

Multi-channel Attached Algae Flow-ways: Design Optimization for Enhanced Biomass Productivity and Quality

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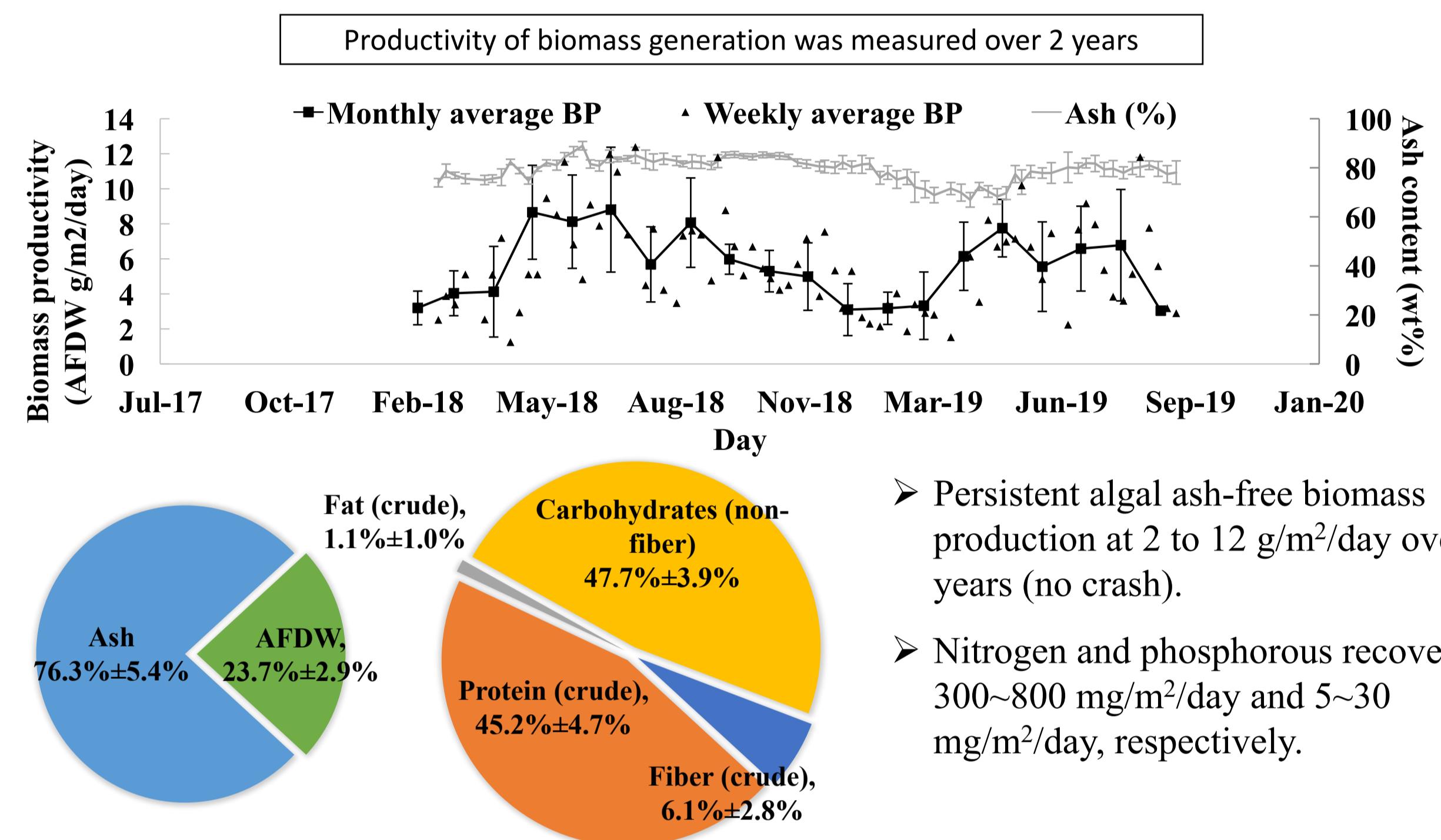
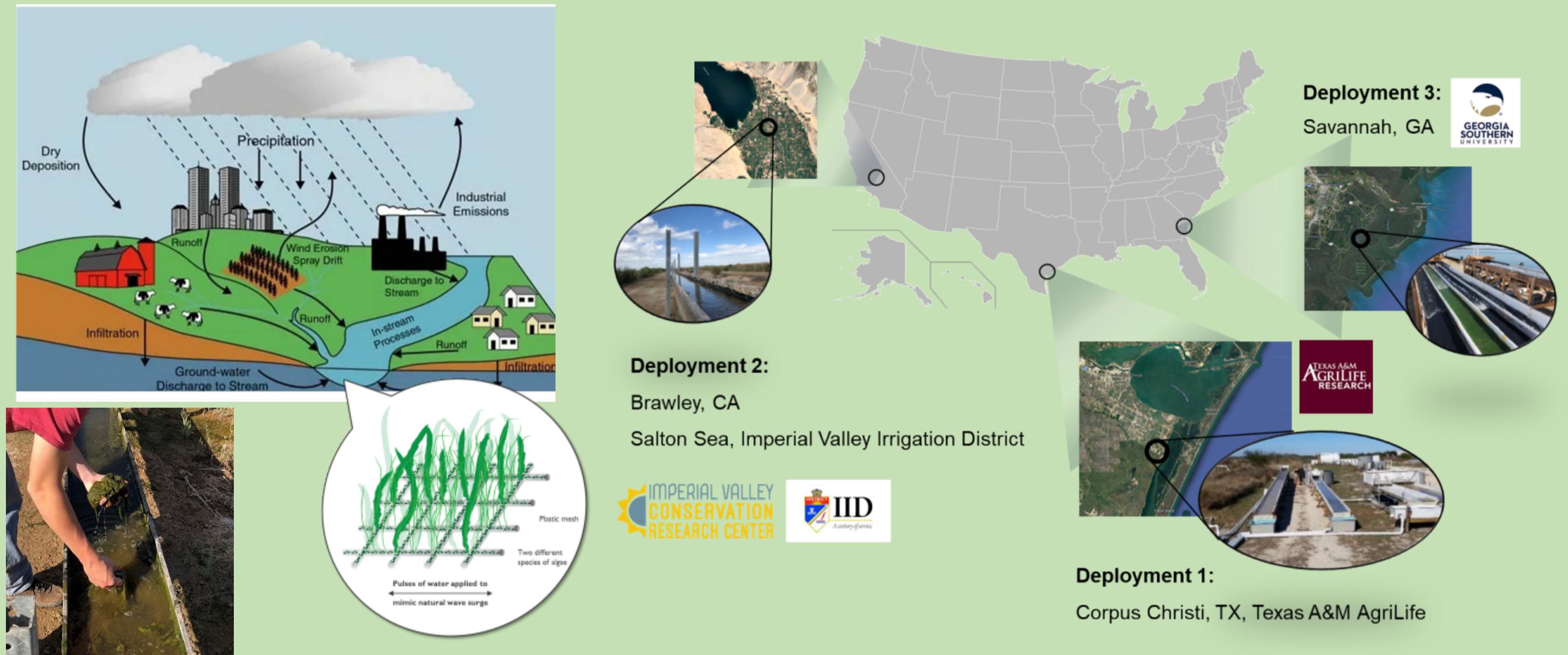
