

Effect of Lime Rock Substrates on Stormwater Treatment Area Water Quality and Vegetation Characteristics

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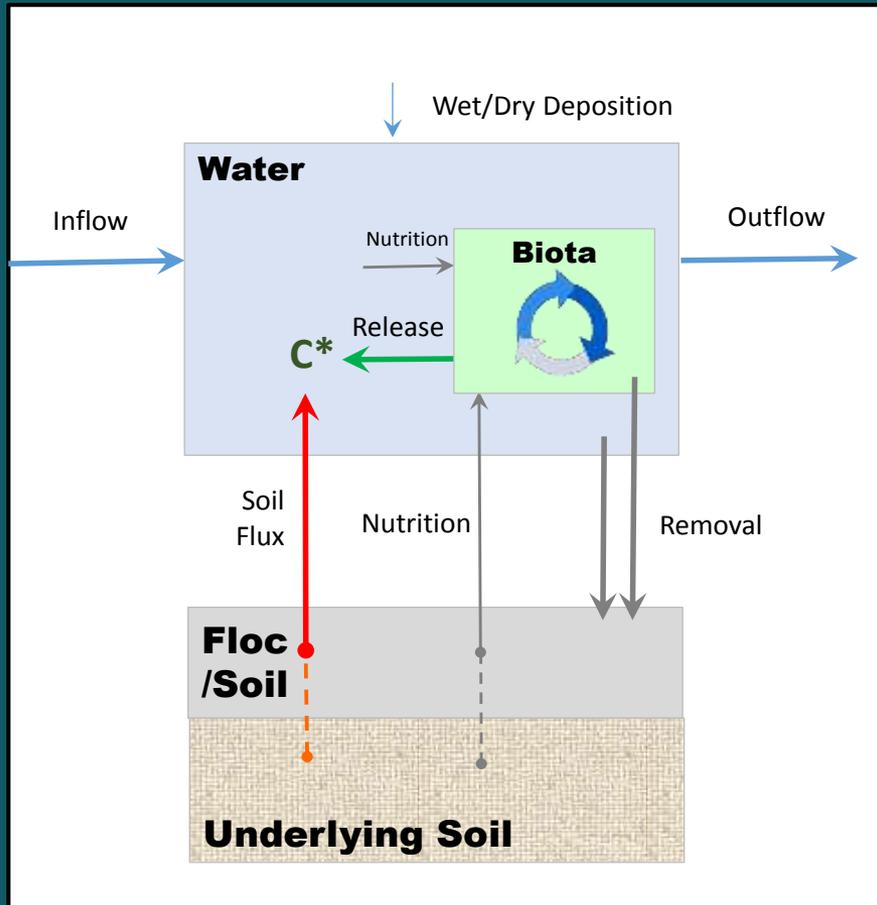


Outline

- Rationale for study of LR-based systems
 - Internal P Loading in the outflow region
 - Evidence of soil P mining by SAV
- “Capping” of P-enriched soils with limerock
 - Effects on water quality
 - Effects on periphyton and macrophyte development
- Implications of Findings

