Stoichiometric Controls of Microbial Enzyme Activities on Nutrient Cycling In Wetlands

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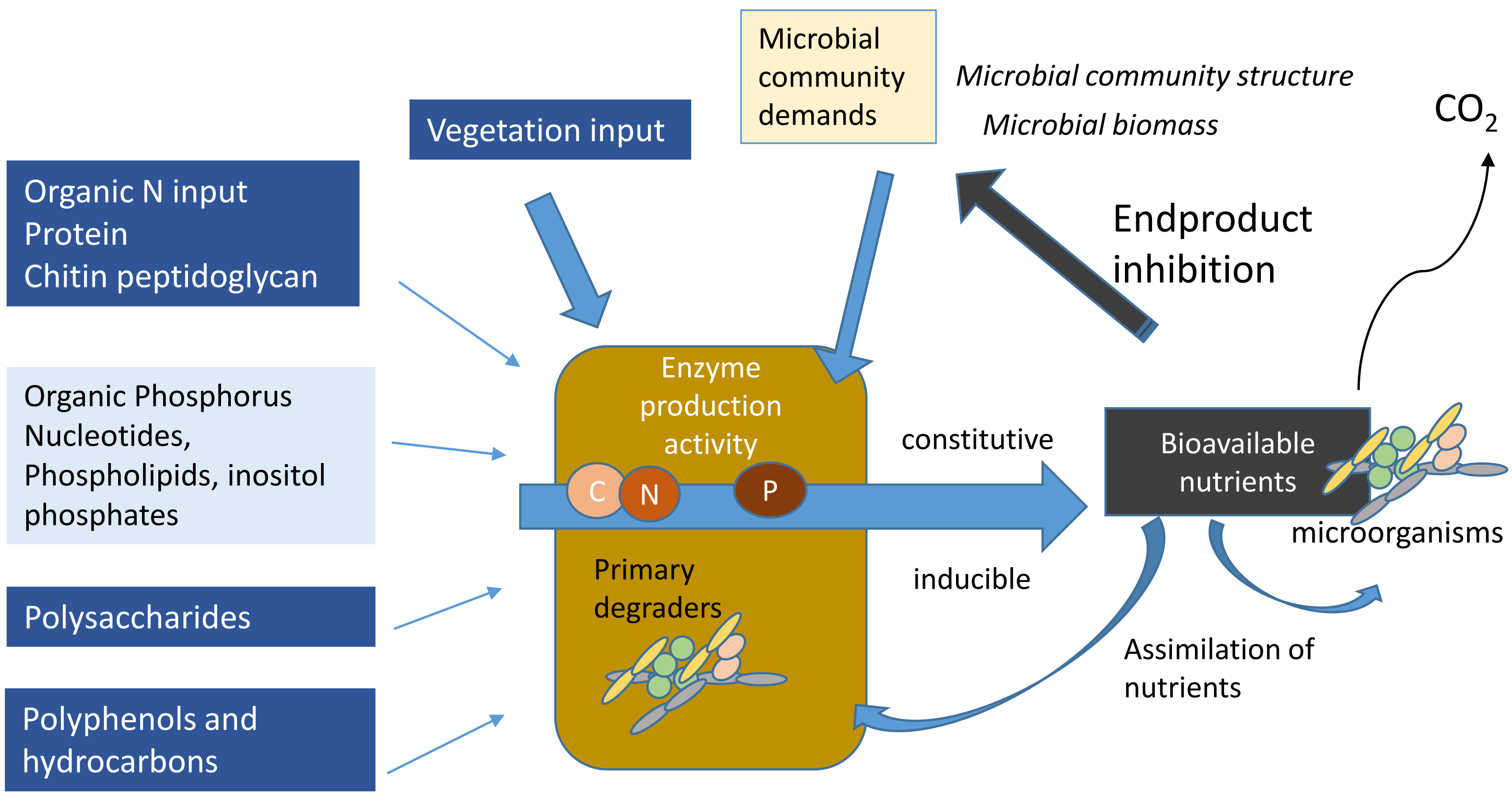
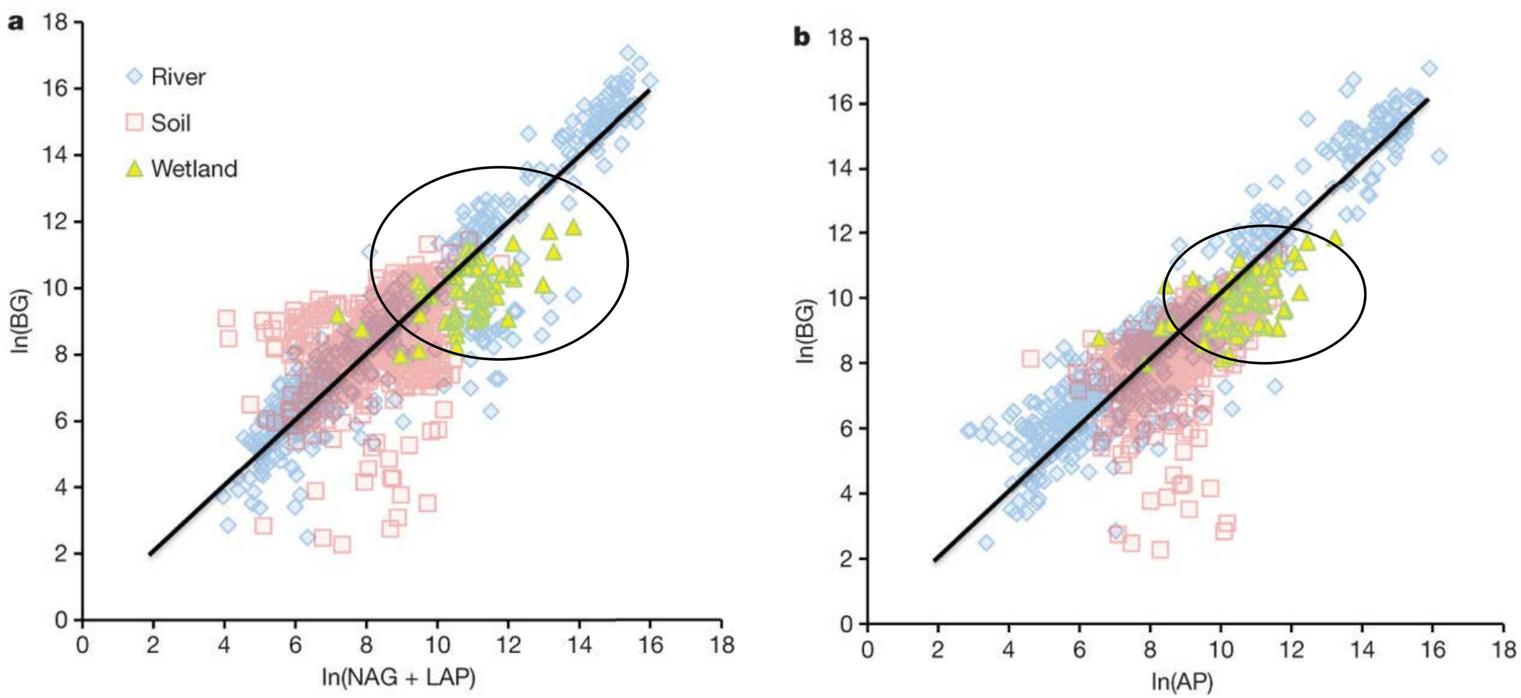
Successional loop that links microbial production, detrital organic matter and enzyme activity



