing Lake Erie Targets

- Regional reduction targets established through load modeling conducted by Maccoux, et al.
- Maccoux estimates better for larger sources with more data available (tributaries and point sources).
- Valuable for determining and assigning large reductions that need to occur on the lakewide scale.



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania-Specific Difficulties

- Maccoux method excellent for large scale TP reductions, hampers Pennsylvania estimations.
- Lack of high-frequency sampling and monitoring in PA, lack of major sources.
- Batch calculated watershed areas mix Central and Eastern Basin PA tributaries.
- Differing interpretations of Central Basin boundary required DEP to determine defined area.
- PA had to use reference watersheds and available data to estimate non-point loading.

Journal of Great Lakes Research 42 (2016) 1151–1165

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Total and soluble reactive phosphorus loadings to Lake Erie
A detailed accounting by year, basin, country, and tributary

Matthew J. Maccoux [a,*], Alice Dove [b], Sean M. Backus [b], David M. Dolan [c,1]

[a] Milwaukee, WI 53222, USA
[b] Water Quality Monitoring and Surveillance Division, Environment and Climate Change Canada, Burlington, Ontario, Canada L7R 4A6
[c] Natural and Applied Sciences, University of Wisconsin-Green Bay, Green Bay, WI 54311, USA

ARTICLE INFO

Article history:
Received 23 December 2015
Accepted 4 August 2016
Available online 3 September 2016

Communicated by Russell Kreis

Index words:
Phosphorus
Soluble reactive phosphorus
Loadings
Lake Erie

ABSTRACT

Information about the loads of total and soluble reactive phosphorus entering Lake Erie is required in order to support commitments made under Annex 4 of the Great Lakes Water Quality Agreement. For these purposes, annual (water year) total phosphorus loads to Lake Erie are updated (2003–2013) and soluble reactive loads are reported on a lakewide basis for the first time (2009–2013). Complete documentation including input data and error estimates are provided. The results confirm previously documented long-term declining TP loads and show how these are driven by early and recent improvements in point source discharges, but are confounded by recent increases in nonpoint source loads that may in turn be due to increasing trends in precipitation and river discharge. The record since 2009 for SRP indicates high interannual variability and no discernible change in loadings over time. Recent TP loads are dominated by nonpoint sources (71%), with lower contributions from point sources (19%) and the balance comprising atmospheric deposition and loads from the upstream Great Lakes. Approximately one-half (49%) of the load of SRP is contributed from nonpoint sources, approximately 39% comprises point sources, and atmospheric deposition and upstream loads comprise 6% each. Loads are highest to the western basin for TP and highest to the Huron–Erie corridor for SRP. U.S. sources account for a majority (>80%) of the phosphorus loads entering the lake. Recommendations for improvements to the study approach are made including the identification of monitoring gaps and the testing of assumptions that require independent verification.

1. Introduction

The 2012 Protocol to the United States–Canada Great Lakes Water Quality Agreement (GLWQA) calls for the review and revision of nutrient-related targets for the Great Lakes, including the establishment of nearshore and offshore water quality and tributary concentrations or loadings goals in order to meet the General and Specific Objectives as outlined in the Agreement. For Lake Erie, the commitments are time-bounded; phosphorus loadings targets have recently been approved, and the establishment of programs and policies needed to attain these targets is to be completed by 2017.

