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A synopsis of the Great Lakes Near shore Initiative attached algae program

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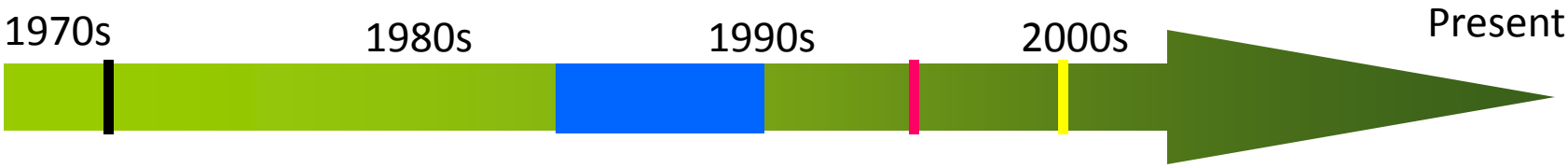
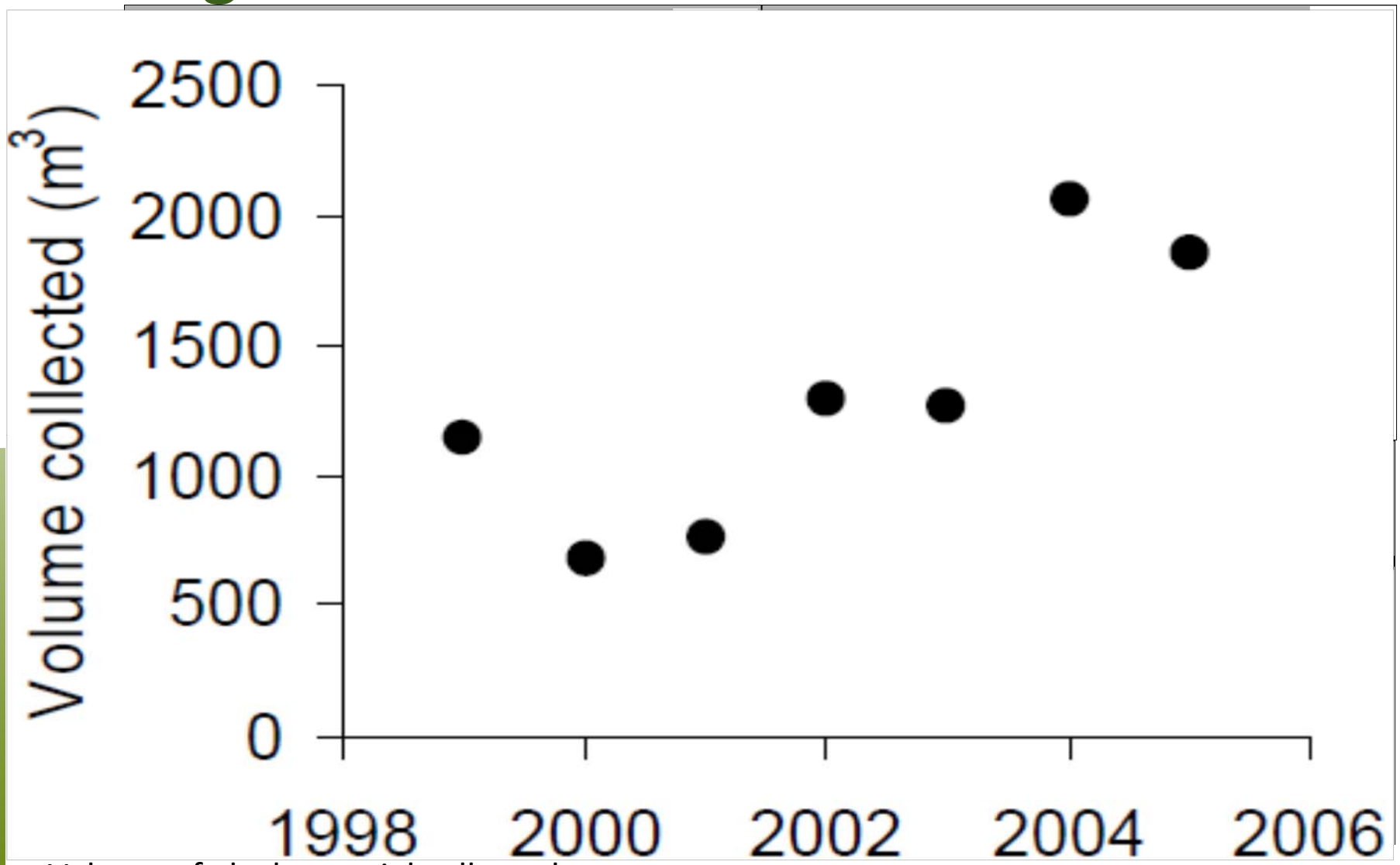
October 30 2013, Lake Erie Millennium Network Meeting

