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Cladophora in eastern Lake Erie: a synthesis of findings from the Great Lakes Nutrient Initiative

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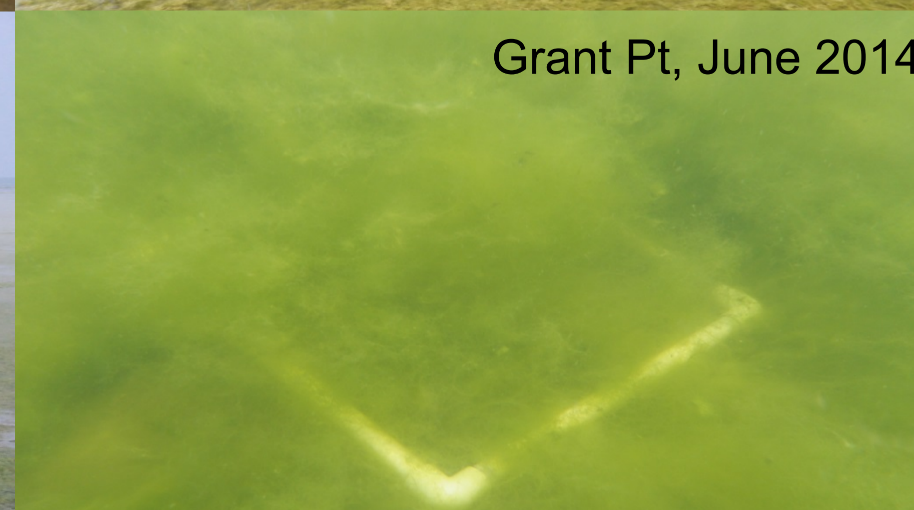
8th Binational Lake Erie Millenium Network Meeting, Windsor ON.

Great Lakes Nutrient Initiative (GLNI)

- Support research in Lake Erie and surrounding tributaries (2012-2015)
- Improve estimation of P loads to Lake Erie from Canadian tributaries
- Research to support development of P load reduction targets under the GLWQA 2012
  - Cyanobacterial blooms
  - Central basin hypoxia
  - Eastern basin *Cladophora*

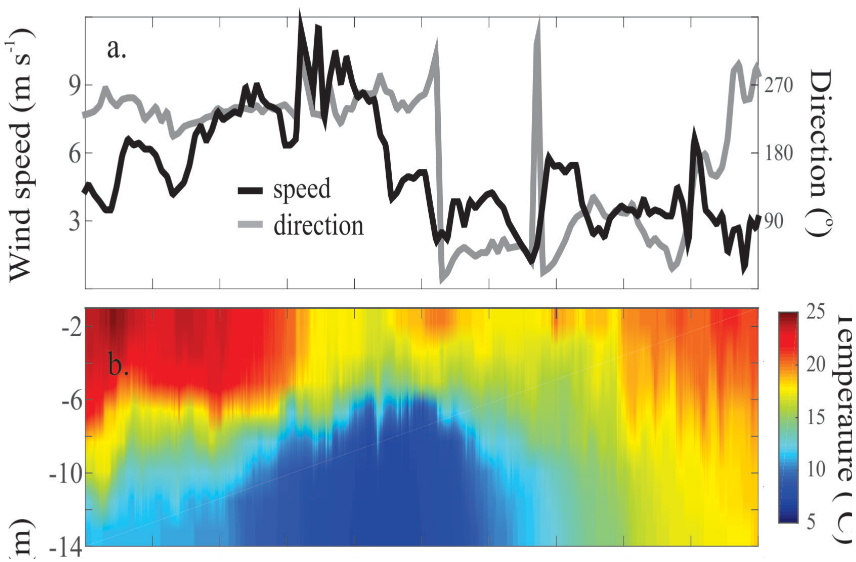
Eastern basin

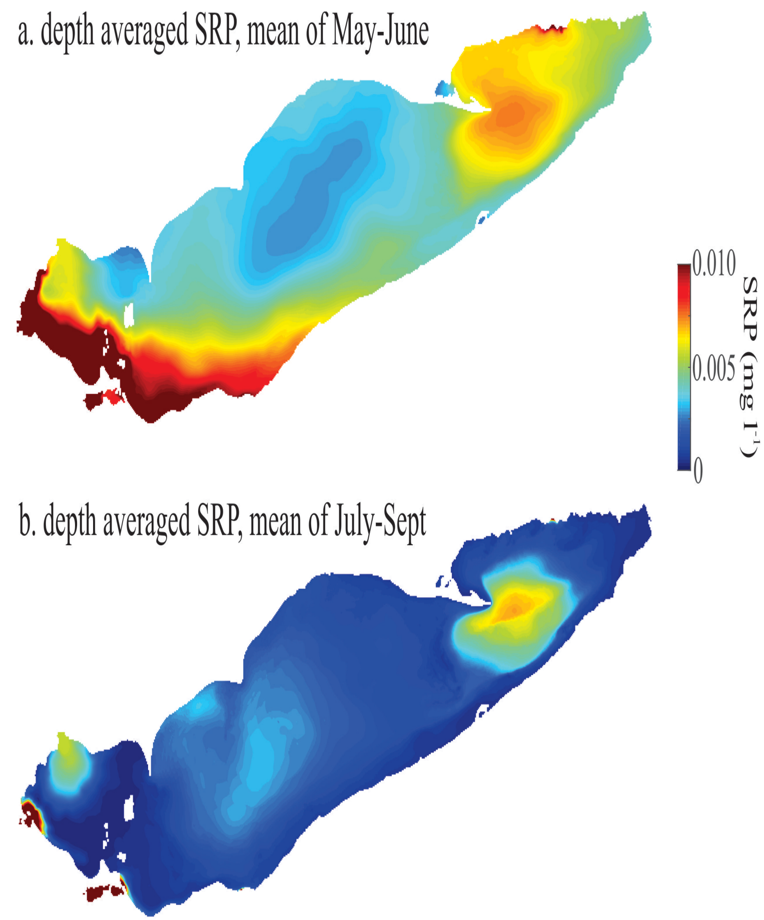


Fundamental challenge for targets

- 1) Basin level P supply as dictated by external P loadings and general trophic status
- 2) Local inputs of P (particularly SRP) to the nearshore
- 3) Efflux of P from the lake bed, mediated by dreissenid mussels as affected by 1) and 2)

On local vs lake – wide drivers



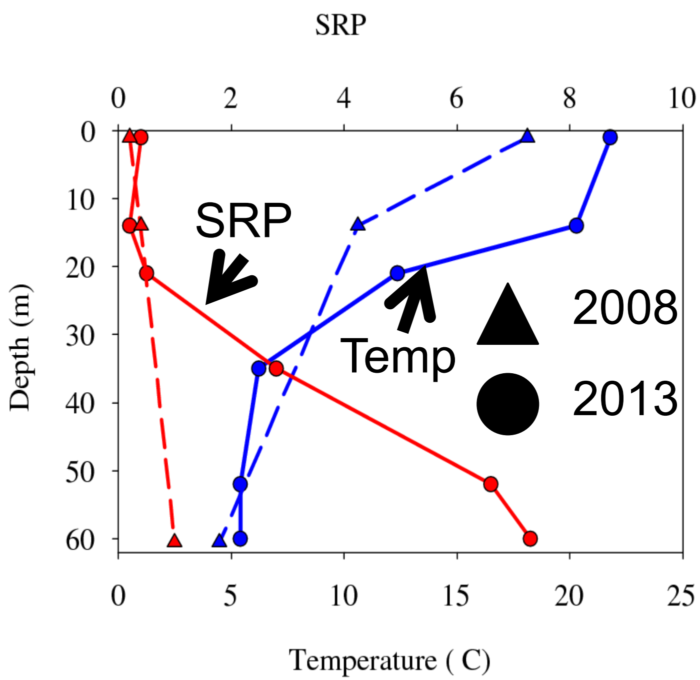


High res modeling

- Insights into NS/OS exchanges
- Spatial variation in growth response
- Scenario testing

