Breathing Life into a Spring
Prioritizing Restoration Activities in Florida's Springs

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Introduction

- Springs have transitioned from submerged aquatic vegetation (SAV) to nuisance algae
- Restoration has primarily focused on nutrient reduction
- Restoration fails because resilience of degraded ecosystems is not considered
- Restoration techniques are not equal and may vary by site
- Ranking a hierarchy of needs for individual sites promotes restoration success

Objective

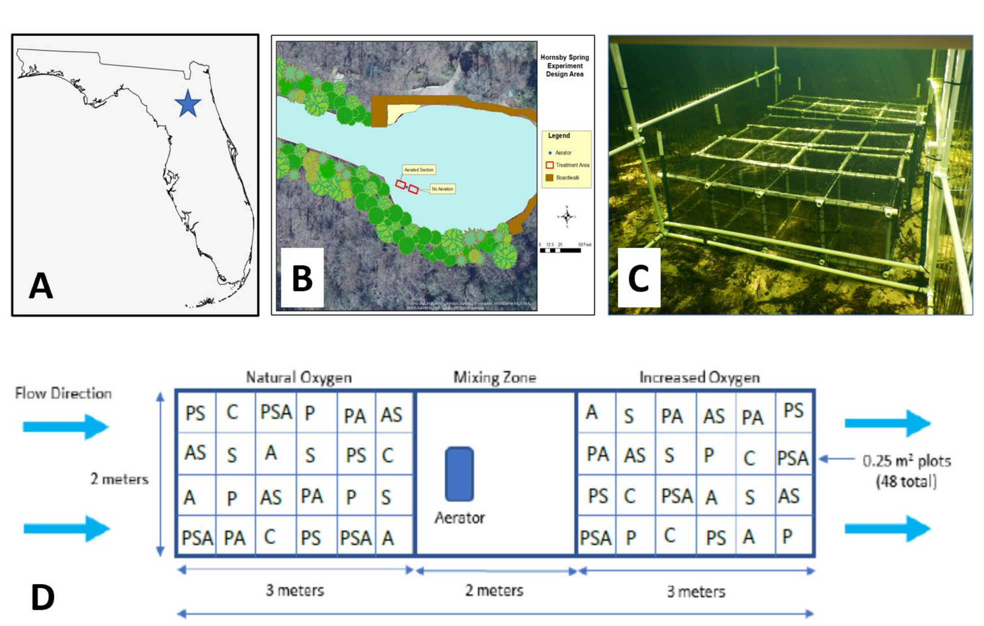
- Determine hierarchy of restoration needs by evaluating competing restoration needs in Florida's iconic springs

Hypotheses

- Dissolved oxygen (DO) is a keystone driver of restoration success
- Plant and snail introductions more successful when dissolved oxygen concentrations are favorable

Materials and methods

- Plant and algal growth measured at Hornsby Spring over one-year period:
- Control plots and combination of 4 variables tested and replicated 3 times (total 48 plots)
  1. Addition of Snails (S)
  2. Removal of Algae (A)
  3. Planting of Submerged Aquatic Vegetation (P)
  4. Increased DO through Aeration (D)
- Dissolved oxygen averaged 0.20 mg/L naturally/increased to 1.77 in aeration
- Light and velocity measurements collected to ensure primary factors equal
- Algal growth measured off ceramic tiles scraped cleaned
- Plant growth measured by counts of stocks and leaf blades measurements



A. Hornsby Spring Location, **B.** Experiment Location, **C.** Experiment Set Up, **D.** Schematic of Experiment Design

Results

- Aeration alone was statistically significant and reduced the slope of the model by ~25%
- Snails were statistically significant when combined with aeration, reduced slope by additional 43%
- Planting SAV and aeration lesser yet still statistically significant reduction in algal biomass
- Removal of algae at the start of the project did not have significant effect of the growth of algae

