Activity analysis of rehydrated biomat to assess impact on system reestablishment (RRS10)

Unit process wetlands and riparian zones

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)

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Background

In the 21st century the impacts of climate change on infrastructure, including engineering wetlands, will continue to be widespread and difficult to predict. The potential for larger floods, stronger storms, and catastrophic disruption events continues to increase with each passing year. These events create concerns with the performance and resilience of engineered wetlands while also creating opportunities for use in storm water treatment and other applications. Our project goal was to provide preliminary information on the potential of open water wetlands to respond to drying events in order to inform future research into these opportunities while also informing the resilience of open water wetlands to catastrophic disruption events.

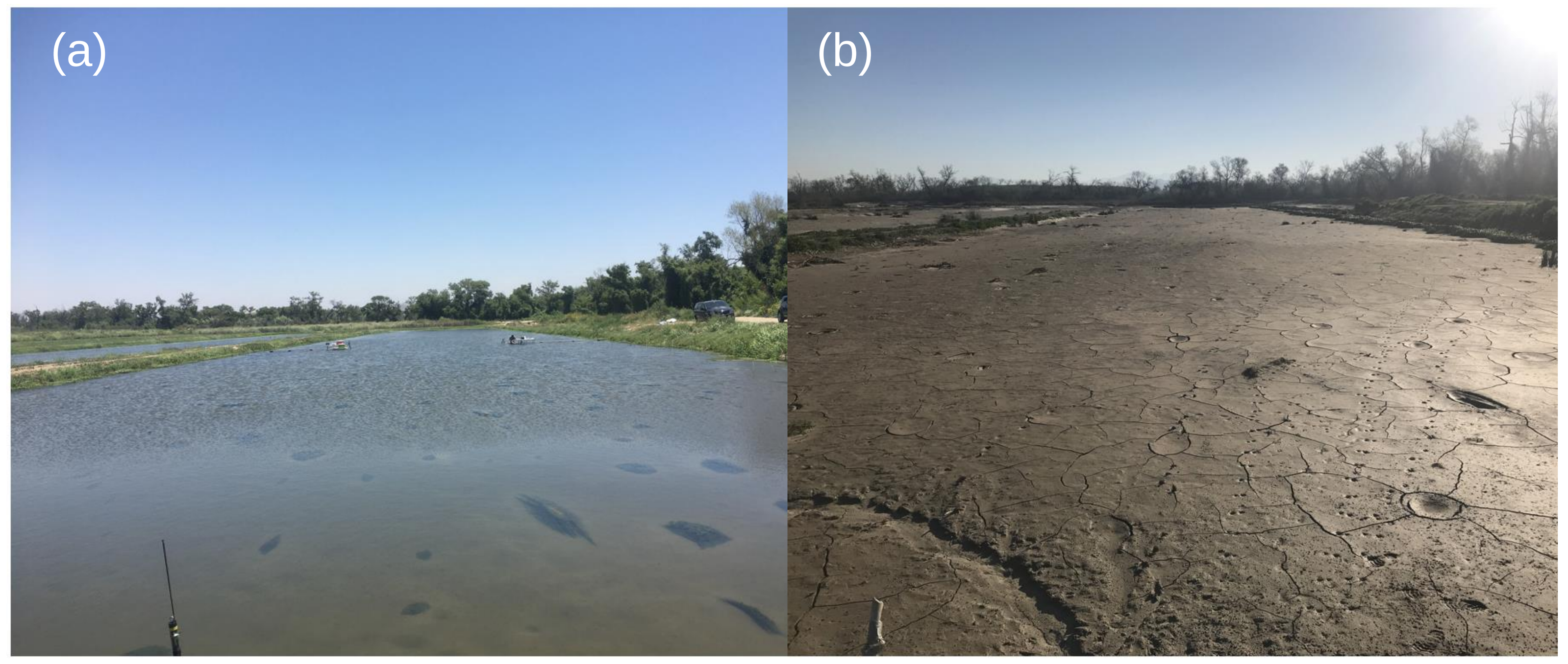

Figure 1. (a) Cell Before Flood Event; (b) Cell After Flood Event

Approach

- The system consisted of four flow-through cells containing an equivalent dry weight biomat and water volume; three cells contained dried biomat collected in November 2018 from the Prado Wetlands Testbed to be rehydrated. The fourth cell contained biomat collected from an operational open water wetland at the Prado Wetlands Testbed in January 2019 and kept hydrated.
- Residence time was approximately 2.6 days.
- Influent was a Prado analog water synthesized in the lab.

