Evaluating Proxies for Seawater in Sea Level Rise and Climate Change Research

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Introduction

- Climate change and sea level rise can change vegetation composition in aquatic ecosystems. As sea levels rise, coastal zones will be increasingly exposed to salinity and inundation (Chambers et al., 2013).
- Using actual seawater to study salinity effects in laboratory and greenhouse experiments is not always feasible, hence commercially available salts might be viable substitutes to mimic natural saltwater-freshwater systems.

Objectives

- In this study we conducted mesocosm experiments designed to address the following questions:

a. Does salt source influence plant response to increasing salinity concentrations?
b. What salt source best mimics natural seawater/brackish water (i.e., elicits plant responses similar to seawater)?
c. Does substrate type (native field soil vs. builders' sand) affect plant response to salinity?

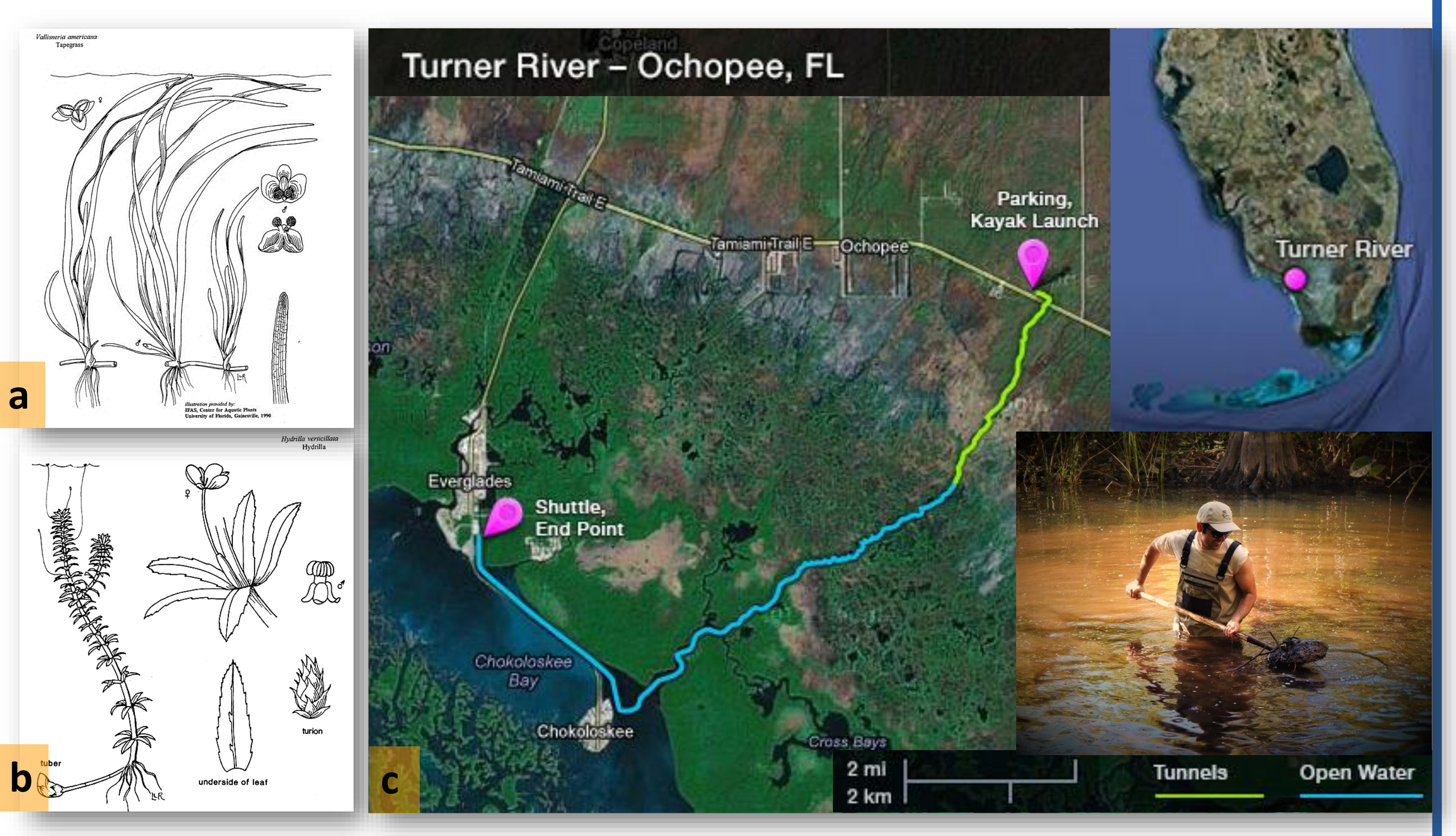

Fig 1. a) *Vallisneria americana*, b) *Hydrilla verticillata* and c) Field soil collected from south of Turner river, Big Cypress National preserve.

Methodology

- A completely randomized design was conducted with 136 (60 L) mesocosms (Fig. 2):
  - 4 salt sources (Instant Ocean, Morton Sea Salt, NaCl and Seawater),
  - 4 concentrations (0.5, 1.0, 2.5 and 5.0 ppt),
  - 2 substrates (Sand and Field Soil)
  - 2 plant species (vallisneria and hydrilla)
  - 4 replications
  - And 8 controls (No salts added, 0.2 ppt)
- Each mesocosm received one planted container of each species, with both species planted in the same substrate (Fig. 2).
- 2.0 g of Osmocote Plus 15N:$9P_2O_5$:$12K_2O$, 220-day release formula was incorporated into the media.

Fig 2. Salinity levels were increased gradually. Water level, salinity and pH were monitored every week.

Results & Discussion

- Experiment ran for 13 weeks.
- Before harvest plants were visually rated on 0-10 scale and after harvest wet and dry biomass were measured.
- Visual evaluation, wet and dry biomass revealed similar effects by treatments; therefore, only dry biomass results are presented (Fig. 3 and 4).

