Overview of Ecosystem Models Selected for the Ensemble Modeling Approach

SAB Lake Erie Phosphorus Objectives Review Meeting

December 10, 2014

Stumpf: Cyanobacteria Index Forecasting

Empirical regression model predicting a remote-sense measure of 30-d Cyanobacteria expanse over Western Lake Erie from

- **spring TP Load from the Maumee R.**
- **spring water temp.**

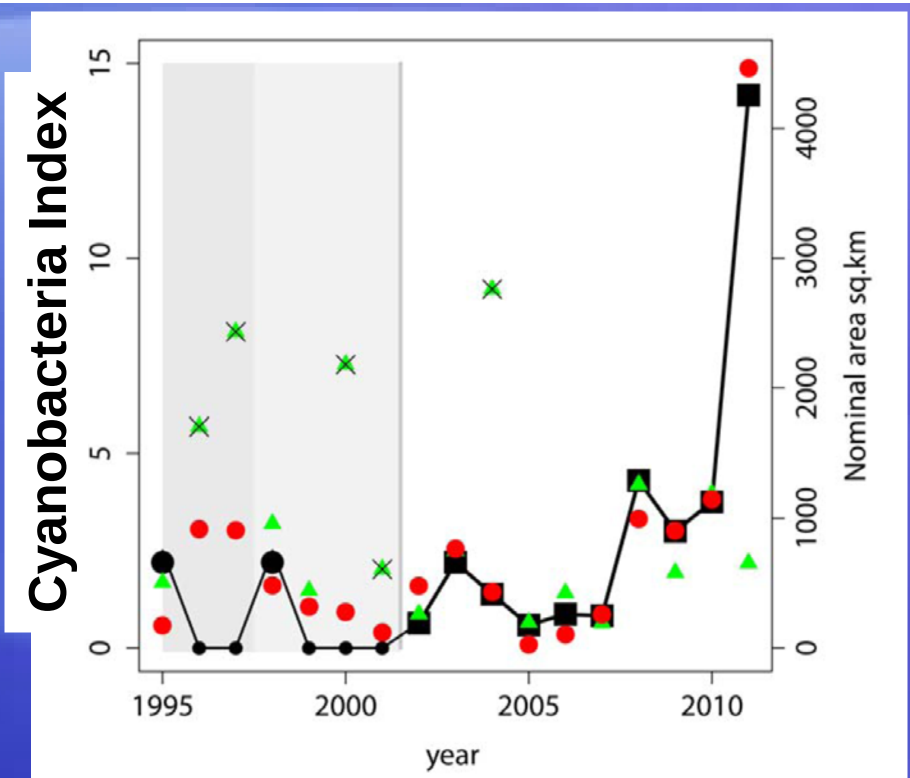


Figure 8. Observed and modeled CI. CI determined here (black squares) from 2002–2011. Period of projected CI is shown in light gray, with black circles giving projected CI based on reports of blooms or not. 1995 and 1998 blooms are assumed to be equal to 2003, other years are assumed zero (no bloom) based on lack of reports. Red circles are CI estimated from exponential Q model. Green triangles are CI from TP for June. Triangles with an X have ratio of $TP_{June}/TP_{March\text{-}May}$ >0.2. Dark gray shade marks time period when the models fail to predict occurrence or absence of blooms.
doi:10.1371/journal.pone.0042444.g008

Stumpf: Cyanobacteria Index Forecasting

Strength:

- provides spring forecasts of expected summer blooms

Limitations:

- calibrated to a limited data set, largely driven by a single-event (year)

- remote-sense Cyanobacteria index is an artificial construct; neither *Microcystis* nor toxicity are predicted

