**2025 Andrews Forest LTER GRA Support Award Proposal**

**“Quantifying Growth of Scorched Western Hemlocks Following the 2021 Heat Dome”**

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***Overview of the proposed project and graduate student***

A paper produced with LTER8 highlights the widespread effects of the 2021 Heat Dome on tree health in the Pacific Northwest (Still et al., 2023). This event occurred during peak growing season the year after an extreme fire year in western Oregon, thereby influencing patterns of delayed tree mortality and regeneration (e.g., Doolittle, *in prep*). Climate change has increased the probability of similarly extreme weather occurring in the future (Fleishman 2025). These compounding disturbances have the potential to profoundly alter species interactions and ecosystem function such as biotic modulation of microclimate.

Increasing understanding of physiological and ecological responses to extreme heat and drought is fundamental to LTER8 goals of understanding how interactions (specifically biotic modulation and legacy) shape and are shaped by changing disturbance and climate regimes. A vital aspect of tree function is stem growth, yet there are many unknowns in understanding and predicting tree responses to historically unprecedented climate conditions. This work forms the basis of Gabby John’s research. Gabby joined Oregon State University in fall 2023 to begin a master’s project building on LTER8 research at the intersection of climate, canopy ecology, and phenology subcomponents. She has been funded mostly by GTAs and is using LTER8 funds to analyze high-resolution microclimate (MV005, MS001) and dendrometer data (TV088) at the HJA. She is also collecting tree cores from the same trees to extend the record and understand the extent to which Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) growth is affected by heat wave and drought events of varying magnitude and seasonal timing. This research is imperative and timely as both weather phenomena are interlinked and threaten the capacity for forests in the PNW to provide microclimate refugia and store carbon (Davis et al., 2023; Duarte et al., 2016). John is on track to complete the analysis and writing of this initial project in summer 2025, which focuses largely on Douglas-firs due to dendrometer sample distribution.

Over the last year, John’s project has identified more questions than she can answer within two years, so she plans to pursue similar work at OSU via a Ph.D. This proposal is an opportunity to help fund additional LTER8 research and information management at HJA, producing a publication that can be integrated into her degree program. Specifically, John would focus on expanding her tree core samples to explore the potential residual effects of the 2021 Heat Dome on western hemlock growth. John will collect cores from a stand of western hemlock trees near the Discovery Trail that experience varying levels of sun exposure through gaps in the surrounding canopy of Douglas-firs. These gaps resulted in a gradient of leaf mortality (foliar “scorch”) as assessed post-Heat Dome in July 2021 ranging from mild (e.g., TSHE 646) to severe (e.g., TSHE 652). Notably, hemlocks were among the most heat-sensitive species in many locations, as their canopies typically experienced the greatest leaf mortality from the 2021 Heat Dome (Sibley et al. *in review*), and observations at the HJA suggest that this event triggered a continued decline in the health of a portion of the most heat-damaged individuals. Western hemlock, as the most abundant understory species in many old-growth stands in this landscape, is a key modulator of microclimate and other critical ecosystem functions. The proposed project takes advantage of the natural gradient of exposure to the most extreme PNW heat wave in recorded history by investigating how the degree of scorch affected a key ecosystem engineer species. John will explore the following questions:

1. How did the degree of foliar scorch affect the growth of western hemlock?
2. Was growth in subsequent years related to the proportion of 2021 scorched crown volume?
3. How did growth response to this extreme event compare with prior droughts and heat waves? ***How the proposed project achieves LTER8 goals***

The proposed project builds upon long-term data and LTER8 projects, supporting Goal I. High temperatures often lead to foliar damage and mortality, which affects a tree’s ability to assimilate carbon (Teskey et al., 2014). Trees and tree health are fundamental to the biotic modulation of microclimate; indeed, current analyses (Jones et al. in review; Fitch et al. *in prep*) suggest that the extent that forest understories are decoupled from climate warming trends is due to biotic modulation and not physical processes such as cold air pooling. Accurate modeling of future forest dynamics and sound forest management decision-making depends on a thorough understanding of how trees and interactions among tree species respond to climate-related disturbances.

