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Linking Watershed and Coastal Ecosystem Models to Assess Harmful Algal Bloom Production in the Western Lake Erie Basin

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Presentation Outline

- Background:
  - Harmful algal bloom (HAB) impacts in Western Lake Erie Basin
  - Role of Maumee River basin
- Assessing harmful algal bloom (HAB) production via the “Western Lake Erie Ecosystem Model”
- Evaluating the benefits of agricultural management practices via a watershed model
- Linking reductions in HAB production with agricultural land management practices
- Summary & next steps

Harmful Algal Blooms (HABs) in Western Lake Erie

Lake Erie Harmful Algal Blooms (HABs): Impacts on Ecosystem Services

- Reduced fish productivity (via removal of nutrients from food chain) – e.g., walleye
- Reduced recreational & commercial fishing
- Reduced beach going / tourism
- Human health impacts – potential for illness resulting from Microsystin (toxin) ingestion
- ***Interruption of municipal water supplies***
  - ***Toledo drinking water crisis of August 2014***

Toledo Water Crisis (Aug. 2-4, 2014)

500,000 residents without water for ~2 days

City of Toledo
Government Organization · 4,861 Likes · August 2 ·

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DO NOT BOIL THE WATER... See More

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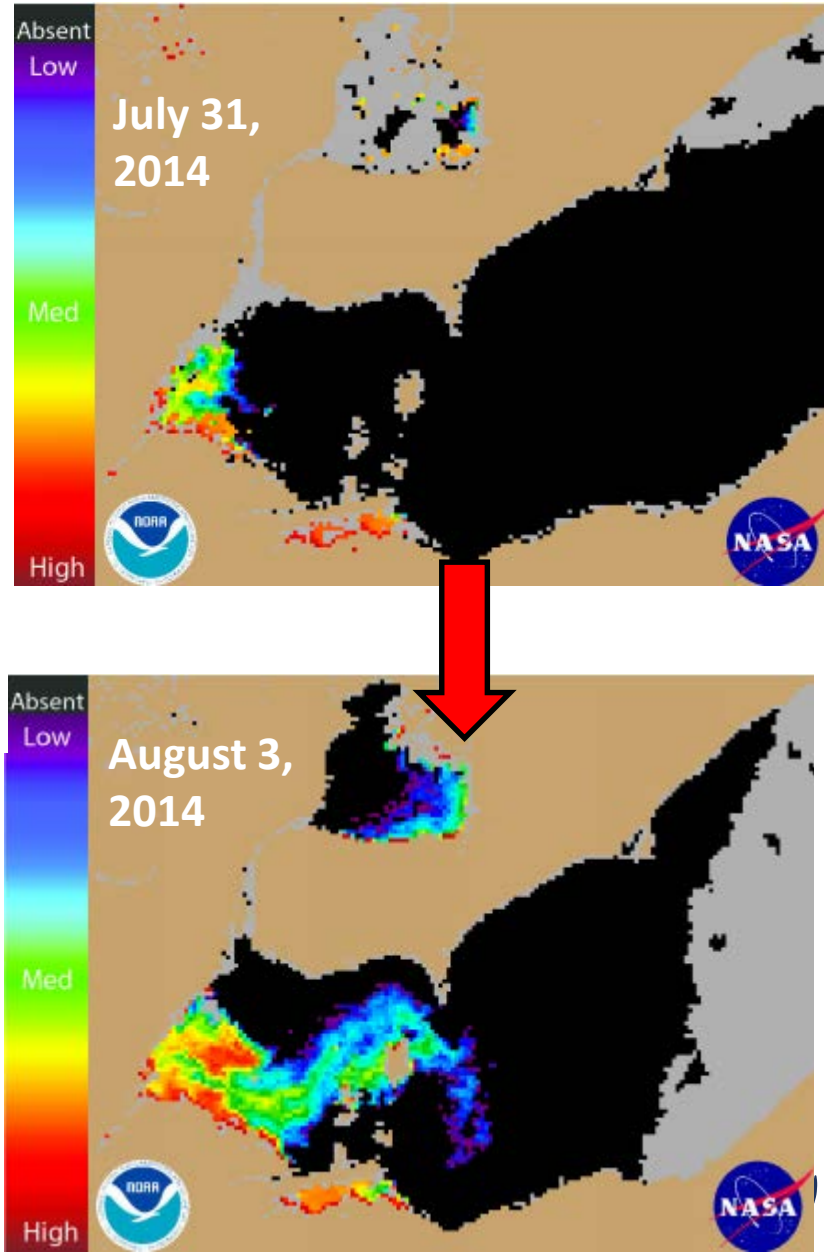
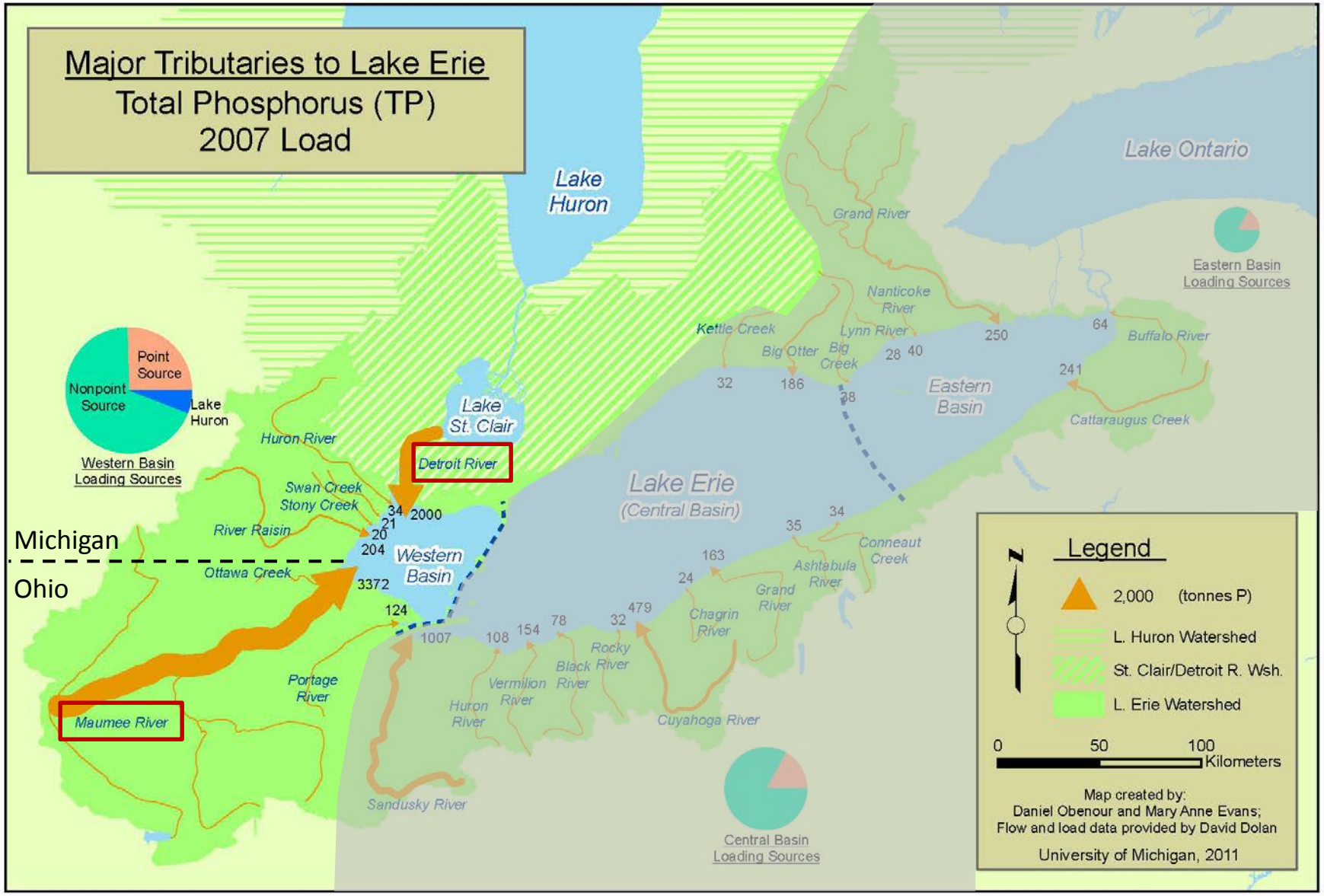
Water crisis grips hundreds of thousands in Toledo area, state of emergency declared

