LimnoTech

Water Environment | Scientists Engineers

Saginaw Bay, Lake Erie & Truckee River

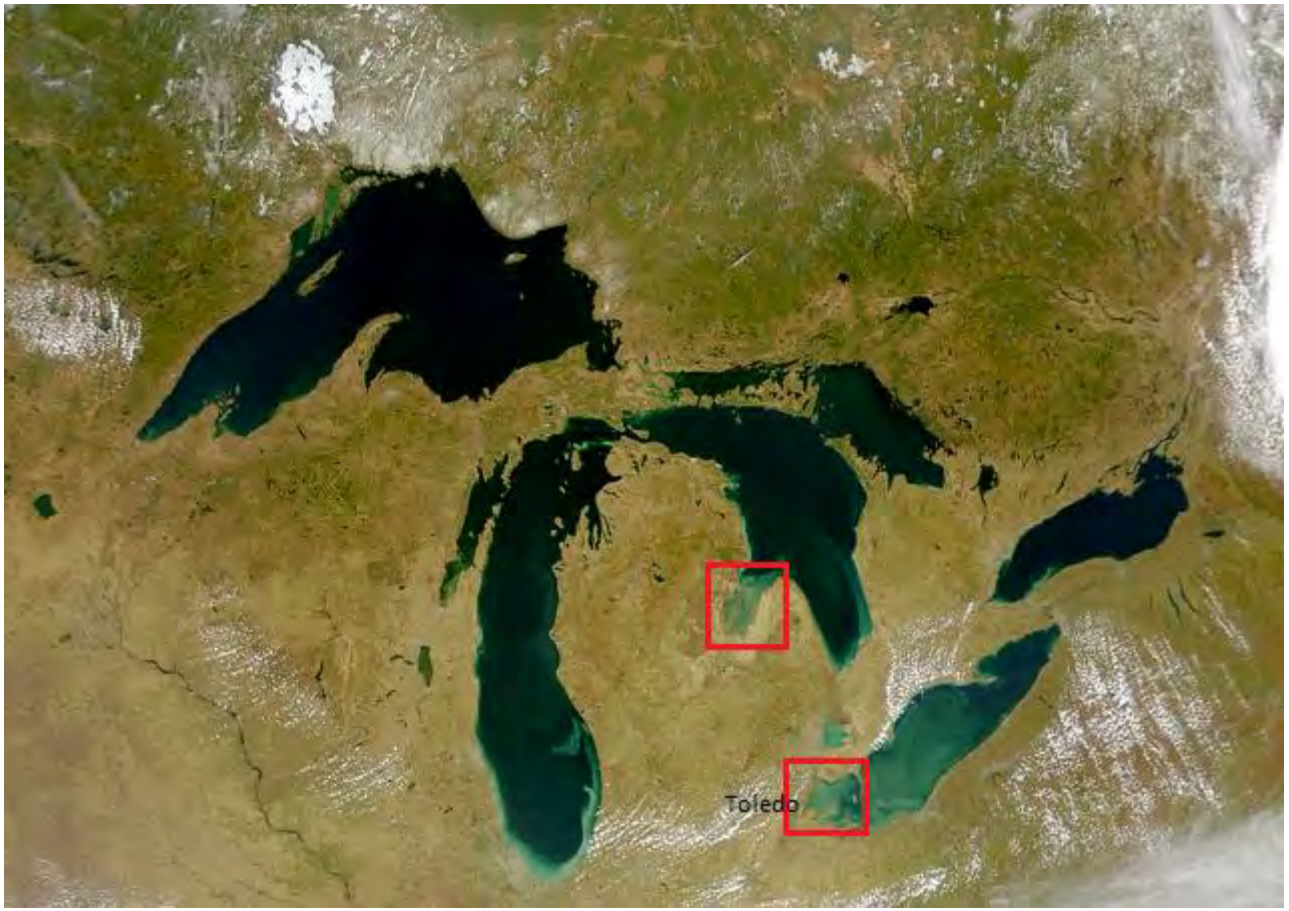
Adapting to changing ecosystems, watersheds, and economics

San Francisco Bay Nutrients Symposium Series

October 6, 2014

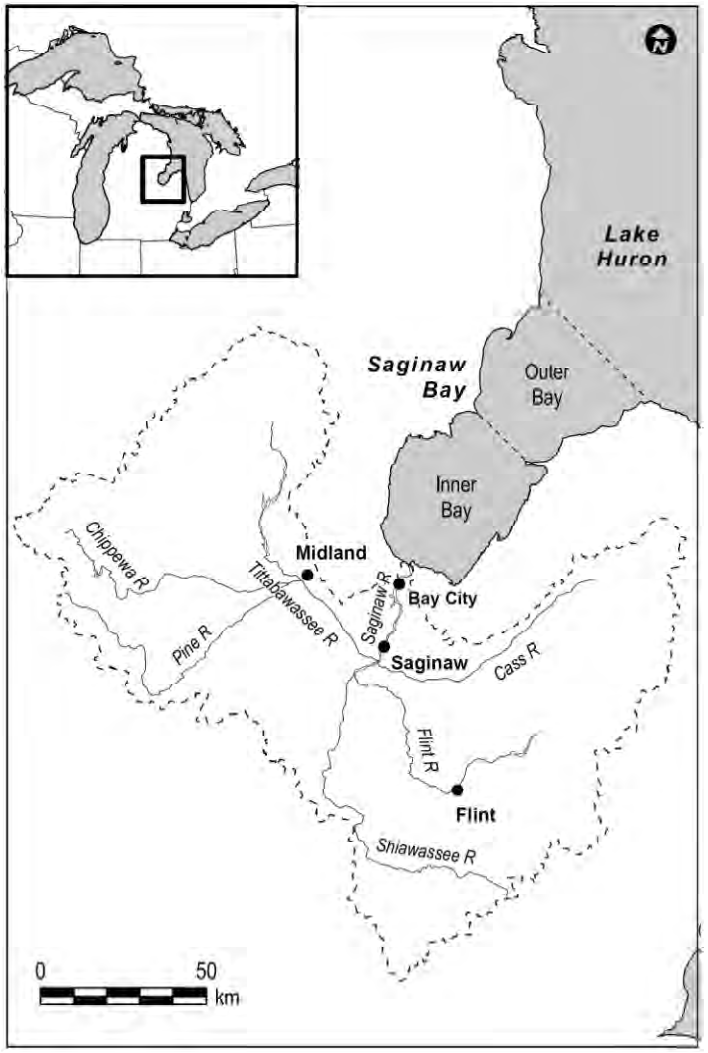
Great Lakes

- Saginaw Bay
- Lake Erie



Saginaw Bay

- Historic Water Quality Issues
  - Large phosphorus loads from point and non-point sources
  - Nuisance algal blooms
  - Drinking water standards for taste and odor exceeded 42% of time
- Great Lakes Water Quality Agreement - 1972
  - Initiated efforts to reduce phosphorus loads
  - Established targets loads to control eutrophic conditions

