Spatial Variability in Microbial-Mediated Biogeochemical Processes in Everglades Stormwater Treatment Areas

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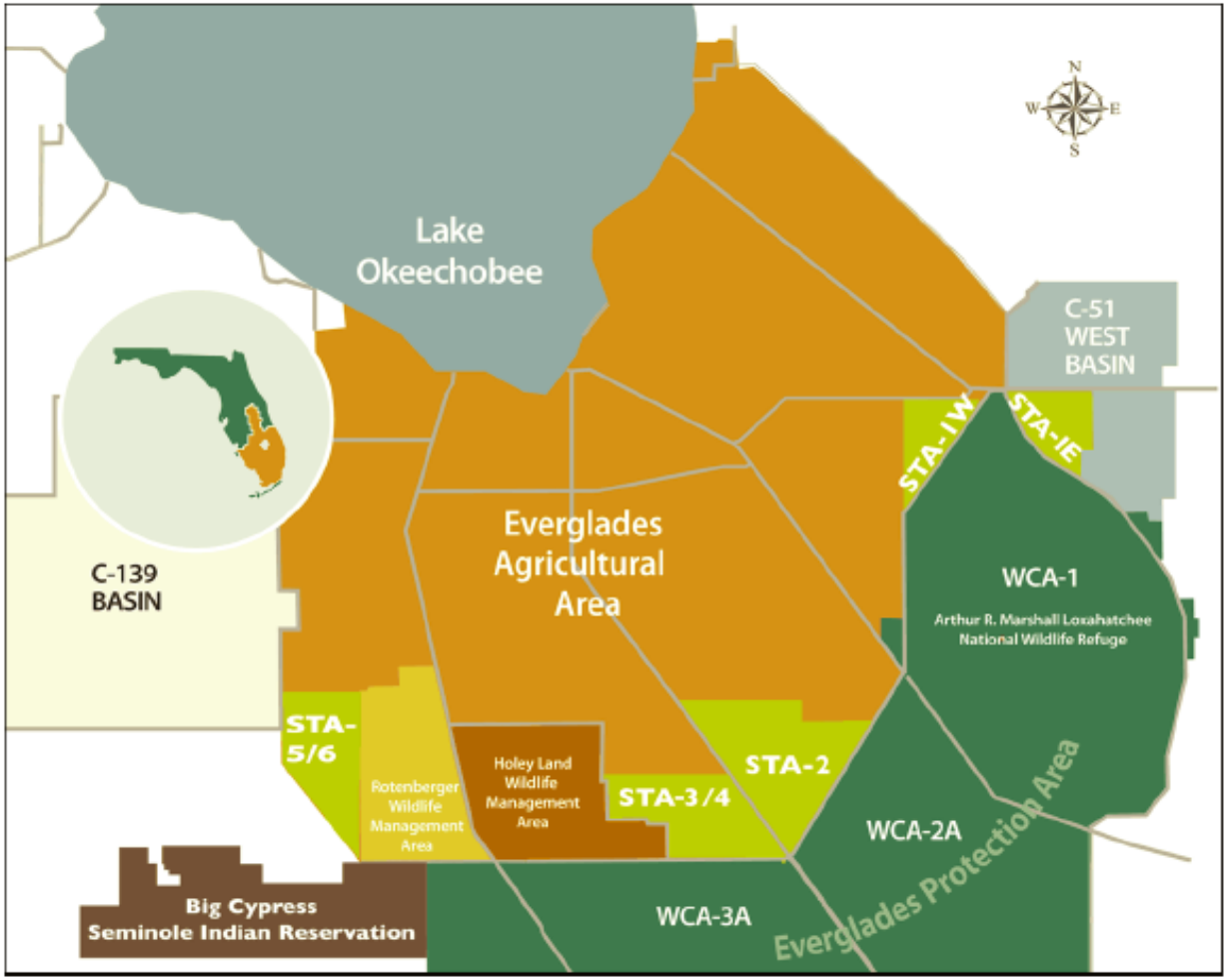
Everglades STAs

