Forestry and Tree Planting in New Mexico

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Abstract

New Mexico's varied climate and geography, coupled with its deep sociocultural background provide a rich and dramatic backstory to its present day position in the forest industry. Resource extraction during the mid-19th century negatively impacted forests and woodlands near settlements in response to growing railroads, mining operations, and ranches. In the 1940s, fire suppression efforts were established to protect the ever-growing timber industry that was feeding the post World War (WW) II housing boom. With these suppression efforts, fuel densities have reached extremely hazardous conditions in many of New Mexico's forests. Combined with severe drought conditions, these dense forests have been burning at catastrophic levels in recent years. In response to both harvest activities and fire restoration efforts, reforestation became a new focus in New Mexico in the 1970s. The John T. Harrington Forestry Research Center, an Agricultural Experimental Station of New Mexico State University, opened in 1972 as part of a State legislative act to improve forest productivity and reforestation success. In 1995, the listing of a federally endangered species, the Mexican spotted owl (*Strix occidentalis*), halted timber production and thus redirected reforestation efforts to that of post-fire restoration. Pressures from tourism, recreation, drought, and increasingly large wildland fires place new demands on the New Mexico landscape. Looking to the future, reforestation and restoration efforts will provide new challenges for New Mexico's nurseries, while increasing forest densities beg the question whether an economically viable timber industry will make a comeback.

Climatic and Geographic Variation

New Mexico varies widely in climate and geography. The highest point, Wheeler Peak at 13,159 ft (4,011 m) above sea level, is located in northern New Mexico's Sangre de Cristo Range, at the southern end of the Rocky Mountains. The lowest point in New Mexico, 2,841 ft (866 m), is at the northern end of the Red Bluff Reservoir on the Pecos River. The mean elevation of the State is 5,698 ft (1,737 m) above sea level, ranking New Mexico as the fourth highest elevation State in the United States (New Mexico Base and Elevation Maps 2013). The dominant soil order across the State is aridisol, although entisols and mollisols are common as well (Soil Survey 2013).

The climate of New Mexico is dry, continental (Sheppard and others 1999, New Mexico Climate Center 2008), with cold, dry winters, and warm, moist summers. Temperatures can vary from 20 to 50 °F (11 to 28 °C) during a day. Western mountain slopes and the northwestern New Mexico area tend to get greater precipitation than eastern portions of the State that are in the rain shadows of mountain ranges. Higher elevations across the State tend to receive more precipitation than do lower elevation areas (figure 1). Winter storms bring snow pack to the mountains, which most people in the Southwest depend on for their water. Winter and spring storms provide the moisture that is most used by woody vegetation in New Mexico (Williams and Ehleringer 2000, West and others 2008);

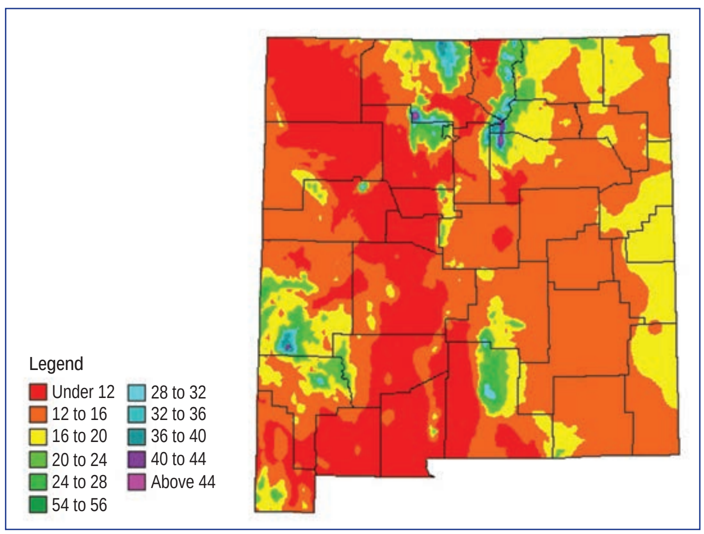

Figure 1. New Mexico annual precipitation in inches per year (1961–1990). (Adapted from Weisburg 1997)

however, late summer monsoon moisture is also important. The greatest proportion of annual precipitation occurs during the monsoon period (early July through mid-September) in high-intensity downpours from thunderstorms (Williams and Ehleringer 2000, New Mexico Climate Center 2008). Solar radiation is intense, especially in the summer; each year, many more days are sunny than have overcast weather throughout the State.