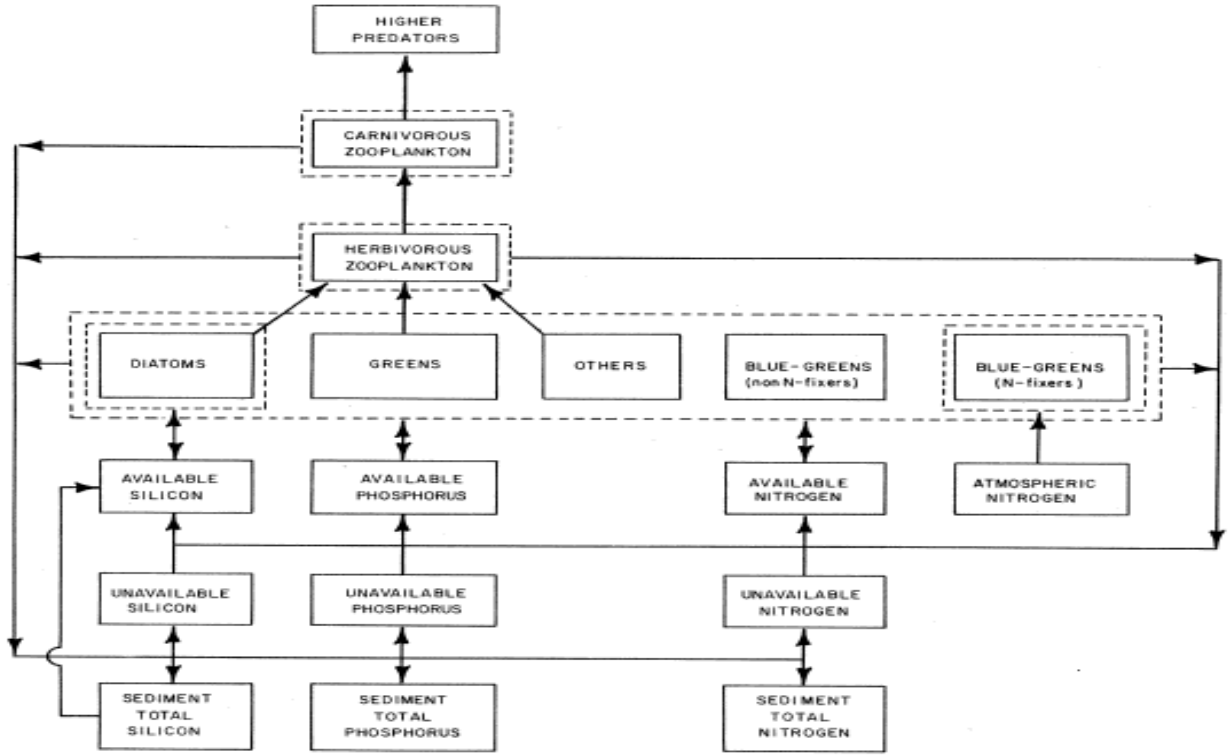


Early Saginaw Bay Efforts

- Acquire baseline data (1974-1975) on nutrient loadings and bay water quality
- Develop and calibrate a water quality model
- Use calibrated model to define target loading rate
- Conduct re-survey (1980)
  - Assess responses to load reductions
  - Post-audit model forecasts

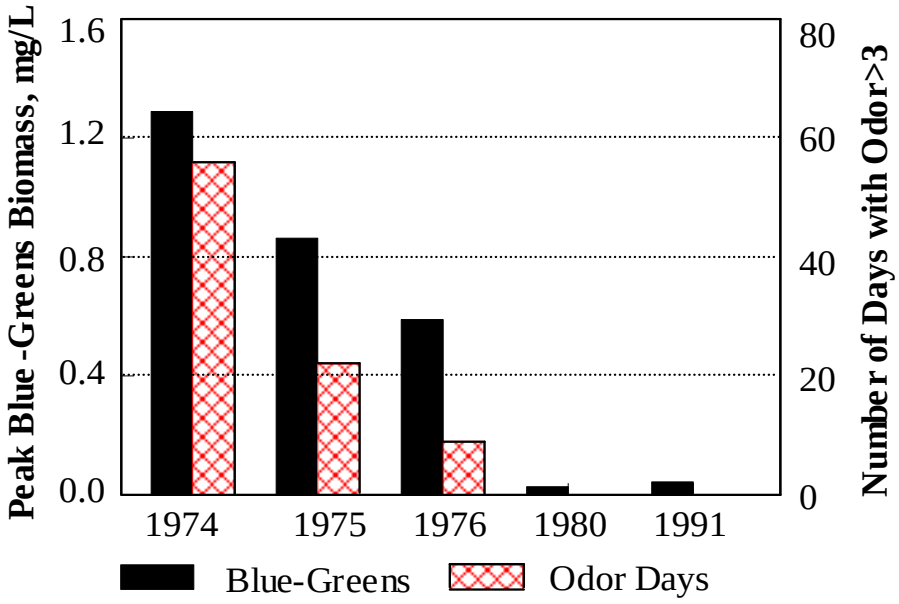
Original Saginaw Bay Model

- Bierman and Dolan, 1981
  - Multiple algal groups
  - Defined phosphorus load reduction necessary to eliminate nuisance blooms



Observed Response to Load Reduction

- Phosphorus loads to Bay decreased >50% between 1974 and 1980
  - 1 mg/l TP limits at major WWTPs
  - Series of dry years reduced non-point source load

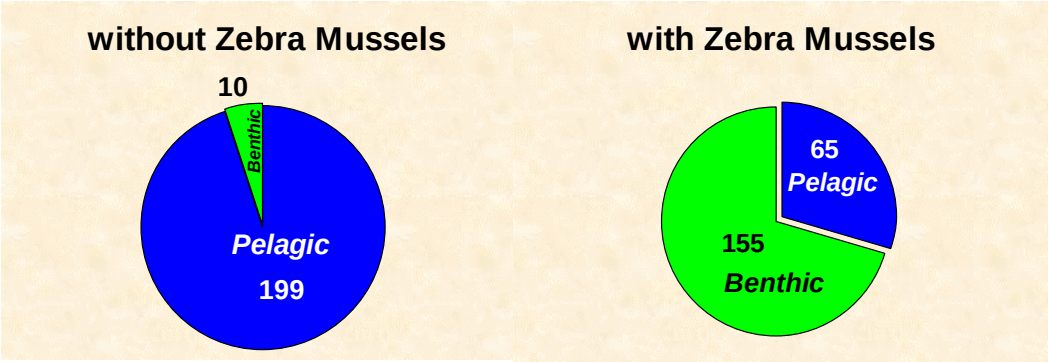


More than a Decade of Success… and then

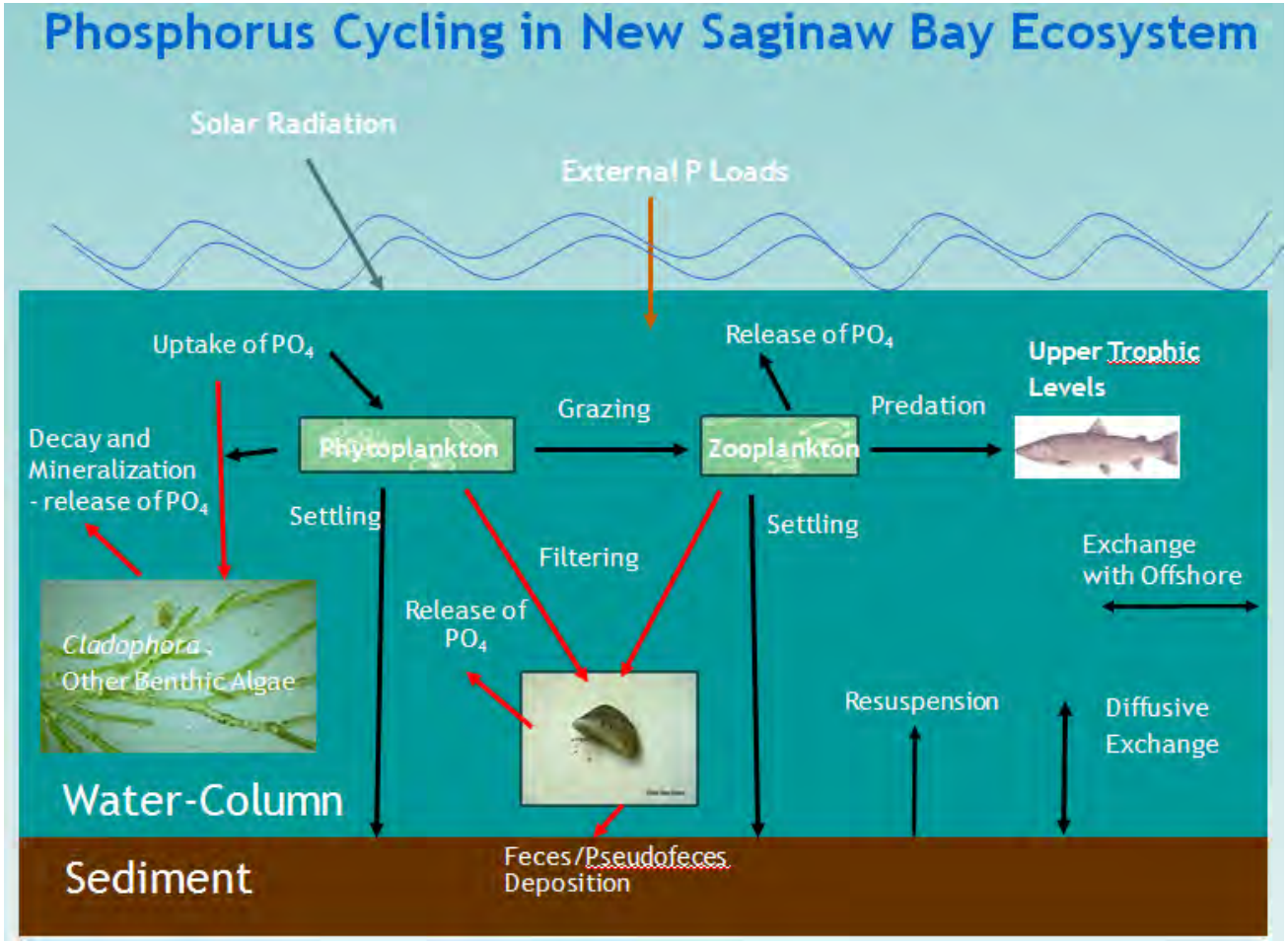
- Zebra mussels appear in Great Lakes in early 1990's
  - Invasive species introduced from ballast water of ocean-going ships
  - Filter phytoplankton from water column
  - Selectively reject blue-green algae
- Algal blooms return in force

