

FIVE-NEEDLE WHITE PINE CONSERVATION ON THE SANTA FE NATIONAL FOREST

Introduction

The National Forest Management Act (NFMA) requires that the Forest Service adopt guidelines for the management of national forests that “provide for diversity of plant and animal communities.” Trees are singled out in NFMA which directs that “steps to be taken to preserve the diversity of tree species.” 16 U.S.C. §1604(g)(3)(B).¹

Tree diversity is also emphasized in the 2012 Planning Rule by requiring that plans maintain or restore “the diversity of native tree species similar to that existing in the plan area.” 36 CFR 219.9(a)(2)(iii). The Planning Rule also requires the use of the best available science to inform the planning process. 36 C.F.R. § 219.3.

In implementing NFMA’s diversity mandate more generally, “genetic diversity within species in ecosystems” is given prominence as a key element in the adaptive capacity of ecosystems to respond to disturbances and stressors. Forest Service Land Management Planning Handbook 1909.12.05.

Despite the recommendations of expert Forest Service pathologists and researchers,² the Santa Fe National Forest Land Management Plan (revised plan) does not acknowledge the unique diversity of the white pine complex, recognize multiple threats or propose binding measures to enhance and maintain their populations. As a result, fuel reduction targets are proposed that eliminate white pines from vast stretches of the landscape. Other threats include the recent appearance on the Santa Fe National Forest (SFNF) of a century-old exotic rust, potential bark beetle outbreaks, a history of mismanaged fire and most significantly a rapidly warming and drying climate. The revised plan does not take a hard look at these cumulative threats or, while it is still possible, propose proactive strategies to conserve a diverse germ plasm needed to confront the dual threats of climate disruption and exotic disease. This failure violates NFMA’s mandate to preserve diversity in general and tree diversity in particular.

This objection to the revised plan is being filed because the agency has not taken the appropriate steps to address the gravity of threats facing white pines on the SFNF. The revised plan and the four volume Final Environmental Impact Statement (FEIS) makes only passing reference to white pines or white pine blister rust. There is nothing about the impacts of widespread clearing

¹ As revealed in its legislative history, the intent of the diversity mandate is to limit timber production and elevate wildlife as a co-equal factor in forest management (Wilkinson and Anderson, 1985:296).

² “The desirability of maintaining and enhancing white pine populations should be addressed in revisions to National Forest plans.” Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01

and burning to the white pine genetic diversity needed to adapt to the rapidly warming and drying climate.

In response to our earlier comments, the revised plan added to its *desired condition for native biota*: “Habitats and refugia for rare, endemic, and culturally important species, are resilient to stressors and support species' persistence or recovery.”

A specific and measurable planning objective was not proposed to enforce this desire condition. Refugia is not defined or mentioned elsewhere in the revised plan. Absent is a criteria for designation and management of habitats and/or refugia for native biota. It is also unclear under what legal authority such protected zones could be established and whether habitats and/or refugia have enforceable protected status. The desired condition by itself, while laudable, is but a vague aspiration and clearly not a sufficient regulatory mechanism.³

Areas cannot achieve lasting protection without first providing basic information on the status and threats to the white pine ecosystem. The lack of basic information in this case violates a key tenet of NEPA which requires “that environmental information is available to public officials and citizens before decisions are made and before actions are taken.” 40 C.F.R. § 1500.1(b).

In 2009 the Santa Fe Municipal Watershed 20 Year Protection Plan recommended that the self-sustaining southwestern white pine population be protected during on-going maintenance activities, including intentional burning (Margolis and Savage 2009).⁴ On December 21, 2018 we notified the SFNF Supervisor that thousand of white pines were being cut and piled for burning on the hillsides above Black Canyon adjacent to the watershed. There was no response.

As a bulwark against the perils that lie ahead, the revised plan should seriously consider the proactive strategy suggested by its own experts as the best available science to preserve the SFNF’s white pines (see below). It is long past time to begin for such an effort.