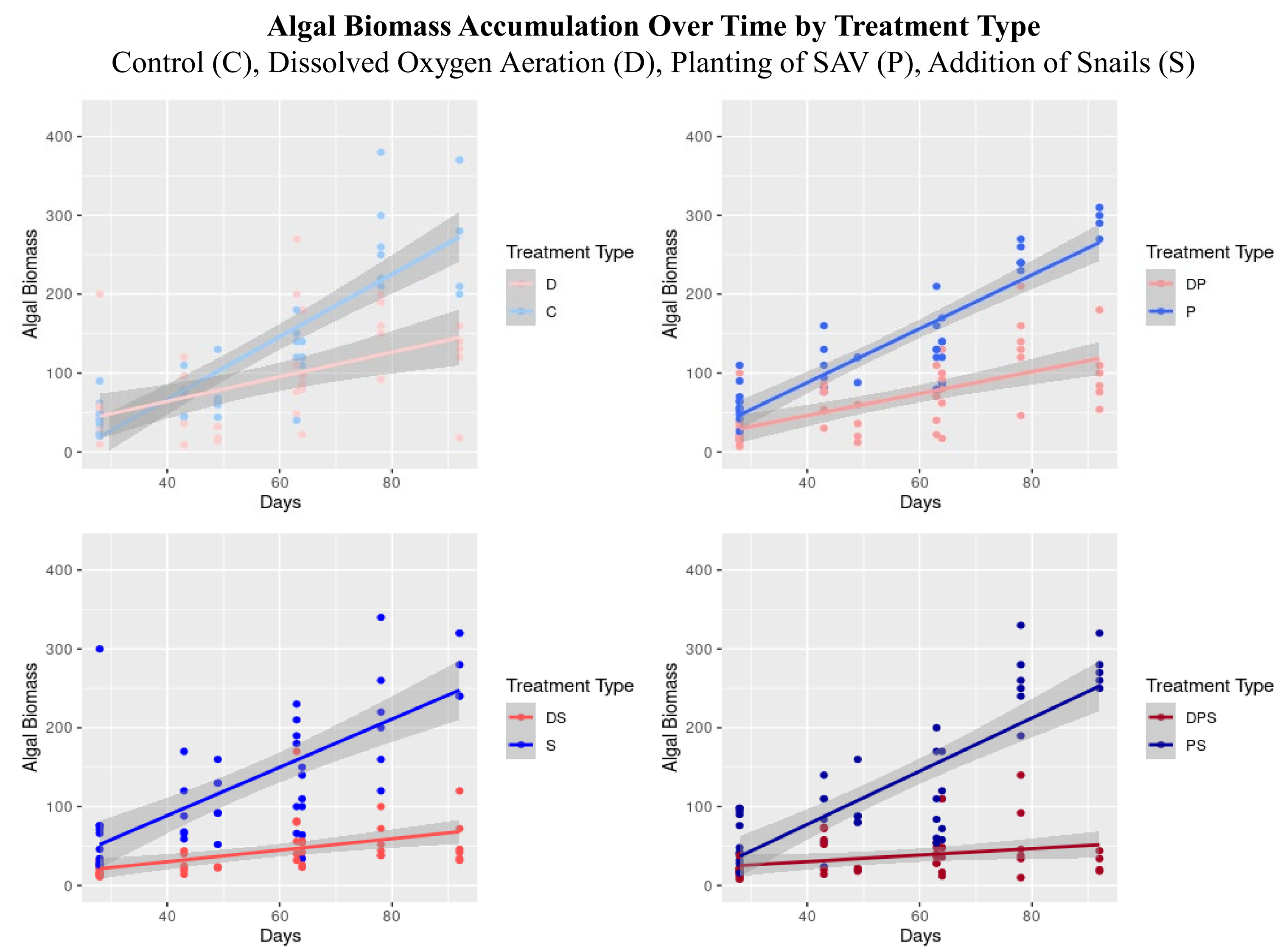
Summary Readout of General Linear Model

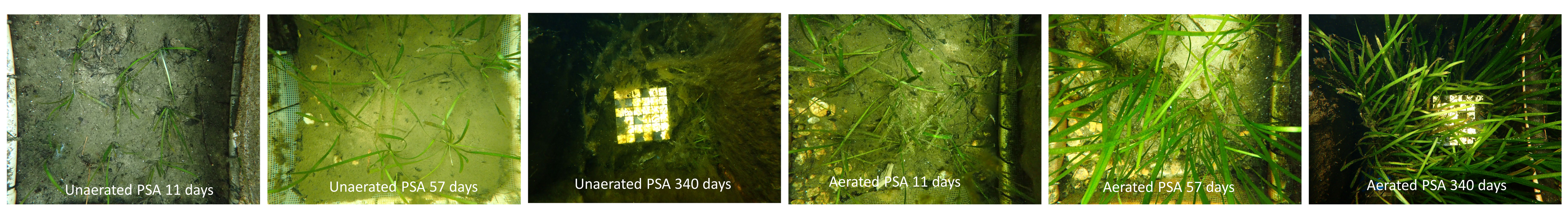
	Estimate	Std. Error	t value	p-value
(Intercept)	1.32	0.058	22.37	< 2.00 e-16***
S	-0.011	0.036	-0.318	0.75
D	-0.013	0.084	-0.154	0.88
P	0.030	0.036	0.849	0.40
A	-0.042	0.036	-1.18	0.24