***Fire impacts on student’s work to date***

In addition to representing a clear instance of extreme weather with profound and perhaps long-lasting impacts, the 2021 Heat Dome compounded the impacts of 2020 fires on forest function and trajectories. Future heat waves will likely alter postfire trajectories of the Lookout and other recent fires.

For the microclimate analyses needed to contextualize growth patterns at the HJA, John has relied on long-term data procured from the FSDB and the Andrews Provisional Data Portal. The Ore Fire delayed and reduced John’s ability to conduct field work and communicate with co-advisor Mark Schulze who was coordinating HJA fire response efforts.

***Specific activities during the funding period***

If selected for this award, we request that John be supported for the fall 2025 quarter. During this time, she will collect and process tree cores, analyze data for publication, and submit updates to MV005 and TV088 datasets. This will bring both LTER8 datasets into compliance by the time of LTER9 proposal submission. Her present project requires her to pull data from multiple large datasets (e.g., MS001, MS005, MV005, TV088). Through academic courses on version control repositories and HJA workshops on best practices for data management, she is developing skills to compile, merge, and quality control gigabytes of data from the Provisional Data Portal into a single data frame available via Shiny. John will also continue utilizing novel R packages for data cleaning and visualizing dendrometry data. These efforts to streamline workflows will facilitate future updates to MV005 and TV088 and may be useful to other LTER researchers who need to visualize and assess provisional data.

Through her current work, John has already collected and mounted eight hemlock cores at the Discovery Trail. With fall funding, John will collect and analyze additional hemlock cores to increase replication across the needle-scorch gradient. Paired with traditional manual as well as newer automated dendrometry datasets, these methods will convey long-term growth patterns and stress responses. John will also apply an allometric equation to tree ring samples to estimate biomass and carbon allocation. As seen in Acosta-Hernández et al., 2020, this practice would allow researchers and forest managers to more concretely convey the relationship between climate change and carbon storage.

***Timeline of student expectations and deliverables for the proposed project***

John is expected to complete and submit a publication from her current LTER8 work on Douglas-fir growth responses to heat waves and drought in summer 2025, allowing for a natural transition to focus on the proposed western hemlock project in fall 2025. Except for summer 2024, John has relied on Teaching Assistantships. This funding would allow John to spend the fall term exclusively focused on research. This is especially valuable since collecting tree cores is ideally done in the fall after the fire season and at the end of the water year and growing season. Freedom from other obligations would put her in a position to finalize TV088 and MV005 dataset updates, analyze the new samples, and have a publication of the proposed project ready before the conclusion of the winter 2026 term.

***Contributions to LTER community***

In line with the expectations outlined in this proposal’s criteria, John will continue her close involvement with Andrews LTER personnel and activities. For example, She applied for the 2025 cohort of LTER graduate student science writers and is registered for the Early Career Critical Zone Workshop at the HJA this March. John and Still will continue to complete necessary NSF annual reporting forms.

An important and sometimes overlooked aspect of science is engaging and communicating with the public. John is a regular attendee of LTER meetings and gave a graduate student flash talk at the December 2024 LTER Monthly Meeting. She is prepared to present the results of the proposed project at another monthly meeting in 2026. Speaking at LTER meetings allows her to hone communication skills as she identifies other meetings and symposia to share the proposed project as she has done in the past.

***References (not including publications in prep or review)***

Acosta-Hernández et al., 2020. *Forests* 11:1134. <https://doi.org/10.3390/f11111134>

Davis et al., 2023. *Fifth National Climate Assessment*. <https://doi.org/10.7930/NCA5.2023.CH32>

Duarte et al., 2016. *J. Plant Physiol.* 205:57–66. <https://doi.org/10.1016/j.jplph.2016.08.012>

Fleishman, E., editor. 2025. Seventh Oregon climate assessment. <https://doi.org/10.5399/osu/1181>

Still et al., 2023. *Tree Physiology* 43(2), 203–209. <https://doi.org/10.1093/treephys/tpac143>

Teskey et al., 2014. Plant, Cell & Environment 38:1699–1712. <https://doi.org/10.1111/pce.12417>