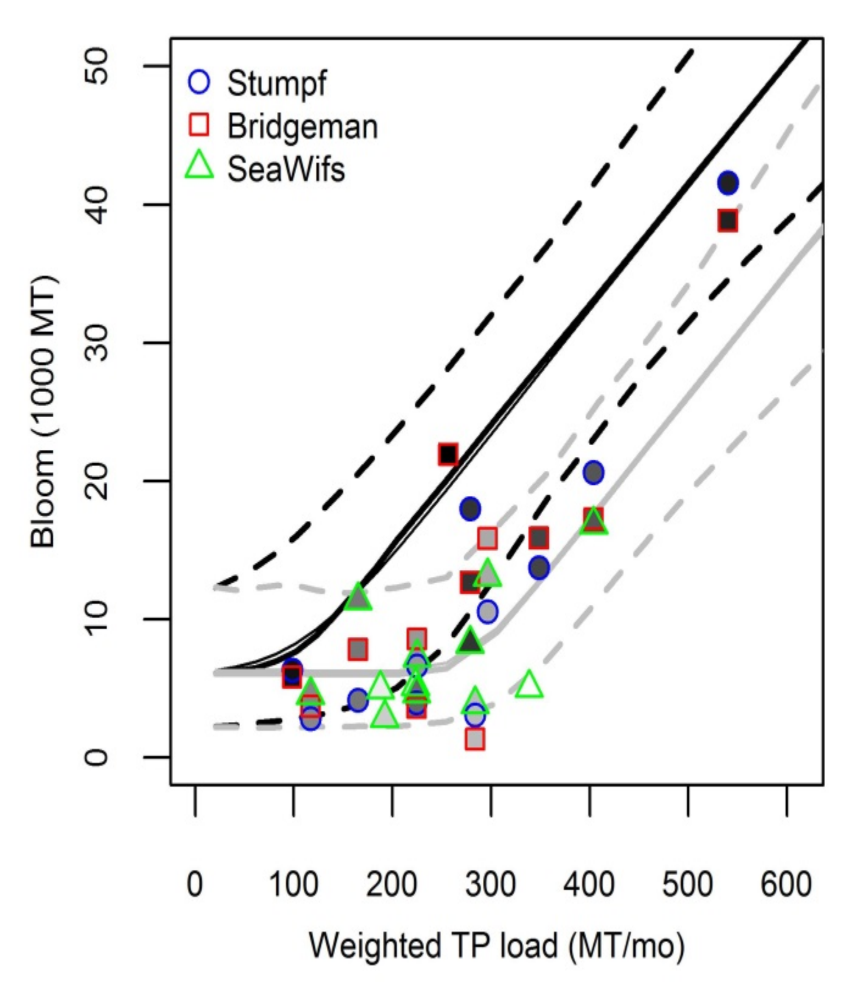
- ignores possible role of Detroit R. (hydrodynamic driver or nutrient source)