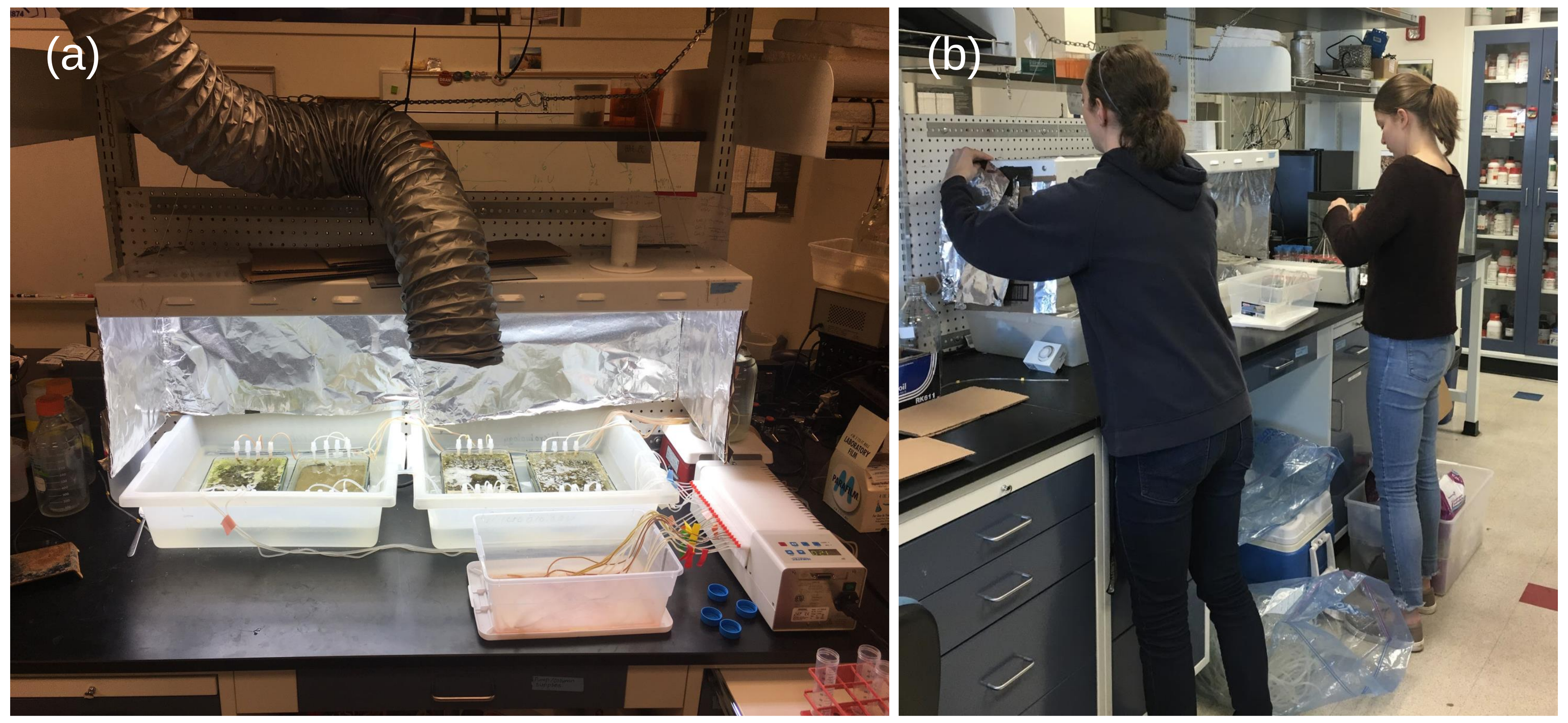

Figure 2. (a) Experimental Set up; (b) Sanelli (left) and Oliver (right) working on experiment

Hypotheses

H1: Dehydrated open water wetland biomat can be restarted with minimal loss of nutrient attenuation potential.
H2: Nitrate removal can be correlated to pH and DO trends in wetland cells, creating an easy-to-measure benchmark of wetland activation, operation, and performance.
H3: The microbial community will not shift during rehydration.

