College of Agricultural, Consumer and Environmental Sciences
Agricultural Experiment Station

John T. Harrington
Forestry Research Center at Mora

NM STATE

John T. Harrington Forestry Research Center at Mora





2025

Table of Contents

Notice to Users of this Report **2**

Agricultural Science Center Locations Map **3**

Executive Summary **4**

Research Highlights **5**

Evaluating Rhizosphere Microbiome-Pathobiome Dynamics in Nursery-Grown Conifer Seedlings for Enhancing Reforestation in Wildfire-Impacted Landscapes *6*

A New Approach to Reforestation: nucleation planting strategies for climate-resilient forests *7*

Carbon Stock Models for Early Post-Fire Reforestation Efforts in the Southwestern United States *8*

Optimizing Seedling Production for Post-Fire Reforestation in the Southwestern United States *9*

A Horizon Scan to Inform Research Priorities on Post-Wildfire Forest Restoration and Recovery in the Western United States *10*

Stemflow-Driven Hydrological Dynamics of Burned Snags and Their Role in Post-Fire Microsite Conditions *11*

Assessing Combinations of Nucleation Size and Planting Density to Improve Survival and Performance of Planted Ponderosa Pine Seedlings *12*

Variation in Phenology and Growth Traits Among Pinus Ponderosa Provenances: Implications for assisted migration *13*

Drought Conditioning Improves Long-Term Field Performance Of Populus Tremuloides and Pinus Ponderosa Under Dry Conditions *14*

Scouts at Philmont Scout Ranch Participate in Reforestation Research *15*

Using X-Ray Computed Tomography to Investigate the Mechanisms of *16*

Intra and Interspecific Resource Competition of Southern Live Oak and Loblolly Pine Regeneration *17*

Cultivating Resilience: A blueprint for growing Hawai'i's state forestry nurseries *18*