Days	0.013	0.001	15.5	< 2.00 e-16***
S:D	-0.244	0.051	-4.76	2.81 e-06***
D:P	-0.106	0.051	-2.06	0.04*
D:A	0.057	0.051	1.12	0.26
D:Days	0.004	0.001	-3.61	0.0004***

Significant codes: 0.001*** , 0.05*

Null deviance: 58.56 on 360 degrees of freedom

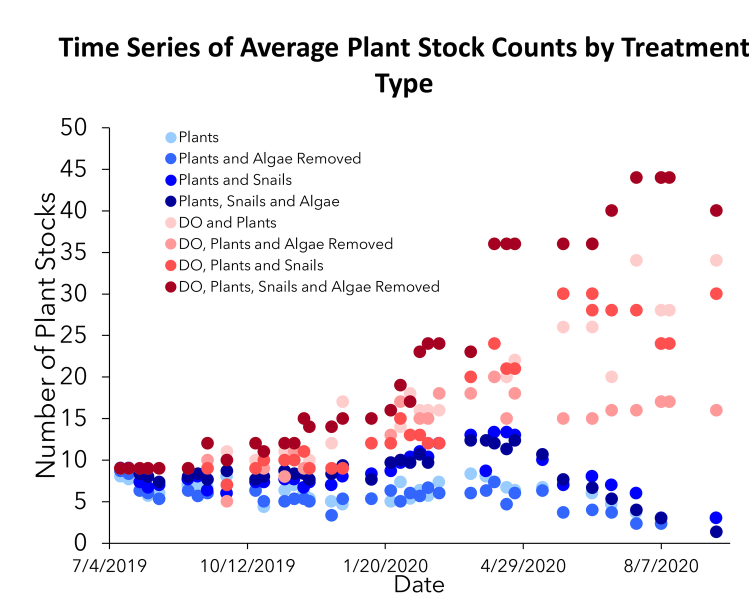
Residual deviance: 20.84 on 351 degrees of freedom