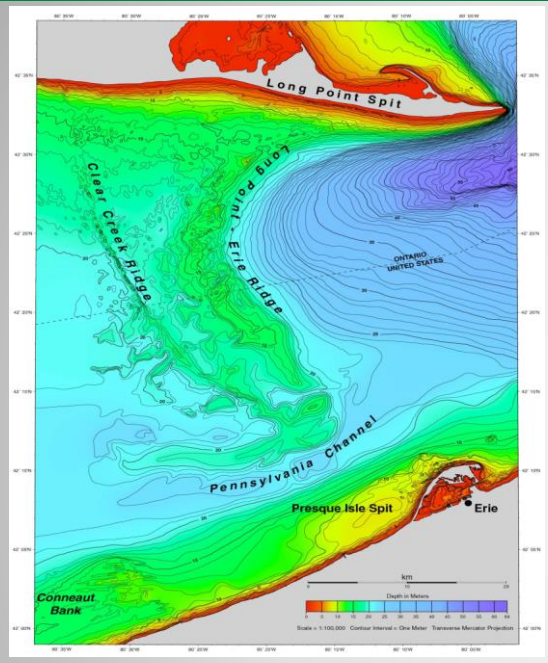
The existing nutrient targets, set forth in the 1978 Amendment to the GLWQA, were based on mass balance models that related in-lake total phosphorus (TP) concentrations to TP loadings. Given the desired trophic status of Lake Erie's western and central basins as mesotrophic and its eastern basin as oligotrophic, the loadings needed to achieve the corresponding in-lake concentrations were established. The programs and measures that were instituted by both the United States and Canada to meet these targets were largely successful at reducing loadings to the Great Lakes, and in-lake concentrations have declined (DePinto et al., 1986). Indeed, in all of the Great Lakes, with the exception of Lake Erie, the offshore environments have shown evidence of phosphorus declines that have overreached their targets, resulting in offshore oligotrophication (Dove and Chapra, 2015). Lake Erie phosphorus concentrations are now lower than maximum values observed in the early 1970s, but they remain higher than targets, show high interannual variability, and persistent nutrient issues remain. Symptoms of excessive nutrient inputs include a resurgence of algal blooms including harmful cyanobacteria in the western basin of Lake Erie (Michalak et al., 2013; Stumpf et al., 2012) and increased hypoxia in the central basin (Zhou et al., 2013). There is also some evidence that, despite a reduction in overall loadings of TP to Lake Erie over time, the proportion comprised by the more bioavailable soluble reactive phosphorus (SRP) component may be increasing (Dalog̃lu et al., 2012; Richards et al., 2010; Scavia et al., 2014). In Lake Erie, the target TP load of 11,000 metric tonnes per annum (MTA) (GLWQA, 1978) was achieved by 1981 (DePinto

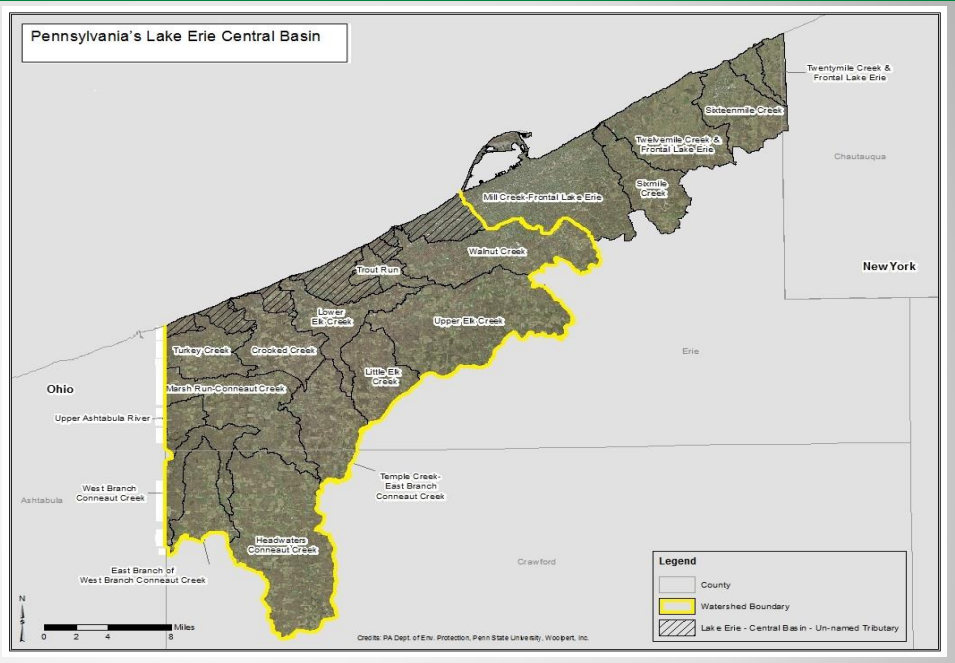
* Corresponding author.
E-mail addresses: maccmj028@gmail.com (M.J. Maccoux), alice.dove@canada.ca (A. Dove), sean.backus@canada.ca (S.M. Backus).
[1] Deceased 18 June 2013.

