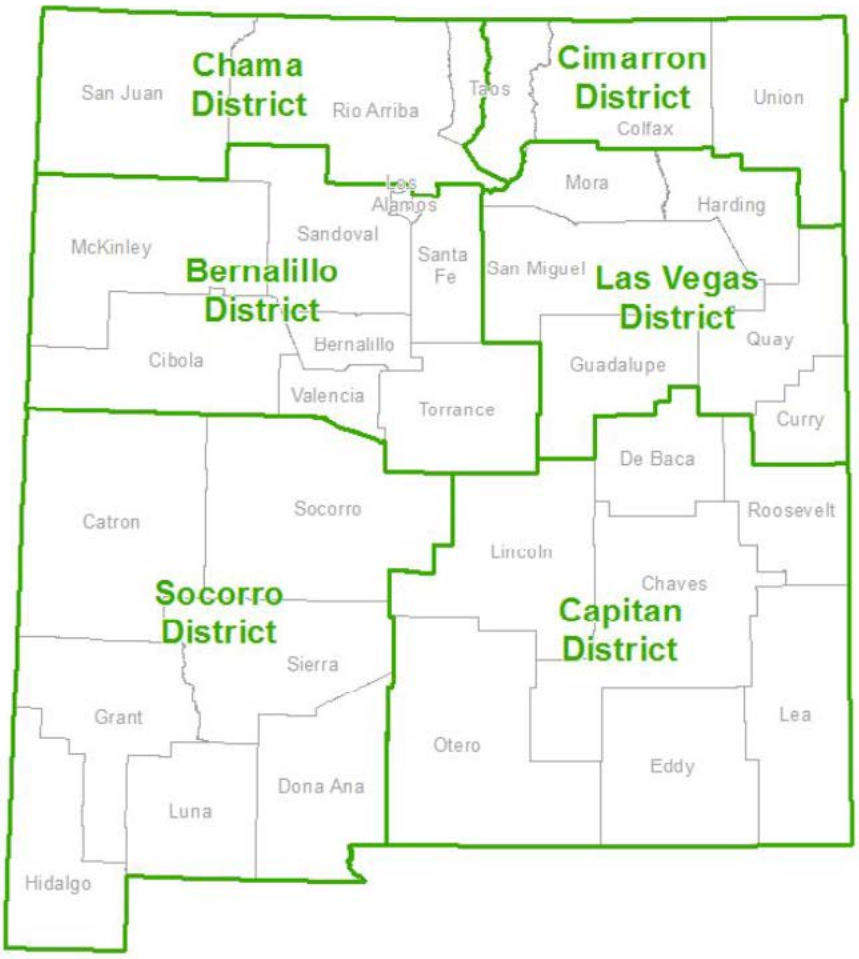
Post-Fire Reforestation:
A Guide For New Mexico Landowners

New Mexico Forestry Division District Units



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Socorro, NM 87801
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IBiS

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Introduction

Once the immediate crisis of a destructive wildfire has passed, landowners and communities are often left wondering what comes next. Can the landscape be restored to health again? What does that look like? How do you even start such a huge effort? This guide provides private landowners with science-based strategies for effectively reforesting their land after wildfires. Additionally, this guide connects landowners with useful informational resources and organizational contacts to aid in reforestation. While this guide focuses on upland areas, a companion guide is available that addresses post-fire restoration of riparian areas. The following timeline provides the order of actions needed to have a successful planting.

0 - 24 months following wildfire

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3 -12 months following wildfire, during the growing season

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3 -12 months following wildfire, during the growing season

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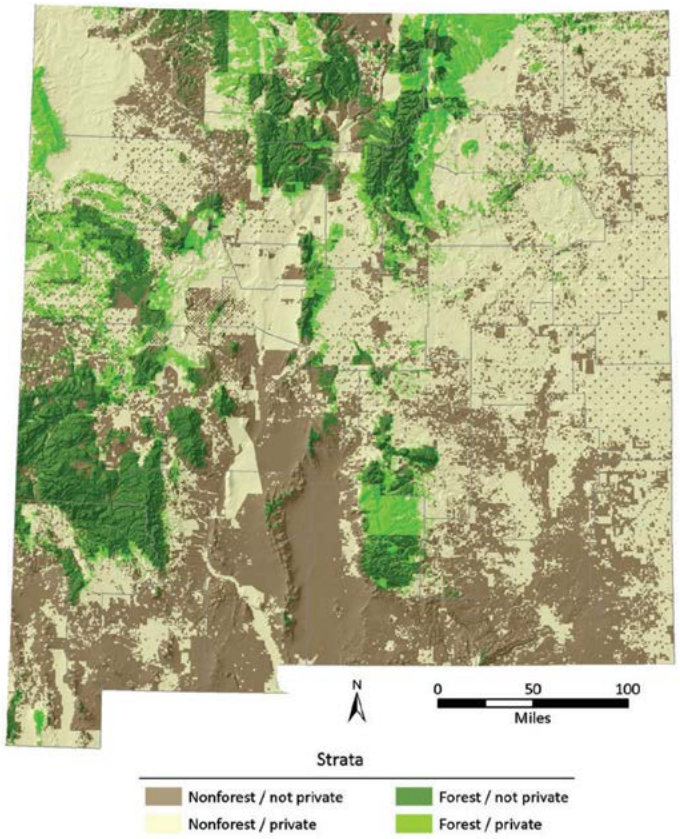
Why Reforest Your Property?



Map of forests in New Mexico on public and private lands. This map and information in the text was summarized from New Mexico's Forest Resources, 2000, a Rocky Mountain Research Station publication (RMRS-RB-3).

New Mexico has roughly 23 million acres of forested lands, which equate to about one third of the state's area. New Mexico's diverse topography, climate, and elevation allow for a wide variety of forest types including:

- piñon-juniper woodlands (65%),
- oak woodlands (7%),
- ponderosa pine (23%),
- mixed conifer (7%),
- aspen (2%),
- spruce-fir (3%),
- riparian and other forest types (5%).

These forested lands provide fish and wildlife habitat, recreational opportunities, wood products, critical water resources, and much more. Trees and forested lands are critical for:

- holding soil in place,
- reducing wind and water erosion,
- providing wind breaks for agricultural lands and communities, and
- serving as a natural water tower, storing water high in watersheds for dry season use.

Roughly 10.6 million acres of forested land are held privately in New Mexico. While public access to these lands is limited, they provide scenic beauty, watershed protection, clean air and water, wildlife habitat, and other ecosystem services. More than half of New Mexicans rely on forested watersheds for a clean drinking water supply, and those same forested watersheds also support roughly 60% of agricultural water needs across the state.

As a landowner, you will have your own additional reasons for wanting to reforest your property after a fire. Give yourself some time to think deeply about your long-term vision for the land. Are you reforesting your lands to:

- Restore aesthetics or beauty?
- Promote recovery of wildlife habitat?
- Re-establish timber production?
- Increase property values?
- Improve watershed health?
- Or some other reason?

Consider realistic time frames when developing your vision. Being as clear as possible about your reasons will help guide your decisions throughout the reforestation process. It takes a century or more for forests to mature and build their natural complexity. You may not live long enough to see your full vision realized. Does that impact your vision? Who might take over and continue pursuing your vision?

Burn scar at Serpent Lake illustrating large areas of dead or dying trees following high-severity wildfire. Image Credit: Matt Dahlseid/The New Mexican

Wildfire Impacts

Fire is a natural part of forested ecosystems in New Mexico. Historically, fires burned along the forest floor, cycling nutrients back into the soil and clearing away accumulated branches, needles and other forest litter, allowing grasses and forbs to grow. Fire reached into the tree canopy in small patches, killing trees that were too dense, and cleaning up accumulated fuels to make room for the next generation of trees. Today, low severity fires often only occur in areas that have been mechanically thinned or have had a history of recent and/or frequent fire.

As New Mexico's forests have become dry and stressed from years of sustained drought and increasing temperatures, they have become more flammable. When these conditions are combined with large accumulations of fuels across the landscape resulting from decades or even more than a century since fire last crossed the land, high-severity fires are often the result. The consequences of a high-severity wildfire can have devastating impacts on the ecological health of forested lands, as well as on downstream communities that rely on those watersheds for their water supply.

When a high-severity wildfire kills or damages large areas of forest, it can reduce or prevent natural regeneration after the fire, with few living trees remaining to provide seed sources. Most of New Mexico's native trees do not resprout after fire, but there are a few exceptions including aspen, scrub oak and some alligator junipers. Extremely hot fire temperatures can kill tree seeds and the beneficial bacteria and fungi in the soil, sterilizing the soil and removing it's ability to absorb and retain moisture, reducing the likelihood of natural regeneration as a result. Without tree roots and forest litter to hold soil in place, it becomes highly susceptible to wind and water erosion. As wildfire size, severity, and frequency continue to increase, so do the devastating consequences of post-fire debris flows that impact water quality and availability while damaging communities and property.

When private landowners choose to reforest their land after a fire, they are investing in the health and wellbeing of New Mexico. Furthermore, active forest management by private landowners can help shift fire behavior back toward low-severity impacts, leaving a healthier forest post-fire without the need for soil stabilization and reforestation practices. If you have areas of your property that have not burned, pursue forest thinning and prescribed fire treatments to help manage fuel loads proactively to reduce high-severity wildfire risk to your property and community.

Approaches to Reforestation

Seedlings

Containerized seedlings have proven to be the most effective option for reforesting disturbed landscapes in the southwestern US. Avoid planting bareroot seedlings on upland sites in the southwestern US. Landowners should plan for a 12 to 24 month lead time to acquire seedlings through a reputable forest nursery producer (*more details in the ordering seedlings section on page 28*). Landowners should be careful to ensure that seedlings are grown using a seed source appropriate for the site where they will be planted. In some cases, seeds must be collected before they can be grown out to fill your order, which can take several years. Seedlings can only be stored effectively for a few weeks after delivery, under proper conditions, and should NOT be held over from one planting season to the next. The longer you hold onto your seedlings the lower their survival rate after planting.

Direct Seeding

Direct seeding is the practice of sowing tree seeds directly into the soil on a reforestation site in an effort to promote regeneration. Direct seeding is not recommended for most tree species, especially in the southwestern US, because the weather can be unpredictable, leading to very low (< 1%) germination and survival. Rodent and insect predation of seeds is very high. Given the high cost and limited availability of tree seeds, combined with the low germination and survival rates of direct seeding in the southwestern US, direct seeding is typically a poor use of seeds and money.

Transplanting

Transplanting naturally occurring seedlings from one location to another is not recommended due to the disturbance this action has on the fragile root system of the seedling and the significant loss of fine roots that are critical to survival. Seedlings growing naturally in a forest typically have roots that grow outward from the seedling in all directions, and much of a natural seedling's root system will be lost when digging it up for transplant. Fine roots are where trees and plants take up water and nutrients so the loss of these critical structures can lead to poor health or the death of a young seedling.

Burned areas in northern New Mexico Image Credit: Andrew Lee, NRCS

A Reforestation Journey After the Hermits Peak/Calf Canyon Fire

Photos and Story By: Mychele Lord

May 2022

Located less than 3 miles from Hermit's Peak, 100% of our property burned, most as high-severity. It was May 2022, and there was absolutely nothing but ash and black trees everywhere and no signs of wildlife remained. The summer monsoons came and the dry, scorched land carried unprecedented water and debris through our arroyos and filled our ponds with ash and tree carcasses. I spent much of early 2023 trying to figure out what to do and who could do the work. We've made a lot of progress since then through trial and error, but the restoration process continues to evolve.

