Evaluating and Communicating Tree Health Indicators and Benefits: A Case Study of UGA Campus Trees

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Jekyll Island, Georgia

Presentation Outline

- Background & Objectives
- Project Overview
  - Methods
  - Results
  - Discussion
- Management Recommendations

So MANY benefits!

School campuses are equally enhanced by the many benefits of trees, like…

UGA Main Campus (Athens, GA):
762 acres
460 buildings

UGA Tree Canopy

>14,000 trees
Grounds Department- Tree care team
Diverse species
Diverse age classes
Living laboratory
UGA Campus Arboretum

UGA Tree Canopy

Campus Donated Trees

- Select Trees: Premier SE field-grown tree nursery near Lexington, GA
- Donated >800 eight-inch caliper trees donated to UGA Athens campus over ten-year period
- Variety of species, including several oaks

Summer 2024 Select Trees Tree Benefits Study

- Evaluated 572 donated trees using iTree Eco
- Canopy coverage: 14.1 acres
- Trees averaged 12-18” DBH

Ecosystem Services:

- 920 lbs pollutants removed/ year (value of $1,360/ year)
- Store 246 tons carbon (C) (value of $46,800)
- Sequester 13.82 tons C/ year (value of $2,630/ year)
- Produce 37 tons oxygen/ year
- Reduce stormwater runoff 309,000 gallons/ year (value of $2,800/ year)
- **Replacement value: $1.39 million***

*Based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al. 2002)

Hannah Mobley
UGA Warnell COFA
undergradaute student

Overview of Our Project

- Summer internship (June-August 2024)
- Two faculty advisors
- Investigated tree stress and benefits of campus trees using subset of trees donated by Select Trees
  - n=10; 5 willow oaks (*Quercus phellos*) and 5 Nuttall oaks (*Quercus texana*)
- Research:
  - Tree stress: water potential, diameter/ daily shrinkage (via a dendrometer), and soil penetrometer
  - Tree benefits: iTree Eco
  - Ambient air temperature (shading)
- Communication/ Outreach:
  - Social media, outreach event, fact sheet, conference presentation

Iain Dallas- Project Intern

Our Project Objectives

- Increase public and campus community knowledge and support of community trees.
- Provide valuable data on tree benefits and stress to the UGA Grounds Department, helping inform management decisions.
- Inform community forestry manager knowledge of tools and techniques that can be used to measure tree stress and benefits.
- And…

UGA Warnell Internship Program: Student Research-Outreach Experience

USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

An internship that introduces undergraduate students to:

- Careers in outreach and Extension education
- Research experiences
- Implications and application of research
- Mentorship in natural resource careers and/or graduate school

Project also supports:

- Improved future job performance
- Communication, conflict management, and problem-solving skills as well as leadership experience

Outputs:

- Students create outreach product communicating research results and participate in an outreach event to complete internship

Gordon, J., Irwin, K., Elkins, D., and McCarty, E. *Enhancing undergraduate learning through research and extension internships* (2021-67037-34643), USDA-AFRI Workforce Development Program, REEU program area.

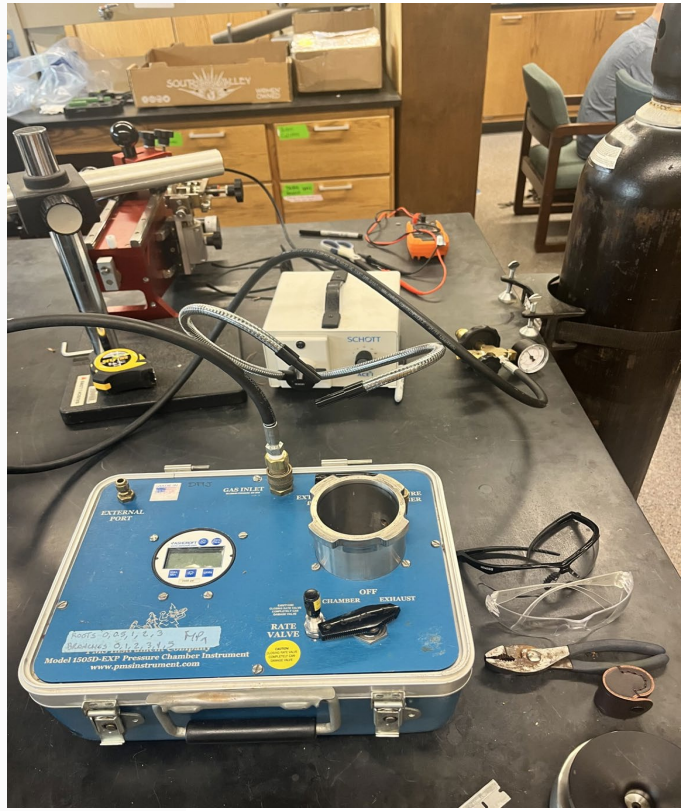
Project Overview

Materials & Methods: Tree Measurements

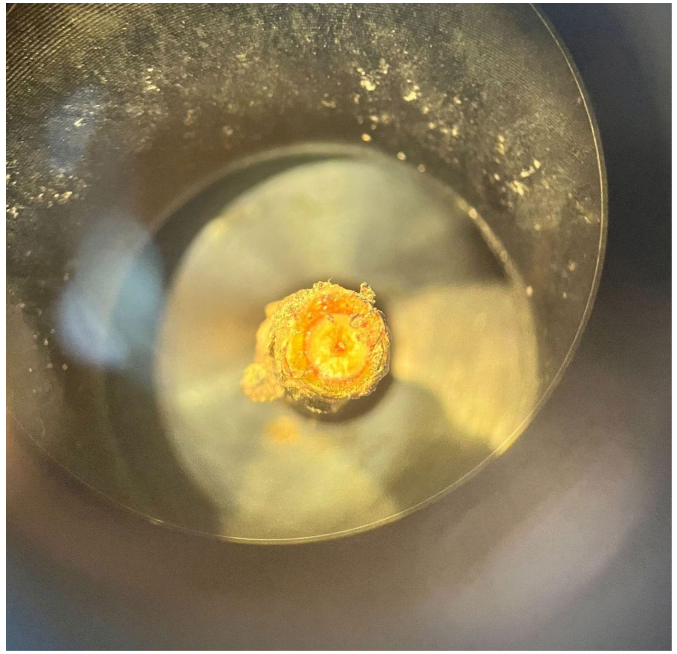
i-Tree

Tools for Assessing and Managing
Forests & Community Trees

Materials & Methods: Water Potential

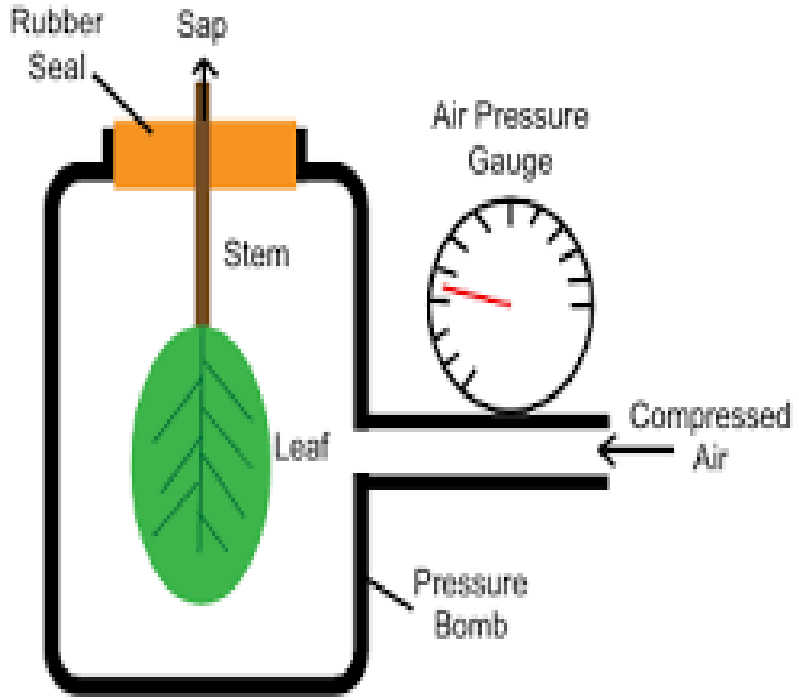


Pressure chamber used to measure predawn and afternoon leaf water potentials



Observing water droplets on a leaf petiole under a microscope

Water Potential Process



Materials & Methods: Dendrometry

Exposed inner-bark layer

Dendrometer sensor attached to cambial/ live bark area

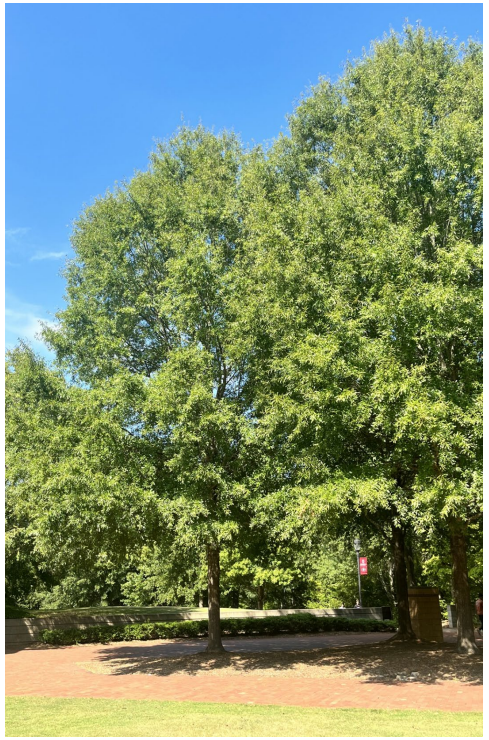
Dendrometer- data logger system attached to tree trunk

