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Sugar Maple Monitoring Project at Stratford Ecological Center

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Response of Sugar Maple to Climate Change: Establishing a Long-Term Study at Stratford Ecological Center

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Introduction:

Revered for their dense, fine-grained wood and the lucrative sap that flows within their stems, sugar maples (*Acer saccharum*) are undoubtedly one of the most important tree species in North America. This species is particularly sensitive to environmental changes due to the specific range of soil moisture levels it can tolerate and the large amount of nutrients that must be present for successful growth (Oswald 2018). Flow of a sugar maple's sap is also temperature dependent, being rapidly sucked up to the branches when temperatures are below freezing and shifting back downward as the sap thaws and descends (Tyree n.d.). Current models predict that the length of the season in which sap flows could drop by 14 days if winter temperatures continue to rise (Skinner 2009). As average global temperatures rise, (notably increasing 0.09°C over the 20th century), sugar maple health overall has been declining and the species is showing increasing rates of mortality across its broad range (Bishop et al. 2015). Declining tree health, warmer conditions, and greater drought stress have all led to concerns that climate change may have a negative effect on sugar maple. A long term experiment to monitor how sugar maple growth and sap sugar concentration vary with annual changes in temperature and moisture was established at Stratford Ecological Center in central Ohio.

Methods:

- Stratford Ecological Center was chosen as the area where this study would take place, they have been tapping sugar maples for many years.
- Trees that were actively being tapped for sap were identified with numerical metal tags. A total of 55 trees with single trunks and no irregularities, branches or knots at 1.37 m height (diameter at breast height, dbh) were selected for study
- Trees were measured in centimeters at dbh (1.37m, Figure 1).
- Additionally, a paint marker stripe was placed at 1.37 m.
- An initial measurement of sugar concentration was taken using a Brix refractometer.
- Sugar concentration is measured in Brix. One unit Brix is equal to 1 gram of sucrose in 100 grams of solution and is a percentage.
- A correlation test between sap sugar content and tree size was run using *R*.
- A scatterplot for the data was made in *Excel* (Figure 3).



Figure 1: Jakob Woodside taking dbh measurement, 2019

Data:

Diameter at Breast Height (cm)
Average DBH Measurement: 31.8690909 cm
Min DBH Measurement: 21.0 cm
Max DBH Measurement: 71.0 cm

Brix (°Bx)

Average Brix Measurement: 1.74545 °Bx
Min Brix Measurement: 1.1 °Bx
Max Brix Measurement: 2.6 °Bx

Correlation Test Result

(Between Brix and dbh)
Pearson's Correlation Coefficient: -0.0541058
P-value 0.811



Figure 2: An example of what a typical network of tapped sugar maples looks like, known commonly as a "sugar bush"