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Problem Statement

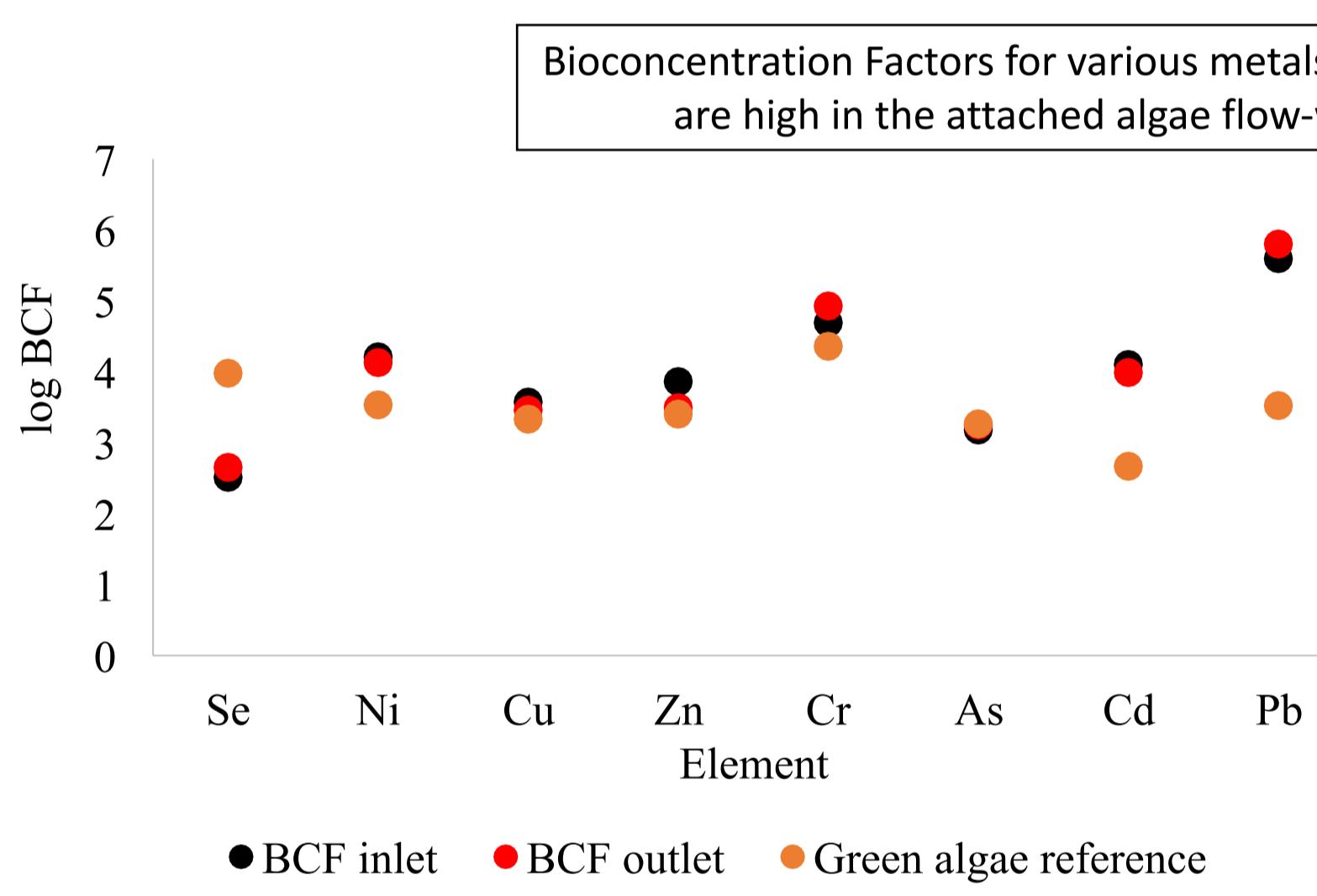
- Sustainable production of biomass as a feedstock for biofuel is needed.
 - The conventional suspended cultivation method suffers from low biomass concentrations (0.1~1% of solid).
 - Wasted nutrients in the agricultural runoff should be removed, otherwise can cause harmful algal blooms.
 - Low biomass quality: high ash and low lipid contents.