Natural History and Biology

The three species of five-needle white pines found on the SFNF are limber pine (*Pinus flexilis*), southwestern white pine (*P. strobiformis*) and Rocky Mountain bristlecone pine (*P. aristata*).⁵

³ Vague, voluntary, speculative and unenforceable measures are not considered sufficient regulatory mechanisms. See, e.g., Oregon Natural Resources Council v Daley, 6. F Supp. 2d. 139, 1153-56, 29 ELR. 20514 (D. Ore 1998) .

⁴ A 2009 Forest Service research publication praised thinning in the Santa Fe Municipal Watershed where white pines were proposed for protection. Unfortunately, retention of white pines was never broadly implemented in the watershed. See Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01, p. 10.

⁵ Family Pinaceae, Genus *Pinus*, Subgenus *Strobus*. Subgenus *Strobus* has been split into two sections, *Parrya* and *Quinquefoliae*. Rocky Mountain bristlecone pine is in section *Parrya*. Limber pine and southwestern white pine are both within section *Quinquefoliae*. Five-needle pines are so named because they have five needle per fascicle.

They uniquely commingle on the SFNF at or near the limits of their geographical ranges. Northern New Mexico and Arizona and southern Utah and Colorado are the *northern* limit of the southwestern white pine population (Andresen and Steinhoff 1971).⁶ In contrast, limber pine reaches its *southern* limit in northern New Mexico.⁷ These two closely related species interbreed on the SFNF to form a unique hybrid zone that extends into southern Colorado (Benkman et al. 1984; Samano and Tomback 2003).⁸ In addition, the southern limit of Rocky Mountain bristlecone pine occurs on the Sangre de Cristo section of the SFNF.⁹

Both limber pine and Rocky Mountain bristlecone pine tolerate harsh, wind-swept sites at treeline and can be of great age.¹⁰ Limber pine is patchily distributed in western North America ranging from 2,250 ft to 12,500 ft (Schoettle et al. 2019). At high elevation sites it often grows with Rocky Mountain bristlecone pine. The range of southwestern white pine extends into the high elevations but also occurs as tall and full-crowned old-growth trees on favorable sites in the SFNF.

These five-needle white pine species and their hybrids provide vital ecosystem services on the SFNF. Occurring at treeline where other conifers are absent, their shade and shelter delays snow melt thus protracting downstream flow (LaMarche and Mooney 1972; Arno and Hammerly 1984; Bunn et al. 2005) and their root systems stabilize the loose, shallow, rocky substrates at high elevation, reducing erosion (Arno and Hammerly 1984; Farnes 1990). Their nutritious seeds are eaten by a diversity of wildlife including squirrels, bears, birds and other rodents. Iconic high-elevation five-needle pines also provide aesthetic and spiritual values for skiers, hikers, backpackers, climbers and mountain visitors to these unique environments.

Significantly, five-needle white pines have coevolved a mutualistic relationship with Clark's nutcrackers (*Nucifraga columbiana*) with the pines obligately dependent upon the bird for dispersal of its large, wingless seeds (Tomback 1982).¹¹ In late summer and early fall,

⁶ The majority of the southwestern white pine population is found in the mountains of northern Mexico.

⁷ Limber pine occurs in a wide variety of habitats stretching from Alberta, Canada, south.

⁸ It is thought that origin of this hybrid zone is ancient and that most of the current population is a result of backcrosses to *P. strobiformis* (Perry 1991).

⁹ The core range of Rocky Mountain bristlecone pine is in south central Colorado, east of the continental divide. A disjunct population occurs on the San Francisco Peaks in Central Arizona (Brower et al. 2011).

¹⁰ The oldest known limber pine exceeds 1600 years in age was found on the Carson National Forest a few kilometers west of Red River, New Mexico (Swetnam & Brown 1992).