Campus Trees Investigated: Willow Oaks

Willow 1

Willow 2

Willow 3



Willow 4

Willow 5

Campus Trees Investigated: Nuttall Oaks

Nuttall 1

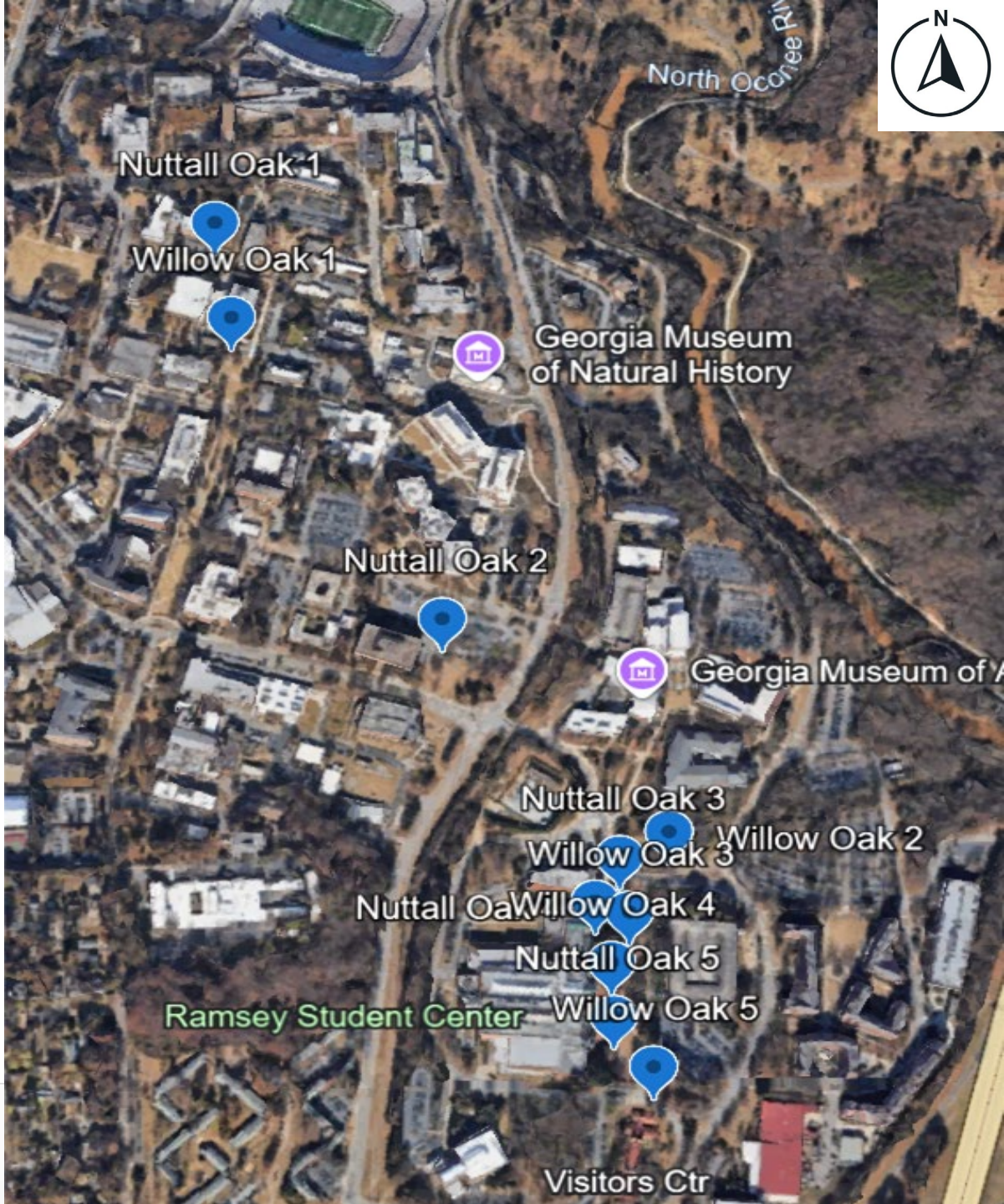
Nuttall 2

Nuttall 3

Nuttall 4

Nuttall 5

UGA Campus Tree Locations



Results: Tree Dimensions

Species	Height (ft)	DBH (in)	Canopy Area (sq. ft)
Willow 1	56.0	16.3	1228.5
Willow 2	59.0	16.1	1342.9
Willow 3	62.0	18.1	1615.3
Willow 4	54.0	14.3	1170.2
Willow 5	59.0	18.2	1496.4
Willow Oak Average	*58.0*	*16.6*	*1370.66*
Nuttall 1	41.0	13.9	926.7
Nuttall 2	48.0	16.3	1269.2
Nuttall 3	51.0	14.5	978.7
Nuttall 4	56.0	16.3	1355.9
Nuttall 5	49.0	15.2	1049.2
Nuttall Oak Average	*49.0*	*15.24*	*1115.94*
Total Average	**53.5**	**15.9**	**1243.3**

Results: Total Tree Benefits

	Total Carbon Stored (Tons)	Carbon Sequestration (tons/yr)	Runoff avoided (gal/yr)	Replacement cost ($)
Nuttall (5)	2.79	0.17	2432.44	$9,531
Willow (5)	2.63	0.13	3479.52	$12,020
Total (10)	**5.42**	**0.3**	**5911.96**	**$21,551**

Results calculated by the **iTree Eco** software: https://www.itreetools.org/tools/i-tree-eco

Results: Temperature

Average Temperatures in °F (three collections over summer):

Morning				Afternoon				Morning	Afternoon
NE-Stem (Shade)	NE-Drip Line (Sun)	SW-Stem (Shade)	SW-Drip Line	NE-Stem (Shade)	NE-Drip Line (Sun)	SW-Stem (Shade)	SW-Drip Line (Sun)	Ambient Temp*	Ambient Temp*
73.0	75.6	72.9	75.3	82.8	96.0	83.5	98.2	74.7	87.7

Average Temperature Differences:

NE Stem	NE Dripline	SW Stem	SW Dripline	Ambient
9.8	20.4	10.6	22.9	13.0

Methods: took 2 measurements each on the NW and SE side of tree during morning and afternoon. Measurement one is 5 ft from stem toward cardinal direction. Measurement two is 5 feet out from drip line toward cardinal direction.

*Ambient Air Temperatures collected from NOAA National Weather Service website.

Results: Soil Measurements

- **8/10 trees** had >50% compaction measurements >300psi*. These sites experience “severe compaction” limiting root growth in the top 15in of soil.
- **2/10 trees** had <50% compaction measurements >300psi*. These sites experience “moderate compaction” limiting root growth in the top 15in of soil.

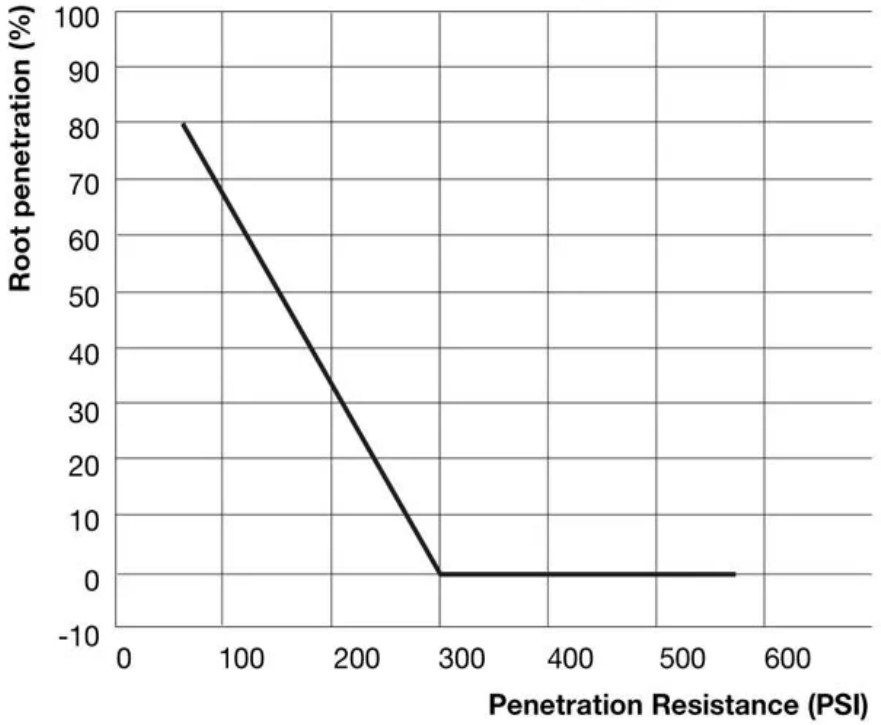


Table 1. Interpretation of penetration resistance measurements.