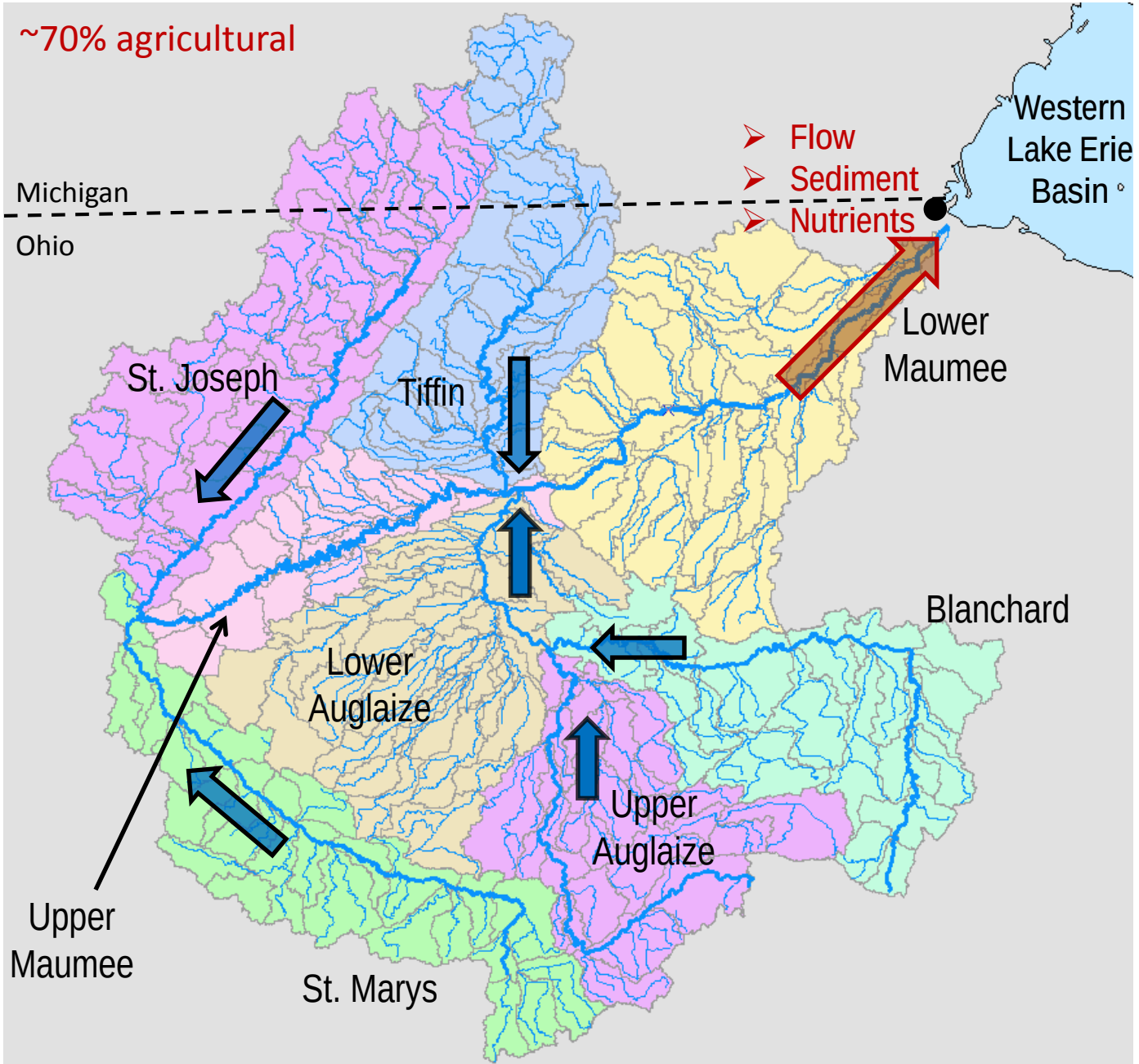


Toledo Water Crisis (Aug. 2-4, 2014)

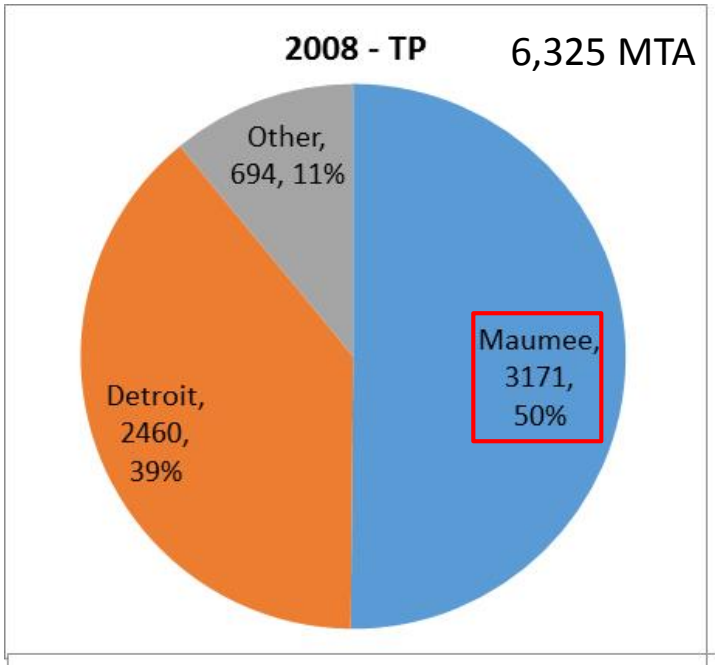
Western Lake Erie Tributary Watersheds

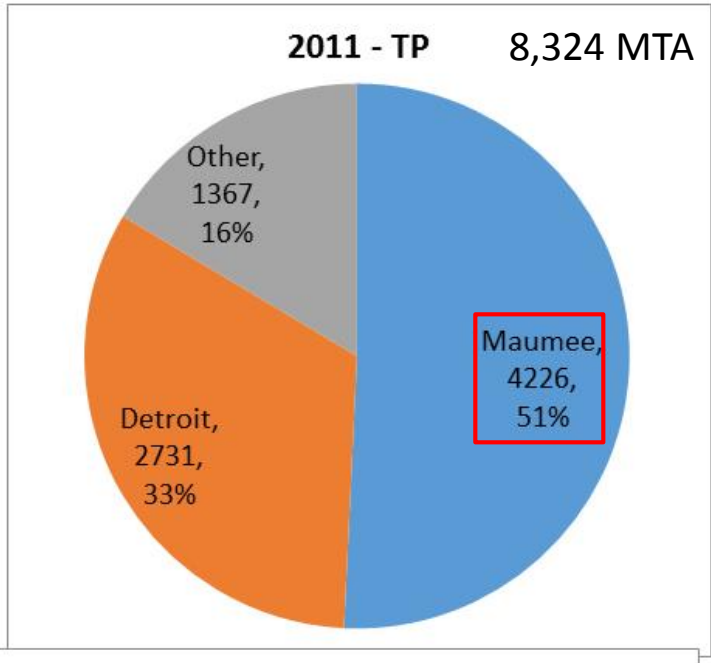


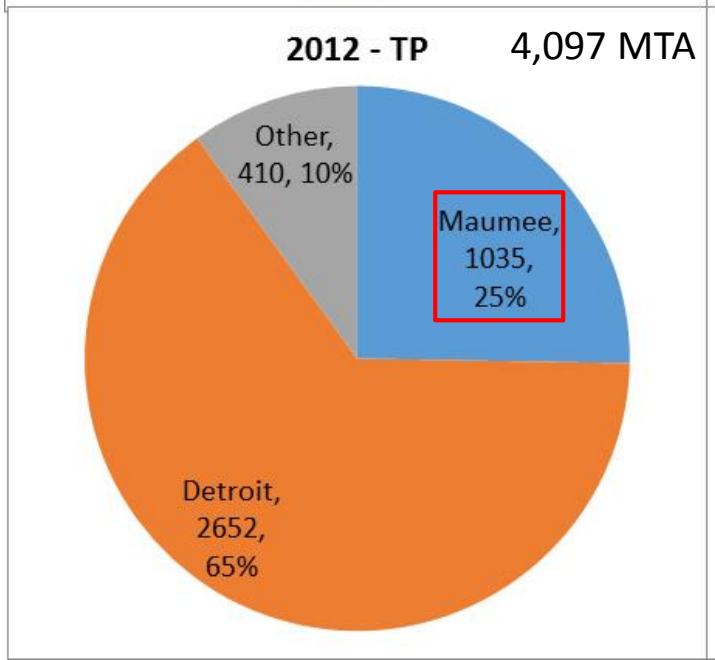
Maumee River Basin – Subbasins & Flow Routing