Early Stabilization

Removing burned trees and clearing tree skeletons after a fire is definitely a skill. Having the right equipment and skilled operators will determine the rate of recovery on your land—just like selecting the right plastic surgeon after a tragedy. I am grateful to have hired Rocky Mountain Forest Products out of Sapello, NM. They began clearing about 250 acres of burned forest in December 2023. With massive equipment they cut, delimbed and debarked trees. It was soon enough after the fire that the large trees were hauled out and sold. The limbs and smaller trees were masticated— turned into mulch and blown all over the ground. In some areas where the mulch was more than a few inches thick, we attached a rake to a tractor and spread the mulch, allowing the ground cover to show through. Additionally, using a tractor and bucket, we moved some of the heavy areas of mulch (where staging took place) and filled in old paths that had been washed out, added some soil with aggregate and packed it down. Because of the mulching, we did not need to do any cross-felling; not even on steep slopes. We did however leave a few dead trees for the wildlife in what are now wide-open spaces.

Pre-Fire Thinning

I am confident my house survived the fire because we had thinned around the house the

year prior. After the fire with much reluctance, I listened to the professionals at the New Mexico Forestry Division and thinned in areas where trees were too close together and were crowding one another. It was difficult to cut living trees after so many had been lost to fire, but the thinning provides more resources to the trees most likely to survive. Additionally, we cut the lower burned branches off trees.

Beetles

The few remaining living trees are having a hard time fighting off the beetles. To date, we have probably lost an additional 5% of the trees that survived the fire to the Ips Beetle. The key here is to remove the trees dying from the Ips beetle only in the dead of winter and to mulch (masticate) them to 1-2". Do not leave the tree or limbs on the ground, it only attracts the beetle. All this is to kill the beetle and keep the beetle from moving onto other living trees.

Replanting

It is important to use only native grass and tree seedlings. The NM Forestry Division helped me with appropriate selections for elevation, climate, etc.

Prior to mastication, we first spread a mixture of 2/3 Monida Oats and 1/3 HPCC Native Grass Blend in 2023. As the burned trees were removed and masticated in early 2024, we followed with a mix of 50/50 oats and native grass blends. The steep slopes took a few more applications and the use of fast-growing plants. We have purchased all our grass seed (Monida Oats, Santa Fe Trail Blend, Homesteader's Choice) & Llano Estacado wildflower seeds from Curtis & Curtis Seed out of Clovis, NM.

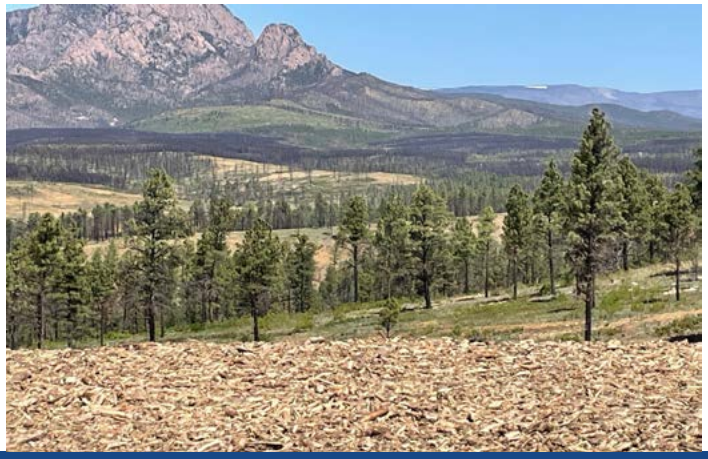
The New Mexico Forestry Division has a Conservation Seedling Program that offers seedlings at a very affordable price. State Forestry staff helped us in our selection of tree seedlings.

Erosion

One of the first and best things I did was engage with the Hermit's Peak Watershed Alliance (https://hermitspeakwatersheds.org) to build one-rock dams, trash racks, Zuni bowls and other natural structures in the arroyos and canyons on my property in 2023. This saved me tremendous damage when the floods came in the summer of 2024. Following the 2024 floods, they added a few more structures. Slowing the water flow has been invaluable to our reforestation.

Summer 2025

It looks completely different around here now. What was once a dense forest, is now open meadows filled with native grass and wildflowers. Trees remain in the canyons with flowing streams. The ponds remain full year-round. Never have I ever seen such an abundance and variety of wildlife.



Site Stabilization Activities

The phrase “go slow, to go fast” is apt for reforestation. One of the scariest parts of a wildfire is the lack of control over the situation, particularly as a landowner. Our first instinct once the flames are out may be to spring into action. We want to take back control and do something, anything! But this is the part of the timeline that requires patience. **Letting nature take its natural course for a year or two before launching into reforestation efforts will give you much needed time to plan and lead to better long-term results.** Taking time to plan doesn’t mean there isn’t anything to do.

There are two actions that can be taken immediately if erosion is an issue on your property; soil stabilization and log erosion barriers. If there are no signs of erosion on your property, you can skip this section.

Use the *Site Assessment Worksheet* at the end of this document to help identify areas of active erosion to prioritize locations where soil stabilization is needed most.

Soils volatilized following a high-severity wildfire. This site will likely need soil stabilization to keep the ash and debris from flooding downstream watershed communities. Image Credit: Dennis Carril, USFS

ACTION #1: Stabilize the Soil

0-24 months following wildfire

Following a severe wildfire, much of the organic matter in the soil has been volatilized, so there isn't much holding it together. Monsoon rains, winter storms, and spring snowmelt can cause erosion and debris flows depending on the size of the area burned, the slope of the burned area, the severity of the fire impacts and the severity of the storm or runoff event. It is important to stabilize soils before starting any reforestation planting to prevent seedlings from being buried in mud or having their root systems exposed by erosion.

There are two things you can do to help stabilize the soil immediately following a wildfire.

- Masticate standing dead trees and/or contour fell to create log erosion barriers.
- Seed the burned area with a (weed free) native grass and forb mix to get vegetation growing quickly.

Mastication is a fuels reduction treatment often used to reduce the risk of high-severity wildfires, but it can also be used after a wildfire to reduce standing dead trees and add organic material back into the soil. A masticator is similar to a wood chipper, but it is often a large spinning toothed drum, mounted on an excavator type tractor which grinds or chips tree and shrub skeletons, leaving the chips behind. The small chunks of woody debris left on the forest floor following mastication can serve as organic mulch, helping to retain soil moisture, reintroduce carbon to the soil, support natural regeneration and reduce erosion.

Be sure to describe the full log erosion barrier process in detail with your contractor. A shorthand term is "Contour Felling" but that is only the first step. To be effective erosion control structures, they must be fully in contact with the ground and anchored in place.

Well secured log erosion barrier. Image Credit: EMNRD

Log Erosion Barriers are a post-fire erosion control technique that involves felling and limbing trees and arranging them along landscape contour or elevation lines to create a series of barriers that slow runoff and trap sediment. By staggering the arrangement of logs, water is less likely to form long channels and runoff doesn't gather as much velocity and/or sediment as it moves downslope.

Standing dead trees are first felled across the slope and limbs removed (at least on the underside) so the log is fully in contact with the ground. Limbs can be left on the downhill side to effectively serve as brakes to help prevent the structure from washing or sliding downhill. Logs are then secured in place to prevent them from being washed downslope; a combination of a trench and staking on the downslope side to anchor the log in place will allow sediment to accumulate on the upslope side of the log. The method's success depends on the steepness of the slope, tree size and density, and proper installation and maintenance.

ACTION #1: Stabilize the Soil (continued)

0-24 months following wildfire

Green areas of natural regeneration soon after the Jaroso Fire. Image Credit: Dennis Carrill

Seeding native grasses and forbs like wildflowers can also help to stabilize the soil immediately following wildfires in areas that are at high risk of erosion. Post-fire seeding is most appropriate for severely burned areas as part of a multi-treatment approach (combined with mulching and/or log erosion barriers) and timed to local precipitation patterns, with careful consideration given to species selection (favoring natives).

Be cautious in deciding if seeding is necessary. In areas less severely burned or flatter areas, revegetation will often occur naturally within 1-3 years post-fire without the need for seeding. Grass and wildflower seeds can disperse over great distances because of their small size and light weight, allowing them to be carried on the wind. **Not seeding is ok if natural regeneration is likely to occur.**

If a decision is made to seed an area, sourcing seed from a reputable business is critical to prevent or reduce the introduction of noxious weeds and other undesirable grasses and plants. Prior to purchasing, landowners may request recent seed test results to understand seed viability and to ensure they are aware of any noxious weeds that might be present. **"Sterile" seed sources are not recommended.** There are several local vendors that collect native seed appropriate for post-fire restoration.

Require that your contractors clean and inspect their equipment before entering your property or project site to reduce the transfer of invasive weed seeds and other undesirable material from invading your recovering site.

ACTION #2: Fell Standing Dead Trees

0-24 months following wildfire

Felling standing dead trees can significantly improve site safety for tree-planting crews. Two years after a fire, those standing dead trees, also known as snags, start to blow down and become a serious hazard, especially during New Mexico's strong spring winds. However, snags are also used by many species of wildlife. A general guide is to retain 5-10 snags per acre. It is best if those snags are located away from human activity like roads, trails, houses, and outbuildings. Leaving a few standing dead trees to naturally decay and fall in their own time will provide some structure as the young forest recovers. Snags can be felled and either masticated or used for log erosion barriers. Maintaining organic material from masticated trees and shrubs on site is critical to stabilizing the soil and jump start the soil recovery process that will support forest regrowth.

Post fire mastication and log erosion barriers created from fire killed trees. Image Credit: EMNRD

ACTION #3: Stabilize Riparian Areas

0-24 months following wildfire

If your property includes riparian areas such as wetlands, seeps, springs, or creeks, it is critical that they are protected to increase water-holding capacity in the watershed. This will improve the recovery of the forest in surrounding areas. Planting willows and other native vegetation along drainages and waterways will help stabilize and rebuild soil, and improve water availability in surrounding upland area plantings. If there is active erosion occurring, see the soil stabilization section for actions you can take immediately post-fire.

Read the *Post-fire Revegetation Guide for Riparian Landscapes* for more detail on actions you can take that are specific to this ecosystem type.

Erosion control structures built around a creek to prevent post-fire damage from sediment laden flood events. Image Credit: EMNRD, Forestry Division.

An area of mixed burn severities. Image Credit: Dennis Carril, USFS

Site Assessment Activities

Before you can effectively plan and implement reforestation efforts, it is important to understand the severity and impacts of the fire, and to assess the highest priority areas for reforestation activities. **Seedling survival can be as low as 25% without proper planning and implementation**. The best practices outlined in this guide, including careful planning site selection, ensuring appropriate seed sources and stock types, site preparation, planting windows, seedling handling, and proper planting tools and techniques which can improve survival rates to 65% or greater. Evaluating your sites carefully will increase returns on your investment of time, energy, and money.

Choose areas to plant where you can maximize your investment by increasing the chances of seedling survival. A *Site Assessment Worksheet* is included in the appendix to assist you.

Walk your property and consider the following ideas while you record information on the *Site Assessment Worksheet* that will help you make decisions in the next step. **It may be useful to have a topographic map or property map that you can make notes on while you are completing your site assessment.**

Reach out to your local New Mexico Forestry Division District for help with a detailed site assessment.

ACTION #4: Evaluate Existing Site Conditions

3-12 months following wildfire, during the growing season

Fire Severity

The U.S. Forest Service often sends a Burned Area Emergency Response (BAER) team before the fire is fully contained. With their trained technical staff, they are likely to conduct a more in depth assessment of the fire effects. Use these data when available, while walking your property to understand the general severity of the fire, which may vary across your property.