Droughts are common in semiarid New Mexico, and the State often has significantly greater evaporative demand than precipitation. The driest time of the year, based on greatest evaporative demand, is in May and June at the end of the relatively droughty winter and spring seasons. A long dry period developed between 1943 and 1971 resulting in a severe drought in the mid-1950s. Drought is a selective pressure that affects some species more than others (McDowell and others 2008). The 1950s drought resulted in extensive die-off of many vegetation types (Betancourt and others 1993) and increased the lower elevation limit of ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) in Bandelier National Monument (Allen and Breshears 1998). Pinyon pine (*P. edulis* Engelm.) and juniper (*Juniperus* spp.) dieoff was marked over the landscape during the 1950s drought as well (Potter 1957, Betancourt and others 1993). A new drought is causing widespread mortality at the lower elevation limits of tree ranges and in relatively high-density stands.

Land Area and Ownership

New Mexico is the fifth largest State in the Union at approximately 77.5 million ac (31.4 million ha). Of this total land area, 21 percent is covered by forest lands defined as areas in which 10 percent or more of that land is occupied by tree species. Forest lands can be further broken down into woodlands (e.g., pinyon pine, Gambel oak [*Quercus gambelii* Nutt.], and juniper) and timberlands (e.g., ponderosa pine and Douglas-fir [*Psuedotsuga menziesii* (Mirb.) Franco]), occupying 15 and 6 percent of New Mexico's total land area, respectively. The largest ownership of forest lands in New Mexico is the U.S. Department of Agriculture (USDA), Forest Service, which administers approximately 48 percent of all forest lands. Private landowners, which include tribal trust lands, are the second largest with 38 percent forest land ownership. The remaining forest lands are owned and managed by U.S. Department of the Interior (USDI), Bureau of Land Management (BLM) (7 percent); the State of New Mexico (5 percent); and other public sources (2 percent). Across all ownership types, approximately 10 percent of forest lands are in reserve status, which includes wilderness areas and national parks (O'Brien 2003).

Forest Types

Forest lands of New Mexico are classified by forest types based on the predominant tree species in a stand (figure 2). O'Brien (2003) describes in detail the distribution of forest types throughout the State. Distribution of forest types is primarily a function of precipitation and evaporative demand. At the lower elevations, approximately 53 percent of forest lands are classified as pinyon-juniper. A rise in elevation (6,000 to 8,500 ft [1,830 to 2,590 m]) results in a forest type shift to ponderosa pine that makes up 17 percent of the total forest lands. In this forest type, ponderosa pine is the predominant species but Douglas-fir, Gambel oak, and pinyon pine also occur. Douglas-fir is the next forest type at an elevation range of 8,000 to 9,500 ft (2,438 to 2,895 m) and includes Douglas-fir, ponderosa pine, white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr), and aspen (*Populus tremuloides* Michx.), all of which make up 6 percent of the total forest lands. In the elevation range of 8,000 to 11,000 ft (2,438 to 3,350 m), the white fir forest type (3 percent of forest lands) exists in association with Douglas-fir, aspen, and ponderosa pine. At the highest elevation ranges (above 9,000 ft [2,743 m] to timberline), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) and subalpine fir (*A. lasiocarpa* (Hook.) Nutt.) dominate the spruce-fir forest type (2 percent of forest lands). The spruce-fir forest type typically has a longer life span (500 to 600 years) compared with the lower elevation forest types because of fewer natural disturbances, such as fire (Battaglia and Shepperd 2007).

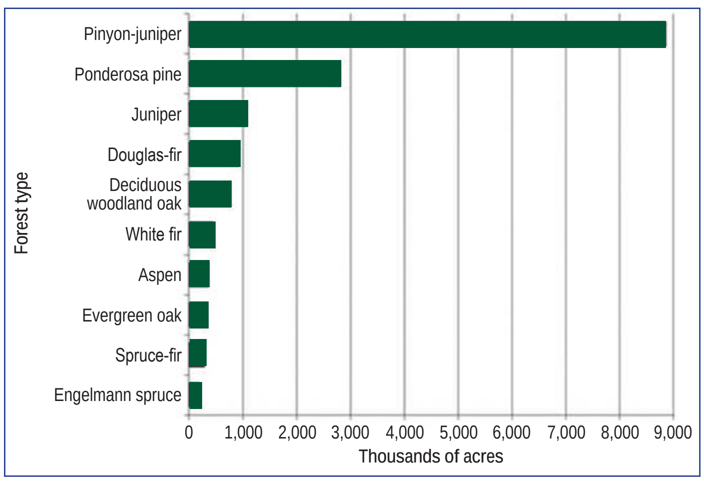

Figure 2. Area of land by forest type. (Adapted from O'Brien 2003)

