Will cyanobacteria (blue-green algae) blooms go away if we meet the total phosphorus TMDL in Missisquoi Bay?

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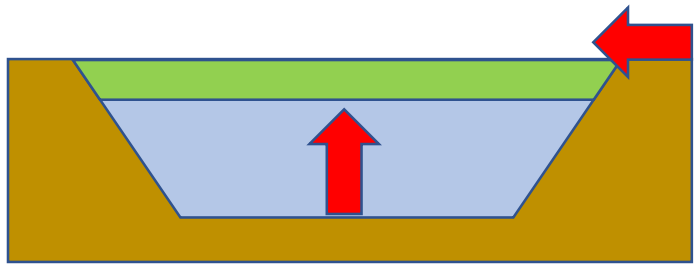
IJC Meeting
May 8, 2019

VERMONT EPSCoR

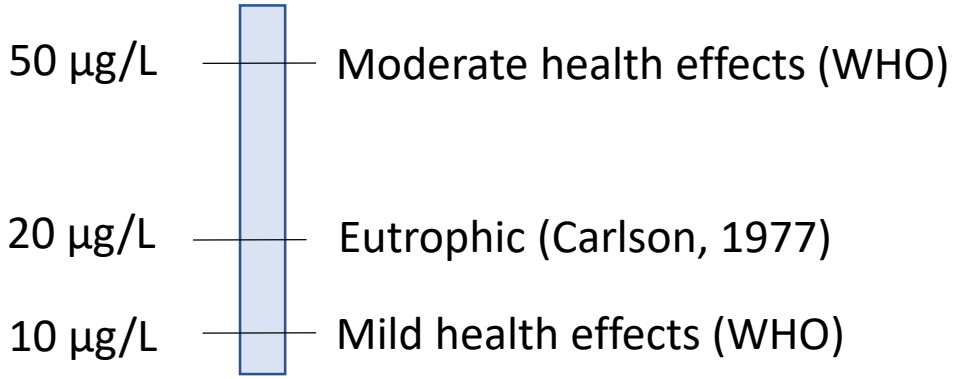
BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

Phosphorus and cyanobacteria blooms in Missisquoi Bay

- TMDL: Annual average of TP samples (~Apr-Nov) cannot exceed 0.025 mg/L
- Mandates a 64.3% reduction in watershed TP load from Vermont by 2035
- High lake TP concentrations, warm water, calm conditions foment blooms
- Meeting the TMDL does not necessarily eliminate cyanobacteria blooms
- Guidelines but no regulations for bloom indicators