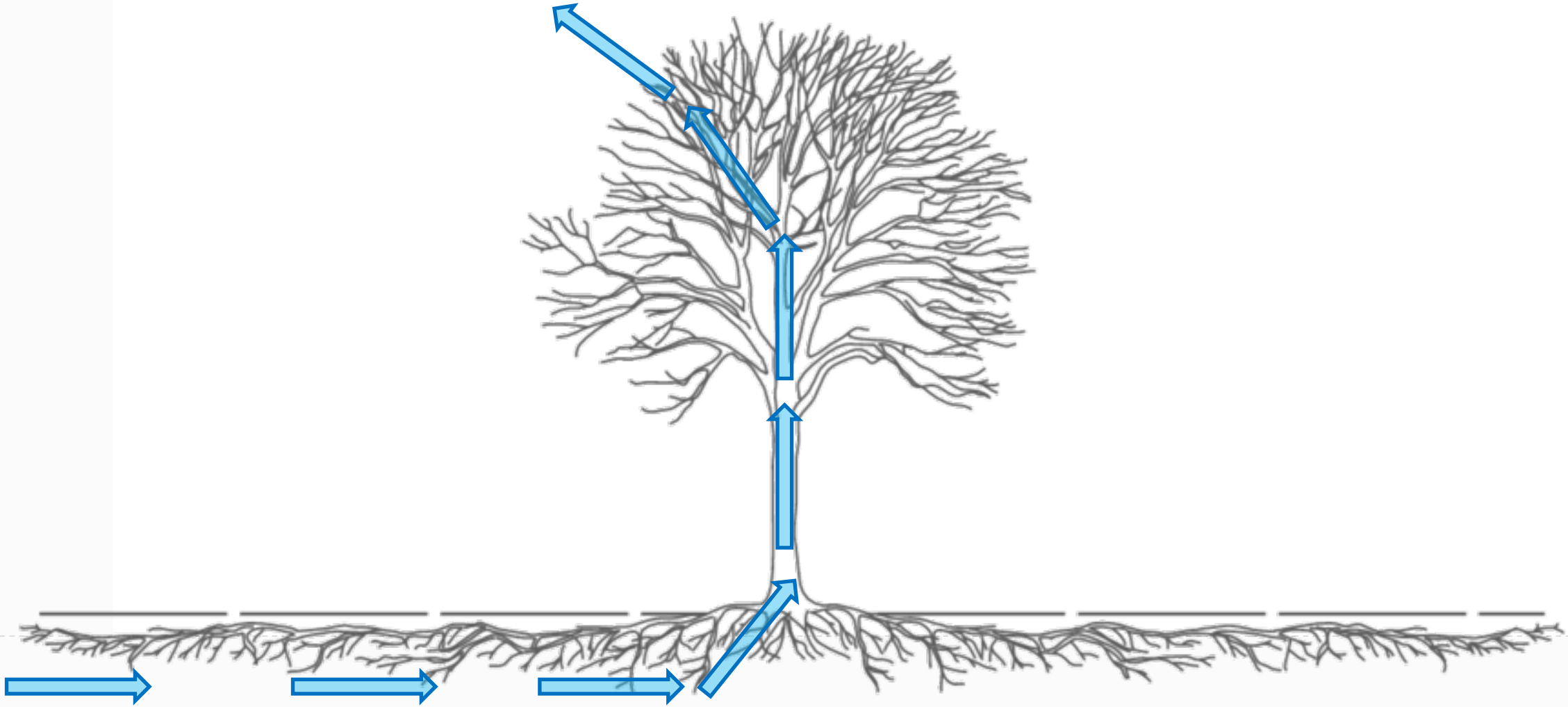
PERCENTAGE OF MEASURING POINTS HAVING CONE INDEX > 300 PSI IN TOP 15 INCHES	COMPACTION RATING	SUBSOILING RECOMMENDED
< 30	Little to none	No
30–50	Slight	No
50–75	Moderate	Yes
>75	Severe	Yes

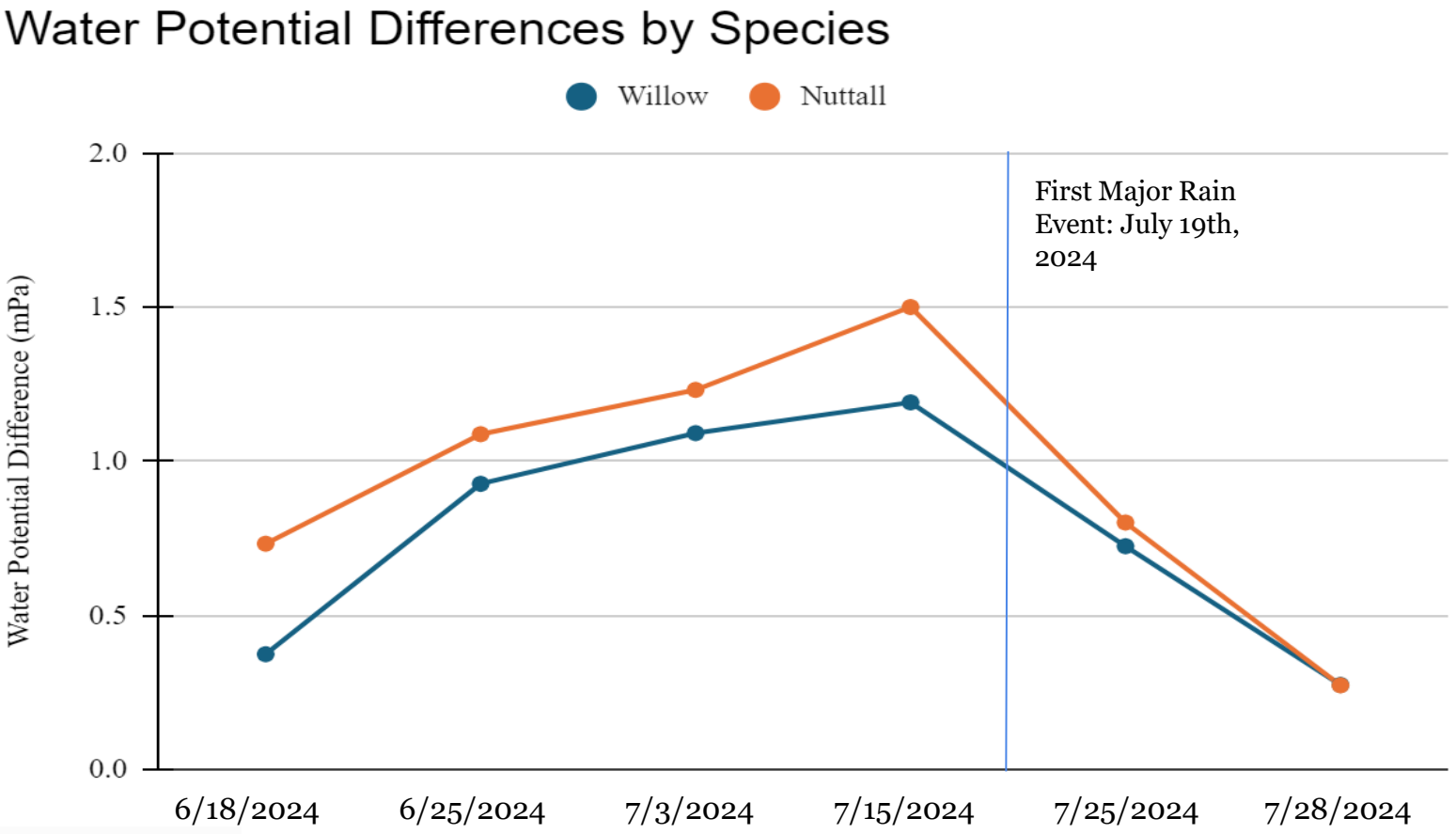
Adapted from: Lloyd Murdock, Tim Gray, Freddie Higgins, and Ken Wells, 1995. *Soil Compaction in Kentucky.* Cooperative Extension Service, University of Kentucky, AGR-161.