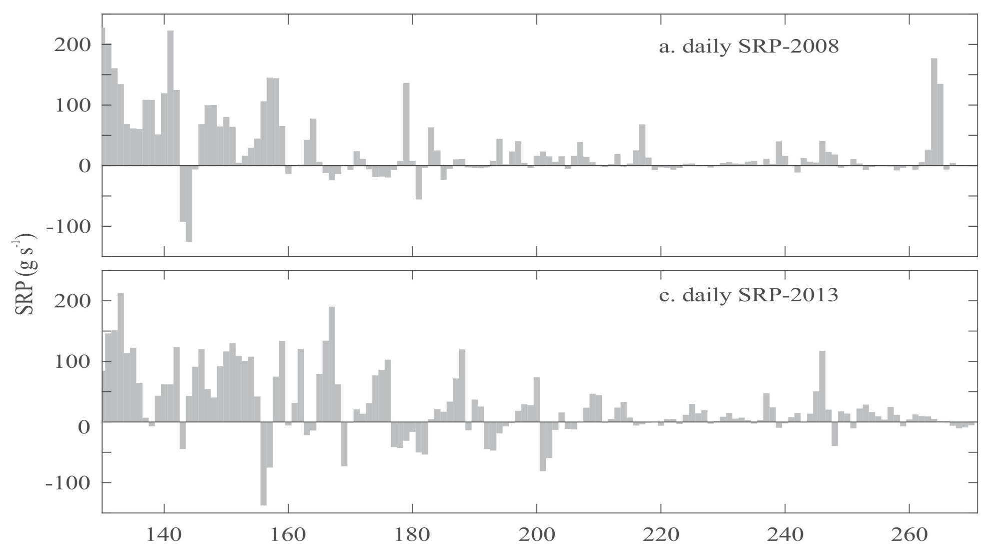
Valipour et al. 2016

Upwelling fluxes



- Hypolimnetic SRP reservoir
- Cause of inter-annual variation unknown

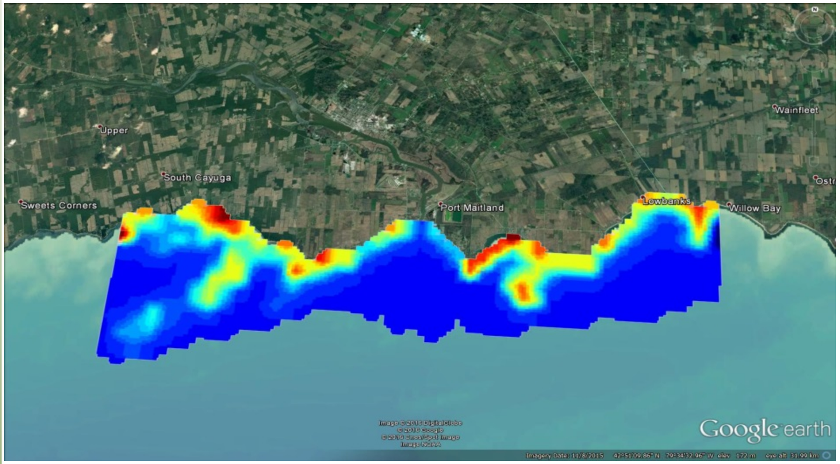
Offshore SRP flux
70 – 140 MT (May – July)
Grand River SRP load
50 – 90 MT (most in April)



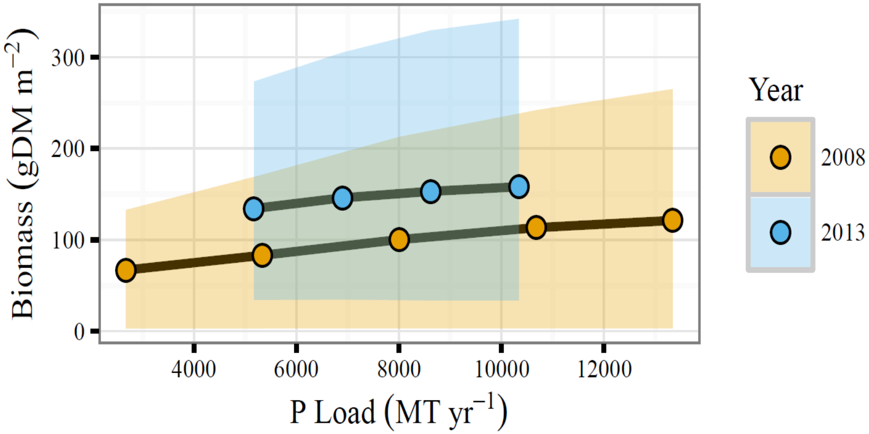
Valipour et al. 2016

Local vs lakewide – some nuances

2013 Base Scenario



Domain (0 – 6m integrated)

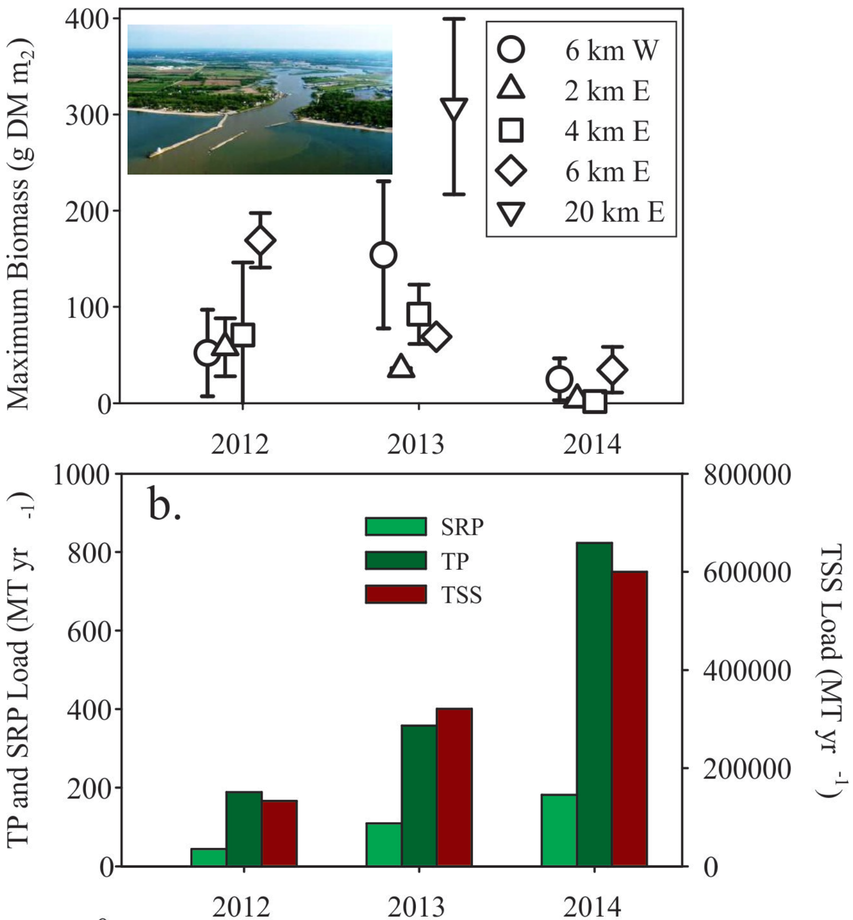


- Scenario 1: No River Input → Net Production ↑ 35 %
- Scenario 2: reduce offshore concentration to "0" → Net Production ↓ 13 %