If the BAER data is not available, you can conduct your own assessment using the following guidelines. The severity classification is a good shorthand for communicating with forest professionals and while reviewing helpful resources. Landowners are most often targeting high severity areas for reforestation investment as lower severity areas are likely to have living trees that can act as seed sources for natural regeneration.

Severity	Vegetation Effects	Soil Effects	Other Effects
Unburned	No vegetation change.	No changes to soils.	Litter and duff intact.
Low	Grasses and surface vegetation scorched or consumed but still recognizable; single tree torching, overstory trees may be scorched, but tree canopy is mostly intact.	Litter and duff charred or partially consumed; soil structure intact and unchanged from its unburned condition.	Tree roots and soil biota are largely unaffected; tree canopy remains green.
Moderate	A mix of low and high severity, where some places may have up to 80% of pre-fire ground cover consumed. Partial canopy consumption; shrubs and young trees dead; small to medium patches of trees killed.	Up to 80% of litter and duff consumed but soil structure is generally unchanged.	Increased risk of erosion, possible tree root damage and particularly fine root damage.
High	Tree canopy completely consumed; most or all vegetation killed.	Soil has hydrophobic properties, organic matter completely consumed, possible soil sterilization.	High risk of soil erosion, intense post-fire debris flows, soil crusting, tree seeds in soil sterilized and infertile.

ACTION #4: Evaluate Existing Site Conditions (continued)

3-12 months following wildfire, during the growing season

Scale

The *Site Assessment Worksheet* asks a series of questions focused on how much land burned and the severity of that burned area. Consider the following while evaluating the scale of the wildfire impacts to inform which areas can be realistically reforested:

- Determine the acreage of contiguous high severity burned areas. Based on your specific reforestation goals, this acreage will be used to guide the areas selected for reforestation activities. For example, those high severity burned areas that are 25 acres or larger may be candidates for creating seedling islands in high quality planting sites. Areas smaller than 25 acres may not require reforestation, depending on neighboring mature trees as potential seed sources, the context of neighboring properties and your property's position in the watershed.
- Smaller reforestation project areas facilitate post-transplant seedling care (watering and maintenance) during establishment that isn't feasible across larger areas. If you have more than 10 contiguous acres that need reforestation, consider breaking the acreage into smaller more manageable project areas using natural boundaries, vegetation changes, edges of fire intensity impact or roads.
- Identify areas of the land that are most important to you. This will help prioritize which areas to reforest and the sequence of those efforts.
- Think about the larger landscape beyond your property lines and how your efforts may impact adjacent landowners or how their activites may impact your land. Consider the potential for collaboration with adjacent landowners.
- Consider leaving some areas for natural regeneration.
- Identify areas with road and vehicle access that can facilitate easier delivery of tools, equipment, materials and seedlings to planting sites.

Understanding the scale of the area burned in the context of the larger watershed, illustrated by this photo, may help inform planting decisions. Image Credit: Dennis Carril, USFS

ACTION #4: Evaluate Existing Site Conditions (continued)

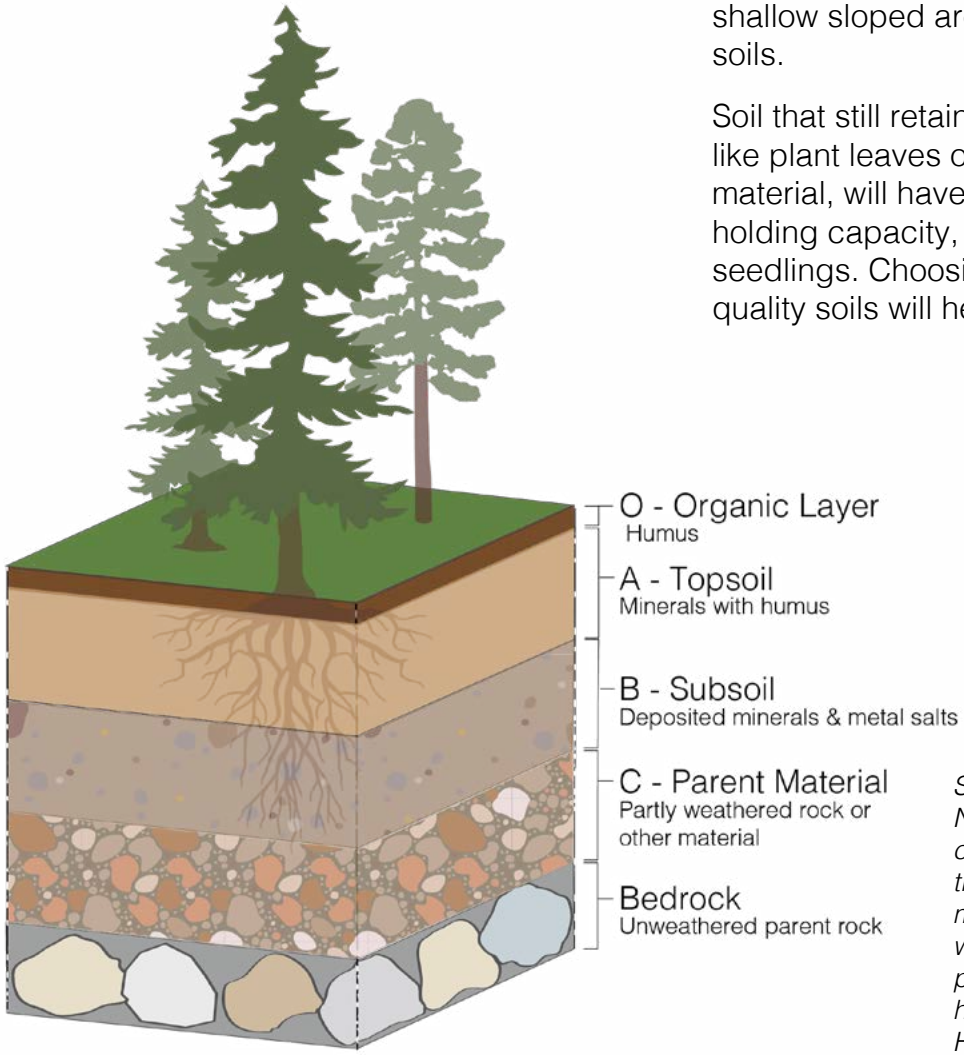
3-12 months following wildfire, during the growing season

Soil Types and Depth

A wildfire can significantly alter soils, combusting organic matter in the topsoil and lower layers. This can expose underlying soil layers that are low in nutrients and do not retain water well. Wildfires can also leave dry ash from the combustion of organic materials. While ash often has high concentrations of calcium and potassium initially, it is easily eroded by wind or water. High severity fire can change the chemical properties of soils causing a hydrophobic layer that repels water to form below ash layers. When present, this layer can cause significant runoff, and such layers lack the structure and composition needed to support living vegetation.

Understanding the type and depth of soil will help you prioritize where replanting might be most successful. **As soil depth and quality increase, so do your seedlings' chances of survival.** Soils vary considerably depending on topography, underlying rock type (parent material, local geology, and vegetation community). Some areas are not good candidates for reforestation because they are too steep or soils are too rocky or do not contain enough organic matter to support a growing tree. Ideally, a tree needs soil that is at least two feet deep to adequately support its mature root structure. If the soil is deep enough to get a planting shovel in the ground and not so rocky to prevent properly close the planting hole, then the soil is deep enough. Valley bottoms and shallow sloped areas often have the deepest soils.

Soil that still retains some organic matter, like plant leaves or roots and decomposing material, will have better soil structure, water-holding capacity, and nutrient availability for tree seedlings. Choosing planting sites with higher quality soils will help increase seedling survival.



Soil horizons commonly found in New Mexico. High intensity wildfires can combust organic materials in the O and A horizons, leaving ash, mineral soil and metal salts behind, which reduces survival of newly planted seedlings due to limited water holding capacity. Image Credit: Sarah Hurteau, IBIS

ACTION #4: Evaluate Existing Site Conditions (continued)

ACTION #4A: Map Soils

Before the Field Portion of the Site Assessment

The Natural Resources Conservation Service (NRCS) Web Soil Survey Tool is a helpful tool to map the soils on your property. The tool uses a national dataset that provides detailed soil type, depth, quality, and many other metrics that may be useful when planning where to reforest. Bringing soil maps with you to the field may help identify favorable planting locations during the field portion of the *Site Assessment*.

ACTION #4B: Map Existing Forest Type(s)

During the Field Portion of the Site Assessment

Note on the *Site Assessment Worksheet* what forest types were present and the approximate locations on your property where each existed. Forest types vary by elevation, slope, aspect (facing direction), and location. Understanding pre-fire forest types informs what to plant now for the next generation of forest, in combination with elevation and topographic conditions, and both current and future rainfall and temperature patterns expected in the area.

ACTION #4C: Map Post-Fire Living Vegetation

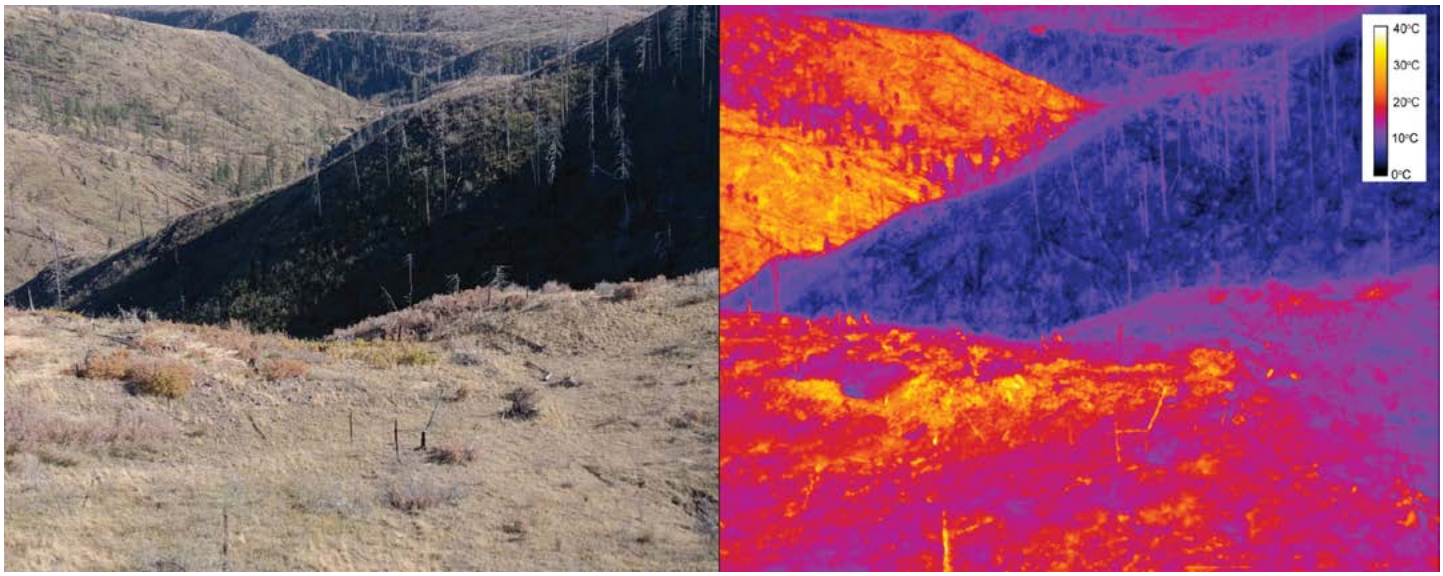
During the Field Portion of the Site Assessment

While a large area of your property may have burned, severity may be patchy, with living trees remaining in some areas. These patches of living mature trees can serve as a seed source to reforest surrounding high-severity burned areas of up to 25 acres depending on the tree species, slope, and tree position on the slope.