History of New Mexico's Forests

The first contact between Europeans and New Mexico was the Coronado Expedition in 1540. Colonists introduced horses, burros, cattle, sheep, and goats as well as new crops (Scurlock 1998). New Mexico became a U.S. territory in 1850 after a military takeover in 1846 during the Mexican-American War. The increase in trade with the United States via the Santa Fe Trail and later the railroads (1872) brought new technologies that greatly improved efficiency in resource extraction. Large-diameter trees could be efficiently felled and bucked with cross-cut steel saws, and steam engines powered lumber mills and increased access to wider markets by railroad. Railroad grades for timber extraction were built through the Sacramento and Jemez Mountains. Extensive areas of forest lands near settlements and railroad lines were harvested for both fuelwood and construction materials. Timber stands were high graded, leaving a few unhealthy or defective trees to regenerate stands. Harvested sites were thereafter grazed and browsed by livestock. Large populations of livestock on open ranges overused grasslands, shrublands, woodlands, and forest lands, which resulted in extensive erosion and shifts of grasslands to shrublands and woodlands (Dick-Peddie 1993). New Mexico became a State in 1912 and national forests were created in 1915. National forests brought a scientific, inventory perspective to timber usage and silviculture, which was originally devised for distant and more productive ecosystems. Transportation and saws powered by internal combustion engines expanded roads and timber harvests into new, remote areas. Upon recognition that wildlands were disappearing, Congress created the first designated wilderness area, the Gila in southwest New Mexico. The conversion of common lands, traditionally used by Indian and Hispanic villagers, to Federal control remains controversial to some to this day.

The Forest Conservation Commission was established in 1957 to address fire protection on State and private land. The commission later became the New Mexico State Forestry Division (hereafter, the Forestry Division), which is now part of the Energy, Minerals, and Natural Resources Department. The Forestry Division's mission has expanded to include timber management and conservation efforts. The Forestry Division's role includes technical forestry assistance to private and State landowners, conservation of forest lands through easements, encouragement of forest industries, inmate forestry work programs, heritage of native plants, and many other programs that support healthy ecosystems in New Mexico. The Forestry Division places the importance of proper watershed management as a top priority to achieve overall ecosystem health. To achieve this goal, the Forestry Division has taken a leadership role in crafting collaborative efforts with local, State, Federal, and tribal agencies, as well as private landowners, businesses, and nongovernmental organizations (Tudor, personal communication 2013).

Fire Suppression and Fire Ecology in New Mexico

In light of antifire feelings fueled by World War II, a campaign (Cooperative Forest Fire Prevention Campaign) was launched to reduce wildland fire risk, part of which was to urge people to be more careful with fire. In 1944, Walt Disney allowed the Fire Prevention Campaign to use Bambi on one of its posters for 1 year. After Bambi's reign on the poster, the campaign chose Smokey Bear as the national symbol for fire prevention. The first Smokey Bear poster appeared in 1944, and since then Smokey has become a national symbol (Thomas and McAlpine 2010). The living symbol of Smokey Bear was an American black bear cub that was caught in the Capitan Gap fire in 1950, which burned 17,000 ac (6,979 ha) in the Capitan Mountains of New Mexico on the Lincoln National Forest. Smokey had climbed a tree to escape the blaze, but his paws and hind legs had been burned. He was rescued by firefighters and was rehabilitated, becoming the living legend of Smokey. The two icons, Bambi and, particularly, Smokey Bear, have saved timber worth more than $17 billion in the National Park System alone (Ling and Storer 1990).

Smokey's message is as relevant as ever; nonetheless, fire ecologists have urged managers and the public to understand the importance of fire as a critical ecological process. Particularly in the ponderosa pine forests of New Mexico and the Southwestern United States, fire suppression has led to increased fuel densities (Covington and Moore 1994). Forests that would have been historically cleared by frequent, low-severity surface fires are now overcrowded and contain high levels of hazardous fuels that contribute to catastrophic fire events (figure 3). Like most of the United States, New Mexico has seen an increase in the area burned in wildland fire during the past 10 years. The State experienced wildfire on approximately 73,000 ac (29,542 ha) per year from 1990 to 2000. From 2002 through 2012, New Mexico burned an average of 416,000 ac (168,349 ha) (NIFC 2013); this fivefold increase occurred in only two decades. In 2011 alone, 1,286,487 ac (520,622 ha) of New Mexico burned; contained in that acreage was the Las Conchas fire (156,293 ac [63,249 ha]), now the second largest fire in the history of New Mexico, surpassed only by the White Water Baldy Fire (297,845 ac [120,533 ha]) of 2012.