Continued Ecosystem Adaptation

- Improved water clarity allows increased penetration of solar radiation to lake bottom
  - Primary production shifts from open water to benthic



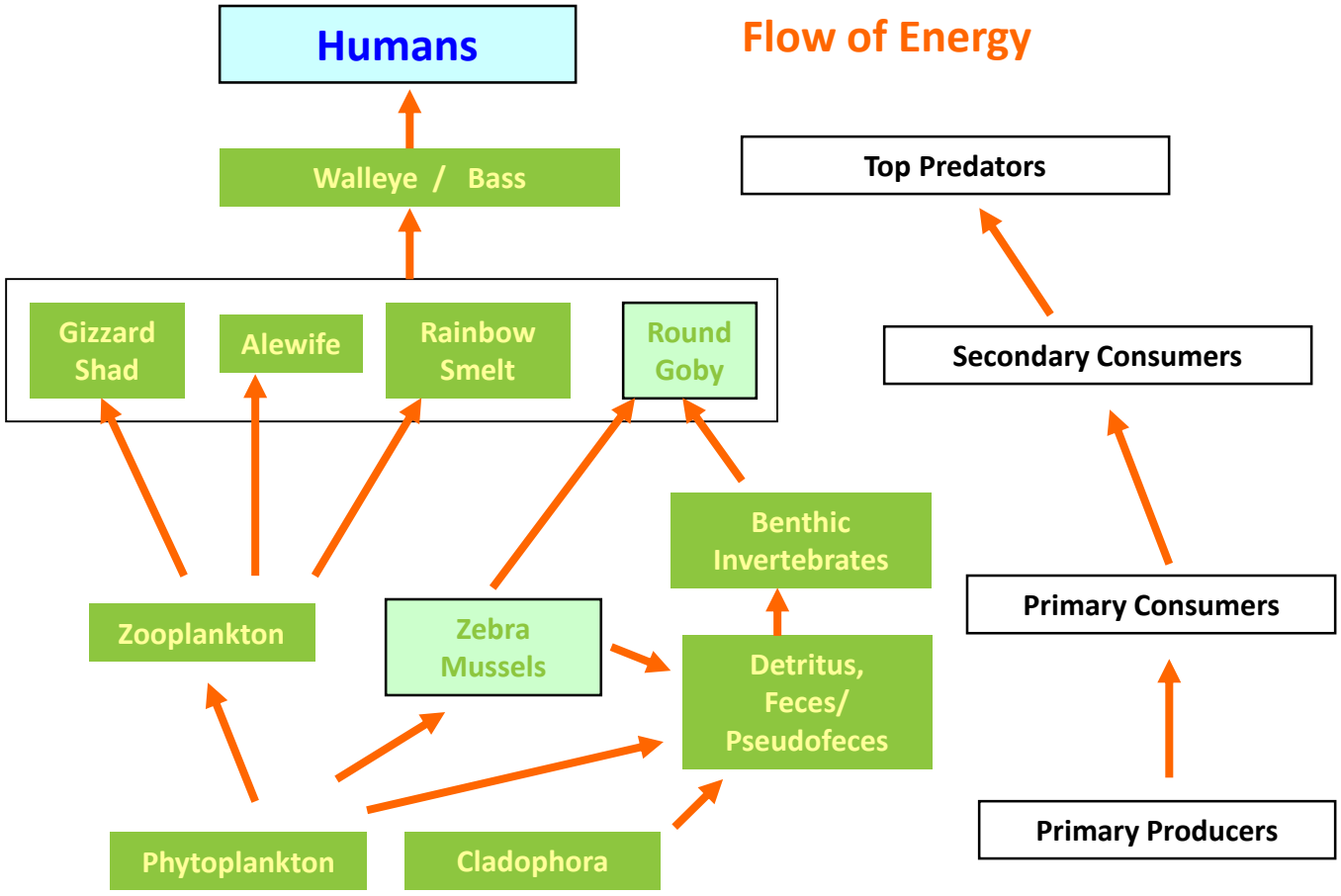
Updated Model



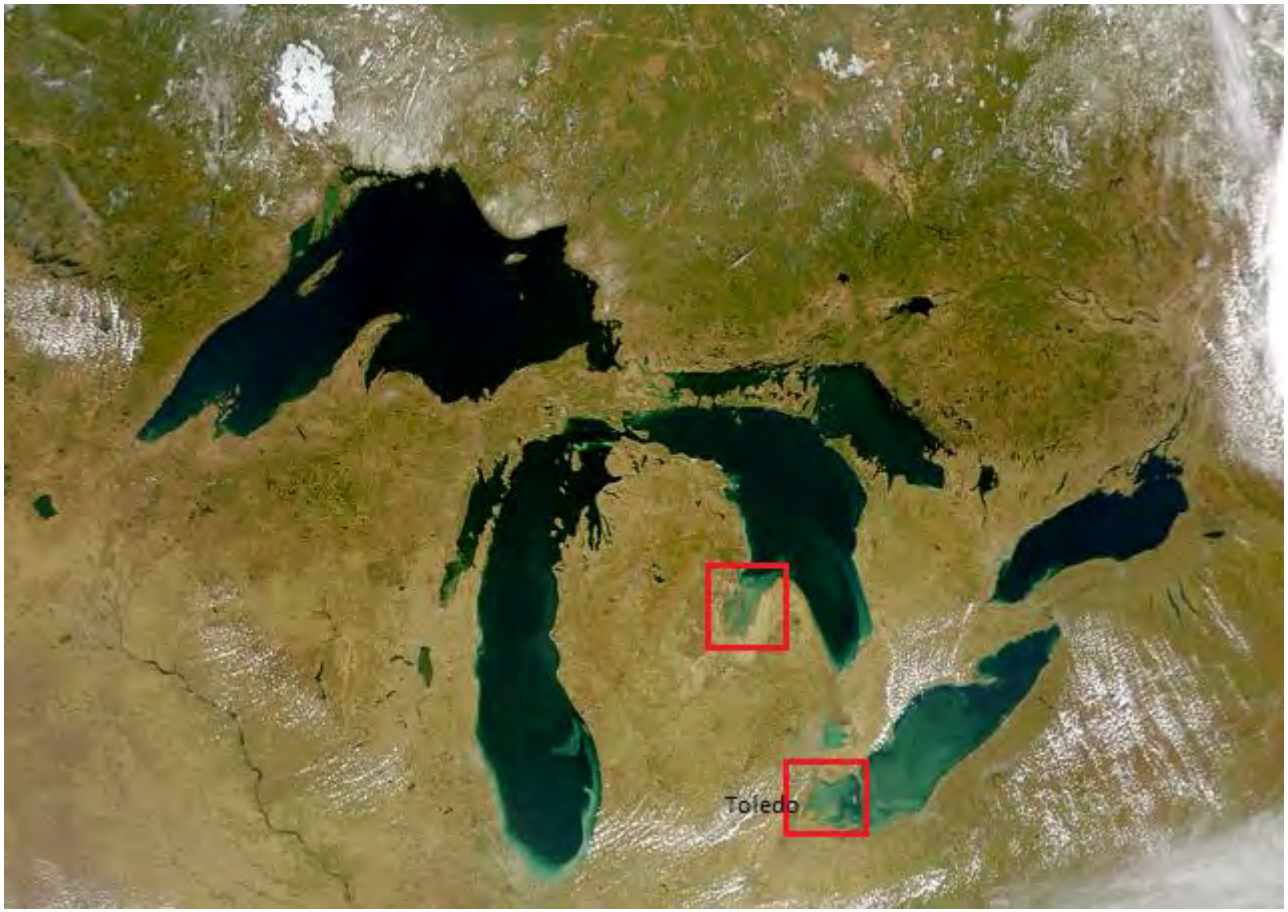
Changes to Food Web

- Phosphorus load is being trapped in the nearshore
  - By filtration of phytoplankton and other particulate P by mussels
  - By Cladophora, which expanded to better water clarity and higher bioavailable P levels in nearshore
- Nearshore P trapping is leading to a reduced transport of P to offshore
  - Leading to reduced offshore fish production