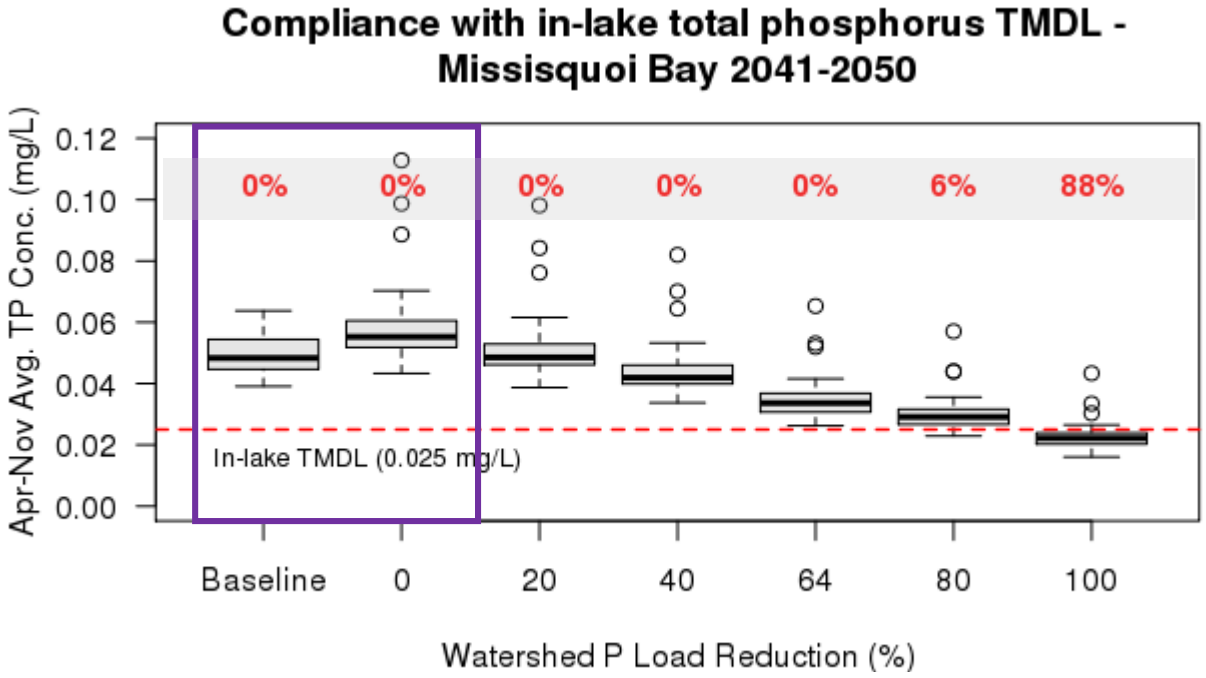


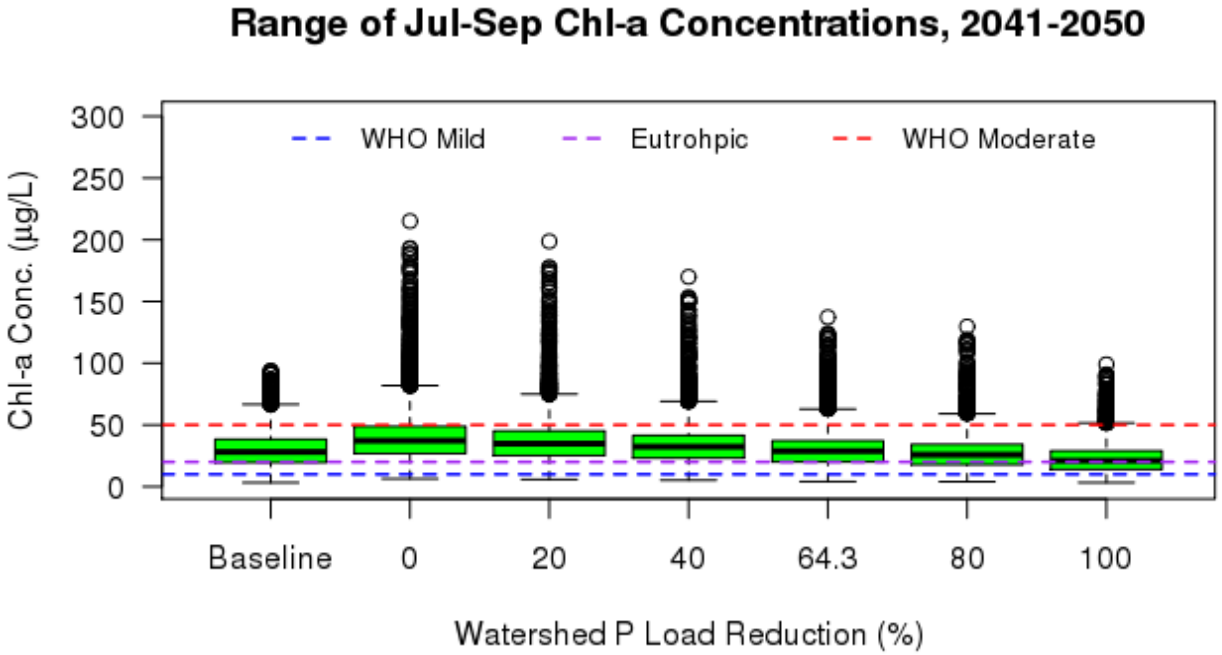
CHLOROPHYLL A (CHL-A) GUIDELINES



Will blooms go away if we meet the TMDL in the future?

- Simulated immediate (2016) load reductions in entire watershed
- Compared baseline (2001 – 2010) with future (2041 – 2050) period
- Started with Business-As-Usual climate scenarios (RCP 8.5), 5 GCMs
- Two factors limit TMDL success:
  - Internal loading of legacy P
  - Climate change

