EFFECTS OF WATER DEPTH ON PERIPHYTON-BASED TREATMENT SYSTEMS

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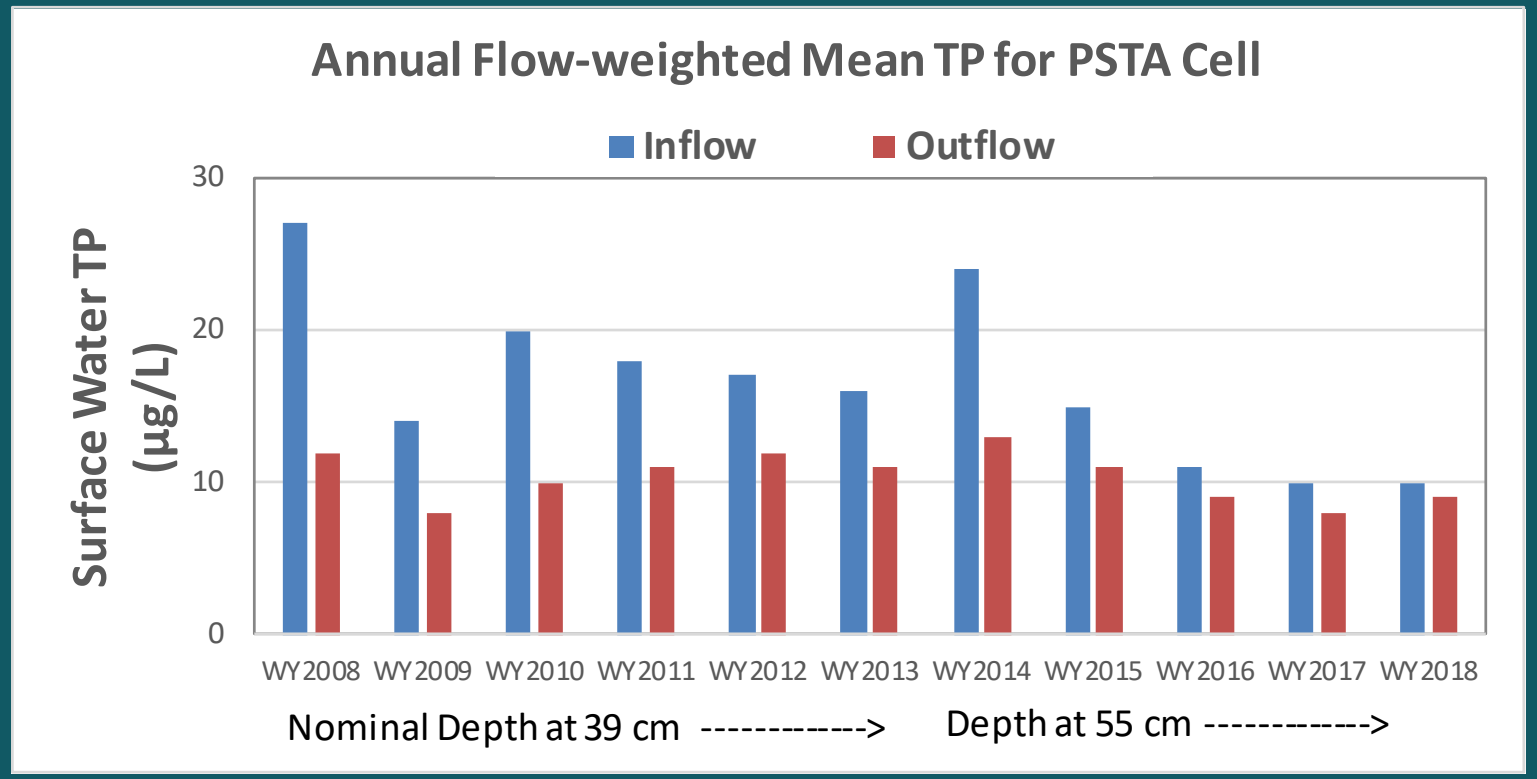
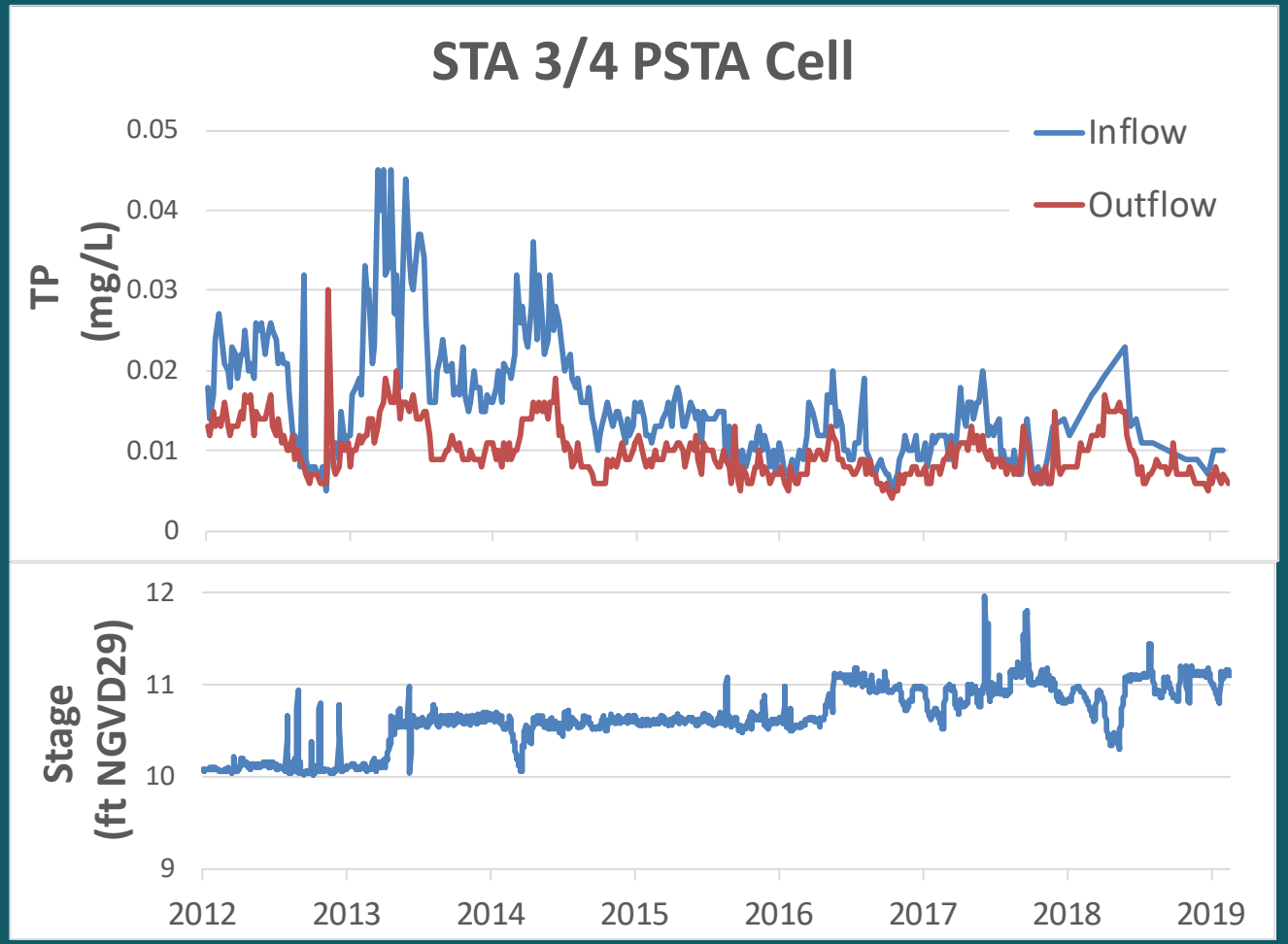
Periphyton-based Stormwater Treatment Areas (PSTA)