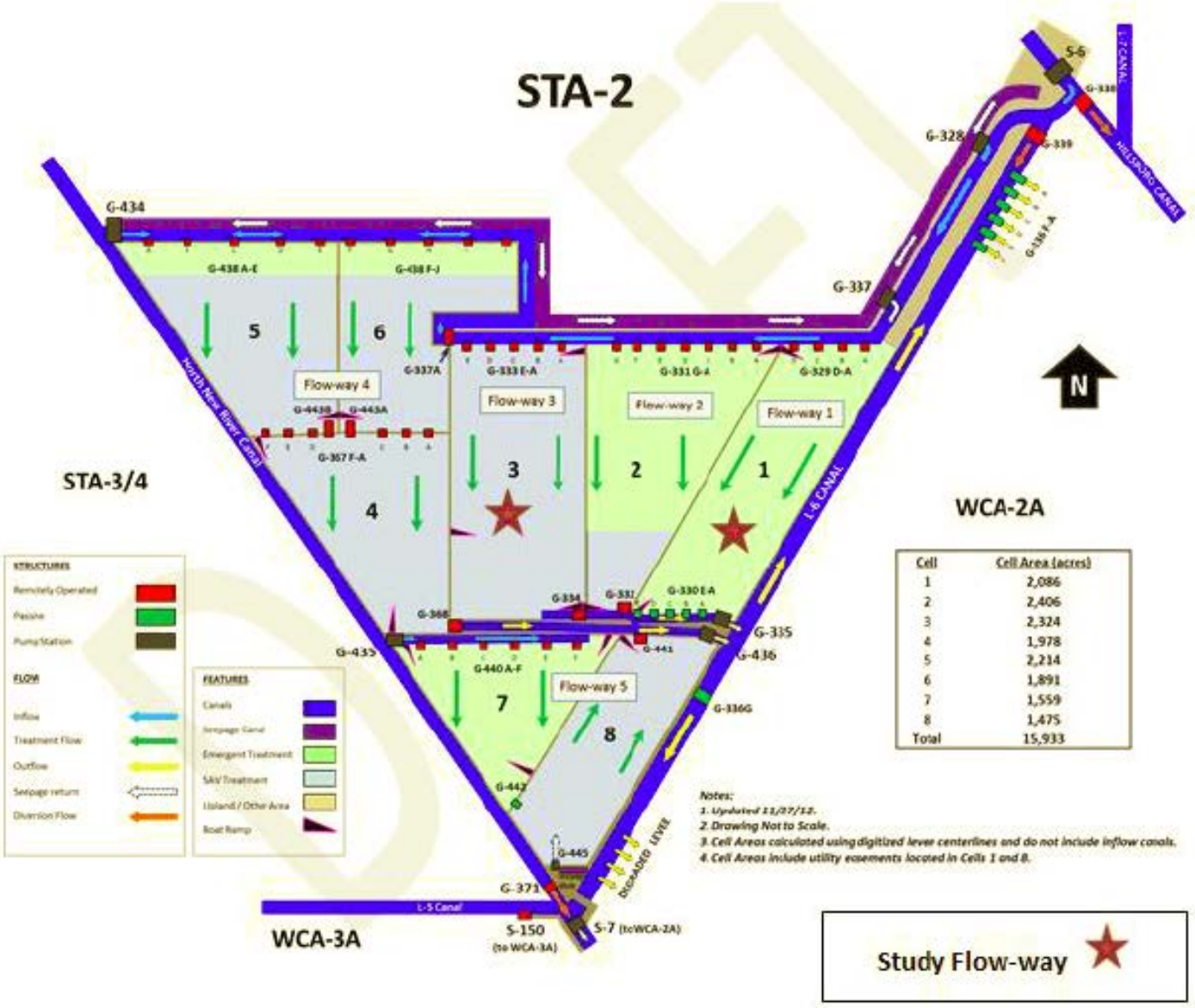


Bhomia et al 2015

Background/Problem Statements

- Influent TP = 113 µg/L, effluent TP = 21 µg/L
- Water Quality Based Effluent Limit (WQBEL) =13 µg/L
- Optimization of wetland nutrient uptake processes are necessary

Study sites: STA-2



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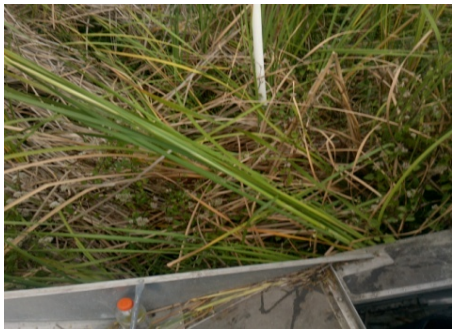
Vegetation