Koa restoration in gorse-dominated landscapes in Hawai'i *19*

Outreach Activities **20**

People and Partnerships **22**

Cooperators and Collaborators *23*

Advisory Committee *23*

ASC Personnel *24*

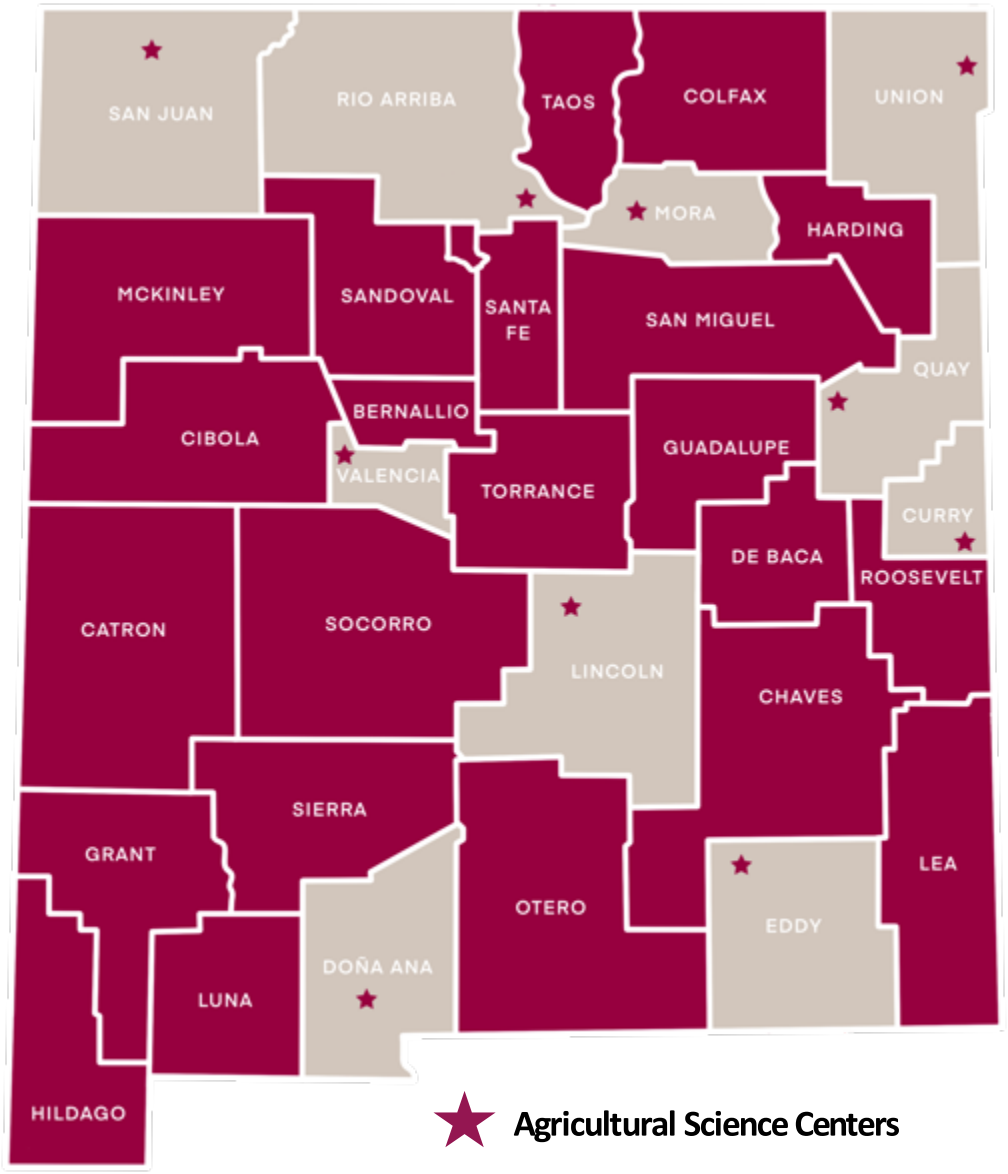
Notice to Users of this Report

These are not formal Agricultural Experiment Station Report research results. The reader is cautioned against drawing conclusions or making recommendations as a result of the summaries in this report. In many instances, data represents only one of several years' results that will ultimately constitute the final formal report.

None of the data are authorized for release or publication without the written prior approval of the New Mexico Agricultural Experiment Station.

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Agricultural Science Center Locations Map



Executive Summary

As of 2025, New Mexico's forests remain in crisis. Many burned landscapes are failing to regenerate naturally after high-severity wildfires. Operationally planted seedling survival rates in the region often hover near 25%, representing both a major ecological concern and a substantial financial risk to public and private reforestation investments. Improving survival and strengthening the full reforestation pipeline (seed, nursery, and outplanting) is essential to sustaining water supplies, wildlife habitat, carbon storage, and rural economies.

The John T. Harrington Forestry Research Center (JTH FRC) at New Mexico State University is addressing this challenge through integrated research, operational nursery production, infrastructure development, and community-based restoration. The Center remains the largest forest seedling producer in the southwestern US, with an annual capacity of approximately 300,000 seedlings supporting restoration on federal, state, Tribal, and private lands. Seedlings grown at the Center are used across major burn scars and degraded landscapes throughout New Mexico and the broader southwestern US.

Research activities in 2025 continued to focus on improving seedling quality and long-term survival. Ongoing genetic testing of 75 *Pinus ponderosa* sources is refining climate-informed seed transfer guidelines to reduce maladaptation under warming conditions. Nursery studies evaluating drought conditioning, seedling physiology, and root development are identifying production practices that improve xylem function, water-use efficiency, and early field performance. New research tracking fungal pathogen communities from nursery to field is providing insight into how nursery systems influence post-planting health and survival. Early results indicate strong differences among nursery production systems, with implications for disease risk and seedling resilience.

Field-based outplanting experiments are evaluating planting density, nucleation strategies, vegetation control, residual snag effects, and animal protection methods. These studies are designed to move beyond short-term survival metrics and evaluate longer-term growth, physiological performance, and ecosystem function. Carbon modeling research has also advanced, with new allometric equations developed to estimate early seedling carbon accumulation under current and projected climate scenarios. Results indicate that mortality remains a limiting factor for carbon sequestration potential, underscoring the importance of improving survival rates before carbon financing mechanisms can be reliably leveraged.

Infrastructure development remains a central priority. The New Mexico Reforestation Center (NMRC), located at the JTH FRC in Mora, represents one of the largest forest restoration investments in state history. As of 2025, design documents are nearing completion, construction is anticipated to begin in 2026, and total secured and pending funding is ~$60 million. The NMRC will integrate seed banking, nursery production, planting operations, applied research, workforce development, and education to expand restoration capacity across the southwestern US.

Collectively, these efforts position the JTH Forestry Research Center as a regional leader in building the scientific, operational, and infrastructure capacity required to restore forests at scale. Strengthening the reforestation pipeline is not only an ecological necessity, but is also critical to protecting water resources, reducing wildfire risk, stabilizing rural economies, and ensuring long-term forest resilience under a changing climate.

Research Highlights

Evaluating Rhizosphere Microbiome-Pathobiome Dynamics in Nursery-Grown Conifer Seedlings for Enhancing Reforestation in Wildfire-Impacted Landscapes

Investigators: Dr. Owen Burney (oburnery@nmsu.edu), Dr. Gregory Reynolds, Dr. Nicholas Wilhelmi, Dr. Mee-Sook Kim, Grace Ganter, Dr. Jane Stewart (PI)

Project Overview: Wildfires have created over 4 million acres of reforestation need in national forests, prompting passage of the REPLANT Act to eliminate this backlog. Meeting that goal requires scaling nursery production, yet nurseries are high-risk environments for pathogen buildup, and infected stock can introduce invasive fungi into restoration sites. Early results of this study show that fungal community composition differs by host species and nursery, with some genera consistent across conditions (e.g., *Penicillium*, *Trichoderma*) and others reflecting environmental or host-specific effects. Nursery 2 supported greater fungal diversity and more saprophytic and symbiotic taxa, suggesting a more balanced microbial environment, whereas Nursery 1 showed greater association with potential pathogens, including taxa such as *Fusarium*, *Cladosporium*, and *Alternaria*. These findings reinforce that nursery-specific management strongly shapes root-associated fungal communities, underscoring the need to understand and manage pathogen dynamics as production expands.