Rationale for studying LR-based treatment in STAs

Internal P Loading

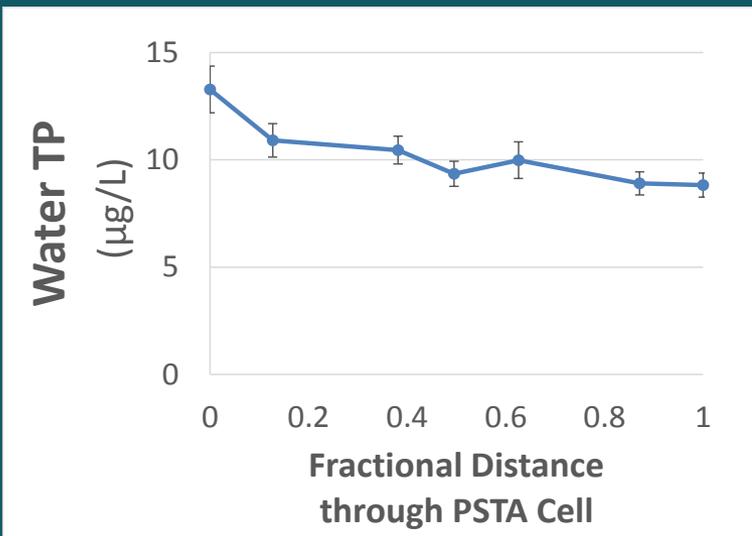


- Modeling study by Juston et al. (2013) showed SAV P mining from muck soils could account for ~1/3 of back-end C* (16ppb) in STA-2 Cell 3
- *Potamogeton* may be a primary "P miner", with rooting depths > 20 cm (through the floc, and into the underlying muck).
- However, direct experimental evidence still required



PSTA - Limerock Substrate Wetlands: Muck removal, or addition of a limerock “cap” over muck

- Overlying muck in the STA-3/4 PSTA cell was removed. Cell achieved outflow TP $\leq 13 \mu\text{g/L}$ for nearly 10 years
- Muck removal can be costly, however, and likely not suitable in STA locations with deep mucks.
- An alternative may be to cover existing muck soils with a LR cap.



Potential Benefits of Limerock Substrate or LR “Cap”

- Short-term incubations revealed that a LR cap can reduce flux from newly flooded, P-rich soils.
- Physical/chemical barrier to curtail soil P flux
- May promote calcareous periphyton growth, and limit macrophyte growth



Key Questions: *Can a LR cap improve P removal on P-rich soils? Is the improvement sustainable in the long-term?*

Important considerations include:

- Rooted macrophytes' ability to access soil P below a LR cap
- Availability of fluxed or "macrophyte - mined" P to benthic and/or epiphytic periphyton. Will fluxed P inhibit periphyton growth?
- Whether the nutritional status of the SAV/periphyton affect the mass and P content of accreted sediments?