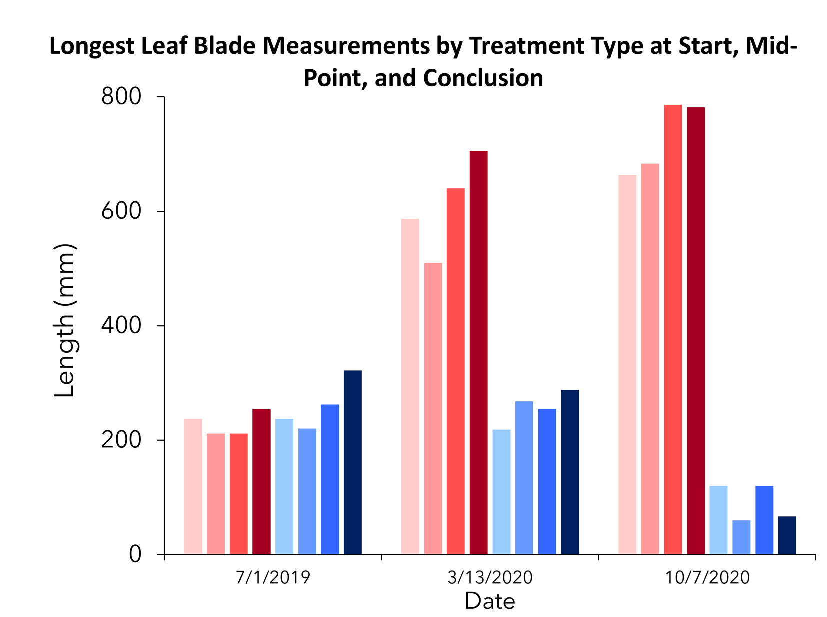




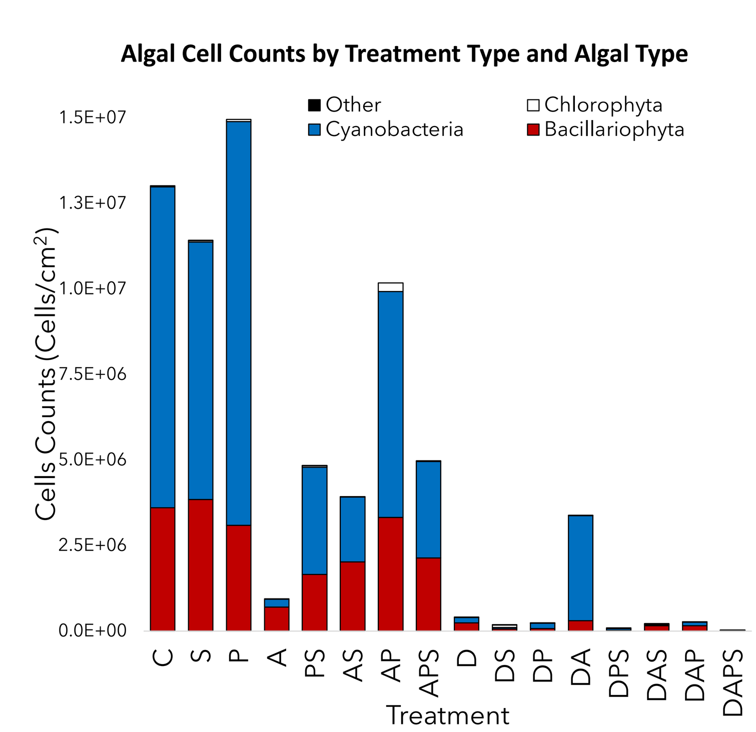
Results continued

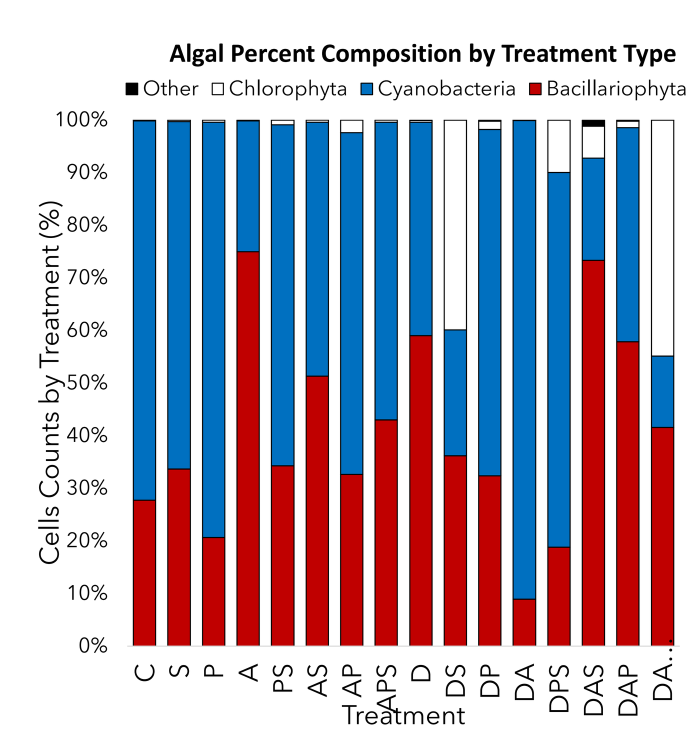
- Aeration had significant effect on establishment and growth of SAV
- The number of plants significantly increased compared to treatments without aeration
- SAV reproduced and flowered over the period of the project only with aeration
- Treatments at background levels of DO (0.22mg/L) experienced high levels of plant mortality
- Algal Cell counts significantly less on treatments receiving aeration vs without
- Composition of algal communities differed between treatments with and without DO