- PSTA treatment systems have been tested at a variety of scales, with mixed success in terms of achieving low outflow TP levels
- 40 ha “PSTA Cell” in STA-3/4 represents the largest and longest running example of the PSTA technology
- The PSTA Cell lowered TP to ≤ 13 µg/L at mean water depths ranging from 39 cm (1.3 ft) to 67 cm (2.2 ft)
- Other factors varied, however, before and after changes in water depth:
  - changes in inflow P concentration across periods
  - potential differences in seepage influence at the two stage levels

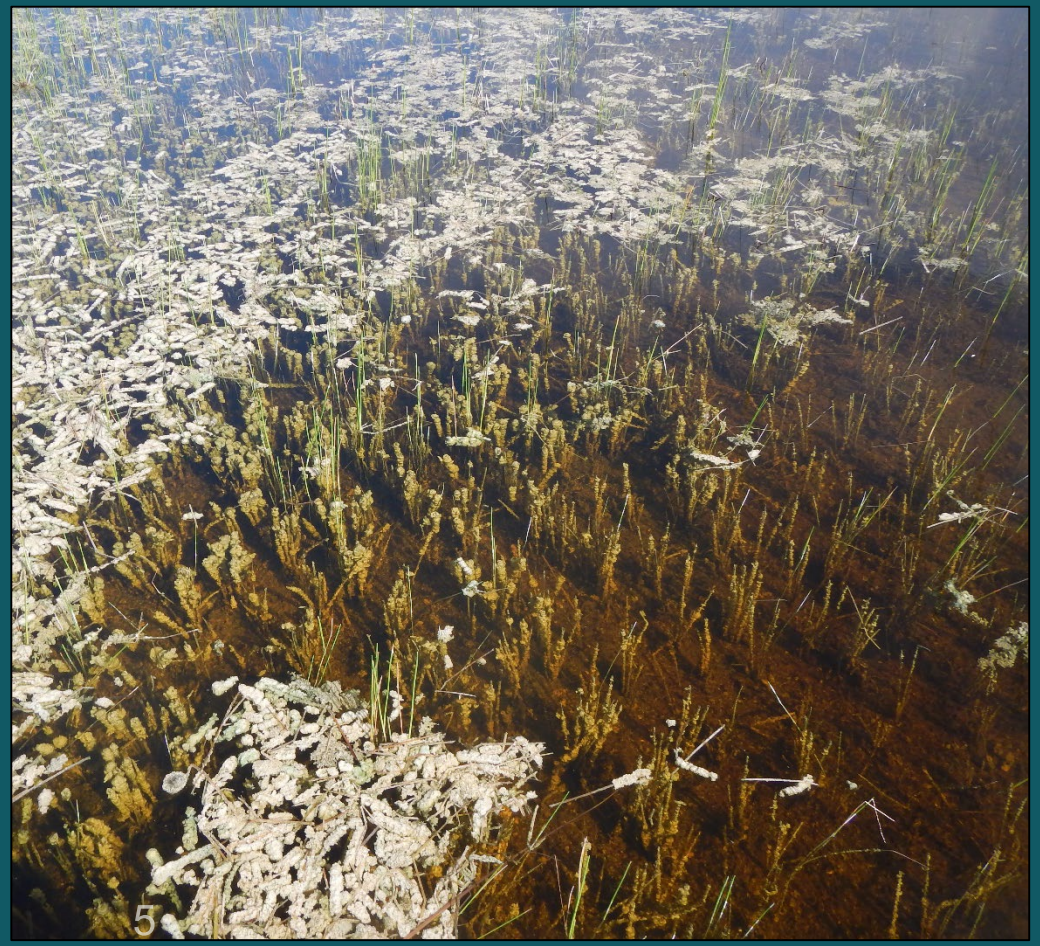
Annual mean inflow-outflow TP in the 40-ha STA-3/4 PSTA Cell operated at two depths



Inflow and Outflow TP and Stage in the 40-ha STA-3/4 PSTA Cell



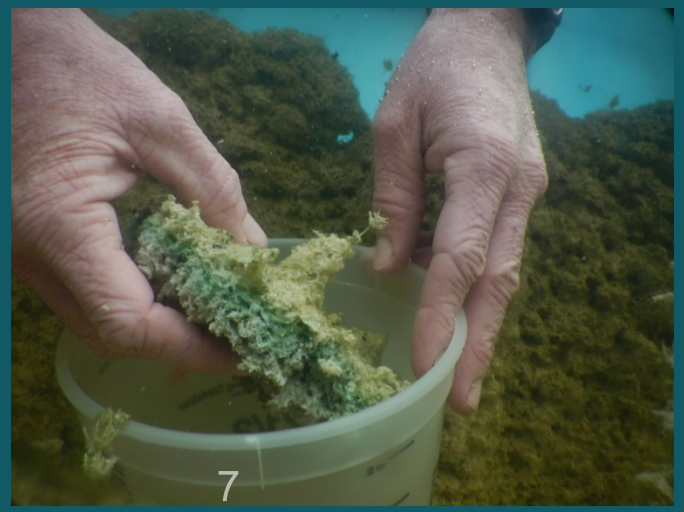
Dense periphyton community in STA-3/4 PSTA Cell