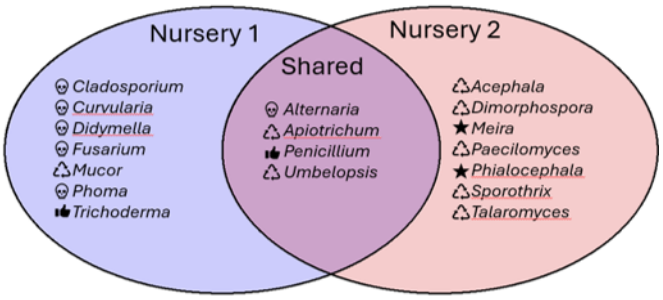
Meeting the Needs of New Mexico: This research will benefit all communities of New Mexico due to the added value it has on many ecosystem services that reforestation has on water, recreation, wildlife, timber, and many other valuable resources.

Impact: This research strengthens the understanding of nursery-associated pathogens in western conifers and determines how these pathogens influence seedling performance, survival, and long-term reforestation success in post-wildfire landscapes.

Graduate Students: Grace Ganter (Colorado State University MS student)

Funding Acknowledgment: National Science Foundation, Centers of Research Excellence in Science and Technology (NSF award #1914463); US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447; USDA Forest Service (FS) Research and Development (R&D) Infrastructure Investment and Jobs Act Research Project (ERR10) and Forest Health Protection Emerging Pests program

Project Collaborators: NMSU – JTH Forestry Research Center, Colorado State University, USDA Forest Service



A New Approach to Reforestation: nucleation planting strategies for climate-resilient forests

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Andrei Toca, Dr. Christopher Marsh, Dr. Matthew Hurteau

Project Overview: This study evaluates nucleation planting strategies to improve reforestation success. The project examines survival probability using spatial models to select 24 1/4-acre nuclei classified as high or low predicted survival, tests four planting densities (194, 436, 889, and 1,742 trees per acre) to assess effects on establishment and stress tolerance, and compares mechanical vegetation removal to no treatment to understand the influence of competing grasses and forbs. Initial field measurements indicate overall survival is approximately 50%, largely driven by an early-season cold weather event. Early trends suggest that higher planting densities may buffer seedlings against unexpected stress events, potentially improving stand resilience under variable conditions.

Meeting the Needs of New Mexico: This research tackles key reforestation challenges by advancing regeneration strategies that mirror natural patterns to build forests resilient to fire, drought, and climate stress, while partnering with Tribal communities to integrate Indigenous knowledge and support long-term, sustainable forest management.

Impact: This project will directly improve reforestation outcomes by identifying planting strategies that increase survival, resilience, and long-term forest stability under variable and changing environmental conditions. By integrating spatial survival modeling, density optimization, and vegetation management, the work will generate actionable guidance for practitioners seeking to maximize establishment success and reduce risk.



Funding Acknowledgment: National Science Foundation, Centers of Research Excellence in Science and Technology (NSF award #1914463); US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: NMSU – JTH Forestry Research Center, University of New Mexico, USDA Forest Service

Carbon Stock Models for Early Post-Fire Reforestation Efforts in the Southwestern United States

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Chris Marsh, Dr. Matthew Hurteau

Project Overview: This project evaluated eight post-wildfire reforestation sites, developed allometric equations to estimate seedling carbon accumulation, and modeled future carbon trajectories under current and projected climate scenarios. Results show that early seedling survival is the primary driver of long-term carbon outcomes, and that projected warming, especially at low elevations, may substantially reduce survival and carbon accumulation, with some areas potentially no longer climatically suitable for ponderosa pine. The study provides climate-informed guidance on planting density, site selection, and realistic expectations for carbon gains, emphasizing that carbon sequestration in the semi-arid Southwest is highly contingent on elevation, moisture availability, and management strategy.

Meeting the Needs of New Mexico: This work delivers practical, climate-informed tools to help New Mexico land managers prioritize high-elevation, moisture-limited sites where reforestation investments are most likely to succeed and contribute meaningfully to ecosystem recovery.

Impact: By identifying where and under what conditions planted seedlings can survive and accumulate carbon in a warming climate, this project improves the effectiveness, efficiency, and long-term resilience of post-fire reforestation efforts across

Funding Acknowledgment: United States Department of Agriculture-Natural Resources Conservation Service, New Mexico Grant No. 0007378

Research Publications: Marsh C, Hurteau MD, Burney OT (2026) Carbon stock models for early post-fire reforestation efforts in southwestern US. *Forest Ecology and Management*. doi.org/10.1016/j.foreco.2026.123507

Project Collaborators: University of New Mexico, USDA Forest Service



Optimizing Seedling Production for Post-Fire Reforestation in the Southwestern United States

Investigators: Dr. Andrei Toca (atoca@nmsu.edu) and Dr. Owen Burney (Co-PI)

Project Overview: Post-fire landscapes are increasingly exposed to drought and heat stress that limit tree regeneration. This project examines how nursery production practices shape seedling performance after outplanting. We tested whether controlled water limitation during nursery growth, known as drought conditioning, combined with different container sizes, influences ponderosa pine establishment in the field. Seedlings were grown under optimal irrigation or moderate water stress across four container types and outplanted in June 2025 into field plots with either ambient conditions or rainfall exclusion. Survival, growth, root development, and plant water stress responses are being evaluated to determine whether early, mild stress improves performance under challenging field conditions.