Mesocosm-scale Investigation

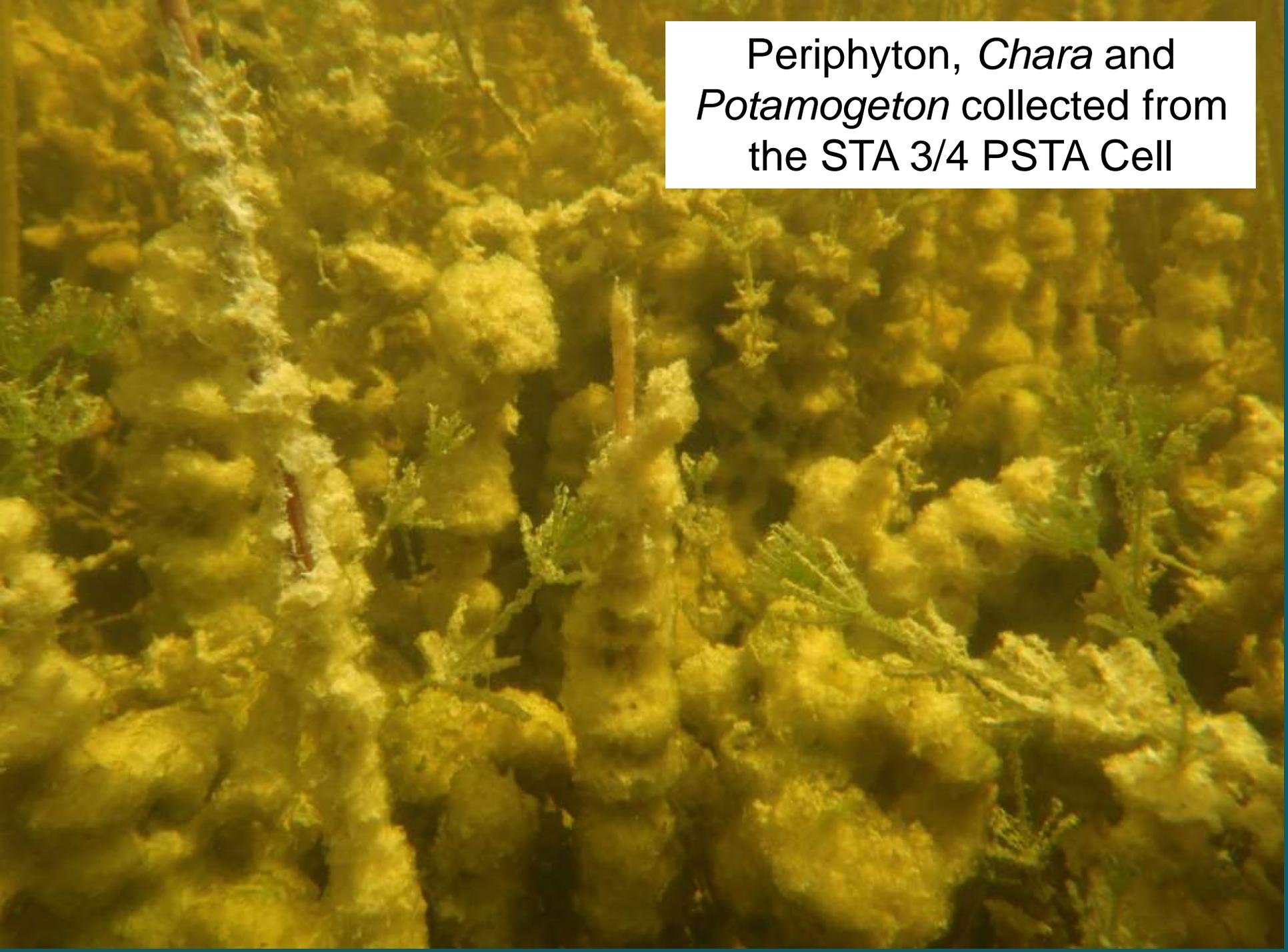
- P-enriched muck (679 mg/kg) capped with 0, 5, 15 cm LR
- Flow through operation: 5-day HRT using STA outflow water
- Stocked with SAV and periphyton from STA 3/4 PSTA Cell