http://dx.doi.org/10.1016/j.jglr.2016.08.005
0380-1330/

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Defining PA Central Basin





- DEP utilized USGS bathymetry and geomorphology, in addition to feedback from USEPA to determine Central Basin boundary.

- 375 mi2, 8 named tributaries, 6 small direct discharge areas.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Point Sources

230+ NPDES permitted discharges
in PA Central Basin.*

- 2 Concentrated Animal Feeding Operations
- 5 MS4 Permits: 4 General, 1 Ind., 1 waived
- 7 POTWs: 5 Minor (>1 MGD), 2 Major (1<5)
- 33 Industrial: 27 Minor, 5 No Discharge
- **170+ Private Wastewater Discharges**

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

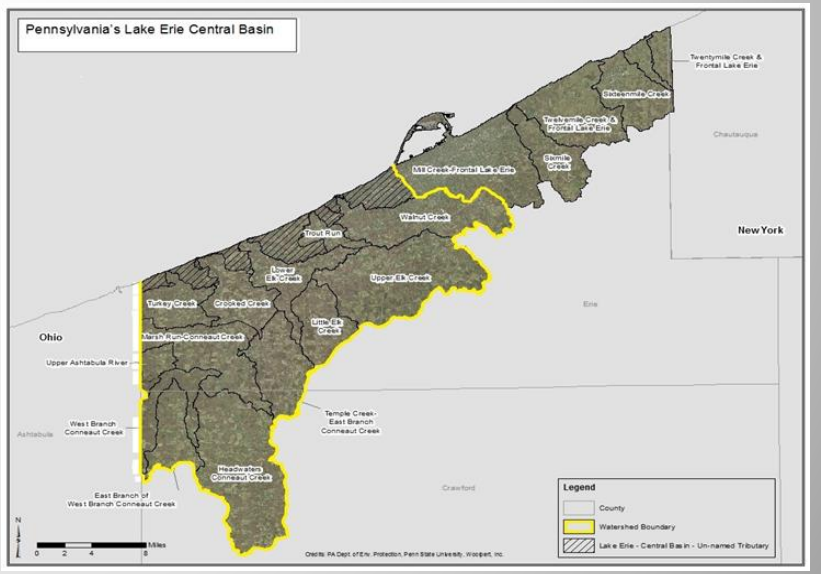
Pennsylvania Non-Point Source Estimates

- Pennsylvania tribs Ashtabula Creek and Conneaut Creek are combined into Ashtabula-Conneaut Complex, others combined into Eastern Basin tribs when they were modeled.
- PA prorated contributions to A-C Complex based on land area due to lack of data. EPA concurred.

*Table 1: Estimated Pennsylvania Annual TP Loading to the Ashtabula-Conneaut Complex (2008-2013)**

Year	Complex Total TP Loading (MTA)	Prorated PA Complex TP Loading (MTA)	PA Percent TP Reduction Over 2008 Baseline
2008	69	32.0	
2009	26	12.1	62.20%
2010	24	11.1	65.30%
2011	40	18.6	41.80%
2012	52	24.1	24.70%
2013	13	6.0	81.30%

*Statistics and percent reductions derived from data presented by Maccoux.



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania TP Loading To CB

- The Ashtabula-Conneaut Complex was used as a surrogate/reference for estimating total PA phosphorus contribution from the entire PA Central Basin drainage.
- PA's Central Basin loading estimate average between 2008-2013 is approximately 40.7 MTA, or 0.51% of the total HEC, WB, CB load during that time period.
- This indicates PA may be loading at or below the 40% TP reduction over 2008 levels for every year except one during that time period.