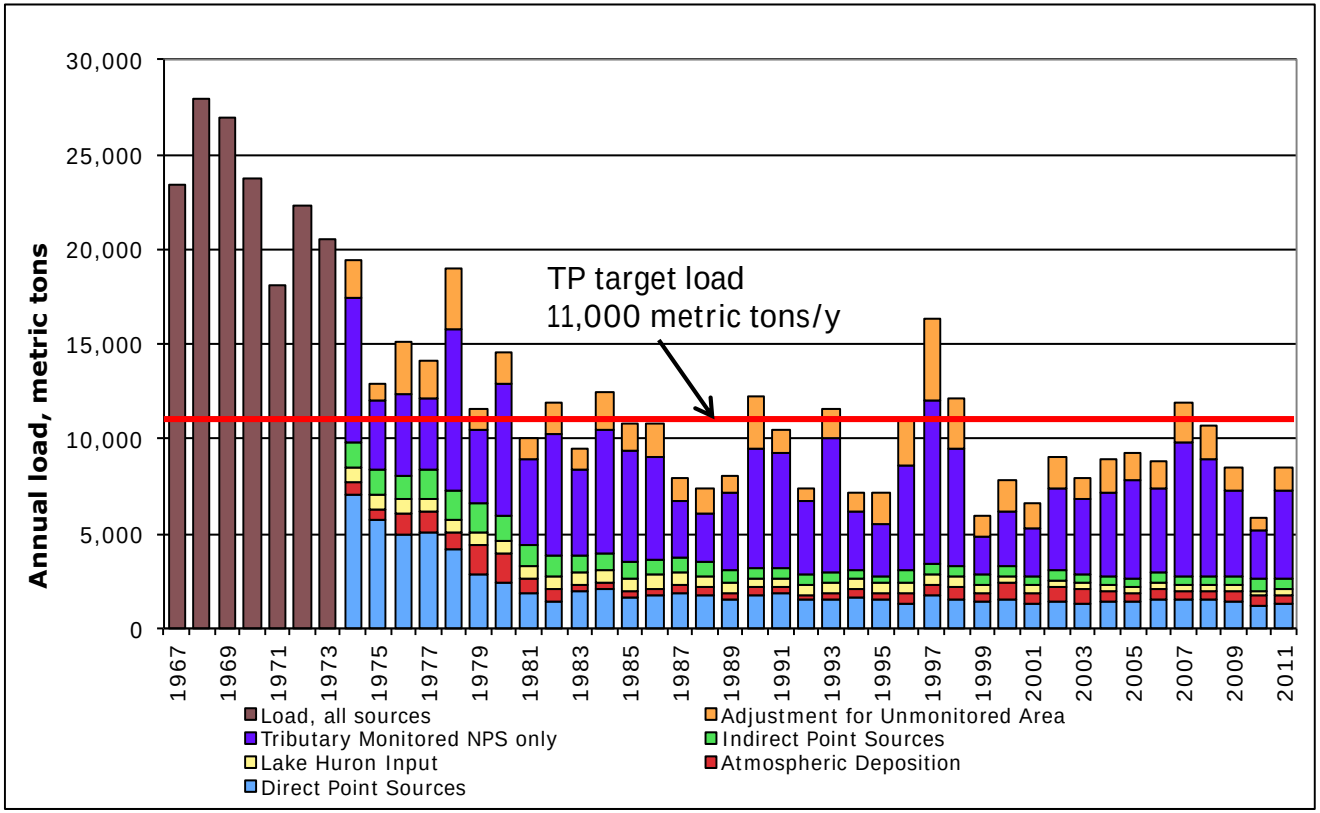
Food Web Implications



Great Lakes
Saginaw Bay, Lake Erie

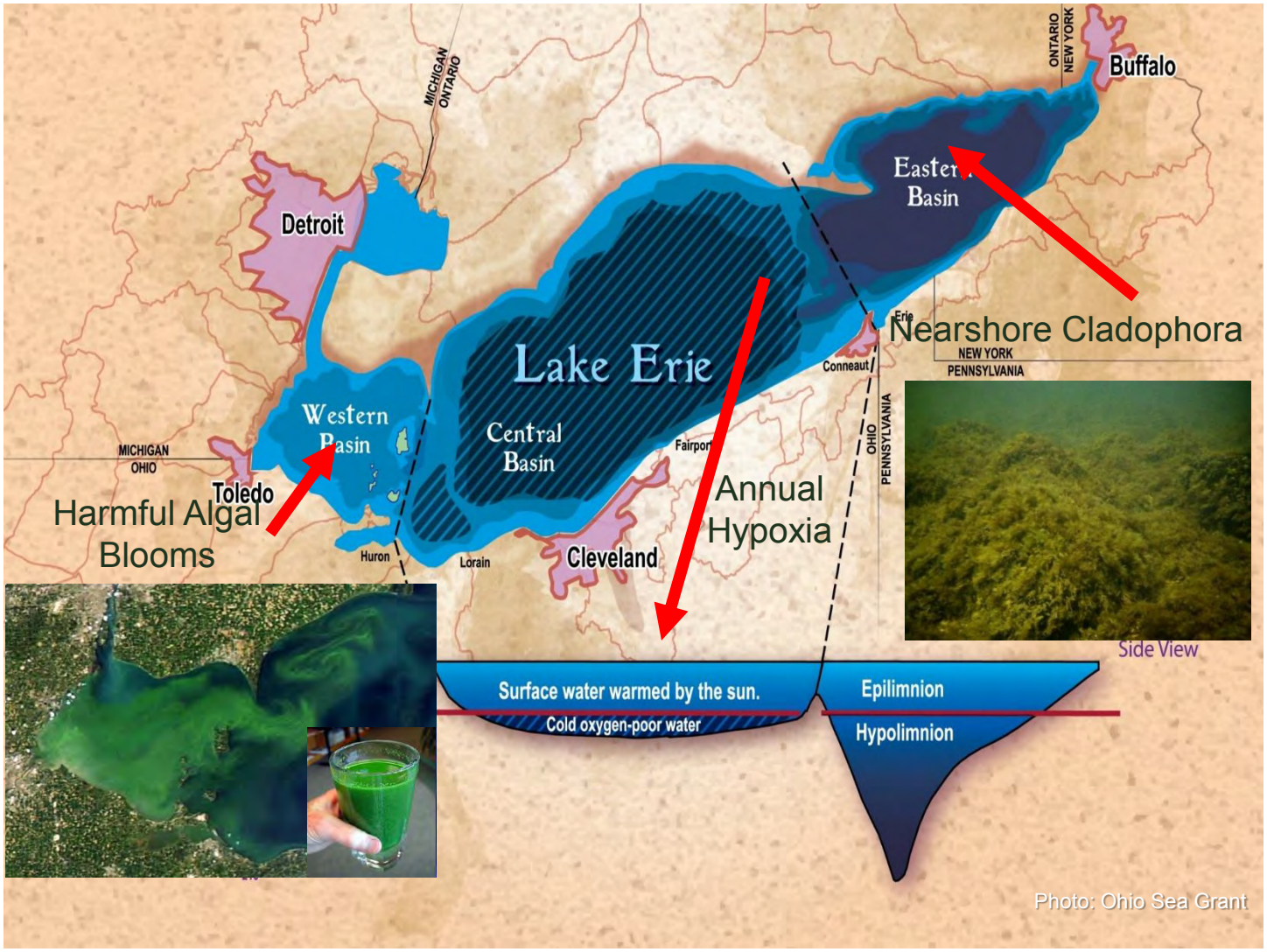


Historical Decrease in Phosphorus Load



Data from Dave Dolan, UWGB

Re-Emergence of Eutrophication



Toledo Residents Cut Off From Water Supply After Tests Show Toxins

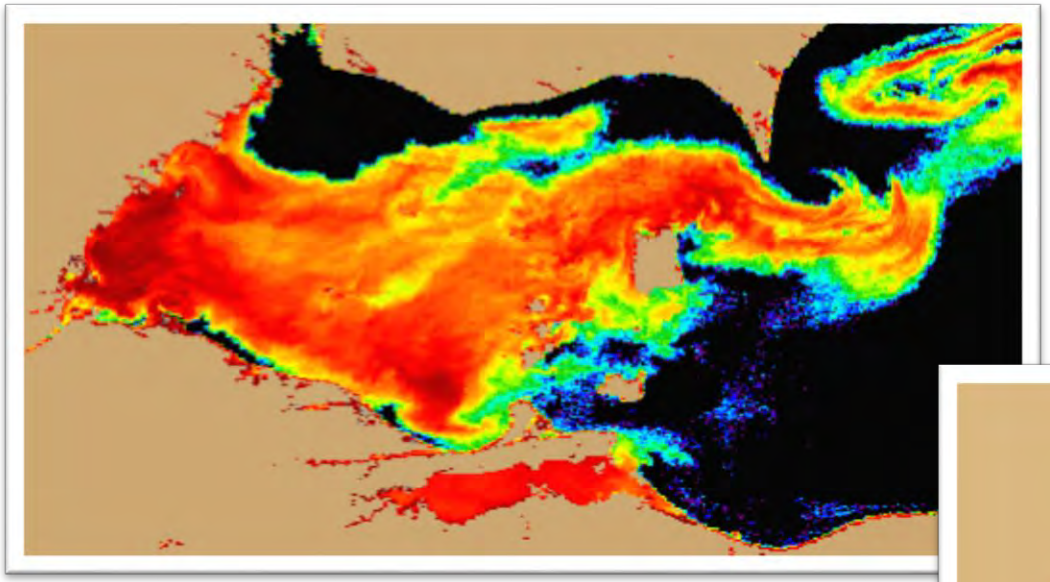
by THE ASSOCIATED PRESS

August 03, 2014 1:17 AM ET