*300 psi indicates near %100 reduction in root penetration

Graph from: *Diagnosing Soil Compaction Using a Penetrometer (Soil Compaction Tester)* by Sjoerd Duiker (2002)

Transpiration Overview



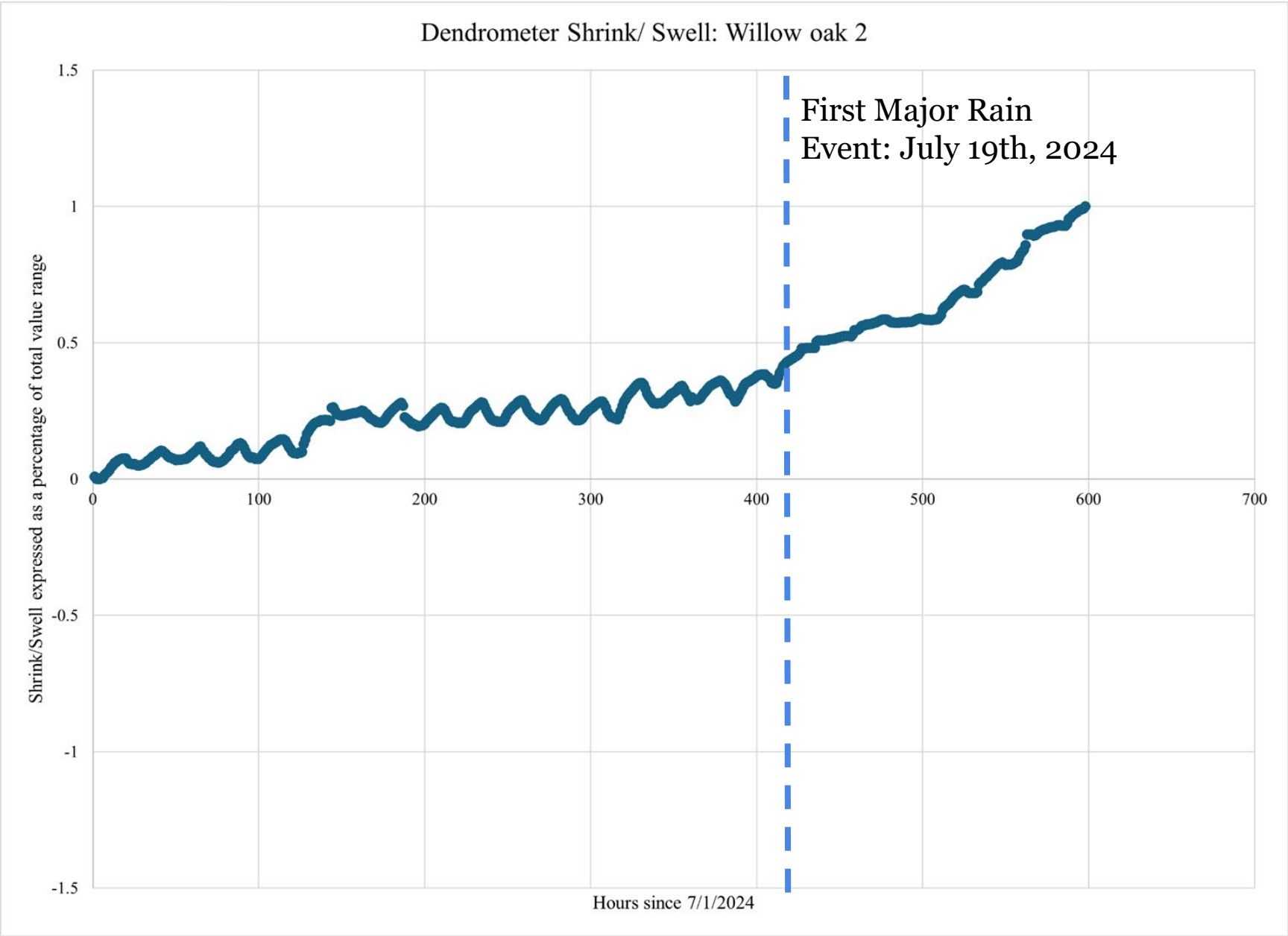


Species	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Willow Oak	0.3738	0.9268	1.0913	1.1912	0.7244	0.2742
Nuttall Oak	0.7325	1.0879	1.2317	1.5005	0.8012	0.2729

Results: Water Potential

- Comparisons between individual water potentials are difficult due to the multidimensional nature of the transpiration process.
- From 6/18/2024 to 7/15/2024, the water potential difference for both species and all individuals rose, reflecting the stress experienced by heat and water limitations.
- Onset of rain events ameliorated large daily water potential differences for all species and individuals.
- Average water potential difference for Nuttall Oaks was consistently higher than the average water potential for Willow Oaks.
- Individual measurements can be useful over long-term projects, but short term stress responses hard to understand without establishing cause-effect

