

Title: Plant Physiological Response to Whole Ecosystem Warming and Elevated CO₂ – Can Bog Plants Be Water Stressed?

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Project Abstract: The last few decades of warming studies and elevated CO₂ experiments have taught us how terrestrial plants react to different environmental conditions, ever informing model predictions of a changing world. At the southern edge of the boreal forest we use large open-top enclosures to expose a forested bog to whole ecosystem warming and elevated CO₂, taking forest manipulation experiments to the next level to investigate the intersection of the temperature and CO₂ responses. Our goal is to answer the questions: “What is the interaction between these temperature and CO₂ responses in a mature natural forest?” and “How do the paradigms we know and understand about plant physiology under climate change conditions hold up in a wetland?”

We know that: 1) warming is likely to stimulate decomposition, potentially increasing nutrient availability for plants, and could extend the growing season as plants green-up earlier in the spring; 2) elevated CO₂ should make photosynthesis more efficient; and 3) reliable water availability from the bog should alleviate water stress, which has been exhibited by other terrestrial systems that experience warming. Perhaps climate change conditions will unleash the productivity potential of these cold tolerant plants?

After three years of experimental treatments at the Spruce and Peatland Responses Under Changing Environments (SPRUCE) site, we find elevated CO₂ concentrations stimulates photosynthesis and growth, but ecosystem warming challenges plants with increased water stress and higher risk of spring freeze damage. We have witnessed crown damage, branch tip dieback and mortality in the dominant tree and shrub species and, in investigating it, have discovered that even bog plants can be water stressed. While the bog plant community have only a small number of species, we have found wide diversity in hydraulic strategies, from conservative to risky, resulting in divergent carbon dynamics among the species.