Global ecoenzymatic stoichiometry patterns



Organic nitrogen (N) acquisition activity and organic phosphorus (P) acquisition activity in relation to carbon (C) acquisition

RL Sinsabaugh *et al.* *Nature* **462**, 795-798 (2009) doi:10.1038/nature08632

Goals

- Assess the stoichiometry of heterotrophic microbial communities:
    - from wetland systems with different dominant vegetation types
    - contrasting states of trophic levels.
- Assess the relationship between the stoichiometry (biomass and enzymes) with C and nutrient mineralization.

Approach

- Microbial biomass C,N,P
- Enzymes involved in C (b-glucosidase),N (L-Aminopeptidase, N-acetyl glucosaminidase) and P (phosphatase, bis phosphatase) cycling.
- Mineralization of P and N

Study Sites

Stormwater Treatment Areas (STAs)

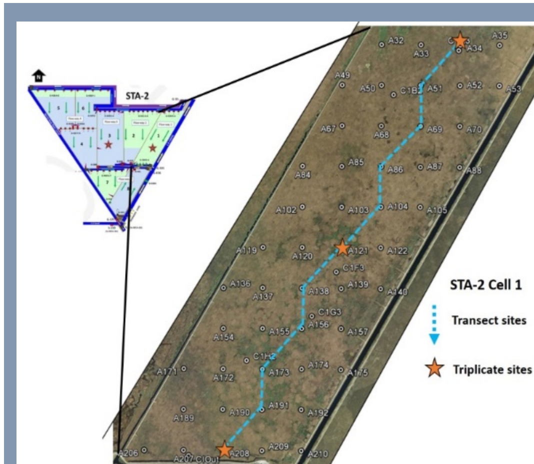
Emergent Aquatic Vegetation

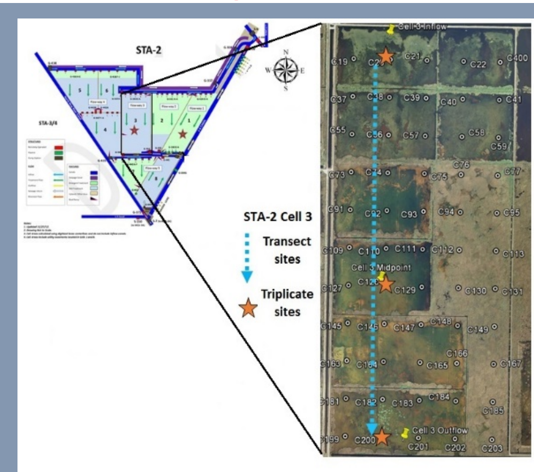
Submerged Aquatic Vegetation

EAV

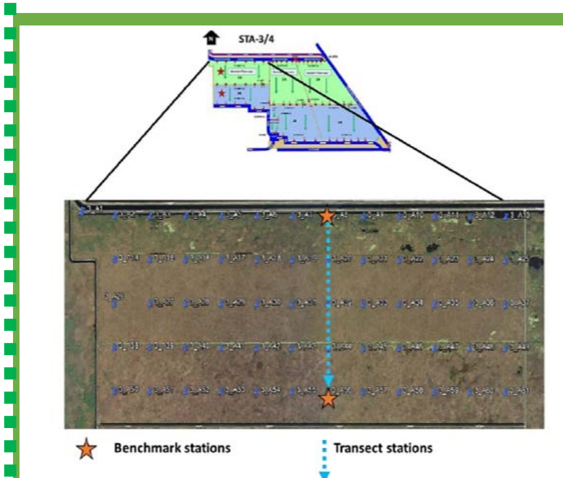