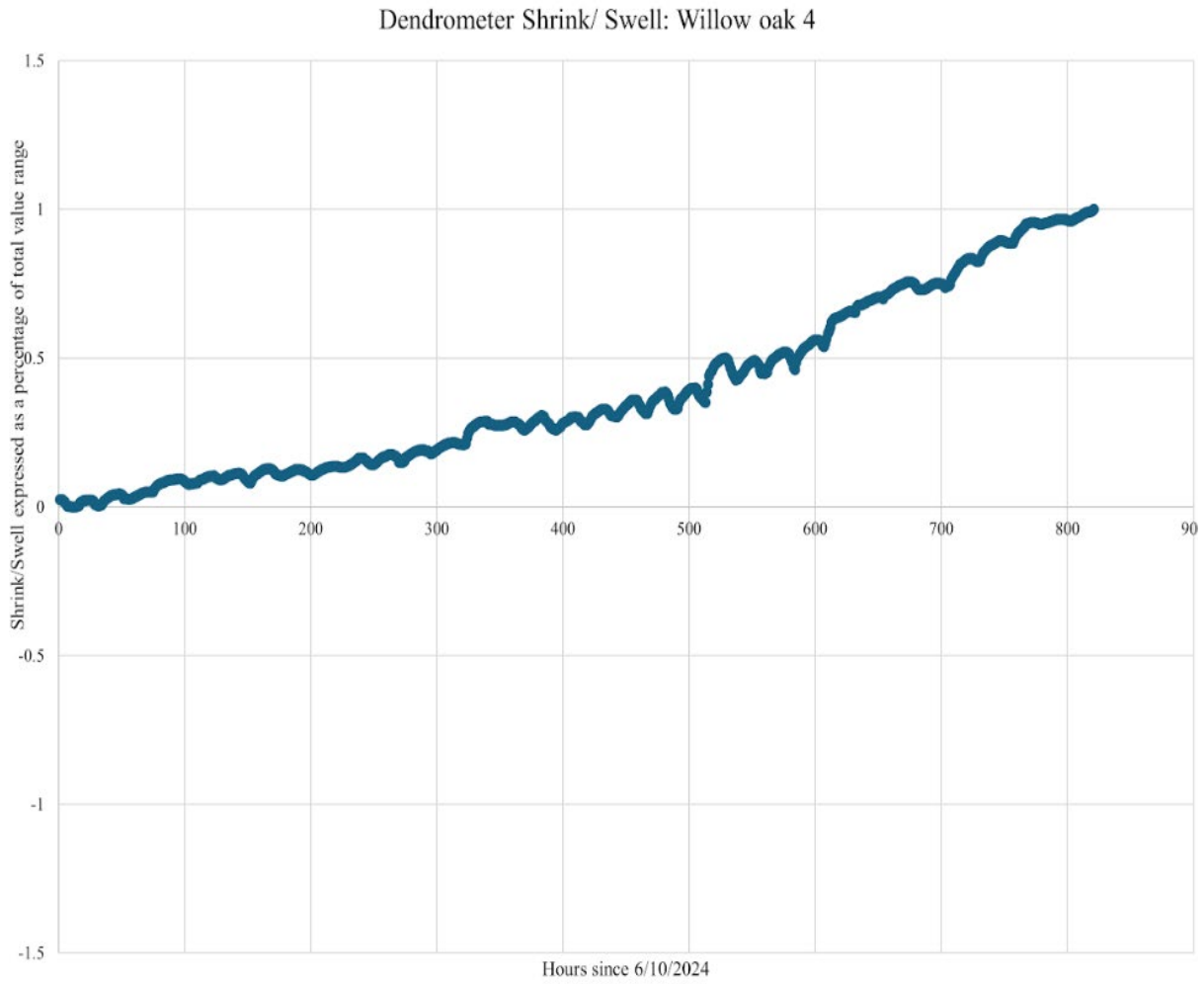
Results: Dendrometry

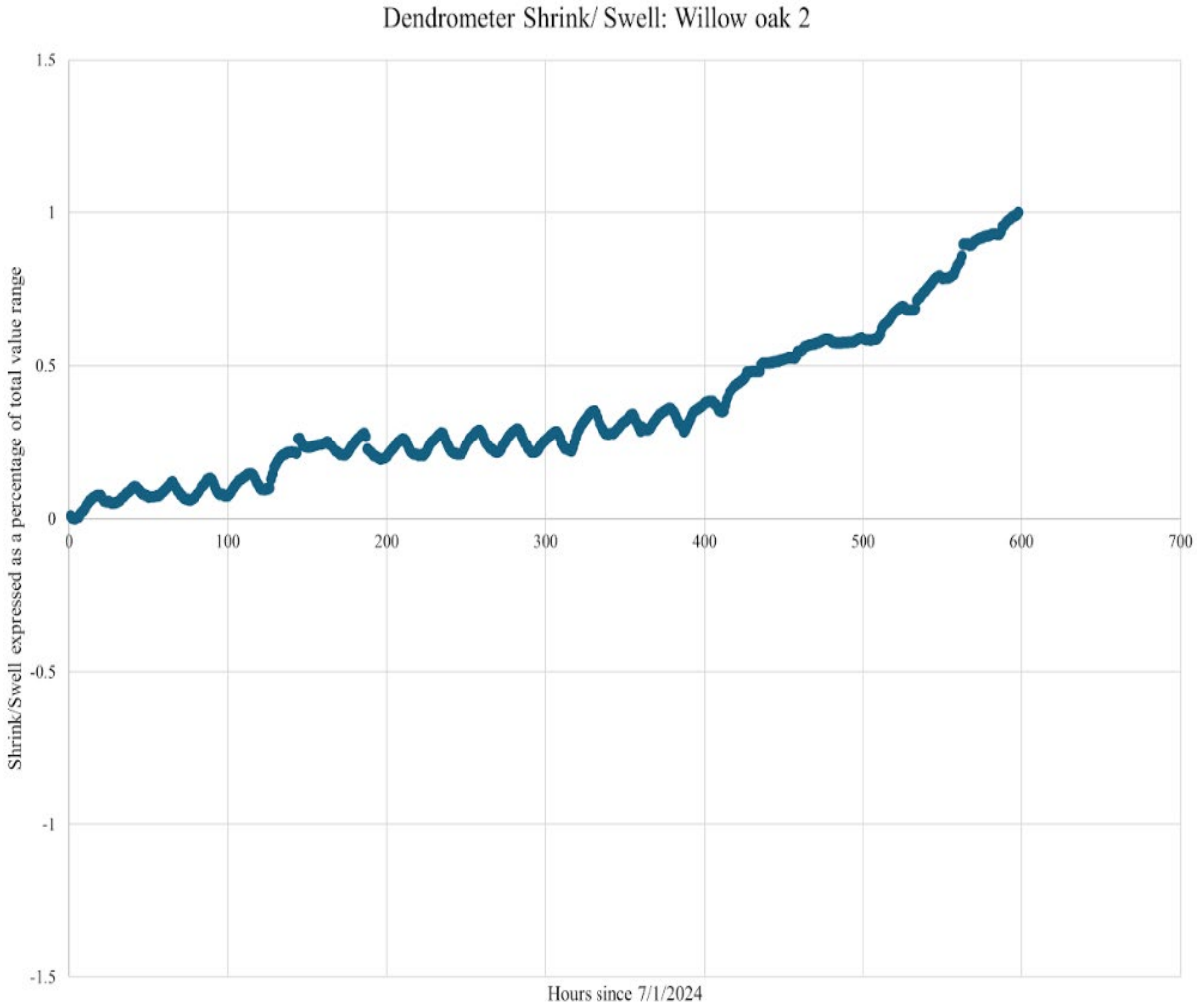


Considerations:

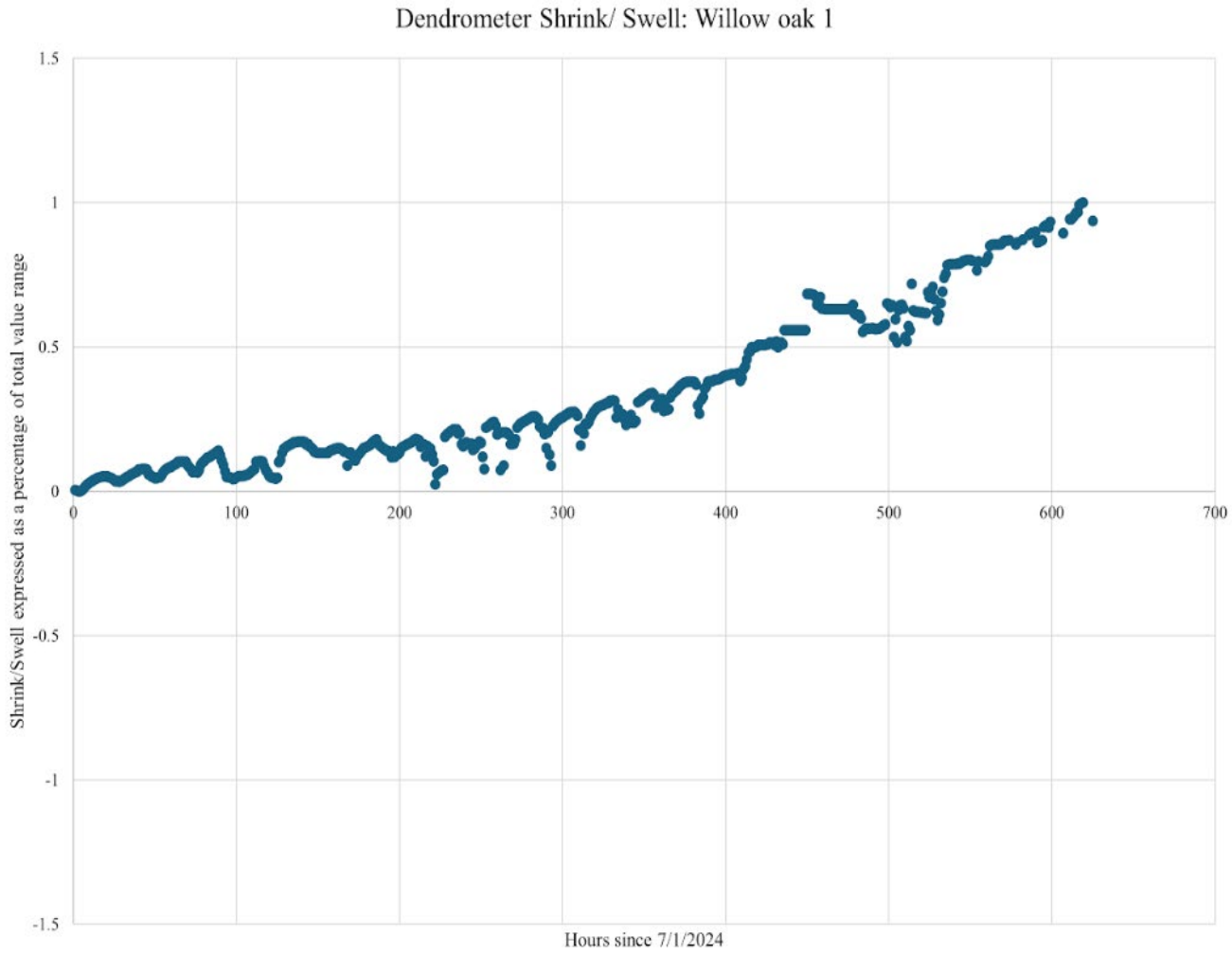
- Defined and consistent trend between negative sloped Shrink/Swell capacities and tree mortality.
- Dendrometry reflects changes in tissue water content, and therefore transpiration as a whole.
- Dendrometry measurements highly associated with soil water availability, as trees do not grow well without readily available water.
- Varied start times due to mechanical errors in data logger-dendrometer system.