Consider how areas where you want to reforest could be naturally regenerated thanks to these living mature seed trees. Areas with living trees can be lower in your planting priority list than areas that may not have any living trees.

Top Photo: High severity burned area, where soils have been damaged and likely need stabilization. Image Credit: Dennis Carril, USFS. Middle Photo: Mixed forest type and topography. Image Credit: Matt Hurteau, UNM. Bottom photo: An area of low burn severity. Image Credit: Dennis Carril, USFS.

ACTION #4: Evaluate Existing Site Conditions (continued)



An infrared camera image helps to illustrate the variable conditions that exist on different slope aspects in this side-by-side comparison. Image on the left is a regular photograph, image on the right is the same location but photographed with an infrared camera. The north facing slopes are shaded and cool, appearing blue to purple in the infrared image. The south facing slopes look hot and dry and the infrared images shows an increased temperature of more than 30°C (80°F). Image Credit: Chris Marsh, UNM

ACTION #4D: Map Topography & Favorable Microsites

During the Field Portion of the Site Assessment

Planting seedlings in areas that naturally collect water greatly increases their chance of survival. Areas around seeps, springs, creeks, and streams will have higher soil moisture. However, avoid areas where there is active erosion that can expose the roots or wash out newly planted seedlings. Use the soil stabilization actions described previously before planting to protect your investment in planted seedlings.

The combination of elevation and topography (e.g., aspect is the cardinal direction the slope is facing), will inform what species were likely there before the fire and play an important role in selecting good candidate locations for replanting. Slope and aspect play a critical role in creating dramatic microsite or microclimate differences.

For example, ridgetops and south and west facing slopes tend to be warmer and drier. North-facing slopes are often shaded, more moist and cooler than south-facing slopes.

In the northern hemisphere, south-facing slopes get more solar radiation, which causes them to be hotter and drier. Slope angle can amplify this effect. For example, areas with very steep slopes might receive no direct sun in the winter, prolonging snowpack or moist conditions.

Slope and topography directly affect the species that grow in various areas because of the microsite conditions they create. These patterns are predictable and should inform which species are selected for reforestation areas. The seedling selection should vary with aspect and other topographic features to mimic natural patterns that existed before the area burned. Understanding and replicating these patterns will improve seedling survival.

ACTION #4: Evaluate Existing Site Conditions (continued)

Tree density varies along ridge tops and south facing slopes. Image Credit: Andrew Lee, NRCS

Microsites or microclimates are localized areas where the conditions are different from the surrounding landscape. They can offer conditions that are favorable for planting seedlings. Here are a few things to look for to find favorable planting microsites:

Vegetation Indicators

- Green or even lush foliage compared to surrounding areas
- Minimal scorching or other fire impacts
- Many different kinds of plants compared to surrounding areas

Soil Conditions

- Cool and damp to the touch within the top two to four inches
- Darker soil color indicating soil moisture and high organic matter content
- Litter and duff intact

Topography

- Swales, depressions, or shallow basins (often at the toe of a slope)
- Logs, rocks, or cliffs that might shade a young seedling
- Aspect provides the context for how important these features are
- NW-SE aspects are more favorable for planting
- The sunnier the aspect (e.g., S-W) the more important microsite conditions become

Other Indicators

- Puddles or moist soil two to four days after rain events
- Wetland insects (like dragonflies or mosquitoes) or wildlife (like frogs and salamanders)
- Evidence of flowing water
- Morning dew on vegetation
- Areas protected from wind

ACTION #4E: Animal Browse

During the Field Portion of the Site Assessment

Look for evidence of mice, gophers, rabbits, deer, elk, and cows. Rodents and ungulates chew on small trees and will likely be one of the biggest challenges to seedling survival. Knowing which of these animal species are present, and whether there are known travel corridors for deer, elk, and other large mammals will inform what protective actions you may need to take to minimize wildlife damage. Knowing whether cows graze in the area is also important to address. Here are a few actions you can take either individually or in combination to protect young seedlings:

- Tree tubes or shelters
- Wire mesh cages
- Vexar or mesh wraps
- Exclosure fencing
- Logs around planting clusters
- Trapping for pocket gophers and other rodents
- Odor- and taste-based repellents (only temporarily effective)

Seedling browsed due to lack of protection. Image Credit: Owen Burney, NMSU

ACTION #4F New Disturbance Patterns

During the Field Portion of the Site Assessment

If the fire has significantly reduced the tree canopy cover, you are likely to see new wind disturbance patterns. Wind events can blow down trees, called windthrow or windsnap, that uproot or snap the trunk of a tree, making terrain difficult to access. When many trees are blown down, they often fall into a jumbled mess. While this can make it challenging to plant in those areas, it can also protect newly planted seedlings from animal browse as it changes wildlife movements and use of an area. Landowners and planting crews should always be cautious in burned areas, especially during windy conditions, due to the possibility of falling trees.

ACTION #4G: Map Active Erosion

During the Field Portion of the Site Assessment

Erosion is the other disturbance pattern that may be new or different than it was before the fire. Look for narrow channels carved into the soil from flowing water, larger gullies forming, or accumulated soils and debris at the bottom of slopes, ditches, or streambeds that indicate active erosion processes. If you have active erosion happening on your property, consider the soil stabilization activities discussed earlier to prevent the erosion problems from getting worse. Sediment-laden runoff can quickly cause large-scale damage to landscapes and homes or communities.

Planning Activities

Thorough planning is the key to success with reforestation projects. Without understanding the scope of your reforestation efforts, and without developing focused strategies to meet your reforestation goals, any effort can be a waste of time and money. There are also long lead times in securing seedlings and contractors to do reforestation work, and a good plan up front will avoid wasted time later in the process. Use your completed *Site Assessment* to help develop the scope of your efforts, which can be framed as goals and objectives, with your budget in mind.

Set realistic timelines and milestones. Fire is fast, but reforestation is extremely slow. Understanding the naturally slow regrowth of a forest will help you see the progress of your planted seedlings as they grow roots first before growing in height. If you approach your reforestation project as an iterative or multi-year project, you are likely to be much happier with the outcomes.

Do not replant your entire property in a single year. Spread plantings over three to five years to ease budget, logistical and time constraints. This will also buffer against unfavorable weather conditions that may exist in a single year and increase survivability as site conditions change and begin to recover over time.

How to Set SMART Objectives

Set clear and achievable goals and objectives for your reforestation projects. Here are a few definitions and examples to help get you started. Identify objectives that are SMART:

Goal: A broad, general statement you want to achieve that provides long-term vision.

Example Goals:

- I want to see trees alongside my road as I drive to my house.
- I want to restore the area around my favorite hunting spot to bring the deer back.
- I want to enjoy the view from my back porch again.
- I want to stabilize the hillsides so my home isn't in the path of debris flows during monsoon storms.
- I want to increase the water quality in local streams to protect fish habitat.

Specific
Measurable
Achievable
Relevant
Time-bound

Objective: A specific, measurable, realistic, time-bound step you can take to achieve your goal.

Example Objectives:

- Complete my site evaluation during the first growing season after the fire.
- Choose which species (elevation and climatically appropriate) I would like to plant next year and see if those seedlings are available.
- Replant five acres a year for the next five years in clusters to augment natural regeneration.
- Accelerate natural regeneration in three high-severity patches larger than 15 acres by planting clusters of seedlings in selected areas next year.
- Hire a planting crew this fall to increase the acreage I can replant this year.

ACTION #5: Set A Reforestation Budget

6-18 months following wildfire

Crew measuring and monitoring seedlings following planting. Image Credit: New Mexico Highlands University

Reforestation activities can be expensive. Establishing a budget will help you prioritize where your money and efforts will be spent and align the scale of your reforestation activities with your budget. There are several federal programs that provide cost-share or grant funding to support private landowner's reforestation and other conservation activities. See *Appendix A: Connecting to Other Resources* for additional detail.

Steps in estimating costs and establishing a budget include:

- Setting specific goals for your reforestation projects based on your *Site Assessment* and priorities.
- Using your *Site Assessment* to guide the scale of your projects and prioritize which areas will be planted in what order and over how many years.
- Estimate costs on planting in one season versus multiple seasons.
- Identifying site stabilization needs, such as log erosion barriers or grass and forb seeding (see the *Site Stabilization* section).
- Estimating how many trees and what species you will plant per acre (see the *What to Plant* section).
- Identifying needed planting materials (e.g., tree tubes and stakes) and seedling planting tools (see the *Pre-Planting Logistics* section).
- Determining whether you will do some or all of the planting yourself or hire a planting crew to do the planting (see the *Who Will Plant* section).
- Identifying transportation requirements, as well as seedling storage and staging requirements (see the *Planting* section).

Your NMFD District Forester can assist you in estimating per acre costs for your specific situation.

ACTION #6: Select Planting Sites

18-24 months following wildfire

Where to Plant

The real estate rule "location, location, location!" is key for seedling planting. Use your property *Site Assessment* to identify manageable project areas (generally less than 10 contiguous acres, but highly variable depending on the context of the area burned on your property and your goals) and prioritize these locations for planting. Stagger project areas over multiple years.

Within each project area, identify patches where there are:

» No active erosion problems that would wash away newly planted seedlings or expose roots.

» Sufficient soil depth and structure to grow a tree. (See *Site Assessment* for details)

» Evidence of regrowth from grasses and other understory plants. This indicates there is enough organic material and soil moisture to support a growing plant.

» Easy access to roadways or other infrastructure needed to bring in seedlings, tools, materials, and planting crews.

» No live seed trees or natural tree regeneration. Areas with seed trees exhibiting natural regeneration may reforest on their own and are not a priority for planting.

Identify smaller microsites with microclimatic conditions that are favorable to seedlings. Look for:

» Topography like small divots, shallow creases, drainages, swales, or depressions where water will gather and naturally irrigate your seedling. These can be subtle, so look closely. If there is active erosion, choose a different site.

» Favorable slope aspects that will provide overall shadier, cooler, or wetter conditions for growing seedings (i.e., NW-SE).

» North side of logs, snags, or stumps that will protect and shade young seedlings. While planting next to these features does carry some fire risk, the benefits outweigh the potential risks.

» Cool, moist, or shaded soils. These areas are likely to have higher soil moisture.

» Signs of water availability (e.g., other plants growing in a clump there or nearby).

