Restoration strategies for submerged aquatic vegetation on sites high in sediment organic matter

Joelle M. Laing and Tom K. Frazer

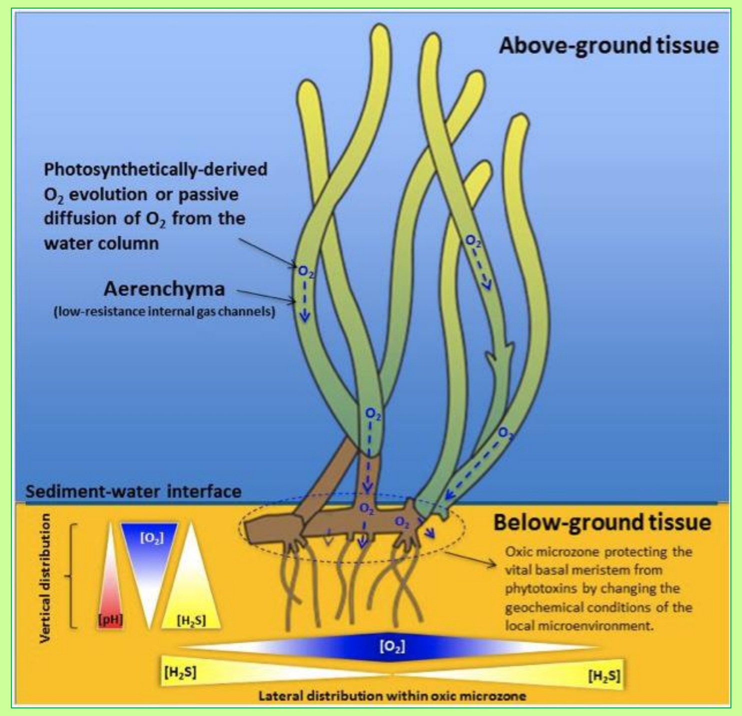
School of Natural Resources and Environment, University of Florida, Gainesville, FL

Introduction

In recent decades rooted submerged aquatic vegetation (SAV) has declined in Florida's spring-fed rivers. At many sites, former SAV beds have been replaced by thick benthic algal mats.

Benthic algae dominance at these sites can create challenges for restoration plantings because organic matter accumulation reduces sediment redox potential. In these reduced conditions, phytotoxic compounds form and can be taken up into plant tissue (Fig 1). Reestablishing SAV on these sediments may require specialized techniques to prevent phytotoxocity and plant senescence.

Fig 1. Phytotoxicity in Reduced Sediments. As sediment redox potential decreases, phytotoxic compounds such as H_2S form. Mature plants protect themselves from H_2S uptake by transporting photosynthetically-derived oxygen to the rhizosphere. However, young plants have less photosynthetic tissue and belowground biomass and may be vulnerable to H_2S uptake. (from Brodersen et al. 2014)



Purpose of Study

We investigated two potential management options as approaches for restoring *Vallisneria americana*, a prominent Florida SAV species, on sediments high in organic matter (Fig 2):

1) Sod Cultivation: Vallisneria is grown on a fiber mat until forming a thick sod. The resulting dense root system may oxygenate underlying sediments.

2) Dredging: Overlying algae and organic matter are removed from sediments. Sediment redox potential may increase due to decreased decomposition.

Fig 2. Potential management approaches. A) Restoration dredging in Kings Bay canals. B) Vallisneria are sparsely planted in coconut coir and grown in open ponds to cultivate sod. C) After 4-5 months, plants form a dense mat.