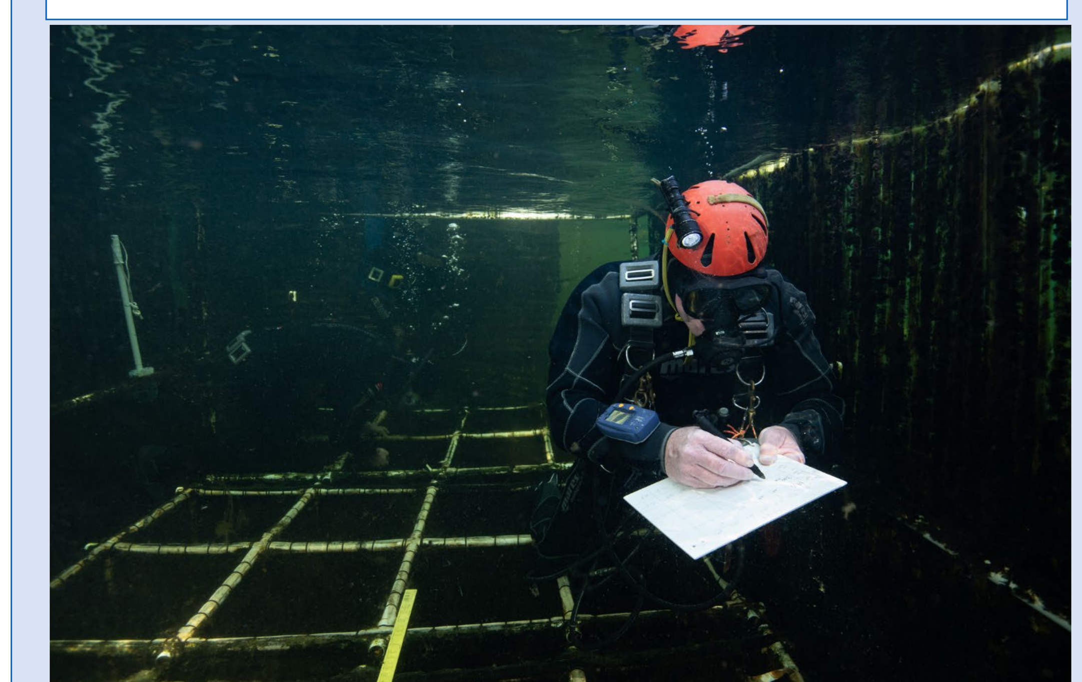
Aeration Treatment Box with Snails and Plants





Conclusions

- Complex interactions among ecosystem drivers and internal processes limit the efficacy of some restoration actions
- Algal removal activities offered limited value either alone or in combination with other activities
- Gastropods have a strong affect on algal growth, but only when dissolved oxygen threshold (>1.67 mg/L) are met
- SAV planting were successful only when dissolved oxygen thresholds (>1.67mg/L) are met
- Dissolved oxygen is the keystone variable controlling spring restoration



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