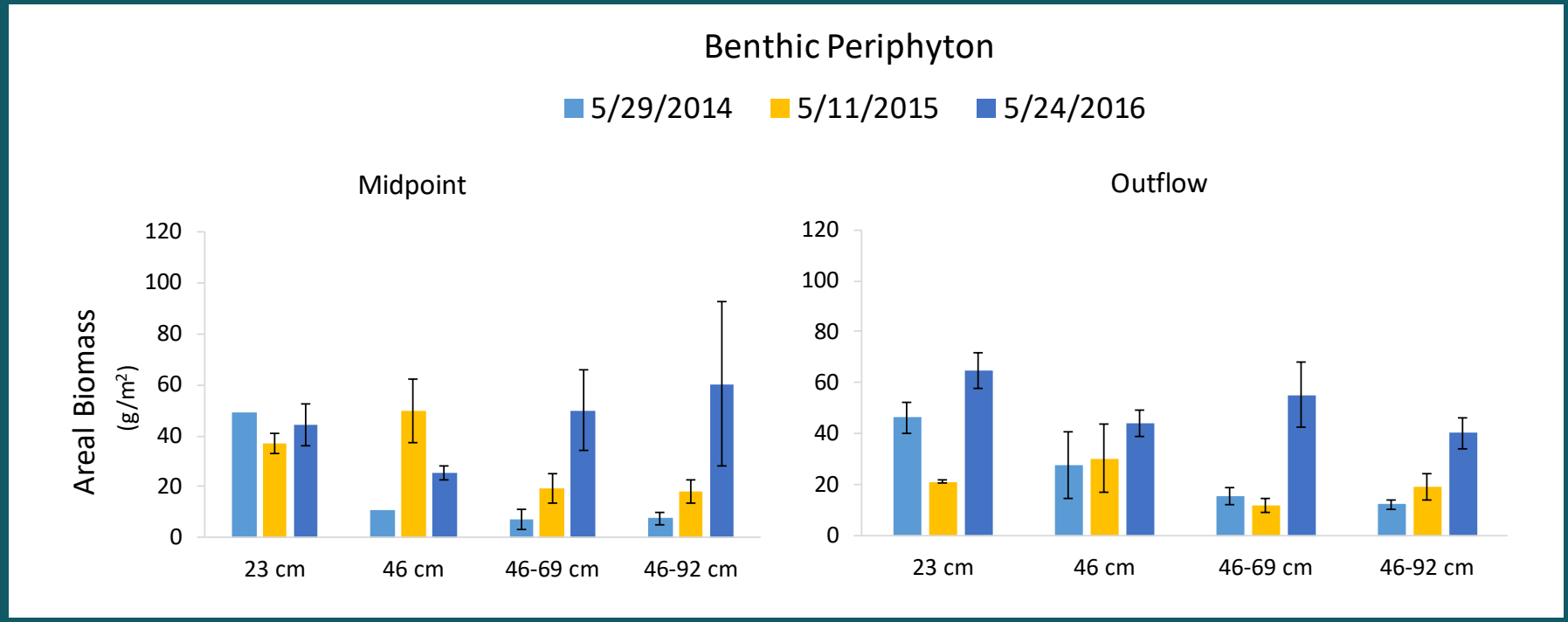


Replicated mesocosm study was conducted to further explore operational boundaries to the PSTA concept: in this platform, factors such as depth and loading could be evaluated separately

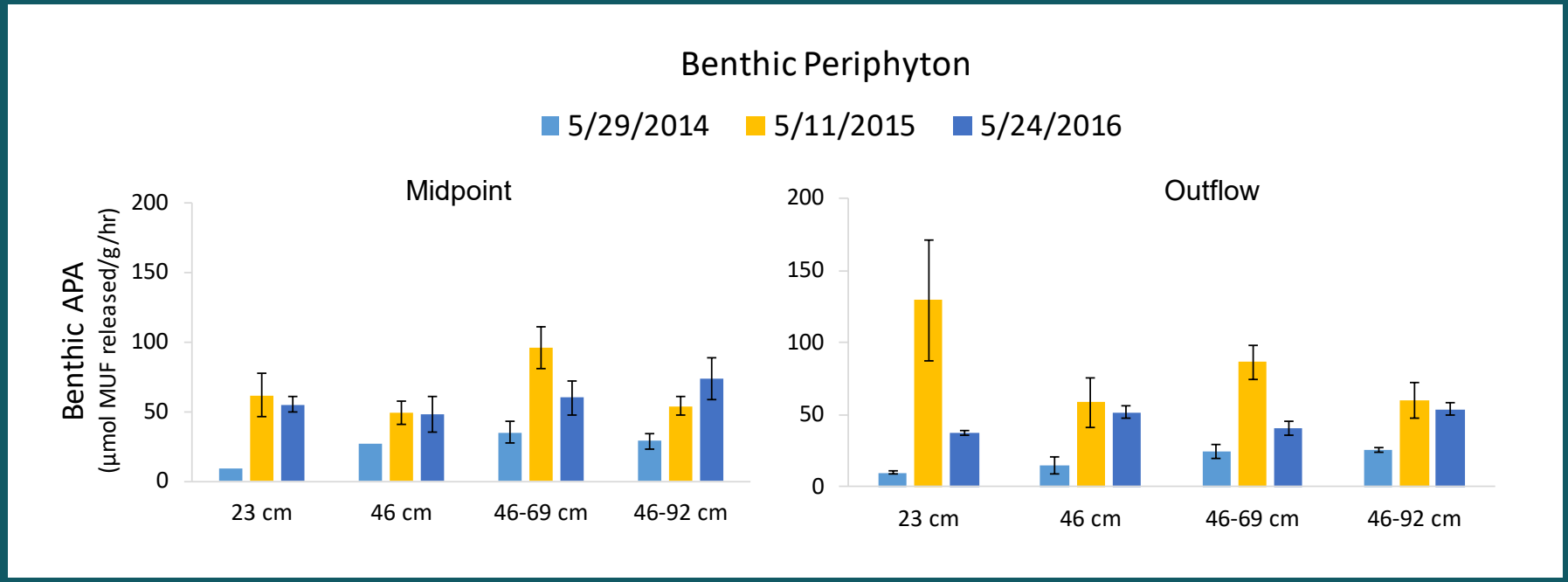
- Triplicate flow-ways operated with STA-treated waters ~20 ppb TP
- Four depths evaluated, ranging from 23 to 92 cm
- Lime rock substrates

Benthic periphyton biomass generally increased over time, & developed most rapidly in shallow mesocosms