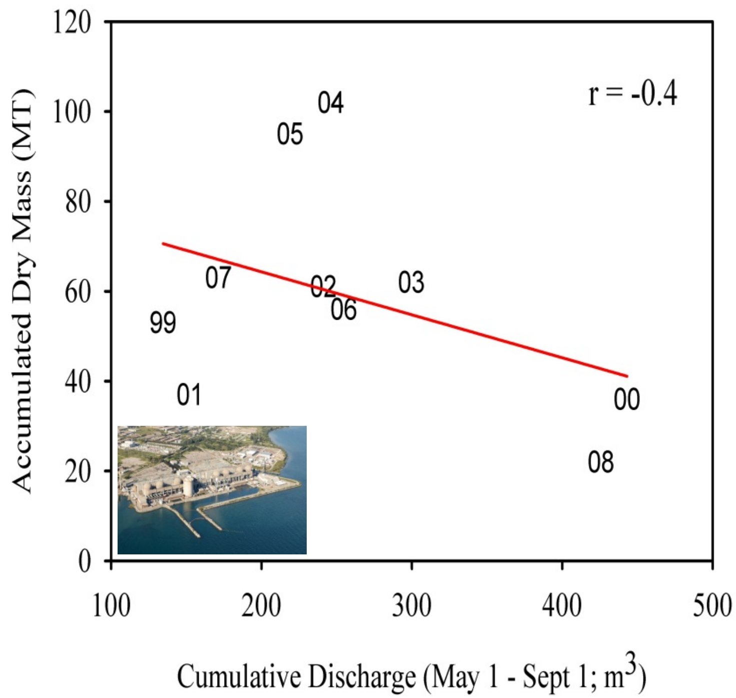
Valipour et al. 2016

Some confirmation…

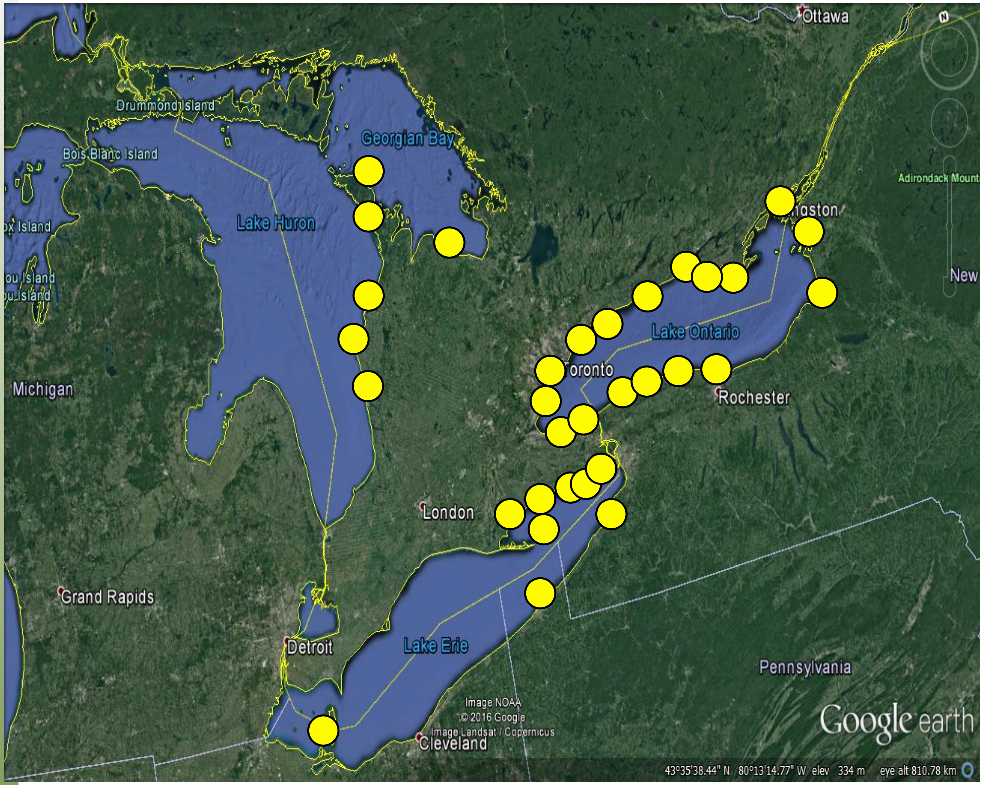
Lake Erie

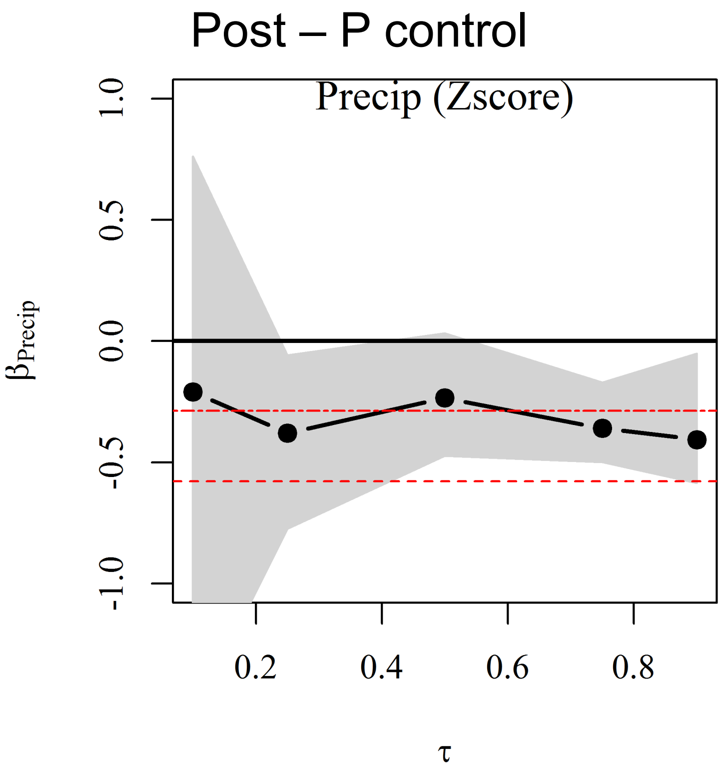


Lake Ontario



Some confirmation…





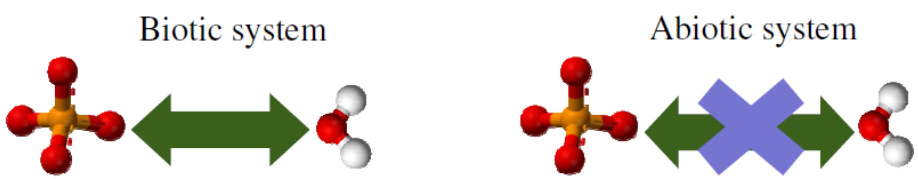
2,716 data records (1967 – 2015)

Depew et al. (in prep)

Upper quantiles (max biomass) respond negatively to ↑ precip

Sources and cycling of P - nearshore

- ^{18}O:^{16}O isotopes to identify and track cycling of PO_4 ($\delta^{18}O_P$)
- Based on disequilibrium of $\delta^{18}O_P$ and $\delta^{18}O_W$