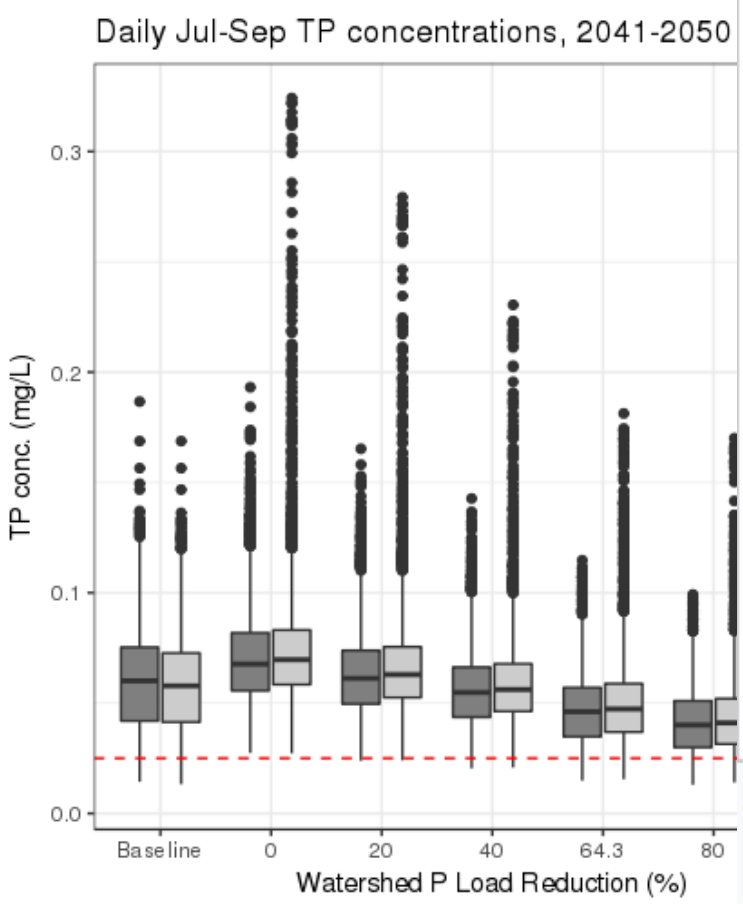


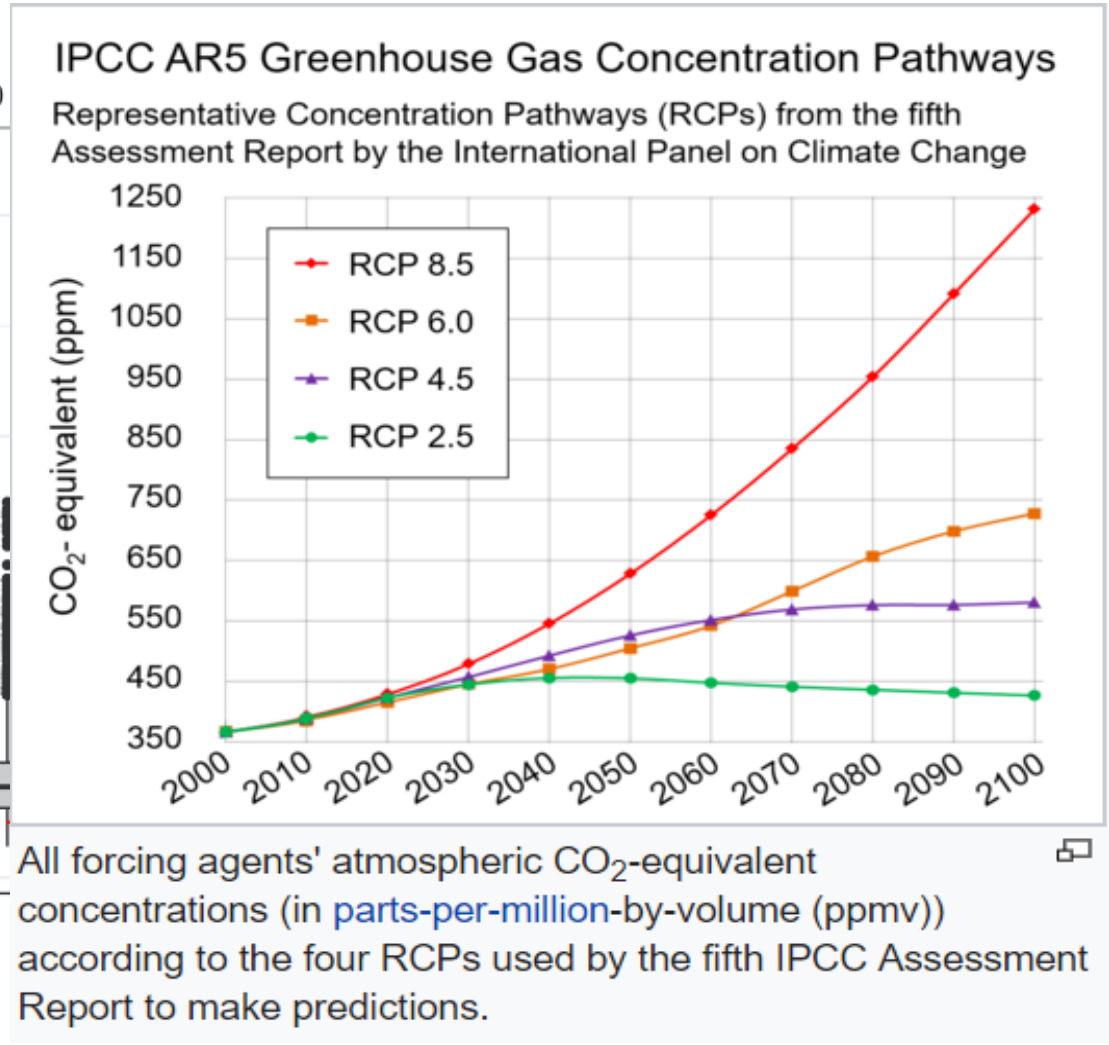


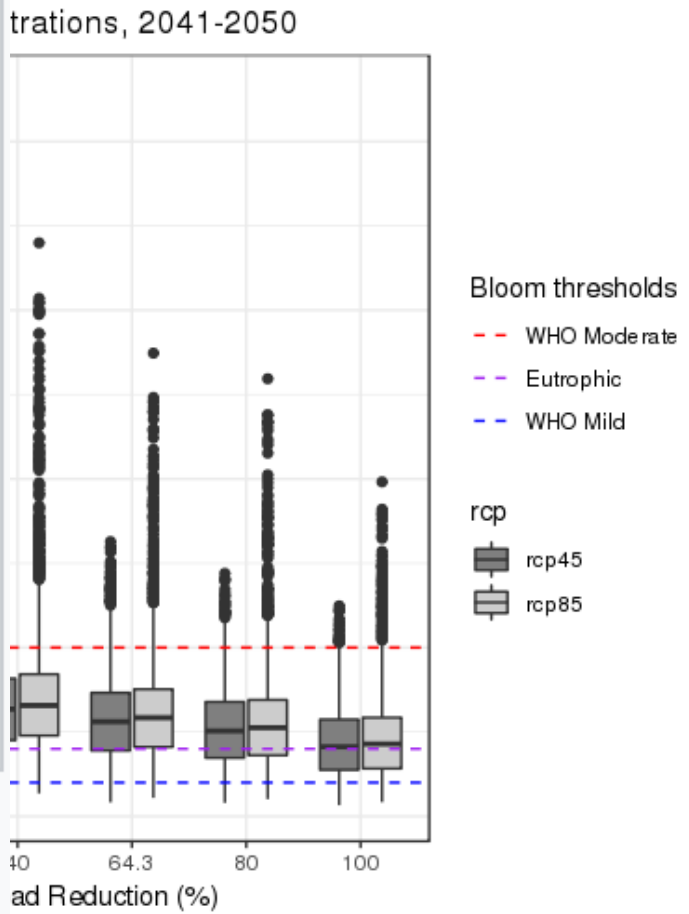
Lower emissions (RCP 4.5) lead to much lower bloom extremes, only relatively mild differences in seasonal averages