Results

Differing Substrates Create Variable Start Up Times

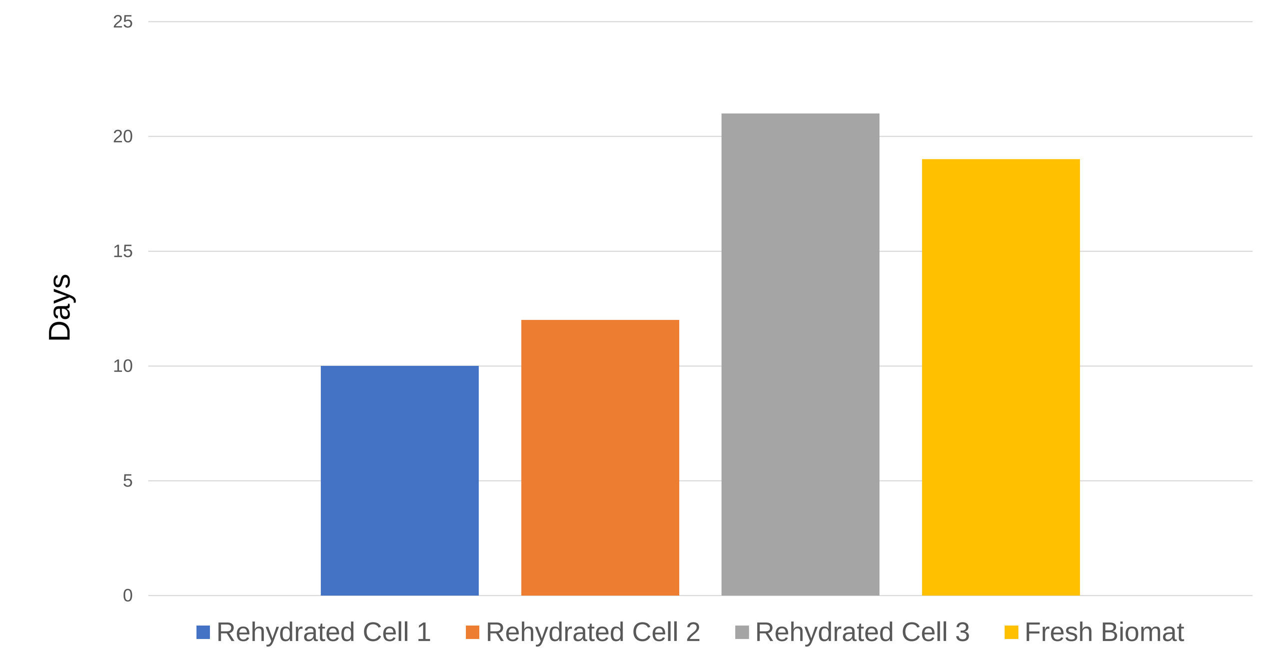

Figure 3. Time Until % Relative Std Dev of Daily pH and DO Shifts < 10%

Similar Performance Seen After Photosynthetic Equilibrium Reached