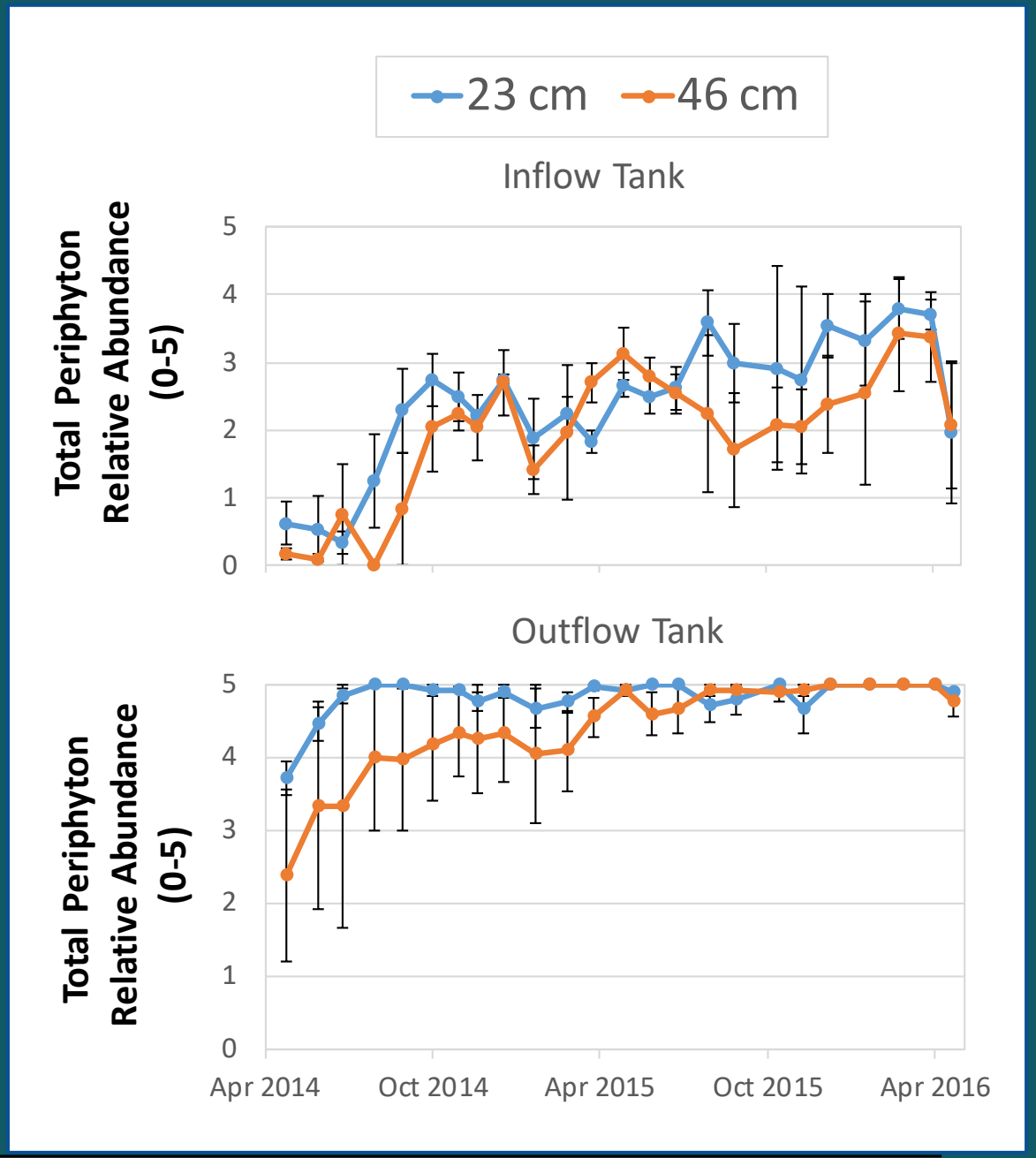


Periphyton phosphatase enzyme activity generally increased over time, not affected by depth