¹¹ The relationship is strongest for limber pine and southwestern white in the northern portion of its range. Nocturnal rodents are primarily responsible for dispersing southwestern white pine seed in the southern portion of its range (Tomback et al. 2011). The cline of seed dispersal runs from wind-dependent in the south to Nutcracker-dependent in the north (Lanner 1996). Bristlecone pines are less dependent on nutcrackers for seed dispersal.

nutcrackers extract ripe seeds from cones, transporting them to open areas in a specialized sublingual pouch. The seeds are cached in the ground with the birds returning to feed on the seeds for up to a year (Tomback 1982). Unretrieved seeds are the primary source of tree regeneration (Hutchins and Lanner 1982; Tomback 1982, 2001). After high-severity fire nutcrackers will travel long distances to cache pine seeds in newly open terrain making them among the first trees to stabilize disturbed sites.¹²

White Pine Blister Rust

The accidental introduction of white pine blister rust *Cronartium ribicola* into Vancouver, British Columbia, on seedlings imported from Europe in 1910 initiated a catastrophe for western forest biodiversity (Mielke 1943, Hummer 2000, McDonald and Hoff 2001). The magnificent western white pines (*Pinus monticola*) in the Inland Northwest were the first to succumb. By the late 1960s, they were nearly gone, decimated by a combination of blister rust, commercial high-grade logging, mountain pine beetle outbreaks and fire mismanagement. Today only 5 to 10 percent of the original 5 million acres still carries a significant component of western white pine (Kinloch 2003). This despite spending \$150 million over a period of 50 years unsuccessfully attempting to eliminate plants in the genus *Ribes* that serve as its primary alternate host (Fins et al 2002).¹³

At first tree branches are killed, reducing photosynthesis and cone production; if the disease grows into the trunk or starts in the trunk, it can girdle trees and kill them. Most infected trees lose their cone-producing capacity years before succumbing to blister rust, resulting in diminished natural regeneration.

White pine blister rust is now well established on two other species of five-needle white pine, the limber pine and Rocky Mountain bristlecone pine in nearby south-central Colorado (Blodgett and Sullivan 2004). The incidence and severity of the disease are expected to increase over time, leading to negative impacts on bio-diversity and ecosystem processes (Schoettle et al 2019). A 40 percent loss in basal area of limber pine is projected by 2030 (Krist et al. 2014). Limber pine is designated as a Species of Management Concern in Rocky Mountain National Park and is of management interest on other Federal, State, and county lands (Burns et al. 2008). It is listed as

¹² This is especially the case with limber pine (Lanner and Vander Wall 1980; Tomback et al 2001).

¹³ After abandoning efforts at direct control, the Forest Service accelerated logging to extract the valuable timber before the rust killed the remaining trees. This removed surviving western white pines that could have served as seed sources for natural selection to increase rust resistance in the next generation (Fins et al 2002). A century earlier the agency encouraged land owners along the eastern seaboard to cut down all American chestnuts before they were killed by an exotic blight. As a result, genetically resistant trees that may have allowed another iconic species to survive and adapt were lost (Kelly 1924). Other blister rust hosts include species in the genera *Castilleja* and *Pedicularis*.

endangered in Canada and Alberta.¹⁴ Limber pine in Wyoming, where it is more common than in any other State, is on the Bureau of Land Management Wyoming's Special Status Species list.¹⁵

On December 2, 2020 white bark pine was proposed by the U.S. Fish and Wildlife Service for listing as threatened under the Endangered Species Act. Infection levels from blister rust can be as high as 100% in the northern part of its range. Rapidly warming temperatures are shrinking the white bark pine's high elevation habitat and making it unlikely that this slow growing relatively immobile species can adapt and compete with the expanding range of neighboring species.

Rocky Mountain bristlecone pine occurs in disjunct mountain-top populations throughout Colorado and northern New Mexico. Little is known about the species' genetic structure or ability to adapt to threats caused by the blister rust, climate change in high elevation systems and bark beetle outbreaks. However it is beyond doubt that the combination of low genetic diversity, high population isolation and long regeneration times puts the bristlecone population at considerable risk (Schoettle et al 2010).¹⁶

The imperiled state of white bark pine and some populations of limber pine are harbingers of what is to come if proactive action is not taken soon to conserve five-needle pines on the SFNF (Coop and Schoettle 2011).