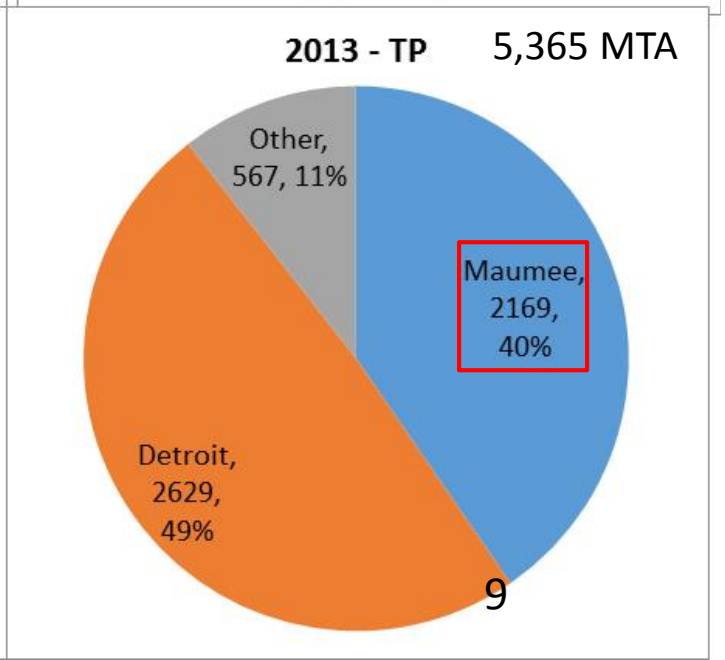


Annual TP Loads to Western Basin (2008, 2011-13)