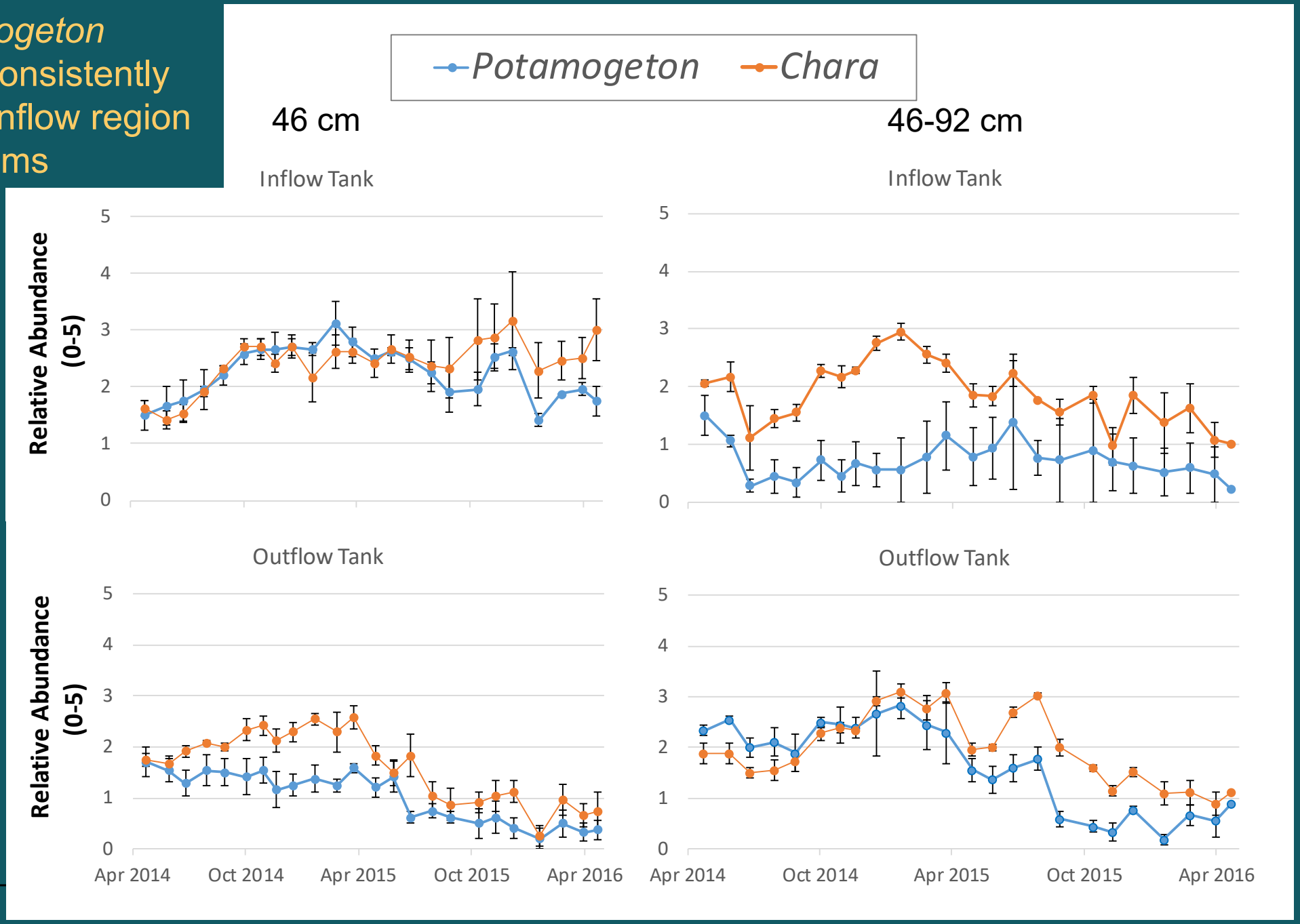


Periphyton Coverage

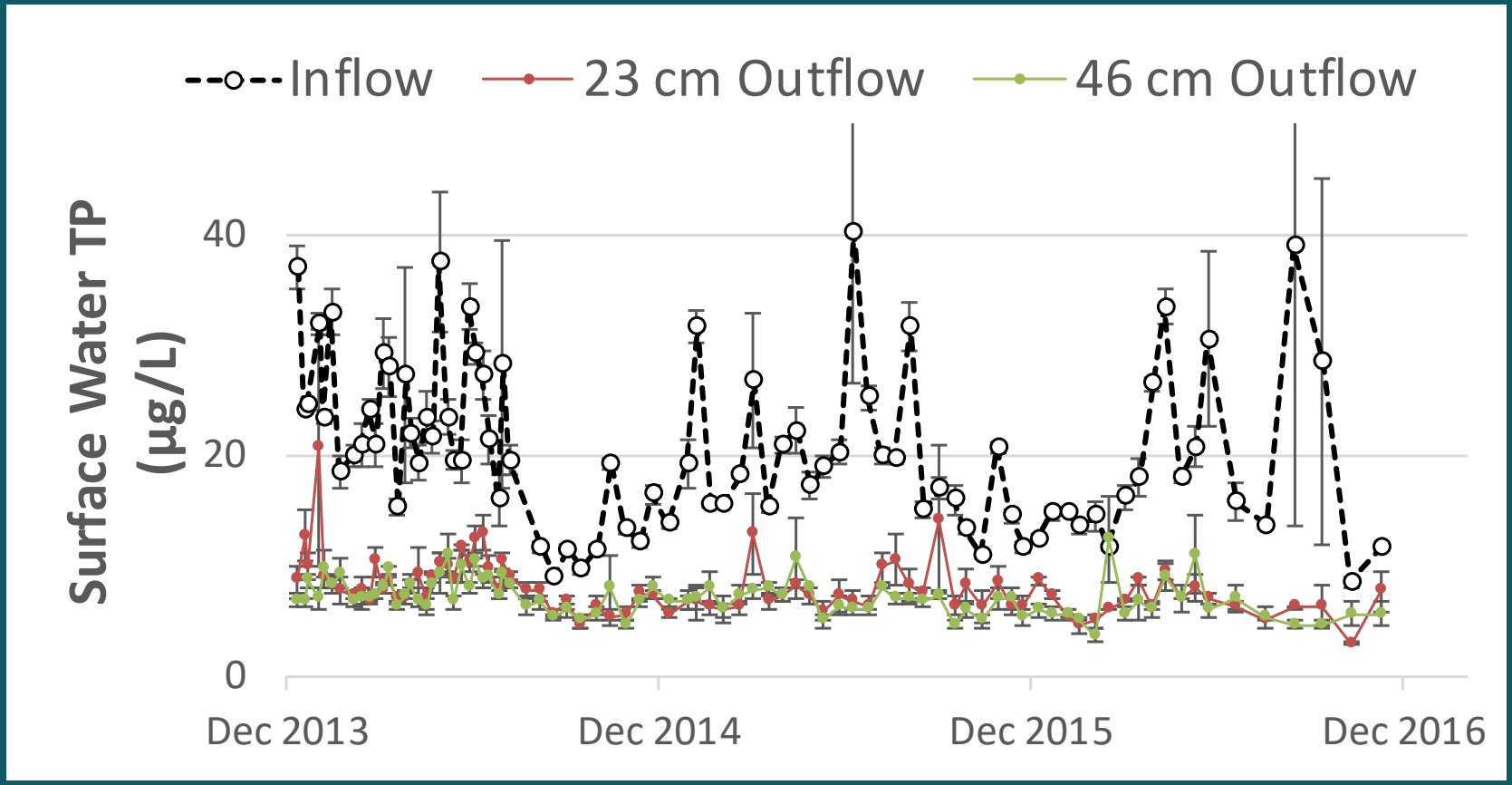
Periphyton colonization was delayed in deeper waters, and more complete coverage was achieved under the 23 cm depth, as compared to greater depths (e.g., 46 cm and deeper)



Chara sp. and *Potamogeton illinoensis* remained consistently abundant only in the inflow region of shallower mesocosms