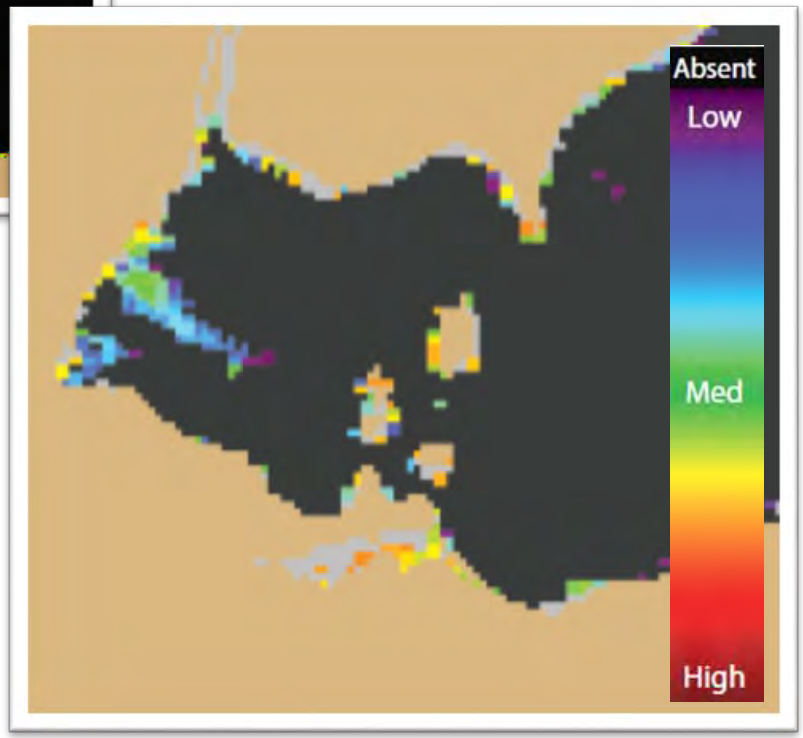
Long lines formed at water distribution centers and store shelves were quickly emptied of bottled water after Ohio's fourth-largest city told residents not to drink from its water supply that was fouled by toxins possibly from algae on Lake Erie.

The warning effectively cut off the water supply to 400,000 people in Toledo, most of its suburbs and a few areas in southeastern Michigan.