Meeting the Needs of New Mexico: By improving nursery production practices to enhance seedling drought resistance and field survival, this project increases the reliability of reforestation efforts in northern New Mexico's fire-affected watersheds. Stronger planting success reduces costly replanting, protects critical water resources, and accelerates long-term recovery of forested landscapes across the state.

Impact: The outcomes of this project provide actionable guidance for operational seedling production in New Mexico. Results will inform how water management and container selection can be adjusted to produce planting stock better suited to water-limited environments. These improvements support the ongoing development of large-scale production systems at the JTH Forestry Research Center and the New Mexico Reforestation Center. By increasing establishment success and reducing uncertainty in post-fire restoration, this work strengthens the return on public restoration investments and contributes to more resilient forest recovery under future climate conditions.

Funding Acknowledgment: US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447



A Horizon Scan to Inform Research Priorities on Post-Wildfire Forest Restoration and Recovery in the Western United States

Investigators: Dr. Owen Burney (oburney@nmsu.edu) and Dr. Kelly Jones (PI)

Project Overview: There is an urgent need to prioritize research that strengthens post-wildfire forest restoration and recovery. Using a structured, expert-driven horizon-scanning process, this project identified 12 high-priority, time-sensitive research topics spanning social sciences, forest management, and hydrology. These topics, including institutional coordination, collaborative governance, seed and seedling systems, climate-informed reforestation, and post-fire watershed response, highlight the need for an integrated social-ecological approach to improve the equity, effectiveness, and efficiency of post-fire recovery. The findings provide a forward-looking research agenda to guide decision-makers, practitioners, and communities over the coming decades.

Meeting the Needs of New Mexico: This work helps New Mexico prioritize research and management investments that strengthen coordination, watershed protection, workforce capacity, and climate-informed reforestation in the face of increasingly severe wildfires.

Impact: By identifying the most urgent and influential knowledge gaps in post-wildfire recovery, this project provides a roadmap for more strategic, science-based, and socially responsive restoration efforts across fire-prone landscapes.

Funding Acknowledgment: National Science Foundation, Transformation Network (Grant #2115169)

Research Publications: Jones KW, Cadol D, Morgan M, Stevens-Rumann C, Agnew D, Burney OT, Calabaza J, Chambers ME, Edgeley CM, Falk D, Hughes LG, Marsh C, Schultz CA, McCarthy L, Morrison R, Montoya M, Padowski J, Piccarello M, Pinto JR, Roach J, Roberts M, Rodman K, Triepke J, Tsinnajinnie L, vonHedemann N, Webster AJ, Buettner WC, Fernandez LA, Mineau A, Rotche L, Russell G, Woolet J (2025) A horizon scan to inform research priorities on post-wildfire forest restoration and recovery in the western United States. *Frontiers in Forests and Global Change*, doi.org/10.3389/ffgc.2025.1595886

Project Collaborators: Dept of Fish, Wildlife, and Conservation, NMSU; Dept of Earth and Environmental Science, NM Institute of Mining and Technology; Univ of New Mexico; Colorado State Univ; Colorado Forest Restoration Institute; Albuquerque Bernalillo County Water Utility Authority; Trees, Water, People; North Arizona Univ; Univ of Arizona; Philmont Scout Ranch; NM Forestry Division; Washington State Univ; Forest Stewards Guild; USDA Forest Service



Stemflow-Driven Hydrological Dynamics of Burned Snags and Their Role in Post-Fire Microsite Conditions

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Simon Landhäusser (PI), Dr. Charles Nock.

Project Overview: This study investigated how wildfire-affected standing dead trees (snags) influence post-fire microsite hydrology and early regeneration under warmer, drier conditions. Field studies in Alberta, CA and northern New Mexico quantified how rain event size, snag location (single-snag, multi-snag, no-snag), and snag species traits affect rainfall partitioning into throughfall and stemflow, near-surface soil moisture, and seedling growth. Results show that rain event size is the dominant driver of hydrologic response, while stemflow is highly sensitive to snag location and species, with greater water concentration occurring near isolated snags and smoother-barked species. Although stemflow inputs increased near certain snags, translation into soil moisture and seedling performance depended strongly on event size and microsite context, highlighting the complex role of snags in post-fire water redistribution and regeneration.

Meeting the Needs of New Mexico: This research provides science-based guidance on snag retention and post-fire management in New Mexico by clarifying how dead trees influence water redistribution and regeneration potential in burned forests.

Impact: By identifying when and where snags enhance localized water inputs and seedling growth, this work informs post-fire restoration strategies that balance regeneration goals with salvage and hazard tree decisions under increasingly variable climate conditions.

Graduate Students: Alexandria Britz (University of Alberta MS student)

Funding Acknowledgment: National Science Foundation, Centers of Research Excellence in Science and Technology (NSF award #1914463); US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: University of Alberta



Assessing Combinations of Nucleation Size and Planting Density to Improve Survival and Performance of Planted Ponderosa Pine Seedlings

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Joshua Sloan, Dr. Aalap Dixit

Project Overview: This study evaluated how nucleation size and planting density influence early survival, growth, and physiological performance of planted ponderosa pine seedlings using a replicated 2 × 4 factorial design at a post-fire site in northern New Mexico. More than 8,000 seedlings were planted across two nucleus sizes and four planting densities, with protective tubes to reduce herbivory. After two years, survival remained high (~90%) and was not influenced by nucleation size or density; however, larger nucleation sizes affected ground line diameter, foliar nitrogen, and carbon isotope ratios, indicating physiological differences linked to stress and resource allocation. Herbivory was the primary cause of early mortality, and shelter effectiveness was strongly associated with reduced browsing damage, underscoring the importance of durable protective measures in large-scale reforestation.