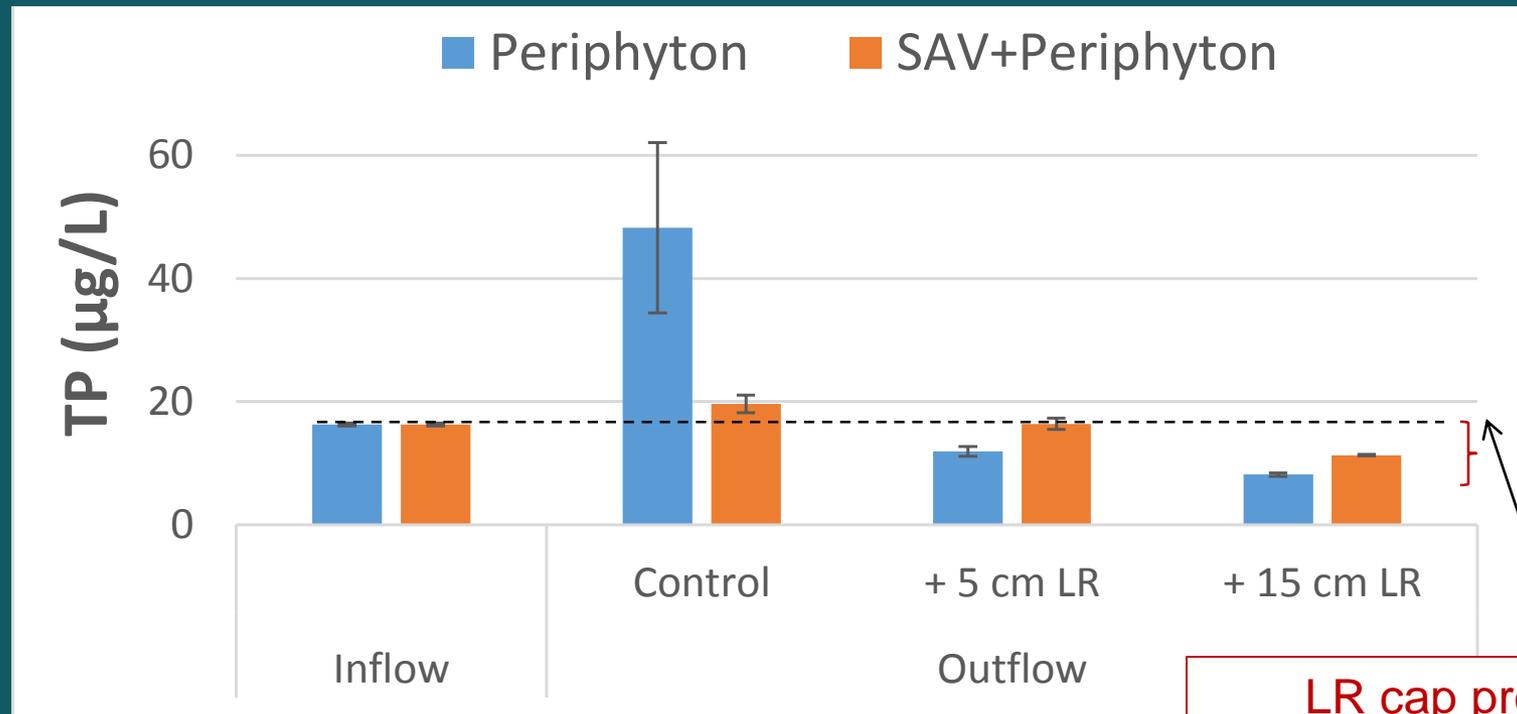
Periphyton, *Chara* and
Potamogeton collected from
the STA 3/4 PSTA Cell