Large Variance in Annual Severity



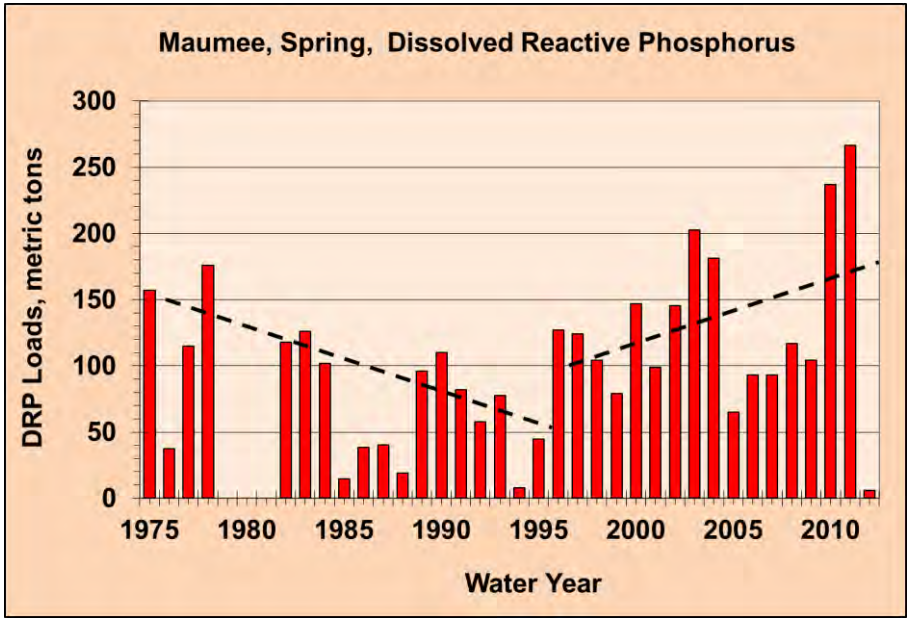
2011



2012

Change in Nature of Loads

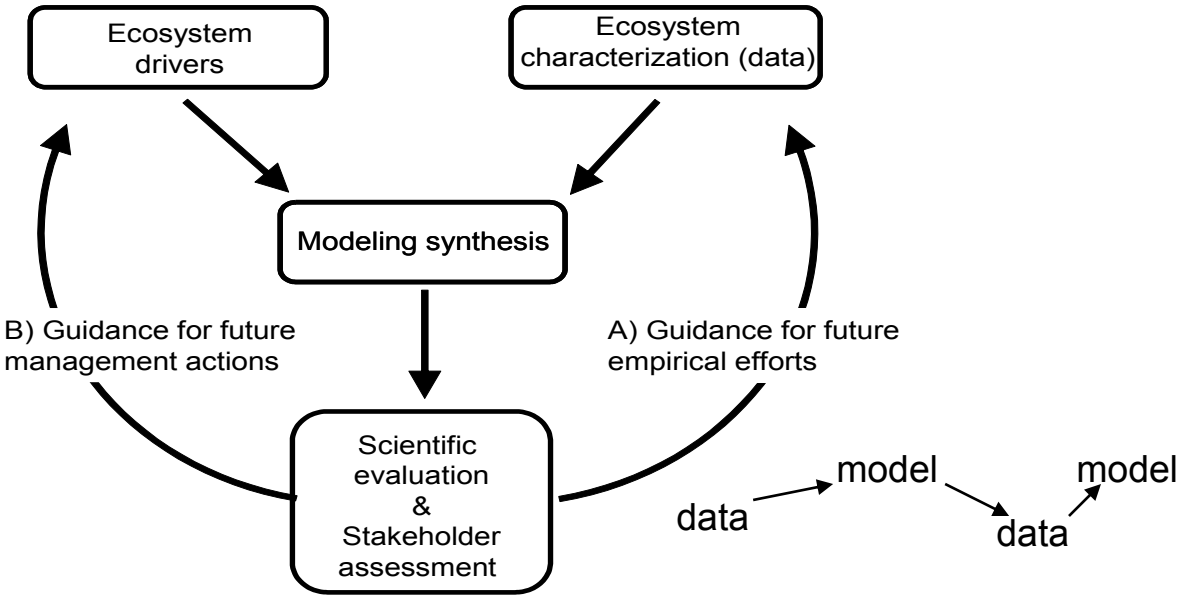
- Total phosphorus load has decreased
  - Dissolved reactive phosphorus is increasing
- Conservation tillage increases surface soil organic content



Updated Management Planning

- 2012 Great Lakes Water Quality Agreement
- Calls for revision of existing targets, considering:
  - P bioavailability, fisheries productivity, invasive species, climate change
- Apply Adaptive Management approach
  - “use adaptive management as a framework for organizing science to provide and monitor the effect of science-based management options”
  - “undertake monitoring and surveillance to anticipate the need for further science activities and to address emerging environmental”

Adaptive Integrated Framework for Managing Impacts of Multiple Stressors



Truckee River

- Flows 114 miles from Lake Tahoe to Pyramid Lake
  - Flows through Pyramid Lake Paiute Tribal land
- Litigation (and bad will) regarding water is commonplace

Lake Tahoe

Downstream of Tahoe

Reno/Sparks

Derby Dam

Connection to Lahontan Reservoir

Connection to Lahontan Reservoir

Connection to Lahontan Reservoir

Newlands Project

Connection to Lahontan Reservoir

Pyramid Lake

Environmental Issue: Dissolved Oxygen

Oxygen concentrations in Truckee River historically violated State water quality standards for dissolved oxygen

Photo courtesy of DRI -Brock/Memot

Truckee River DO Problems

- Nutrients grow attached algae
- Algae consume oxygen
- Low river flow/shallower water exacerbates algal effects on dissolved oxygen

Truckee River Total Maximum Daily Load

- Developed by Nevada Department of Environmental Protection in 1994
- Determined maximum nitrogen and phosphorus loads that would result in compliance with oxygen standards
  - Communities build state-of-the-science treatment plant to comply with new limits
  - Nonpoint sources left unchanged

Desire to Revisit TMDL

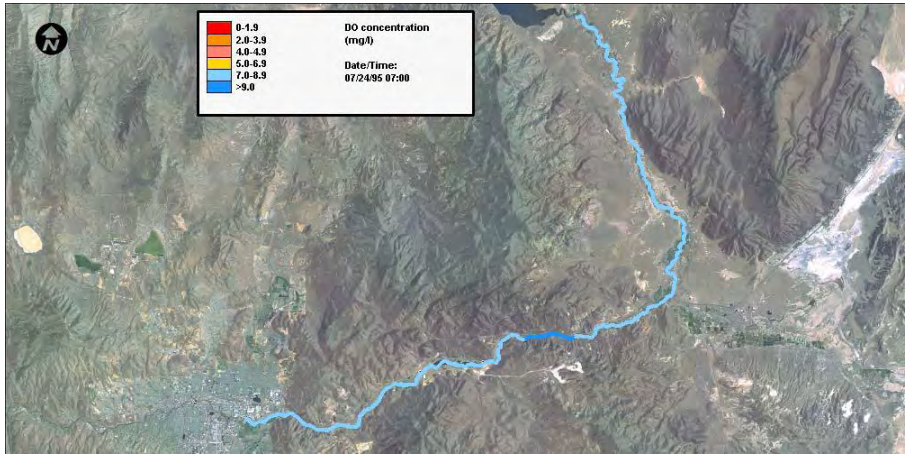
- Rapid population growth in late 1990s
  - Concurrent increase in wastewater flows
- Regional planning study concludes that compliance with TMDL not economically feasible if population growth continues

Why Revisit the TMDL?

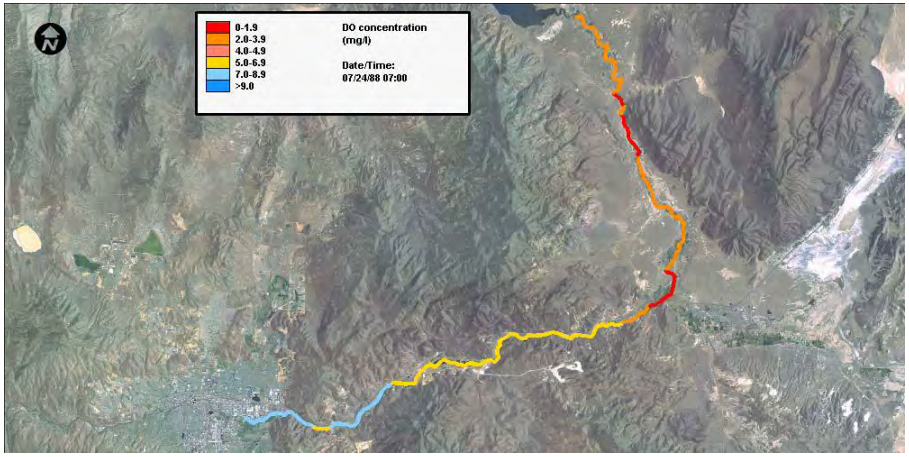
- Municipalities believed that water quality could be maintained, even with regional growth
  - Expected increase in summer river flows in response to Truckee River Operating Agreement
  - Better representation of the system

Sensitivity of Oxygen to River Flow

- High flow summer



- Low flow summer



Why Revisit the TMDL?

- Cities/County believed that water quality could be maintained, even with regional growth
  - Expected increase in summer river flows in response to Truckee River Operating Agreement
  - Better representation of the system
    - Much of the nitrogen in wastewater treatment effluent in a form not available for algal uptake

Third Party TMDLs

- Cities of Reno and Sparks decide to conduct "third party" TMDL
  - TMDL developed by someone other than the lead water quality agency
  - Brings external resources to the process
  - Can expedite TMDL development
- Sponsors multi-year stream monitoring program
- Develops updated models of the river