Objectives

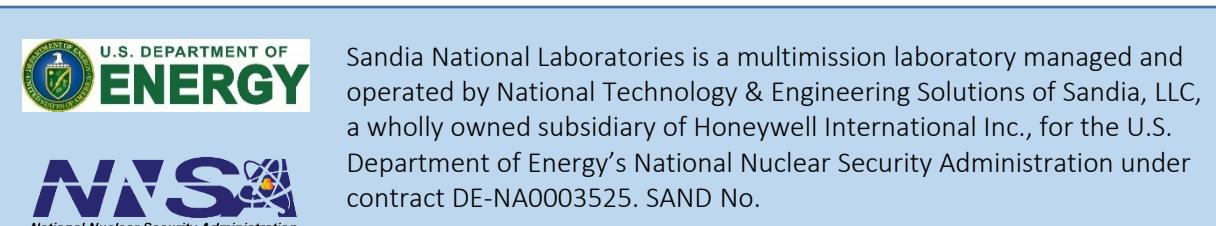
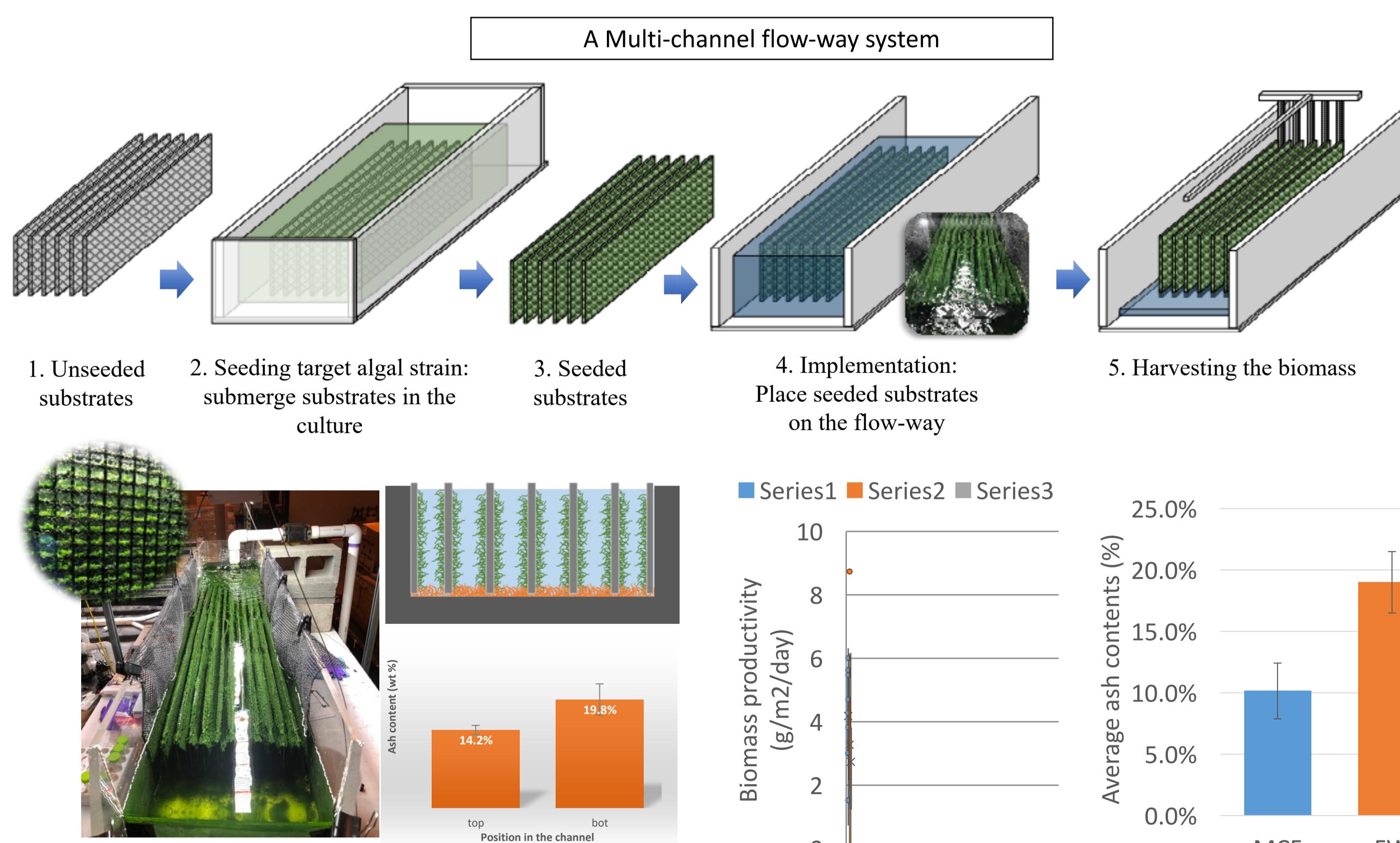
- Improve footprint biomass productivity through optimization of design and operation of the attached algae flow-way
 - Improve quality of biomass through the understanding of algae-associated microbial community dynamics and domination of key algal strains



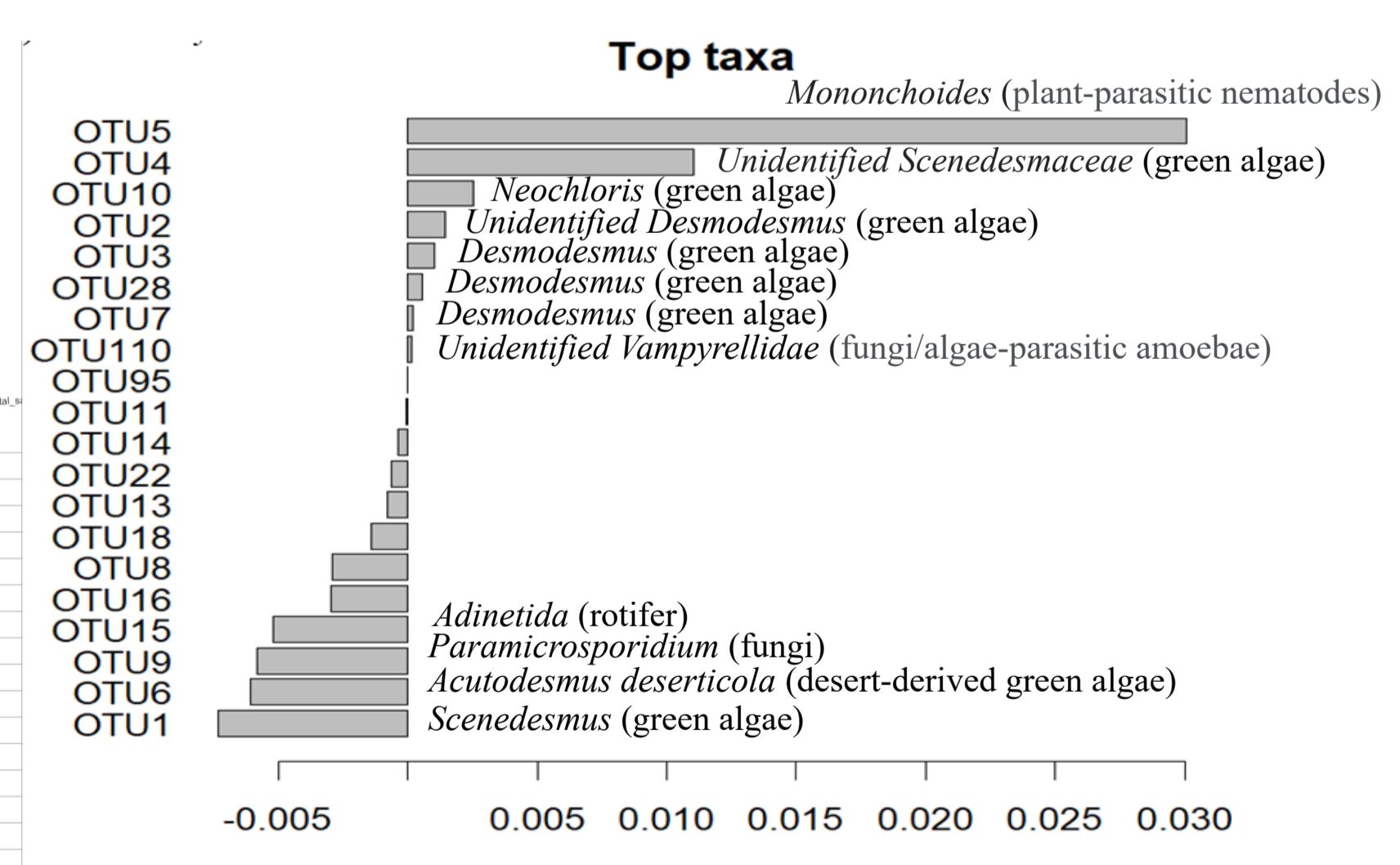
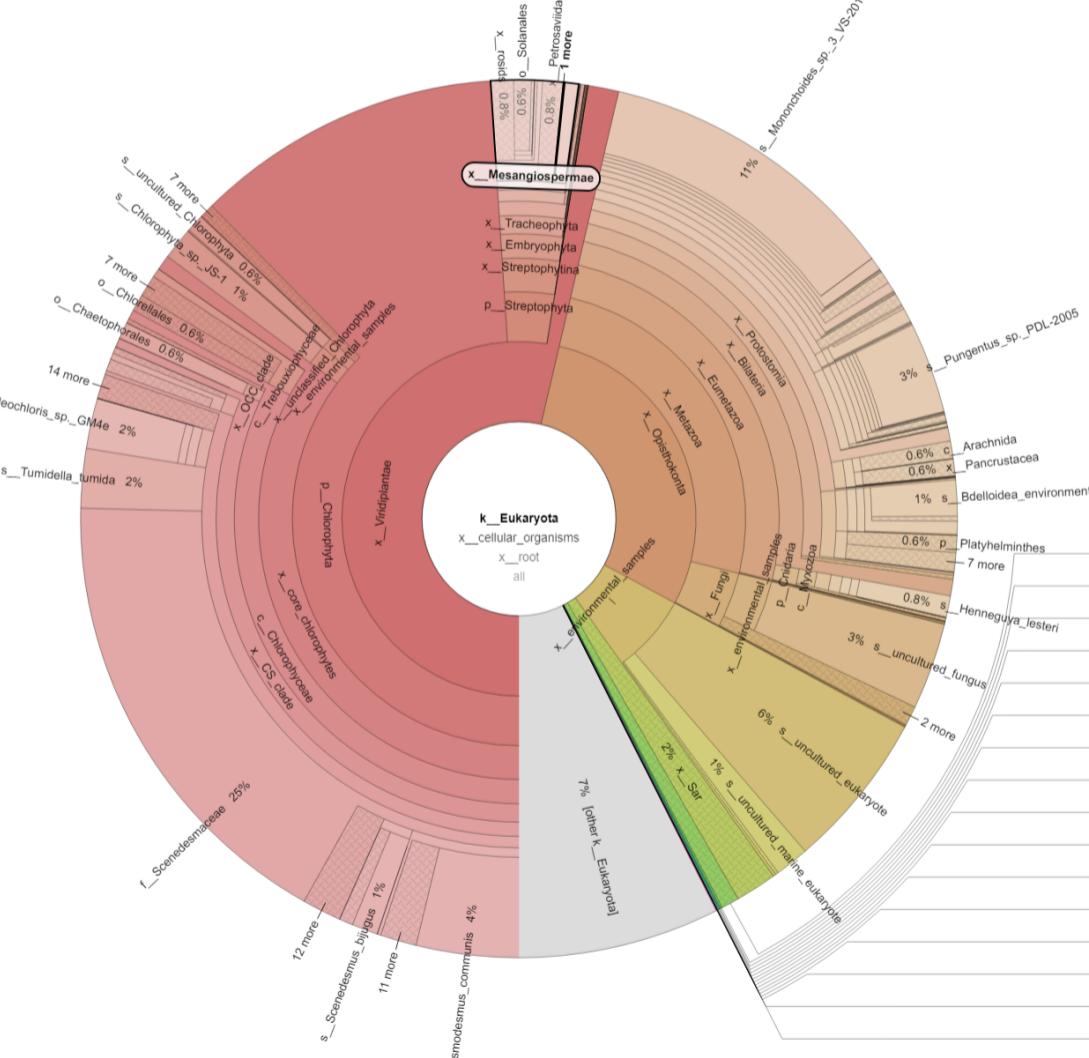
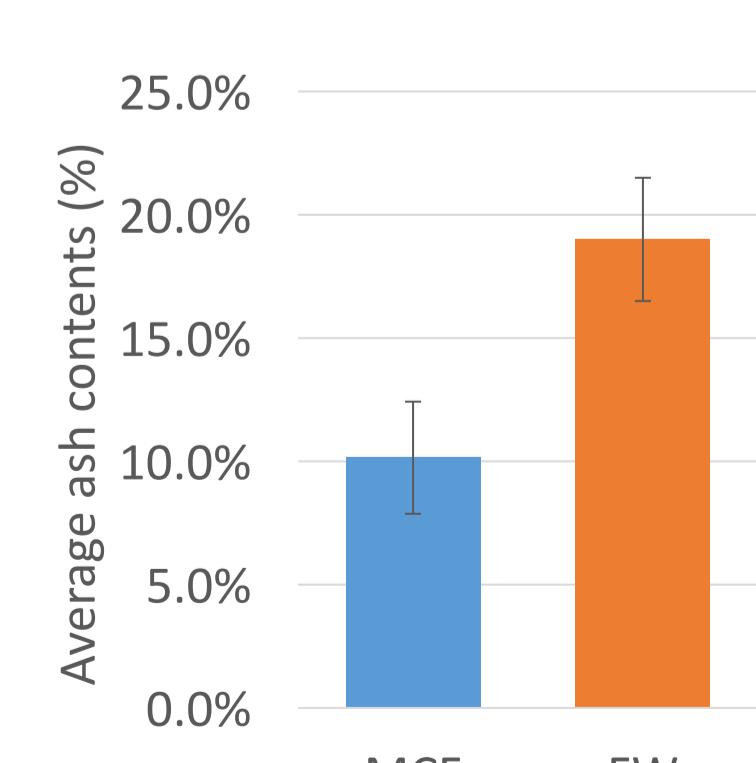
- Persistent algal ash-free biomass production at 2 to 12 g/m²/day over two years (no crash).