SAV

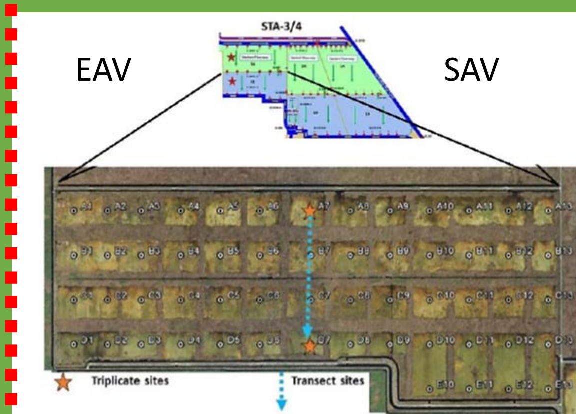
STA 2

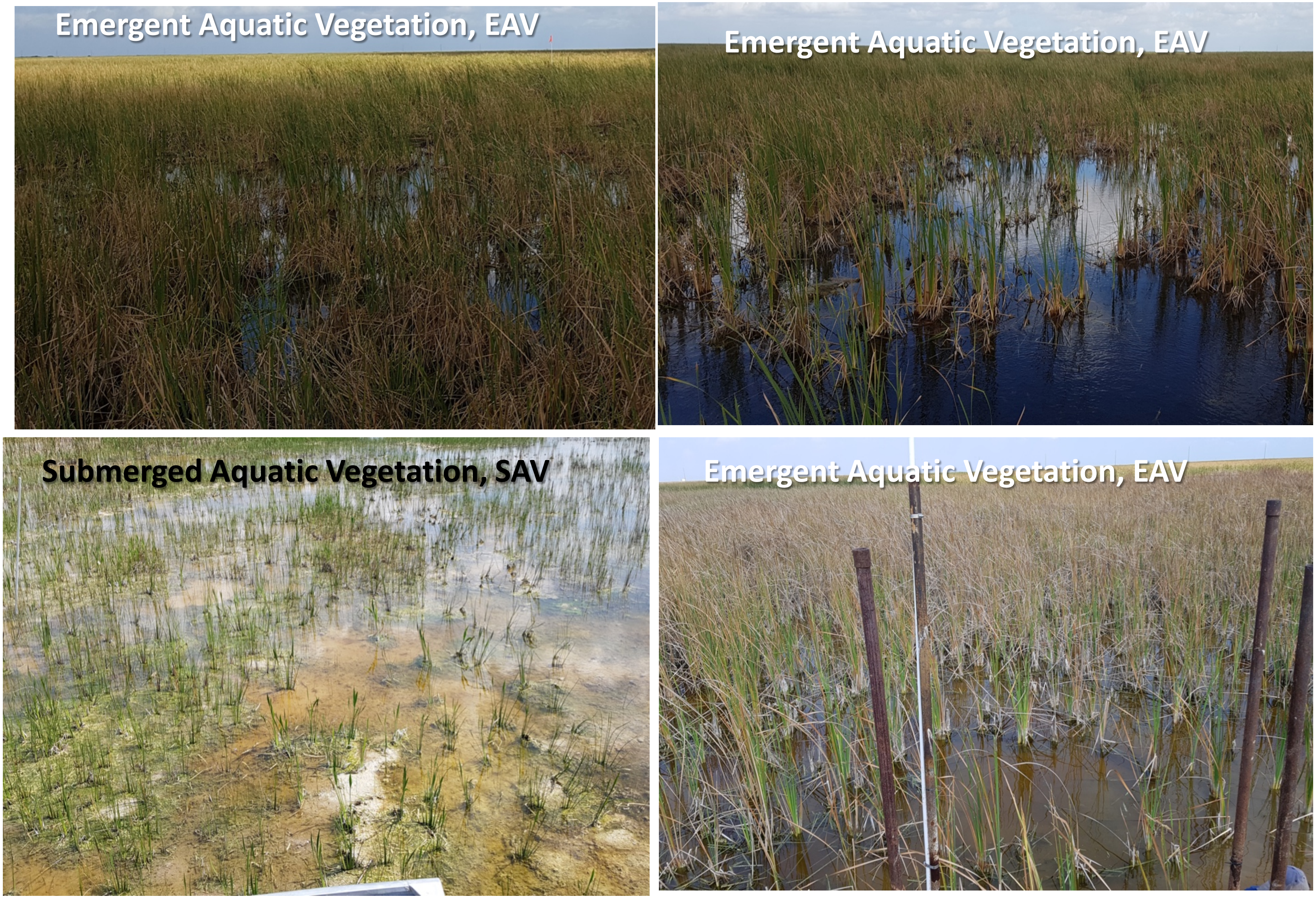




STA 3/4

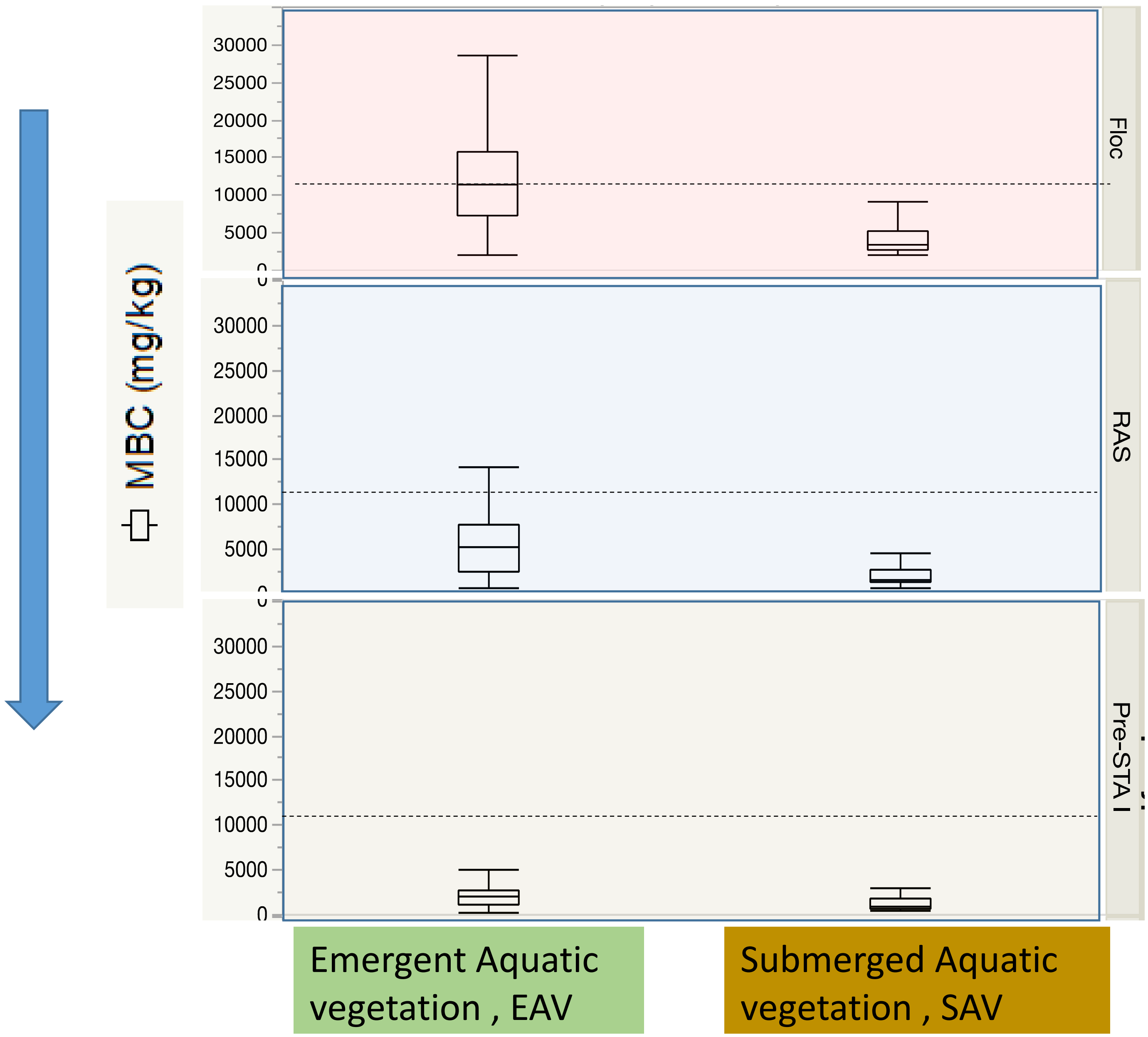






Photos credit: K. Pietro

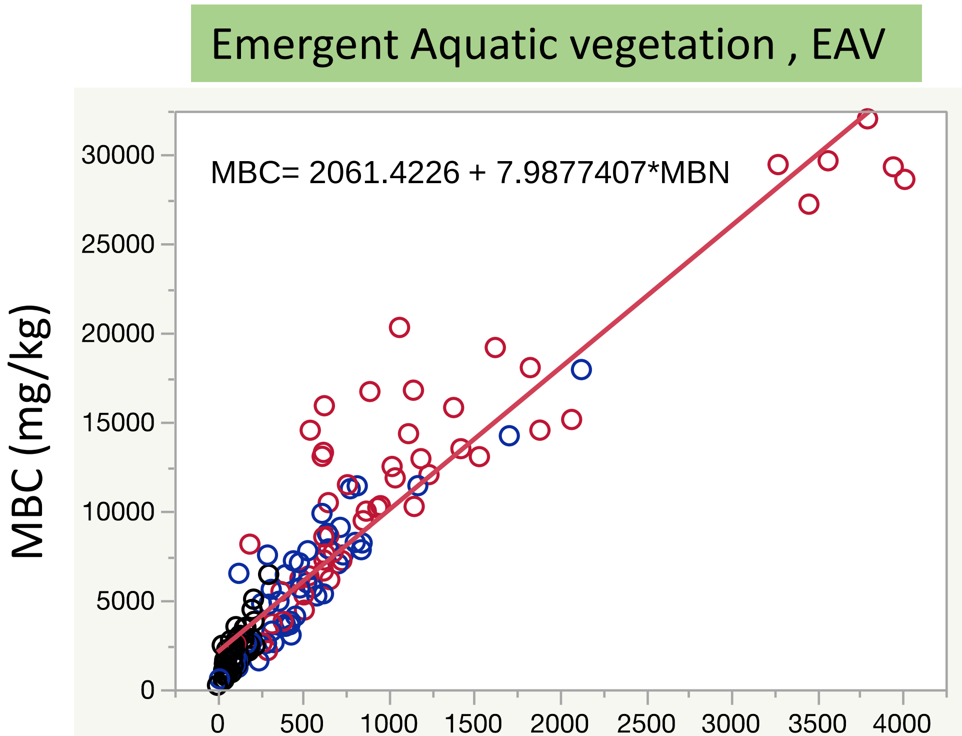
Microbial biomass C in vegetated cells

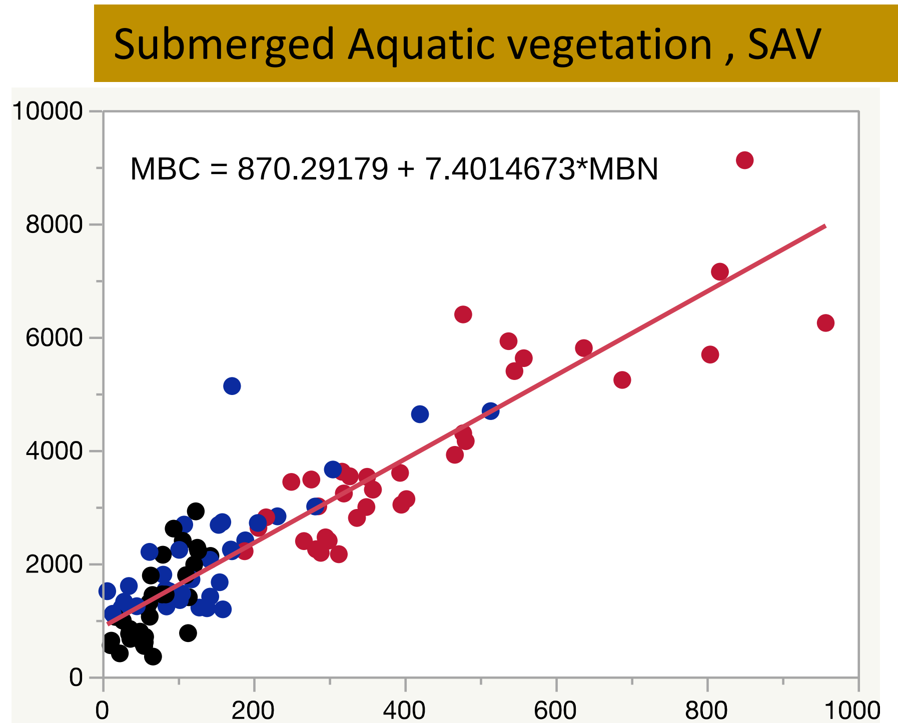


Microbial biomass abundance was higher in emergent vegetation (EAV)

Microbial biomass abundance was highest in Floc > Recently accreted soil (RAS)> Pre-STA1 soil

