Invasion, Nitrogen, and Rising Seas:
Greenhouse gas responses of coastal marshes

Summary of Research from Bringing Wetlands to Market II, Waquoit Bay NERR | Serena Moseman-Valtierra, Ph.D., University of Rhode Island

Invasive Species: *Phragmites Australis*

Invasive species are rapidly changing coastal ecosystems. In the northeast US, the non-native reed, *Phragmites australis*, has rapidly encroached upon the upward borders of most coastal salt marshes. In this region, *P. australis* towers over native vegetation, shading other species and establishing deep roots in the soils. *P. australis* impacts on long-term carbon sequestration (or storage) are not well known. In our study, we compared greenhouse gas fluxes (carbon dioxide, CO_2 and methane, CH_4) from *P. australis*- invaded zones of several coastal marshes with varying salinity levels. Both gases were examined because CH_4 has significant warming effects per mass compared to CO_2 (45 times sustained flux global warming potential over 100 years, *Neubauer and Megonigal 2015*). In salty marshes, we found that *P. australis* zones had among the greatest uptake rates for CO_2 (along with the native cordgrass species, *Spartina alterniflora*) *(Moseman-Valtierra et al. 2016, Fig. 1)*, and that CH_4 emissions were low. However, salinity is a strong control on CH_4 emissions. In brackish marshes, zones dominated by *P. australis* emitted significantly higher CH_4 emissions than their native counterpart (salt marsh hay, *Spartina patens*) *(Martin and Moseman-Valtierra 2016)*.

P. australis removal is often considered as a part of salt marsh restoration efforts. In Round Marsh in Jamestown, RI, we monitored changes in CO_2 and CH_4 emissions following an attempted removal (direct aboveground clipping) of a *P. australis* stand. In this brackish marsh, *P. australis* regrew within months allowing parallel changes in gas emissions to be rapidly observed *(Martin and Moseman-Valtierra 2017)*. At this site, significant increased uptake of CO_2 coincided with the increased productivity of the *P. australis* plants. Meanwhile, CH_4 emissions did not change considerably. This suggests that salinity is a stronger control on CH_4 emissions than the invasive *P. australis*. These findings further suggest, given the intensive effort and limited success of mechanical *P. australis* removal, that restoring tidal flushing may be more effective for long term plant community recovery and for minimization of CH_4 emissions.

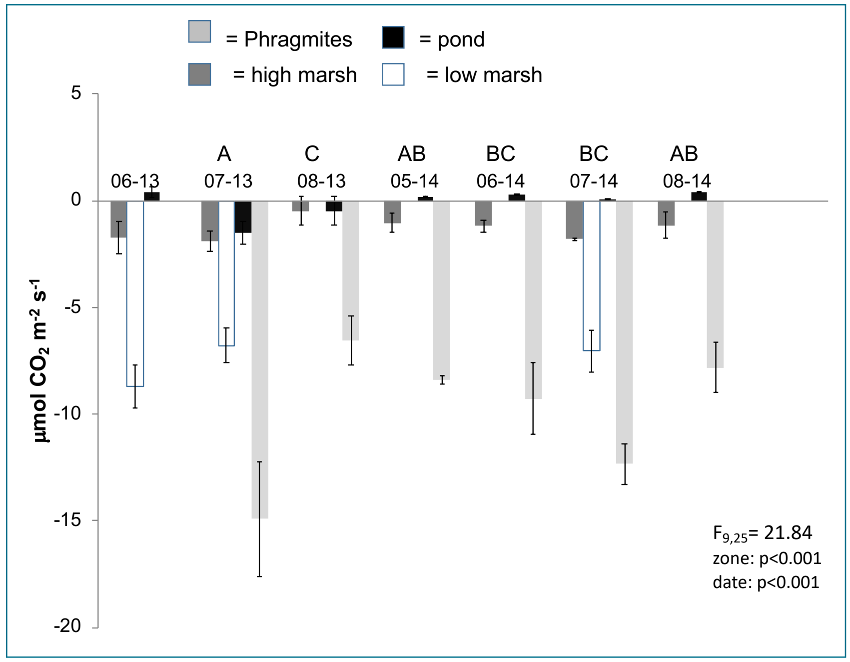

Fig. 1 — Net CO_2 fluxes from native and invasive plant zones in Sage Lot Pond, Waquoit Bay, Cape Cod MA *(Moseman-Valtierra et al. 2016)*