TOTAL PHOSPHORUS

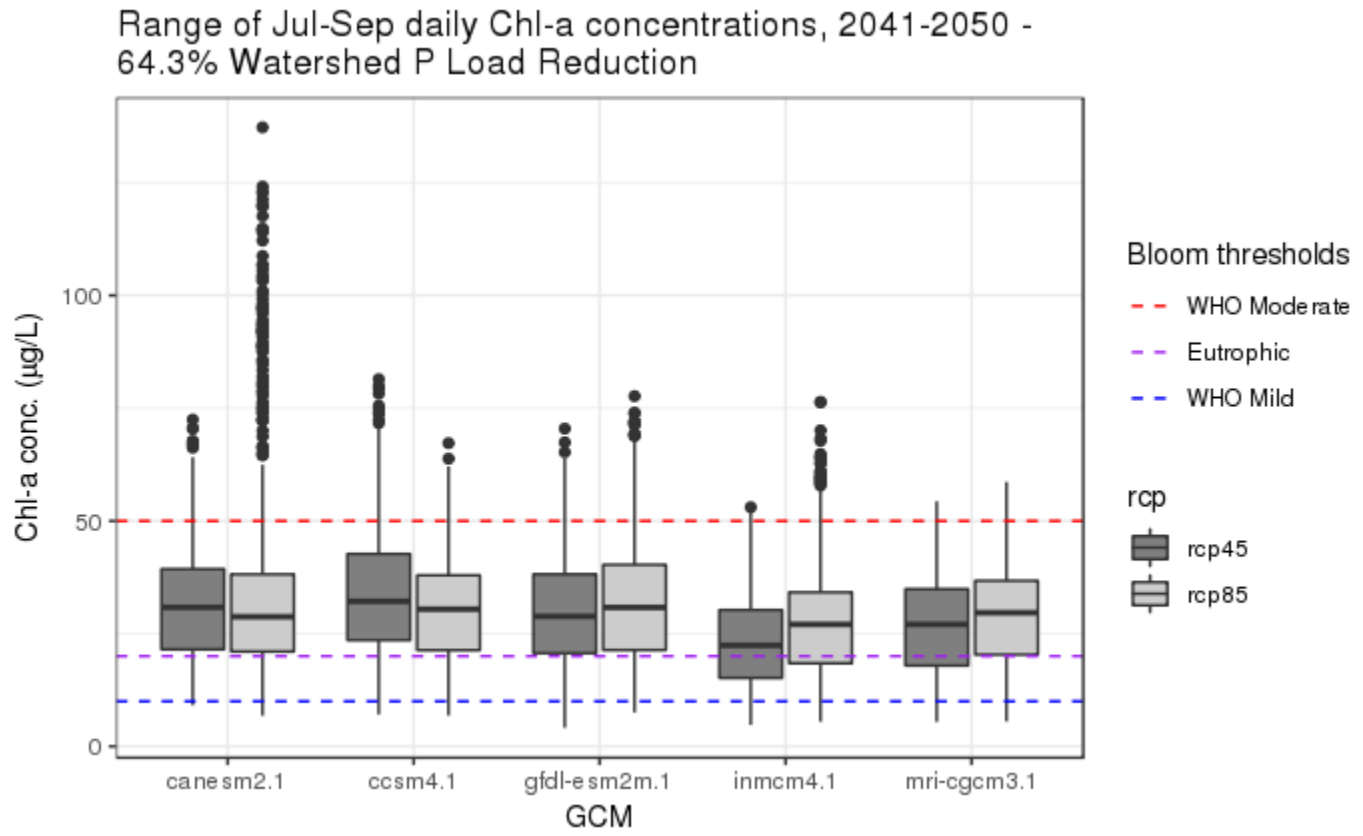
CHLOROPHYLL A



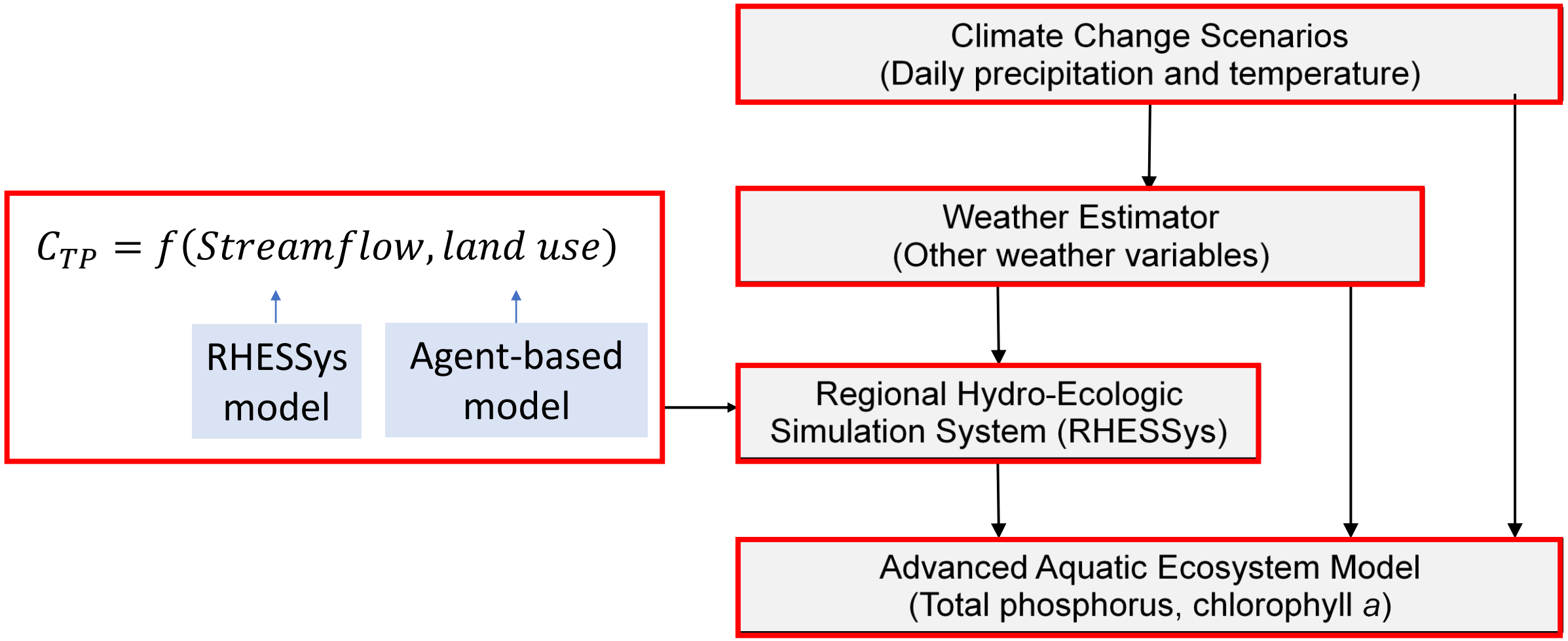




Between-GCM variability of daily chl-a projections



BREE Integrated Assessment Model in TMDL analysis



Summary

- Watershed P load must be reduced by much more than 64.3% to meet TMDL in 2040's
- Internal P loading and climate change both inhibit reduction of blooms
- TMDL-mandated P reduction could offset increased blooms from climate change
- Reducing GHG emissions will alleviate bloom extremes, but eutrophic conditions will persist
- BREE IAM can assess implications of watershed management decisions
- Need model comparisons, uncertainty analysis

http://www.rcinet.ca/fr/2014/02/16/villes-dici-noms-dailleurs-venise-en-quebec-aux-abords-du-lac-champlain/

Thank you! Merci!