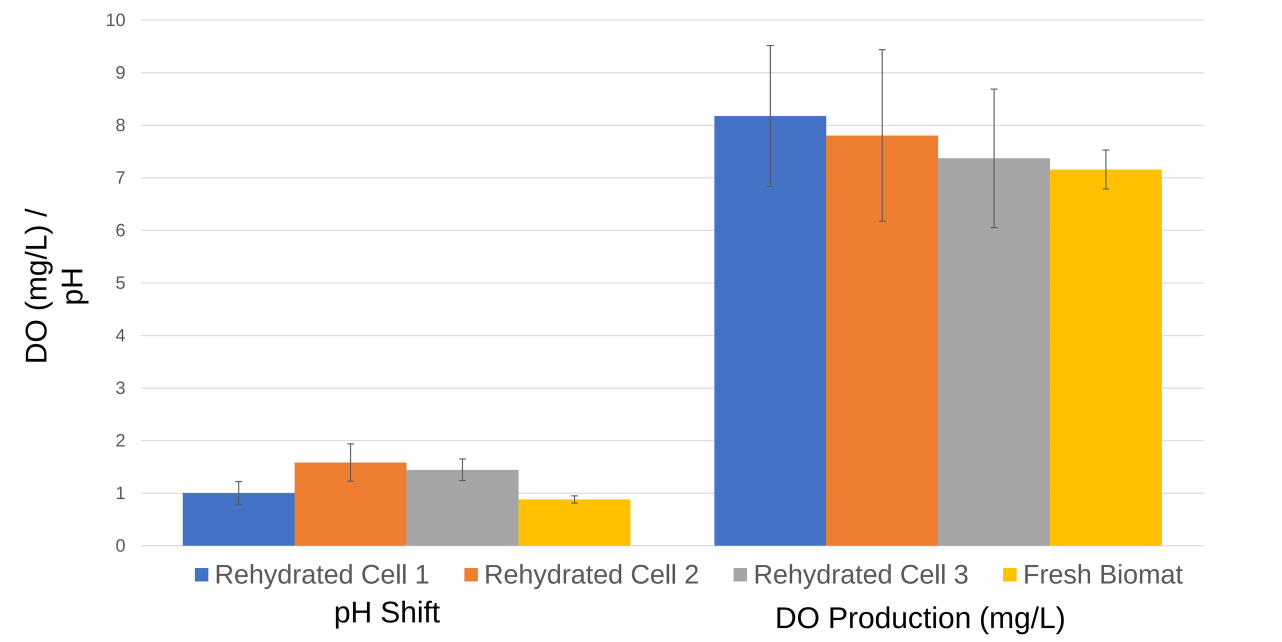

Figure 4. Average pH Shift and DO Production per Cell

Similar Average Nitrate Removal Rates Throughout Experiment

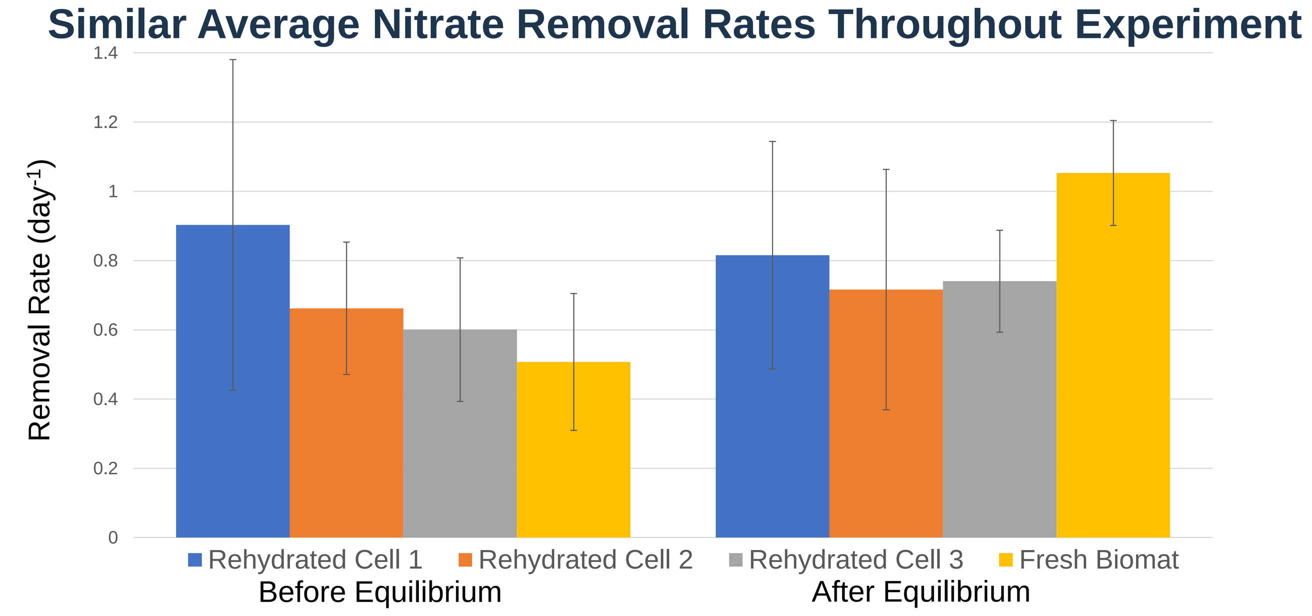

Figure 5. Nitrate Removal Rate Before and After pH/DO Equilibrium

