‘A DIFFERENT TYPE OF FOREST’

Collecting cones. Photo: Josh Sloan/NMHU.

Reforestation researchers train new generation of trees for drier, hotter future

By Emery Veilleux
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In New Mexico, reforestation is an increasingly urgent mission. But forests affected by wildfire or drought need more than scores of seedlings: They need a new generation of trees that are better prepared for conditions to come. By gathering cones from fire-resistant trees, training seedlings to withstand extreme drought and finding favorable spots on the landscape, scientists are innovating every step of the way to restore forests for the future.

In the greenhouse at New Mexico State University’s John T. Harrington Forestry Research Center, Owen Burney and Andrei Toca are stressing trees out.

Their young ponderosa and Douglas-fir seedlings are fragile creatures, less than a year old and barely 6 inches tall. In what should be ideal greenhouse conditions, Burney, the center’s director, and Toca, its research scientist, are strategically exposing seedlings to soaring temperatures and withholding water for a week at a time.

They’re no mad scientists—far from it. Through their research, Burney and Toca are helping seedlings become more resilient to drought, heat and unpredictable weather—conditions the Southwest is already experiencing and predicted to feel more intensely in the coming decades.

Monitoring seedlings. NMSU.

They’re not alone: Across New Mexico’s universities, researchers are finding new ways to return trees to the scores of forested lands that have burned in high-intensity wildfires statewide—7 million acres since 2000, to be precise. The Hermit’s Peak-Calf Canyon Fire alone left behind a need for at least 17.6 million seedlings. At New Mexico’s current production rate of 300,000 seedlings annually, it would take 50 years to restore that footprint alone.

But to meaningfully recover, burned areas need more than scores of seedlings: They need a new generation of trees that are better prepared for hotter, drier and more unpredictable conditions.

The work will coalesce in late April with the groundbreaking of the New Mexico Reforestation Center, the new regional hub for research and reforestation in the Southwest. Once fully operational, this cutting-edge, full-reforestation pipeline will ramp up production to 5 million climate-adapted seedlings annually, representing a new horizon for the future of forests from Mora to Ruidoso and across the Southwest.

Step 1: The best seeds from the worst site

Reforestation starts humbly: with seed. Leading seed researchers at New Mexico Highlands University started humbly, too: with a chile roaster in an old warehouse.

Josh Sloan, director of reforestation operations, described how the quintessentially New Mexican contraption was used for a key step in the seed-production process: tumbling pinecones until they release their seeds.

It’s one small step in the complex process of banking seeds for reforestation in burned areas. The process follows a calendar.

By May each year, researchers get rolling with “boots on the ground and eyes on the trees” to locate where crops of pinecones are developing across the state, Sloan said. Come July, they’re monitoring those crops for insect infestations and maturity. From August through October, they take to the trees, climbing into the most promising canopies to gather cones.

In 2023, their first fully operational year, Highlands' staff and partners and their trusty chile roaster collected a whopping 3.8 million seeds. This number quickly tripled in 2024, when they collected 12 million seeds, thanks to seed collection coordinator Pouli Sikelianos and reforestation technicians Dilshad Safiullah and Veronica Griego.

"With our operational workflow and processing, along with our cone-crop monitoring approach, we're yielding a world-class seed product," Sloan said. "Our seed quality is on par with the best in the world in terms of purity, germination rates and viability."

It sounds good, right?

"But it's more complex than that," Sloan said.

To reforest a site, foresters need to have already banked a seed source that's adapted to that particular site. For example, the Gila Forest area needs trees suited to the Gila, not the Carson further north. The process of scouting, collecting, drying, extracting, cleaning and testing seeds from a site can take all year. On top of that, researchers need to time their work just right: Ponderosa pines produce a cone crop roughly once per decade. Collect too early, and the seeds may not germinate. Too late, and you've missed the window.

Step 2: Toughening up seedlings

Back at NMSU's Forestry Research Center, Burney and Toca are getting seedlings as tough as they can be.

"Here, we're introducing them to the challenges they would see in the field," Toca said.