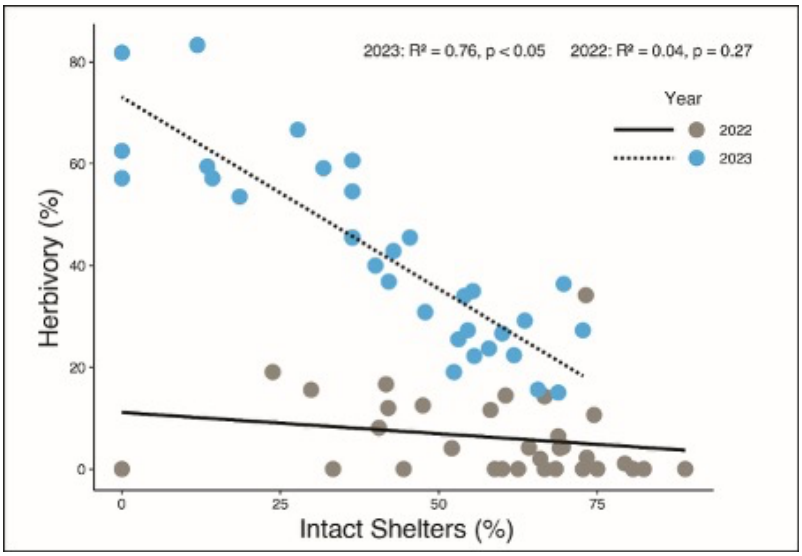
Meeting the Needs of New Mexico: This research provides field-based evidence to guide planting configuration and seedling protection strategies that improve ponderosa pine reforestation success on New Mexico's post-fire landscapes.

Impact: By identifying how nucleation design and herbivore protection influence early seedling performance under stressful post-fire conditions, this project strengthens the long-term effectiveness and resilience of reforestation investments in climate-vulnerable southwestern forests.

Graduate Students: Dilshad Safiullah (NM Highlands University – graduated 2024)

Funding Acknowledgment: National Science Foundation, Centers of Research Excellence in Science and Technology (NSF award #1914463); US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: New Mexico Highlands University, Philmont Scout Ranch



Variation in Phenology and Growth Traits Among *Pinus Ponderosa* Provenances: Implications for assisted migration

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Aalap Dixit, Dr. Joshua Sloan

Project Overview: This study evaluated phenological, growth, and physiological variation among 75 ponderosa pine provenances planted in a common garden in northern New Mexico. Significant genetic differences in bud burst timing, height, and diameter persisted after 13 years, with warmer, lower-latitude sources, particularly from Arizona and southern New Mexico, showing later bud burst and superior growth under contemporary warming conditions. Growth and phenology were strongly linked to source climate and transfer distance, demonstrating that seed sourced for future climate conditions outperformed northern and some local sources that were maladapted to longer growing seasons. Physiological traits related to water-use efficiency varied with climatic origin but were context-dependent, underscoring the complexity of matching genotypes to increasingly variable environments.

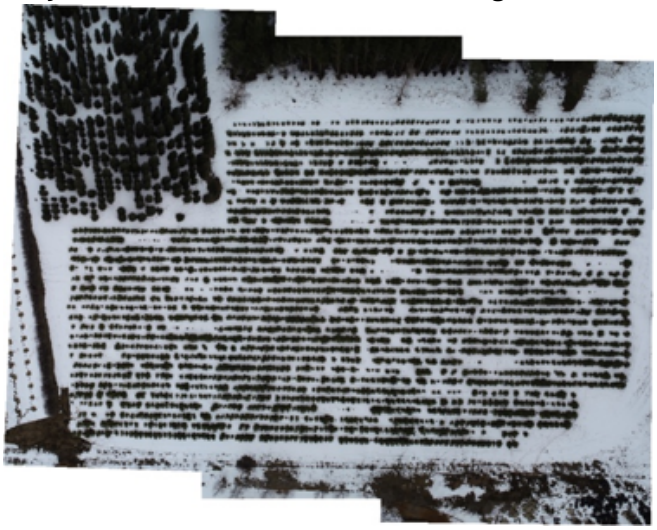
Meeting the Needs of New Mexico: This research provides long-term, field-based evidence to guide climate-informed seed sourcing and assisted migration strategies for restoring ponderosa pine forests in New Mexico and the greater southwestern US.

Impact: By identifying which seed sources are best adapted to warmer future conditions, this project reduces the risk of maladaptation and strengthens the long-term resilience of reforestation investments in the southwestern US.