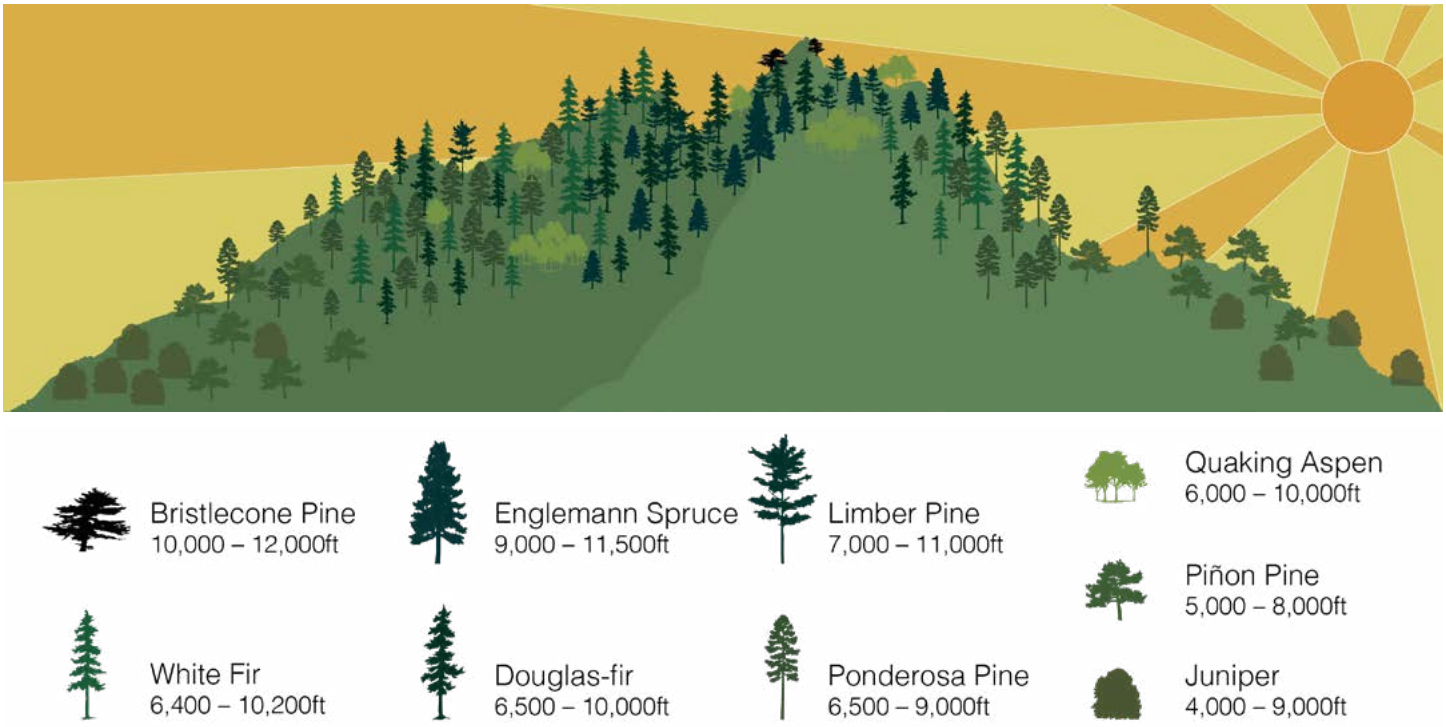
» Other characteristics outlined in the *Site Assessment* for best planting sites.

Prioritize sites for reforestation that have these site characteristics. If the site is a priority for you but only some of these characteristics exist, you can enhance the site by creating your own microsites. Create small planting wells on the downhill side of seedlings by building small berms to help collect and store water. For larger areas, you can use machinery or log erosion barriers to create some of these characteristics that can increase the survival of planted seedlings.

Newly planted seedlings in an area with favorable microsite features. Image Credit: University of New Mexico

ACTION #7: Select Which Species to Plant

18-24 months following wildfire



A species' range is dependent on specific site conditions such as slope, aspect, topography, soil condition and micro climatic characteristics. For example, a sunny, south facing aspect might cause species to occupy a higher end of the range. A shaded north aspect might allow species to occupy the lower end of the range. Microsite characteristics may offer refugia from harsher conditions that allow pockets of greater diversity in species composition and density in growth. Image Credit: Sarah Hurteau, IBIS

What to Plant

The large trees that burned during a fire started their lives decades ago, under different climate and forest and watershed conditions. Some species adapted better than others. Temperature and precipitation patterns are anticipated to continue to change, which affect what tree species will likely do best moving forward. Simply replacing what was there before may not be the best strategic approach.

Species suggestions for New Mexico include, depending on elevation and aspect:

» Bristlecone pine (*Pinus aristata*) 10,000-12,000 feet
» Limber pine (*Pinus flexilis*) 7,000-11,000 feet
» Engelmann spruce (*Picea engelmannii*) 9,000-11,500 feet
» Quaking aspen (*Populus tremuloides*) 6,000-10,000 feet
» Douglas-fir (*Pseudotsuga menziesii*) 6,500-10,000 feet
» White fir (*Abies concolor*) 6,400-10,200 feet
» Ponderosa pine (*Pinus ponderosa*) 6,500-9,500 feet
» Juniper spp. (*Juniperus monosperma*, *J. osteosperma*, *J. deppeana*, or *J. scopulorum*) 4,000-9,000 feet depending on specific species selected
» Piñon pine (*Pinus edulis*) - 5,000-8,000 feet

ACTION #7: Select Which Species to Plant (continued)

18-24 months following wildfire

Where you are planting (slope, aspect, elevation) will also inform what species you plant. For example, you may be able to replant species that were there before on cooler northeast, north, and northwest facing slopes, but not for warmer and drier southeast, south, or southwest facing slopes. For drier sites like southerly facing slopes, consider planting the vegetation type of the elevation zone below what was there before. For example, if you had a lower elevation ponderosa pine forest, a mix of piñon-juniper may perform better instead.

Mixing different tree species where appropriate will add to the natural feel of the forest when it matures and better mimics natural regeneration.

If the site is a priority for you but only some positive site characteristics exist, you can enhance the site by creating your own microsites. Create small planting wells on the downhill side of seedlings by building small berms to help collect and store water. For larger areas, you can use machinery or log erosion barriers to create some of these characteristics that can increase the survival of planted seedlings.

Your NMFD District Forester can help advise you on the right species to replant given the location, elevation and topographic context of your property, the intensity of the fire that burned across your land, and the appropriate seed source for the species you selected for replanting based on the most current research.

Ponderosa pine seed collection in New Mexico for post-fire reforestation. Image Credit: NMHU.

The seed source used to grow your seedlings is critical to their survival. For example, if you source a ponderosa pine seedling grown using seed from the Pacific Northwest, it may not be well adapted to the dry harsh conditions in the desert Southwest.

Consider sourcing your seed from the southern portion of the seed zone which contains your planting site. Seedlings sourced from dry and hot areas may have a better chance of surviving in the more exposed post-fire conditions you now have.

Foresters and nursery managers use seed zones and elevation bands, along with climate modeling, to determine where seedlings grown from a particular seed source are likely to be successful. They should be able to advise you on the best seed source for your property, **so be sure to tell them where you are located and the current conditions of your land.**

ACTION #8: Determine How Many Seedlings To Order

18-24 months following wildfire

Planting Design

The design and spacing of seedling planting is important to the recovery of the forest and the larger watershed. These guidelines will help you plant in a way that balances the feasibility of planting (e.g., ease of access and short travel distances) with long-term forest structure and restoration goals. To restore natural forest conditions:

- Avoid planting in a grid; instead use nucleations or "tree islands" or some form of random planting patterns. Nucleations should vary in size between ¼ of an acre to no more than 2 acres in size.
- Mimic natural regeneration patterns by planting seedlings at varying distances between 8 and 18 feet apart, selecting for favorable micro-site conditions.
- Plant seedlings in clumps or patches at a distance from each other. This sets up a forest structure that mimics natural regeneration and is more resilient to future fires by providing canopy breaks. Leave a minimum of 150 feet between edges of each cluster.
- Identify areas that may act as seedling refugia like areas that had lower severity fire effects that left some trees and shrubs alive, where microclimate characteristics are present or small amounts of natural regeneration are occurring.
- Fill in large empty patches between living clusters that survived the fire with clumps of new plantings to build off natural regeneration.

Photo illustrates the patchy nature of natural regeneration. Mimic these clumps and groups, also known as nucleation planting, to create a more natural structure in reforestation areas. Image Credit: Andrew Lee, NRCS

ACTION #8: Determine How Many Seedlings To Order (continued)

18-24 months following wildfire

Crew member planting seedlings in a recently burned area. Image Credit: NMHU

Who Will Plant

Deciding who will plant the seedlings requires an honest evaluation of your own capacity. Here are a few things to ask yourself when evaluating if you can and/or want to do it yourself, or if it's better to contract it out. Consider:

- How many seedlings will be planted.
- Size of the area(s) to be planted (related to above).
- Physical labor required to access the sites and plant the seedlings.
- Equipment and tools required.
- Do you have the expertise or are you willing to learn how to plant seedlings properly?
- Do you have the time to dedicate to planting the seedlings?
- Do you have the capacity to handle the amount of work?
- Can you work with your neighbor to increase efficiency?

Contracting is a good option if you don't think it's feasible to do it yourself. Planting rates per person for experienced planters in the southwestern US range from 100 to 500 seedlings per day, depending on site conditions and planting experience, although planting rates on the low end of this range are more common. Here are a few key steps in establishing a successful seedling planting contract:

- Hire established tree planting contractors. Meet with your NMFD District Forester for assistance with selecting quality contractors and developing contract guidance.
- Write a contracted scope of work so that you and your contractor are clear on what your overall reforestation goals and objectives are, results of your *Site Assessment*, areas identified for planting, how many tree seedlings will be planted, the date range when it will occur, whose responsibility it is to order and coordinate the delivery of the seedlings, and what approach will be taken with regard to planting inspections for purposes of quality control.
- Based on the written scope of work, get cost estimates from reputable planting crews.
- Schedule time to actively monitor contractors, inspect the quality of their planting and conduct planting inspections during and after planting episodes.
- Consider hiring an experienced consulting forester to provide guidance, assistance, and serve as your agent for managing contracted reforestation services.

ACTION #9: Select The Planting Season

18-24 months following wildfire

When To Plant

Soil moisture is one of the most important factors in seedling survival. Reforestation projects are often too large or too distant from reliable water sources to provide even intermittent watering. It is likely that tree seedlings will have to survive on precipitation alone. Given that, in New Mexico the following times are considered the most viable seasons to plant seedlings:

» Monsoon season is the first choice. Only begin planting after the rains have started and it is predicted that there are more storms coming.

» Fall is the second best choice (late September through late October). Plant seedlings when daytime temperatures are cool, there is still some soil moisture from the monsoons, and three to four weeks before overnight temperatures dip below freezing. If an above average snowpack is predicted for that winter, it is a good time to plant seedlings, keeping in mind that seasonal forecasts can be uncertain. North facing slopes should be planted first in the late summer or early fall because they are the first to accumulate snow.

» Avoid spring planting unless there are opportunities to provide supplemental water (e.g., if your planting will have a smaller number of seedlings or cover a smaller area close to irrigation infrastructure). South-facing slopes should be planted first in the spring because they are the first to be free of snow and the first to dry out.

You will need to plan far in advance to ensure you can get your seedlings in time for your preferred planting season. See the *Ordering Seedlings* section below for more details.

Looking ahead to weather conditions when you plant will also help you decide if and how much of an area you will plant for the following year. Look for El Niño/La Niña forecasts.

El Niño weather patterns tend towards cooler temperatures with above average precipitation for New Mexico, while La Niña patterns tend to be warmer and drier. Because you will have to order seedlings so far in advance, look ahead at National Oceanic and Atmospheric Administration (NOAA) seasonal forecasts for summer and winter precipitation before you order your seedlings. If both forecasts are below average, you may consider skipping planting that year and waiting for more favorable conditions. However, once you have received seedlings, it is not recommended to hold over seedlings between years, so once you order your seedlings, you just have to go for it and hope for the best.

During your planting year, monitor soil moisture or use a rain gauge on your property throughout the growing season if you can. Rain volumes can be patchy, so be sure to check all possible planting sites for signs of rain. This can help refine where and when you plant.

Crew member planting seedlings in a recently burned area. Image Credit: NMHU

Pre-Planting Logistics

Once you have developed a strong planting plan which includes planting project areas and timelines, species and amounts to plant, and who will be planting, you can move on to arranging planting logistics. If you have decided to work with a contractor, coordinate closely with them to understand responsibilities and timelines.

Seedling Sizes

There are many different sizes of seedlings that vary in diameter and height. Be sure to order seedling sizes based on soil conditions. For example, if you have deeper, moist soils you can choose larger sizes. If your project includes reforesting areas burned by high severity fire or rockier sites, then you likely have shallower soils and should order seedlings in smaller containers.