	Cell-3	Cell-1
Inlet		
Mid		
Outlet		

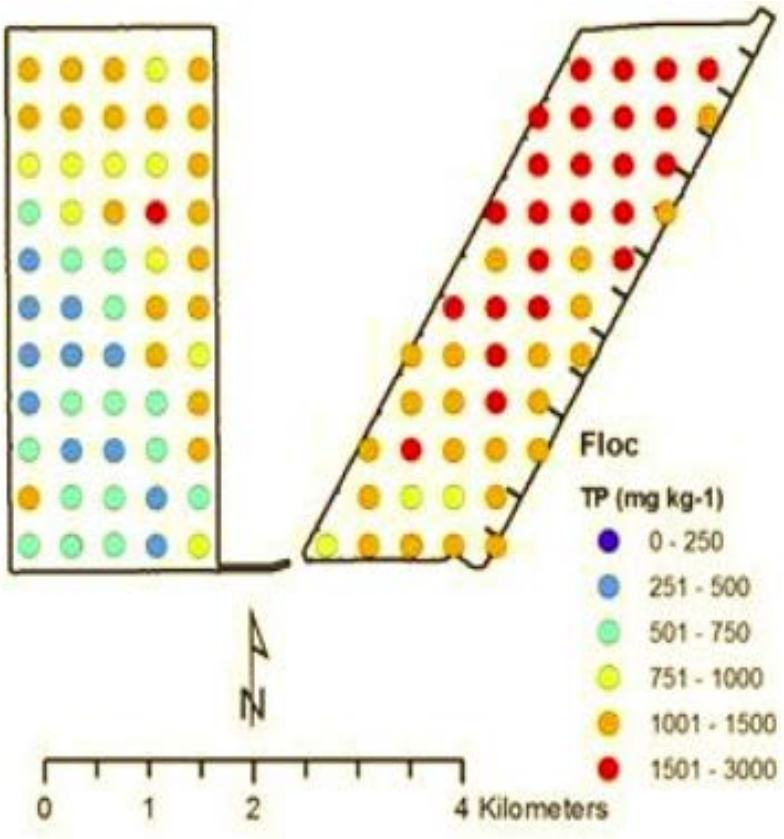
Sediment Core

Cell-3

Cell-1

What we know about STA2

- Water Total P (TP) gradients
- Floc and RAS TP gradients
- Floc TP > RAS TP
- Effect of vegetations:
  - Higher TP concentrations in floc of cell 1 (EAV) than cell 3 (SAV)
  - More P is in organic form in cell 1, while more P is in precipitate or orthophospate in cell 3
  - Lower pH in cell 1 (EAV)
  - Higher DO amplitude in cell 3 (SAV)



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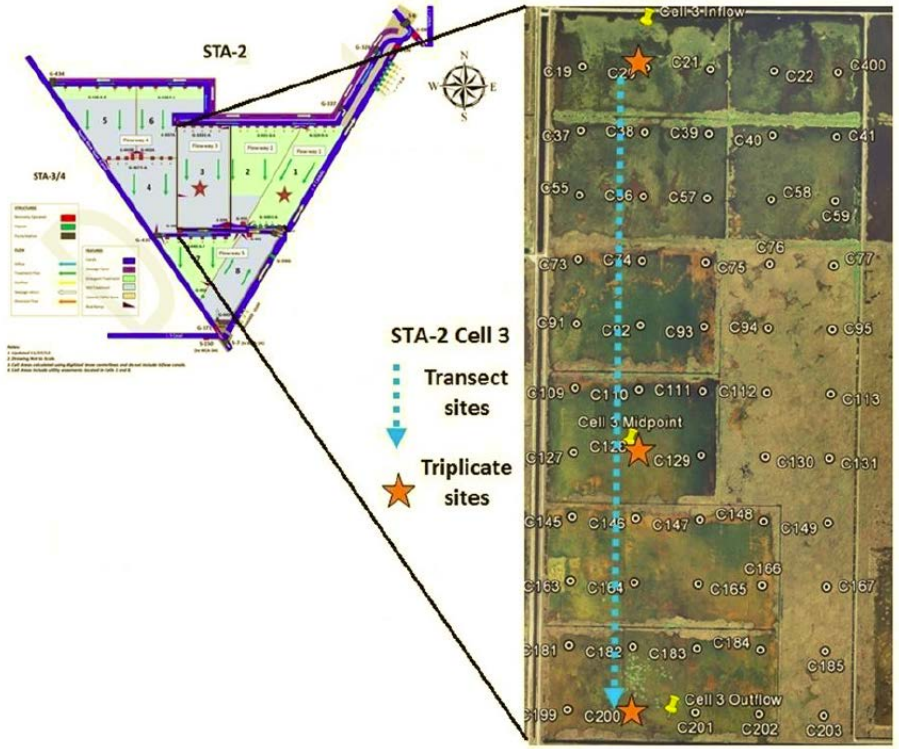
What we do not know

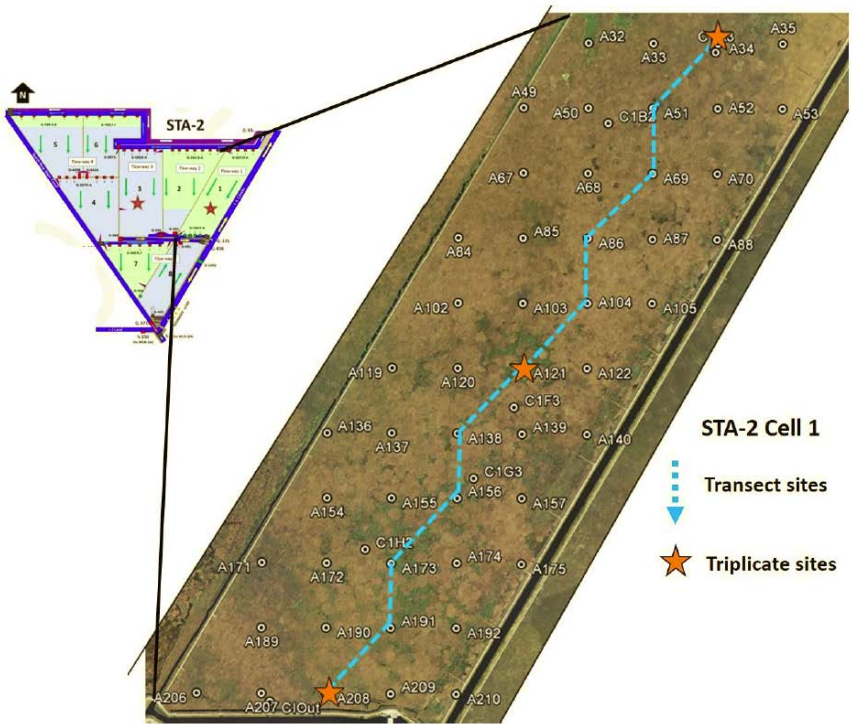
- Factors affect P cycle
- Mechanistic processes related to P cycle
- Microbial community compositions and microbial roles in P cycle

Research questions

- Do floc and RAS microbial communities differ along the P gradient?
- Do microbial communities differ along the vertical gradient?
- Do water column microbial communities differ from floc's?
- Do vegetation types affect sediment microbial communities?