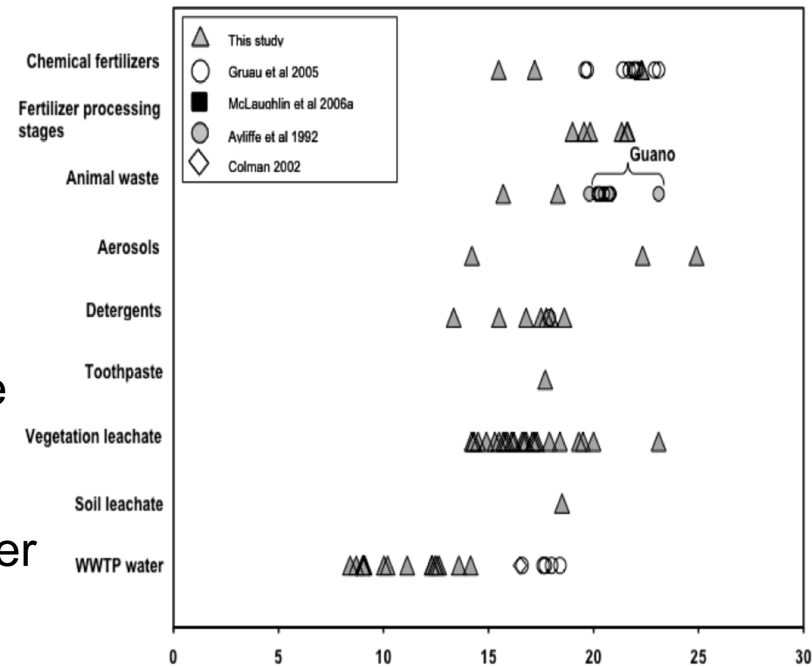


DOP recycling
Mixing w 2nd source

Mixing w 2nd source

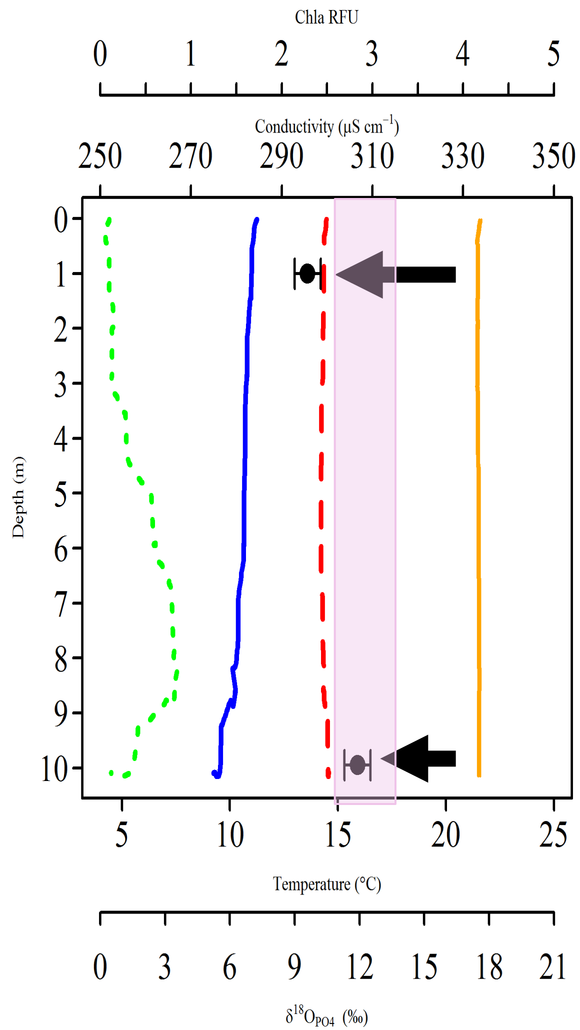
lower — $\delta^{18}O_w$ Eq — higher

Internal PPase cycling

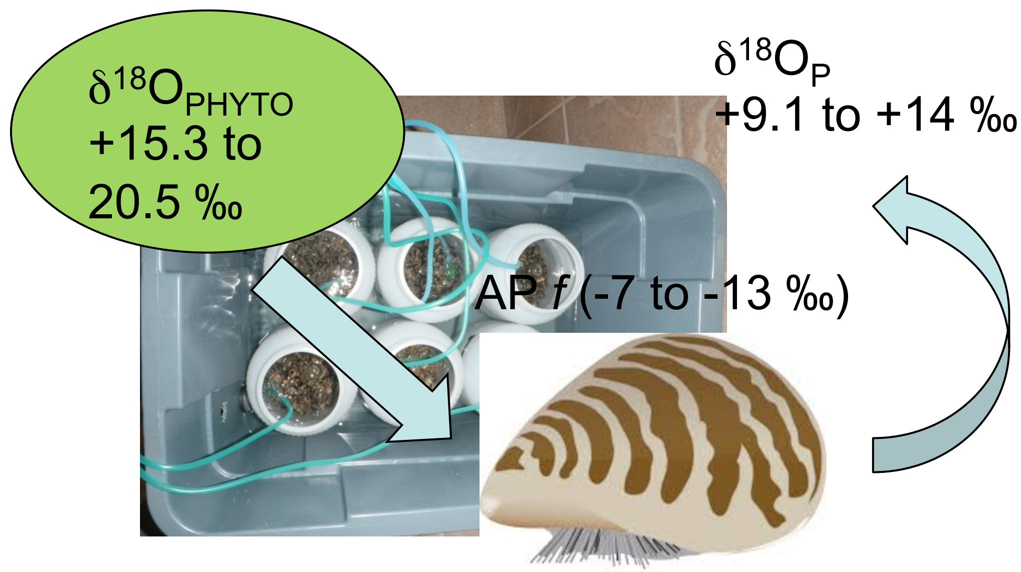


Young et al. 2009

Sources and cycling of P - nearshore

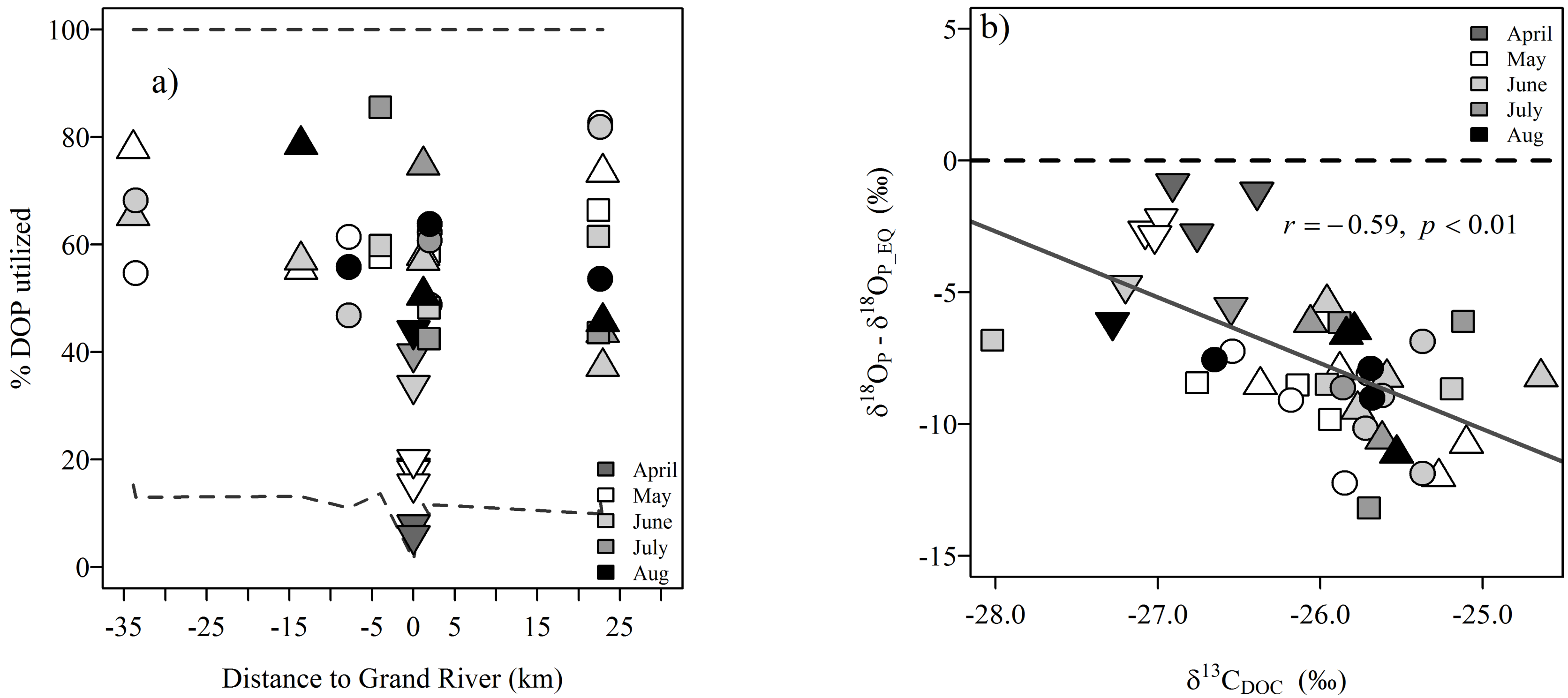


- $\delta^{18}O_P$ strong negative offset at surface
- $\delta^{18}O_P$ enriched near lake bed