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Zia, A. and others. Climate change-legacy phosphorus synergy hinders lake response to aggressive water policy targets. In preparation.

Zia, A. and others. 2016. Coupled impacts of climate and land use change across a river–lake continuum: insights from an integrated assessment model of Lake Champlain's Missisquoi Basin, 2000–2040. *Environmental Research Letters,* doi:10.1088/1748-9326/11/11/114026.

Zia, A. and others. Understanding lags, thresholds and cross-scale dynamics in social ecological systems. In preparation.

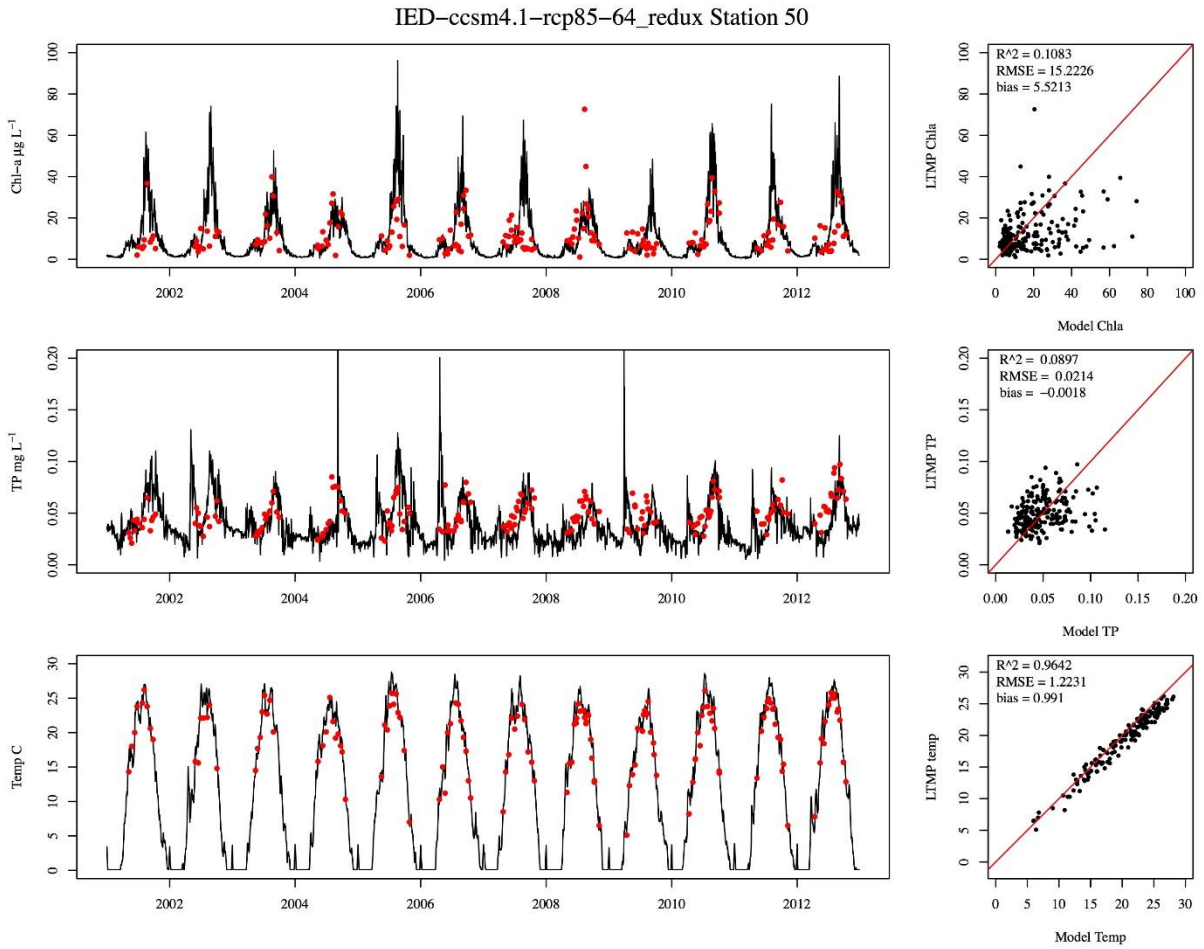
Hecht, J.S. and others. Calibration residual treatment in Integrated Assessment Model simulations of extreme water quality events. In preparation.

Hecht, J.S. and others. The sensitivity of cyanobacteria blooms to future changes in climate variability. In preparation.