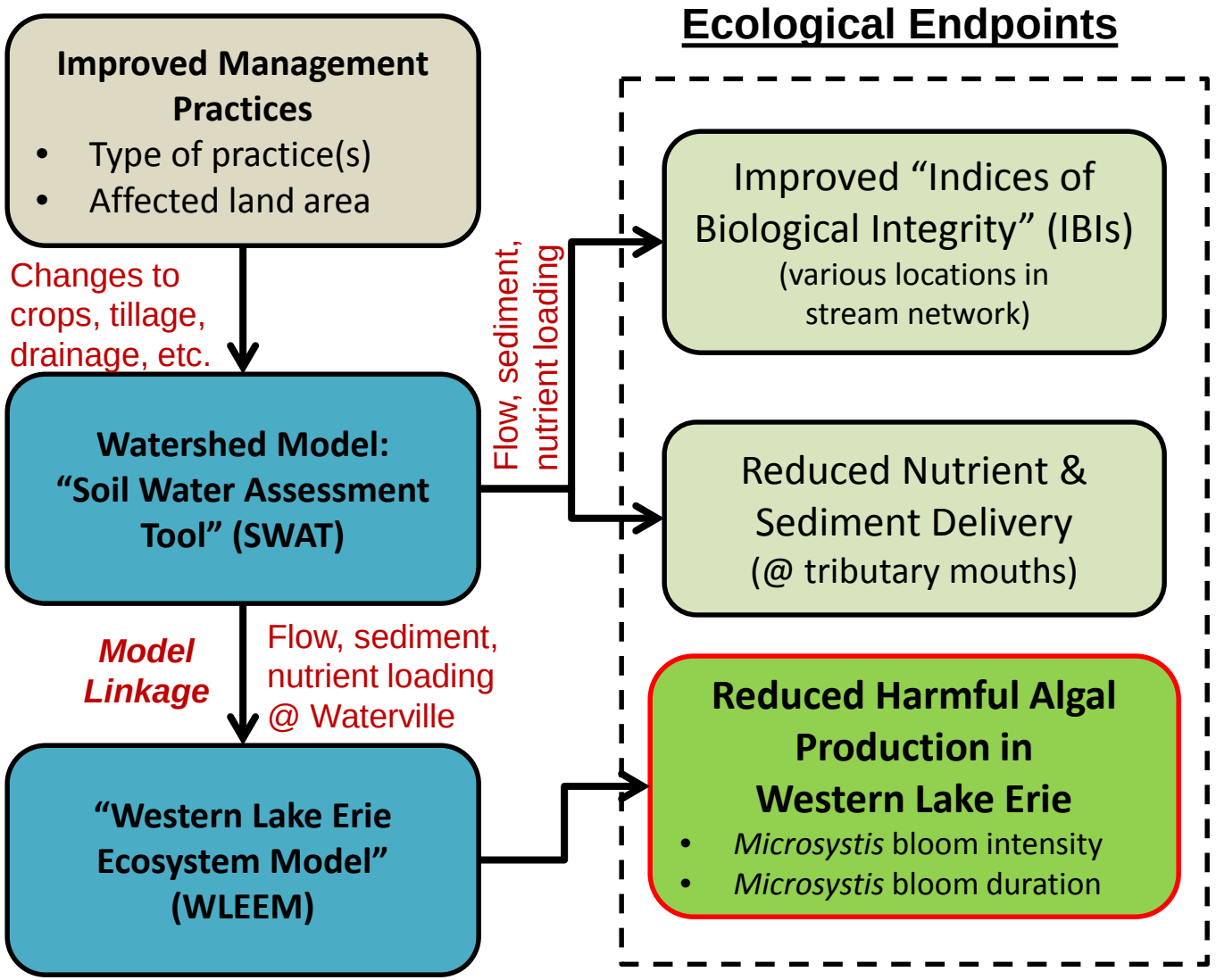






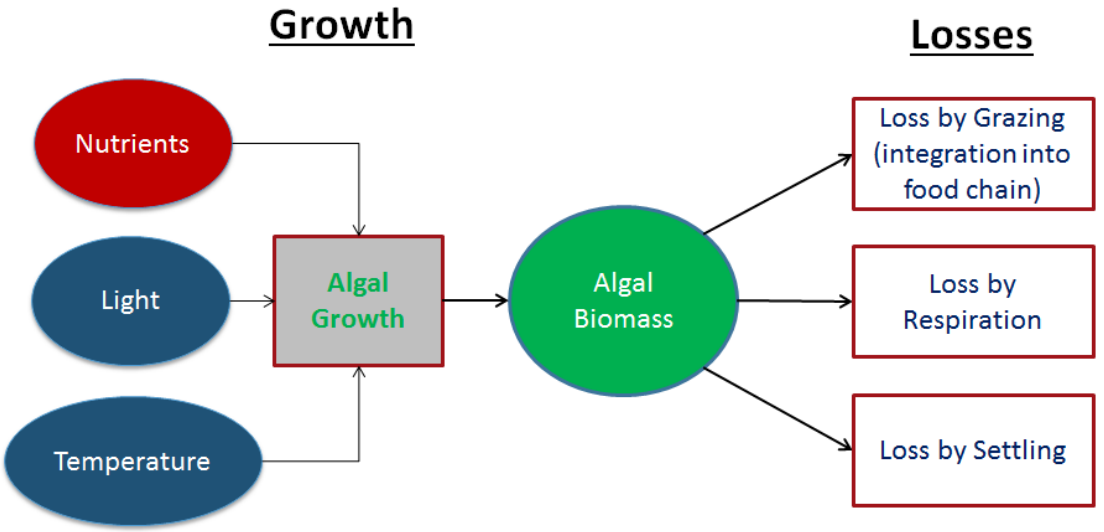


Using Linked Models to Quantify Ecological Benefits

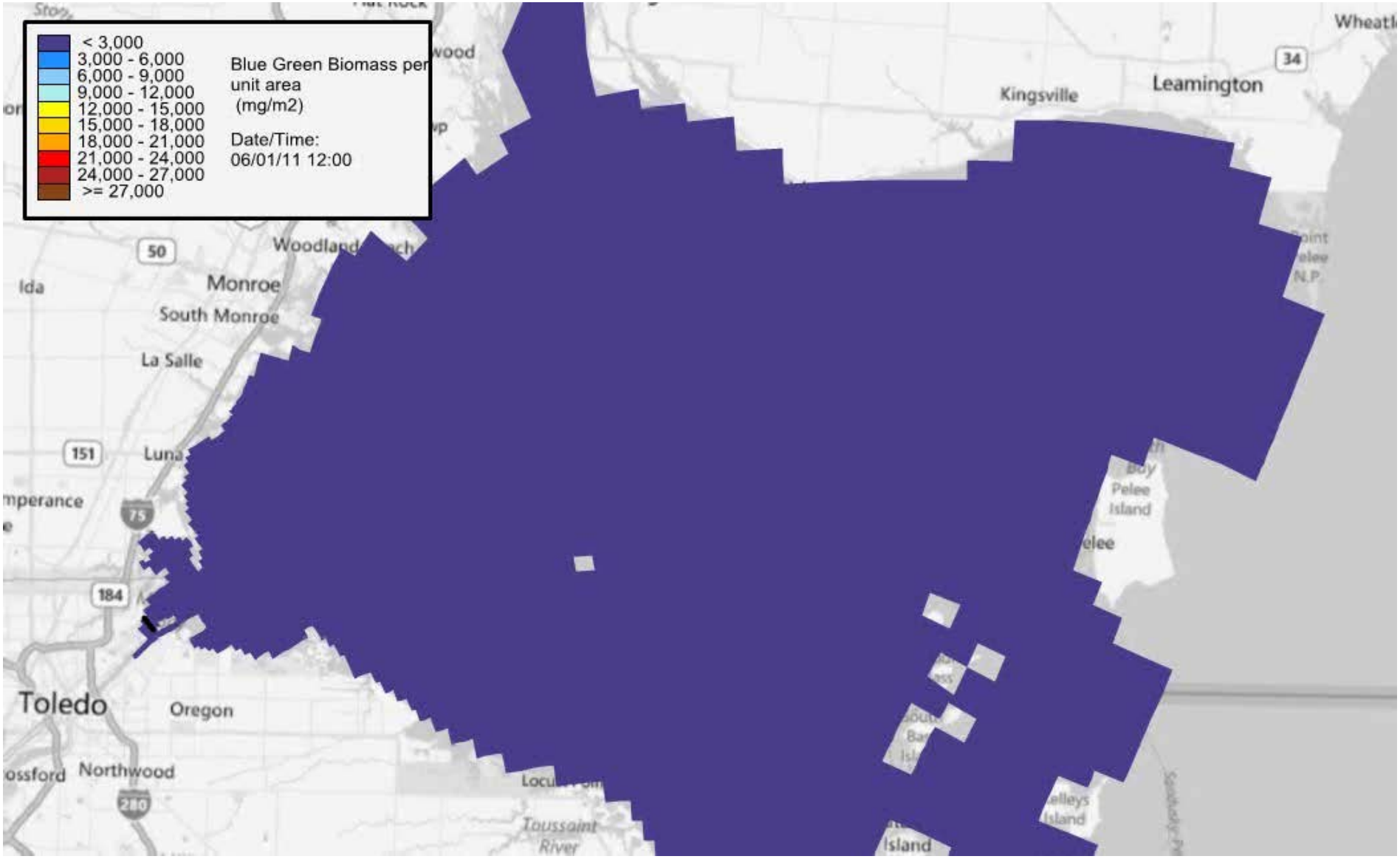


Scientific Basis for "Western Lake Erie Ecosystem Model" (WLEEM)

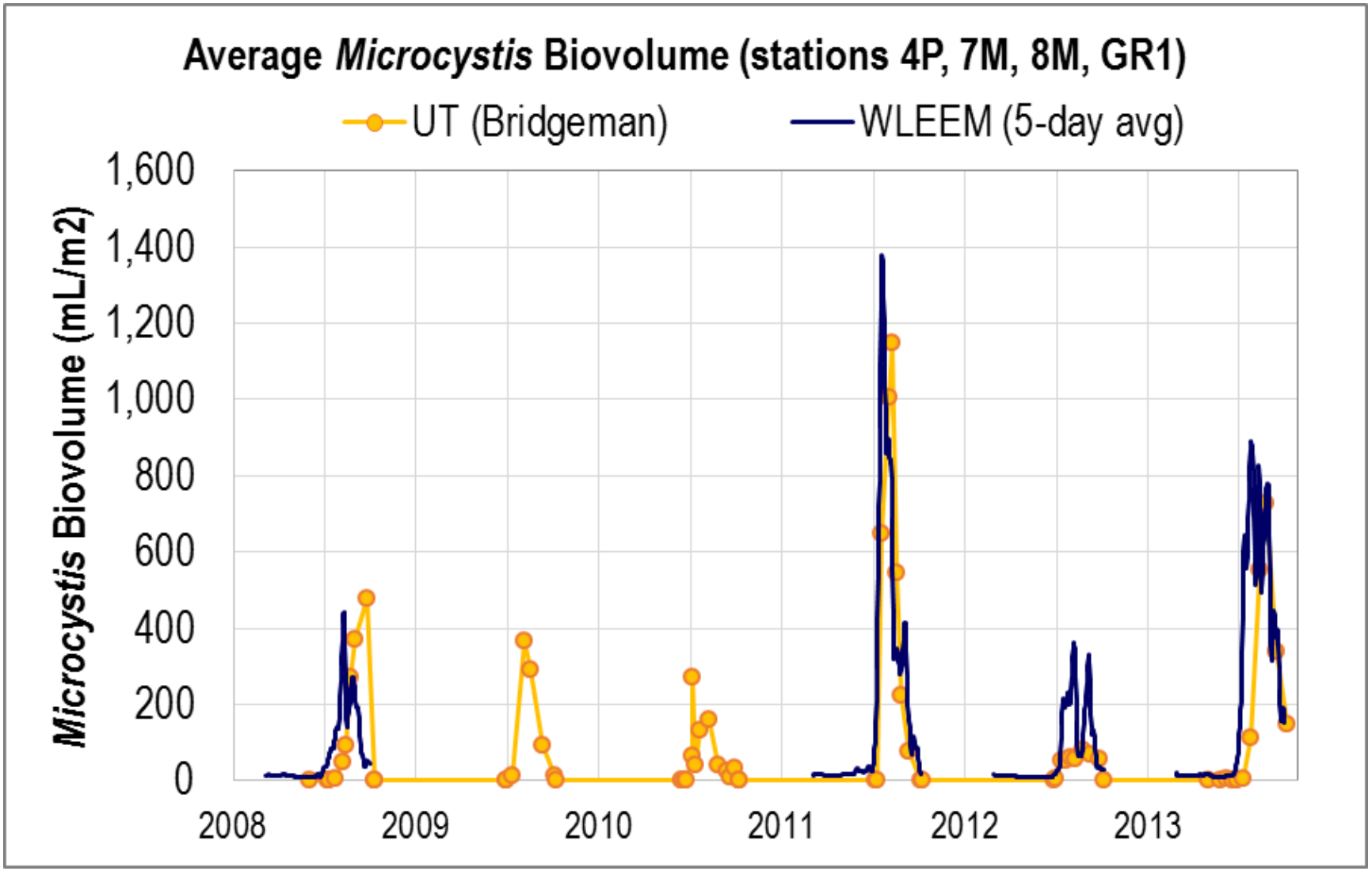
- Decades of research → well-established relationships between nutrient (N/P) availability, water clarity, and algal growth
- Western Lake Erie datasets from past 10 years support calibration of model processes (via U. of Toledo):
  - Nutrient (P/N) concentrations
  - Chlorophyll *a*
  - Harmful algal bloom (*Microsystis*) biomass