Depew et al. in review

Sources and cycling of P - nearshore

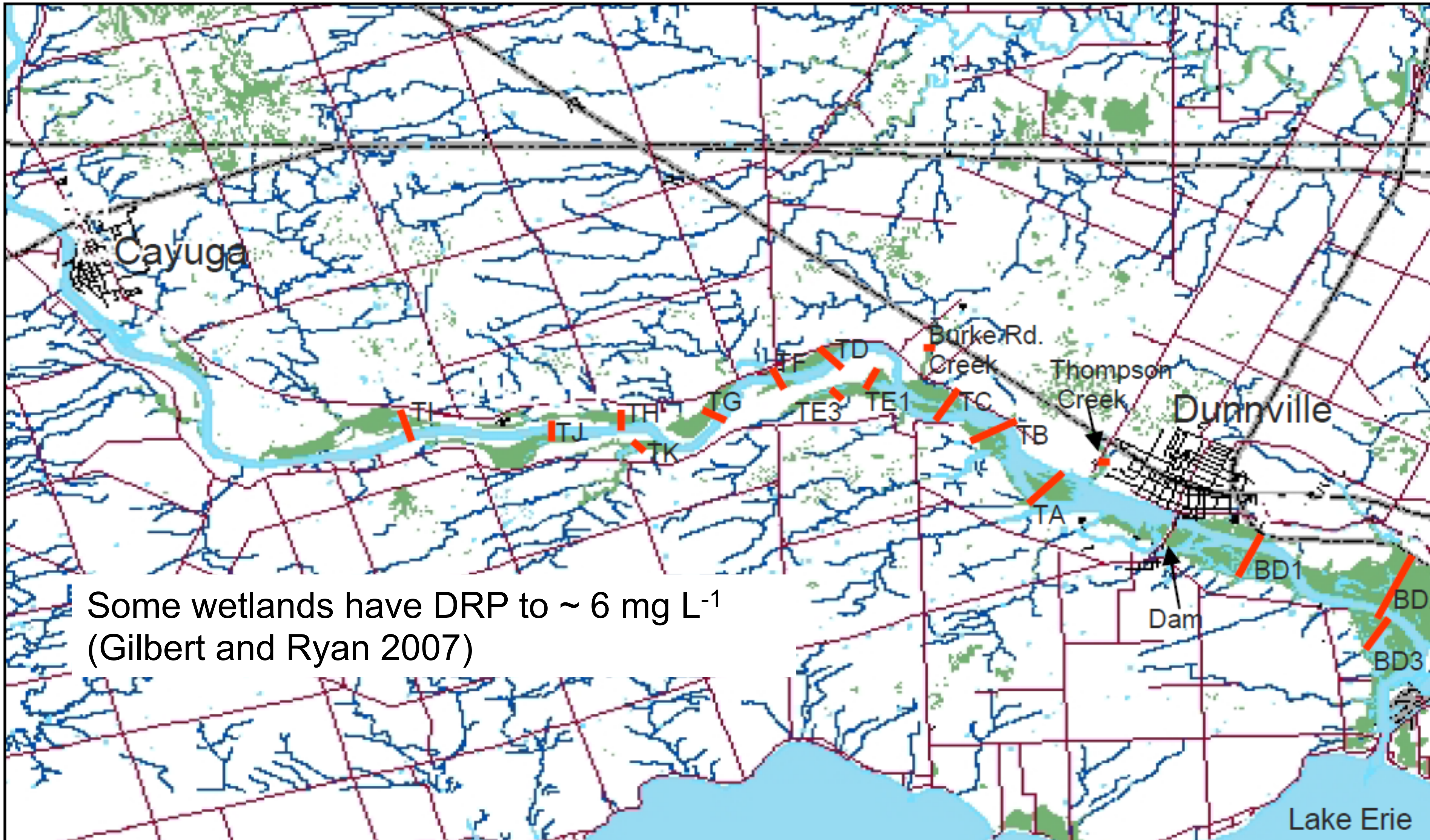


- DOP recycling dominant
- % DOP ↑ as DOC pool becomes more autochthonous

Depew et al. in review

Some emerging thoughts…

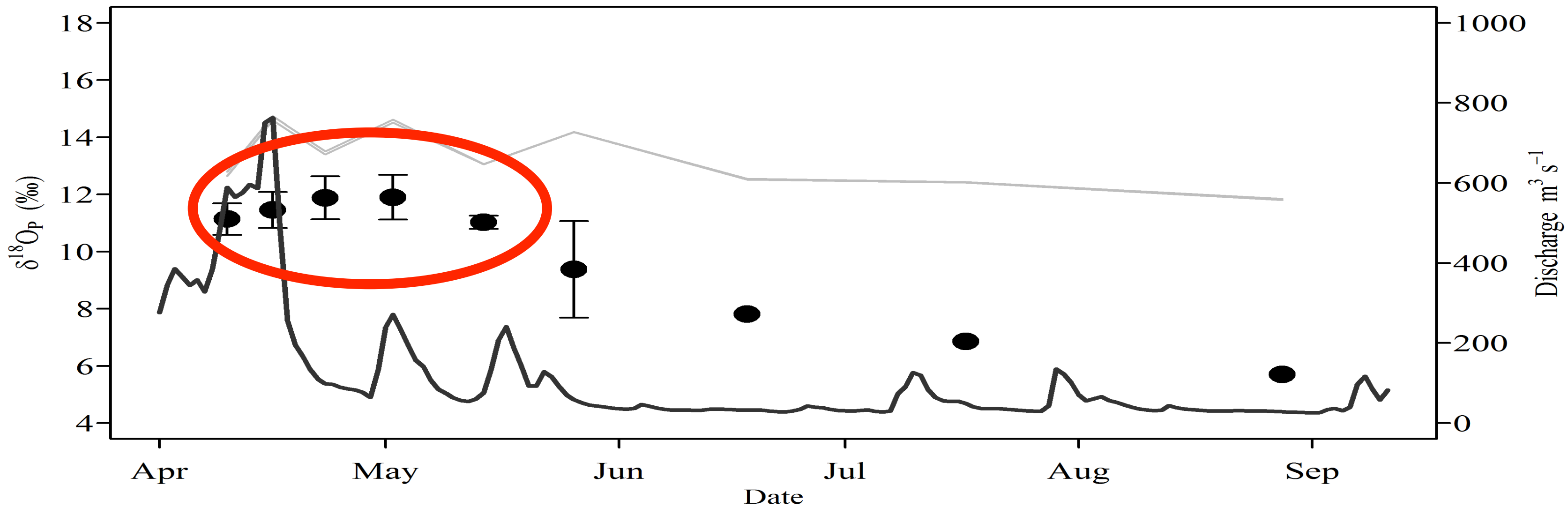
Are loads adequately reflected for modeling purposes?



Some wetlands have DRP to ~ 6 mg L^{-1}
(Gilbert and Ryan 2007)

Are loads adequately reflected for modeling purposes?