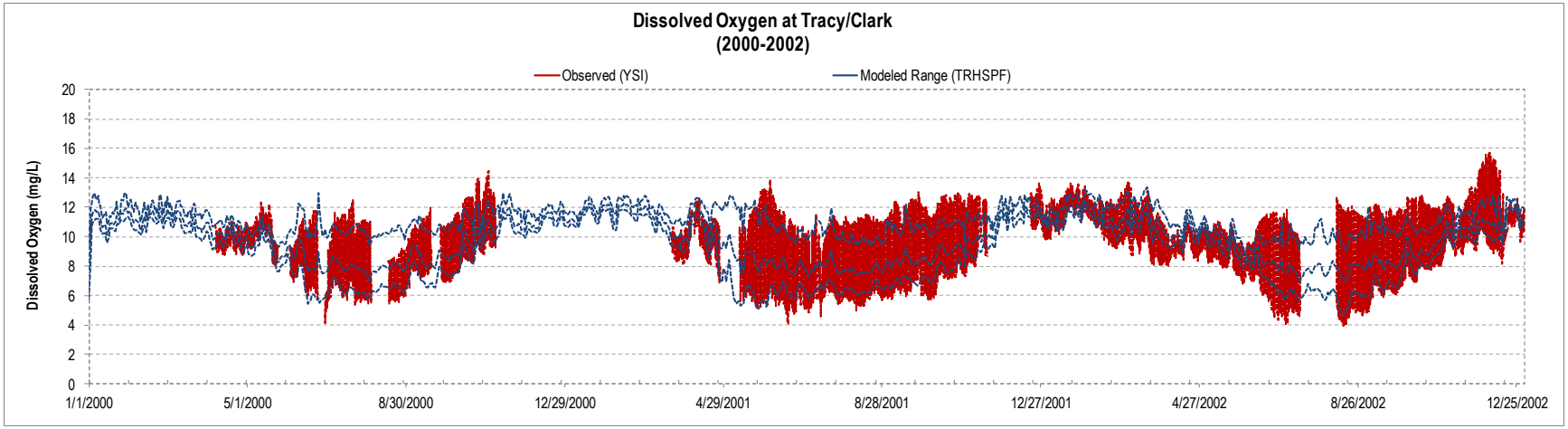
Comprehensive Monitoring Program

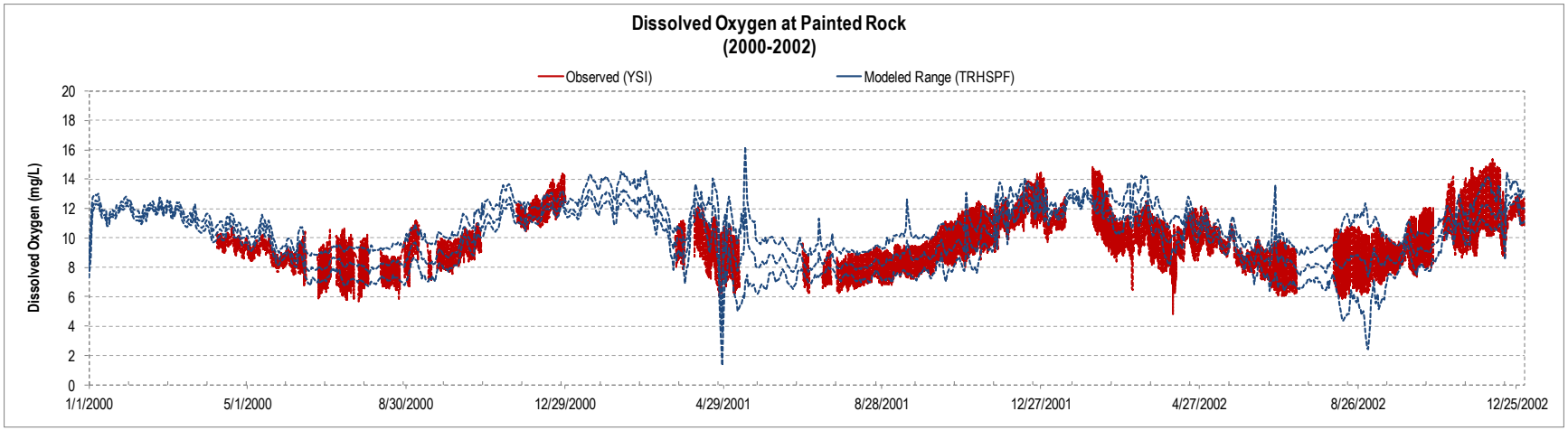
- 2000-2002 monitoring program initiated by Cities
  - Continuous dissolved oxygen, water chemistry, and benthic algae data collected at multiple locations

Watershed/Water Quality Models

- Linked watershed-water quality model developed
  - WARMF watershed model simulates nonpoint source loading to River
  - Existing HSPF model of river upgraded to include rigorous description of periphyton behavior

Water Quality Model Calibration





Stakeholder Feasibility Assessment Conducted

- Concludes that watershed-wide goals can only be achieved by a group of regional interests
  - Western Regional Water Commission formed
  - Washoe County and Truckee Meadows Water Authority officially added as “third parties”
- TMDL revision begins

TMDL Work Plan

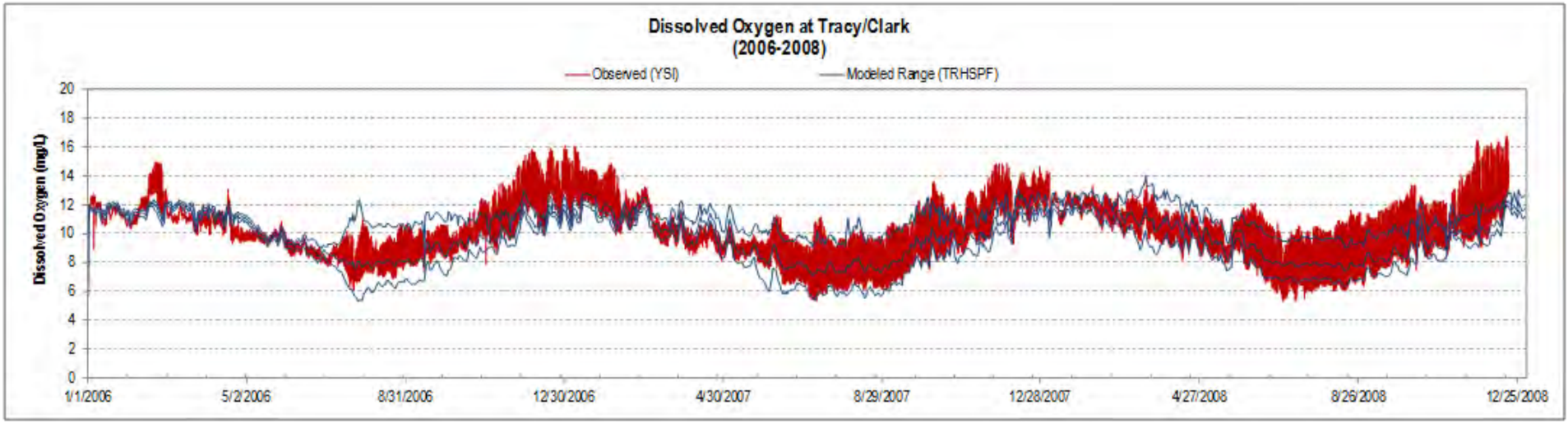
- Working group convened of State, EPA, and third parties
- Official “TMDL Development Work Plan” created to maximize process transparency
- Provides flexibility in structure of TMDL
  - Allows future trading between sources
  - Allows credit for stream restoration

Reality Intervenes: Part 1

- Water utility concerned with independent litigation regarding irrigation use
- TMDL redevelopment put on hold
  - Economic slowdown lessened immediate need for new TMDL

TMDL Re-Start

- Work on TMDL commences
- Several years had passed since completion of comprehensive monitoring program
  - Model confirmation runs conducted



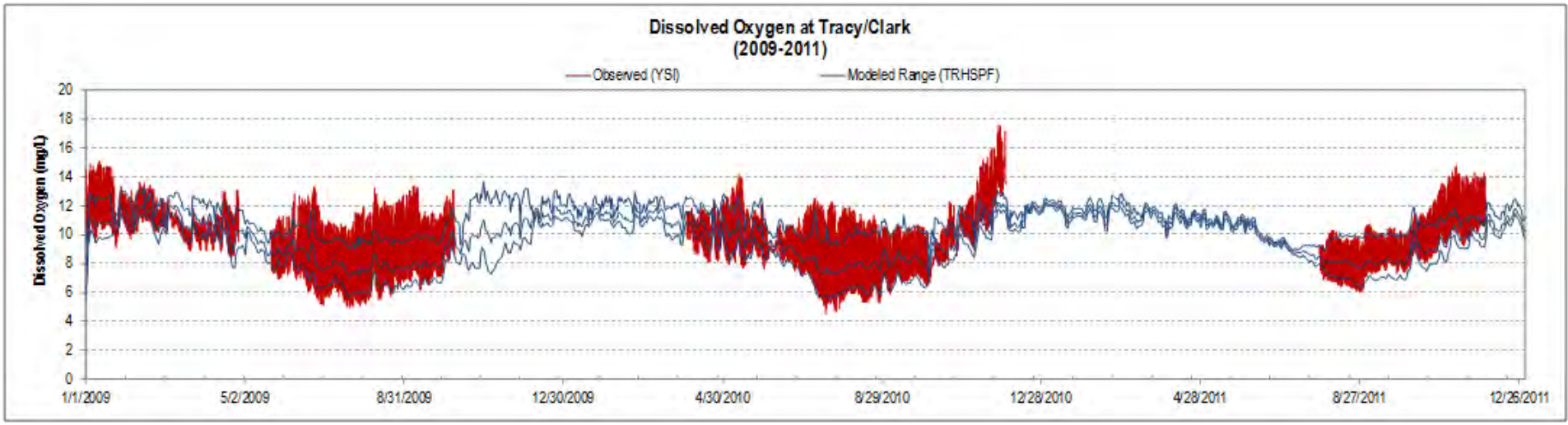
Reality Intervenes: Part 2

- State/EPA decide that Truckee River TMDL cannot be completed without full consideration of impacts on Lahontan Reservoir
- TMDL development put on hold until State develops WQS for Lahontan