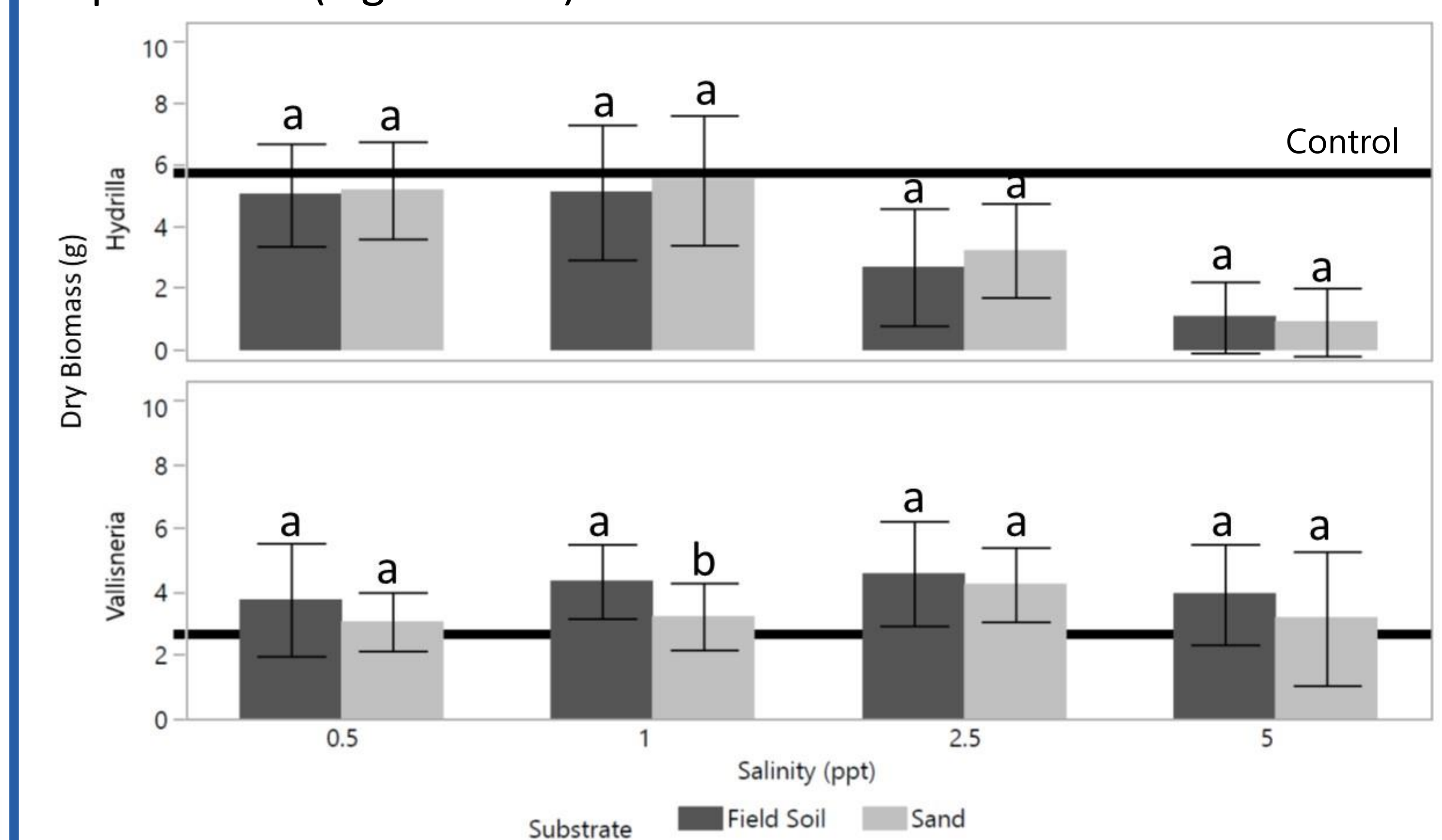

Fig 3. Dry biomass at different salinity levels in different substrates. Analyses were performed separately within each salinity level.

- Hydrilla biomass was not affected by substrate type. Vallisneria had greater biomass in field soil only when salinity was 1.0 ppt.
- Substrates with high organic matter content can increase inorganic N availability to plants and potentially stimulate higher production of proline, which can make plants more tolerant of salt stress (Twilley and Barko, 1990; Mulholland and Otte, 2002). All substrates were amended with controlled-release fertilizer to prevent nutrient deficiency, this might have masked any substrate effects.