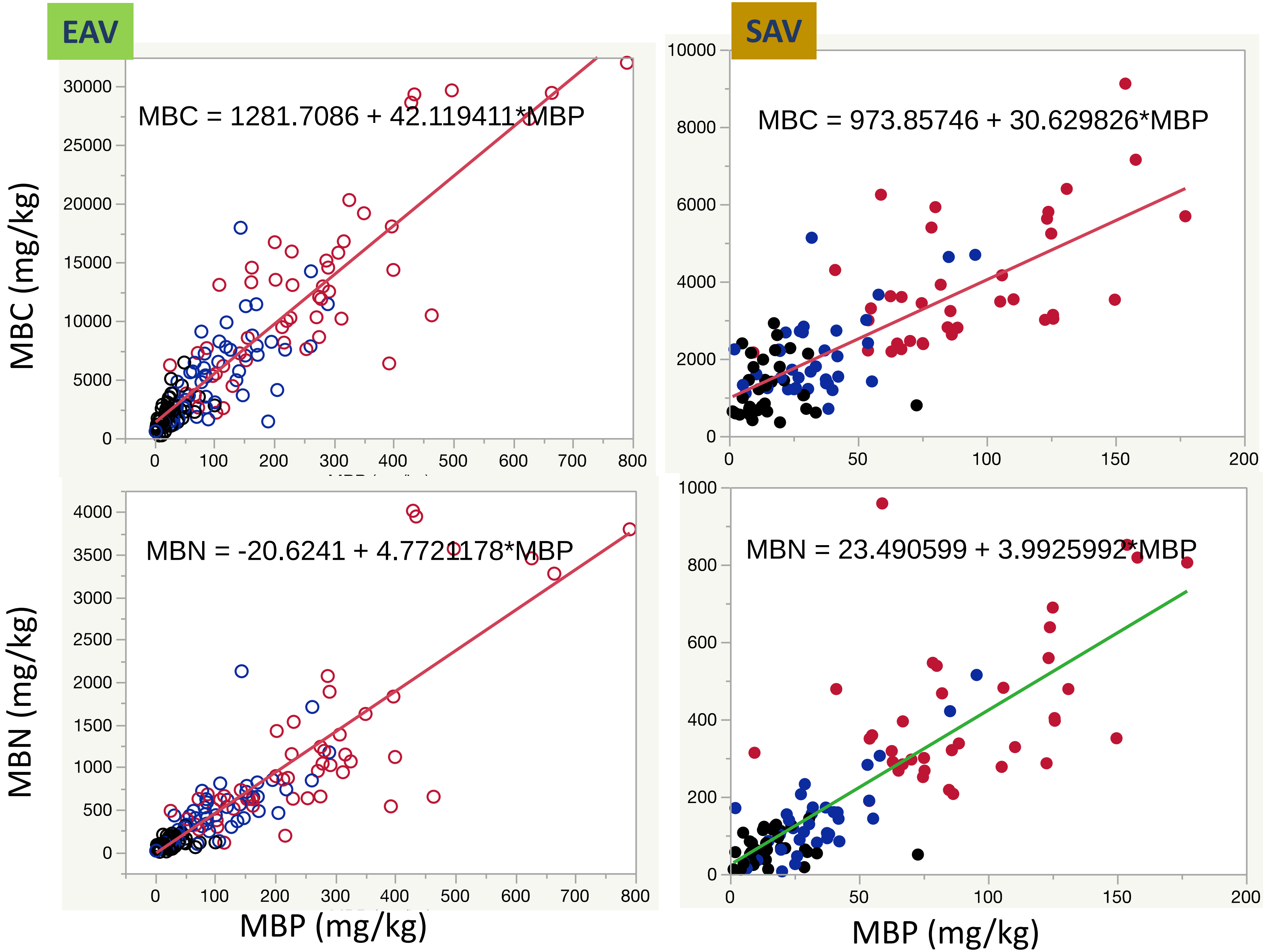
Relationship between microbial C & N



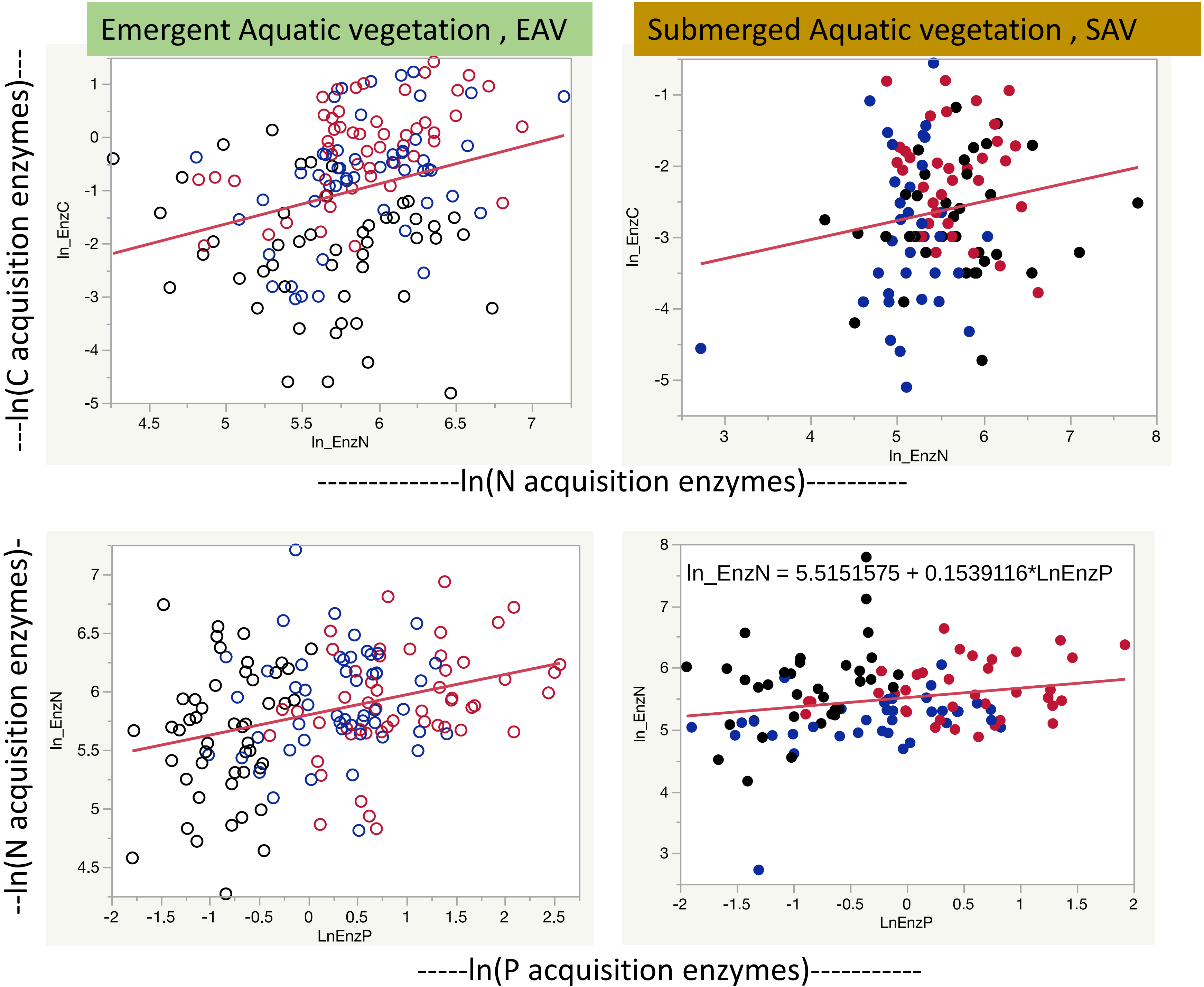


--------MBN (mg/kg)-------

MBC:N in SAV and EAV are similar

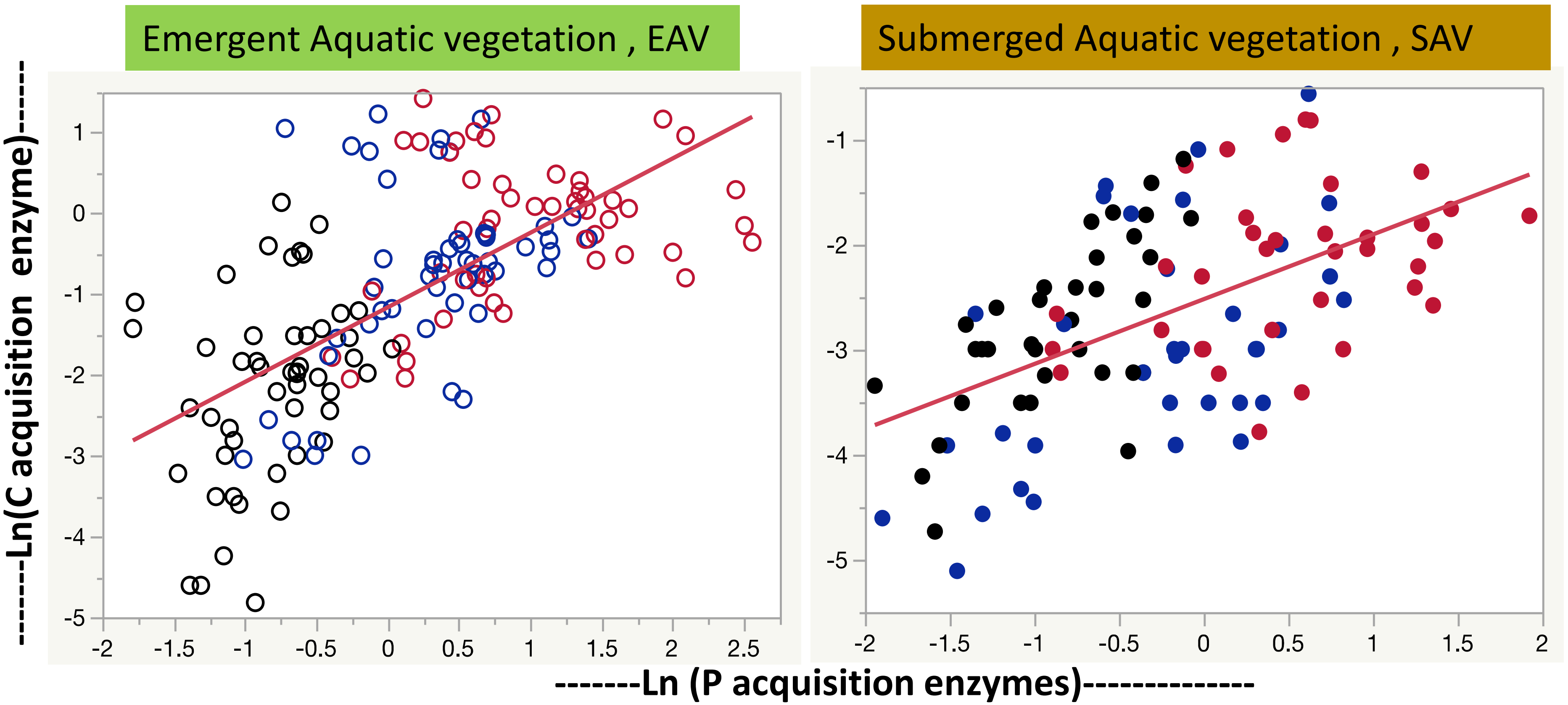


Microbial N:P and microbial C:P is lower in SAV suggesting relatively higher P demand in EAV systems



Emergent Aquatic vegetation , EAV