White Pine Blister Rust in New Mexico

The largest white pine populations in New Mexico are on the SFNF in the north and the Lincoln and Gila National Forests in the south.¹⁷ The first white pine blister rust infection was detected in

¹⁴ Government of Canada. 2014. COSEWIC Wildlife Species Assessments (detailed version), November 2014; Limber pine. Wildlife Species Assessment. Retrieved September 29, 2017 from http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Limber%20Pine_2014_e.pdf.
Government of Alberta. 2014. Species assessed by Alberta's endangered species conservation committee. Retrieved November 10, 2014, from <http://esrd.alberta.ca/fish-wildlife/species-at-risk/documents/SpeciesAssessed-EndangeredSpecies-Jul18-2014.pdf>

¹⁵ Bureau of Land Management Wyoming. 2013. Limber Pine (*Pinus flexilis*), Special Status. Retrieved November 10, 2014, from <http://www.blm.gov/wy/st/en/programs/forestry/sp-status.html>.

¹⁶ The SFNF erroneously considers dense stands of bristlecone pine seedlings and saplings in alpine grasslands to be a consequence of fire exclusion and suppression instead of an important genetic buffer against future mountain pine beetle or blister rust mortality (Coop and Schoettle 2011).

¹⁷ There are roughly 75 million white pines in the Southwestern Region according to the Forest Inventory and Analysis data (O'Brien 2002, 2003; USDA Forest Service 2008; Figure 3). The Forest Service refers to southwestern white pine, limber pine and hybrids between the two species collectively as "white pine."

New Mexico on southwestern white pine near Cloudcroft in March 1990 (Hawksworth 1990)¹⁸ and was described as having “savage intensity” (Kinloch 2003). Frank et al. (2008) demonstrated how this and other infestations in the Southwest and adjacent regions could have resulted from long-distance (>100s of km), aerial dispersal of spores from the Pacific Southwest. Surveys conducted between 1990 and 2002 estimated the disease was increasing by an average of 2.6 % per year among white pines (Conklin 2004). Blister rust infections have been found on SFNF white pines on in the Jemez and near Las Vegas.¹⁹ The disease is also present on the Gila, Apache-Sitgreaves and Cibola national forests. There is a high risk of the infection spreading to surrounding mountain ranges (Geils et al. 1999).

Recent research has identified high levels of resistance to blister rust in Southwestern white pines that may prove useful in restoration and possible future reforestation efforts. Trees grown from seed collected in the Lincoln, Cibola and Santa Fe National Forests were inoculated with blister rust spores. After 7.5 years three populations had a greater than 70% survival representing perhaps the highest level of resistance documented to date in a North American white pine species (Johnson and Sniezko 2021 in press). These findings add urgency to the need to identify and protect in the wild genetically unique five-needle white pine populations.

Five-Needle White Pine Conservation

Major conservation programs are underway in the Rocky Mountains to promote self-sustaining five-needle white pine ecosystems that have both resilience to disturbances and genetic resistance to white pine blister rust. A key strategy is to conserve the intact genetic diversity of native populations in ecosystems such as those on the SFNF that have not yet been impacted by

¹⁸ At that point the disease had spread through much of the range of southwestern white pine in the Sacramento Mountains and nearby habitats.

¹⁹ The sites in the Jemez may have been eliminated by the Las Conchas fire in 2011 (personal communication, Greg Reynolds).

widespread infection. (Keane and Schoettle 2011)²⁰ and encourage natural regeneration.²¹ This would include ecosystems that provide habitat for southwestern white pine, limber pine, Rocky Mountain bristlecone pine and hybrid populations unique to the SFNF that may harbor rust resistant genes. All are in imminent danger from blister rust and other stressors (Tomback, 2011).

Evidence suggests that southwestern white pine and limber pine on the SFNF are hybridizing and moving north in response to climate disruption (Menon et al. 2019). This expanding hybrid zone may contain novel adaptive traits to more effectively resist blister rust infection²² and combine limber pine's greater cold tolerance with southwestern white pine's ability to better withstand drought (Menon et al. 2021). The revised plan should provide standards to facilitate this northward expansion. These hybrid populations are an ideal source for germ plasm that may be needed for assisted migration in the coming decades.