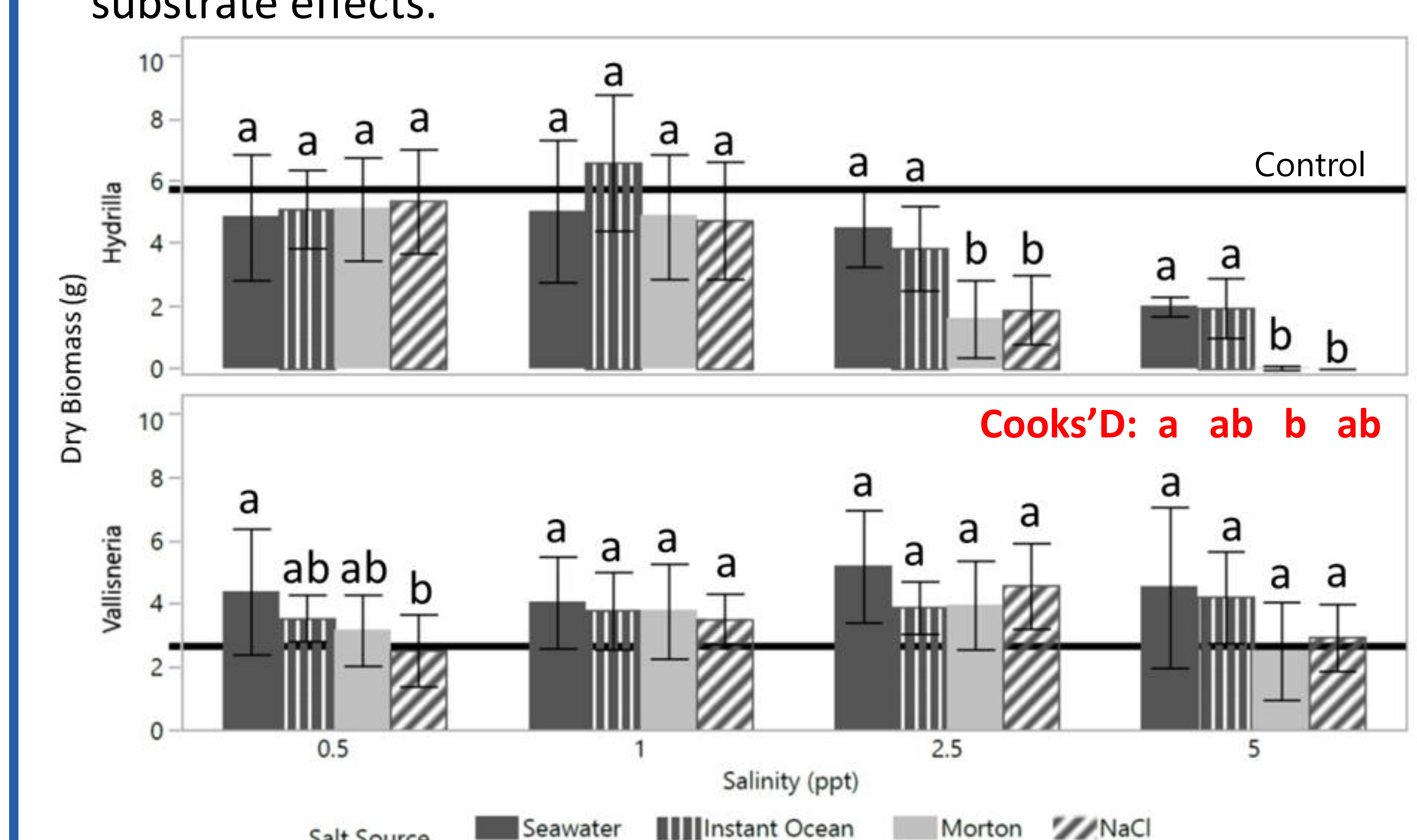

Fig 4. Dry biomass at different salinity levels produced by different salt sources. Analyses were performed separately within each salinity level.

- When salt source was Morton or NaCl, hydrilla had severe damage at 2.5 ppt and was completely dead at 5.0 ppt; while with Instant Ocean or seawater, there was less damage and hydrilla remained alive at 5.0 ppt.
- Vallisneria was not affected by different salt sources across salinity levels, except at 0.5 ppt where NaCl had smaller biomass than seawater.
- When **Cook's Distance** influence test excluded two influential outliers. Tukey's test did reveal effects of salt sources on vallisneria biomass at 5.0 ppt salinity level.

Results & Discussion

- Table 1. Elemental composition of 5.0 ppt saline solutions induced by the addition of different salt sources to pond water (control treatment; 0.2 ppt salinity).

Salt source	Total N	Total P	K	Na	Cl	Ca	Mg	S
	(ppm)							
NaCl	0.508	0.237	5.5	1953	2854	47.0	2.0	2.5
Morton	0.471	0.237	6.1	2071	3255	54.1	3.1	5.7
Seawater	0.404	0.455	72.9	1693	3348	80.1	209	153
Instant Ocean	0.498	0.448	65.4	1690	3291	101.1	204	191
Control	0.483	0.000	0.3	18	28	44.2	1.5	2.1

- Na, is around 16% higher in solutions when a salinity level of 5.0 ppt was induced using NaCl or Morton vs. Instant Ocean or seawater (Table 1).
- This increase in Na could be above the threshold tolerated by hydrilla (which would explain the death of plants grown at 5.0 ppt with NaCl or Morton as a salt source) and could be responsible for the reduction of vallisneria biomass under the same conditions (remember, there was no reduction in vallisneria biomass when salinity was 5.0 ppt and the salt source was seawater or Instant Ocean).

Conclusions

- Hydrilla and vallisneria's responses to saline conditions is significantly affect by the salt source.
- This effect may be due to differences in elemental composition among the salts evaluated in these studies.

Highlights

1. Substrate had no effect on plant growth.
2. Hydrilla was more stressed by NaCl or Morton Salt than seawater or Instant Ocean.
3. The effects of salinity induced by Instant Ocean and seawater were similar.
4. Instant Ocean appears to be a good proxy for mimicking seawater.

Future Research

- Salt tolerance variability between different ecotypes of vallisneria.
- Impact of proline on salt tolerance ability of aquatic plants.
- Competitive ability of aquatic plants under saline conditions

Acknowledgement

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References

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