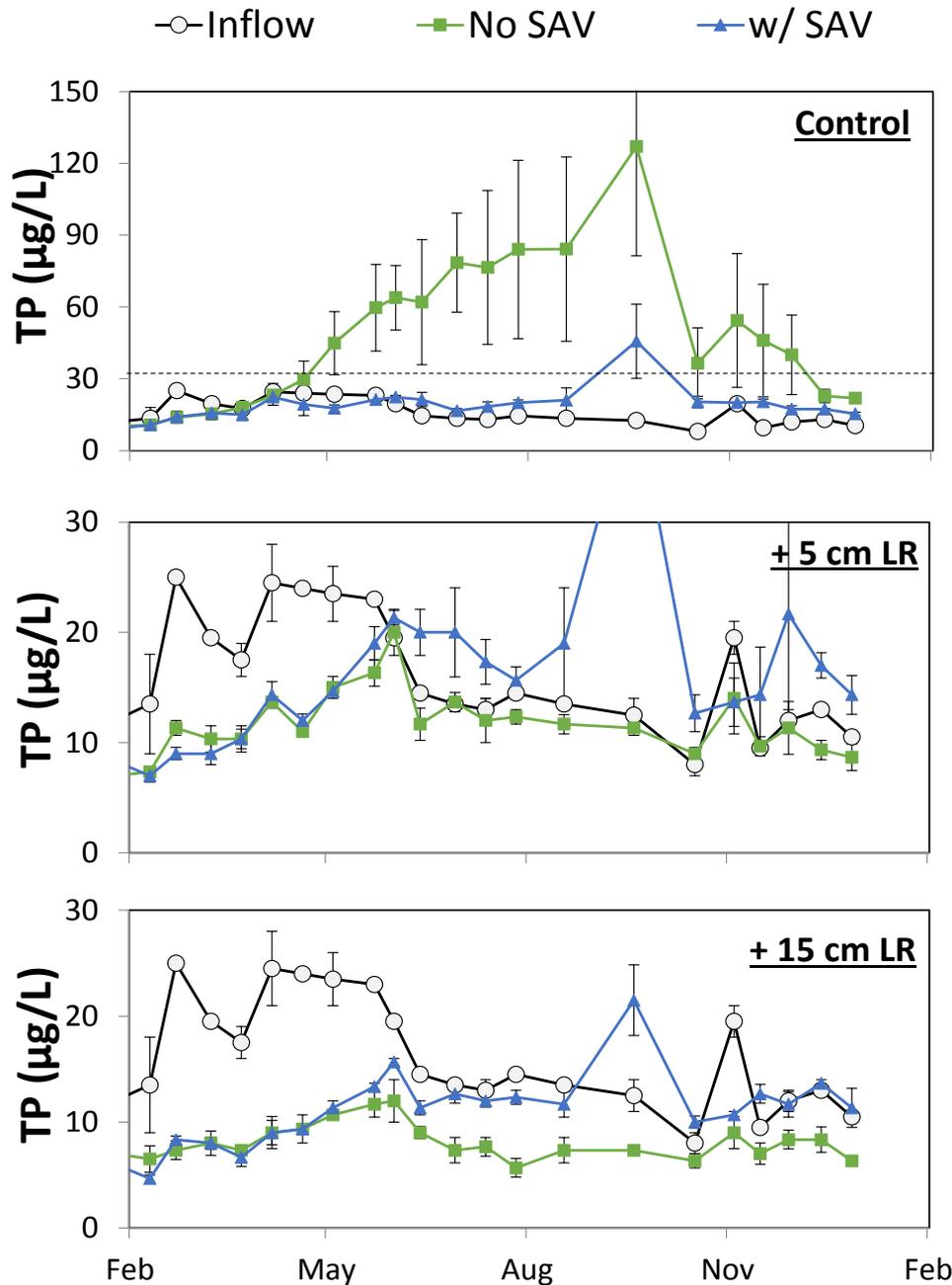
Periphyton, *Chara* and
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LR Cap is effective at improving long-term P removal performance in mesocosms