The revised plan should highlight the need for a proactive strategy and facilitate its implementation. Keane and Schoettle 2011 provide a credible strategy for areas such as the SFNF that harbor intact and unique five-needle white pines populations. These measures include:

- *Educate and engage.* Increase awareness of the threats to the High Elevation Five Needle Pine ecosystems and facilitate a shift from crisis management to managing for sustained resilience.
- *Gene conservation.* Take advantage of the intact healthy ecosystems to assess and capture the genetic diversity for gene conservation, research and future management activities.

²⁰ Forest Service pathologists also routinely recommend genetic conservation: "The long-term natural selection that is occurring in these trees is a strong justification for retaining white pine during routine management of natural stands with a western white pine component. Fins et al. (2001) and Neuenschwander et al. (1999) both call for conservation of genetic diversity by retaining western white pines that still remain in natural stands." Schwandt et al_2013 *White Pine Blister Rust General Ecology and Management, Insect and Disease Management Series*, 14.2. "Maintaining and promoting genetic diversity among white pines should be a key management objective" and "... retention of wild trees (where they remain) is strongly recommended to help provide a broad genetic base and promote natural selection (Fins and others 2002). Similar recommendations have been made by geneticists throughout the western U.S. and Canada." Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01.

²¹ "... Schoettle and Sniezko (2007) and Burns and others (2008) advocate proactive options to encourage natural regeneration of white pine in areas not yet impacted by blister rust, to improve the odds in natural selection following eventual disease establishment." Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01

²² Genetic screening of these hybrids show higher resistance to blister rust than pure limber pine, the more susceptible of the two species (Menon et al. 2019:12)

- *Research patterns, processes and responses.* Gain information on natural disturbances and management responses to provide valuable process-level information to evaluate future impacts and treatment effectiveness as well as parameterize predictive models. Assess geographic patterns of natural frequencies of resistance mechanisms to white pine blister rust.
- *Prepare the landscape for change.* Develop and implement interventions to increase adaptive capacity, mitigate ecosystem impacts of tree mortality, and accelerate the increase in frequency of rust resistance.

The creation of large and small openings should be avoided as it heightens the potential for blister rust damage (Schwandt et al. 1994; Fins et al. 2001). Increased sunlight reaching the forest floor often causes *Ribes*, the main alternative host, to proliferate leading to increased opportunities for the spread of blister rust. Dense conditions limit not only *Ribes*, but also dispersal of rust spores. Forest Service pathologists in the Southwest recommend careful consideration of the potential hazard of clearing and burning projects that may increase long-term damage from blister rust (Conklin et al. 2009).

Not being a desired timber species, five-needle white pines are often targeted in mixed stands for removal in favor of ponderosa pine and Douglas fir. This practice is abetted by the mistaken belief that white pines are less fire-resistant than other species. In fact, white pines are ecologically well-adapted to fire.²³ The revised plan should establish standards that favor white pines in silvicultural treatments as a simple and cost-effective conservation strategy.²⁴

It should be noted that five-needle white pines are generally present in low numbers on the SFNF and thus preserving them does not greatly affect other management objectives.²⁵ But low numbers also mean unique genetic variants can be eliminated in landscape scale fuel reduction projects which could swiftly lead to vortices of extinction (Conklin et al. 2009).

In summary, the revised plan fails to establish proactive standards to protect populations of native five-needle white pines threatened by an exotic disease, climate disruption and landscape

²³ “In recent years, the justification has often been that white pine is less fire-resistant than these other species. This rationale seems narrow-focused and short-sighted: in fact, white pines are ecologically well-adapted to fire and have probably been affected negatively by more than a century of fire suppression/exclusion (Fins and others 2002; Samman and others 2003).” Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01

²⁴ “Favoring white pines in silvicultural treatments is a simple, cost-effective strategy that will not interfere with other resource objectives” Conklin et al. 2009 *White Pines, blister rust and management in the southwest*, USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-FH-09-01

²⁵ In contrast to the 75 million white pines in New Mexico and Arizona, there are approximately 1.5 billion ponderosa pines and 540 million Douglas fir (O’Brien 2002, 2003).

level fuel reduction targets. Failing to act now, before significant loss of tree diversity, is not an approach informed by the best available science (Tomback et al. 2001b).

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