Background



- **Implementation of GLWQA, beginning of point source P control**
- **Dreissenid mussels invade L. Erie, P loads continue to decline**
- **Blooms of *Cladophora* recur along north shore of E. L. Erie**
- **Revival of *Cladophora* related research in E. L. Erie and elsewhere**

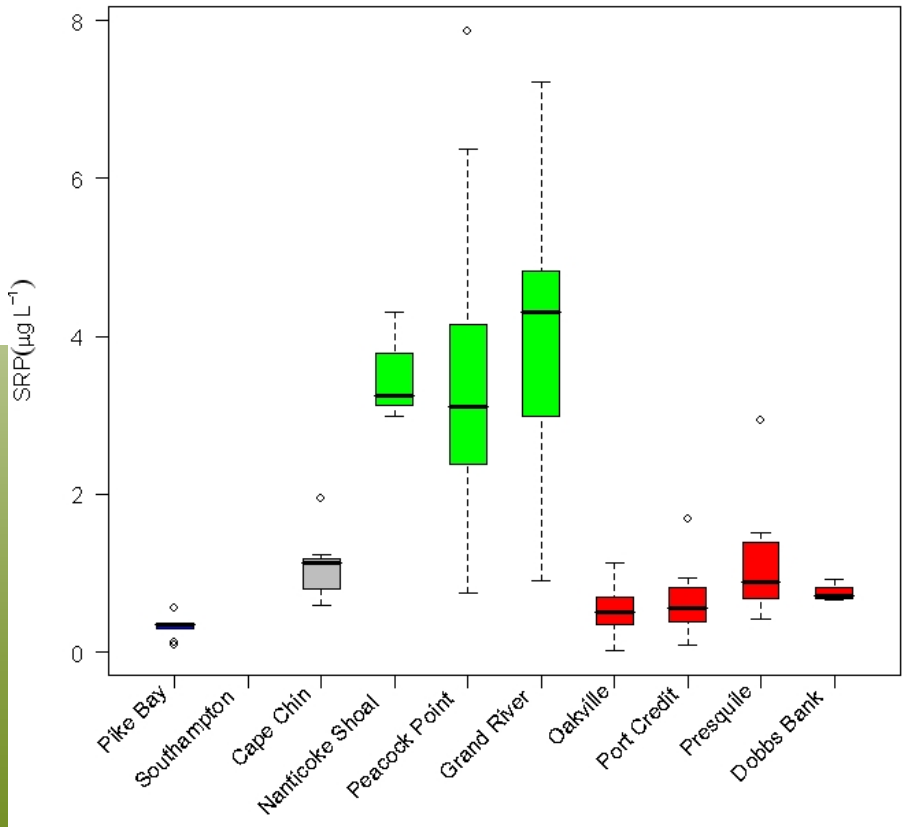
Background



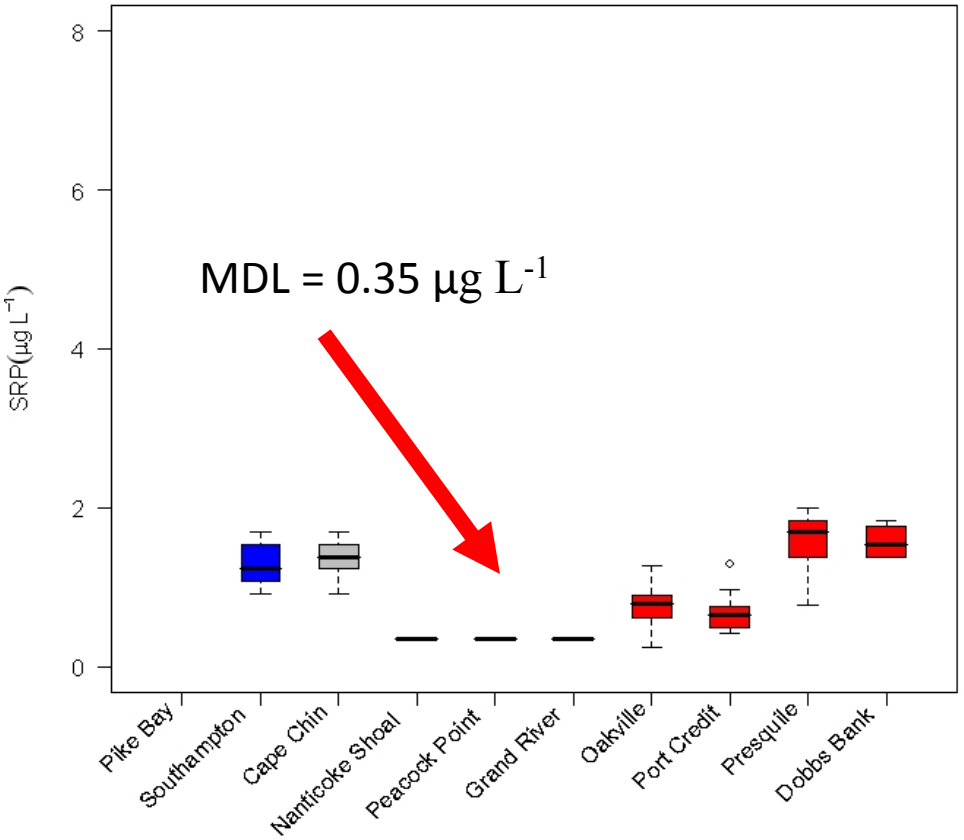
Volume of algal material collected on Intake screens: OPG Pickering.

Soluble Reactive P levels (2 – 10 m)

Apr – May 2005



July – Aug 2005



Present Status…

- Benthic algal blooms continue to impair near shore water quality, habitat and recreational uses.
- Near shore P levels not indicative of excessive nutrient loading.
- Temporal trends not easy to identify.
- Elucidation of causal factors has proven challenging, but evidence to-date supports the role of dreissenid mussels as key agents of change.