Graduate Students: Dillon Alexander (New Mexico Highlands University MS student – graduated June 2025)

Funding Acknowledgment: US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: New Mexico Highlands University, USDA Forest Service



Drought Conditioning Improves Long-Term Field Performance Of *Populus Tremuloides* and *Pinus Ponderosa* Under Dry Conditions

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Jeremy Pinto, Dr. Joshua Sloan, Dr. Andrei Toca

Project Overview: This study evaluated the long-term field performance of nursery drought-conditioned *Pinus ponderosa* and *Populus tremuloides* seedlings planted in northern New Mexico. Building on prior nursery experiments, seedlings from three seed sources were grown under three irrigation regimes and outplanted to test whether drought conditioning produced persistent differences in survival, growth, and plant water status under harsh field conditions. For ponderosa pine, drought-conditioned (i.e., lower nursery irrigation) resulted in greater five-year height and diameter growth, with survival responses varying by seed source under low irrigation. For aspen, drought-conditioned seedlings had significantly higher survival, while seed source strongly influenced growth and plant water status. Across both species, seed source played a consistent role in long-term performance, and irrigation treatments applied during nursery culture had species-specific and trait-dependent legacy effects.

Meeting the Needs of New Mexico: This research provides applied, field-based evidence to refine nursery irrigation practices and seed source selection for successful reforestation on New Mexico's drought-prone and degraded landscapes.

Impact: By demonstrating that nursery drought conditioning and seed source selection influence long-term growth and survival under harsh field conditions, this project improves the reliability, cost-effectiveness, and resilience of reforestation efforts on challenging sites across the western US.

Funding Acknowledgment: US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: New Mexico Highlands University, USDA Forest Service



Scouts at Philmont Scout Ranch Participate in Reforestation Research

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Jennifer Peters, Dr. Andrei Toca, Dr. Chris Marsh

Project Overview: This collaborative reforestation research and education project focuses on restoring forested areas burned in the 2018 Ute Park Fire on Philmont Scout Ranch land. Researchers from NMSU and UNM trained Philmont staff and guided high school-aged scouts through hands-on lessons on fire ecology, the reforestation pipeline, and proper seedling planting techniques. Approximately 2,000 young scouts planted seedlings in research plots designed to test whether pre-planting vegetation removal improves survival. The project combines education, outreach, and scientific investigation to improve forest restoration success throughout New Mexico.

Meeting the Needs of New Mexico: New Mexico's post-fire landscapes are increasingly difficult to reforest due to extreme heat and drought, causing high seedling mortality. This project directly addresses these challenges by testing improved reforestation practices while educating youth about forest restoration. By combining research with community-engaged learning, the project supports ecosystem recovery, strengthens the forestry workforce pipeline, and benefits communities statewide that depend on healthy forest ecosystems.

Impact: By combining operational reforestation, applied research, and large-scale youth engagement, this collaborative effort restored 50 acres of burn scar with 10,000 seedlings while generating data on site preparation strategies to improve survival. The project advances evidence-based reforestation practices in New Mexico and cultivates the next generation of forestry leaders through hands-on ecological restoration.

Funding Acknowledgment: US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Outreach Activity: Educational programming for ~2,000 young scouts on forest ecology, fire recovery, and reforestation practices.

Project Collaborators: Philmont Scout Ranch; Univ of New Mexico



Using X-Ray Computed Tomography to Investigate the Mechanisms of

Investigators: Dr. Jennifer Peters (Petersj@nmsu.edu), Dr. Andrei Toca, Dr. Borys Drach

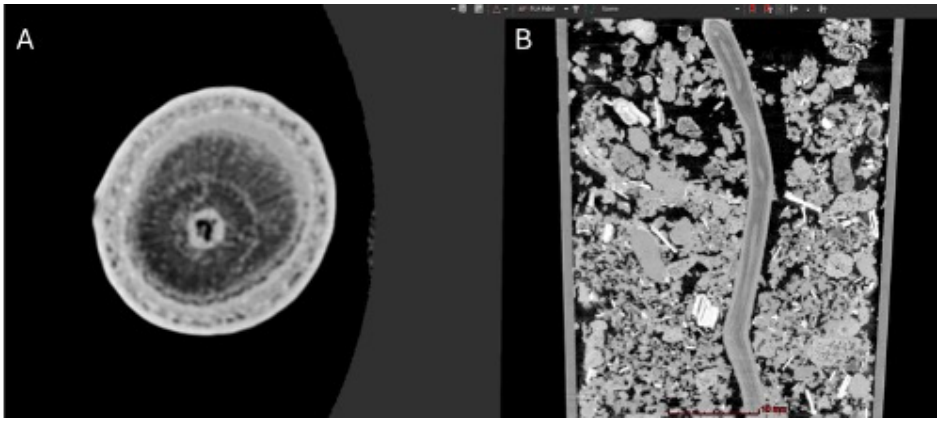
Project Overview: This project uses X-ray microCT imaging to study how nursery-based drought conditioning improves drought resistance in tree seedlings. By visualizing internal xylem structure and monitoring embolism formation, this study seeks to understand the physiological mechanisms that help seedlings tolerate drought. The project also builds collaboration across NMSU departments and tests the use of MicroCT as a new tool for forestry research, ultimately supporting more effective reforestation practices statewide.

