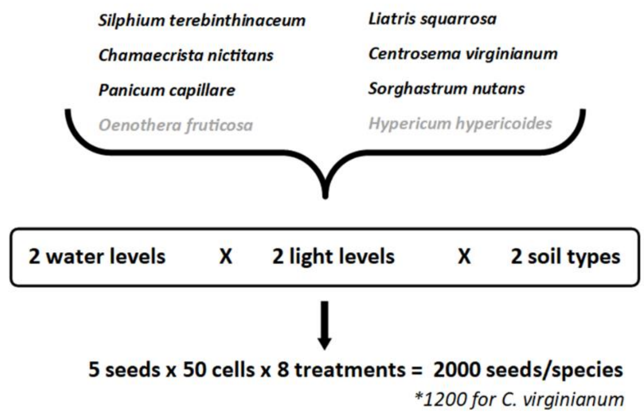
<u>**Determining germination and establishment requirements of native prairie plants**</u>

Mission & Work

The Piedmont Prairie is an imperiled grassland community composed of a diverse herbaceous layer and characterized by high light availability historically maintained by burning, grazing, and tree-deterring soils. Today the system largely persists in disturbed habitats like roadside and powerline rights-of-way where rare plants are threatened by herbicide spraying. To conserve and restore prairie communities in safer habitats, it is critical to understand the factors which promote germination and establishment from seed.

Of significant concern is whether prairie plants, which are typically extant on regionally-rare soil series, are able to germinate and establish on more common soils. Prairie plants may persist on rare soils because they are adapted to the high amounts of calcium and magnesium which deter other plants from growing, or simply because these rare soils were not cultivated for agriculture due to chemical and physical properties which made them inarable. To test the impact of environmental conditions on the earliest stages of prairie plant growth, I designed an experiment to grow eight prairie-affiliated species under different combinations of light, moisture and soil types.



The species and experimental design for this project. We sowed seeds of eight prairie-affiliated species under eight different treatment combinations. Two species failed to germinate at high enough rates to include in the experiment (labelled here in light gray.)

I began collecting seeds for this project in the fall of 2021, which we cleaned and counted in the lab at North Carolina State University. I altered my study species based on abundance at the prairie which I sourced the seeds from, while maintaining the functional and taxonomic diversity which I had originally intended to collect. I stratified seeds according to the best practices available in the literature for each species. In the spring of 2021, I collected 20 cubic feet of soil: 10 cubic feet from the regionally-rare and prairie -associated Iredell Alfisol series, and 10 cubic feet from a regionally-common Creedmoor Ultisol series. In the lab we sieved the soil to break up clay clods (and to remove worms!) before layering it over gravel and peat in growing trays. To administer the light treatments, growing trays were either placed in full sun (high light treatment) or under shade cloth (low light treatment.) To administer the moisture treatments, the high moisture growing trays were supplementally watered every other day, in addition to the automatic sprinklers which watered all trays in the experiment. Seeds were sown in June and thinned down to one individual per tray cell in July. We tracked their survival until the first frost in October. For plants which flowered, we counted inflorescences. In October, we removed, scanned and weighed single leaves from every plant. After sampling single leaves, we removed entire plants

Cotyledons of *Liatris squarrosa* push up through the soil, one with a seed coat and characteristic pappus still clinging to it.

from the trays, rinsed off their roots, and separated them into above- and below-ground biomass. The biomass and the single-leaf samples have been stored at NCSU and will be dried and weighed this year.

We set up the growing space so that half was covered in shade cloth. This photo was taken shortly before we thinned the trays down to just one plant per cell.

Results & Further Work

See the end of the document for graphical results.

For all species except *Liatris squarrosa,* growth on the regionally-rare Iredell Alfisol facilitated germination (quantified here as the opening of cotyledons.) The effects of light and water were minor relative to the importance of soil type. Species emerged at different rates, with *Chamaecrista nictitans* germinating at the highest rate (an average of 77% of seeds germinating.) Two species had fewer than one plant emerge per treatment, *Oenothera fruticosa* and *Hypericum hypericoides,* and have been removed from further consideration in the experiment.