Cone collection efforts from tree climbing (top right), cone transport (bottom left) and cone storage (bottom right) prior to processing to remove the seeds from the cones for long-term storage. Images Credit: NMHU

ACTION #10: Order Seedlings

18-24 months following wildfire

A young seedling in the John T. Harrington Forestry Research Center being grown for reforestation projects. Image Credit: Owen Burney, NMSU

Ordering Seedlings

Order early! Forest nursery producers take orders 12 to 24 months in advance, and nursery space fills up fast. The actual time to grow seedlings is between 5 to 18 months depending on the container size and species you order. The longer you wait to order, the fewer choices you have, and this will likely affect your seedlings' survival.

Buying locally-adapted seedlings is critical to increasing the chances of their survival. The genetics of the seed source is very important. Talk with the seedling producer when you order to ensure you are getting seeds sourced from an appropriate location that would be a good match for your planting site(s).

For smaller orders (< 1,000 seedlings), order seedlings directly from the NM Forestry Division Conservation Seedling Program. The NM Forestry Division sources their tree seedlings from the John T. Harrington Forestry Research Center in Mora, New Mexico, operated by New Mexico State University. Other growers produce some of the woody shrubs and forbs sold through the program. The Research Center can currently only produce about 75,000 to 100,000 seedlings each year for private landowners. Supplies are limited, so order early. EMNRD Forestry Division, NMSU's John T. Harrington Forestry Research Center, NMHU Reforestation Operations, and UNM's Department of Biology have partnered to found the New Mexico Reforestation Center and are working to increase supplies to accommodate more reforestation projects. These programs collect native tree seeds from resilient seed sources across New Mexico to increase the probability of survival in harsh post-fire climatic conditions.

If you order from private nurseries or from out of state, make sure they know you are planting the seedlings in New Mexico and ask for a seed source that is best suited to be planted at your exact planting location. Ideally, the best seed source for your planting site should be identified using a combination of seed zone, elevation band, and climate projections for your area. There is no such thing as a one-size-fits-all seed source! When sourcing seedlings from a nursery you should consider the nursery's reputation and track record for producing quality seedlings. NM Forestry Division Foresters can assist you with finding appropriate seedlings.

Buying local is critical to your reforestation success. Seedlings from nurseries outside of the Southwest are likely not well suited to New Mexico's hot temperatures and dry soils and would suffer significant stress being shipped here.

Tillamook Forest Example - Why Genetics Matter

Oregon Coast Mountain Range following what became known as the "Tillamook Burn" in 1933. Image Courtesy of the Oregon Department of Forestry

The Tillamook State Forest in Oregon's Coast Range, about 40 miles west of Portland, was shaped by a series of historic wildfires that burned between 1933 and 1951, collectively called the Tillamook Burn. The fires devastated the area that was mostly private lands at the time until Oregon Governor Tom McCal renamed the 355,000 acre area the Tillamook State Forest. The replanting that occurred following these fires has become a primary example of why forest genetics are important and the need to specifically source seed that is locally adapted.

Following the devastating Tillamook Burn, extensive replanting efforts were undertaken to restore the forest. It is estimated that more than 72 million seedlings were planted. Everyone from forest workers, volunteers and school children contributed to the effort.

Early research guided the reforestation effort leading to its ultimate reforestation success.

Locally-Sourced Trees: Trees grown from seeds collected from nearby, local sources (such as the Mount Hebo area in the coastal mountains) thrived in the moist, specific environmental conditions of Tillamook.

Distant-Sourced Trees: In contrast, trees from more distant sources, like the drier east slopes of the Cascade Mountains, did not perform as well. They were not genetically adapted to the moist coastal climate and struggled to survive and grow. These distant seed sources contributed to the severity of Swiss Needle Cast, a disease seen in the coast range.

This experience underscored the forestry principle that genetic differences exist within the same tree species across different geographic ranges, and these differences are often adaptive to local environmental conditions.

Foresters use seed zones, areas with fixed boundaries on a map, to ensure that plant materials are transferred within an area where they are genetically suited to the local climate and conditions, minimizing the risk of poor adaptation. The Tillamook example is a classic illustration that highlights why strict attention to the source of origin is vital when planting native materials in restoration activities.

These same principles are being used today to source seed for post-fire reforestation throughout the western U.S. Proper planning to ensure seed or seedlings are ordered from a reputable source that adheres to these principals is vital to seedling survival rates.

High School students helped with replanting efforts following the fires in 1945. Image Courtesy of the Oregon Department of Forestry

ACTION #11: Order Tools & Materials

24-30 months following wildfire

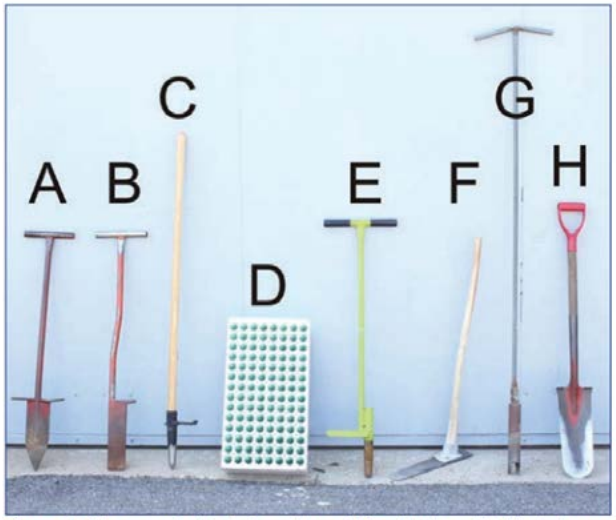
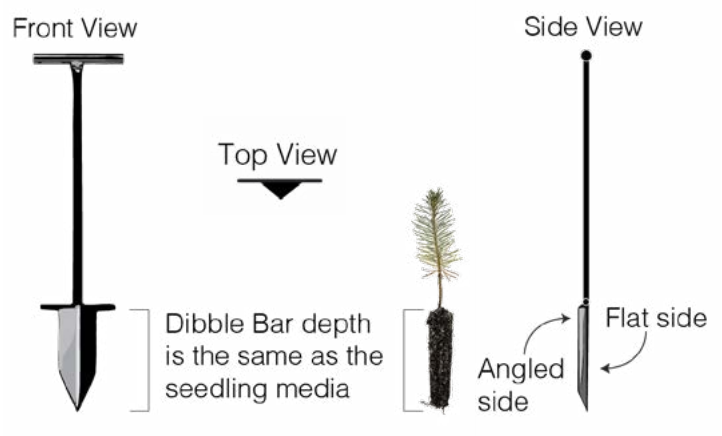


Figure 1. The seven planting tools and type of Styroblock used in this study were (A) JIM-GEM® KBC dibble bar, (B) JIM-GEM® OST dibble bar, (C) Terra Tech Styro 8 dibble stick, (D) Copperblock™ Styroblock, (E) container seedling tube dibble, (F) hoedad, (G) auger, and (H) shovel. (Photo by Daniel J. Leduc, USDA Forest Service, Southern Research Station, Alexandria Forestry Center, 2012)

There are a wide variety of hand tools that can be used to plant seedlings. Selecting the correct tool is a key planning piece that aids seedling survival. Be sure to match the length of the tool with the size of the seedling being ordered. Image Credit: Owen Burney, NMSU



The Jim-Gem Dibble Bar is the recommended tool for most conditions when planting seedlings in New Mexico. Make sure that the depth of the dibble bar is slightly longer than the container of your seedling. This will ensure the hole is the correct size for planting the seedling. Image Credit: Sarah Hurteau, IBIS

Planting Tools

Using the proper planting tools to plant seedlings is more important than you might think. Using the wrong tool can leave air pockets that can kill the roots of your newly planted seedling. There are many types of planting tools used to plant trees, including shovels, hoedads, dibble bars/sticks, and plug bars. **Selection of a planting tool is based on the size and species of seedling, site conditions**, and availability. If you are not using a contractor who already owns the tools and equipment needed, you will need to order them.

Hand planting tools such as shovels and planting bars are easier and cheaper to use for landowners who aren't hiring a planting crew for their projects or for remote planting sites. The best tools for the typical upland or reforestation planting sites and seedling sizes in the Southwest are the dibble bars or dibble sticks. Hoedads and certain shovels cause too much soil disturbance during the action of planting that results in quickly drying out soils, potential air pockets, and damage to the roots of newly planted seedlings. Planting procedures with hand tools must be closely followed to ensure high survival, and proper planting technique should be prioritized over planting speed.

ACTION #12: Order Seedling Protection

24-30 months following wildfire

A newly planted seedling protected with Vexar tubing that is secured with bamboo stakes. Image Credit: Owen Burney, NMSU

Seedlings protected from animal browse using Vexar tubing. Image Credit: Owen Burney, NMSU

Seedling Protection

Without adequate protection, seedlings can end up just feeding the wildlife.

Rigid Tree Protection tubing is the most effective method to protect your newly planted seedling from animal predation. Purchase rigid tree protection tubes such as Vexar (a range of sizes from 3 to 5 inches in diameter and 24 to 48 inches in height) from a forestry supplier.

Bamboo stakes hold the rigid tree protection tube in place. Two stakes are woven on opposite sides through the tube and firmly pressed into the soil. There is no need to use zip ties to secure the tube to the stake; it just adds trash to the forest. Bamboo stakes can be purchased from a garden store or a forestry supplier.

The tubes and stakes will need to be collected in 2-3 years after the sun has caused the tubes to disintegrate. Replace as needed.

Exclusion Fencing can be cost effective when you are planting a single, large area to prevent deer, elk, or cow browsing when you have high densities of these species. Cows, elk, deer, and other browsers prefer soft, fresh leaves and stems, making young seedlings particularly tasty. A seven- to eight-foot fence is recommended for areas with elk and deer to prevent them from jumping over the top. Fencing can be removed once the seedlings have grown into saplings and are less susceptible to browsing because new shoots are above their browse height. Remove fencing after roughly five years or after trees reach approximately seven feet tall, whichever is later.

ACTION #13: Seedling Delivery and Storage Logistics

24-30 months following wildfire

Preparing For Seedling Delivery

Careful planning is needed to prepare for your seedling delivery including transportation, storage and care of seedlings before they are planted. **Seedlings can easily be stressed, damaged, and/or killed through poor handling before they get planted.**

Transporting Seedlings - Depending on how many seedlings are being purchased for the year, special transportation may need to be coordinated. The seedlings will need to be:

- Well watered before transporting them to your property. Coordinate with the nursery on your pick-up schedule and confirm before accepting seedlings.
- Covered or enclosed during delivery. Seedlings can quickly dry out or overheat in the back of trucks or trailers. A refrigerated box truck is highly recommended.
- Don't pick up more seedlings at one time from the nursery than you can safely store and plant in a timely manner.

Seedling Storage - Have a plan for where seedlings will be stored once they are delivered to your property. It may take several weeks to complete planting, so storage is an important consideration to maintain seedling viability while they are waiting to be planted.

Long-term Storage - Store well-watered seedlings in a refrigerated cooler (34 to 36°F) for no more than 2 months. Monitor soil moisture, which may require watering (try to avoid getting leaves or needles wet to prevent disease issues). If long-term storage is required but

Seedlings protected from wind damage during transport. Image Credit: Chris Marsh, UNM

On-site storage of seedlings to protect them from heat and other damaging conditions. Image Credit: Owen Burney, NMSU

ACTION #13: Seedling Delivery and Storage Logistics (continued)

24-30 months following wildfire

refrigeration is not available, plan on multiple pick-ups from the nursery. This may cost slightly more but helps preserve seedling quality.