Obenour
Probablistic Cyanobacteria Bloom Forecasting Model

Empirical regression model Based on

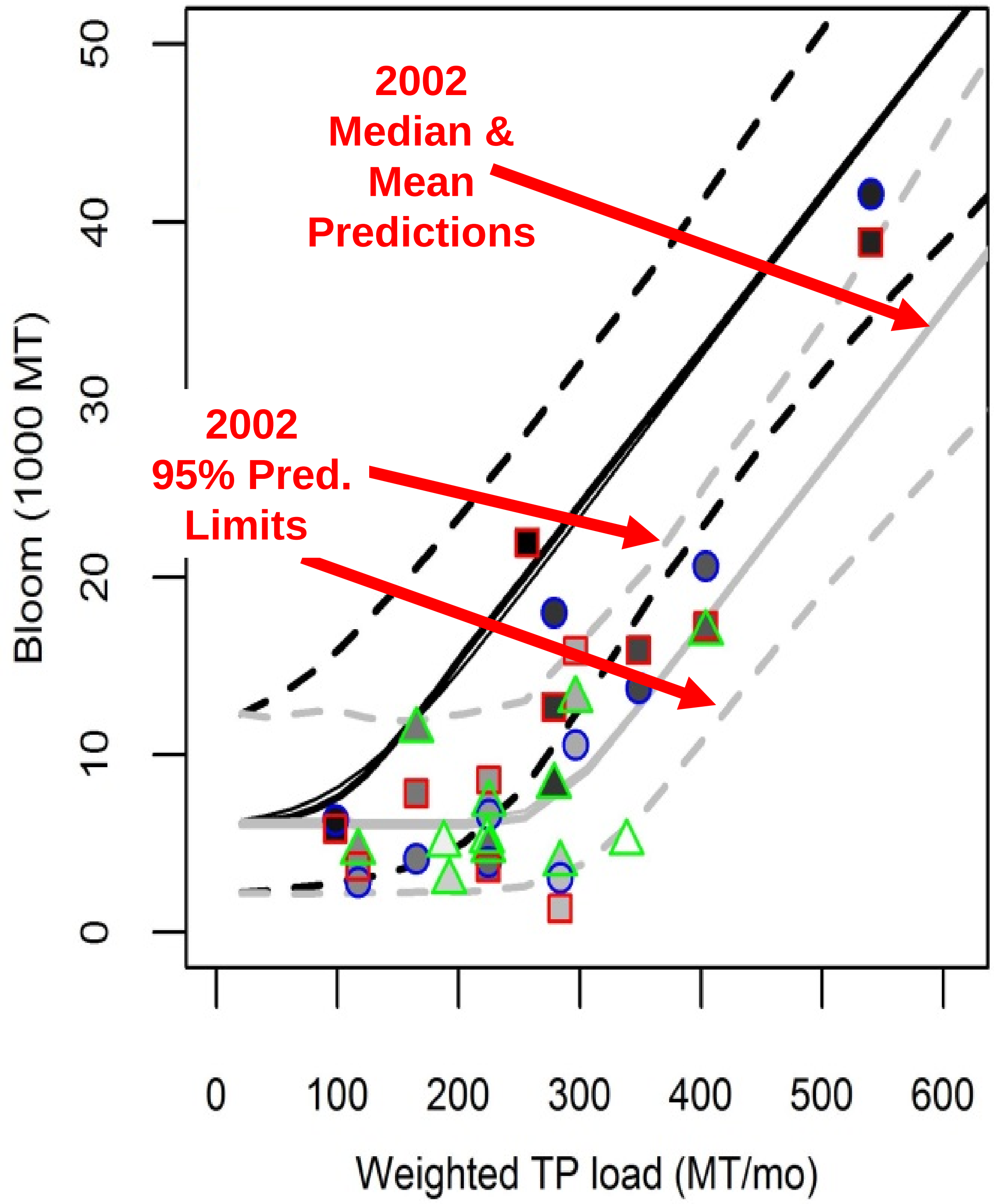
- **bioavailable fraction of spring TP weighted monthly load**
- **model year**
- **Intra-annual variability**

2002-13 data suggest that Western Basin is becoming more sensitive to spring phosphorus load