Connection to Lahontan Reservoir

TMDL/WQS Re-Start

- State/EPA reconsiders Lahontan decision in 2012
- Allows Truckee TMDL to re-commence
  - Additional requirement that water quality standards must first be re-assessed for the Truckee
- More model confirmation runs conducted

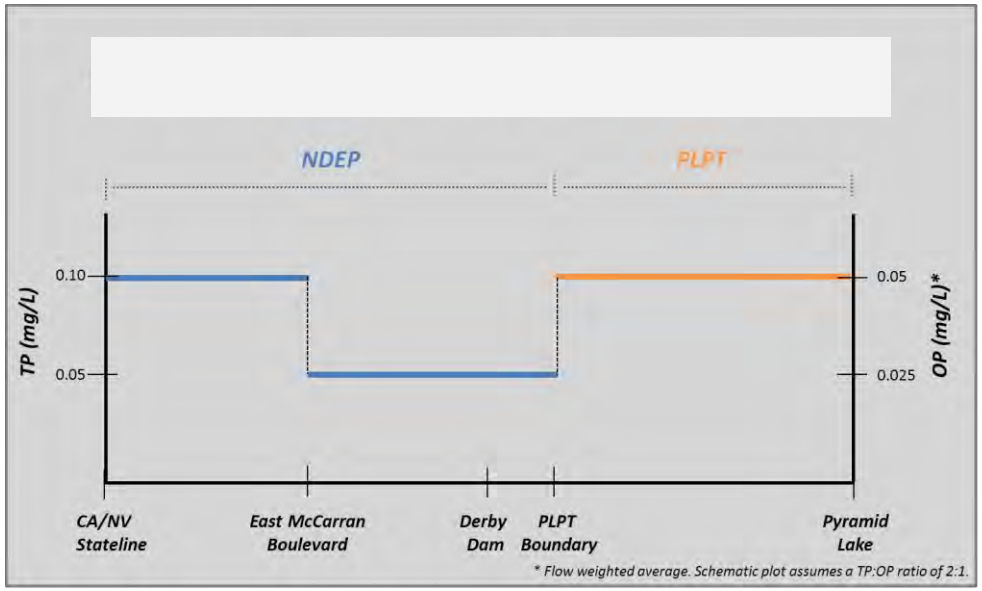


WQS Re-Start

- Model simulations conducted to examine compliance with WQS for dissolved oxygen
  - different nutrient concentrations
  - different flow regimes

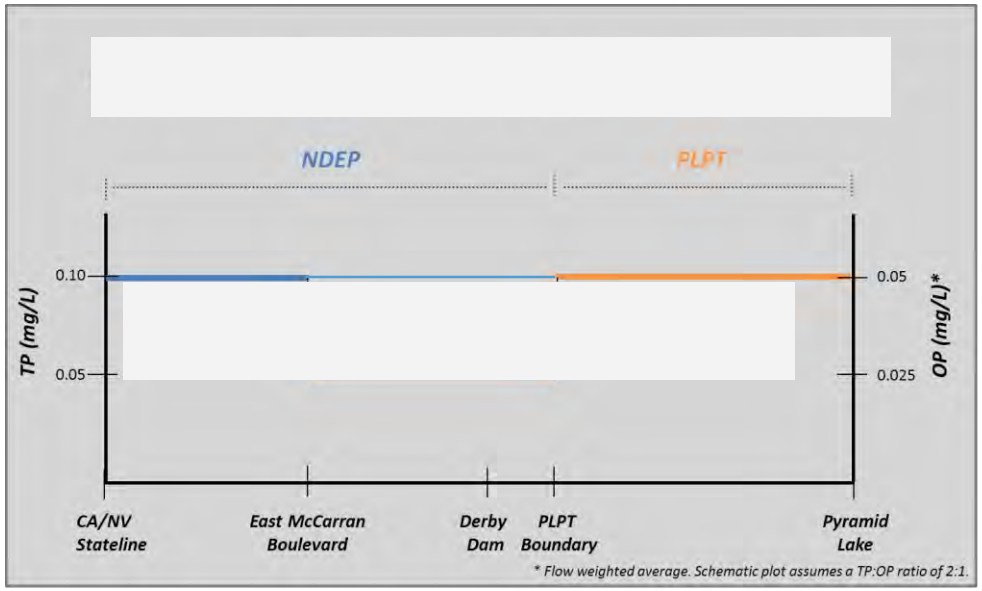
Proposed Change to Numeric Nutrient Criteria

Existing



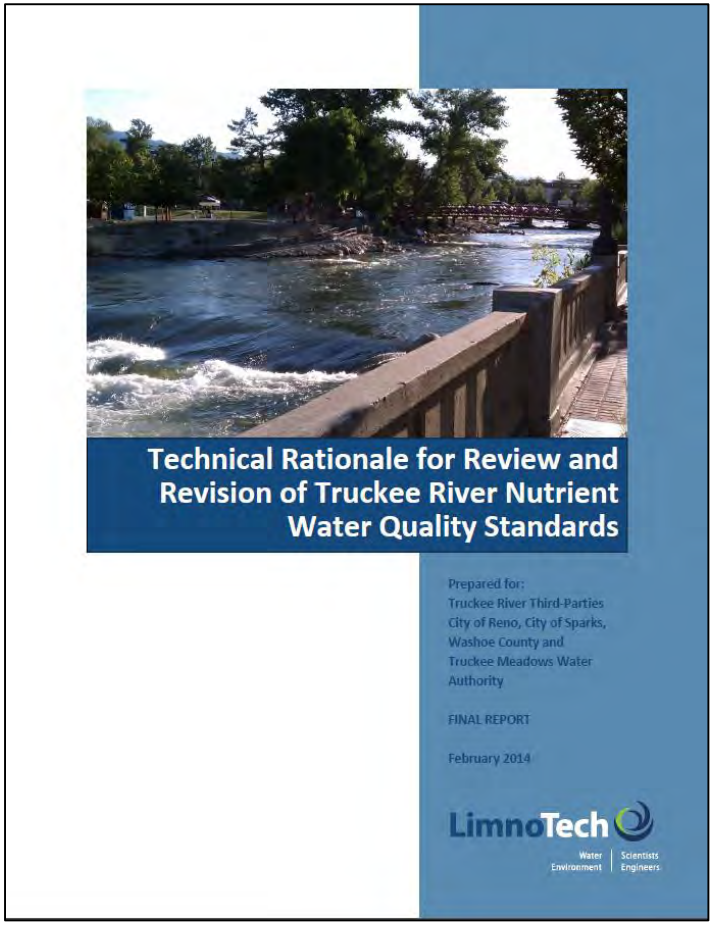
Proposed Change to Numeric Nutrient Criteria

Proposed



Reality Intervenes: Part 3

- Public process completed presenting science behind new standards
- Tribe says that they want to revisit their own nutrient standards
  - Water quality standards revision (and TMDL) put on hold until Tribal standards are revised



- "According to an internal memo obtained by the Reno Gazette-Journal, the treatment plant has capacity for only 3,800 more hook-ups"

- "The 3,800 additional sewer hook-ups does not include about 16,000 hookups for subdivisions that have been approved"

- "Construction of Tesla's $5 billion battery gigafactory, which could add as many as 22,000 jobs"

Closing Thoughts

- Ecosystems change
  - Change in one link of the food web has major implications on ecosystem response (and appropriate management)
- Watersheds change
  - Shift in nutrient forms can be important
- Regulations, once imposed, can be difficult to change
- Management plans need to be adaptable
  - Pure adaptive management is easier said than done
  - Explicit provision of flexibility may be a start