Survival through the entire experiment varied less dramatically among species than germination. Light was the greatest factor determining survival of *Chamaecrista nictitans* and *Silphium terebinthinaceum.* Plants of those species growing in the high light treatment were more likely to die before the end of the experiment, though the high mortality rate was offset somewhat when growing on the regionally rare Iredell Alfisol. Though we did not measure soil moisture through the experiment, casual observation indicated that the Alfisol retained water better, allowing seedings of *C. nictitans* and *S. terebinthinaceum* to withstand hot, sunny days that imposed water stress on plants growing on the common Ultisol. Survival varied little between treatments for the other four species, with relatively high survival rates across the board. Investment in leaf tissue varied the most between species, and primarily with soil type. While the leaves of *Silphium terebinthinaceum* and *Sorghastrum nutans* grown on Iredell Alfisol were typically heavier than those of plants grown on Creedmoor Ultisol, the inverse was true for *Liatris squarrosa* and *Panicum capillare.* Due to plant senescence in response to the early onset of cold weather in Fall 2022, we were unable to weigh leaves of *Chamaecrista nictitans* and some *P. capillare.*

These results suggest that soil type is important for prairie restoration, with some characteristic prairie species tolerating and even thriving on a regionally-common Ultisol soil. Though germination rates were lower for most species growing on the common Ultisol, no species failed to

Erin rinsing the soil off the roots of a *Silphium* seedling. Some of the seedlings' roots were over a foot long!

establish except those which failed in all treatments. If the restoration potential for prairie species on common, degraded soils is high, restoration efforts need not be limited to sites with suitable soils.

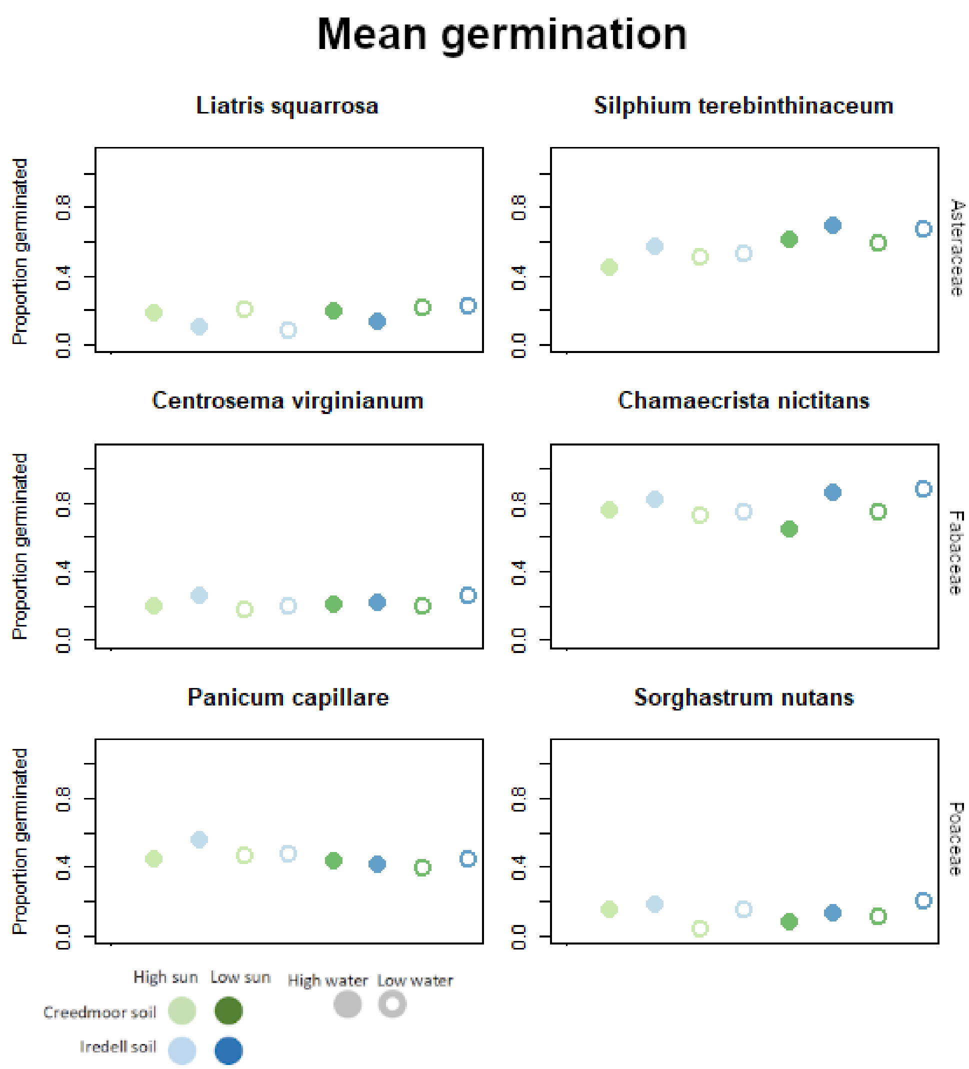
Once the remaining samples have been weighed, the dataset will be complete. In addition to the data summarized above, the dry weights of leaves will enable me to calculate several important measures of plant resource investment: leaf area, specific leaf area, dry leaf matter content. With these metrics and through calculating ratios of above to below-ground mass, I will be able to describe in detail how seedlings invest their resources under different environmental conditions.