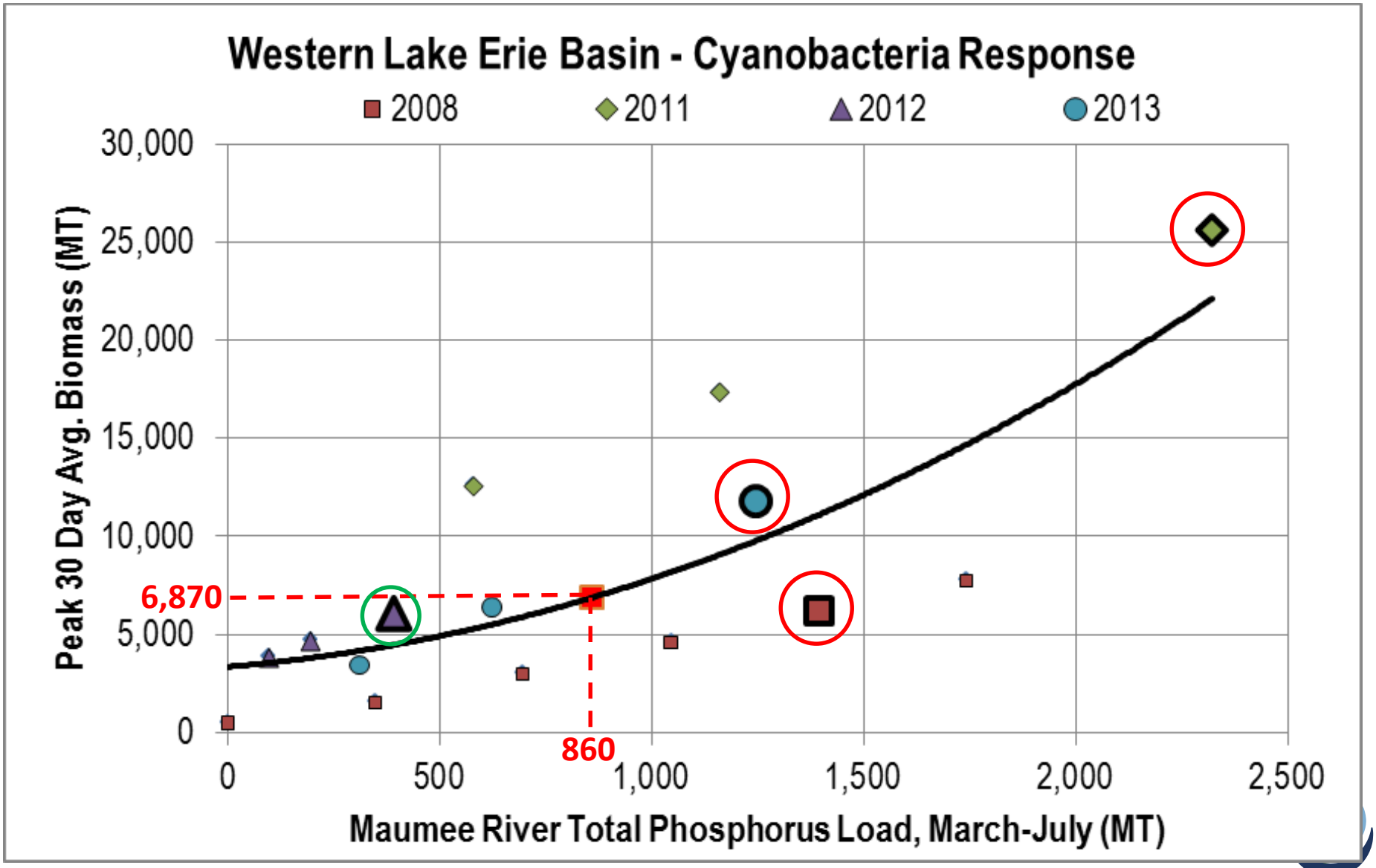
WLEEM Results – Harmful Algal Bloom Animation (June – September, 2011)



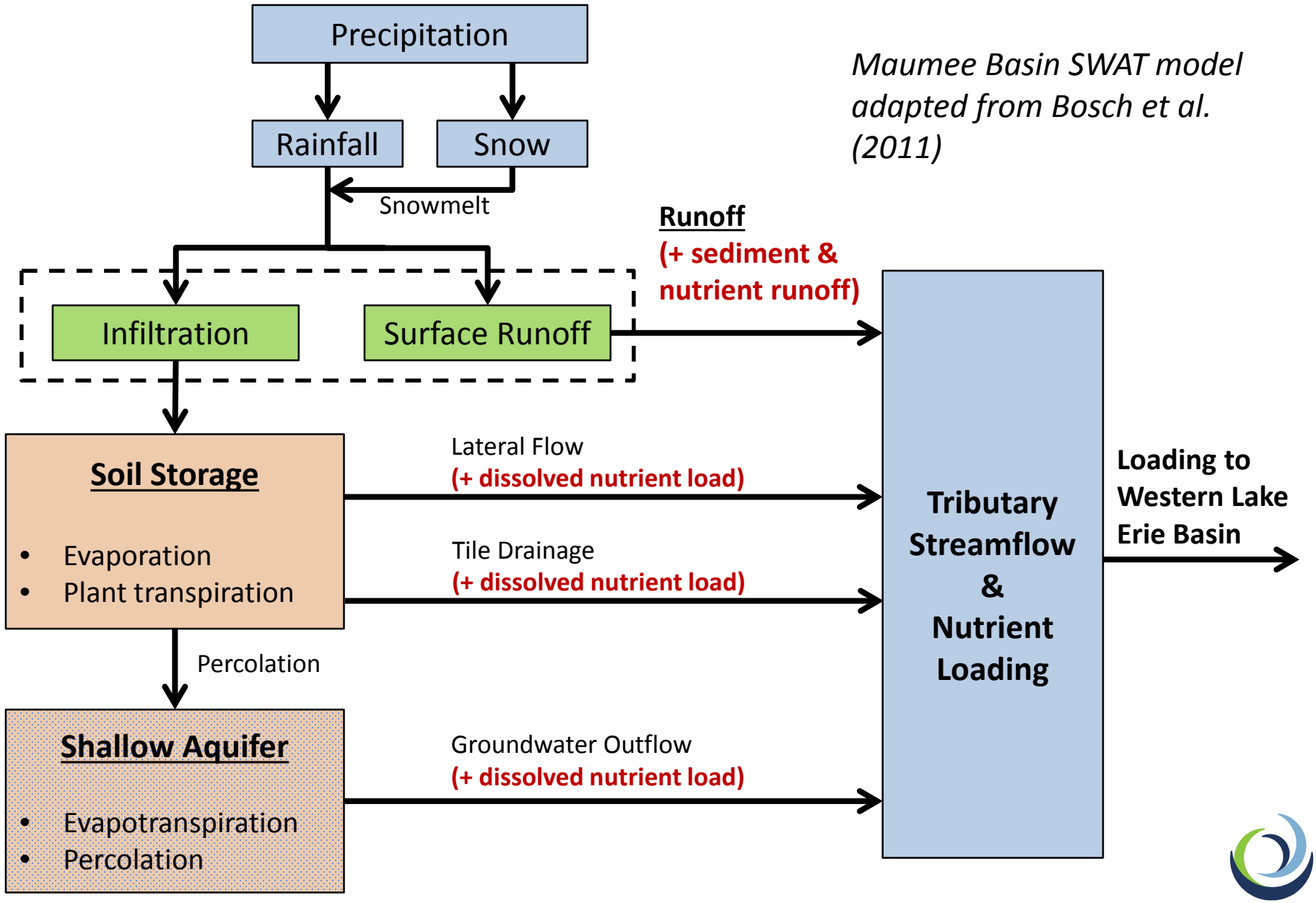
WLEEM Comparison to U. of Toledo *Microsystis* (HAB) Observations