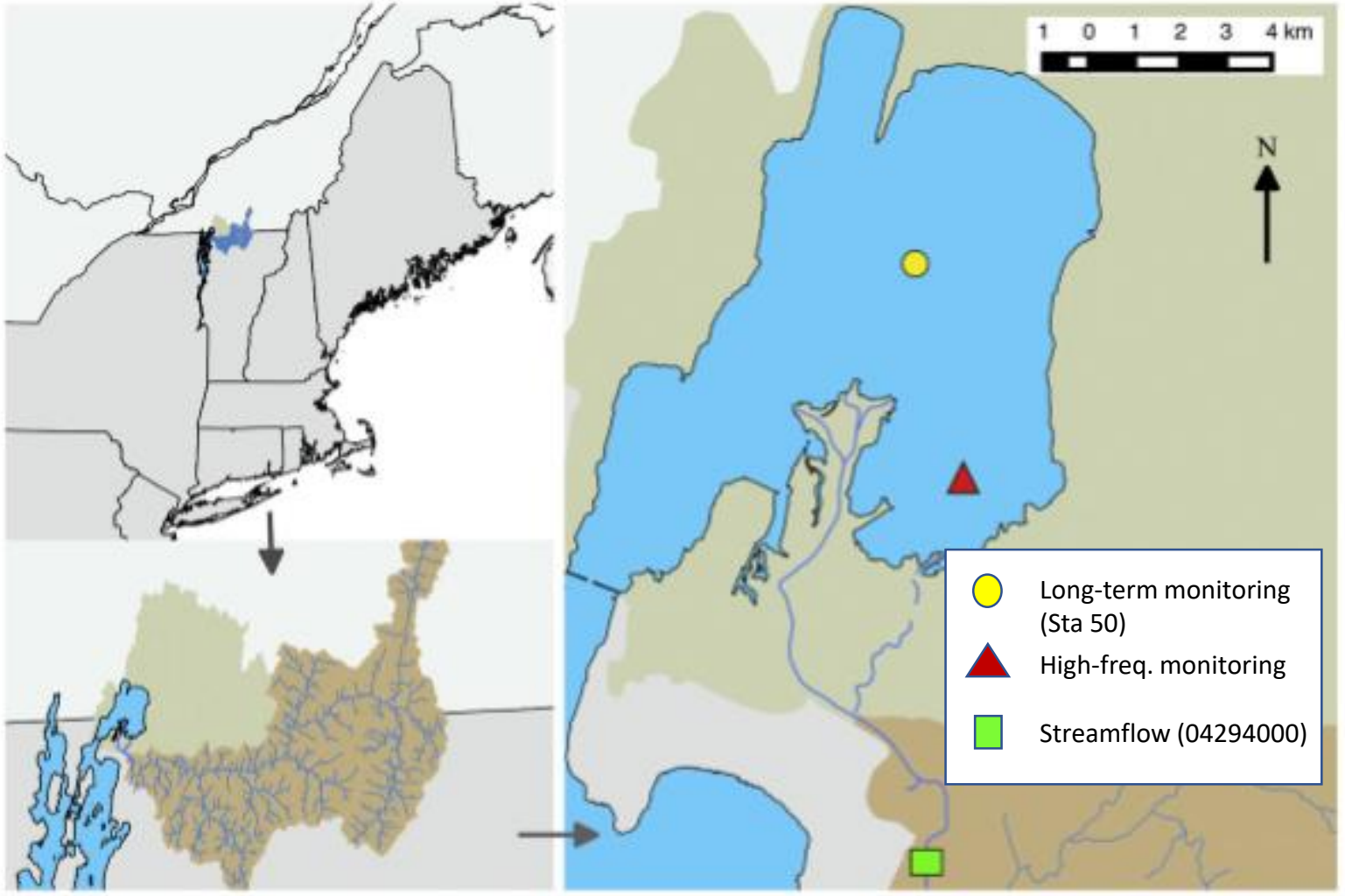
For other Vermont EPSCoR publications, please visit https://epscor.w3.uvm.edu/2/node/3449

https://www.flwfishing.com/news/2016-06-22-where-to-catch-bass-on-lake-champlain

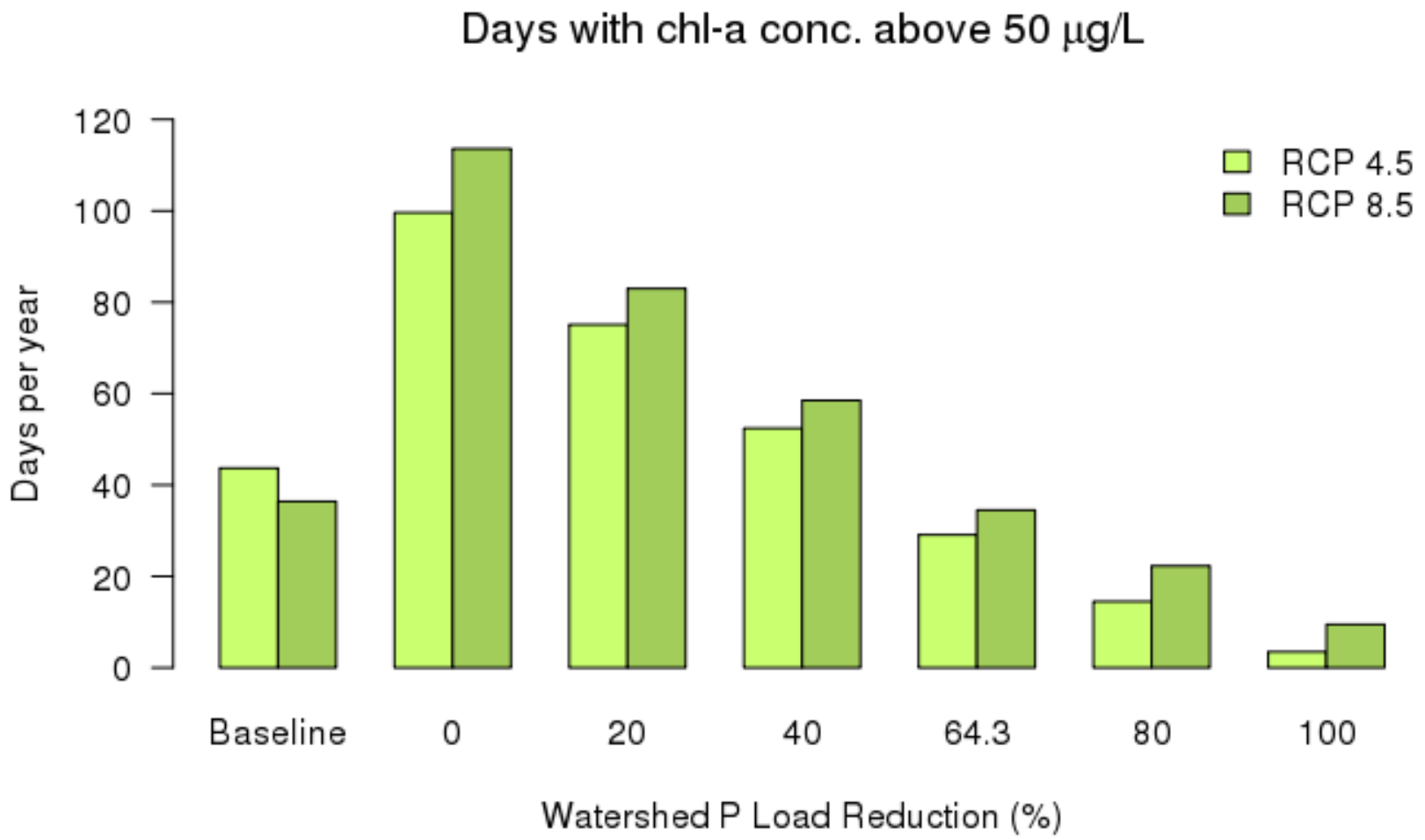
Calibration of lake water quality at Station 50