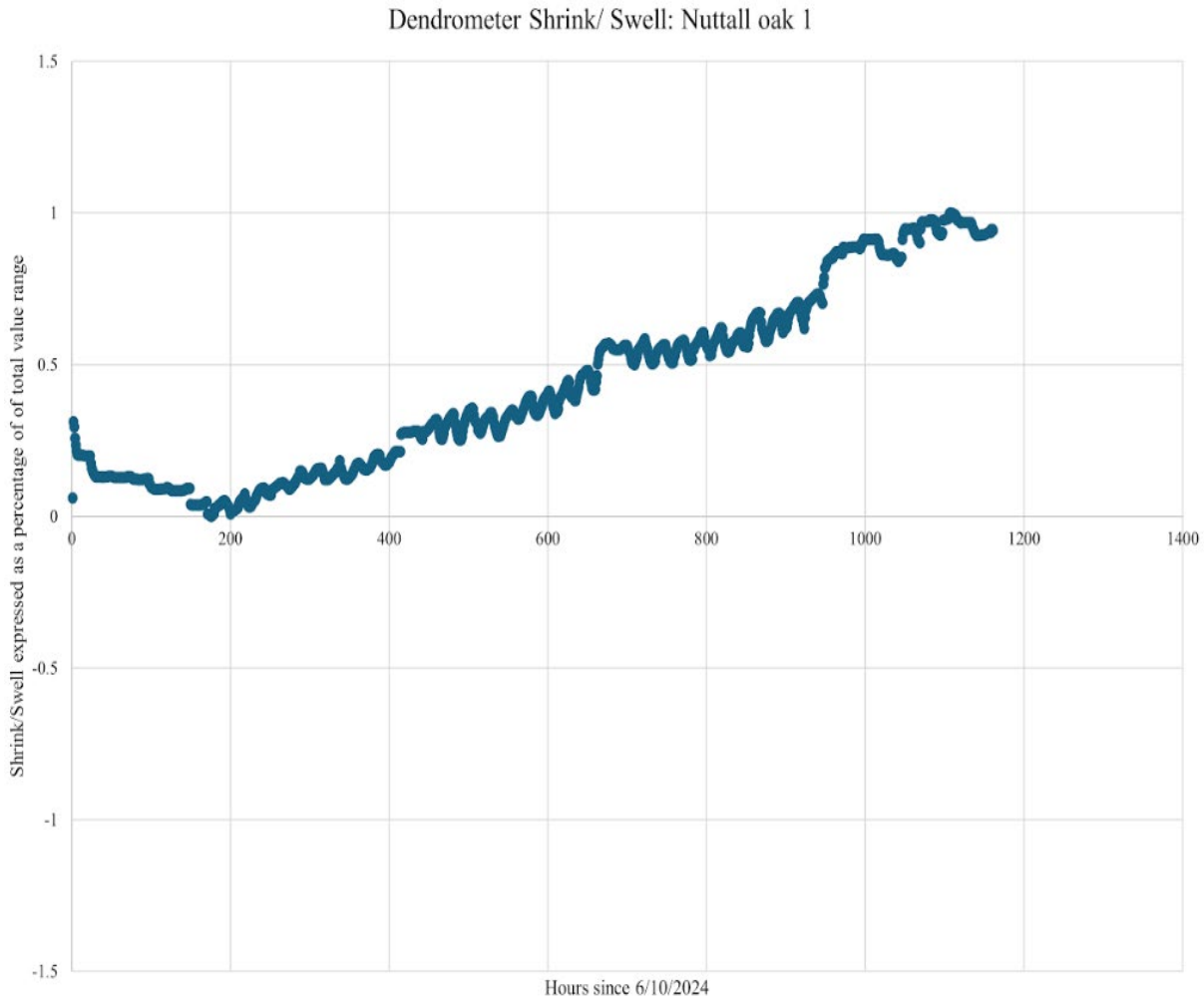
High Growth:


Dendrometer Shrink/ Swell: Willow oak 4
Shrink/Swell expressed as a percentage of total value range
1.5
1
0.5
0
-0.5
-1
-1.5
0
100
200
300
400
500
600
700
800
90
Hours since 6/10/2024

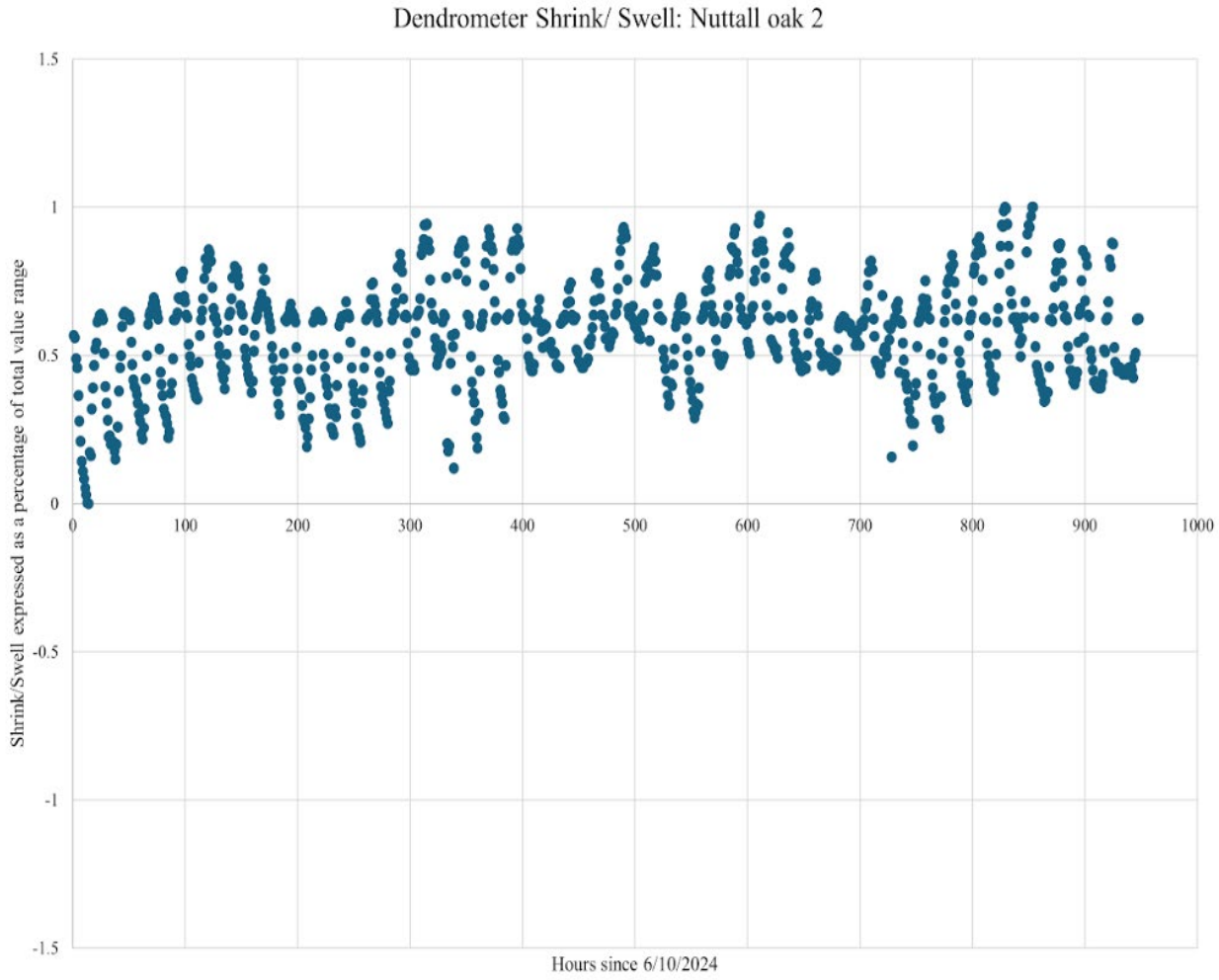

Dendrometer Shrink/ Swell: Willow oak 2
Shrink/Swell expressed as a percentage of total value range
1.5
1
0.5
0
-0.5
-1
-1.5
0
100
200
300
400
500
600
700
Hours since 7/1/2024

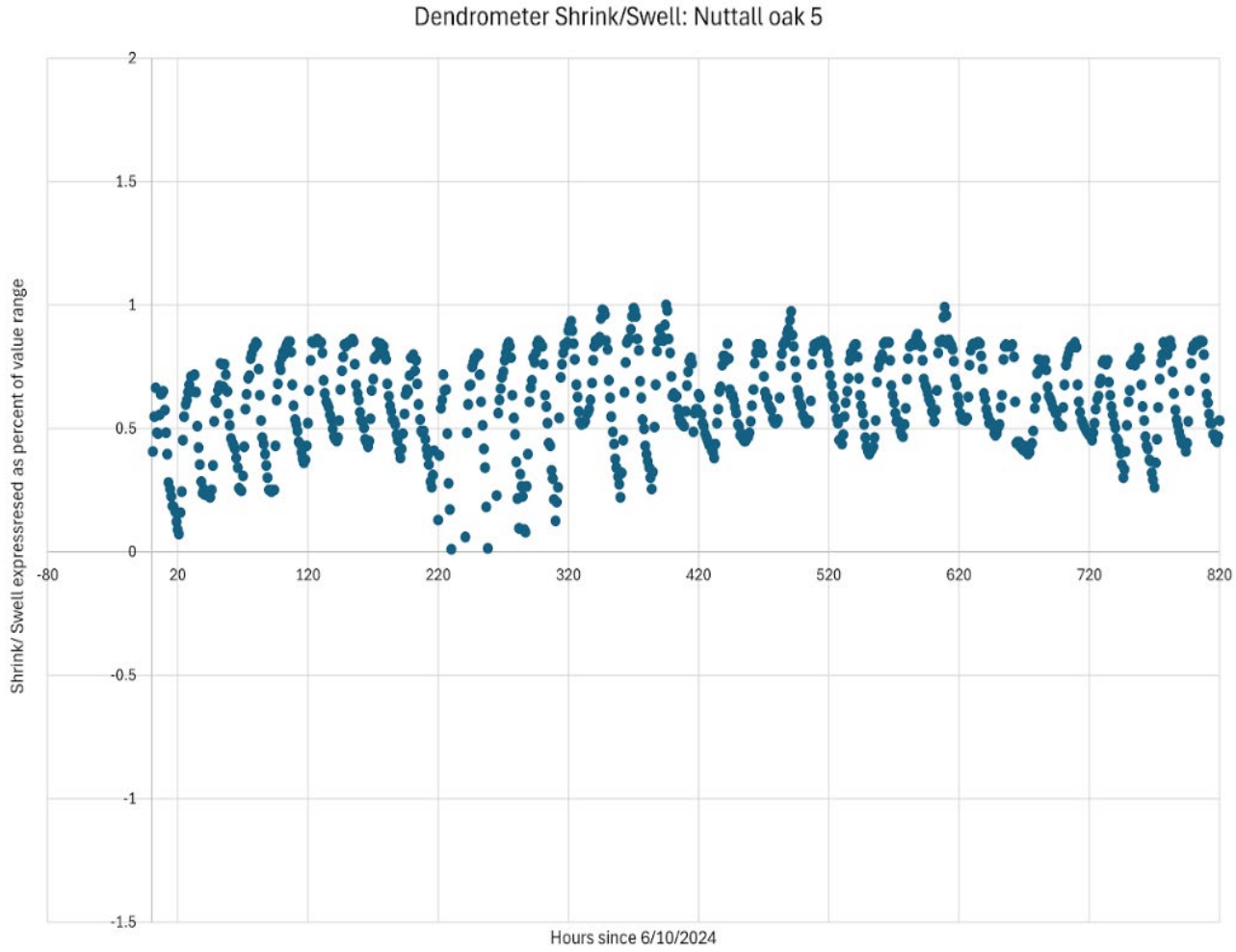
High Growth cont:



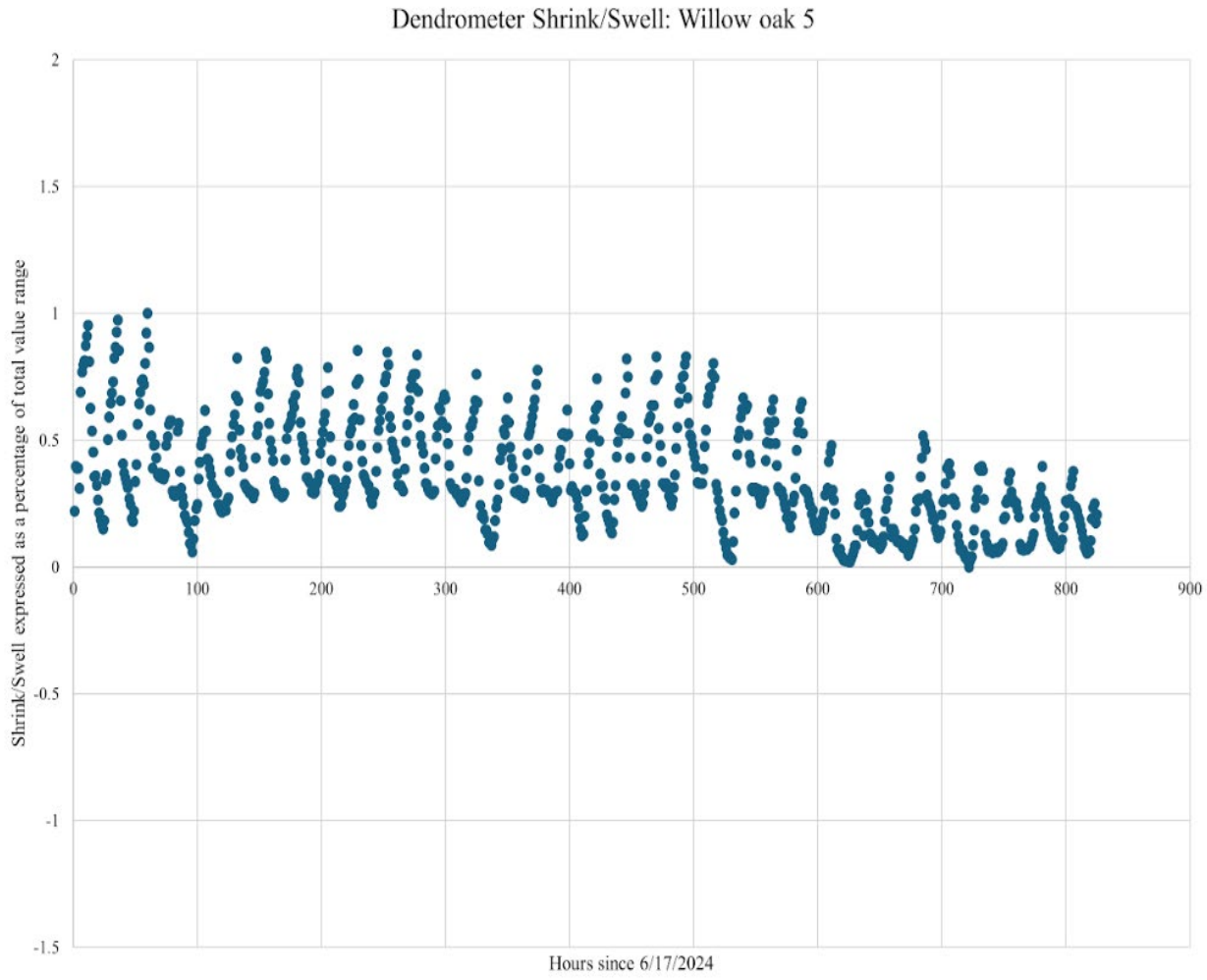


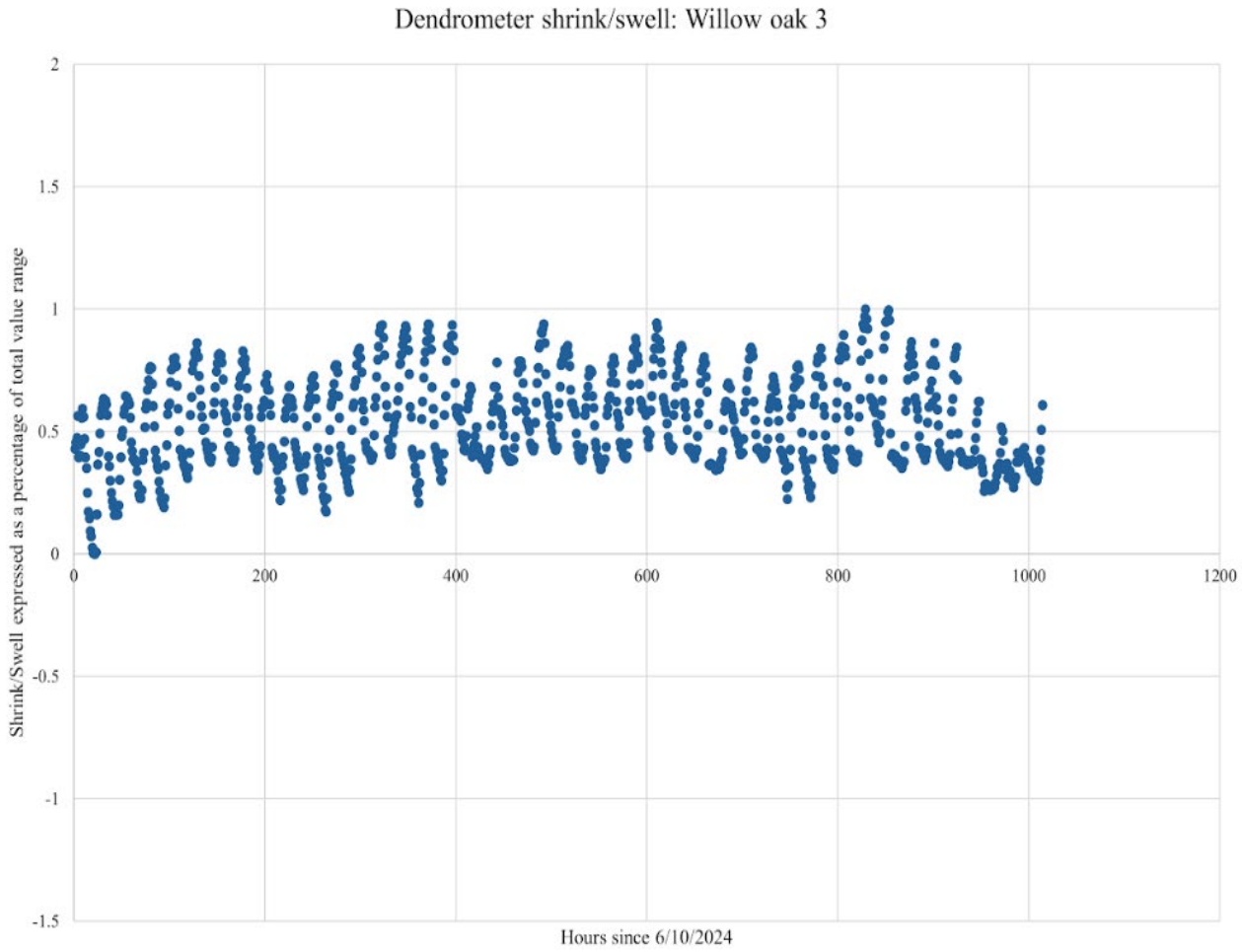
Low Growth


Dendrometer Shrink/ Swell: Nuttall oak 2
Shrink/Swell expressed as a percentage of total value range
1.5
1
0.5
0
-0.5
-1
-1.5
0
100
200
300
400
500
600
700
800
900
1000
Hours since 6/10/2024