Western Lake Erie – HAB Response Curve & Total Phosphorus Loading Threshold

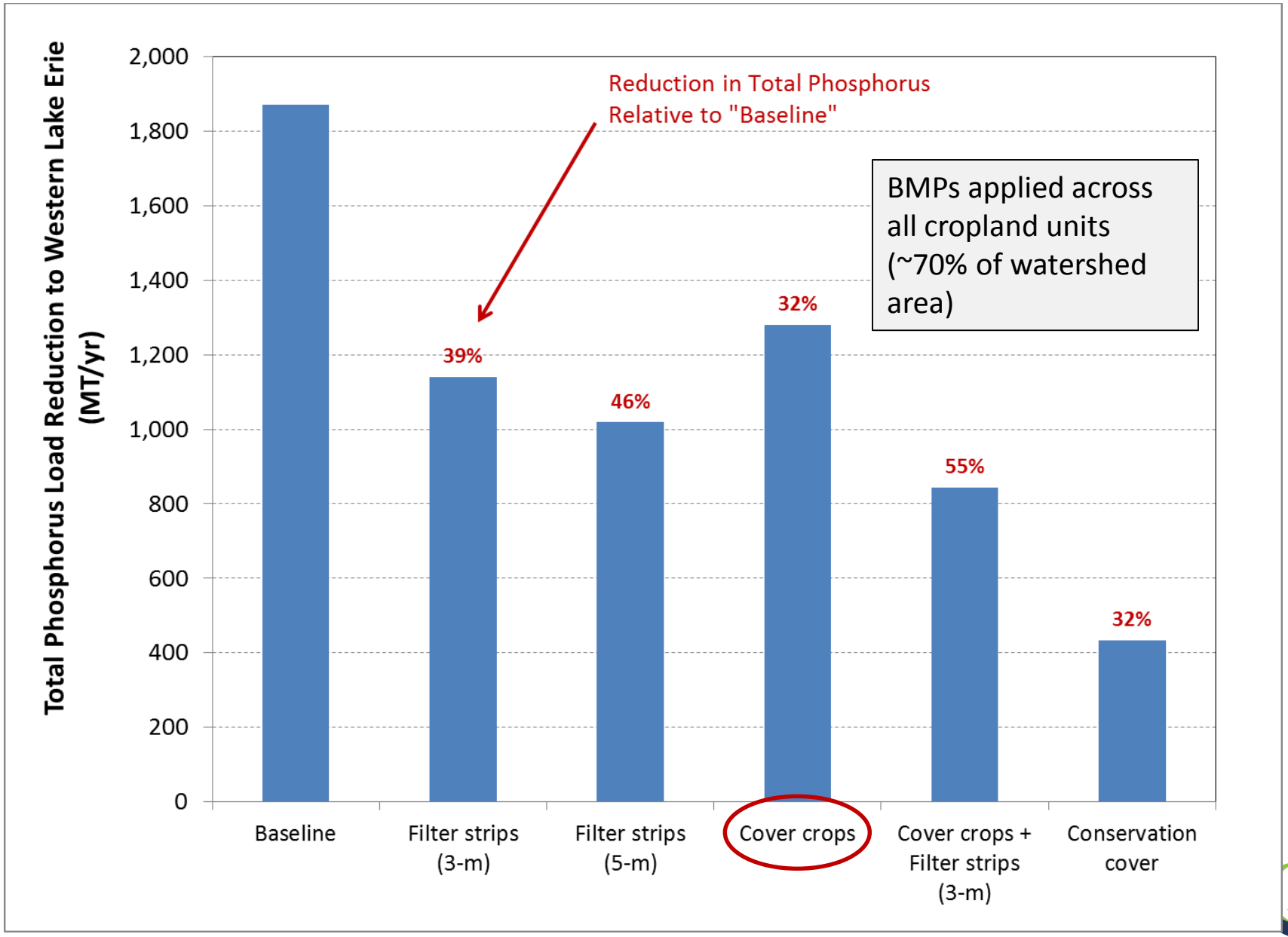


Maumee SWAT Model Conceptual Diagram

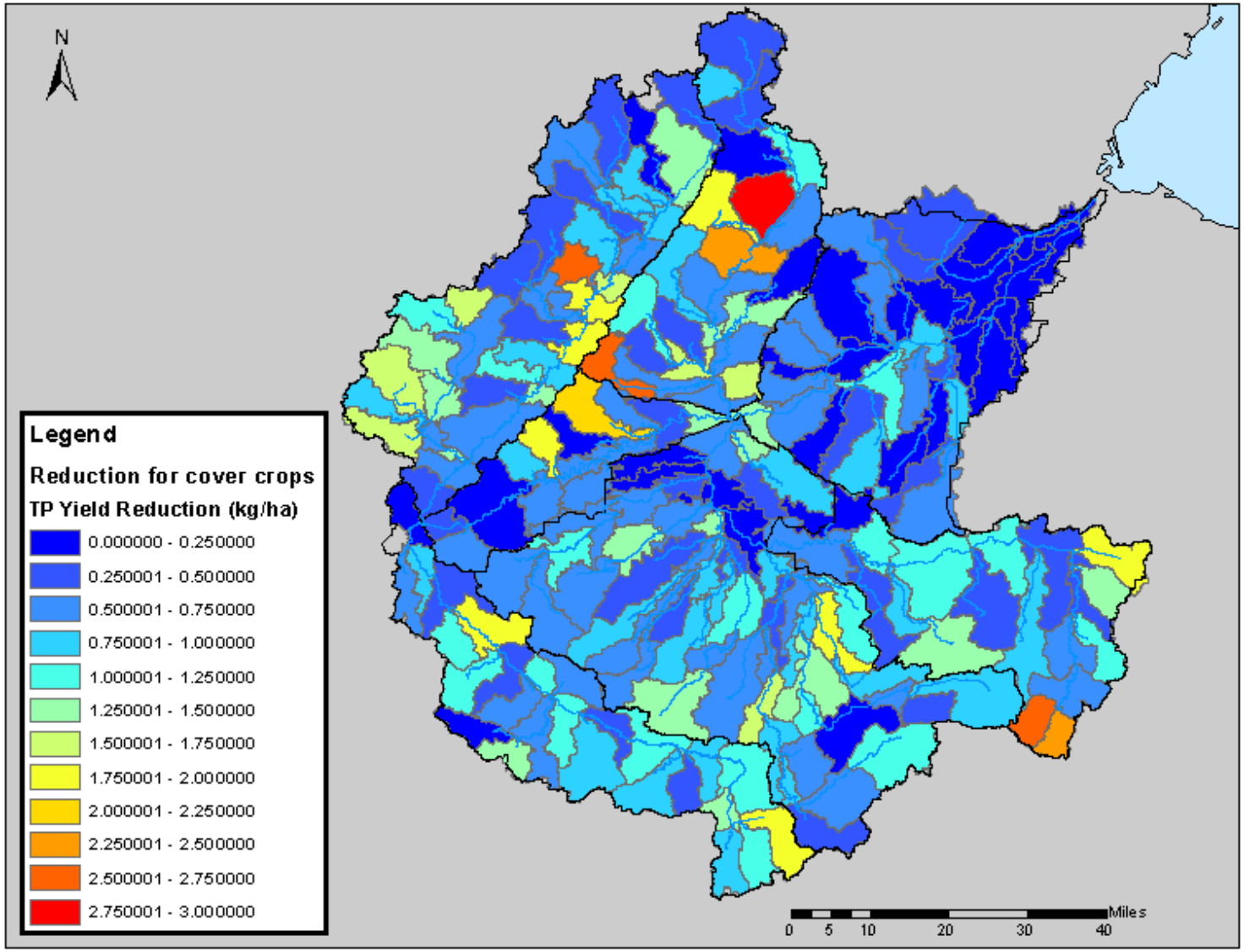


Maumee Basin SWAT model adapted from Bosch et al. (2011)