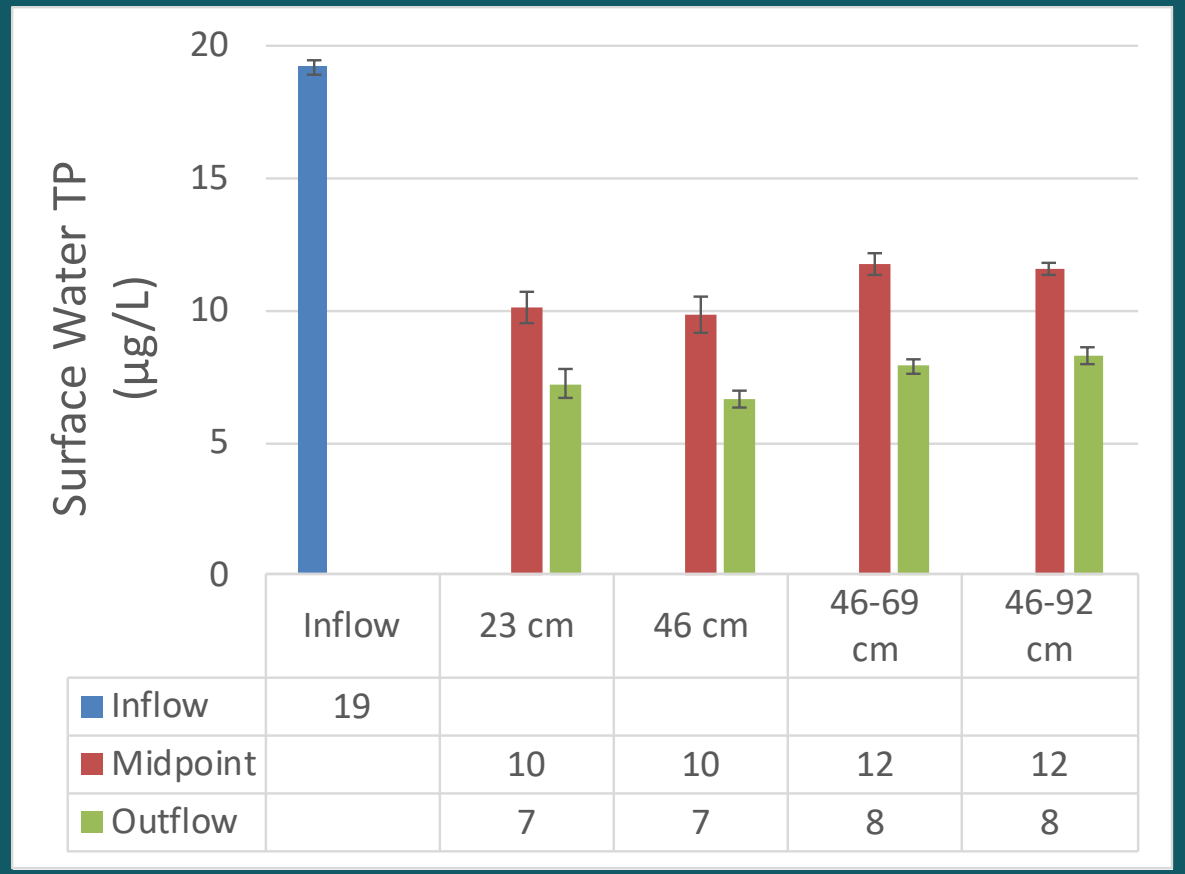


Shallow depth (23 and 46 cm) PSTA mesocosms provided the most consistently low, and stable outflow TP concentrations over 2.7 years



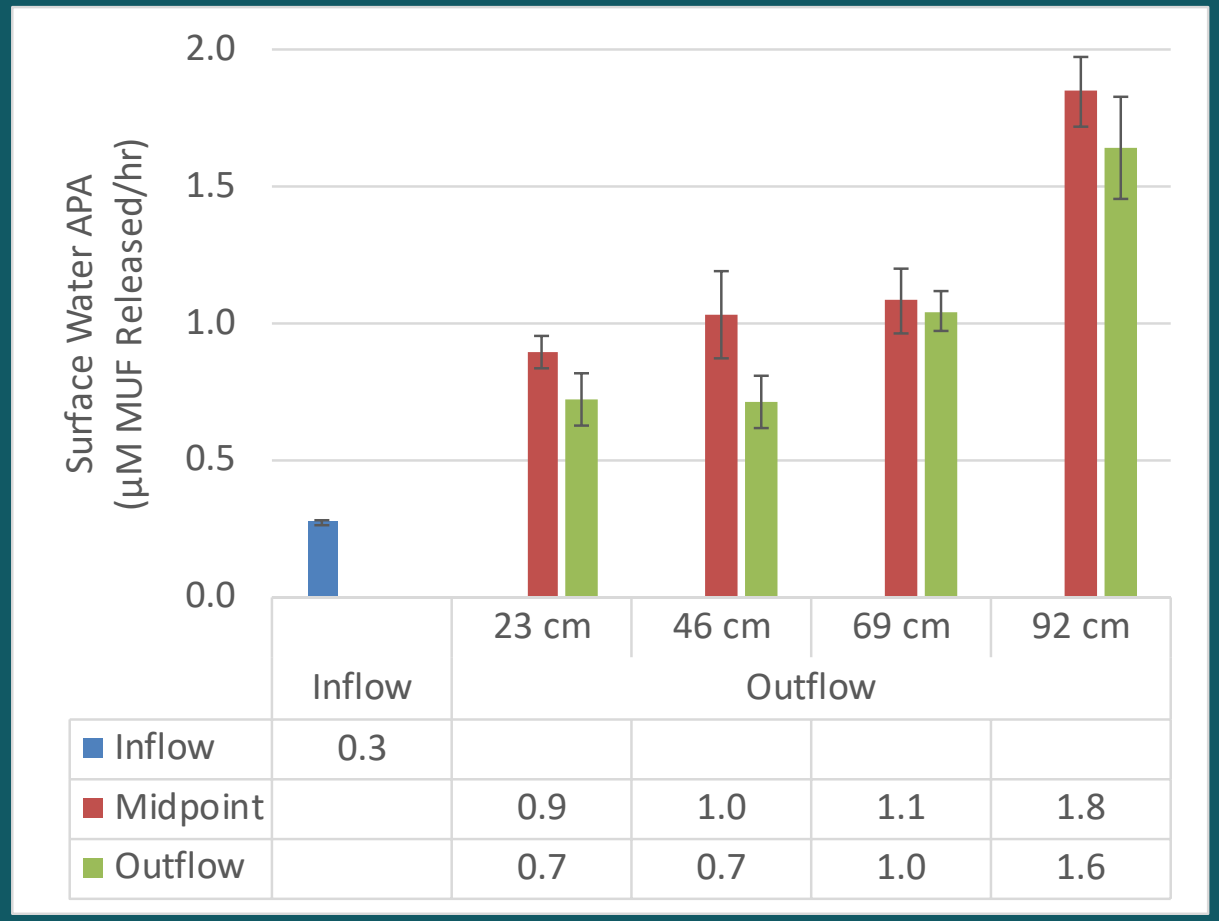
Period of record (16 mo) average TP concentrations in all mesocosms under static depths

- Similar reductions in TP observed across a range of depths



Period of record (16 mo) average alkaline phosphatase activity (APA) under static depths