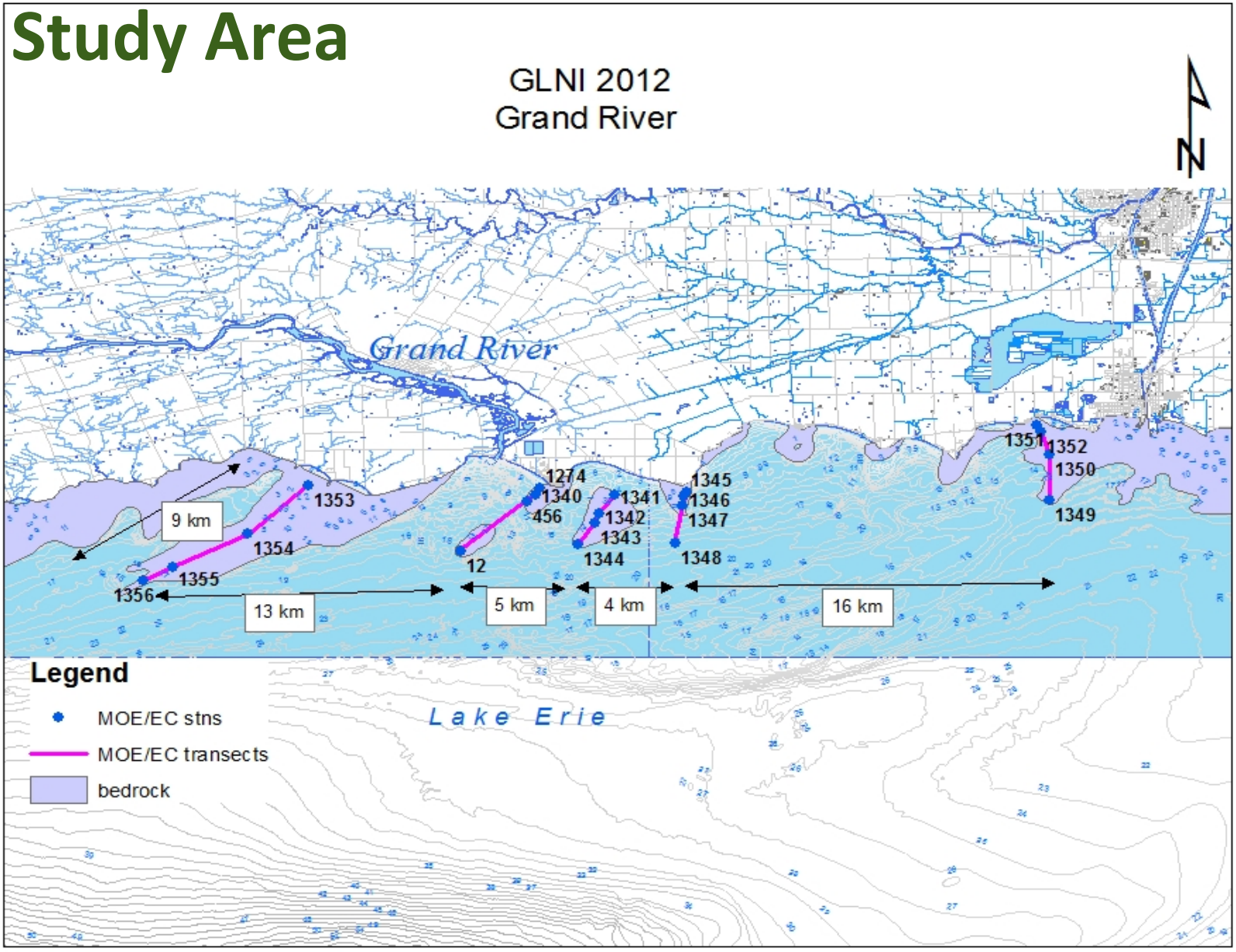
Key Question

What, if any nutrient target(s) may provide reasonable protection of near shore regions from recurrent blooms of benthic algae?

GLNI attached algae program objectives

- **Identify proximate sources of P contributing to nuisance blooms**
- **Quantify P processes in and above dreissenid beds in Eastern Lake Erie (R. Smith, J. Majarreis, U Waterloo)**
- **Reconstruct historical timeline of benthic algal resurgence in E. Lake Erie (K. Mueller, U Waterloo)**