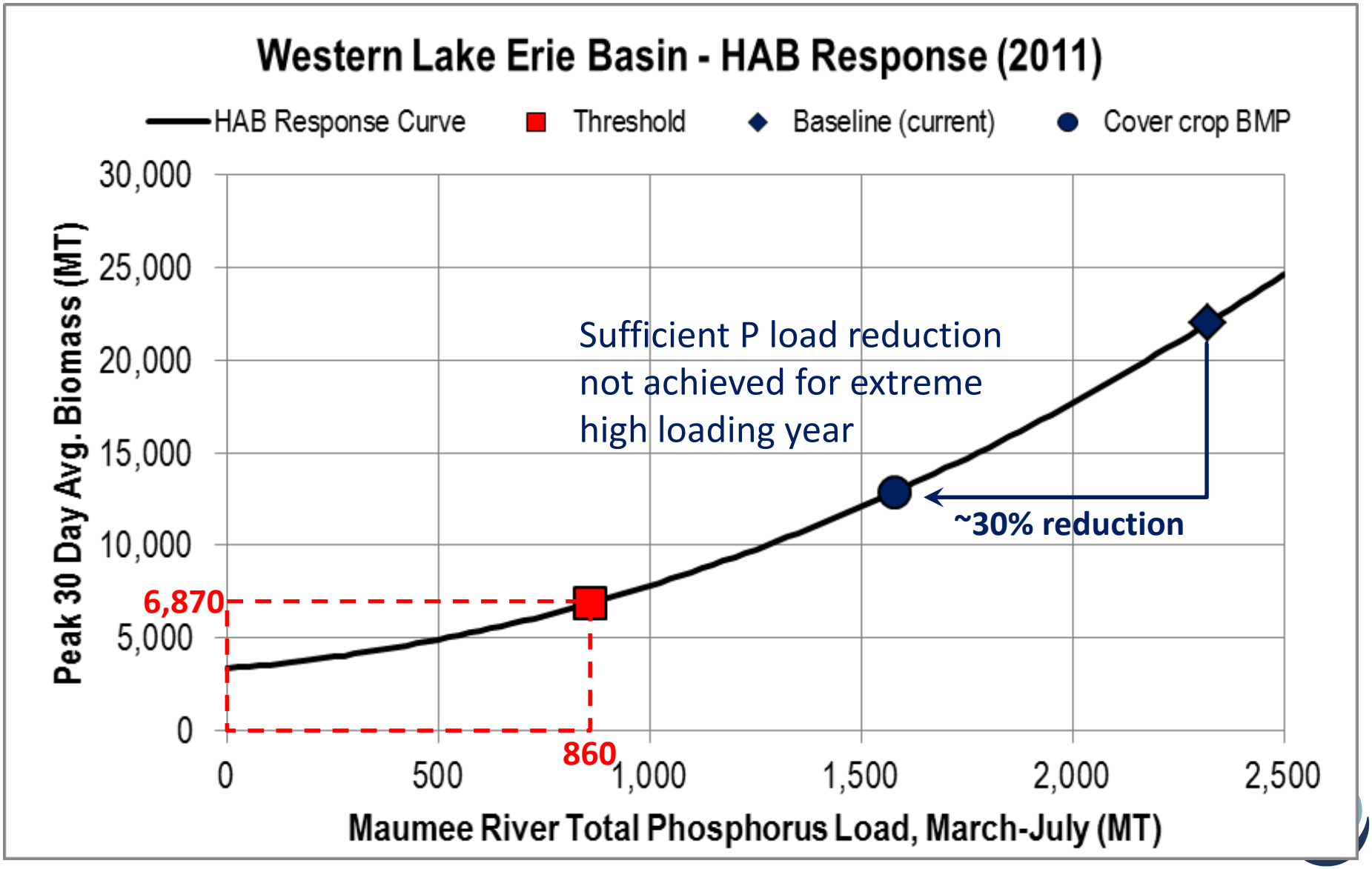
SWAT Results for “Upscaled” BMPs



SWAT Total Phosphorus Yield for "Upscaled" Cover Crop BMP



Harmful Algal Bloom Reduction via Cover Crops (Year 2011)