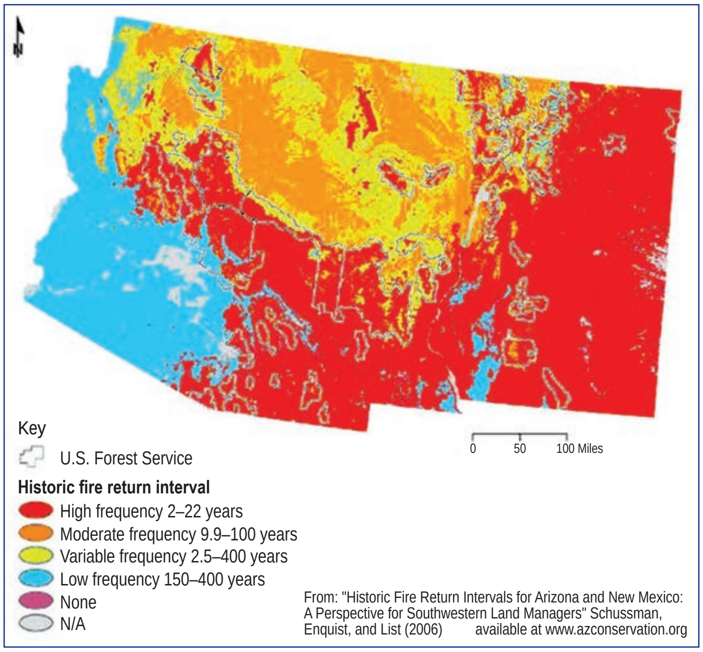

Figure 3. Historical fire frequency for Arizona and New Mexico. Most of New Mexico's forests were historically cleared out by very frequent, low-severity surface fires. This low-severity fire regime has been replaced by catastrophic fire events. (Schussman et al. 2006)

Current State of New Mexico's Forests

New Mexico's forests currently have increasing demands placed on them from recreation, tourism, and scattered urban and rural development. The population of the Southwest has grown tremendously during the past few decades, placing greater demands on recreational opportunities. Since 1965, the USDA Forest Service system lands have seen a fourfold increase in recreation-visitor-days (Dahms and Geils 1997). With the expanded growth in human population, water requirements continue to strap an already limited resource. Other significant forest demands are because of grazing and mining interests. New Mexico's forests experienced light grazing pressure in the 1800s and severe pressure in the first few decades of the twentieth century. Attempts are being made to balance number of livestock with the land's grazing capacity. The number of range cattle and sheep in New Mexico peaked during or shortly after World War I and have since declined. Around 1920, range cattle numbered approximately 1.6 million in New Mexico and have since dropped to 1.2 million head. Sheep populations have also experienced a decline from 2.3 million head to 0.2 million (Dahms and Geils 1997). Scattered urban development divides forest and woodlands into small parcels under diverse management paradigms. Homesteads increase the complexities and difficulties in managing wildfires.

After WWII, strong housing markets and public policy increased timber harvests on national forests lands. Timber harvest in New Mexico increased from about 150 million board feet (MMBF) annually to a peak of nearly 300 MMBF in the late 1960s. Harvest dropped in the 1970s and 1980s, with the late 1980s averaging about 190 MMBF annually. Since the late 1980s, New Mexico's timber harvest has declined dramatically. The greatest decline in timber harvesting has been on private and tribal lands (-53 MMBF Scribner). Further declines have been caused largely by decreases in harvests from national forests. New Mexico's national forest timber harvest has followed a pattern similar to that of many Western States. Harvest levels on national forest lands declined in the early 1990s, because of a combination of pressures related to threatened and endangered species and appeals and litigation directed at Federal timber sales (Keegan and others 1995a, 1995b; Keegan and others 1997; Warren 1999). In New Mexico, the listing of the Mexican spotted owl (*Strix occidentalis*) had a profound downward impact on national forest timber harvest levels. The Mexican spotted owl was listed as threatened by the U.S. Fish and Wildlife Service in March 1993. In August 1995, a Federal judge prohibited the logging of new timber sales on national forests in New Mexico pending development of a recovery plan for the owl (*Silver* v. *Babbitt* 1995). This injunction remained in place until December 1996. The lifting of the injunction resulted in small increases in national forest timber harvests in subsequent years. Overall timber harvests in 1997, 2002, and 2007 were 97, 74, and 39 MMBF Scribner, respectively. Most current harvests are for sawlogs. In 2007, ponderosa pine and Douglas-fir accounted for 47 and 25 percent, respectively, of the State's timber harvest. Value of timber products from New Mexico in 2007 was $25.6 million.