Sampling Design





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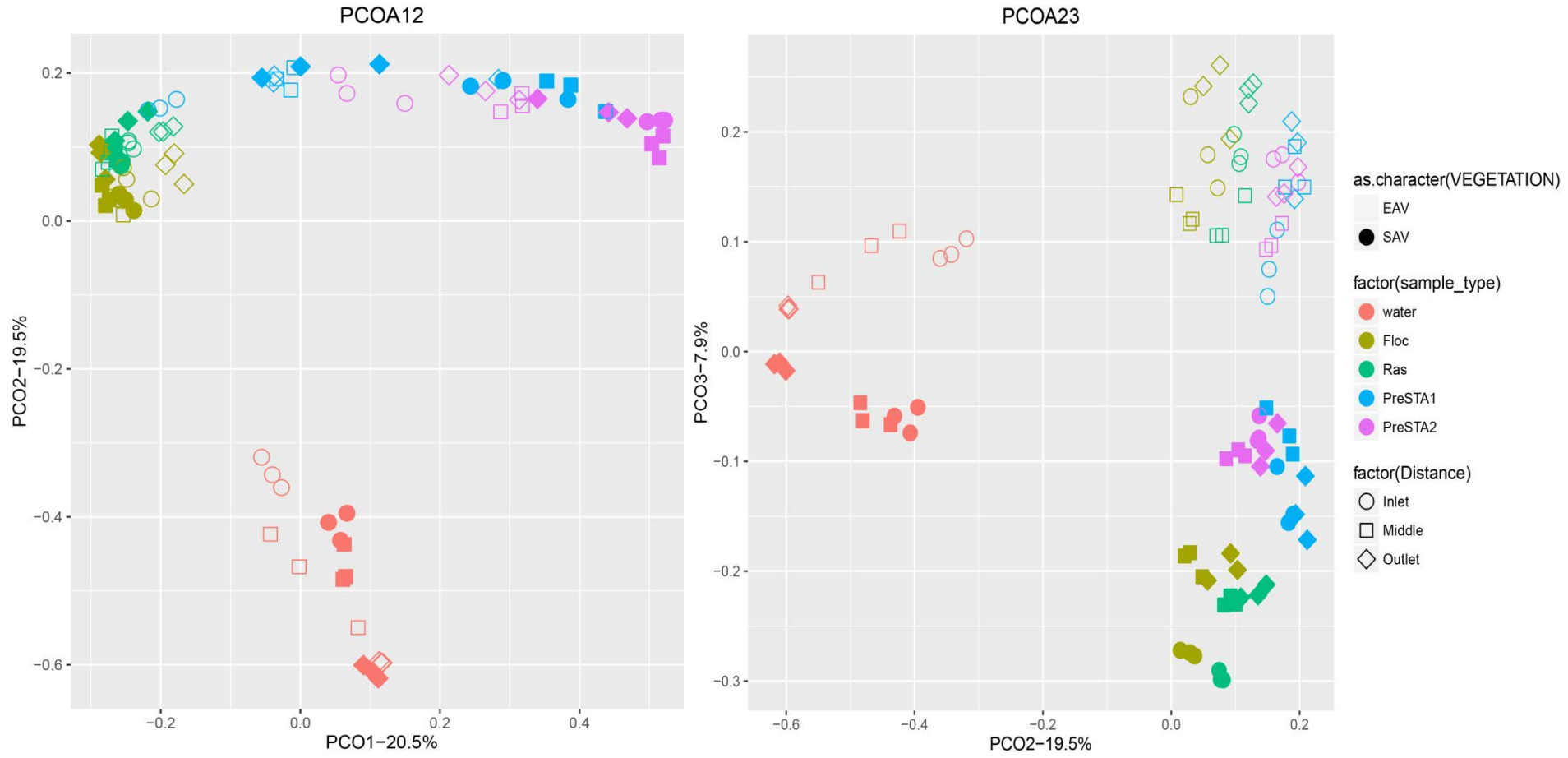
Water and sediment core (Floc, RAS, preSTA-1, and preSTA-2): 5X3X3X2=90