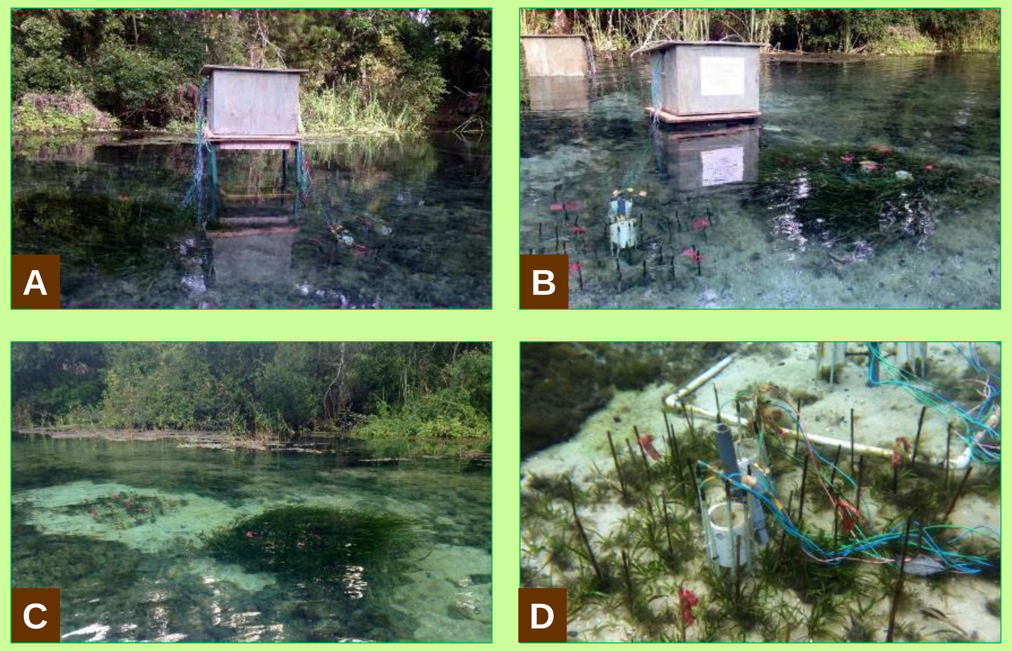


Fig 3. Experimental Setup in Gum Slough. Ramet and Sod plots were established in: A) Algae sediments B) Bare Sediments C) Dredged Sediments. D) Platinum redox electrodes measured redox potential in 15-min intervals at 1 cm and 4 cm depth.

Experimental Design

We established 1 m^2 plots of two vegetation types (**Ramets** and **Sod**) in three sediment types in Gum Slough, Sumter County, FL (Fig 3):

Algae: Sediments covered in benthic algae

Bare: Sediments free of benthic algae

Dredged: Sediments where benthic algae and organic matter was removed via hand dredging

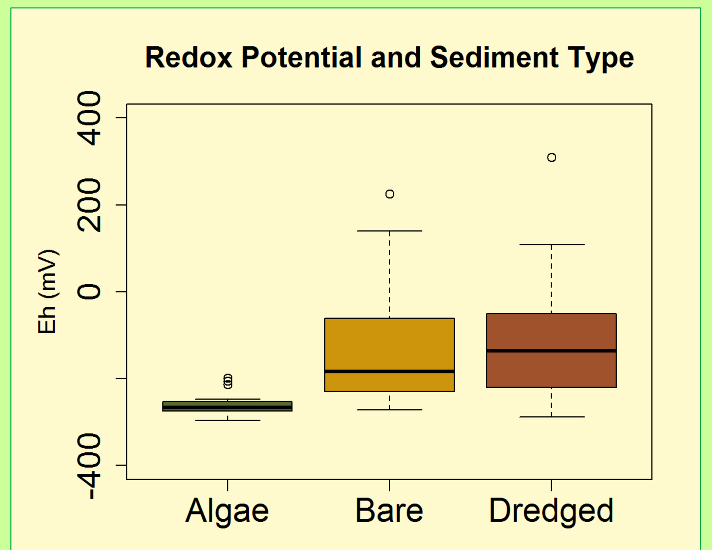
Platinum electrodes measured sediment redox potential in two-week intervals for each experimental replicate. After four months we measured plant growth: biomass, leaf elongation, and shoot density.

Results

Sediment redox potential in Dredged plots was significantly higher than in the Algae plots, indicating that dredging effectively raised sediment redox potential (Fig 4).

Shoot density was significantly correlated with redox potential in the Ramet plots, but not in the Sod plots (Fig 5). Pairwise comparisons for statistically significant differences in mean growth showed that Dredged and Bare plots grouped together in the Ramet treatments, while Dredged and Algae plots grouped together in the Sod treatments (Fig 6).