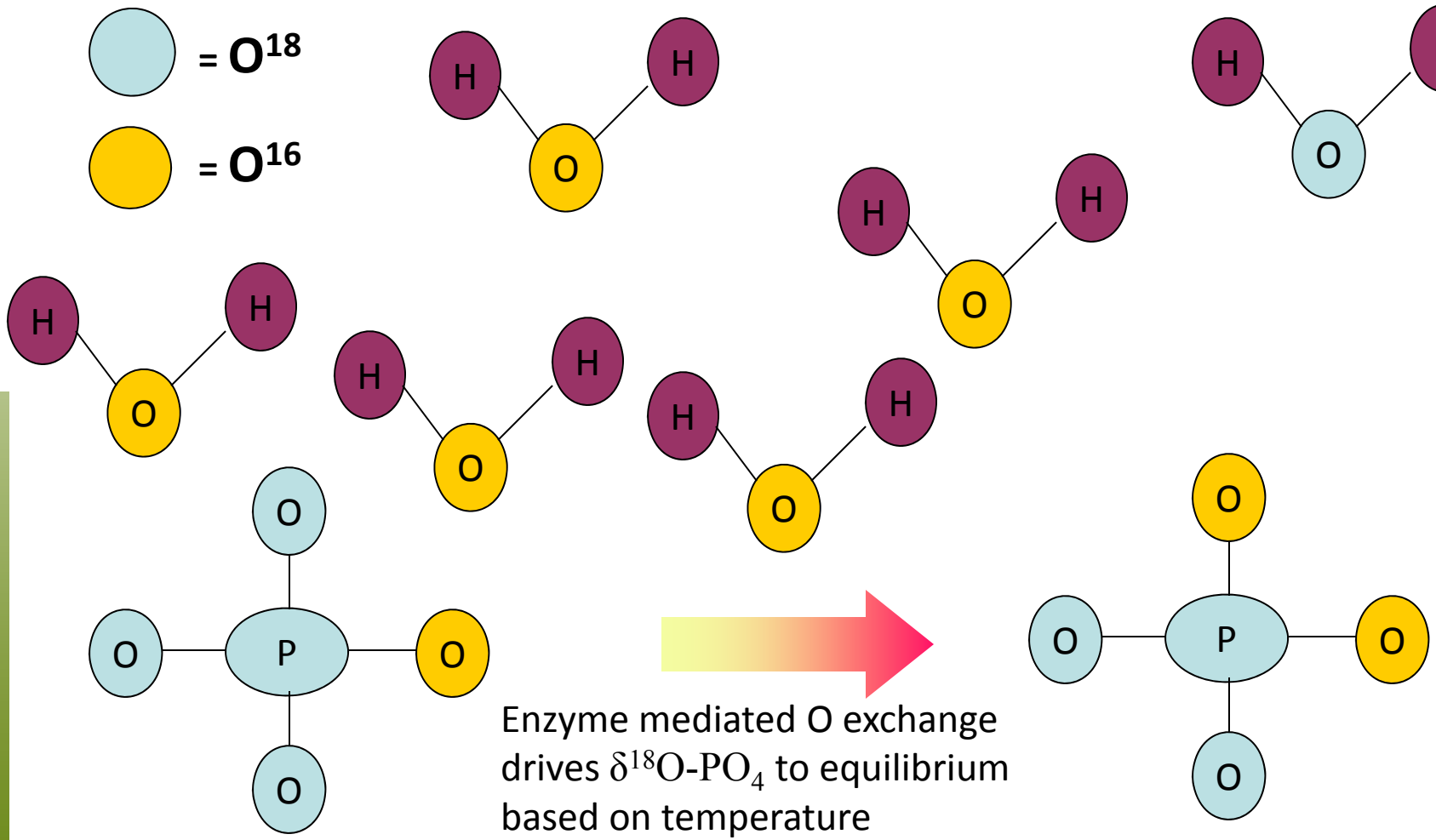
Study Area


GLNI 2012
Grand River
N
Grand River
1353
1354
1355
1356
9 km
13 km
1274
1340
456
12
5 km
1341
1342
1343
1344
4 km
1345
1346
1347
1348
16 km
1351
1352
1350
1349
Legend
MOE/EC stns
MOE/EC transects
bedrock
Lake Erie
0 2.5 5 10 Kilometers