LR cap providing additional polishing of "typical" STA outflow waters

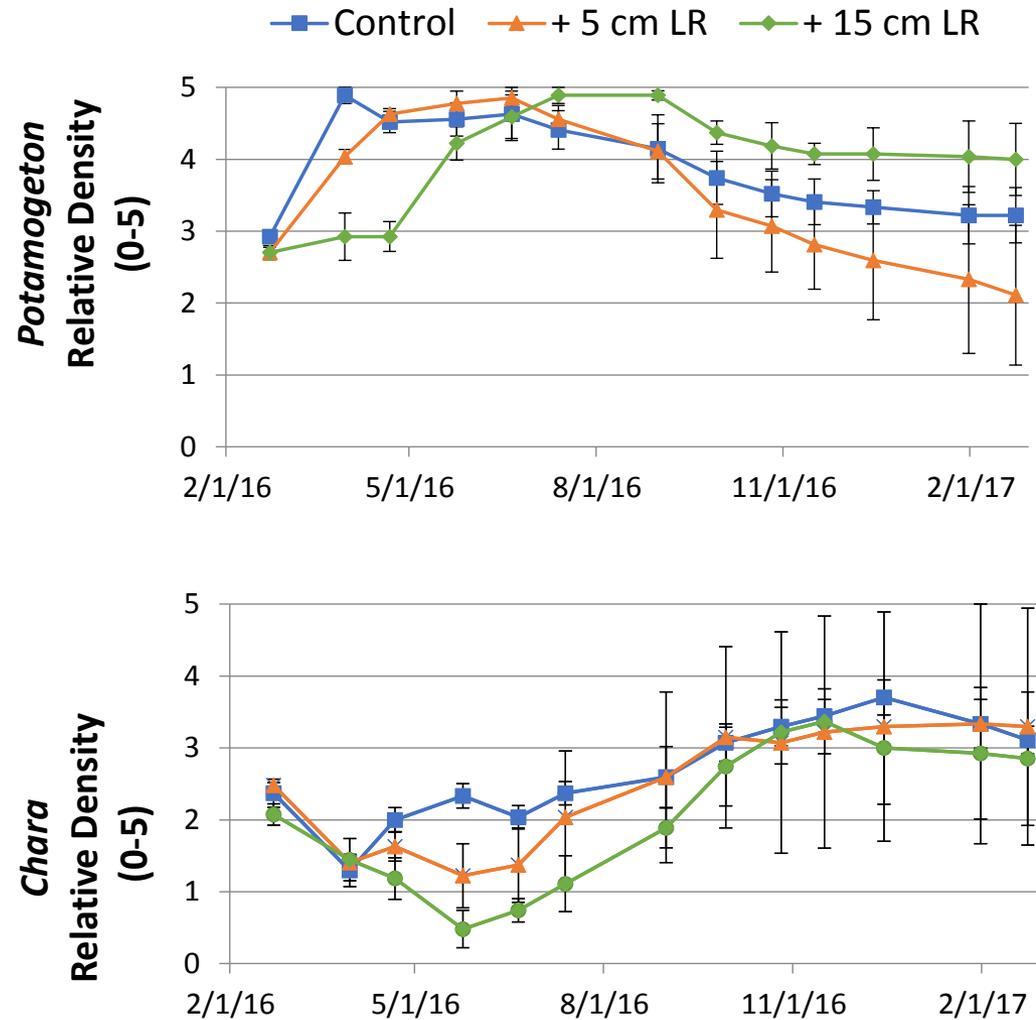


Effect of SAV on P Removal Performance

- Clear benefit of SAV without LR (Control)
- Negative effect of macrophytes in the LR treatments
- Lowest TP achieved on +15 cm LR without SAV

Temporal changes in SAV relative density

- *Potamogeton* (rooted species) growth initially restricted by LR cap. **Roots eventually penetrating LR cap?**
- *Chara* (non-rooted species) growth initially restricted by LR cap