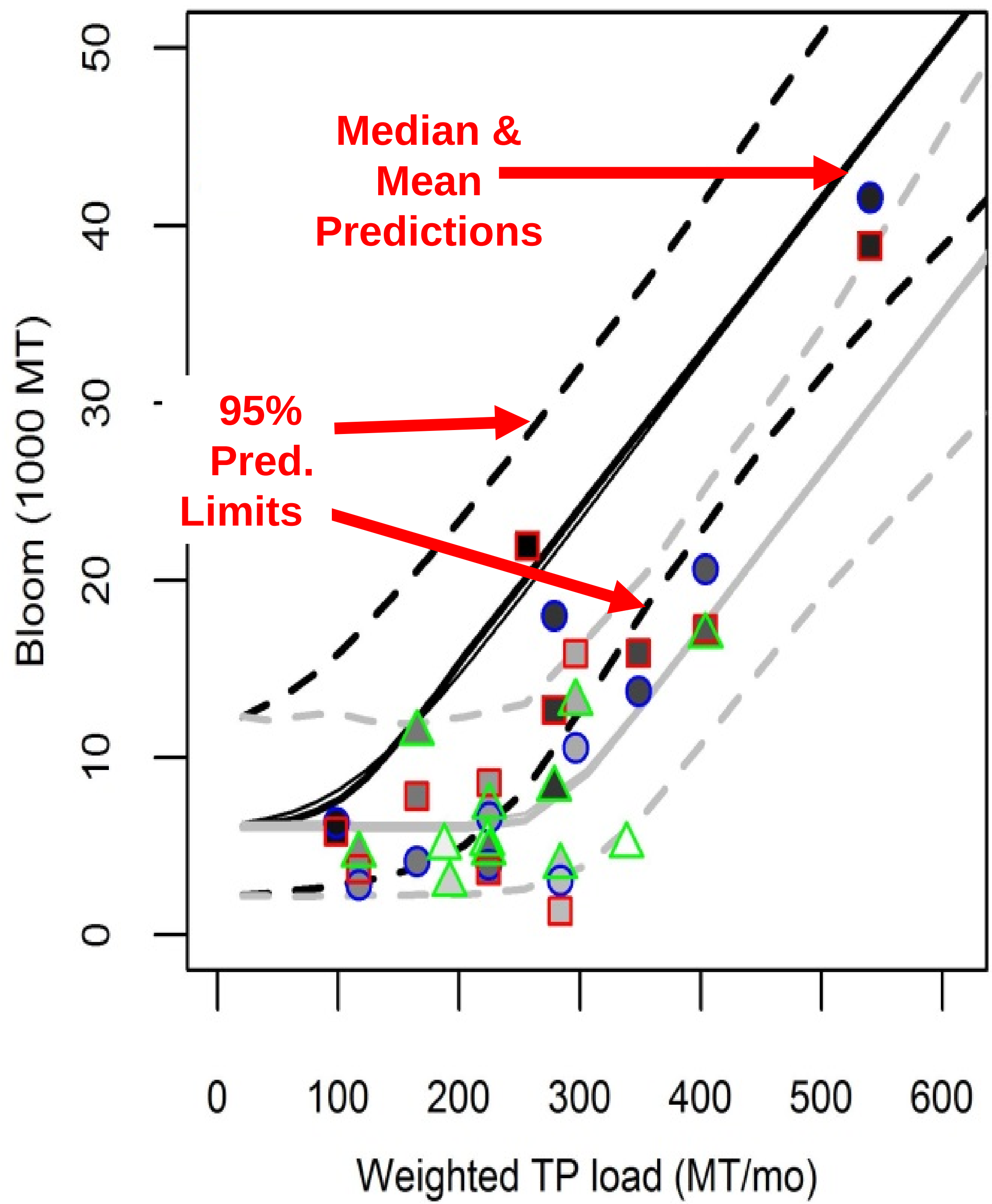
Obenour

Predictions based on 2002 Lake Erie conditions



Obenour

Predictions based on 2013 Lake Erie conditions



Obenour: Cyanobacteria Bloom Forecasting

Strengths:

- Uses two independent measures of HAB biomass (Stumpf, Bridgeman to model sampling uncertainty
- Explicitly models interyear variability as a source of uncertainty; extremes provide measure sensitivity

Limitations:

- unidentified recent response modeled as 'sensitivity factor', implying continuing threat
- ignores possible role of Detroit R. (hydrodynamic driver or nutrient source)

Stumpf & Obenour: Cyanobacteria Blooms

Recommendations:

- use with caution, in combination

- continue to evaluate & refine models with new data annually

Auer - Great Lakes *Cladophora* Model

Growth along N shore of E. Basin predicted from

- light penetration to 2 m
- water temperature
- SRP

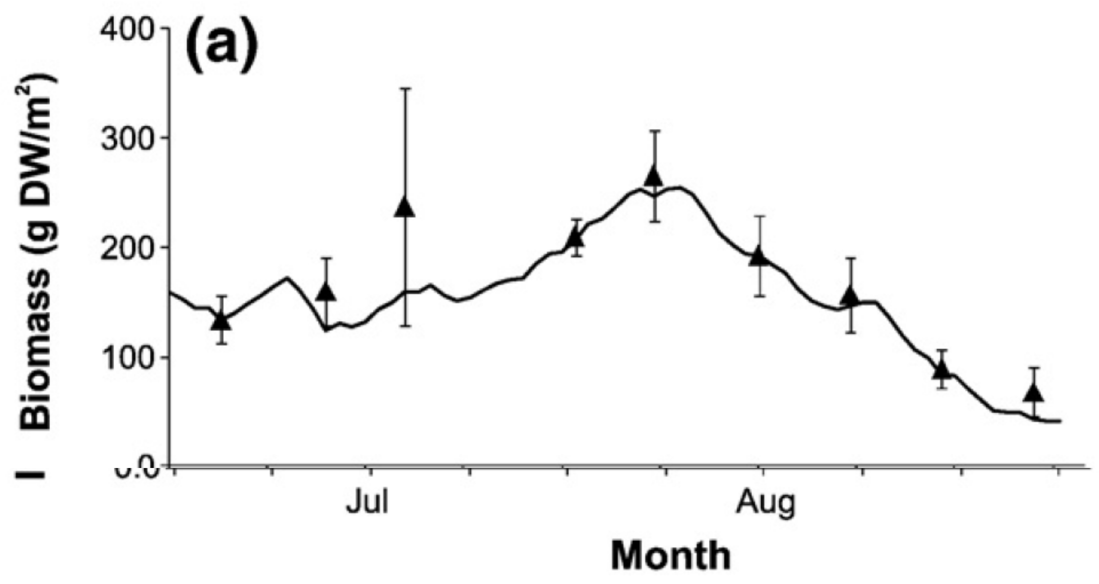
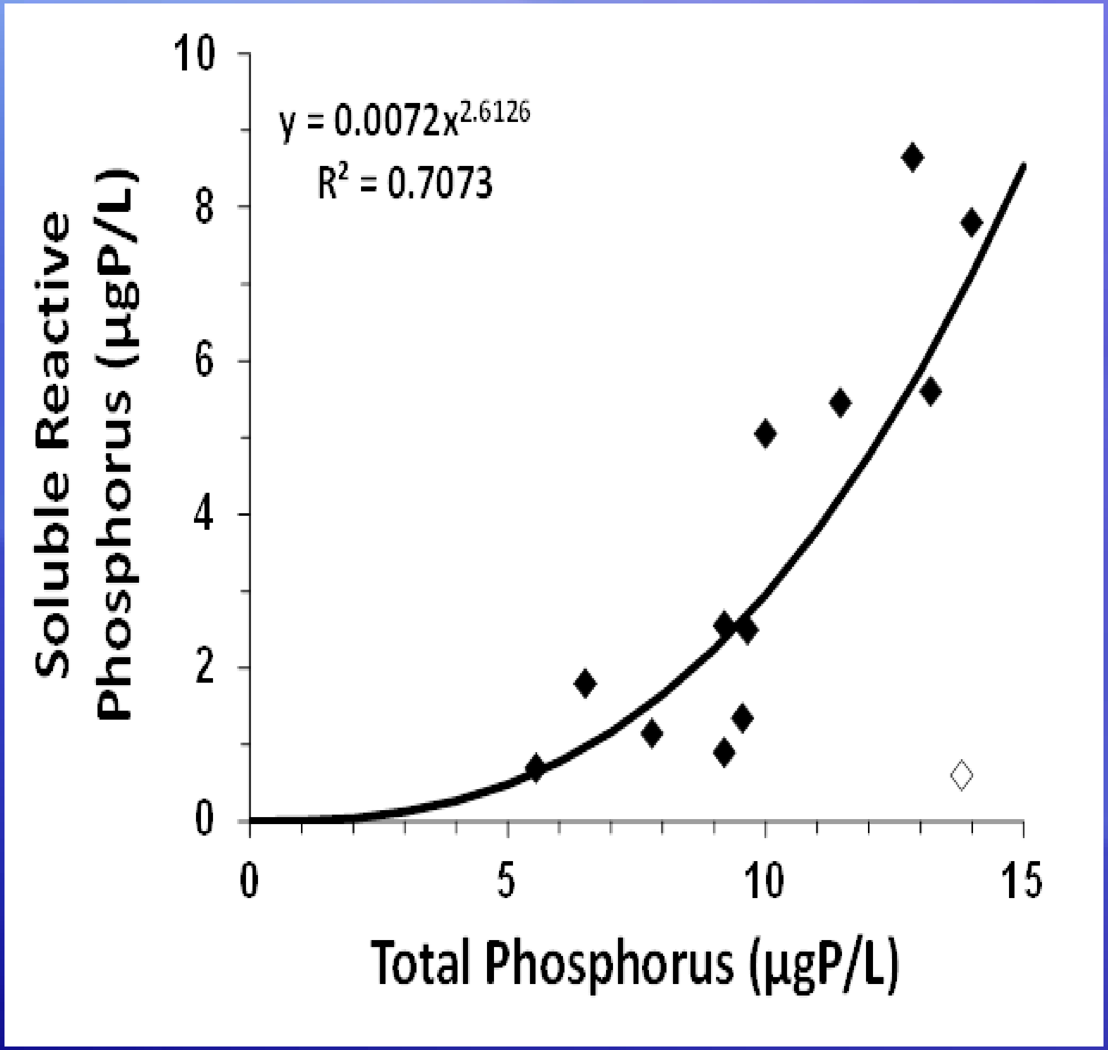


Fig. 6. Model performance in simulating seasonality in (a) *Cladophora* biomass and (b) internal phosphorus content at the Atwater Beach, Wisconsin, study site on Lake Michigan. Data collected in 2006. Bars indicate standard deviation of the pool of measurements.