Short-term Storage - If refrigerated coolers are not an option, well-watered seedlings should be stored in a deeply shaded, cool location (i.e., garage, cellar, etc.) and protected from freezing temperatures (ideal range is 34 to 50°F, with colder being better). Plan on no more than 2 weeks of storage under these conditions and monitor soil moisture, which may require watering (again, trying to avoid wetting leaves or needles).

On-Site Storage - Daily storage conditions at the planting site are similar to short-term storage conditions. Place trees in shaded areas (i.e., under a ventilated and covered truck bed, canopy of a tree, pop-up tent, etc.) and keep them as cool as possible. Do not plant or store seedlings on hot or freezing days, both of which can result in seedling damage or death.

Never keep seedlings from one growing season to the next. Seedlings will become root bound in their containers. Transplanting seedlings into larger containers and storing them over winter is a major undertaking that most private landowners are not prepared for. Unless you have a greenhouse on your property, winter storage is highly discouraged.

Smoky Lake Forest Nursery, Alberta. Seedlings being packaged in bundles of five in preparation for shipment. Image Credit: Owen Burney, NMSU.

Planting Activities

Don't make common planting mistakes that can kill your seedlings. Unfortunately, this is easy to do! All seedlings experience some transplant shock, but using proper planting techniques is critical to the success of seedling survival.

ACTION #14: Coordinate Planting Process

36-40 months following wildfire

Choosing, preparing, and staging sites for seedling planting will help minimize transplant damage and increase survival. Here are some general guidelines:

Choosing and Preparing Microclimate Sites for Planting

- Review your *Site Assessment Worksheet* and planning notes to select microclimate sites with favorable conditions.
- Protect areas of natural regeneration by using flagging to delineate areas that are naturally regenerating and communicate with planting crews and heavy equipment operators (e.g., loggers doing log erosion barriers, mastication, or other earth work) to avoid flagged areas.
- Work with your District Forester to determine whether existing site vegetation will need to be managed to avoid competing with seedlings for soil moisture availability, and what control method will be most effective for your specific site conditions. Each seedling should have a four-foot diameter area clear of competing vegetation. Control should be done prior to planting and can be accomplished with hand tools such as shovels, hoes, hoedads, or brush saws/mowers, or with safe and effective herbicides.

Coordinating Planting Crews

- Communicate regularly with your planting contractor to understand the logistics needed leading up to the planting date.
- If you are not hiring a planting contractor, coordinate volunteers, neighbors, family or others that may help you with planting.
- Coordinate seedling delivery and have on-site storage ready in time for outplanting crews.

Outplanting Transport and Staging

- **Handle every seedling and/or bundle of seedlings with care. Seedlings are fragile and vulnerable to damage or death during this stage.**
- Establish shade for the seedlings in the field, such as placing a reflective tarp over the seedlings. This will minimize seedling exposure to direct sunlight and prevent them from drying out.
- Thoroughly wet the seedlings in their containers 24 to 48 hours before planting.
- Seedlings may be loaded into a planting bag for more efficient planting, but don't overstuff the bag, which can cause seedling damage.

ACTION #15: Plant Seedlings

36-48 months following wildfire

There are several methods for seedling hole preparation that are dependent on the planting tool(s) selected for the planting sites. Regardless of the specific tool used, the same basic planting guidelines are the same to make sure the seedling stays in contact with soil and does not dry out.

Locating a Planting Spot

- Probe the soil with a planting bar, making sure you can get to a depth one inch deeper than the seedling's root plug. **Spots where a planting bar goes in easily provide a better chance for seedling survival and growth.**
- Avoid hard and/or rocky soil areas that may impede root growth and/or have air pockets that can dry out seedling roots.
- Planting holes must be in mineral soil and not just in ash or the duff layer (decomposing forest litter).
- Use the northern side of logs, shrubs, snags, and other physical structures to help protect the seedling from sun and wind.
- Avoid planting in standing water or rocky outcrops.

Preparing the Planting Hole

- Remove competing vegetation in a four-foot diameter surrounding each seedling's planting hole for increased soil moisture availability.
- Use the right tool for planting based on the species and size of seedlings being planted. The length of the planting bar should be slightly longer than the length of the seedling's root plug to prevent shallow planting.
- Open a planting hole at least one inch deeper than the seedling's root plug, trying to minimize soil disturbance as much as possible. Don't pull soil out and fill it back in (this is a common problem with hoedads and planting shovels).
- Do NOT mix soil with snow, grass, sticks, or rocks.
- DO NOT use fertilizers when planting seedlings in the Southwest. Fertilizing is tricky and can do more harm than good in dry soils. It's very easy to get it wrong and harm or kill the seedling.
- DO NOT use root stimulants on seedlings. They are not intended for this application and can harm or kill the seedling.
- It is not recommended to use any mycorrhizal additives as there is limited research showing their effectiveness.

Crews planting new seedlings and installing rigid protective tubing to prevent browse. Image Credit: Owen Burney, NMSU

36-48 months following wildfire

Gently squeeze the container between your thumb and pointer finger to loosen the soil. Gently pull the seedling from the container at the base of the seedling stem. Image Credit: Owen Burney, NMSU

Experimental planting at Philmont. Data were recorded on location, species, and are monitored annually to understand survival. Image Credit: NMHU

Preparing Containerized Seedlings for Planting

Remove the plastic container holding the seedling media/roots. **Remove only one seedling at a time to avoid drying out seedlings.** Squeeze the tube between your fingers to loosen the root plug from the sides of the tube. Tap the edge of the container on the handle of the planting bar if needed.

- Gently pull the seedling straight up out of the container by the base of the main stem. If the seedling resists coming out, tip the container upside down and gently pull the seedling to the side. If the root plug still cannot be extracted, cut 1/2 inch off the bottom of the tube and repeat the step above.
- Check for circling roots. Some seedling containers have vertical ribs inside the container that force the tree roots to only grow down. If the seedling container lacks these vertical ribs, check for roots that are encircling the root plug and sever those encircling more than halfway around the root plug.

ACTION #15: Plant Seedlings (continued)

36-48 months following wildfire

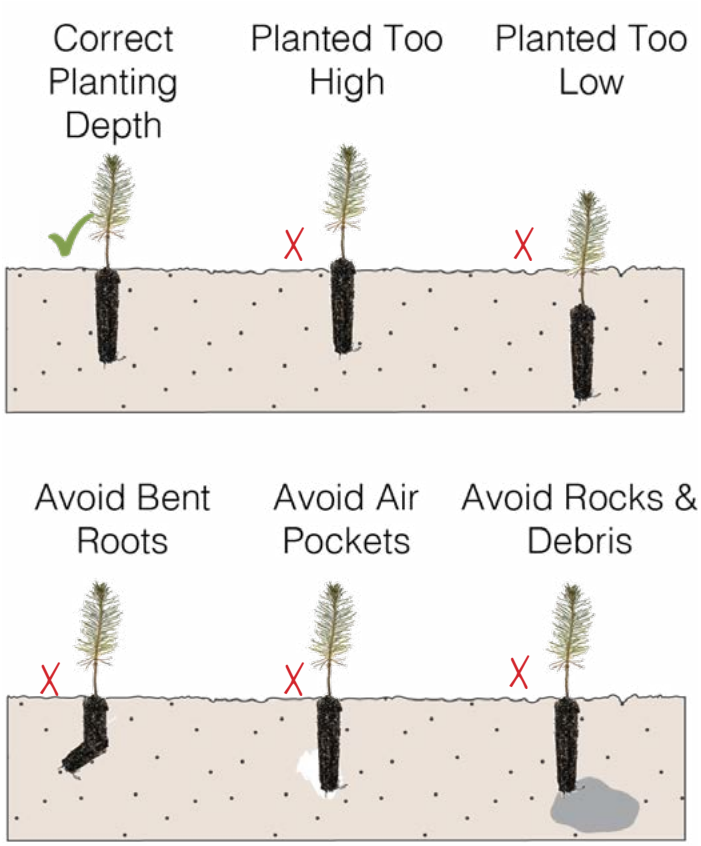
Planting the Seedling

- **Place the seedling in the planting hole with foliage straight up (not at an angle) and with the top of its root plug or root media at the surface or slightly deeper.** Planting the seedling too high exposes the roots, leaving them prone to drying out.
- Allow roots to hang naturally without turning or twisting. Do not bend the main root in a "J" or "L" shape in the planting hole.
- Gently tap around the seedling with your foot to anchor the seedling and remove air pockets.
- Test how firmly the seedling has been planted by grasping the base of the stem with the thumb and index finger and gently pulling up. A seedling should feel well-anchored in the soil and not easy to pull out.

After Seedling Planting

- Install seedling protection, being careful not to damage the seedling.
- Water seedlings immediately after planting, if possible, to help settle soil and to reduce seedling moisture stress during establishment.
- On poor or marginal sites, a thin layer of mulch or duff around newly planted seedlings will help reduce evaporation and retain soil moisture.

Seedlings often invest growth energy in roots first, so don't be surprised if you don't see much growth in the first few years.

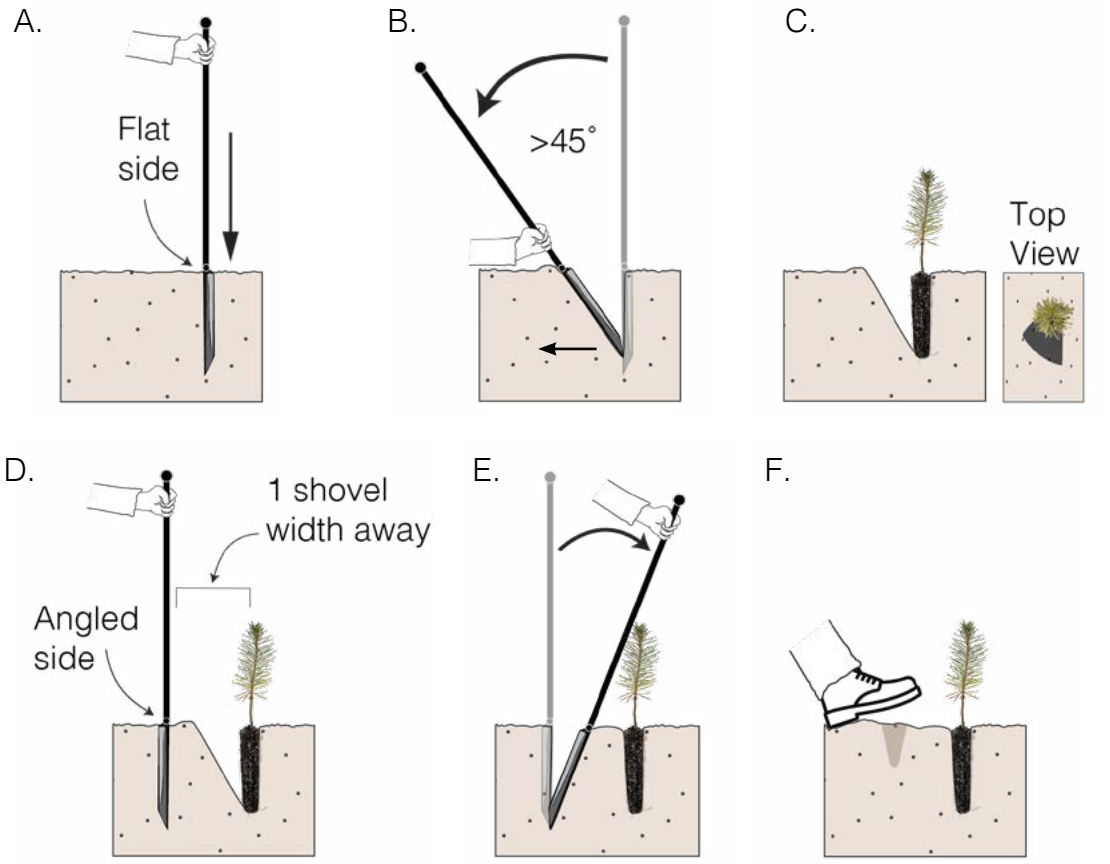


Proper planting depth of the seedling with root collar at or just below the soil level. Seedling roots must remain in contact with soil. Planting too high can expose roots, leaving them prone to drying out. Avoid bending the roots. Avoid air pockets and planting over large rocks that can limit root growth and access to water and nutrients. Image Credit: Sarah Hurteau, IBIS

Documentation

As a final step in planting, document how many seedlings were planted, year(s) planted, species, and location(s). If using a contract crew for planting, it is important to inspect planting quality and conduct spot inspection behind the crew. Make adjustments to the crew in real time if issues in planting are discovered. Keep all records, along with your *Site Assessment Worksheet*, to help monitor planting efforts and make adjustments in future years.