Submerged Aquatic vegetation , SAV
---ln(C acquisition enzymes)---
ln_EnzC
ln_EnzN
-------------ln(N acquisition enzymes)----------
--ln(N acquisition enzymes)-
ln_EnzN
LnEnzP
ln_EnzN = 5.5151575 + 0.1539116*LnEnzP
-----ln(P acquisition enzymes)-----------

Relationship between C & P acquisition enzymes



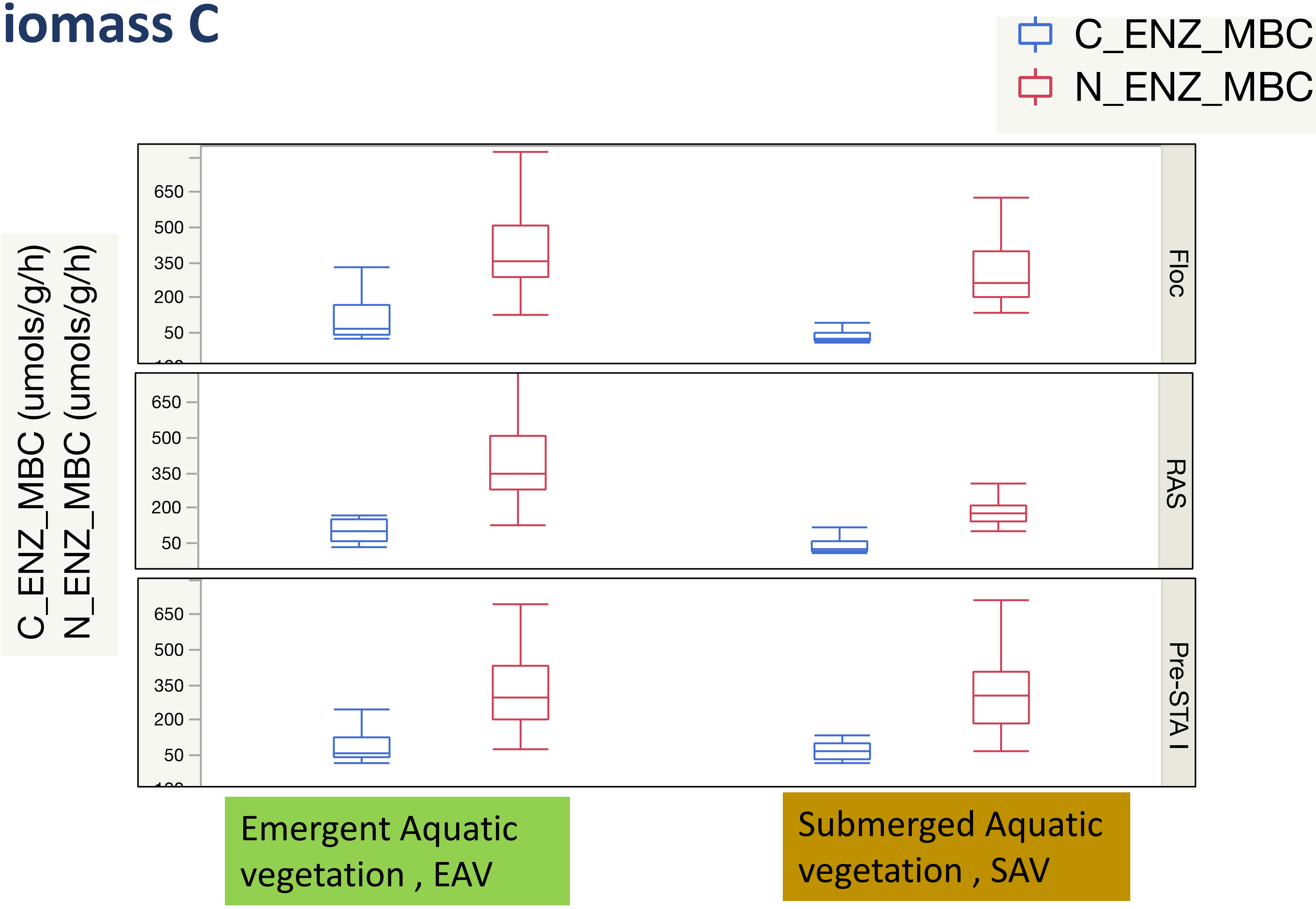
ln_EnzC = -1.163857 + 0.9225445*LnEnzP
R^2=0.41