Approach

- $\delta^{18}O_{PO4}$ to delineate P sources responsible for *Cladophora* blooms
  - SRP
  - *Cladophora* tissue
  - Dreissenid tissue
  - Dreissenid "wastes"
- Use of other isotope based tracers (e.g., DOC^{13}, $^{15}N^{18}O_3$) to constrain sources
- Standard physical and chemical water quality metrics with quantitative benthic survey data

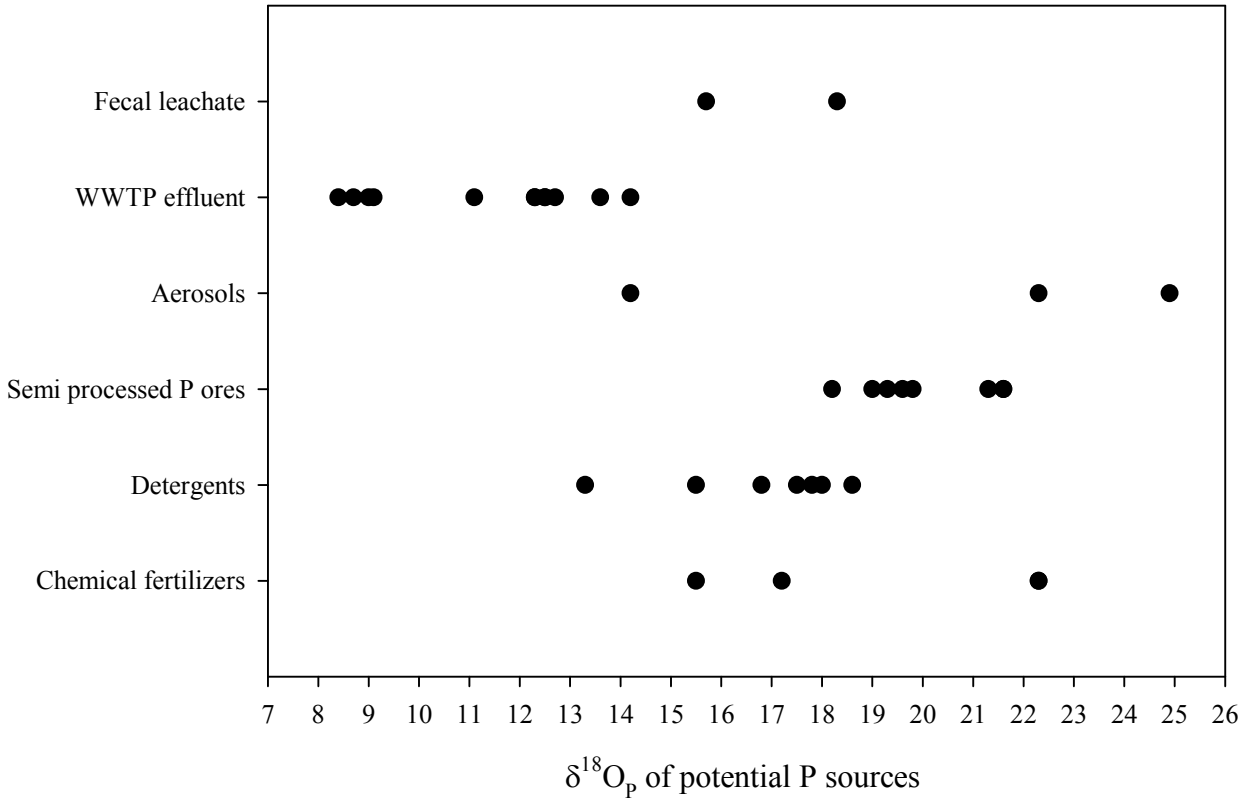
$\delta^{18}O - PO_4$ Primer



Enzyme mediated O exchange drives $\delta^{18}O$-PO_4 to equilibrium based on temperature

$\delta^{18}O - PO_4$ of different P sources

Do different P sources have different $\delta^{18}O - PO_4$?