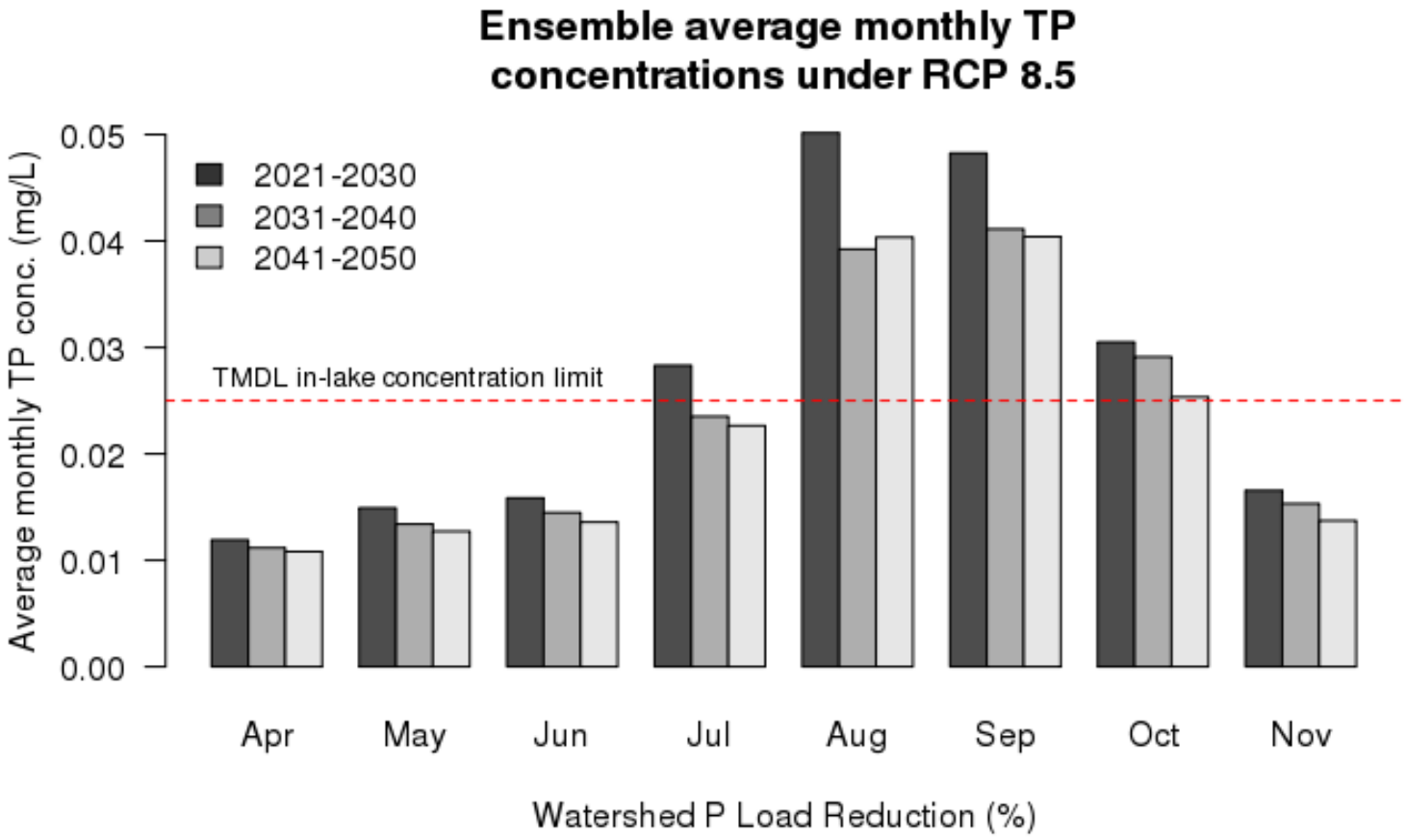
Missisquoi Bay station locations



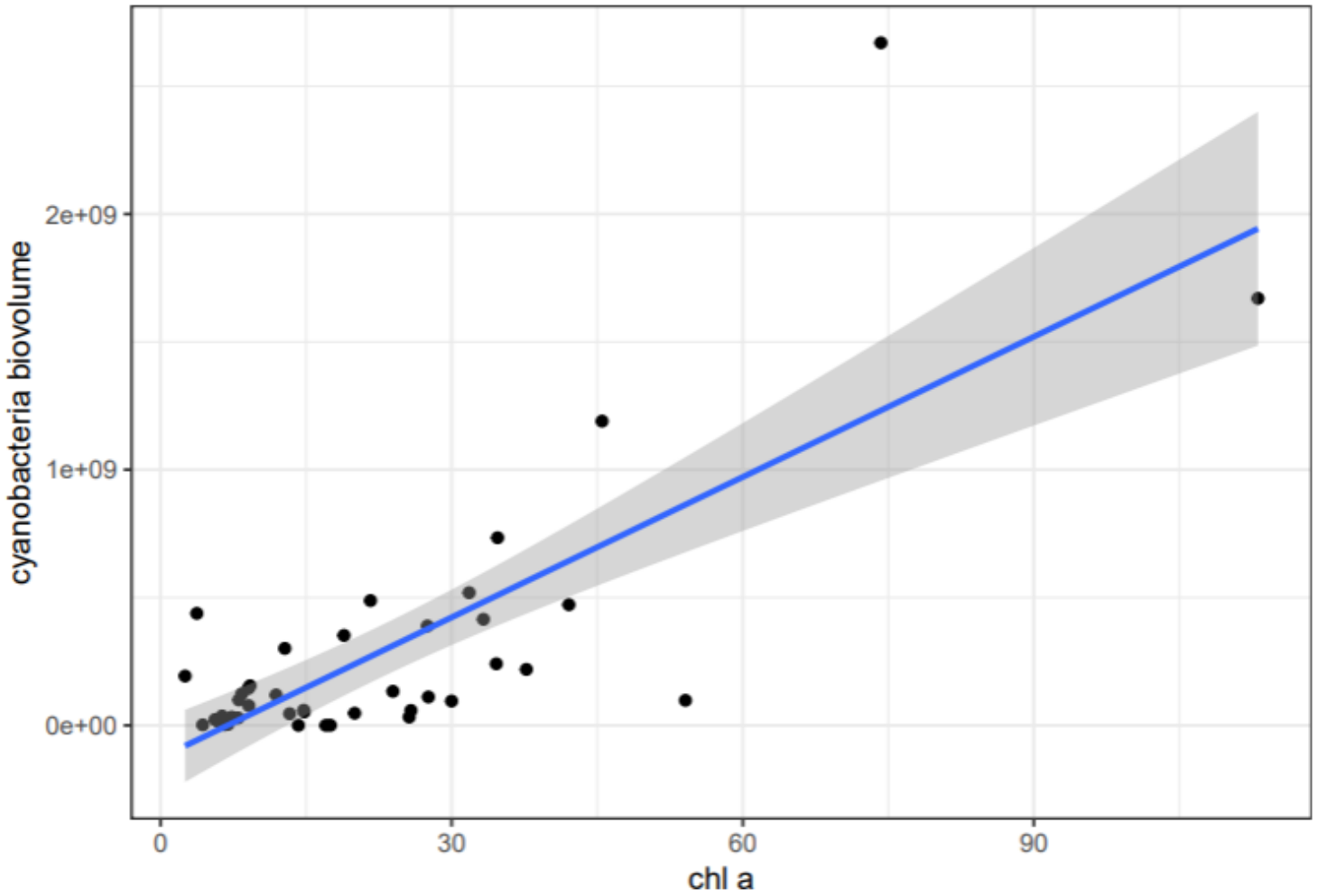
Changes in days with Moderate Health Risk (chl-a > 50 µg/L)



100% watershed P load reduction does not meet TMDL target