Rehydrated Biomat Approached Photosynthetic Performance of Fresh Biomat

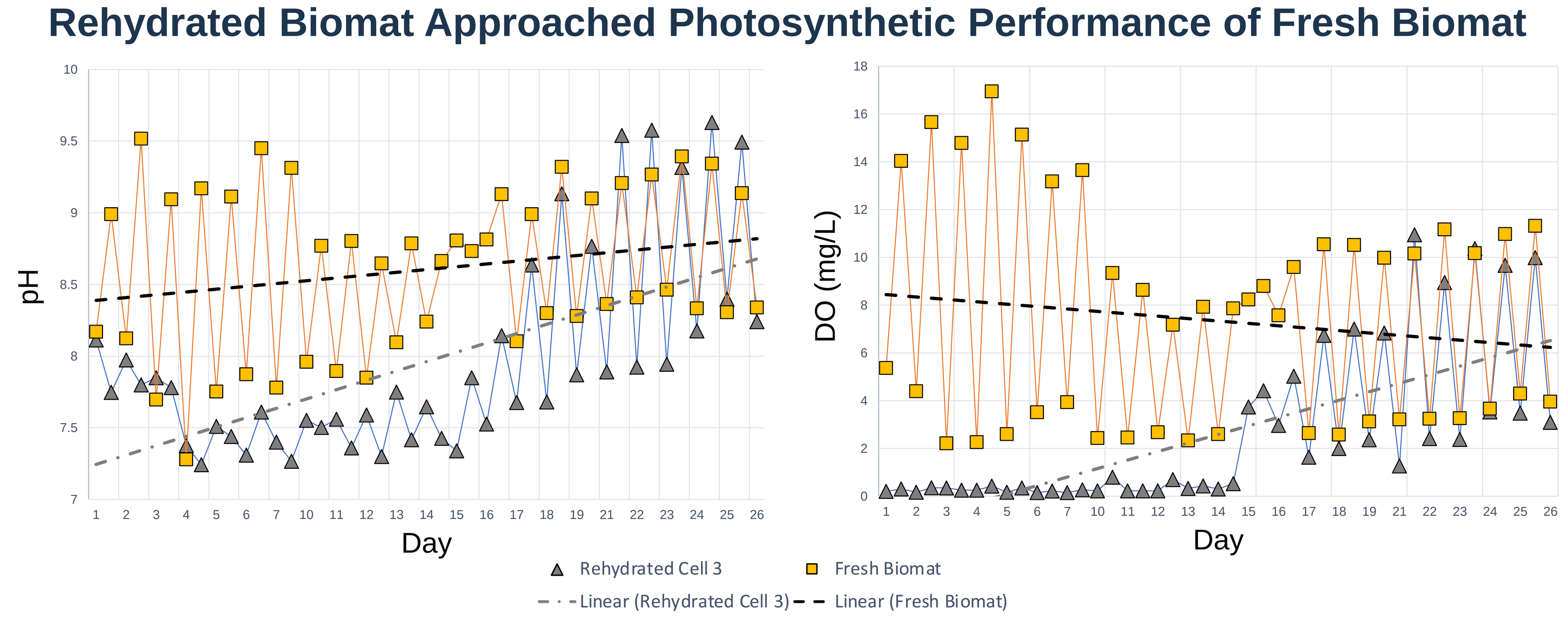

Figure 6. Comparison of pH (left) and DO (right) between Rehydrated Cell 3 and Fresh Biomat