ACTION #15: Plant Seedlings (continued)



Planting sequence illustrating seedling planting with a planting bar, showing proper techniques to increase seedling survival. *Image Credit: Sarah Hurteau, IBIS*

A. Insert the planting bar vertically into the soil up to the pegs with the angled side facing away from you. Minimize big wiggling of the planting bar, which can create air pockets. Small side-to-side wiggles to move the planting bar down into the soil are okay. Avoid back and forth wiggles that create an hourglass-shaped hole. If you cannot get the tool into the soil up to a depth slightly longer than the seedling's root plug, find a new spot.

B. Pull the planting bar towards you past a 45° angle to break the soil. With your hand at the base of the planting bar, pull the soil back to create space at the bottom of the hole.

C. Replace the planting bar with the seedling, making sure the seedling is tucked in the corner of the hole you just created. If the seedling doesn't stand up by itself, you will need to hold it while closing the hole.

D. Insert the planting bar again up to a depth slightly longer than the seedling root plug, this time with the flat side facing away from you, and about one shovel width away from the seedling.

E. Push the planting bar towards the seedling, pushing the soil to close the planting hole. Push until just closed, do not compress the soil around the seedling (this can create an air pocket). Use the planting tool to chop the soil to fill in the new hole. BE CAREFUL not to damage the seedling in the process. If the hole is not closing well, move to the other side of the seedling and try the process again. Try to eliminate any air pockets around the seedling.

F. Tap gently with your shoe around the hole to fill in any air pockets and secure the seedling in place. You can pull up slightly on the seedling, grasping at the base to make sure it is firmly in place.

Post Planting Follow-up

A field crew monitoring survival after planting. Image Credit: NMHU

It is best practice to check in on your seedlings twice a year (spring and fall) for the first three to five years. This will give you an opportunity to see how they are doing and make corrections to protect your investment.

ACTION #16: Monitor Seedling Survival

48-72 months following wildfire

Using your record of how many tree seedlings were planted, year(s) planted, species, and location(s), count how many seedlings lived during each growing season for the first two to three growing seasons following planting. If you can't or don't want to do monitoring yourself, hire a crew to monitor your seedlings at least once a year. Monitoring information is critical for informing future efforts.

During monitoring:

» Look for tree shelter tubes/fencing that are damaged, missing, or need to be restaked or repositioned. **Remove tree shelter tubing when it starts to degrade and is no longer providing protection to the seedling (or if the seedling inside has died).**

» Remove grass or weeds that have grown up inside the tree shelter tubes and manage competing vegetation within a three- to four-foot radius in select areas. **Be extremely careful not to touch and injure your seedling or its roots when controlling vegetation.**

» Water during heat waves or drought in the first three years if possible. This will help seedlings get through those tough times when their root systems are fragile.

ACTION #16: Monitor Seedling Survival (continued)

48-72 months following wildfire

It's helpful to remember that even if you do everything right, things can still go wrong. Reforestation work is hard and unpredictable. Do the best you can with careful planning and keep these things in mind to head off any problems or seek comfort in them when your outcome isn't what you expected.

- **Planning is the best remedy for most of the common mistakes. Do NOT skip it!**
- If you have substantial failure in a planting event, try to identify the contributing factors. If you can mitigate those issues in a future planting to increase survival, it may be worth trying again. Otherwise, it might be more cost effective to try another site that has more favorable conditions.
- **Seedlings usually invest more energy into growing roots first, then start growing shoots above ground.** Be prepared for slow visible growth rates. This pattern can vary by species, so you may see different responses in different areas of your property depending on what you are planting.
- It's normal for seedlings to experience a period of transplant shock for three to five years after planting. Be patient.
- Seedlings are fragile because of their small root systems, so they have a much narrower tolerance of environmental factors that make them more vulnerable to heat and drought. **Manage expectations - there will be seedling mortality.**
- Even if you do everything right, a hot "non-soon" or severe drought can kill a huge number of seedlings. Evaluate whether the site is a good candidate for additional planting in a future season with a favorable long-range weather outlook.
- Using tree shelters (e.g., tubes) does not prevent all animal damage. Deer, elk, cows, rodents, and other wildlife are eager to try out your seedlings to see if they are tasty.
- If you are trying to reach a particular tree density, replanting or supplemental planting in the years following should be expected.

Field crew members learning proper seedling handling and planting techniques at a training. Image Credit: NMHU

APPENDIX A: Connecting to Other Resources

There are many resources that are available to support landowners with reforestation. The following organizations and programs may be able to support landowners with funding, educational opportunities, information on contractors, seedling sourcing, and much more.

Landowners considering reforestation should speak with a tax advisor to explore the tax incentives and benefits available for reforestation projects. Visit the National Timber Tax website to learn more: https://www.timbertax.org/getstarted/reforestation/

NM Forestry Division (NMFD)

The NMFD has six District offices throughout the state that provide comprehensive technical assistance, including site visits to private landowners for identifying forest health issues, aiding in species selection for reforestation, and developing written management plans for critical restoration and wildfire mitigation. District staff partner with landowners and fire departments on forest conservation practices to deliver essential: fire training, manage wildland fire suppression, and ensure compliance with harvesting regulations, all aimed at fostering healthy, resilient forests and watersheds statewide.

Links to website and other helpful documents

- Reforestation - Forestry
- Tree Farm Program - Forestry
- Technical Assistance for Landowners - Forestry
- Conservation Seedling Program - Forestry:

  The Forestry Division offers **low-cost seedlings** to landowners for reforestation, erosion control, and wildlife habitat improvement, among other benefits like climate change mitigation. For further details including ordering windows and species availability, please visit the Conservation Seedling Program website.

Natural Resources Conservation Service (NRCS)

The NRCS provides support to farmers, ranchers and forest land owners to increase conservation practices across America's working lands.

- Environmental Quality Incentives Program (EQIP)
- Web Soil Survey App

New Mexico Reforestation Center (NMRC)

The NMRC is a collaborative project between the New Mexico Forestry Division (NMFD), New Mexico State University (NMSU), University of New Mexico (UNM), and New Mexico Highlands University (NMHU).

The purpose of the NMRC is to increase the production and availability of regionally appropriate seedlings that can be used to reforest the southwestern landscapes following wildfire. Currently most seedlings in the western US are grown in Idaho, Oregon, and Washington and are not well adapted to the desert Southwest's hot and dry conditions. In New Mexico, the John T. Harrington Research Center is our only large-scale supplier of seedlings. Their maximum production capacity is around 300,000 seedlings each year. It is estimated that New Mexico needs approximately 5 million seedlings each year to reforest the areas that have been lost to fire and aren't naturally regenerating. This leaves an enormous gap between supply and demand.

The NMRC has been able to secure $42 million dollars in state and federal funding as of 2025 to begin building 2 of the 5 greenhouses planned. They have acquired an architectural design, and a portion of the facility can be constructed with existing funds, with seedling production anticipated to begin in 2028.

APPENDIX B: Site Assessment Worksheet

Depending on the size of your property and the extent of the area burned, this may take several trips to complete for your entire property. Bring multiple copies of this worksheet with you in the field if you have multiple locations. Create unique site names or numbers so you can record the following information for each area. A *Summary Table* is available at the end of this worksheet, that may be helpful if you have multiple locations you are mapping.

Helpful Hint: *Bring a property map or topographic map with you in the field, that you can mark up while completing this site assessment worksheet. Collect information for each category for the site before moving to the next location.*

Scale

- ☐ How big of an area burned? _____ acres
  - ☐ Is it a contiguous patch? Or many smaller patches?
  - ☐ How big of an area are you considering reforesting?
    - ☐ Less than 5 acres
    - ☐ 5-10 acres
    - ☐ 10-100 acres
    - ☐ More than 100 acres
  - ☐ Can you split your site into smaller more manageable areas based on natural boundaries or edges? Note potential boundaries like ridges, valleys, roads, fencelines, etc.

    _____

    _____
  - ☐ Other challenges you see? _____

    _____

Forest Type

Make a note of what forest types were present before the fire and where they are on the property.

- ☐ Pinion Juniper _____
- ☐ Ponderosa Pine _____
- ☐ Oak Woodland _____
- ☐ Mixed Conifer _____
- ☐ Spruce Fir _____
- ☐ Aspen _____
- ☐ Riparian _____
- ☐ Other _____

Living Vegetation

- ☐ Are there areas that burned but still have living trees, shrubs or other plants? Where?

  _____

- ☐ Are there areas that are naturally regenerating? Where?

  _____

- ☐ Are there areas that you can exclude from planting because there are living mature trees that can serve as a seed source for natural regeneration? Where? _____

  _____

Soil Types & Depth

Use the Natural Resource Conservation Service Web Soil Survey Viewer to map your soil types:

- ☐ Are your soils:
  - ☐ Shallow
  - ☐ Moderate
  - ☐ Deep
- ☐ What does the soil look like in burned areas?
  - ☐ Dry ash
  - ☐ Pumice
  - ☐ Soil with some plant litter mixed in or on top

Elevation, Topography & Microclimates

What is the approximate elevation range of your property?

Locate the following topographic features that may influence if and where you might plant:

- ☐ Valley bottoms _____
- ☐ Hillsides _____ Aspect _____
- ☐ Rocky areas _____ Aspect _____
- ☐ Ridgetops _____
- ☐ Steep slopes _____ Aspect _____

- ☐ Do you have seeps, springs, creeks, or streams on your property? _____
- ☐ Are there swales, depressions, or shallow basins where water might collect? _____
- ☐ Do you see puddles or moist areas 2-3 days after rain events? _____
- ☐ Do you see evidence of flowing water? _____

- ☐ Are there areas of green vegetation surrounded by otherwise dry or blackened soils? _____
- ☐ Do you see dew or fog drip on vegetation in the mornings? _____
- ☐ Are there down logs, large rocks or stumps that might collect water or shade seedlings? ____

  _____

Animal Browse

- [ ] Do you see recent animal browse such as nipped branch ends at an angle or a uniform browse line on trees and shrubs? _____

_____

- [ ] Do you know of travel corridors for wildlife across your property? _____

_____

- [ ] Do cows graze on your property? _____

New Disturbance Patterns

- [ ] Is there windthrow (trees uprooted or snapped from wind events)? Where? _____

_____

- [ ] Is there evidence of erosion starting to occur? Look for narrow channels carved into the soil from flowing water, larger gullies forming, or accumulated soils and debris at the bottom of slopes, ditches, or streambeds.

_____

_____

Other Notes:

Sites Assessment Worksheet Summary Table

Site ID	GPS Coordinates	Elevation	Forest Type	Approx Size (acres)	Site Attributes*	✓Promising Planting Sites

*Site Attributes: Living Vegetation/Natural Regeneration, Soil Types and Depth, Topography, Microclimates/Water, Animal Browse, Disturbance Patterns