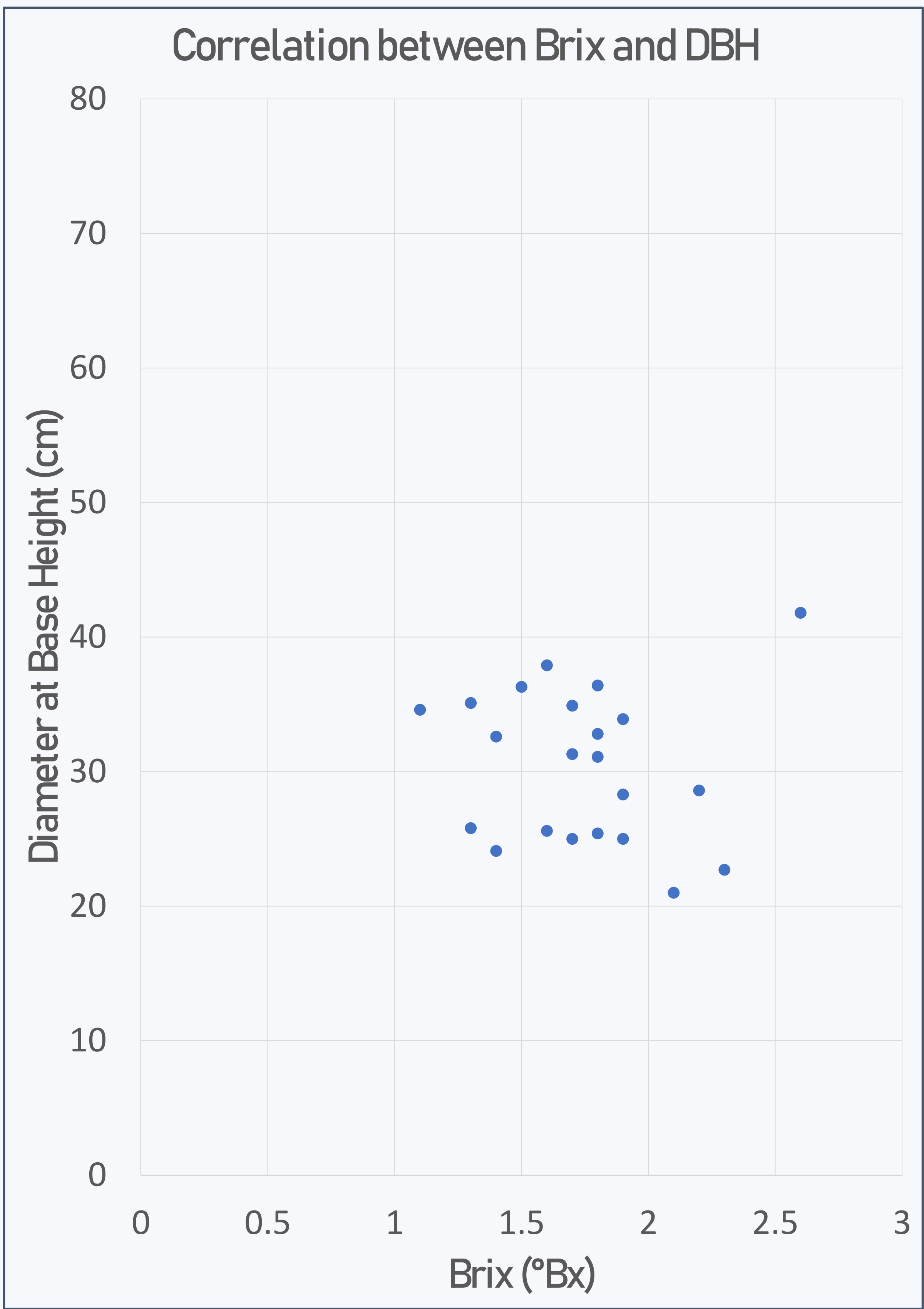


Figure 3: Scatterplot of Brix vs. Diameter at Base Height

Results:

Trees ranged in size from 21.0 cm to 71.0 cm in diameter. The mean size was 31.86909 cm. Brix readings ranged from 1.1 °Bx to 2.6 °Bx. The mean sugar concentration was 1.74545 °Bx. The correlation test between sugar concentration and tree diameter revealed a P-value of 0.811.

There was no significant correlation between sugar concentration and diameter at breast height, suggesting that overall tree size is not related to sugar content in the sap. However, regular diameter measurements over a number of years will allow us to check other relationships, such as links between sugar content and tree growth, and to monitor the responses of both sap sugar content and tree growth to annual variations in rainfall and temperature.

We also plan to take additional sap measurements over the sugaring season. This year, there was trouble acquiring a sample of sap that was not frozen solid throughout due to subfreezing temperatures on field days.

Discussion:

As the experiment continues in the years to follow, there are plans for dendrometer bands to be set up to monitor tree diameter changes with greater sensitivity over a long period of time. Also, this is merely a 55 tree study, something that could be expanded on by future students. Working around freezing conditions to collect more sap data next spring will be necessary. Understanding how maple sap quality is affected by climate change is absolutely essential in order to effectively tap these trees for their sap. A typical tapping season runs eight weeks, and the number of days that sap flow occurs has been shown to decline with increasing temperature (Stinson 2018). Our study will allow Ohio Wesleyan students to document changes in our local environment that are affecting local sugar maples and their sap, and determine if these effects are consistent with those observed in other parts of sugar maple's range.

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