ln_EnzC = -2.519768 + 0.6173704*LnEnzP
R^2=0.30

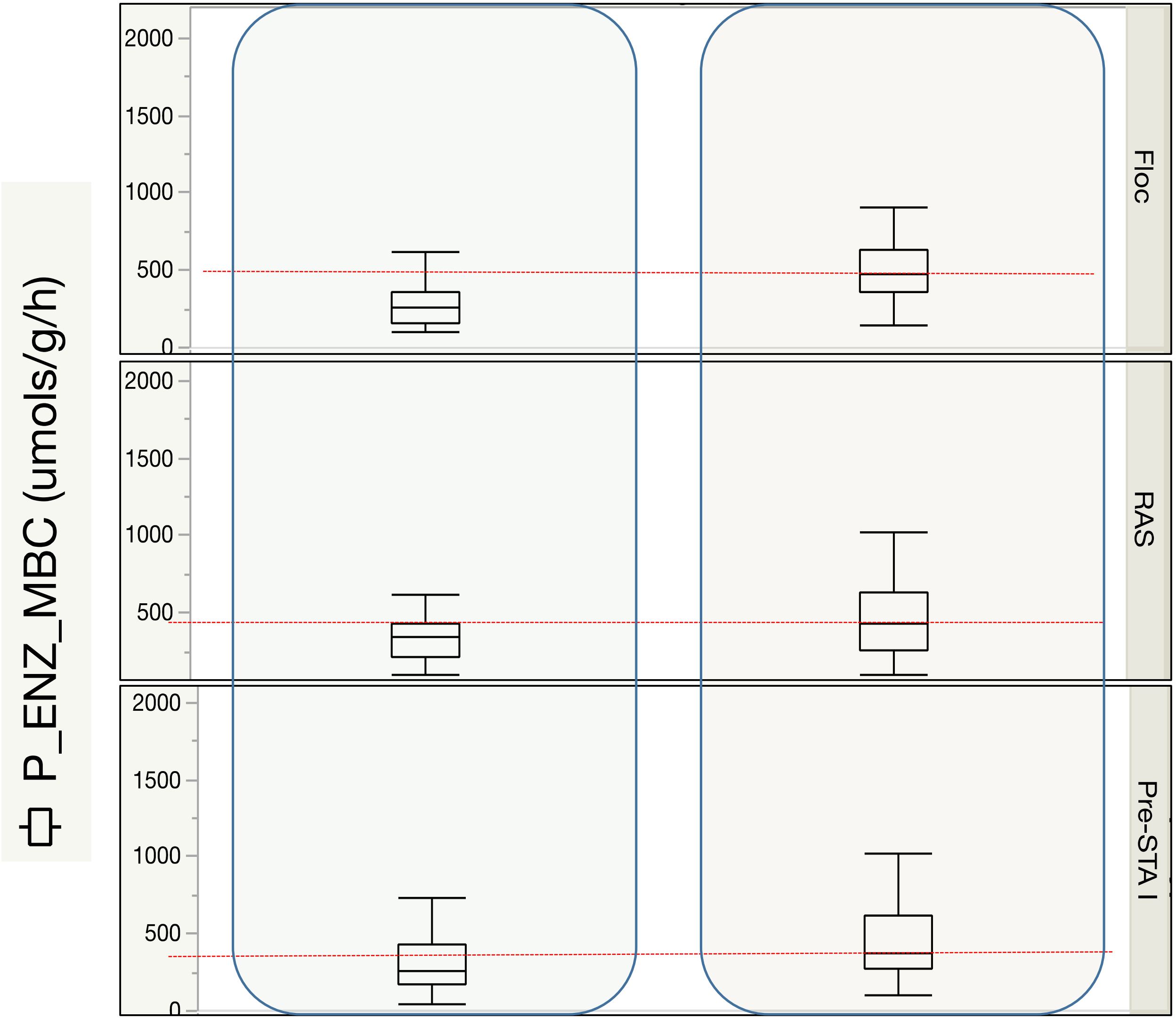
P enzymes= phosphatase+bis_phoshatase

C enzymes= β-glucosidase

Specific Enzyme activity –C & N acquisition per Microbial biomass C



Specific Enzyme activity –P acquisition per Microbial biomass C

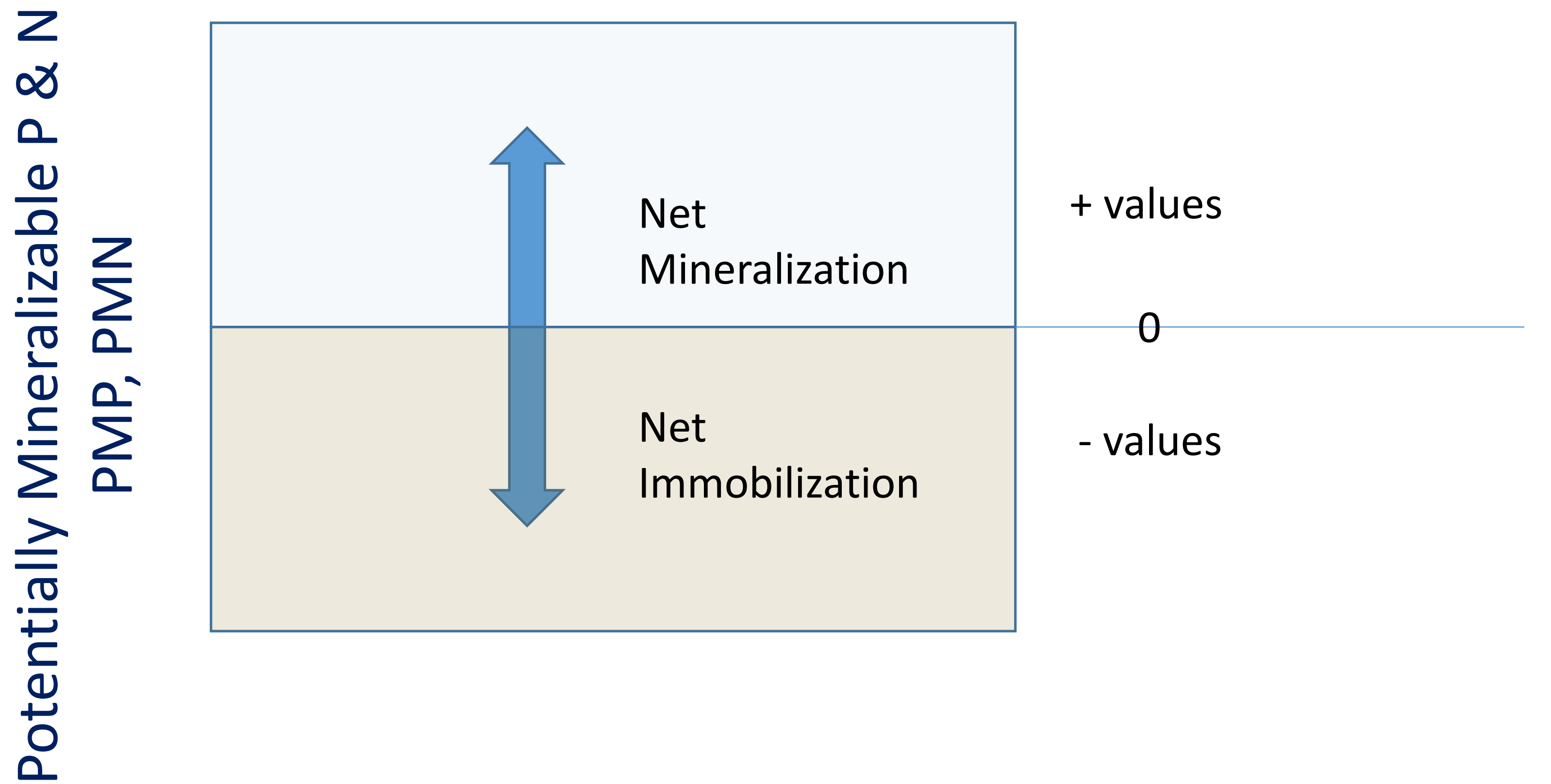


Emergent Aquatic vegetation , EAV

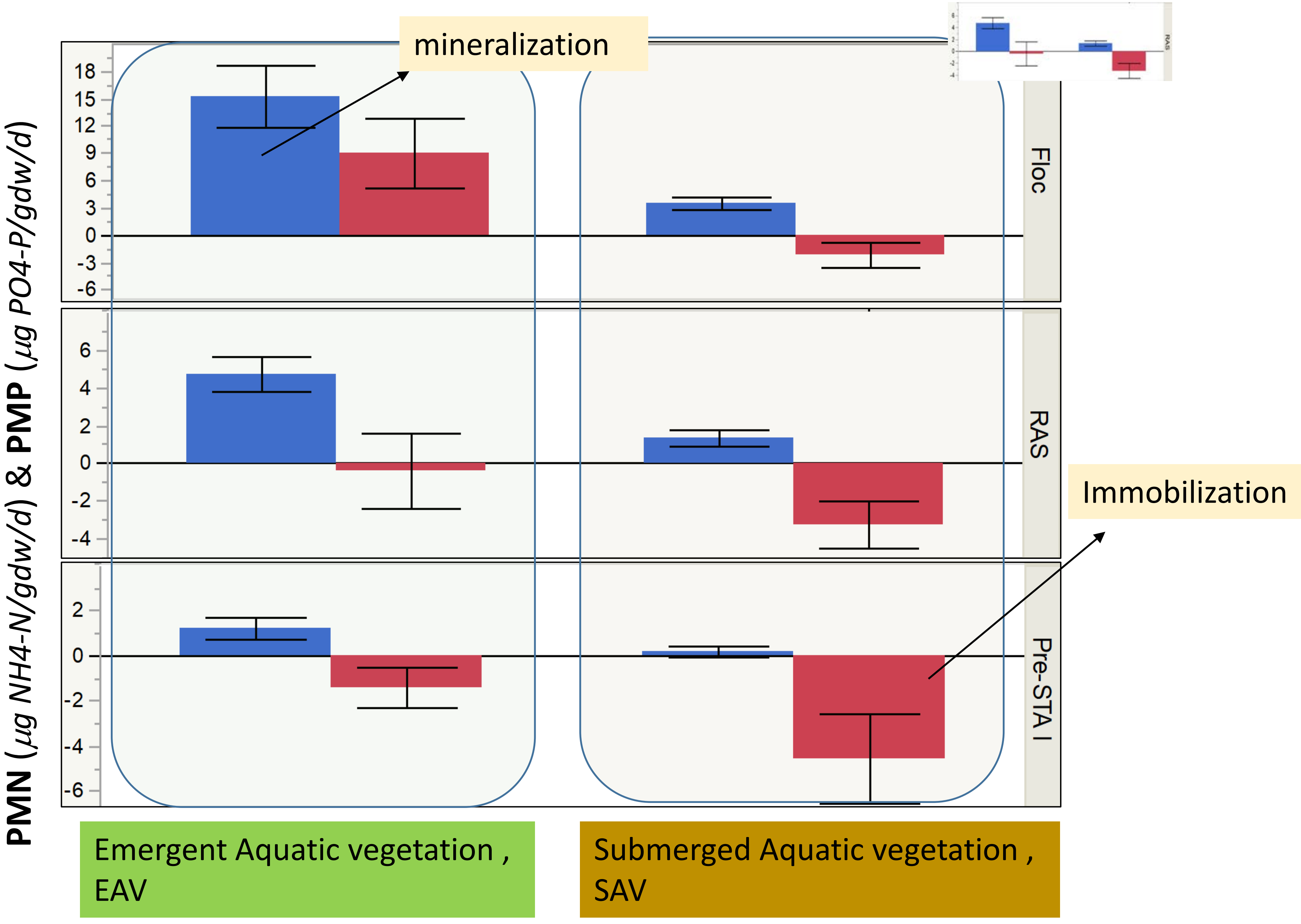
Submerged Aquatic vegetation , SAV

Means of specific P-acquisition activity was higher in the SAV systems.

Phosphorus (P) & Nitrogen (N) Mineralization



Phosphorus (P) & Nitrogen (N) Mineralization



Conclusions

- The microbial nutrients were not as reflective of nutrient availability as the enzyme ratios were.
- Microbial biomass stoichiometry indicated that EAV systems were more likely to be P limited.
- Enzyme stoichiometry indicated the SAV systems exhibited higher P demand.
- Mineralization of Nutrients, P and N were in agreement with the enzyme stoichiometry.
- Stoichiometric differences corresponded to patterns in enzyme activity and mineralization.

Implications

The finding here have implications for interpretation of enzyme stoichiometry data and for decomposition models that use stoichiometry to determine the nutrient turnover or limitation.

Acknowledgements

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South Florida Water Management District

Photos: Kathy Pietro