Photo: R. Martin

Nitrogen Loading

Wastewater inputs can alter the structure and function of salt marshes. Nitrogen (N) from wastewater and fertilizer usually increases aboveground plant productivity. However, it may also increase soil organic matter decomposition rates and greenhouse gas emissions, particularly of nitrous oxide (N_2O) which has a sustained flux global warming potential 270 times that of CO_2 *(Neubauer and Megonigal 2015)*.

We evaluated whether coastal salt marshes with historically high N loads (ranging from < 10 to 300 g N m^{-2} y^{-1}) emitted different amounts of N_2O. In about 200 measurements of N_2O fluxes from several New England marshes, we found very few cases of significant N_2O emissions (Fig. 2). Highest emissions were observed following short term pulses of nutrients. However, negative fluxes (indicating complete reduction of N_2O to N_2 via denitrification) were observed in marshes with the highest chronic N loads. This supports a high capacity for N retention and efficient cycling in marshes even after long term nutrient loading.

Sea Level Rise

Rising sea levels pose a major long-term challenge to coastal marsh sustainability. The appearance of new pools of permanent standing water in the high marsh are one indicator of sea level rise. Vegetation dies in these pools due to the anoxic soils. We found that pools with standing water were net sources of CO_2 rather than CO_2 sinks during summer months (Fig. 1). If these bare pools continue spreading, then coastal marshes will sequester less carbon.

Interacting Factors

Global change factors may synergistically impact coastal marshes. While N is known to facilitate *P. australis* invasion, N impact on marsh resistance to rising sea levels remains unclear. Collaborative research and adaptive management is needed to identify priorities for restoration.

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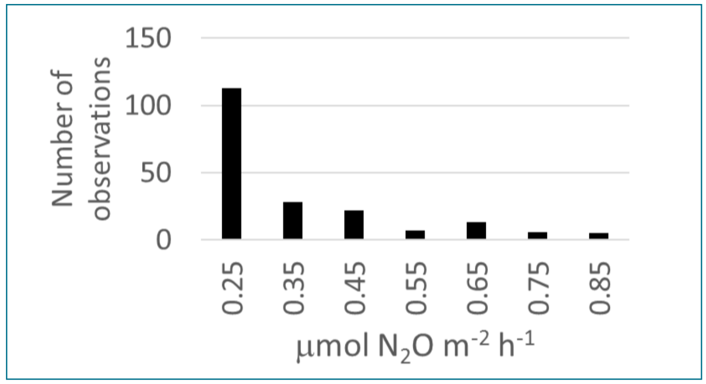

Fig. 2 – Frequency distribution of nitrous oxide fluxes from several coastal marshes with varying nitrogen loads *(unpublished data, S. Moseman-Valtierra)*

Standing Pools on Marsh – Photo: K. Szura, Mary's Creek, RI

ABOUT BRINGING WETLANDS TO MARKET

This research was supported by the Bringing Wetlands to Market (BWM) project. The BWM project was led by the Waquoit Bay National Estuarine Research Reserve and a multidisciplinary team of partners. For nearly a decade, the BWM team has been at the forefront of blue carbon science, creating the knowledge and tools that communities need to leverage this science to support wetlands management, restoration, and conservation goals, and help facilitate the integration of coastal wetlands into carbon markets.

Support for the project was provided by the National Estuarine Research Reserve System (NERRS) Science Collaborative. By engaging decision makers in the research process, collaborative science projects directly address community needs. Through a national network dedicated to sharing tools and knowledge, local research strengthens all 29 NERR sites and the communities they serve, leaving them better prepared to manage our changing coasts.

To learn more about BWM and access other project resources, please visit: http://waquoitbayreserve.org/research-monitoring/salt-marsh-carbon-project/expanding-blue-carbon-phase-2/