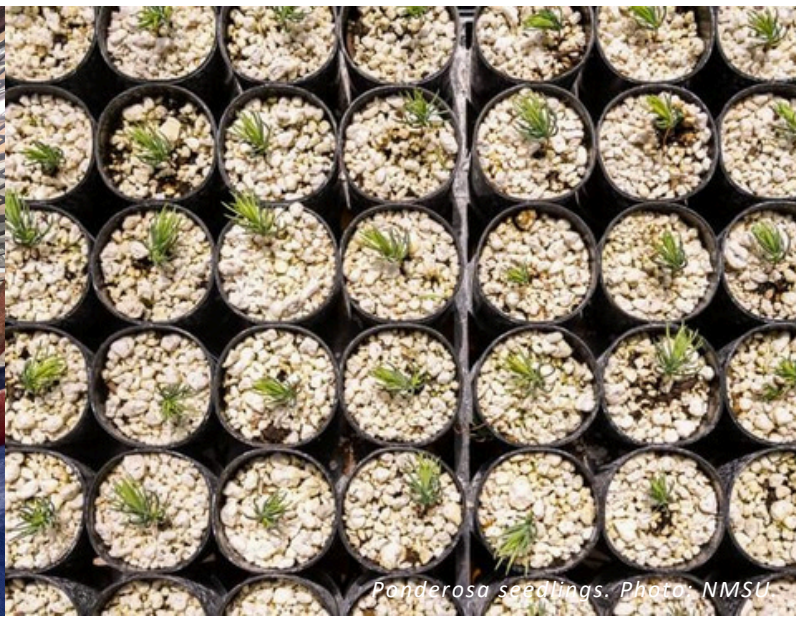
Typically, greenhouses baby the plants they grow. Temperatures stay balmy and consistent, nutrients are abundant, and water arrives every day. Those pampered seedlings thrive and grow quickly. But they're not well-adapted to life in the real world.

"Because burn scars are exposed to full sunlight, surface temperatures can be very high; we're talking 140 degrees or more," Toca said. "These 6-inch seedlings are very close to the ground where temperatures are very high, especially on south-facing slopes."

Seedling growth success depends heavily on water, which, "as we are seeing right now, it's not very abundant at times," Toca said. In the real world, seedlings might have to hold out for weeks between precipitation.

John T. Harrington researchers strategically expose seedlings to soaring temperatures and drought spells.


The trusty chile roaster. Photo: NMHU.


Ponderosa seedlings. Photo: NMSU.

"We're looking at a roughly 20 to 25-year process before we can have a seed bank that's well and fully stocked to be able to respond rapidly to reforestation needs as they arise in the state," Sloan said.

So far, they've focused heavily on trees suited to the Hermit's Peak-Calf Canyon burned area. But the work needs to be scaled up.

To prepare for drier, hotter conditions region-wide, the Highlands team is getting more creative about where they collect seed. Increasingly, they're turning to resilient trees that have already survived drought, wildfire or temperature extremes—"the best trees on the worst sites," Sloan said.

But this is just the first step in a seedling's journey.


Planted seedling
Gwen Wion/NMFD

Greenhouse seedlings typically don't lose more than 20-25% of the water in their containers before being quenched. At Harrington, researchers push seedlings to withstand losing 50%.

All this training forces seedlings to adapt to tougher conditions earlier. The young trees learn to grow stronger, deeper roots to access a more stable water source. They keep their leaf area small to protect the water they do get for tougher days ahead.

Collecting cones. Photo: Josh Sloan/NMHU.

"We try to hijack the plant's physiology to force them to develop resistance mechanisms," Toca said. Experimental research shows that plants have stress memory, meaning once they face a stressful situation—a weekslong dry spell or a dicey wildfire—and survive, they remember what to do next time.

Where conditions are increasingly unpredictable, this stress memory may help trees survive a new normal, Toca said.

"Change is the name of the game for forests."

Now hardened and ready for the real world, the seedlings are poised to hit the slopes.

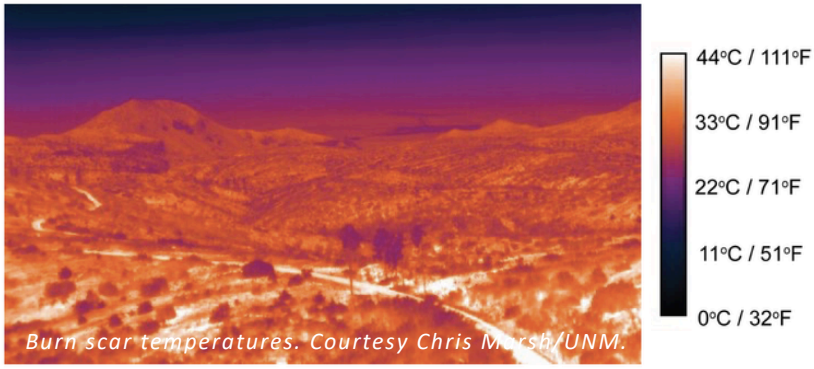
Step 3: Microsites and the big picture

Picture reforestation, and perhaps the image that comes to mind is a hillside neatly dotted with rows of new trees. Christopher Marsh wants you to think again.