Auer - Great Lakes *Cladophora* Model

SRP is empirically estimated from TP

(updated from Chapra model)

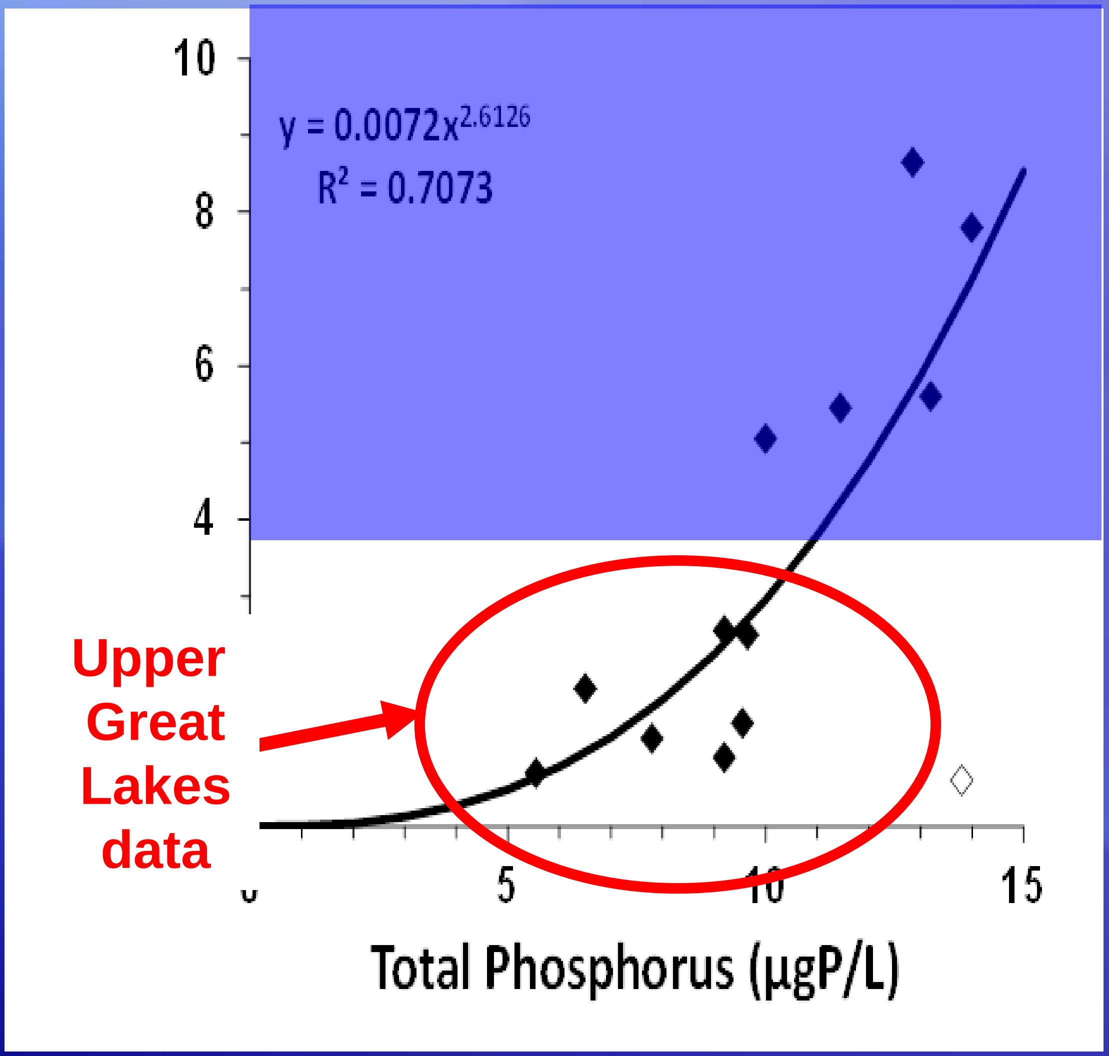


Auer - Great Lakes *Cladophora* Model

Limitation:

Calibration data relating SRP to TP come from different lakes;

Within-lake relationships are weak



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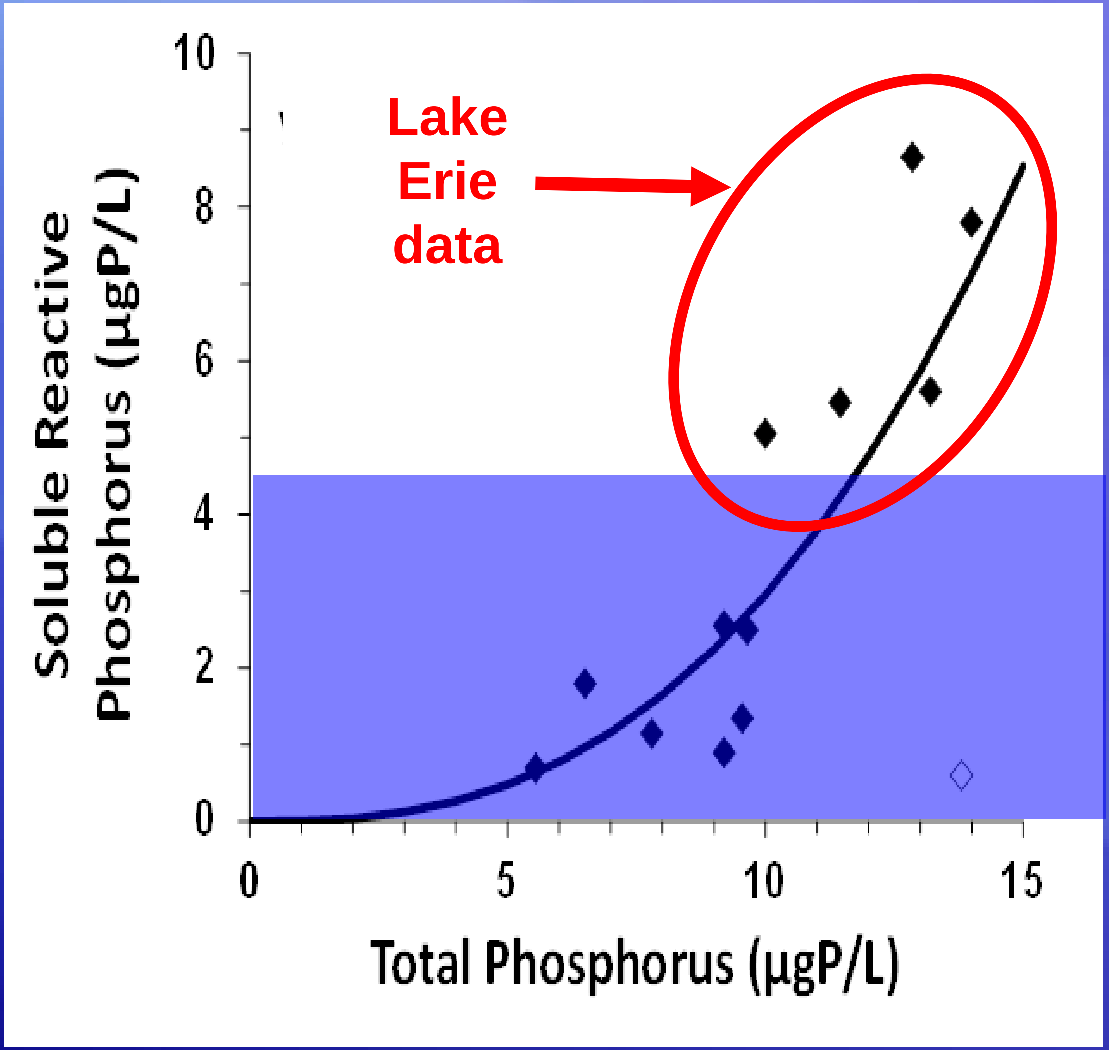

Auer - Great Lakes *Cladophora* Model

Strength: **Process-based and physiologically-based model**

Limitation: **model is not spatially delimited; source(s) of SRP not specified (from offshore vs from tributary watersheds)**

Recommendation: **Recalibrate SRP-TP relationship with Lake Erie data**