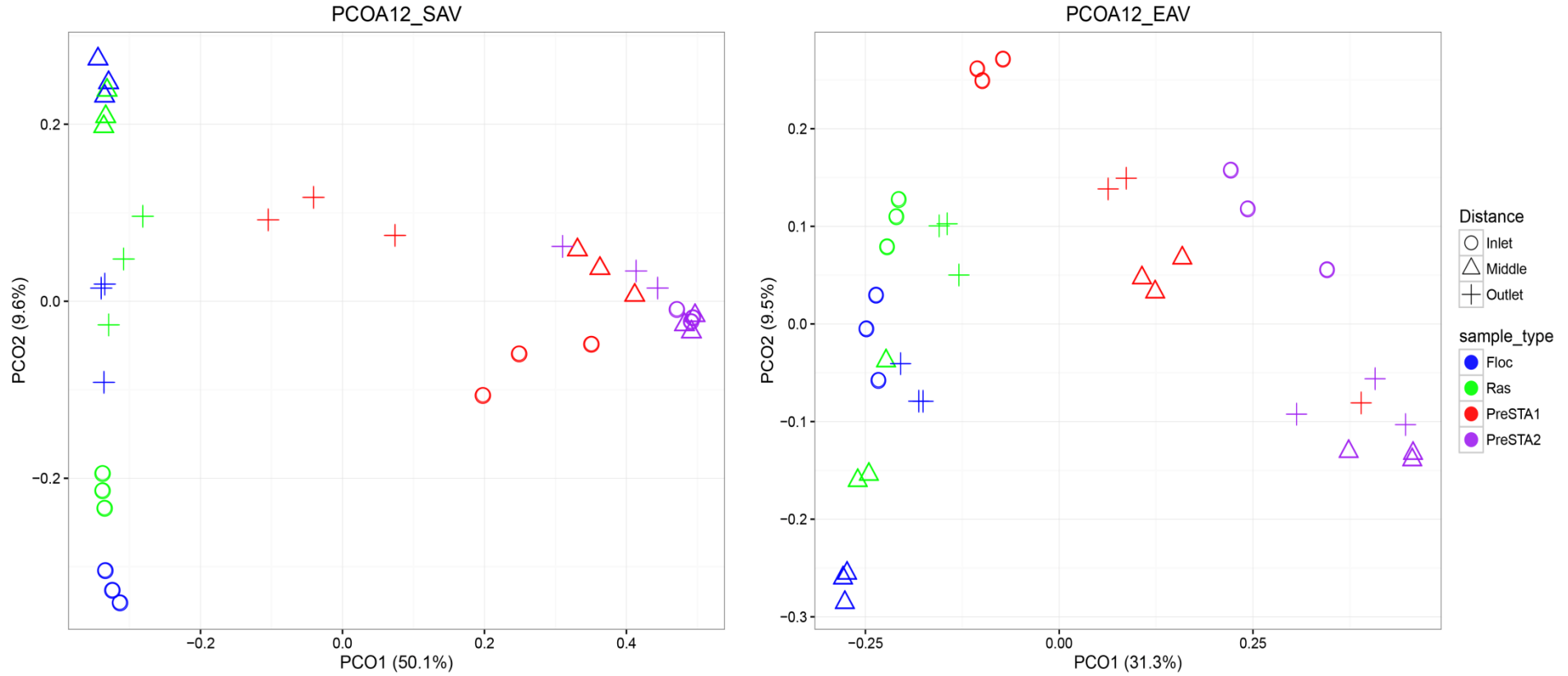
Sample collection on March 12-17, 2017

Results

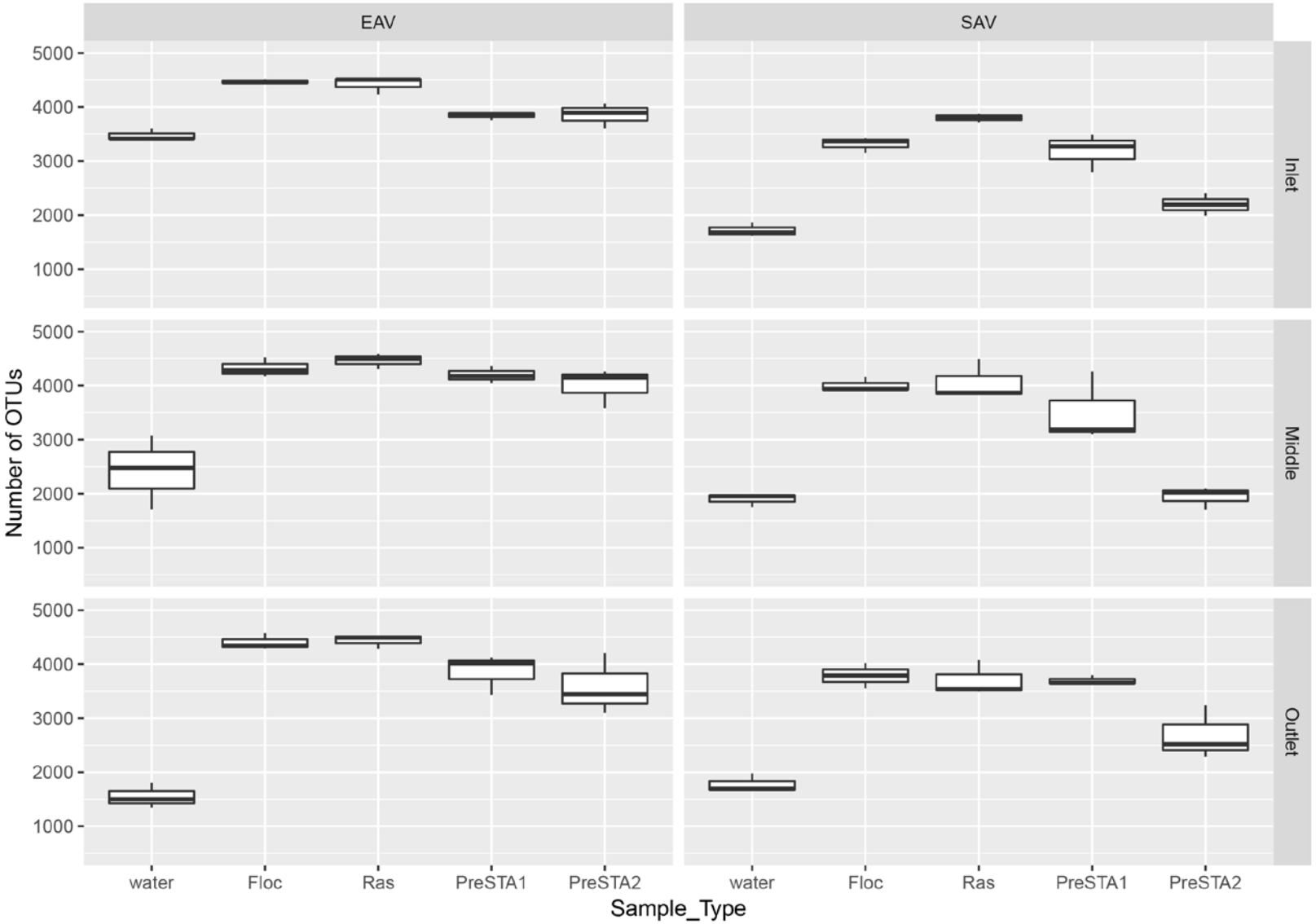
Microbial community compositions (MMC)