Forest Regeneration and Nurseries

Before 1995, most tree planting programs in New Mexico were aimed to reforest areas harvested for timber on public and private (mainly tribal) lands with an additional focus on fire restoration. After the listing of the Mexican spotted owl as a threatened and endangered species, however, timber harvests on national forests in the Southwest nearly halted (Kosek 2006). Many forest industry operations, such as the Vallecitos mill owned by Duke City Lumber, closed down in response to the significant decrease in wood supply (Forrest 2001). Because of the lack of industry, the current state of tree planting has shifted away from reforestation efforts and toward restoring those forest lands severely damaged from catastrophic wildfires (figure 4). Burned sites that are not quickly revegetated are vulnerable to significant issues with flooding and erosion.


Figure 4. Las Conchas fire of 2011 burning 156,593 ac (63,371 ha) in New Mexico, the second largest forest fire in the State's history. (Photo by Tammy Parsons, New Mexico State University 2011)

Early reforestation programs (until the 1970s) in New Mexico acquired bareroot seedlings from out of State. Seed source was not an ecological concern at that time, which in combination with long-distance shipping, hindered much of the reforestation efforts. This hindrance quickly changed with the introduction of the first forest nursery and research center in Mora, NM. New Mexico State University (NMSU) opened the Agricultural Research Station in Mora in 1972 as part of a State legislative act to improve forest productivity and reforestation success, principally on State and private lands. The mission of the station was to conduct research on tree improvement, nursery operations, forest regeneration, and other areas of forestry. The greenhouse nursery was constructed in 1976 and began producing seedlings in Spencer-Lemaire "root trainers" containers. Container types have changed multiple times in response to research developments and new technology. Since the spring of 1980, more than 2.5 million seedlings have been produced generating approximately $1.3 million in sales. Ponderosa pine and Douglas-fir are the dominant species produced at the Mora nursery. The Mora nursery currently grows more than 125,000 seedlings annually of more than 25 different species, both conifers and hardwoods, in Ray Leach SC10 containers (figure 5). Seedlings are sold via large contracts to forestry division and tribal lands. Use of local seed sources and improved nursery and outplanting techniques has resulted in dramatically improved survival of distributed conifer seedlings from 15 to 80 percent (Fisher, personal communication 2013). In 1993, the Mora program was placed in the hands of Dr. John Harrington and new directions were followed as research opportunities surfaced. His innovative progress as a researcher, professor, and station superintendent distinguished his career. After his death in 2011, the Mora Research Center was renamed the "John T. Harrington Forestry Research Center" to honor his contributions.

The second forest nursery to open in New Mexico was operated by the USDA Forest Service in Albuquerque from 1977 to 1990. It was primarily a bareroot nursery with production rates up to 3 million seedlings per year. In addition to the bareroot seedling production, a greenhouse facility existed on site capable of producing approximately 20,000 containerized seedlings. The nursery also featured a seed extractory and a large seed storage freezer where all the USDA Forest Service Southwestern Region seedbank was stored. Most seedlings produced were ponderosa pine with a minor component of Engelmann spruce and Douglas-fir. These seedlings mainly went to Federal restoration and reforestation efforts within the region. Poor site conditions and technical problems (such as high soil pH and lime-induced chlorosis) greatly hampered production and Federal customers began to purchase containerized seedlings from private sources. In addition, demands from national forests in the Southwestern Region were much lower than originally estimated. As a result of these issues, the nursery closed in 1990 and the remaining seed from the seedbank was moved to the USDA Forest Service Lucky Peak Nursery in Boise, ID, where it remains today (Hinz, personal communication 2013). In addition to the closing of these two nurseries, a few private and tribal nurseries have come and gone since the Mora nursery was established. The most notable nurseries that are currently, or were very recently, in operation include Riparian Restoration Technologies (subsidiary of Plant Propagation Technologies in Las Cruces, NM), Johnson Enterprises (Cuervo, NM), Mescalero Apache Tribe (Mescalero, NM), and the Pueblo of Zuni (Zuni, NM).