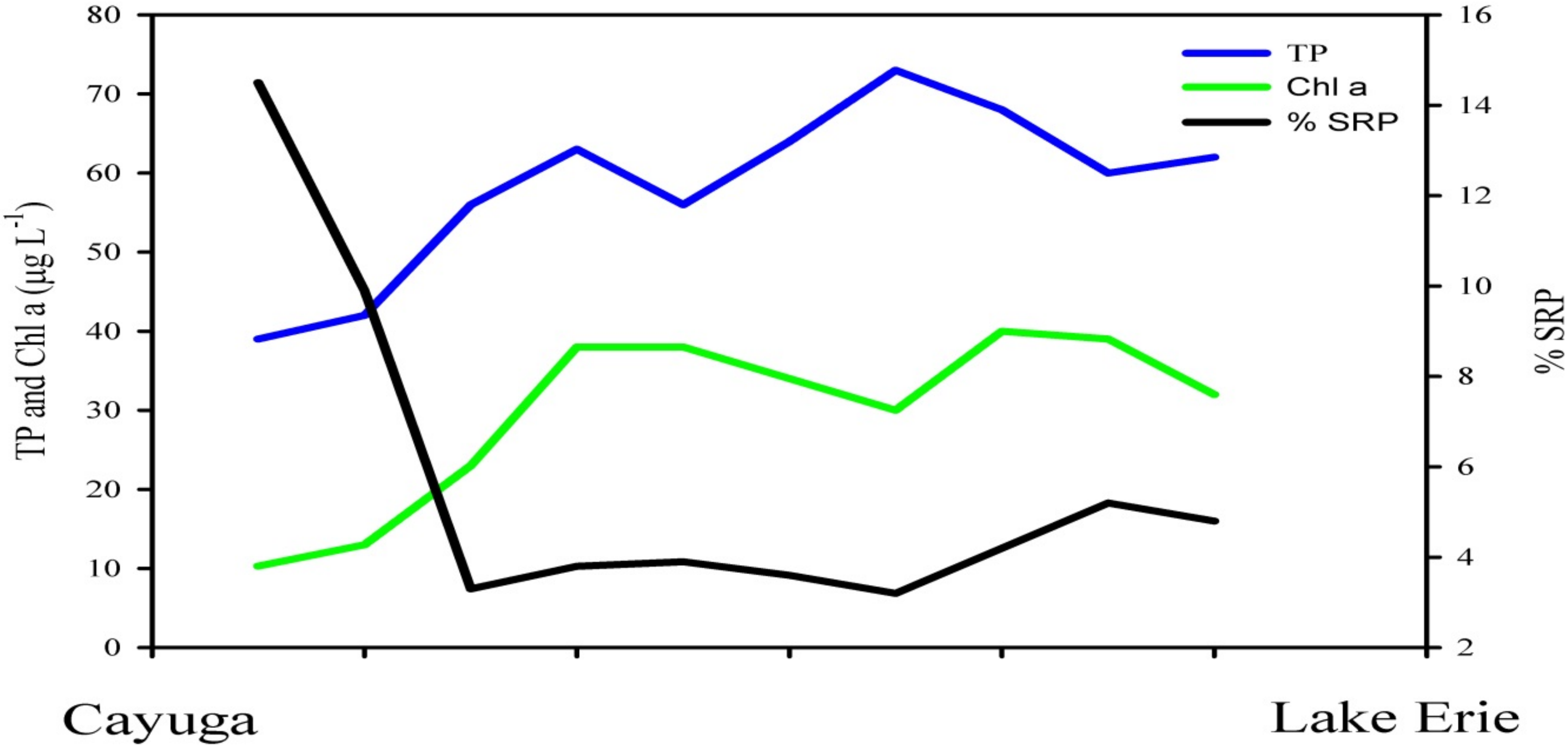
Mouth of Grand River



- $\delta^{18}O_P$ largely invariant during spring runoff period – unexpected from multiple sources
- $\delta^{18}O_P$ consistent with equilibrated soil P and decomposed OM

Depew et al. in review

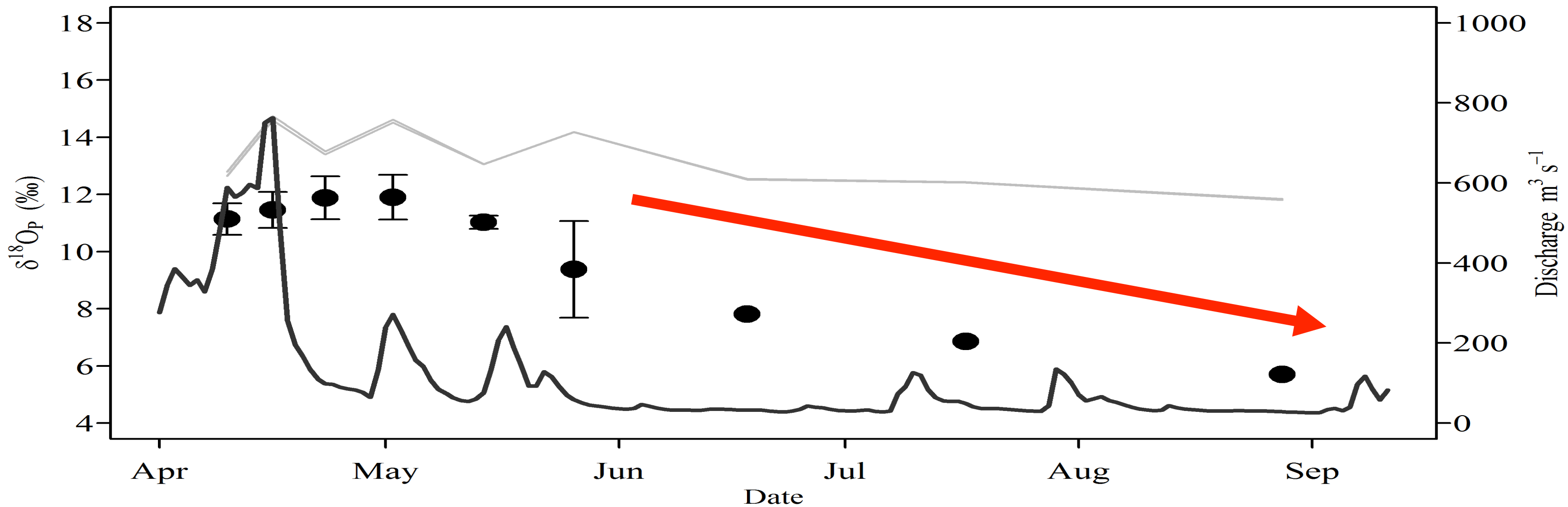
Are loads adequately reflected for modeling purposes?



Kuntz (2008)

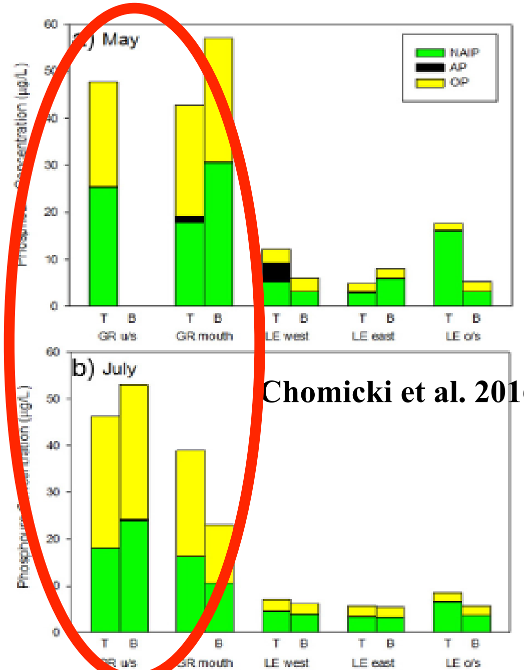
Are loads adequately reflected for modeling purposes?

