Linking stomatal morphology to photosynthetic performance in invasive common reed (*Phragmites australis*)

Julian Garrison, Class of 2019

While invasion of common reed (*Phragmites australis*) into North American marshes has been well-documented, the link between specific environmental factors and *Phragmites* invasion success is much less clear. *Phragmites* is a perennial grass that can tolerate a wide variety of habitats (Chambers et al. 1999). Critically, it is an invasive ecosystem engineer that can drastically modify its local environment, outcompeting native species and resulting in dense monocultures and community collapse (Chambers et al. 1999; Lantz 2012; Saltonstall 2002). Consequently, considerable effort has been directed towards finding solutions to *Phragmites* invasion and research in this field aims to understand its invasion ecology—that is, *why* it is so successful.

Figure 1. *Phragmites australis* at New Meadows, Bath, ME.

Much of *Phragmites*' invasion success has been attributed to its phenotypic plasticity, or the ability of an organism to alter its physiological and morphological traits in response to its local environment (Caplan et al. 2015; Chambers et al. 1999; Douhovnikoff et al. 2016; Mozdzer and Caplan 2018; Mozdzer and Megonigal 2012; Saltonstall 2002). Recent research has shown that *Phragmites* strongly responds with greater growth and morphological changes to disturbances like nutrient pollution and carbon dioxide (CO_2) enrichment (Caplan et al. 2015; Mozdzer and Caplan 2018; Mozdzer and Megonigal 2012; Uddin and Robinson 2018). *Phragmites* is also known to exhibit plasticity in the characteristics of its stomata (Douhovnikoff et al. 2016), microscopic pores on the surfaces of leaves. Since stomata directly influence photosynthesis and growth by regulating intake of CO_2, they may help explain *Phragmites*' response to disturbance. To my knowledge, however, the link between photosynthetic physiology and underlying stomatal morphology under CO_2 and nutrient disturbance regimes has not been directly investigated.

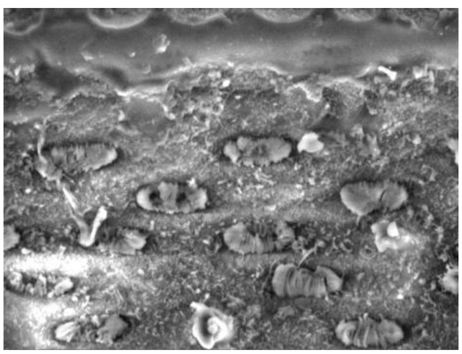

Figure 2. Microscopic image of *Phragmites* stomata at ~2000x magnification.

Through the Freedman Summer Research Fellowship in Coastal/Environmental Studies and in collaboration with Prof. Thomas Mozdzer of Bryn Mawr College, I have been studying the relationship between *Phragmites* stomata and photosynthetic performance. My leaf samples come from the Smithsonian Environmental Research Centre where ongoing open-top chamber experiments simulate elevated CO_2 and nutrient environments. Back at Bowdoin, I image stomata using an environmental scanning electron microscope and take two measurements: stomatal density (number per unit area) and length. From these measurements I calculate maximum stomatal conductance, which can be thought of as the total surface area available for photosynthetic gas exchange (Douhovnikoff et al. 2016; Taylor et al. 2012). I'm looking for treatment-specific differences in stomatal conductance and will ultimately relate these data to photosynthesis rates measured from these same samples.

While it's still too early to make any definitive conclusions, preliminary results have been suggestive. *Phragmites* grown under disturbance conditions showed a trend of greater stomatal conductance (Fig. 3), which may relate to significantly greater photosynthetic rates (Fig. 4). The next step is to increase sample size and I'm looking forward to continuing this research into the academic year with a year-long honors project. I'm extremely grateful for all the support, guidance, and feedback from my faculty mentors and collaborators.

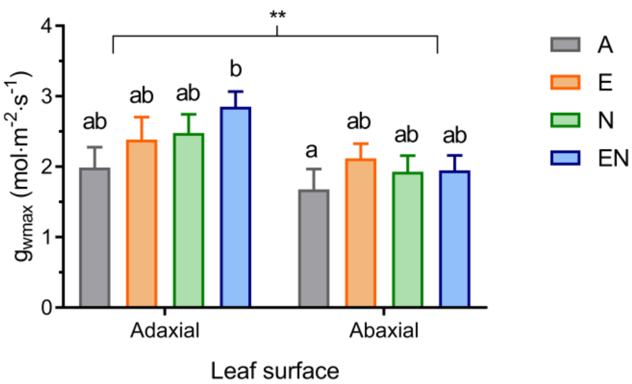

Figure 3. Stomatal conductance (g_{wmax}) was generally greater for *Phragmites* plants grown under disturbance treatments (E, N, EN) than under ambient conditions.

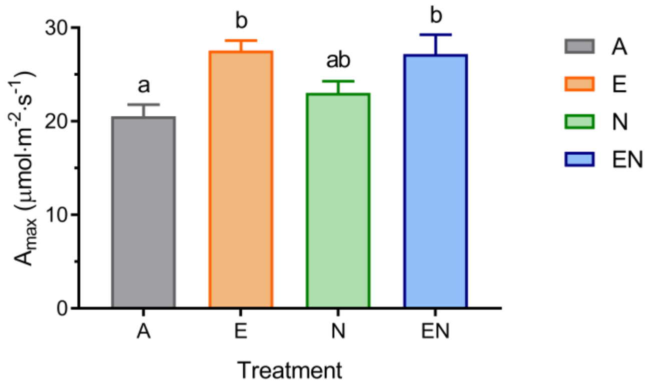

Figure 4. Maximum photosynthetic rate (A_{max}) was significantly greater for *Phragmites* plants grown under disturbance treatments (E, N, EN) than under ambient conditions.

Faculty Mentors: Barry Logan & Vladimir Douhovnikoff
Collaborator: Thomas Mozdzer (Bryn Mawr College)
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