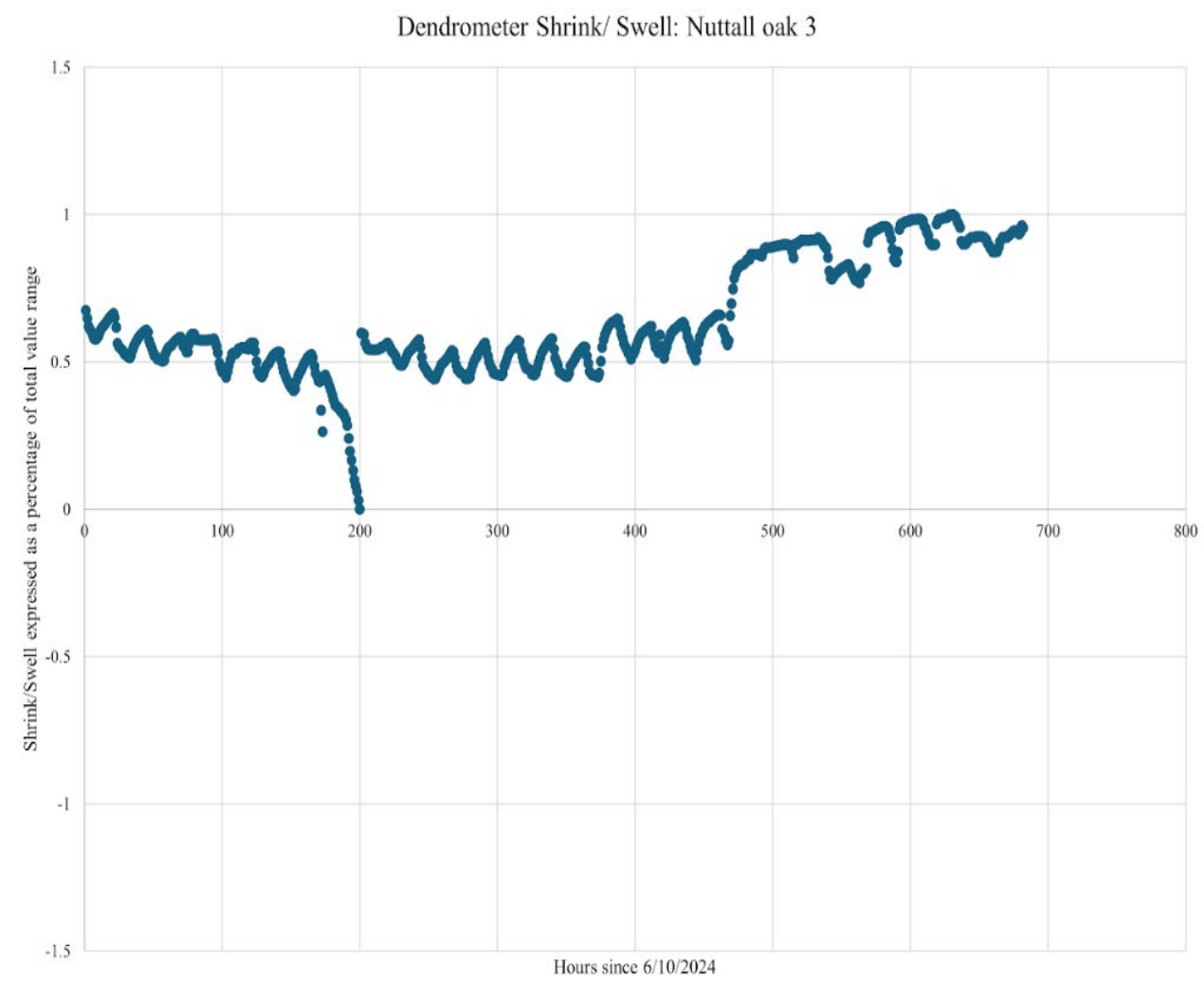

Dendrometer Shrink/Swell: Nuttall oak 5
Shrink/ Swell expressresed as percent of value range
2
1.5
1
0.5
0
-0.5
-1
-1.5
-80
20
120
220
320
420
520
620
720
820
Hours since 6/10/2024

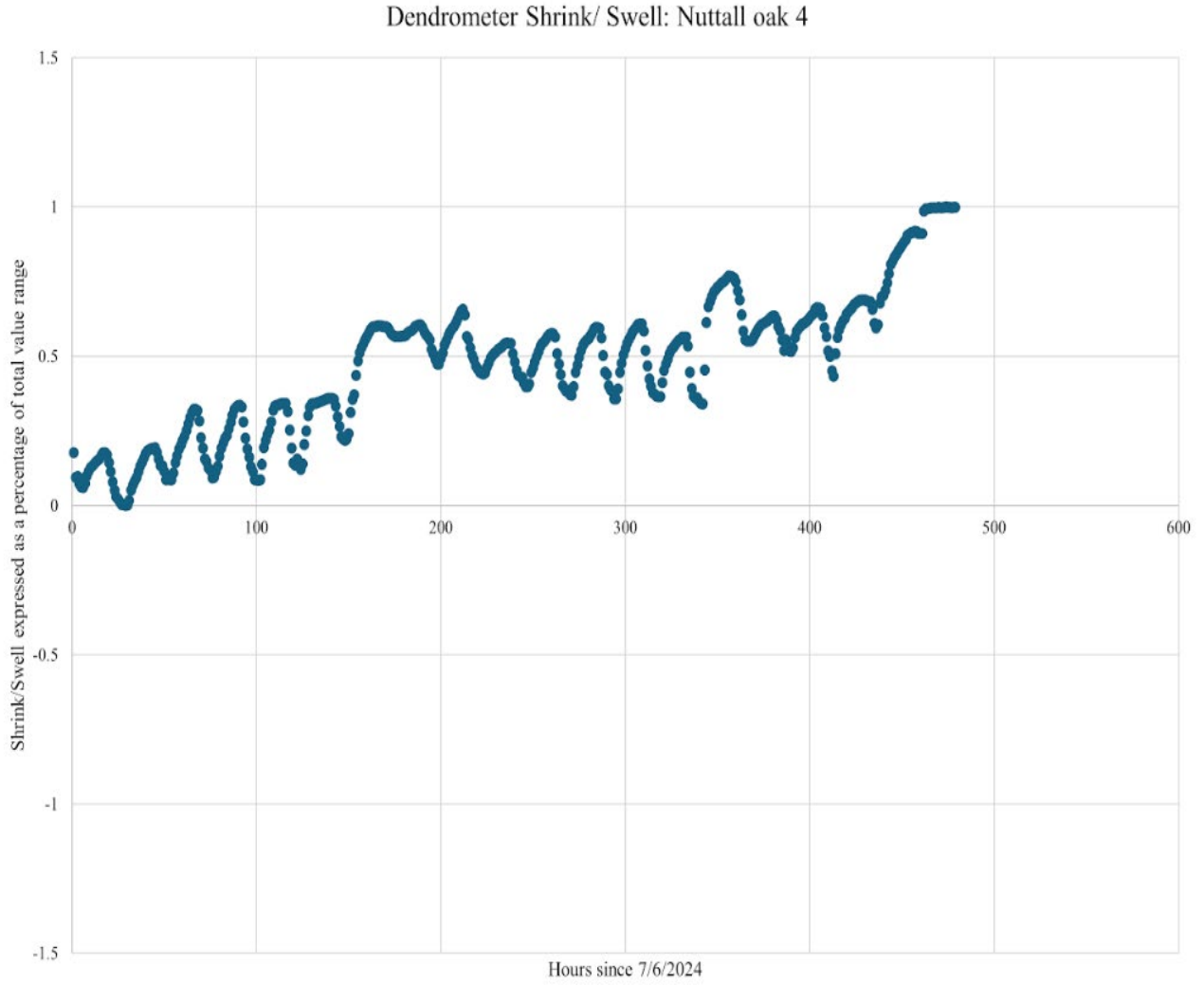
Low Growth cont:





Hard to analyze:





Results: Outreach

- Social media videos (Warnell social media)
- Fact Sheet - Will be available on UGA Warnell Website (Jan 2025)
- Tree Walk for Campus Community (July 29th, 2024)
- Conference Presentation- (today!)

Discussion

- iTree Eco
- Summer weather (low rainfall and high heat) impacted results
  - Water potential
  - Dendrometer data
  - Penetrometer
- Temperature measurements (much variability but shading has significant impact on temperature)
- Outreach events
- Management implications and instrument application at community level

Setbacks:

Dendrometers:

- Multiple battery failures
- Internal clock failure
- Data retained from previous uses
- Movement of sensor during high winds

Water Potentials:

- Hard to find good leaves at accessible heights for some trees
- Subjective nature of measurements

Citations

Duiker, S. W. (2002). Diagnosing soil compaction using a penetrometer (soil compaction tester). Penn State Extension. https://extension.psu.edu/diagnosing-soil-compaction-using-a-penetrometer-soil-compaction-tester

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Thank You & Questions

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SELECT TREES