Synergistic work

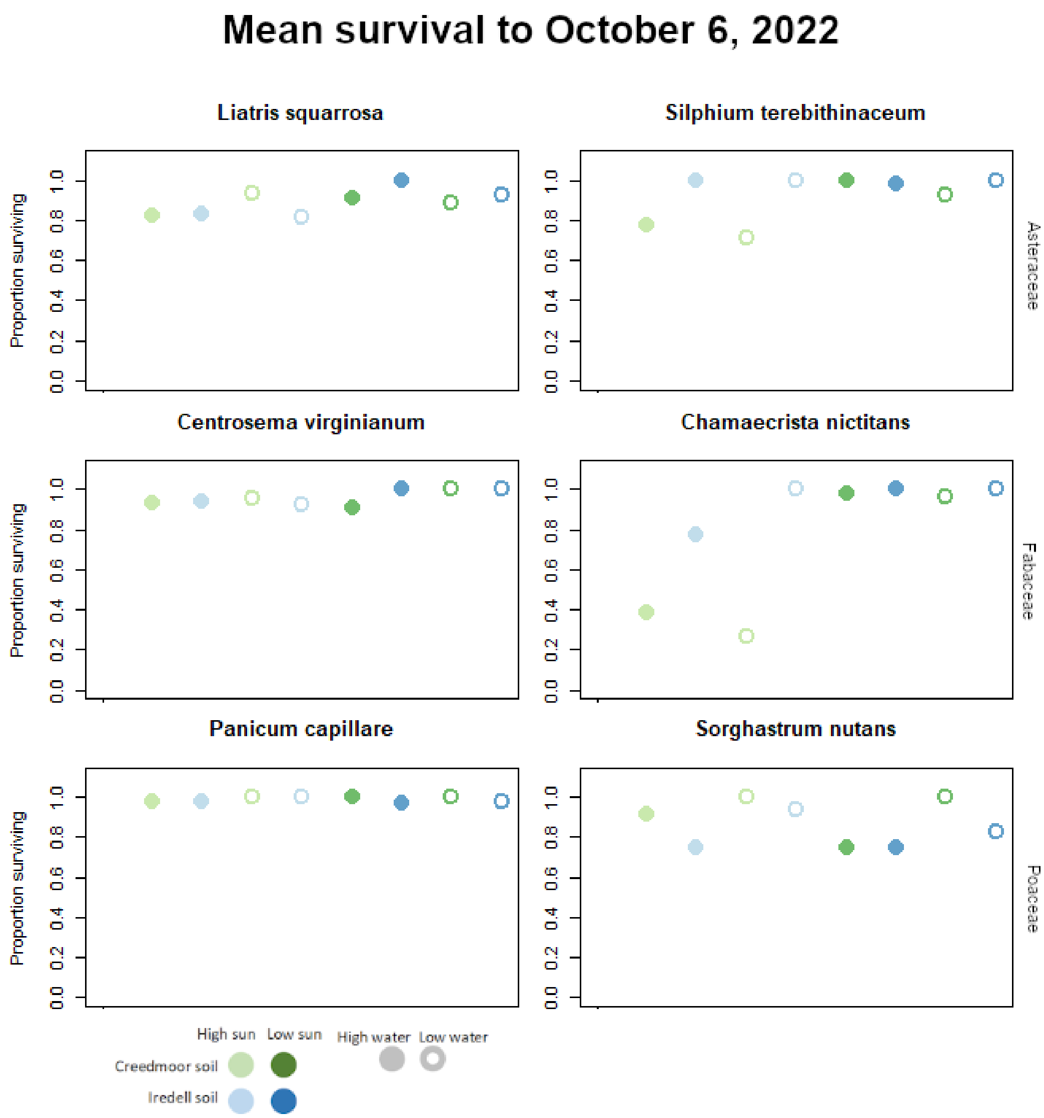
This work has enabled me to train up a group of undergraduate students in the philosophy and methodology of science. Caroline Blythe, Amanda Hoffman, Trey Jeffers, Kassidy Moore and Em Trentham have all assisted me in the hands-on work, from the earliest days of collecting and cleaning seeds, through planting, watering and surveying, to the weighing and sacrifice of the seedlings in October. Amanda Hoffman has designed and is currently carrying out an experiment to investigate stratification techniques for *Oenothera fruticosa* and *Hypericum hypercoides,* to build upon this work which found very low growth rates for the species. I have also discussed my work at public outreach events such as Darwin Day at the NC Museum of Natural Sciences and Family Day at the NC Botanic Garden, and incorporated elements of my research into my undergraduate course teachings.

To see more photos and keep up with my ongoing work, please visit eichenresearch.wordpress.com.
Thank you to the North Carolina Native Plant Society, the Irwin Lab, the NCSU BeeMORE REEU program, and the NCSU Horticulture Field Lab for your support! Additional thanks to Caroline Blythe, Merry Conlin, Laurie Hamon and April Sharp for their help in the field.