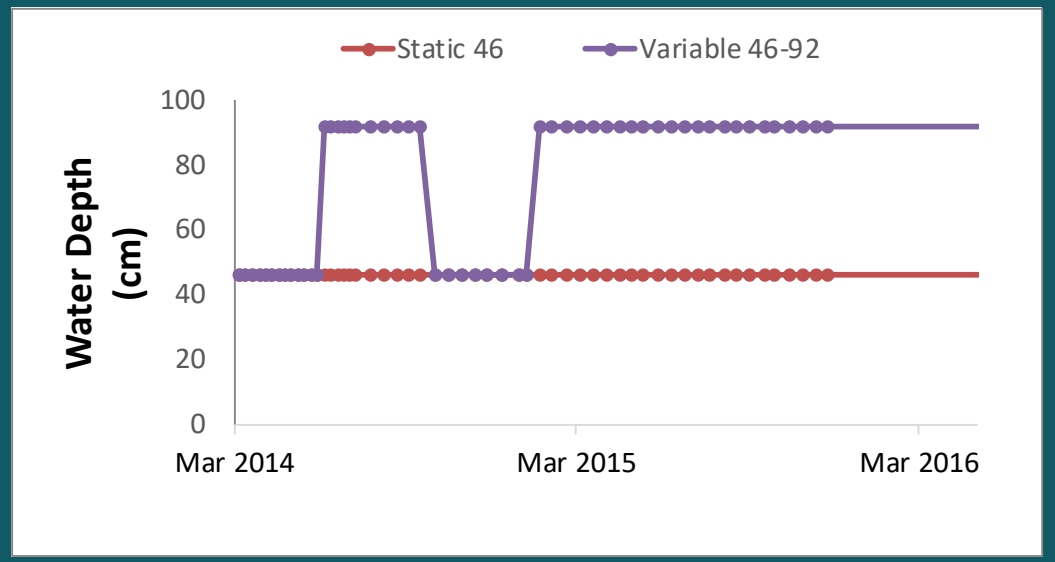
- APA increased from inflow to outflow across all depths
- Water enzyme activity greatest at 92 cm

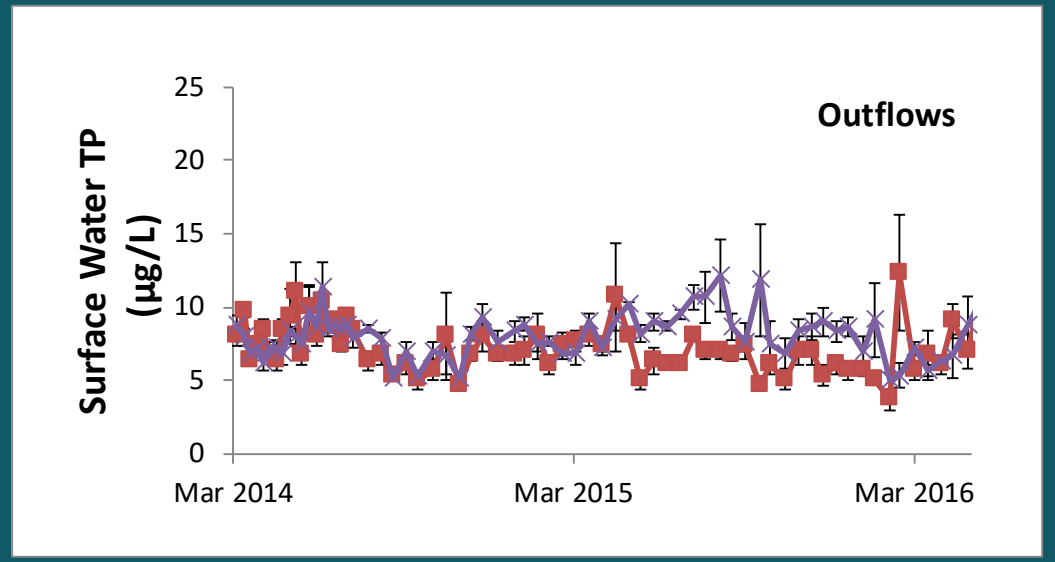


	Inflow	Outflow			
Inflow	0.3				
Midpoint		0.9	1.0	1.1	1.8
Outflow		0.7	0.7	1.0	1.6

Operations under variable depths, which occur in a full-scale PSTA system, also provided good P removal performance

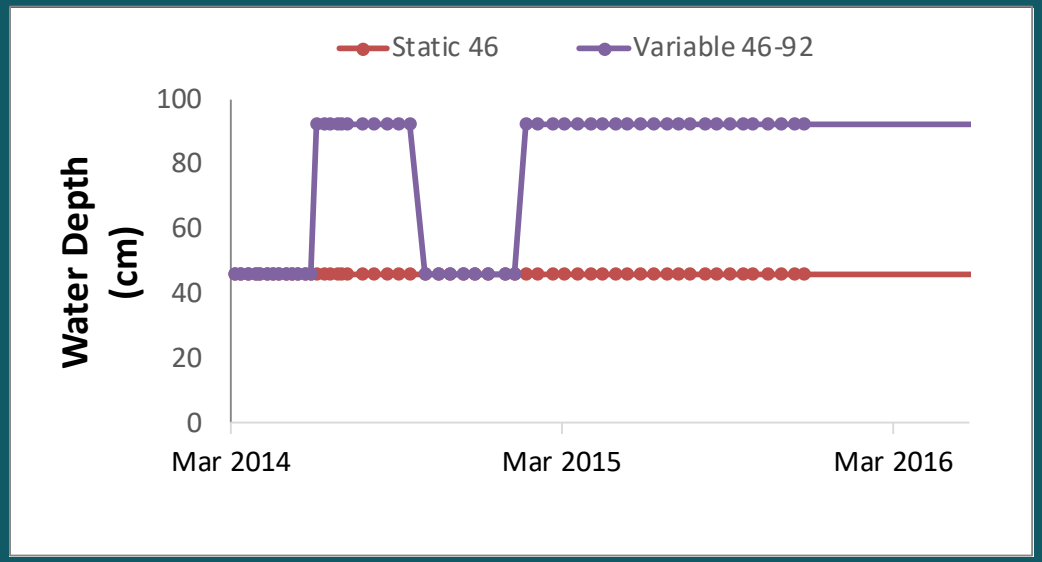
- Static 46 cm depth provided more consistent P removal, compared to variable depth (46-92 cm) conditions