MMC: Inlet to outlet gradient



Microbial diversity



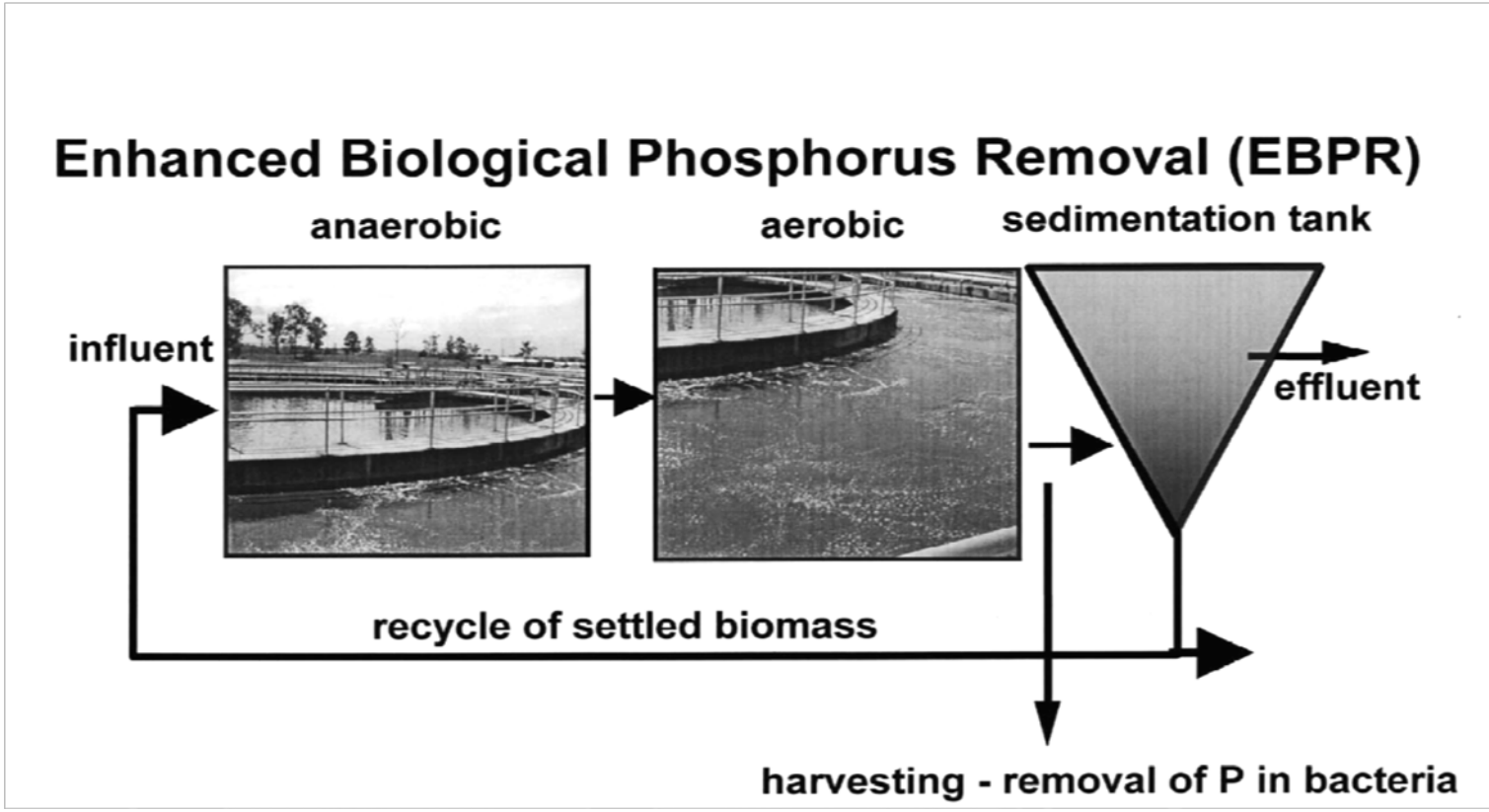
Mechanistic level of questions

- Are the Phosphate Solubilizing Bacteria (PSB) present in sediments?
- Is Phosphate Accumulating Organisms (PAOs) enriched in STAs, particularly in SAV?

