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LESSONS LEARNED FROM THE LARGE-SCALE THIRST FORESTRY EXPERIMENT

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Image 1. White spruce trees among plots with fully constructed eavestroughs at the ThiRST site. Photo: Chloe Larstone Hunt, 2023

LESSONS LEARNED

- Remain overly cautious with material selection and be proactive, rather than reactive, with maintenance and repairs of large outdoor structures.
- Despite thorough planning and preparation, things may still not go as planned - especially when the weather is uncooperative.
- Data should be collected thoroughly and THE analysis adapted in response to unforeseen circumstances.

Droughts are projected to increase in frequency and severity across Canada in the coming decades. In drought conditions, photosynthesis is limited by reduced transpiration which reduces tree growth. To mitigate the effects of drought and promote growth, silvicultural thinning can be used to lower the number of trees per stand to reduce competition for water, light and soil nutrients.

At the University of New Brunswick, Dr. Loic D'Orangeville is exploring this method with the ThiRST (Thinning to Reduce Stress) experiment in collaboration with Silva21, the Canadian Forest Service and industry partners, JD Irving.

The goal of this project is to explore how thinning can mitigate drought conditions and reduce the vulnerability of white spruce (*Picea glauca*) to summer drought. To do so, the project has established a large-scale rainfall exclusion experiment on a 16 year old white spruce plantation to assess the effects of thinning on various levels of drought. Using 2x4s and 2x6s (approximately 6,500 pieces of lumber) 82 eavestroughs were constructed around individual trees to collect rainfall and divert it away from the experimental plots (Image 1). The original experiment design consisted of 27 plots, 20m x 20m in size, allowing for different combinations of tree densities (~100, 60 or 40 trees per plot) and rain exclusion (0, 25 and 50%) (Image 1). Regardless of treatment combination, each plot contains 10 experimental study trees for which growth data was collected.

CHALLENGES DURING FIELD SEASON

The ThiRST experiment eavestroughs were built in four months in the summer of 2022. This required a great deal of coordination between JD Irving (who supplied the lumber), planners who designed the eavestroughs, field crews responsible for construction and installation, as well as supervision and graduate student field work. Maintaining the construction schedule was also particularly challenging considering tricky topographical features which required frequent problem solving. This was made worse given the remote location of the site which is situated three and four hours away from the University of New Brunswick and from Laval University, respectively. Due to time restraints during building, eavestroughs were only installed in two out of the three of the originally-planned blocks, for a total of 18 plots made up of 180 experimental trees (instead of 27 plots with 270 experimental trees).

Tarps were designed to be incorporated to collect water (Image 1) and were installed during the first two weeks of May 2023, with data collection beginning shortly after. During this first field season, water began pooling in the tarps, causing the eavestrough frame to cave in due to inadequate wood structure and framing. Luckily, the leftover wood originally intended for the third replicate was used to provide additional structure to the eavestroughs (Photo 2) which improved flow of the water. Because of time constraints, one of the two replicates was prioritized for repairs to ensure the best data collection possible.

With all damages accrued throughout the summer, one of the two blocks (specifically which was prescribed 50% rainfall exclusion) was damaged and, without time for repairs at the end of the field season, was labeled as incomplete. The remaining damaged eavestrough were eventually repaired during the fall of 2023 after data collection had finished. Regardless of the state of any and all eavestroughs throughout the summer, data collection continued as planned to maximize data collection but with additional notes indicating levels of damage where they occurred in the hopes they could be accounted for in later data analysis.

POTENTIAL IMPACT ON DATA ANALYSIS

Due to the varying degrees of eavestrough collapse, the applied drought treatment no longer represented the desired area coverage. Thus, any damage to eavestroughs throughout the site had the potential to allow for greater precipitation than originally planned. This created unintentional effects on response variables including xylem water potential, soil moisture, and tree diameter growth for this sampling year. Despite this, data collection continued for all response variables as planned but while keeping track of eavestrough damage at onset and throughout the repairs.

Image 2. Eavestroughs repaired and reinforced with additional wood, without tarps. Photo: Chloe Larstone Hunt, 2023

Currently, there are 10 labeled white spruce trees in each plot (180 experimental trees total), with point dendrometers or manual dendrometer bands installed collecting diameter growth data. In the initial data analysis, the effect of rainfall exclusion was to be analyzed at the plot level to explore the response of all 10 study trees in each plot. However, since the two blocks were not perfect replicates of each other during data collections, the effects of the treatments applied during 2023 will likely be explored at the individual tree level. Using the same response variables, data analysis could instead explore tree-level soil water availability and competition within each plot by incorporating competition index and tree level information (such as damage of nearby eavestrough and length of time that eavestrough was damaged). To present, all damaged eavestroughs have been repaired and data collection is planned to resume during the 2024 growing season with data analysis to be performed at the plot level, as originally planned.

Lastly, it is also important to consider time lags of drought effects and the possibility that the effect of rainfall exclusion during summer 2023 may not be visible until the following growing season. However, given the long-term nature of the ThiRST experiment, any future repairs or corrections will be done as soon as possible to not compete with this effect on the applied treatments.

LESSONS LEARNED

1. Material Selection

It is important to remain overly cautious with material selection. For example, we learned that we obtained better outcomes with longer, thicker screws rather than the slightly smaller screws initially used. It is essential to use high quality lumber and materials that can withstand outdoor elements.

2. Uncooperative climate

The summer of 2023 was exceptionally wet, with approximately twice the amount of average precipitation. This certainly impacted the effectiveness of the drought treatments (possibly canceling them out altogether), in addition to causing more damage

3. Expect the unexpected

Despite thorough planning and preparation, things may still not go as planned. There was a great deal of thought and consideration from many qualified professionals for the design of the eavestroughs for which design and testing began several years prior to starting the experiment. However, even with this expertise, there were still structural issues due to the natural environment that could not have been accounted for during testing.

4. Rigorous data collection

Data should be collected thoroughly even when adapting to unforeseen circumstances. In order to keep the response variables and repeated measures within our experiment, it was important to remain flexible. This includes potentially modifying future statistical analysis according to the data available when necessary rather than attempting to run original analysis with missing data. Luckily, in the case of the ThiRST experiment, planning the experimental design and data collection was done carefully which further allowed for the ability to modify analysis after data collection.