Conclusions

1. Each experimental cell consisted of biomat collected from separate open water wetland cells with unique designs. These different substrates resulted in variable start-up times with respect to DO and pH equilibrium (Figure 3).
2. Once photosynthetic equilibrium was reached, the rehydrated and fresh biomat cells exhibited similar performance in DO production and pH shifts occurring during light periods (Figure 4).
3. Regardless of cell substrate or time taken to reach photosynthetic equilibrium, all four cells demonstrated similar average nitrate removal rates throughout the entire experiment (Figure 5).
4. Rehydrated biomat cells seemed to approach the photosynthetic performance with respect to pH and DO of fresh biomat as the experiment progressed (Figure 6).
5. Nitrate removal may be attributed to either denitrification or assimilation as biomass.
6. The nitrate removal observed in all cells indicated that an open water wetland may be able to be restarted after a dry period with minimal loss of performance in nitrate attenuation.

Figure 7: Cells at Day 0

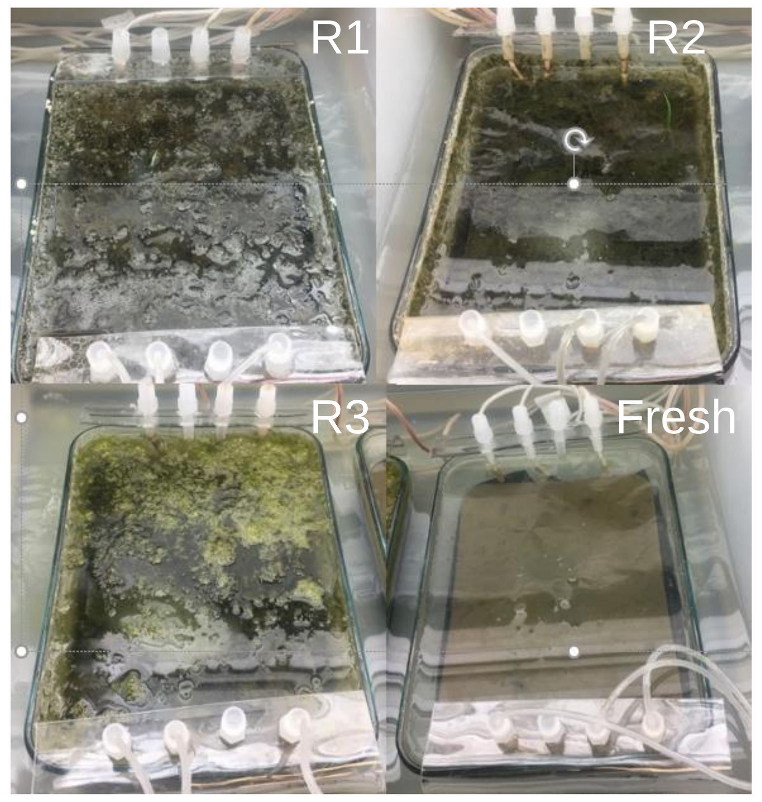

Figure 8: Cells at Day 26

Next Steps

- Investigate the relationship between pH, DO, and nutrient removal at steady state.
- Investigate microbial community via DNA extraction and analysis to observe if any changes occur in the population throughout the rehydration process.
- Determine if there is a limit to the number of times biomat can be rehydrated before nutrient attenuation is no longer viable to determine harvest potential.
- Evaluate denitrification potential to differentiate between denitrification and assimilation to determine maximum nutrient attenuation versus biomat growth.
- Determine impact of catastrophic event on rehydration potential and resilience of an open water wetland cell.

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