during peak bloom season in 2040s

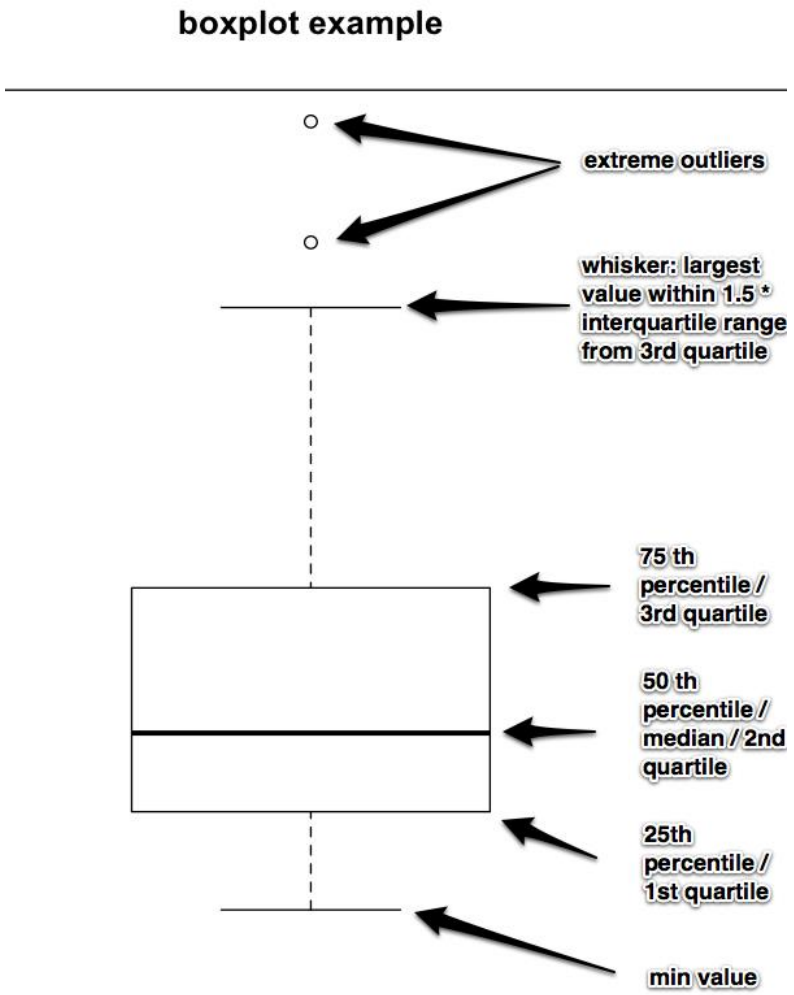


Chlorophyll-a vs. cyanobacteria biovolume



From Wilton Burns

Boxplots in R statistical software



http://earlh.com/blog/2011/09/18/labeled-boxplot-in-r/