"The way I like to see reforestation approached is that instead of all or nothing, we're picking out the areas that will be most favorable," he said.

Marsh is a research assistant professor at the University of New Mexico's Earth Systems Ecology Lab, where researchers are focusing on microsites, or niches on the landscape that might lend seedlings their best shot at survival.

For instance, seedlings might fare best on the shady north side of a hill, or in a small gulley between rocks where water might pool. Hardly noticeable to a hiker, these microsites might be the difference in temperature or moisture that makes life possible.



Burn scar temperatures. Courtesy Chris Marsh/UNM.

Existing plants can help, too. Marsh has found that Gambel oak, which often proliferates after a fire, can be a help rather than a hindrance. The shade they provide can retain water and cool microsites by as much as 13 degrees Celsius, or 23 degrees Fahrenheit. So far, this beneficial relationship appears specific to Gambel oak and isn't seen with other shrubs. "We're finding there are specific combinations of tree seedlings and shrub species that work well," Marsh said.

This collaboration-over-competition approach extends to planting in clusters, or "nucleation sites," where seedlings help each other retain water, withstand wind and self-seed new trees more efficiently.

"These strategies are promoting a different type of forest than the 'pines-in-lines' approach," Marsh said.

> "Change is the name of the game for forests."
>
> *Andrei Toca, research scientist, New Mexico State University's John T. Harrington Forestry Research Center*

Where planting neat rows of trees yields little success—as low as 11% in the Las Conchas burned area— selecting areas with favorable microsites has boosted success rates to 65% or higher.

With each step taken in sequence—a solid seed source armed with tools to better withstand dry spells and hot summers and plugged into a promising microsite—these hardened seedlings fare substantially better and consistently outcompete their counterparts.

"We've seen positive effects in pretty much all cases with so far very few downsides," Toca said. Ideally, these climate-adapted trees will produce new generations of climate-adapted seed, reinforcing the success of reforestation efforts.

"It's like peering into the future and seeing what natural selection would do in these landscapes and then speeding up that clock" Marsh said.

For researchers, early results are hopeful, but no less urgent.


Scouting for cones. Photo: Gwen Wion/NMFD.


Halved cones. Photo: Josh Sloan/NMHU.


Seedlings ready. Photo: Gwen Wion/NMFD.

"There's kind of a climatic window where we can find favorable microsites which will support seedlings," Marsh said. "But if we leave it for 20 years, those same sites may not support seedlings anymore."

Choosing to do nothing might mean certain areas permanently stay un-forested.

"There's a clock ticking," Marsh said. "Slowly, but there is a clock ticking."

Thinking in landscape time

Adding to the challenges is the difficulty of planning for future, unpredictable climates.

"We're not used to thinking about winter mortality because of cold," Toca said. Snowpack helps insulate trees. But in warmer, drier winters when snow doesn't accumulate, young trees are vulnerable to big dips to temperature. At a planting site on Johnson Mesa in northeastern New Mexico, half of planted seedlings died this winter where snowpack barely reached 11% of historical median.

Timing planting can also be difficult. Seedlings should be planted when moisture is reliable, but with unreliable monsoons, finding that window gets tough.

Choosing to do nothing might mean certain areas stay permanently un-forested.

"That's why we focus so much on drought resistance," Toca said. "We're trying to increase the window where plants can survive until good conditions come around."

It's a tricky needle to thread: Seedlings need to be able to survive conditions as they are today as well as what they will become in 10 to 100 years.

For all this complexity, researchers like Sloan, Toca and Marsh are cautiously optimistic that their careful yetcutting-edge scientific approach can give reforestation work the boost it needs to regrow forests from Mora to Ruidoso.

"If we're taking a whole-pipeline approach, that really puts us in the best position with the best technology with the best survival rates and performance," Sloan said.

The New Mexico Reforestation Center is set to marry this science with the partnerships needed to make it happen.

"Reforestation is not new, but it's new in that there's an urgent priority to make it happen," said Rachael Foe, southern Rockies director for American Forest Foundation, a key partner in reforestation and the Center. "The technical science pieces will not move forward without the people. So, we're building trust and communication—we're all building our reforestation muscles together."

While the urgency motivates the work, reforestation partners statewide are committed to see the work through thick and thin.

Gwen Wion, reforestation program coordinator at the Forestry Division, keeps this scope in mind. "It's a lifelong process," she said. "We're doing this for the next generation—it's you and me for the rest of our lives. We're thinking in landscape time."

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