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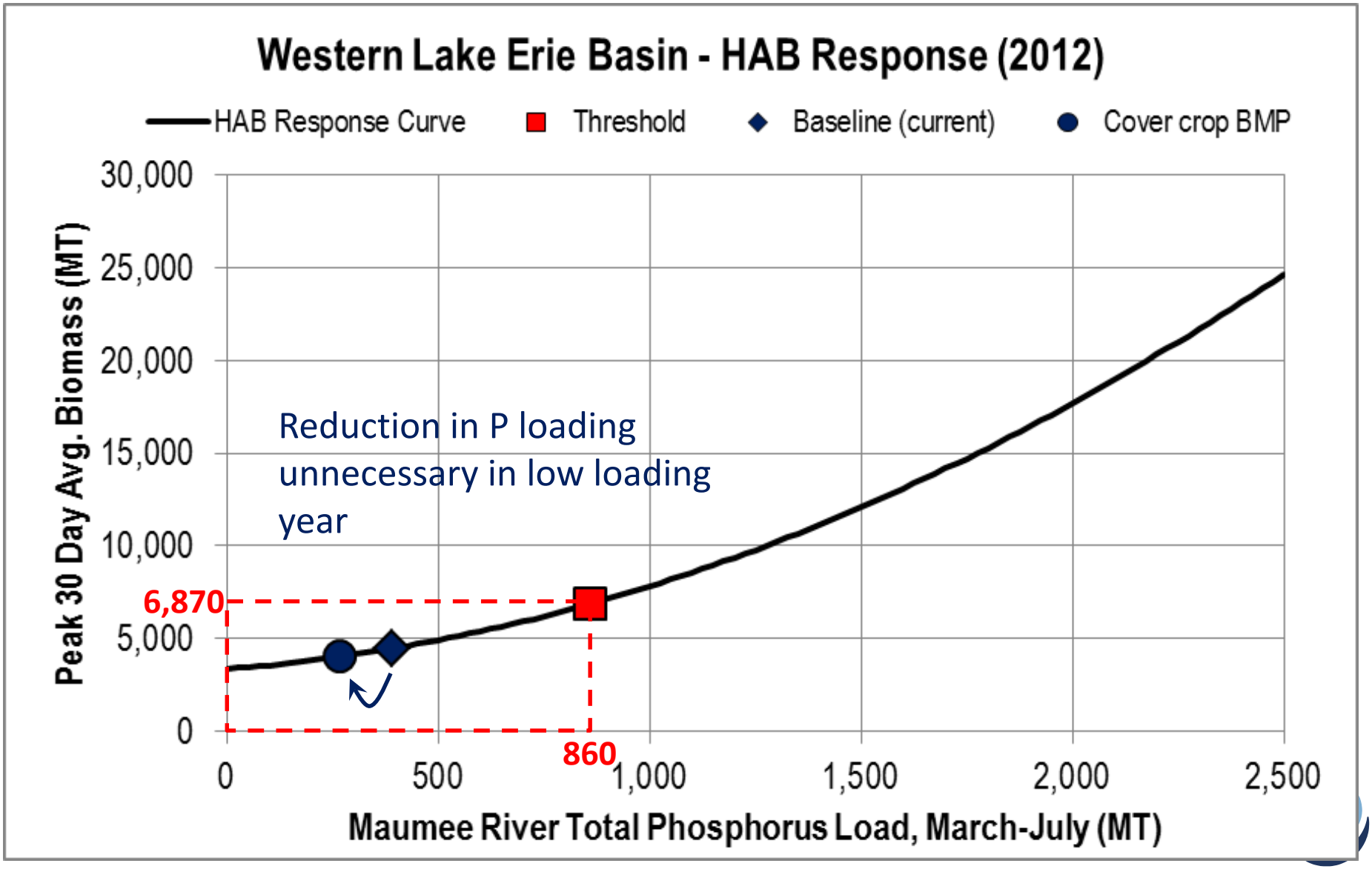
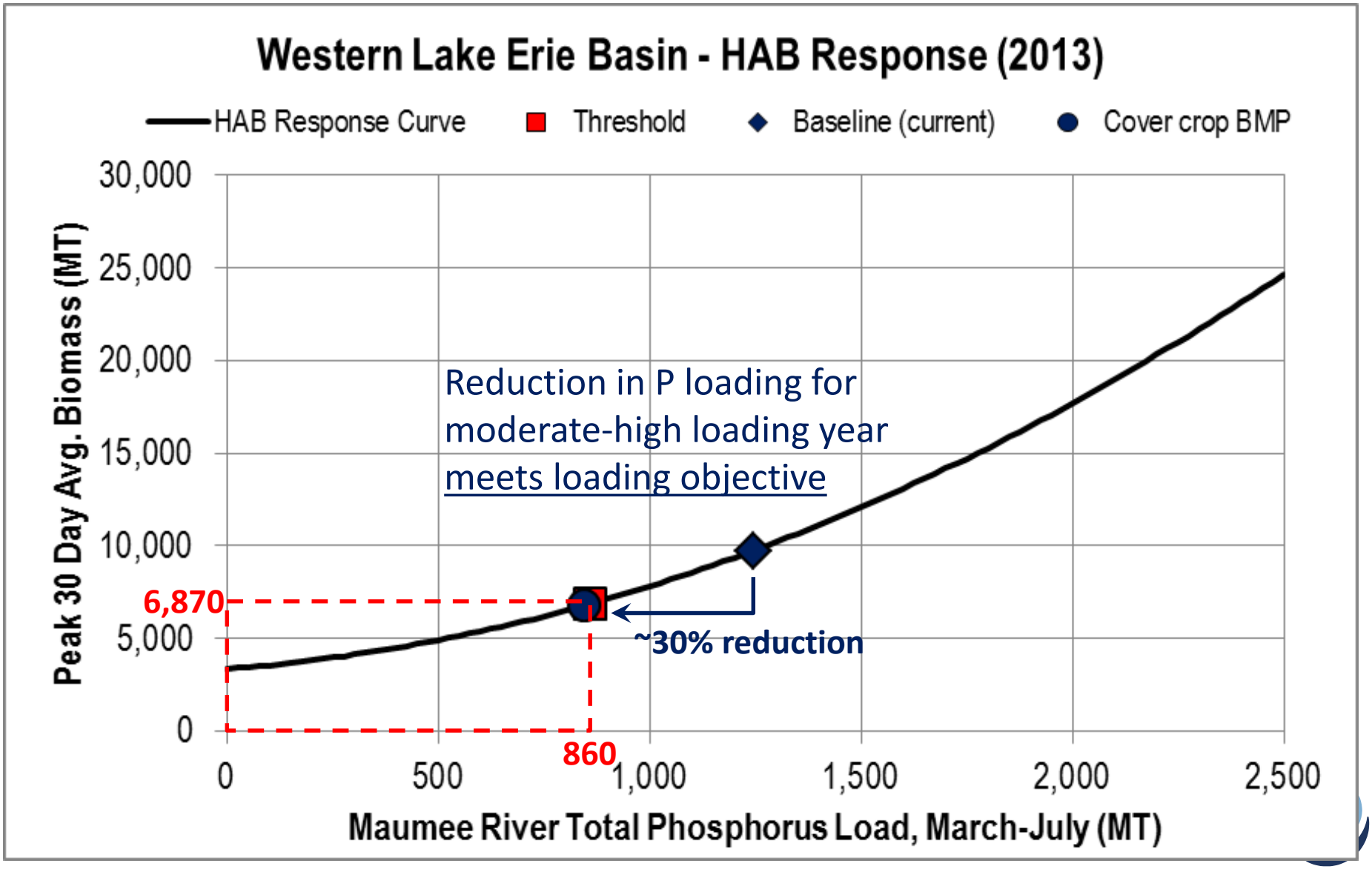
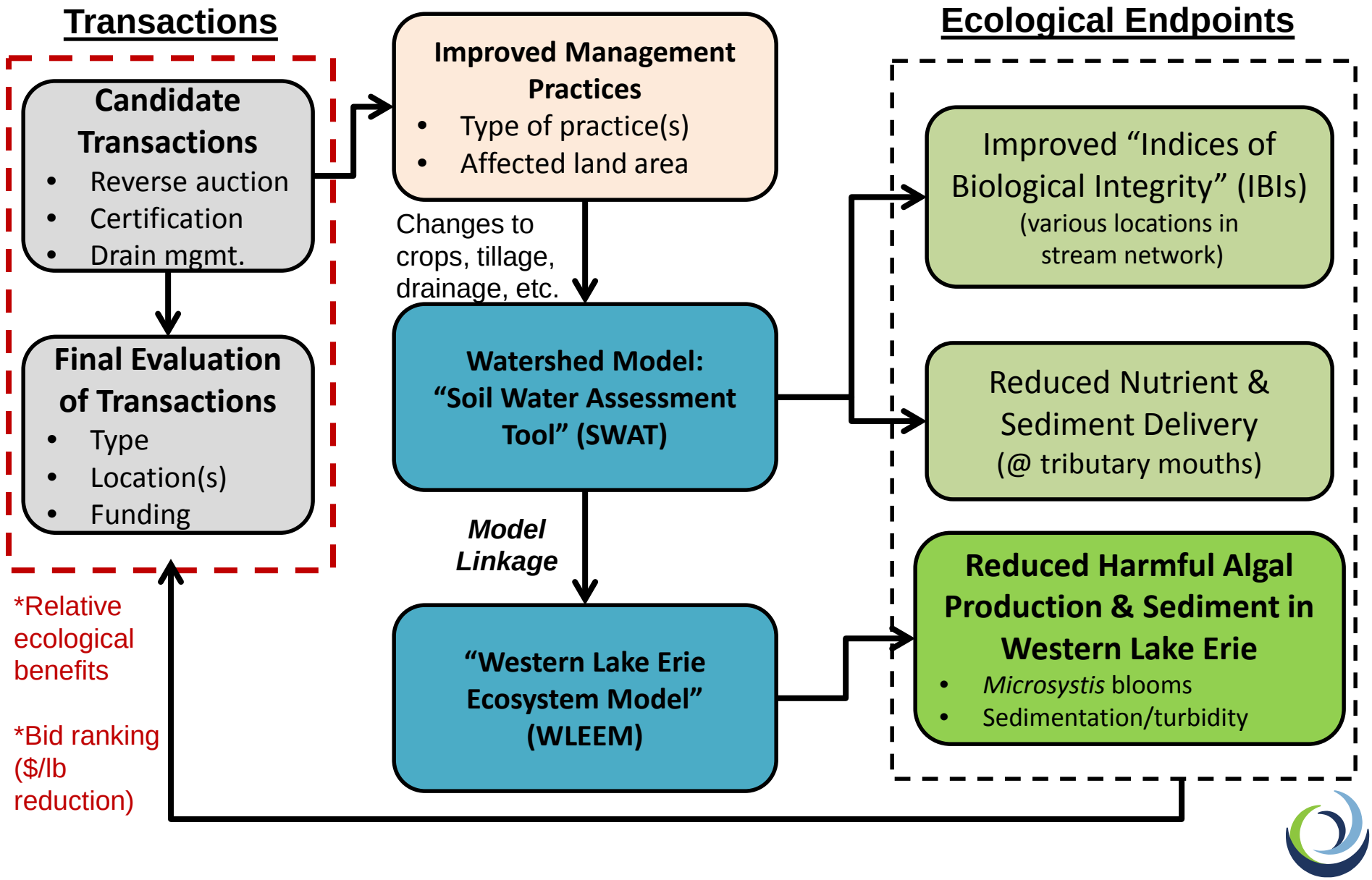


Harmful Algal Bloom Reduction via Cover Crops (Year 2013)



Transactions to Address Ecological Endpoints



Summary & Next Steps

- Harmful algal bloom (HAB) response in Western Lake Erie is closely linked to:
  - Maumee River loads
  - Climate factors within specific year (nutrient loads, water temperature, wind)
- "Western Lake Erie Ecosystem Model" can quantify relationships between load and HAB response
- Maumee basin SWAT model can:
  - Assess effectiveness of specific BMPs
  - Quantify level of implementation to achieve P loading threshold
- Very significant investment in management strategies will be needed to reduce HABs to threshold level for most years
- Ongoing & future efforts:
  - Evaluate feasibility of specific transaction types (reverse auction, certification)
  - Bioeconomic modeling tool (optimized cost-benefit analysis)

Questions?

- Acknowledgements:
  - Funding Sources:
    - Great Lakes Protection Fund
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    - Heidelberg University
    - University of Michigan Water Center
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