 - Nitrogen and phosphorous recovery at 300~800 mg/m²/day and 5~30 mg/m²/day, respectively.



- Principal Component Analysis (PCA) shows that biomass productivity has a stronger positive correlation with weather conditions (high solar irradiation and warm temperature) than with concentrations of key nutrients
 - A relatively weaker correlation with nutrient concentration offers the algae flow-way independence from the changes in nutrient availability
 - Bioaccumulation of metal contaminants enables the algae flow-way a unique benefit to local ecosystem remediation.



1. Kim, S., Quiroz-Arita, C., Monroe, E.A., Siccaldi, A., Mitchell, J., Huysman, N., Davis, R.W. 2021. Application of attached algae flow-ways for coupling biomass production with the utilization of dilute non-point source nutrients in the Upper Laguna Madre, TX. *Water Research*, 191, 11686.
2. Hennequin, L.M.*; Kim, S.*; Monroe, E.A.; Eckles, T.P.; Beck, N.; Mays, W.D.; Fennell, P.S.; Hallett, J.P.; George, A.; Davis, R.W. 2022. Reclamation of nutrients, carbon, and metals from compromised surface waters fated to the Salton Sea: Biomass production and ecosystem services using an attached periphytic algae flow-way. *Algal Research*.



- Relative abundance of microbiome between two group (high (>3 g/m²/day) and low ash-free biomass productivity) was assessed.
 - Abundances of top 50 features across two different groups (high vs. low) have shown significantly different.
 - Cross-validation accuracy is high with AUC = 0.837 (AUC>0.6 is typically considered accurate)
 - Relative abundances of 27 bacterial genera collectively associated with ash-free biomass productivity of the flow-way with 17 of them positively associated and 10 of them negatively associated.