Phosphate Accumulating Organisms (PAO)

- Enriched in Enhanced Biological Phosphorus Removal (EBPR) processes in wastewater treatments.
- EBPR: Phosphorus accounts for 4 to 5 % of sludge dry weight with PAO compared to 1.5-2% by heterotrophs alone

Typical system configuration



Blackall et al 2002

PAO identity

- Candidatus Accumulibacter phosphatis (CAP)
  - First described in 1999 (Hesselmann et al 1999)
  - Not isolated but enriched in lab (80% of relative abundance)
  - Closely related to genus Rhodocyclus (betaproteobacteria)
  - Account for nearly 3 to 5% in large scale EBPR

Mechanisms: Proposed model

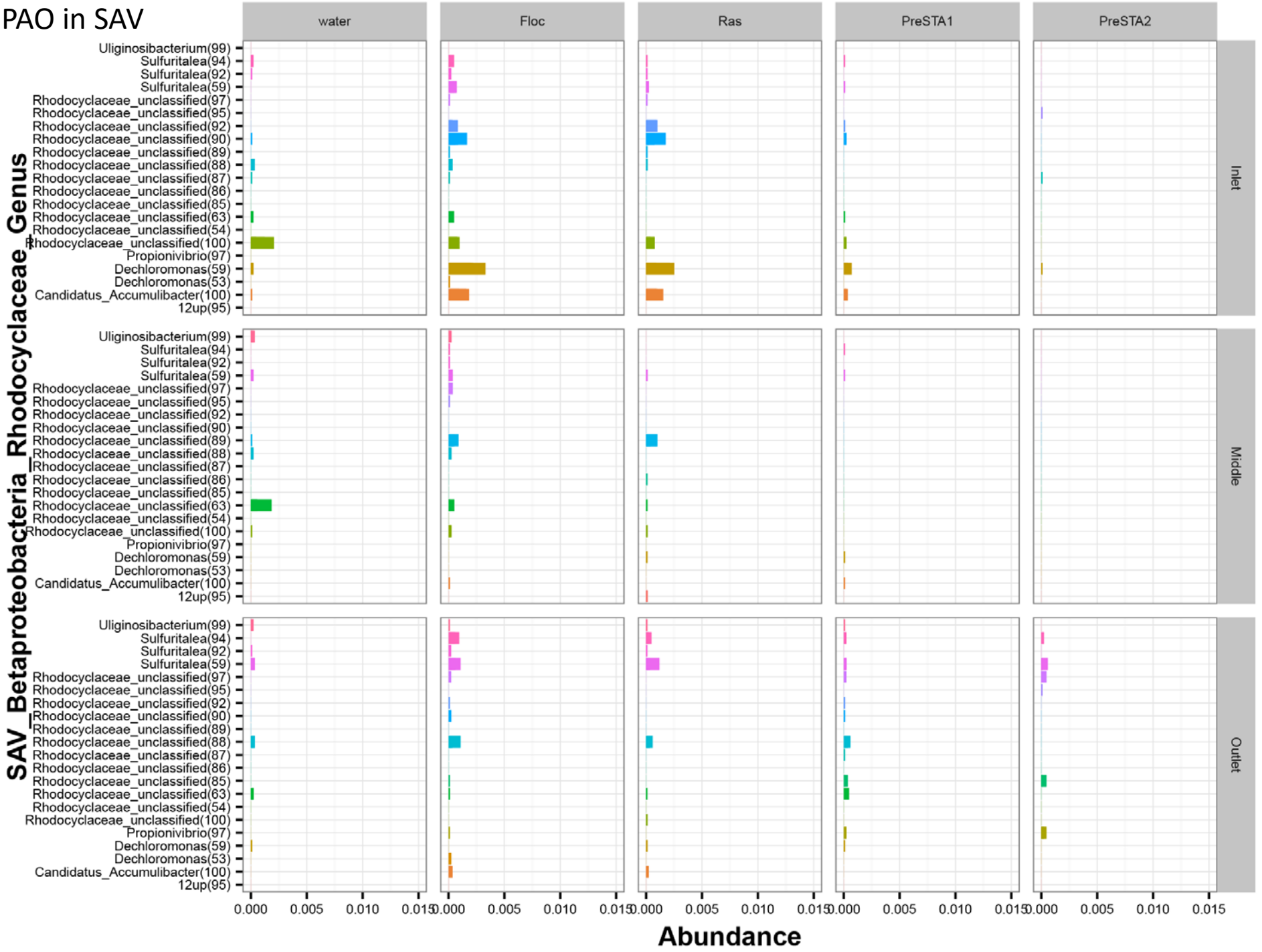
Anaerobic tank

- Poly-P → orthophosphate
- VFAs → polyhydroxyalkanoates (PHAs)