Meeting the Needs of New Mexico: Wildfire-impacted landscapes in New Mexico face increased flooding, water contamination, and long-term ecosystem damage. Reforestation is essential for restoring water security, economic stability, and forest health, but seedling mortality remains a major barrier. This project addresses a critical statewide need by investigating drought-conditioned seedlings. By understanding the mechanisms that confer drought resistance, this research will guide nursery operations, enhance reforestation outcomes, and ultimately accelerate post-fire ecosystem recovery for New Mexican communities that depend on forest resources.

Impact: By applying advanced X-ray microCT imaging to evaluate how drought conditioning alters xylem structure and embolism resistance, this pilot study strengthens the scientific foundation for producing more drought-resilient seedlings. The findings will directly improve nursery practices and post-fire planting success in New Mexico while expanding interdisciplinary research capacity and supporting long-term watershed protection and forest resilience statewide.

Funding Acknowledgment: NMSU AES Seed Grant

Project Collaborators: NMSU Non-Destructive Evaluation Lab; Mechanical Engineering Department.



Intra and Interspecific Resource Competition of Southern Live Oak and Loblolly Pine Regeneration

Investigators: Dr. Owen Burney (oburney@nmsu.edu) and Dr. Douglass Jacobs (Co-PI)

Project Overview: This study evaluated live oak restoration within former loblolly pine plantations along the southern Atlantic Coast by testing how pine–oak competition and belowground ectomycorrhizal fungal (EMF) communities influence early seedling survival, growth, and drought physiology. After two years under harsh sandy, drought-prone conditions, mortality was high (~39%) and did not differ among competition treatments, while growth responses were largely unaffected by species mixtures. Border tree height positively influenced center tree height in both oak- and pine-centered plots, suggesting potential "trainer tree" effects that may accelerate canopy development. Oak exhibited lower osmotic potential than pine, reflecting contrasting drought strategies, and EMF communities shifted over time but did not differ among treatments, with most species identified as generalists. Findings indicate that prior pine plantations did not inhibit oak-associated fungal communities and that stocktype, container size, and site stress likely played larger roles in early survival than interspecific competition.

Meeting the Needs of New Mexico: This research expands the visibility of NMSU and the JTH FRC in Mora. This work informs New Mexico restoration by clarifying how competition dynamics, seedling stocktype, drought physiology, and mycorrhizal communities influence early survival under harsh outplanting conditions.

Impact: By identifying the relative importance of competition, seedling production methods, and drought tolerance strategies in early restoration success, this project strengthens science-based guidance for establishing resilient forest canopies on degraded and climate-stressed sites.

Graduate Students: Brianne Innusa (Purdue University MS student – graduated in May 2024)

Funding Acknowledgment: US Department of Agriculture, National Institute of Food and Agriculture, McIntire Stennis, Grant Accession Number 1002447

Project Collaborators: Purdue University, US Fish and Wildlife



Cultivating Resilience: A blueprint for growing Hawai'i's state forestry nurseries

Investigators: Dr. Owen Burney (oburney@nmsu.edu) and Dr. Douglass Jacobs (Co-PI)

Project Overview: This project provides a comprehensive assessment and strategic blueprint for strengthening Hawai'i's state forestry nursery system to meet rapidly increasing reforestation demand. Through interviews, system evaluation, and stakeholder engagement across twelve state-managed nurseries, the report identifies operational strengths, systemic bottlenecks, and strategic investment opportunities. Key recommendations focus on improving seed collection and propagation systems, enhancing plant health and phytosanitation, increasing staff training and support, upgrading infrastructure, and strengthening coordination statewide. The report outlines both near-term actionable improvements and long-term strategic considerations to build a more resilient, efficient, and adaptive nursery network capable of supporting large-scale restoration across Hawai'i's diverse ecosystems.

Meeting the Needs of New Mexico: This research expands the visibility of NMSU and the JTH FRC in Mora. This blueprint provides a scalable model for evaluating and strengthening state nursery systems, offering practical guidance that can inform New Mexico's efforts to expand seedling production capacity, improve plant quality, and meet growing post-fire reforestation demand.

Impact: By identifying strategic investments that increase production capacity, improve plant health, and strengthen operational efficiency, this project advances the long-term resilience and effectiveness of state forestry nurseries, ensuring they can meet accelerating restoration needs in a changing climate.

Funding Acknowledgment: State of Hawai'i (Division of Forestry and Wildlife), USDA Forest Service

Outreach Activity: Hands-on training sessions were delivered on core nursery operations to support and strengthen the skills of nursery staff across the state of Hawai'i.

Project Collaborators: Purdue University, State of Hawai'i (Division of Forestry and Wildlife), USDA Forest Service



Koa restoration in gorse-dominated landscapes in Hawai'i

Investigators: Dr. Owen Burney (oburney@nmsu.edu), Dr. Douglass Jacobs (Co-PI), Travis Idol (PI), JB Friday (Co-PI)

Project Overview: Gorse (*Ulex europaeus*) has invaded thousands of acres on the slopes of Mauna Kea in the Humuʻula region, forming dense, thorny thickets that regenerate aggressively after disturbance. In collaboration with the Department of Hawaiian Home Lands (DHHL), this project tested a large-scale strategy to convert gorse-dominated pastures into productive, tree-based systems by crushing alleys into intact gorse stands and planting koa, sugi pine, and redwood within them. Half of the alleys received herbicide to evaluate regrowth suppression, and extensive temperature monitoring was conducted to determine whether surrounding gorse buffered seedlings from frost at 2,000 m elevation. After two years, koa survival was high (82%) with strong first-year growth (~75 cm), herbicide showed no measurable effect on gorse regrowth, and temperature data indicated no consistent frost protection from adjacent gorse. Overall, crushing rows into intact gorse appears to facilitate seedling establishment while leveraging gorse as a physical barrier against ungulates, offering a promising pathway for long-term canopy transition.