Mouth of Grand River

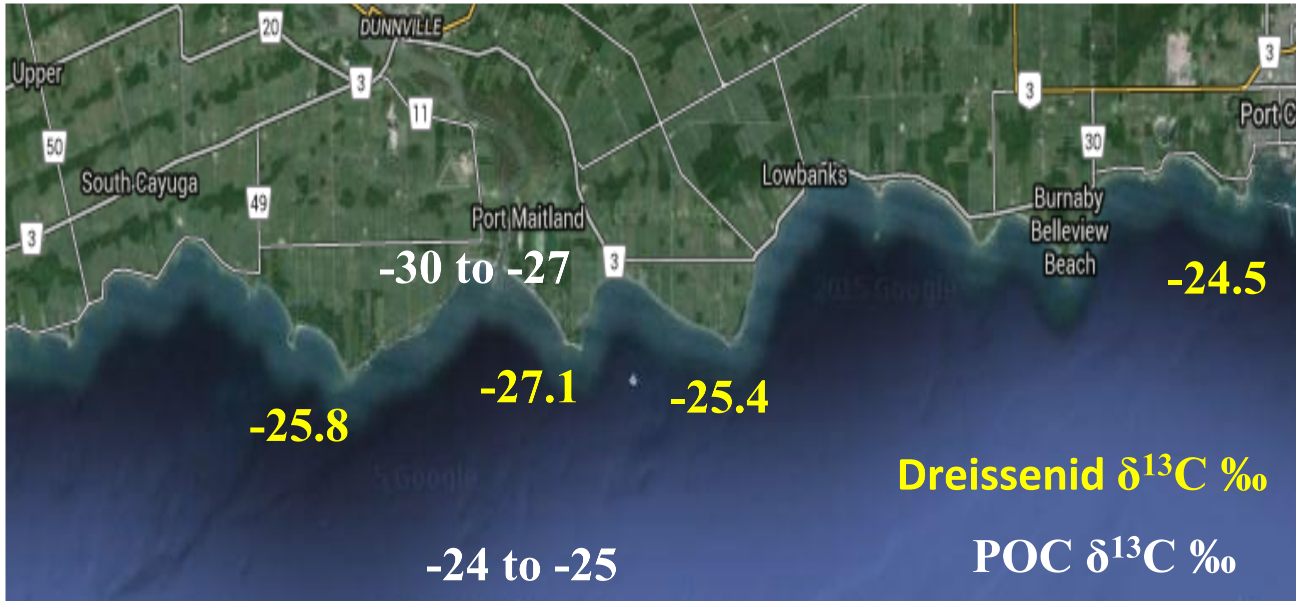


- $\delta^{18}O_P$ ↑ disequilibration during summer – only expected if DOP recycling is important

So what is actually entering the nearshore?



Chomicki et al. 2016

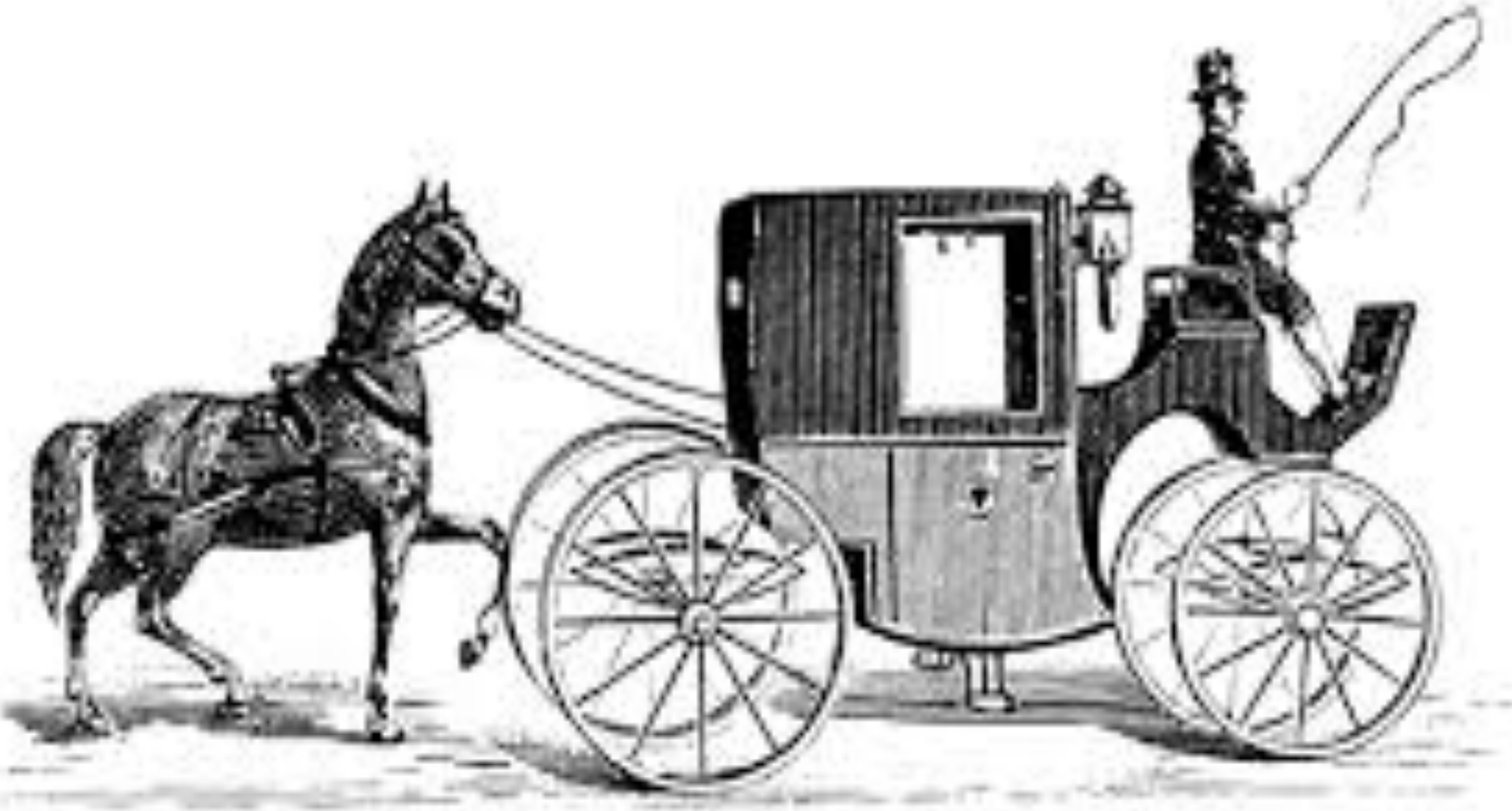


- 50 – 80 % of Org P exported during summer is phytoplankton
- δ^{13}C of dreissenids and POC suggests partial reliance on plankton exported from river

Summary

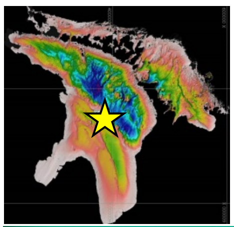
- Management of *Cladophora* blooms will require attention to lake – wide and local inputs, not just of SRP but also P in phytoplankton
- Models will require validation of key processes in order to fully separate impacts of competing (and variable) mechanisms of P supply
- Better understanding of the impact of watershed management on forms of P exported from rivers and the light climate in receiving waters is needed

This isn't working at all... I should warn others not to put their cart before the horse.