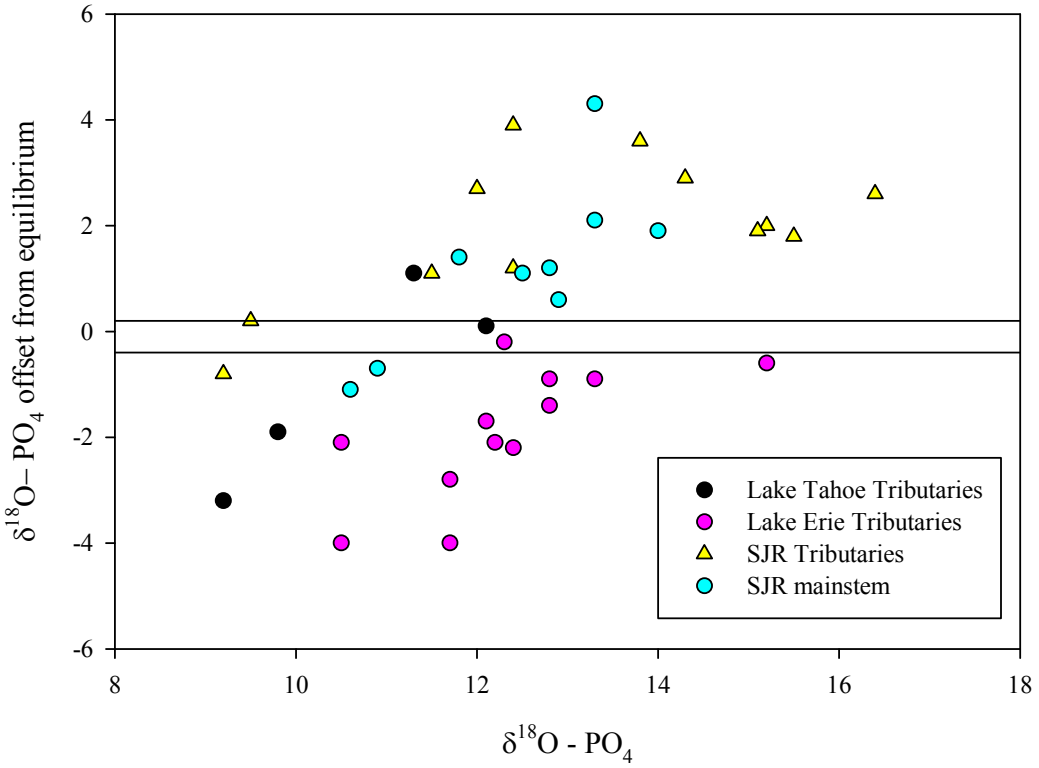


(Data from Young et al. 2009)

$\delta^{18}O - PO_4$ in different freshwaters

Does rapid P cycling overprint source signature too quickly?

- Isotopic disequilibrium observed in freshwaters to date
- Biological processing of P does not completely eliminate source signatures in freshwaters
- Indication of at least 2 distinct sources in C and W basin L. Erie



(Data: McLaughlin et al. 2006a,b, Elsbury et al. 2009, Young et al. 2009)

Progress to date

- Cons
  - Low SRP (< 1 µg L^{-1}) requires large volumes of lake water (> 100 L)
  - Organic matter contamination
  - Long sample processing time
- Pros
  - Suitable optimization of purification protocol for low SRP waters is close
  - Good recovery of free phosphate from *Cladophora* tissues without structural P components (e.g., hydrolyzed biological molecules) – does this reflect "recent" P sources?

Future outlook

- Cautious optimism – little good data for low P freshwater systems
- More samples – help to constrain the range of variability expected in $\delta^{18}O - PO_4$ in lake waters, *Cladophora* tissues and dreissenid wastes
- Need a better grasp of fractionation effects induced by extra-cellular enzymes and digestive processes