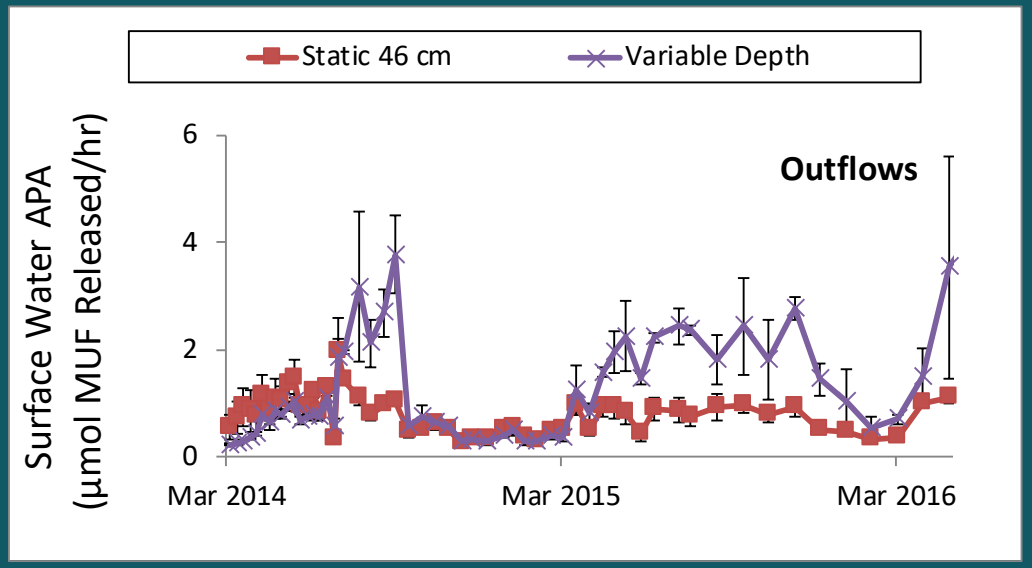




Variable water depths also affected phosphatase enzyme activity

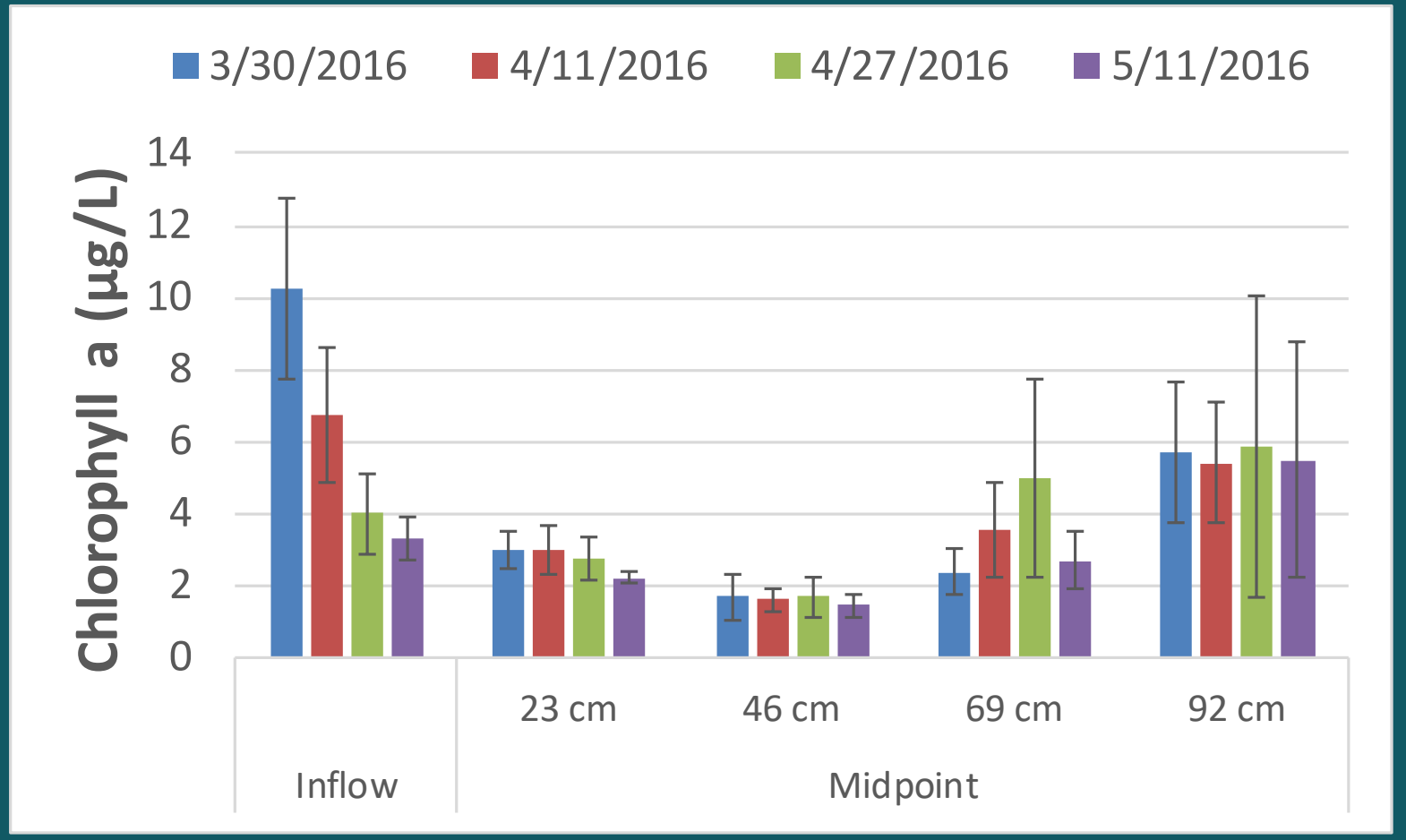
- Enzyme activity showed clear response to deep water conditions under variable depth conditions





Higher phytoplankton concentrations observed in deeper (69 and 92 cm) mesocosms

- Phytoplankton can contribute to elevated water column TP levels
- P-starved phytoplankton also may contribute to higher water column APA



Summary of Findings

- Benthic periphyton community development was most rapid in outflow tanks and at shallow depths (23 cm), but occurred across a range of higher water depths, up to 92 cm
- Macrophytes were most abundant in shallow waters, and were largely restricted to inflow mesocosms
- Ultra-low P concentrations were achieved at a range of depths in mesocosms (23 – 92 cm) and field-scale (39-67 cm) platforms
- Deeper conditions, in particular fluctuating depths, resulted in slightly elevated TP levels within the mesocosms

Summary of Findings (continued)

- The observed alkaline phosphatase activity (APA) responses provide confirmation that the mesocosm algal assemblages were responsive to the treatments imposed
- APA in the PSTA mesocosms:
  - increased over time in the benthic periphyton
  - was stimulated in the water column under deeper conditions
- Increased APA in deep mesocosms may have been associated with observed higher phytoplankton concentrations

Acknowledgements

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