Meeting the Needs of New Mexico: This research expands the visibility of NMSU and the JTH FRC in Mora. This project provides a practical model for converting invasive shrub-dominated landscapes into productive tree stands, offering insights into frost risk, invasive regrowth, and large-scale planting strategies applicable to high-elevation restoration in New Mexico.

Impact: By demonstrating that strategic row crushing and targeted planting can achieve high seedling survival in invasive-dominated systems, this project advances scalable restoration approaches that increase land productivity, promote long-term canopy transition, and reduce reinvasion risk.

Graduate Students: Aaron Wehrman (University of Hawai'i)

Funding Acknowledgment: Department of Hawaiian Homelands, University of Hawai'i

Project Collaborators: Purdue University, University of Hawai'i, Department of Hawaiian Homelands



Outreach Activities

Philmont Scout Ranch Reforestation Project (Youth Engagement – K-12 Focus)



- In partnership with Philmont Scout Ranch and the University of New Mexico, provided seedlings, technical guidance, and science-based planting design for large-scale post-fire restoration.
- Approximately 2,000 young scouts from across the nation participated in hands-on planting activities, establishing roughly 10,000 seedlings across 50 acres of burn scar.
- Youth participants received instruction on wildfire impacts, forest ecology, reforestation, and proper planting techniques.
- The project integrated research with experiential learning, directly engaging K-12-aged youth in active forest restoration and workforce development.

JTH Forestry Research Center Public Field Day

- Hosted a public Reforestation Field Day at the John T. Harrington Forestry Research Center in Mora, NM focused on strengthening New Mexico's reforestation pipeline.
- Organized as a booth-based showcase where attendees rotated among stations hosted by key partners, including NMSU, University of New Mexico, New Mexico Highlands University, EMNRD Forestry Division, Philmont Scout Ranch, USDA Forest Service, and additional Tribal and nonprofit collaborators.
- The event provided practical, science-based information to landowners, students (including high school and university participants), agency personnel, and community members to improve reforestation outcomes across the state.
- Topics Covered:
    - Climate-resilient seed sourcing and genetic testing
    - Nursery practices to improve survival
    - Outplanting strategies such as nucleation ("tree island") planting
    - Overview of the New Mexico Reforestation Center
    - Current statewide planting efforts and partnership coordination



Southwest Reforestation Partnership Workshop – "The Reforestation Pipeline: Planting and Post-Planting Activities"

- Co-led a regional workshop in collaboration with American Forests, the Colorado Forest Restoration Institute, and the USDA Southwest Climate Hub, USDA Forest Service, and New Mexico Highlands University.
- More than 80 restoration professionals from Arizona, Colorado, New Mexico, and Utah participated.
- Delivered a comprehensive presentation outlining seed supply challenges, nursery bottlenecks, stocktype innovation, planting density considerations, and post-planting monitoring protocols.
- Facilitated structured discussions identifying regional constraints and opportunities for cross-boundary coordination to improve large-scale reforestation outcomes.



People and Partnerships

Cooperators and Collaborators

Collaborating Main Campus (and other ASC) Faculty & Staff

- New Mexico Highlands University
- Utah State University
- Colorado State University
- Purdue University
- Northern Arizona University
- University of New Mexico
- University of Hawai'i
- University of Alberta

NMSU, University, State, and Federal Collaborations

- New Mexico Forest and Watershed Restoration Institute
- State Forestry Division, New Mexico EMNRD
- National Park Service
- US Forest Service
- US Geological Survey

Industry & Tribal

- Institute of Applied Ecology
- Philmont Scout Ranch – Boy Scouts of America
- The Nature Conservancy
- International Union of Forest Research Organizations
- Santa Clara Pueblo
- Jemez Pueblo
- Trees, Water, People
- Imerys Minerals

Advisory Committee

- Owen Burney, New Mexico State University
- Josh Sloan, New Mexico Highlands University
- Matt Hurteau, University of New Mexico
- Alan Barton, NM Forest & Watershed Restoration Institute
- Lindsay Quam, NM State Forestry Division
- Daniel Denipah, Santa Clara Pueblo
- Jim Youtz, USDA Forest Service
- Eytan Krasilovsky, Forest Stewards Guild

ASC Personnel

JTH FRC Personnel

- Dr. Owen Burney, Professor and Director



- Tammy Parsons, Nursery Manager



- Dr. Andrei Toca, Research Scientist



- Josh Trujillo, Ag Science Center Laborer



- Donna Ebler, Fiscal Assistant



- Dr. Jennifer Peters, Assistant Professor



- Braden Dedrick, Farm Ranch Manager



- Marisol Martinez, Student Intern



- Isabella Martinez, Student Intern