Guidance on ecosystem objective is critical

Lake Huron 2013
45 m depth



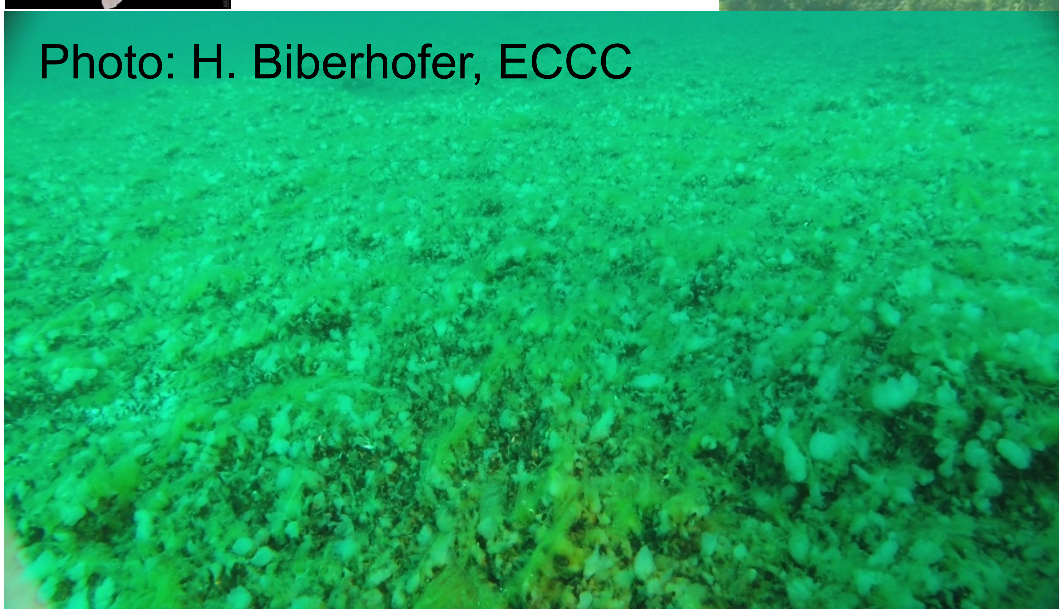
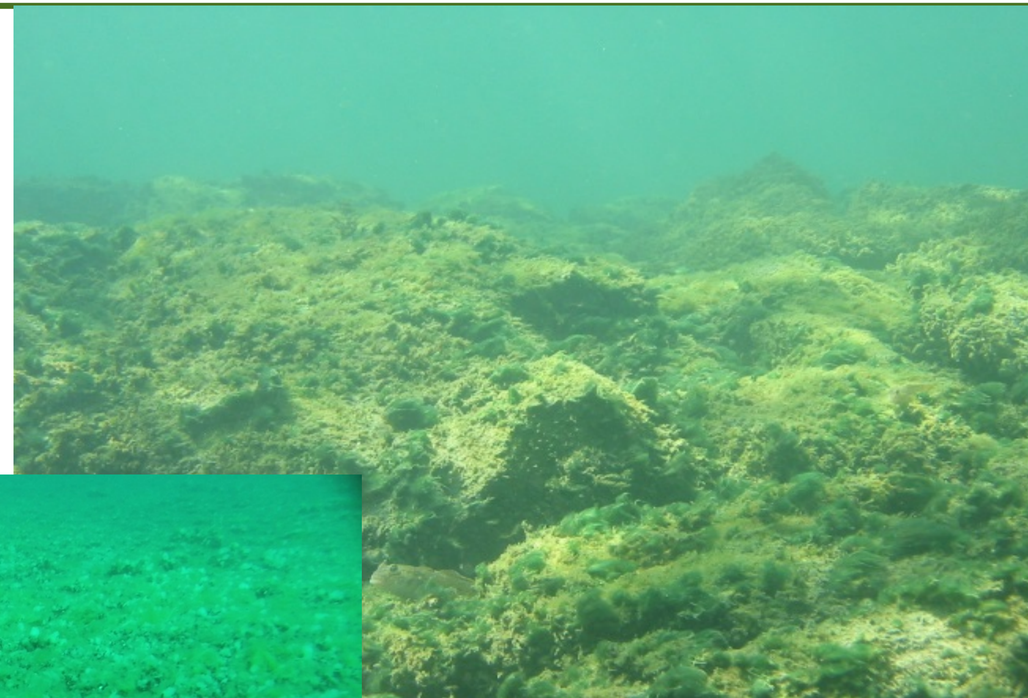


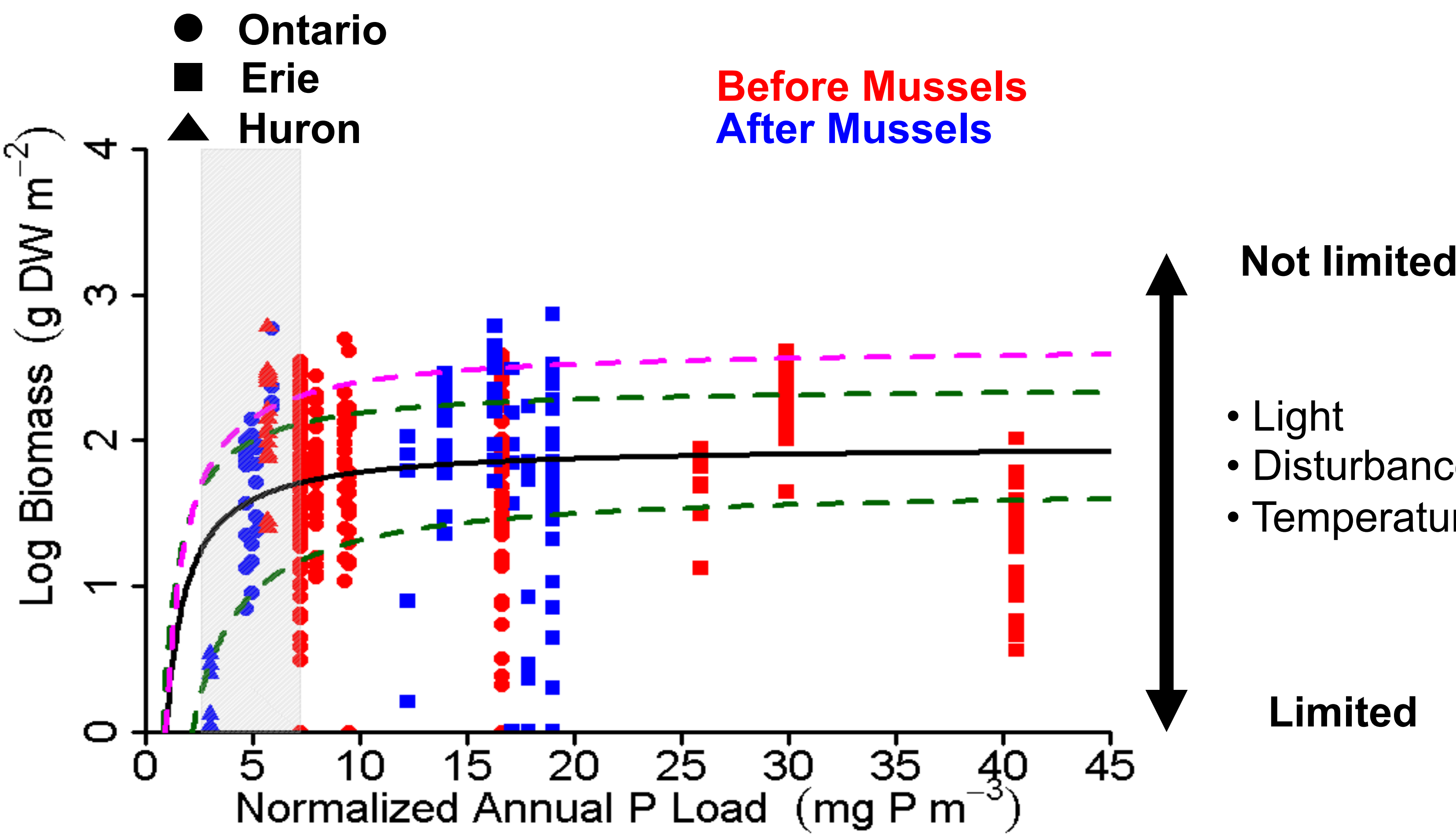
Photo: H. Biberhofer, ECCC



Lake Erie 2013
5 m depth


Thanks !

What should the objective be?



- Light
- Disturbance
- Temperature