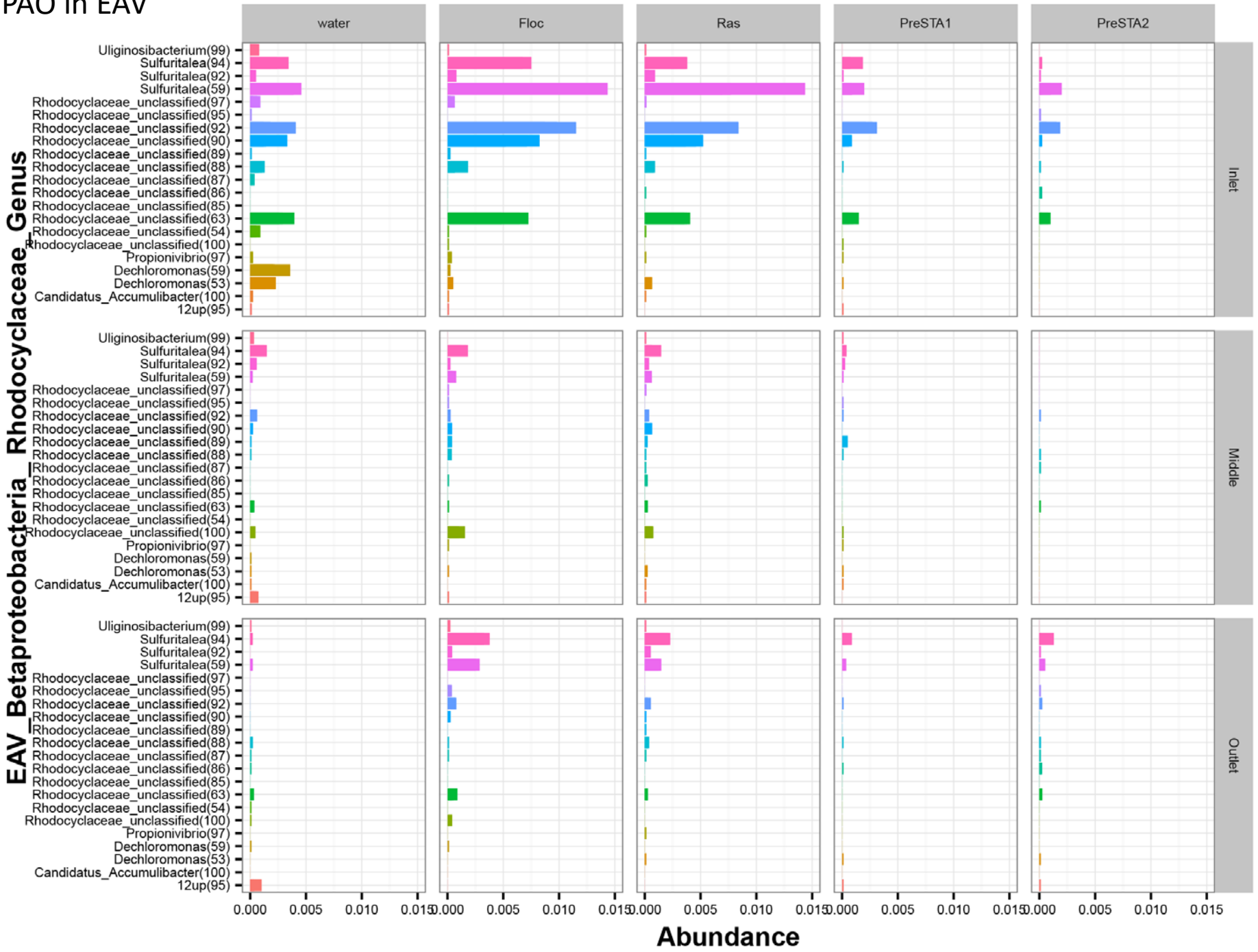
Aerobic tank

- Orthophosphate → Poly-P
- PHAs degradation → intermediates → CO_2 + H_2O

PAO in SAV


water
Floc
Ras
PreSTA1
PreSTA2
Inlet
Middle
Outlet
SAV_Betaproteobacteria_Rhodocyclaceae_Genus
Uliginosibacterium(99)
Sulfuritalea(94)
Sulfuritalea(92)
Sulfuritalea(59)
Rhodocyclaceae_unclassified(97)
Rhodocyclaceae_unclassified(95)
Rhodocyclaceae_unclassified(92)
Rhodocyclaceae_unclassified(90)
Rhodocyclaceae_unclassified(89)
Rhodocyclaceae_unclassified(88)
Rhodocyclaceae_unclassified(87)
Rhodocyclaceae_unclassified(86)
Rhodocyclaceae_unclassified(85)
Rhodocyclaceae_unclassified(63)
Rhodocyclaceae_unclassified(54)
Rhodocyclaceae_unclassified(100)
Propionivibrio(97)
Dechloromonas(59)
Dechloromonas(53)
Candidatus_Accumulibacter(100)
12up(95)
0.000
0.005
0.010
0.015
Abundance

PAO in EAV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0.010
0.015
Abundance

Summary

- MCC were clustered based on water or sediments and sediment fractions.
- The vegetation also affected MCC.
- Spatial trend in MCC along the transects.
- PAOs were enriched in SAV, particularly in Floc and Ras fractions of inlet.

Acknowledgments

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Questions?
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