Fig 4. Redox potential and sediment type. Analysis of variance of the linear mixed-effects model showed a significant effect of sediment type on mean sediment redox potential (p=0.00382). Dredged plots were significantly different from Algae plots (p=0.0452), while Bare and Dredged plots were not significantly different from one another (p=0.9316)



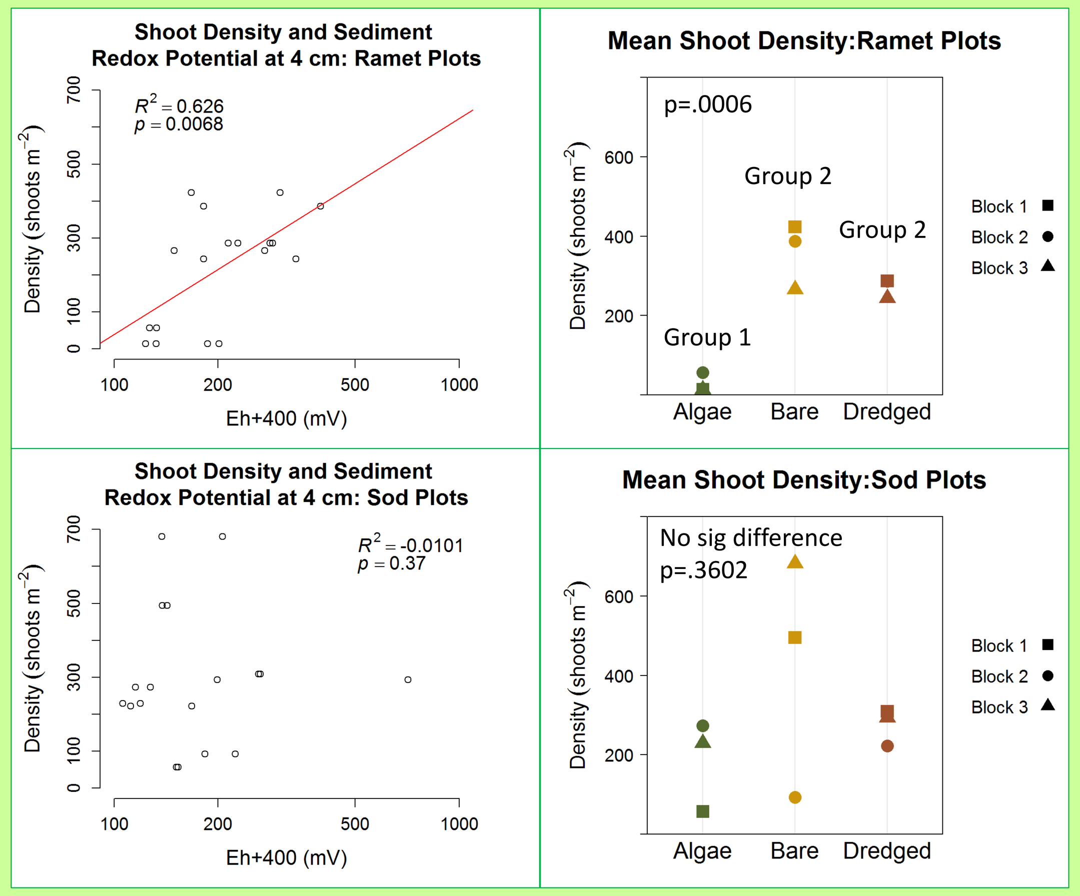


Fig 5. Shoot density four months post-planting..Mean shoot density in Ramet plots was significantly correlated with redox potential and had a significant sediment treatment difference. In sod plots there was no relationship with sediment redox potential and no significant sediment treatment difference.

Fig 6. Growth of Vallisneria four-months post planting (p-values represent differences in mean values.) In Ramet plantings, Dredged plots performed as well as Bare plots. In Sod plantings, growth was higher overall, but growth was lower in Dredged plots than Bare plots when significant.

Restoration Implications

1) Dredging may be an effective tool for planting ramets on sites formerly dominated by filamentous algae if managers can minimize future algal growth.
2) When dredging is not a possibility, managers may increase likelihood of planting success by installing Vallisneria sod.

Reference: Brodersen KE, Nielsen DA, Ralph PJ, Kuhl M (2014). Oxic microshield and local pH enhancement protects Zostera muelleri from sediment-derived hydrogen sulphide. New Phytologist (In Press).

UF Water Institute UNIVERSITY of FLORIDA

School of Natural Resources and Environment
A University-wide Program in Ecology, Environmental Science and Sustainability