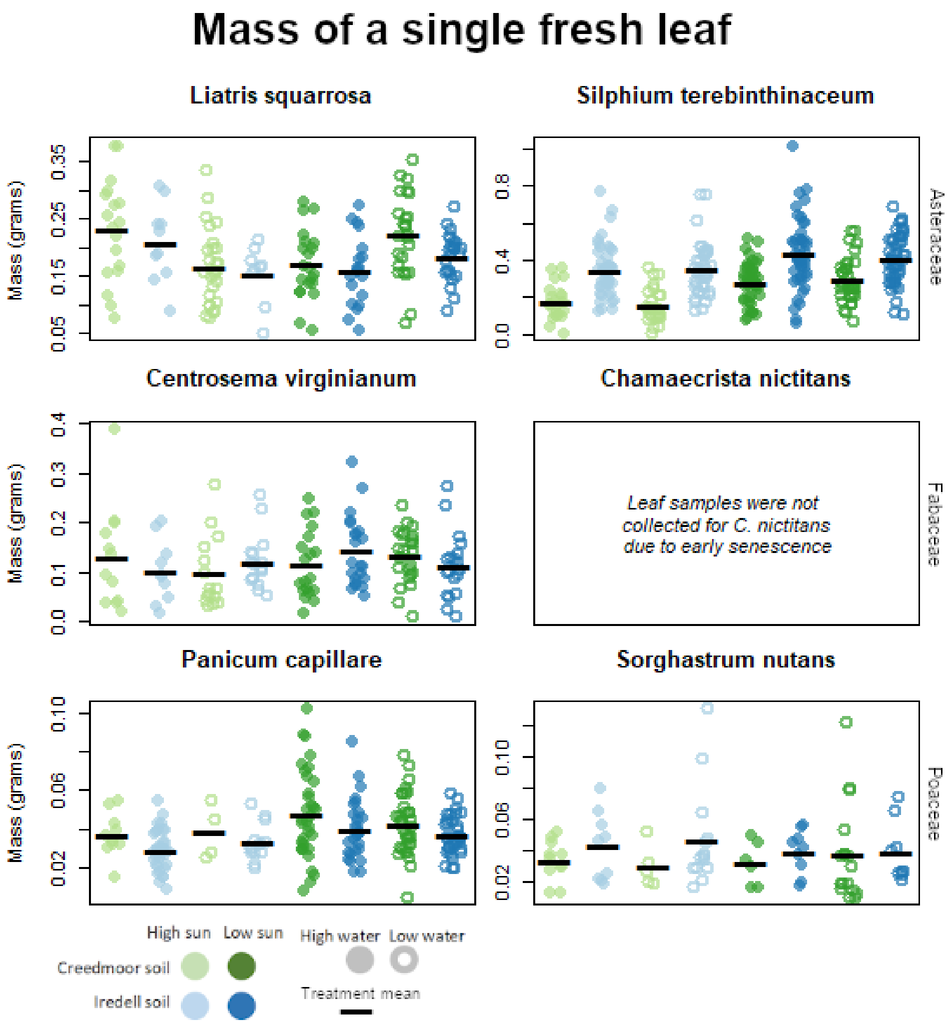
Erin sweeping out the hoop house at the Horticulture Field Lab after the completion on the project.



Mean germination rates for each treatment and all species monitored in the experiment. Green points represent seeds sown on Creedmoor Ultisol and blue points represent seeds sown on Iredell Alfisol. Light points indicate seeds sown in full sun, and dark points represent seeds sown under shade cloth. Filled points represent seeds receiving supplemental watering, and open points represent seeds without supplemental watering. *Panicum capillare* was sown on June 15, 2022, *Liatris squarrosa, Silphium terebinthinaceum* and *Sorghastrum nutans* on June 16, 2022, and *Centrosema virginianum* and *Chamaecrista nictitans* on June 17, 2022.



Mean survival rates for plants in each treatment which lived to the experiment endpoint on October 6, 2023. Plants were censused once a week from June 22 through to October 6. Green points represent plants growing in Creedmoor Ultisol and blue points represent plants growing in Iredell Alfisol. Light points indicate plants growing in full sun, and dark points represent plants growing under shade cloth. Filled points represent plants receiving supplemental watering, and open points represent plants without supplemental watering.



Mass and treatment mean mass of a single fresh leaf from non-senesced plants after October 6, 2023. Leaves were removed and immediately weighed to minimize desiccation. Green points represent plants growing in Creedmoor Ultisol and blue points represent plants growing in Iredell Alfisol. Light points indicate plants growing in full sun, and dark points represent plants growing under shade cloth. Filled points represent plants receiving supplemental watering, and open points represent plants without supplemental watering.