After 5 and 11 months, tissue P content of *Potamogeton* and epiphytes evaluated



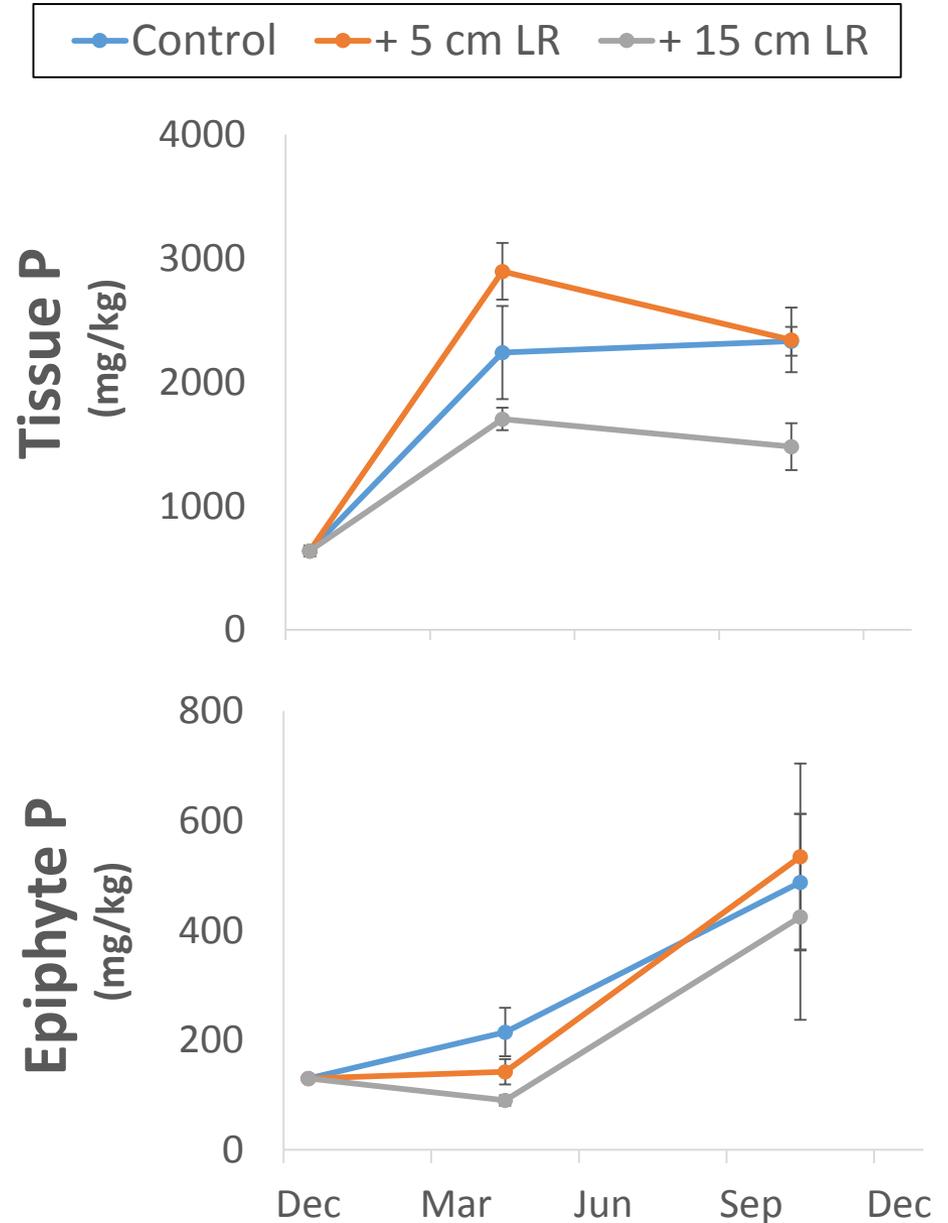
Control, 0LR

+5 cm LR

+15 cm LR

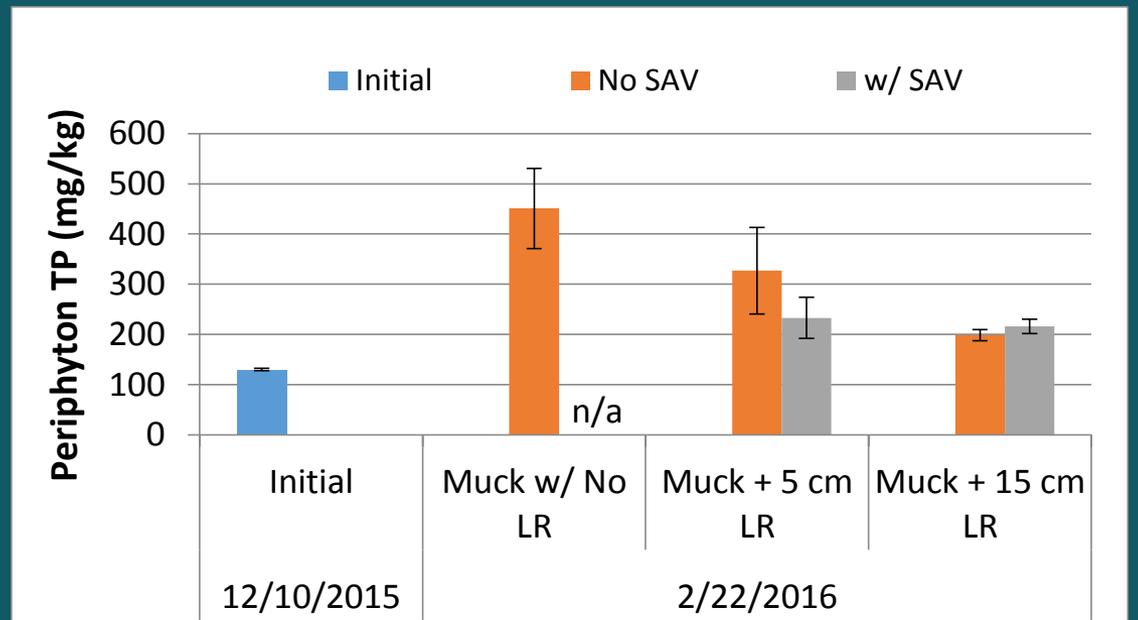
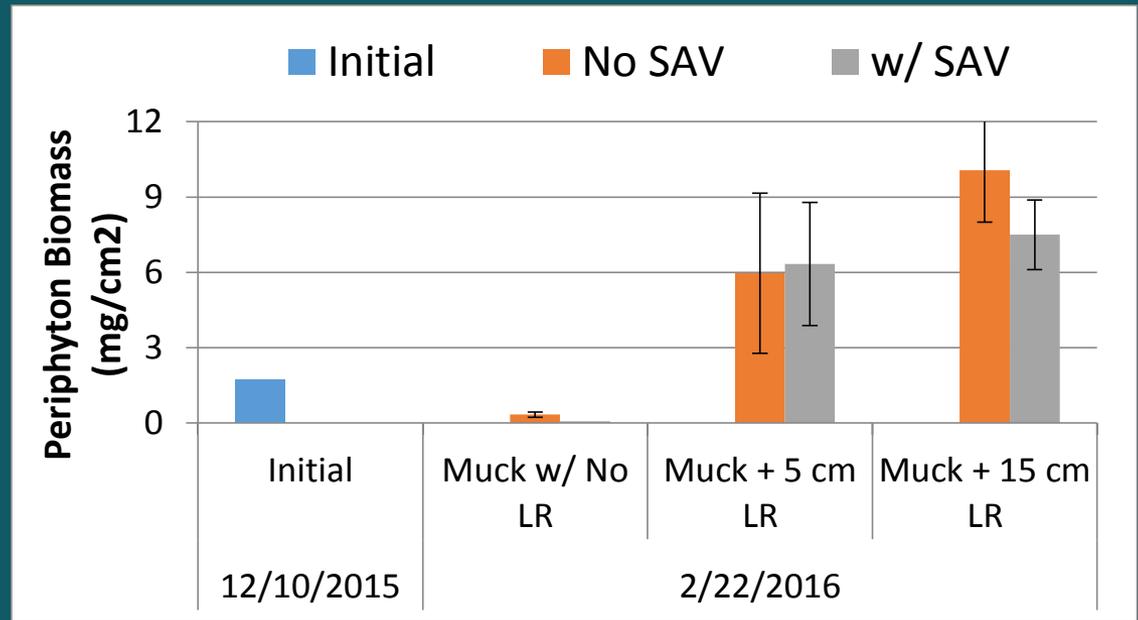
Evidence of *Potamogeton* accessing soil P

- *Potamogeton* tissues increased in P content
- 15 cm LR limited SAV P-enrichment
- Epiphyte enrichment delayed, but increasing over time



Benthic periphyton response to LR caps

- After 8 weeks, periphyton had grown in, and increased in P content (sourced from muck?)
- LR cap improved periphyton biomass, and resulted in lower tissue P than controls



Synopsis: Implications of LR Substrates for STAs

- Initial mesocosm results show LR cap can be effective in suppressing flux from high-P soils, and help achieve lower outflow TP
- After 12 months of flow-through operations, P removal to ultra-low levels continues in treatments with a LR cap and no SAV.
- Longer-term operation of this experimental platform will enable us to define sustainability: (i.e., will the nutritional status of the macrophytes/periphyton affect the mass and P content of accreted sediments?)
- Feasibility and cost-effectiveness of large-scale LR capping remains unknown