Seedlings produced by tribal lands are typically used only on their own land for fire restoration, reforestation, and riparian restoration. A large portion of the seedlings produced from NMSU's Mora nursery are sold to tribal communities to supplement the seedlings that they have either grown in their own nursery or acquired from other nurseries. The Mora nursery also produces most of the seedlings for the New Mexico State Forestry Conservation Seedling Program, which offers low-cost seedlings to landowners for a variety of purposes including reforestation, fire restoration, erosion control, windbreaks, and Christmas tree plantations. In addition, the program purchases bareroot seedlings from the Colorado State Nursery (Fort Collins, CO) and containerized seedlings from Riparian Restoration Technologies and Johnson Enterprises.

Figure 5. Ponderosa pine seedlings grown in Ray Leach SC10 containers at the John T Harrington Forestry Research Center in Mora, NM. (Photo by Jane Moorman, New Mexico State University 2012)

Tree Improvement Program

In 1977, the New Mexico Cooperative Tree Improvement Program was approved by the USDA Forest Service Southwestern Region to implement the tree improvement and forestation plan submitted by New Mexico State Forestry. In 1978, the State of New Mexico tasked both the New Mexico Forestry Division and NMSU's Forestry Research Center in Mora to implement the Tree Improvement Program (Harrington and others 1996). The overall goal of this program was to partially address the decline in forest industry and productivity observed on New Mexico's State and private lands over previous decades. Owing to overexploitation and fire, more than 100,000 ac (40,468 ha) of forest land were considered unstocked or understocked in 1978, often with natural regeneration dependent upon remnant inferior seed trees because of high-grading logging practices.

A specific program goal was to develop genetically improved seed and planting stock for three main species (ponderosa pine, Douglas-fir, and Engelmann spruce) for both State and private lands. Traits targeted for improvement included survival, growth rate, and tree form. Other native conifer and hardwood species are open for consideration to be included in the tree improvement program, although they are not specifically addressed. Progress to date includes identifying stands with superior trees, collecting seed from these superior trees, establishing multiple progeny and provenance tests, conducting research on drought tolerance, and establishing the first seed orchards in the State (figure 6).

Future Directions

Looking to a future of changing climatic conditions and potentially more catastrophic fires, restoration and reforestation efforts will need to address new and increasing challenges. The federally funded Burned Area Emergency Response (BAER) program is designed to address large fire effects through implementing emergency treatments on Federal

Figure 6. Seed orchard converted from a progeny test of ponderosa pine planted in 1979 in Mora, NM. (Photo by Robert Heyduck, New Mexico State University 2013)

lands to minimize threats to life or property or to stabilize and prevent unacceptable degradation to natural and cultural resources. Some of the more common post-fire stabilization techniques that BAER teams recommend are reseeding of ground cover with quick-growing or native species (USDA 2013). The BAER team that treated the Las Conchas fire area on the Santa Fe National Forest seeded 5,200 ac (2,104 ha) with native grass seed (approximately 33 lb per ac [37 kg per ha]) and used aerial mulching techniques on another 1,100 ac (445 ha) (InciWeb 2013). Nearly 500,000 Douglas-fir seedlings were also planted on approximately 2,000 ac (809 ha) near popular recreation areas (Los Alamos Daily Post 2013).

Most current tree planting efforts in the State are aimed to restore areas after severe forest fires, which produce a harsh, dry, and nutrient poor environment for planting seedlings (Harrington and others 1996). Thus, a new direction for the Tree Improvement program will be to focus research efforts on heat and drought tolerance given the issues with survival on these harsh site conditions. In addition, it will be important to establish more accurate seed zones for primary tree species to be used for creating seed transfer guidelines. Based on the combination of improved seed source selections and seed zones, a seed bank will be established to conserve these specific genotypes for moderately long-term storage.

With the ever-increasing forest densities of New Mexico's ponderosa pine forests, it is critical to find an economical means to thin these forests to protect them from catastrophic fire events. A new forest industry must emerge to capture these small diameter resources. Many monetary and political obstacles need to be overcome to reestablish the forest industry in New Mexico. Most of the forest lands in need of thinning, however, are owned by the USDA Forest Service; timber harvests on Federal lands have been significantly limited because of changes in management strategies and environmental litigation. If the Federal Government opens more harvesting options in New Mexico, it may attract forest product businesses to the State and promote healthy forests and a strong forest industry.

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