Table 2: Estimated Pennsylvania Annual TP Loading to the Central Basin (2008-2013)

Year	Complex Total TP Loading (MTA)	Estimated PA Central Basin TP Loading (MTA)
2008	69	75.2
2009	26	28.3
2010	24	26.2
2011	40	43.6
2012	52	56.7
2013	13	14.2
2008-2013 Average Annual TP Loading	37.3	40.7

Table 3: Estimated Pennsylvania Annual Percent TP Loading to the Central Basin (2008-2013)

Year	Maccoux Central Basin TP Loading (MTA)	Estimated PA Central Basin TP Loading (MTA)	Estimated PA Central Basin % of Total Loading
2008	9736	75	0.77
2009	7637	28	0.37
2010	5352	26	0.49
2011	10092	44	0.43
2012	7045	57	0.80
2013	7493	14	0.19
2008-2013 Estimated Average PA Percentage of Total CB Loading			0.51

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania TP Loading To Central Basin

Conclusions:

- PA's phosphorus contributions to CB are de minimus and have little overall effect on the hypoxia/anoxia being observed in CB.
- Even if it was possible to reduce tributary loading from current levels (which are low), it would likely only provide reductions on the hypoxia issue by a small fraction of a percent.
- Pennsylvania's loading contributions to the Central Basin of Lake Erie are possibly already attaining the 40% reduction in TP over the 2008 baseline.
- Additionally, stream assessments suggest that any additional large-scale phosphorus reductions in some Pennsylvania tributaries may affect the biological productivity of the stream systems.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Commitments

BY 2021: Provide Greater Assurance of Pennsylvania Phosphorus Loading Estimations

Research and Assemble all Available Water Quality Data for Central Basin Tributaries

- Assemble and research monitoring data and discharge monitoring records for permittees located in the Central Basin.

Evaluate and Assess Applicability of Existing Data and Report

- Evaluate the quantity and quality of the data sources, catalog by tributary, assess the applicability of the data for phosphorus reduction estimations, identify data gaps, and produce a report defining data needs.

Conduct Tributary Land Use Assessment and GIS-based Nutrient Modeling

- Conduct land use and land cover assessment and GIS-based pollutant transport modeling appropriate for the size and scale of the tributaries.
- During the years 2021 and 2022, Pennsylvania will determine any additional data needs in specific tributaries necessary to increase the statistical confidence of the pollutant transport models.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Commitments

Prioritize Delivery of Nutrient Reduction Programs to Central Basin Tributaries

- **PADEP Clean Water**
  - SWM Associated with Construction Activities
  - Small Flow Treatment Facilities
  - Concentrated Animal Feeding Operations
  - MS4 Permitting
  - Act 537 Sewage Facilities Planning Program
  - NPDES E&S Control Permitting
  - Manure and Nutrient Management
  - Agricultural Erosion and Sediment Management
- **PADEP Coastal Resource Management Program**
  - Coastal Zone Management Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Commitments

DEP Partnerships with County/Local Governments and Non-Governmental Orgs

- PA Vested in Environmental Sustainability Program (VinES)
  - Erie County Conservation District
- Erie County Small Flow Treatment Facility Program
  - Erie County Department of Health
- Urban Stormwater Management and Green Infrastructure Initiatives
  - Multiple Partners

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PA Domestic Action Plan

Measuring Progress and Achieving Consensus

- DEP will report NPDES loading based on Discharge Monitoring Reports.
- DEP will report on known phosphorus contributions and reductions.
- DEP will submit phosphorus contribution and reduction data for the purposes of tracking and accounting for total lakewide phosphorus reductions.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PA Domestic Action Plan

Public Participation and Adaptive Management

- Lake Erie's basins are dynamic, natural systems that require adequate time to assess how the system is responding to inputs. ***Adaptive Management***
- Update plan every 5 years based on lake response and local success.

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PA Domestic Action Plan

Thank you!

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION