COLLABORATIVE STEWARDSHIP TO PREVENT WILDFIRES

BY MELANIE LENART

PEOPLE tell many stories about Northern Arizona's Rodeo-Chediski fire of 2002: In the early summer, following on the heels of one of the region's hottest, driest springs on record, it raged for two weeks, crossing nearly half a million acres in northern Arizona; it moved against the wind and during the night; its two fronts blasted 113,000 acres in one day, torching acre-sized stands of trees in mere minutes; White Mountain Apache Hotshots and others led by Rick Lupe risked their lives to keep the wildfire from crossing Route 60 and reaching Pinetop-Lakeside and Show Low, the area's biggest commercial district.[1] Perhaps some less-told stories about the Rodeo-Chediski fire are even more important: What made the northern Arizona forest susceptible to such a devastating fire in the first place? What did it do to catalyze collaboration in fire prevention communities?

Even with all the hard work and an eventual firefighting cost of $159 million, the Rodeo-Chediski fire managed to destroy 465 homes and burn 468,000 acres of mostly forest to varying degrees. Roughly two-thirds of the burn area fell over Arizona's White Mountain Apache Reservation, with the other third in Apache-Sitgreaves National Forest and a smattering of private lands, particularly in the Linden-Pinedale and Heber-Overgaard areas.[2]

The devastation fits into a trend observed in the western United States. Despite the best efforts of firefighters, the amount of area burned by wildfire in the West has been increasing since the mid-1980s (see Figure 1 on page 11). During the dry summer of 2002 that brought the Rodeo-Chediski fire, roughly 6.9 million acres burned across the West. Major fires occurred in each of the 11 western states, including another half-million acre fire in Oregon. In other parts of the country, Georgia and Alaska were hit by significant blazes as well.

The increasing number of burned acres follows several decades of mostly successful fire suppression. In fact, fire historians consider the success of fire suppression efforts for several decades (starting with the 1950s) as among the reasons modern forest fires have become so intense. With fire suppression and a century of grazing and logging, many western forests have become powder kegs. Drought and climate change are lighting the fuses to ignite susceptible forests into uncontrollable infernos. Defusing these time bombs by means other than catastrophic wildfire will require ingenuity, entrepreneurship, and community cooperation.

Fortunately, the number of collaborative groups addressing wildfire danger also has increased dramatically in recent years.[3] These participatory decision-making groups can fill a crucial role in promoting the sustainability of forests and the local industries that depend upon them. One collaborative group, the White Mountains Natural Resources Working Group (NRWG), is facing the challenges that modern forest conditions have wrought. NRWG formed

in 1996 in the same northern Arizona area that would later face the Rodeo-Chediski fire. Members include politicians, loggers, environmentalists, and agency representatives from the federal, state, and county levels. With the facilitation of longtime chairman Stephen Campbell, a University of Arizona (UA) cooperative extension director, the group has been developing plans on city, state, and regional scales to sustain forest health, community amenities, and local economies over the long term. As part of an integrated assessment of the White Mountains area, UA's Climate Assessment for the Southwest (CLIMAS) attended group meetings and related events and interviewed NRWG members during 2004–05.

In the months and years following the Rodeo-Chediski fire, NRWG and its sister groups were able to convince many community residents of the need for a variety of initiatives to reduce wildfire danger. Perhaps most notably, NRWG paved the way for the nation's largest 10-year stewardship contract, issued in 2004 under the authority granted by Congress in the 2002 budget. The contract aims to thin roughly 150,000 acres in the Apache-Sitgreaves National Forest over the next decade (see Figure 2 on page 12). To oversee the contract, the U.S. Forest Service appointed a Stewardship Monitoring Board comprising about 16 local community members, government and agency representatives, and regional environmentalists—almost all of them active members of the Natural Resources Working Group.[4]

Collaboration and Wildfire

The need for collaborative stewardship contracts is set to increase in years to come. Large-scale western wildfires have become more common since the Yellowstone fire of 1988 (see Figure 1). Western fires in 2002 burned 6.9 million acres, destroyed more than 800 structures, and caused the deaths of 23 firefighters.[5] Even more area burned in 2000, with 8.4 million acres affected to varying degrees.[6] However, it is not the acreage but the severity of some of the fires that is eliciting concern from the scientific community. The burned acreage remains well below levels that would occur naturally, as shown by tree-ring records of pre-settlement fire occurrence.[7] But in the past, fires in some forest types often involved only surface burns, as evidenced by an individual pine tree's ability to record dozens of fire events in non-lethal scars that can be used to reliably date the fire to the specific year.

Tree-ring records show the pattern of recurring surface fires comes to an abrupt stop sometime during the late nineteenth and early twentieth centuries throughout much of the west. The introduction of commercial grazing at the turn of the nineteenth century reduced grass cover, thereby limiting the potential for surface fires to clear the stands of small trees, leaf litter, and fallen branches. Logging encouraged the growth of saplings, as did grazing and fire suppression. Many of today's western forests contain an abundance of small trees that can carry fires from the ground into the canopy, where they can be fatal even to mature trees that evolved under a surface fire regime.

As a result, government agencies at many levels are encouraging the "thinning" of some of these small-diameter trees to reduce wildfire danger. Some federal legislation requires collaboration for agencies (including the U.S. Forest Service) to apply for certain grants related to thinning treatments. The Healthy Forests Restoration Act passed in 2003 in response to the volatile fire seasons of 2000 and 2002 and California's runaway fire season of 2003. The act provides little money for thinning treatments but does require agencies to use a collaborative approach to apply for grant money. Land managers and communities must collaborate on fire plans to create a "seamless" treatment to reduce wildfire danger across private and tribal forests and adjacent public lands.[8] The White Mountains Stewardship contract focuses on removing small-diameter trees from 5,000 to 25,000 acres a year, starting with the "interface" areas near forest/community boundaries. Such federal stewardship contracts are designed to better equip the national forest to handle future wildfires. As a bonus effect, they are expected to make some forests, including Ponderosa, more resistant to drought, beetle attacks, and climate change.

The western Ponderosa pine forests are particularly vulnerable. In 2002, about 21 million acres of Ponderosa pine forests in the west and several bordering states plus Alaska were designated as being at risk for bark beetle infestation because of high densities of small trees and related stand conditions, according to a report by the U.S. Forest Service and the Western Forestry Leadership Coalition.[9] The

A bus carries firefighters through the evacuated streets of Show Low, Arizona, during the Rodeo-Chediski fire while 100-foot-tall flames threaten to cross Route 60, into town.

density issue is even more of a problem during drought years. Small trees compete for limited resources (like water), so their abundance can make the entire stand more susceptible to drought, and water-stressed trees also are more likely to succumb to bark beetle attacks and fire. Dense conditions also make stands more susceptible to large-scale wildfire, as the report noted. Northern Arizona's Apache-Sitgreaves National Forest contains about 1.3 million acres of Ponderosa pine forest, of which about 800,000 acres face increased wildfire danger because of stand conditions, including a high density of small trees. Other forest types around the world may face similar management challenges, particularly those that evolved under a regime of frequent surface fires that has since been interrupted.[10] However, it should be noted that selective logging in some moist forests, such as the Amazon rainforest, can expose stands to increased drying and wind damage, potentially making them more susceptible to fire and pest infestations.

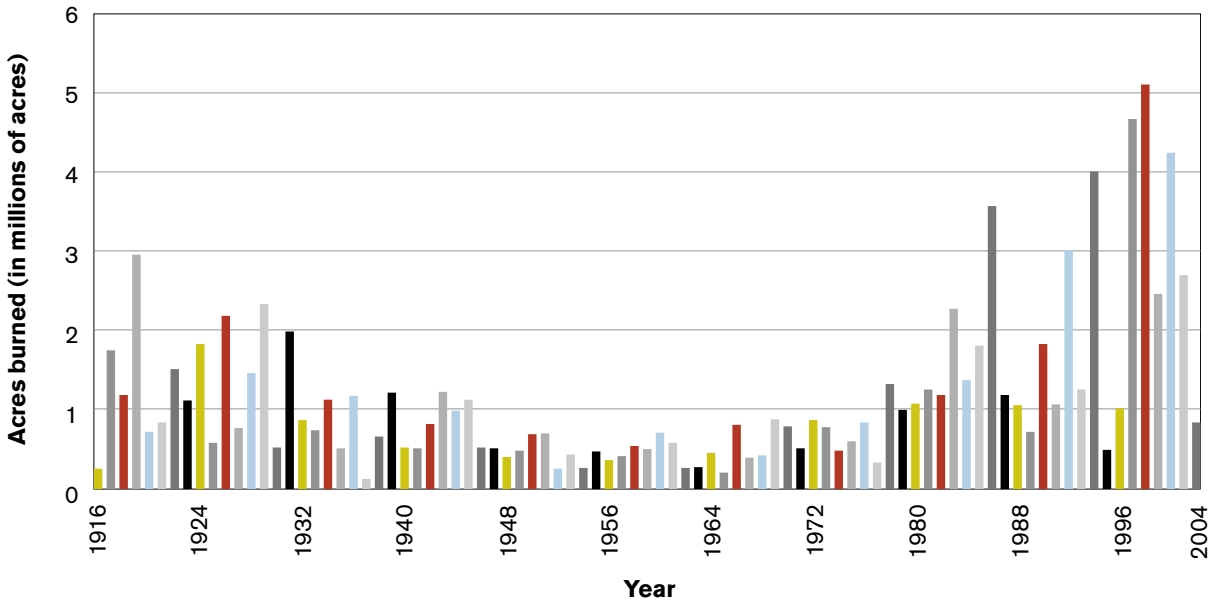
The Fire Triangle

Climate, topography, and stand conditions are considered the "fire environment triangle" because of their well-documented impact on wildfire danger.[11] Of climatic factors, precipitation, winds, and temperature all play important roles in wildfire danger. Large-scale drought increases regional fire danger.[12] The ongoing western drought contributed to the high national tallies of burned acreage in 2000 and 2002. Local winds also have an important influence on fire behavior, but wind variations are difficult to predict at the seasonal scale or beyond. Temperature influences wildfire regimes, in part because it plays a critical role in the timing of snowmelt, a key factor in western wildfire risk.[13] Even without a long-term drought, it only takes about 40 days of hot, dry weather for forests to become dangerously flammable.[14]

The rising temperatures that accompany global climate change are expected to increase the incidence of large-scale fires. Semi-arid regions like the western United States and Australia may be particularly vulnerable.[15] Scientists have already detected a link between rising temperatures and an increasing incidence of large-scale wildfire in Canadian forests.[16] Any dry forests subject to an increase in year-to-year variability in precipitation levels is likely to face increased wildfire danger, as are any moist forests faced with extensive precipitation deficits. Many climate change scenarios project a global increase in the variability of precipitation—more extreme rainfall, snowfall, and drought events.[17] Thus, the influence of climate change on precipitation and temperature is likely to exacerbate the trend toward the increasing number of acres burned in the west.

Fire managers also consider topography—the lay of the land—when evaluating how a wildfire will move and mutate. As with climate, fire managers have no control over the topography. Yet land features determine whether a fire will be racing upslope, moving horizontally with the wind, or facing a valley before it

Figure 1. Acres lost to wildfire in the western United States, 1916–2004



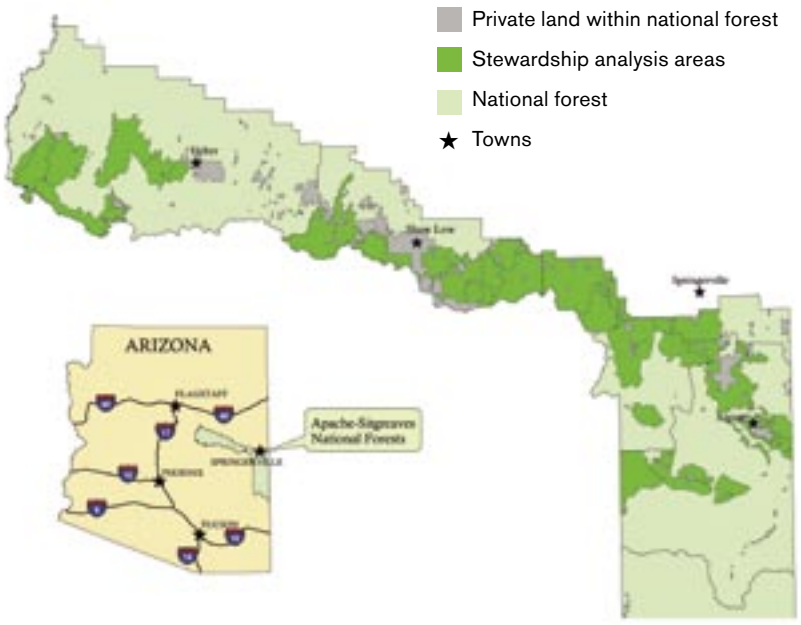
NOTE: The area burned in western wildfires has increased in recent decades as suppression efforts become less effective. The values above are sums of totals from the 11 states west of Colorado's eastern boundary.

SOURCE: Data for 1916 through 2004 were compiled from a variety of sources by Anthony L. Westerling of the Climate Research Division of Scripps Institution of Oceanography (University of California–San Diego) and used by permission.

can reach another mountain. Recent years have brought some surprises, with wildfires moving against the wind, traveling by night as well as day, and jumping over highways. Land managers and firefighters once considered the wildland-urban interface as a housing development that stretched about half a mile into the forest. But given how fast and how far modern fires have been moving, some officials are extending their definition to four miles, ten miles, or more.[18]

"Fuels" form the third side of the fire environment triangle—the only side subject to management.[19] For many years, forest managers had noticed that even catastrophic wildfires often settled down into surface-fire mode when confronted with a "thinned" section of the forest, at least when the small trees had been removed from a reasonably large section of more than a few acres. This anecdotal observation held up to systematic research.[20] Northern Arizona University researchers looked at hundreds of plots on White Mountain Apache lands affected by the Rodeo-Chediski fire and found that the combination of selective logging and prescribed burns made the stands most resilient to wildfire. Overall, the researchers found that such treated areas contained a higher number of live trees, a lower "bole char height" (measuring how high the fire had reached on tree trunks), and a higher number of regenerating Ponderosa pine trees. Areas that had been treated by burns, whether prescribed or naturally occurring, also tended to be more resilient. Their findings also indicated that untreated and high-severity areas would be more likely to shift into a different vegetation cover, such as oak/manzanita chaparral.

Figure 2. White Mountain stewardship project analysis areas



NOTE: The Apache-Sitgreaves National Forest covers roughly 2 million acres in northern Arizona and includes the Southwest's largest continuous stretch of ponderosa pine forest. The map shows in dark green the areas analyzed for treatment as part of the stewardship contract to reduce wildfire danger. It also highlights the intermingling of national forest (light and dark green) with private land (gray).

SOURCE: Courtesy of Pamela J. Klein-Taylor of the U.S. Forest Service, Apache-Sitgreaves district.

The White Mountains

The conditions that led to the Rodeo-Chediski conflagration had been building up for more than a century. In Arizona's White Mountains, many stands within Ponderosa pine forests had been more open before the influx of settlers during the late nineteenth century, as Northern Arizona University's Ecological Research Institute (ERI) has documented. Research indicated that some pre-settlement Ponderosa stands consisted of 20 to 40 large pines per acre, with abundant grass cover and open space beneath the tall canopy.[21] Contemporary forests commonly reach stand densities of 300 to 500 trees per acre of relatively small trees.[22]

Meanwhile, research on fire-scarred Ponderosa trees from the University of Arizona's Laboratory of Tree-Ring Research indicated that pre-settlement Ponderosa forests had faced a regime of frequent surface fires.[23] The findings indicated that surface fires in the White Mountains area generally recurred approximately every 3 to 12 years. The researchers surmised that these frequent fires helped keep seedlings at bay while encouraging grasses to thrive in the many open spaces between canopy trees.

However, the lush grass understory attracted the interest of ranchers settling from outside the area, including the Aztec Land and Cattle Company. In 1890, the company counted 150,000 head of cattle and 120,000 head of sheep among its holdings in the Little Colorado River watershed (which includes the White Mountains).[24] Tree-ring evidence from fire-scarred trees indicates that these turn-of-the-century grazing practices had virtually eliminated surface fires by the nineteenth century's end. With the reduction in grass cover, fires could gain no foothold with which to travel through the forest.

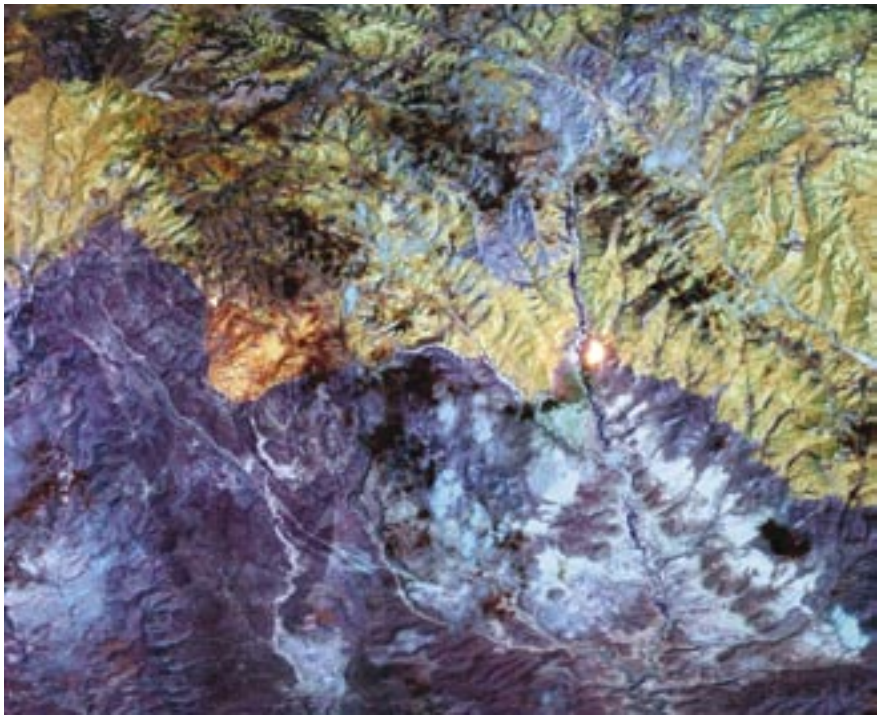
Large-scale logging in the White Mountains began at about the same time, with

the completion of a railroad line between Seligman and Prescott in 1887. In 1890, 35 miles of logging railroad line extended from Flagstaff along the Colorado Plateau's Mogollon Rim. In addition to making the White Mountain forests accessible for logging, the railroad company encouraged logging by selling its timber rights on forested allotments throughout the Colorado Plateau. The Atlantic Pacific Railroad had been given 13 million acres of land in alternate odd-numbered sections of square-mile allotments stretching 40 miles wide from either side of the tracks.[25] A photo circa 1904 shows a logging truck filled to capacity with the trunks of three trees, each of them about five feet wide.[26]

It wasn't until the 1980s that the U.S. Forest Service had retrieved all the private timber rights held within the national forest system in the Southwest. Until then, companies retrieving the trees within the private allotments felt little compunction to follow Forest Service advice about harvest timing and techniques, although they faithfully followed the rule to take only the trees larger than 12 inches in diameter.[27] Selective logging of large, old trees often meant a stand of young, dense trees would spring up in their place.

The logging of large trees continued on public lands in the Apache-Sitgreaves Forest through the mid-1990s. The U.S. Forest Service had undergone several different approaches to logging over the years because its director changes with each political administration. During the Reagan years of the 1980s, federal practices led to national timber harvesting at rates environmentalists considered unsustainable, including in the Apache-Sitgreaves National Forest. When the Mexican spotted owl was listed as an endangered species in 1993, environmental nongovernmental organizations (NGOs) around the nation turned to the Endangered Species Act to protect diminishing old growth forest as spotted owl habitat.

Timber harvesting trends in the Southwest reflected those in the country as a whole (see Figure 3a on page 14). In Apache County, income from logging ventures climbed through the 1980s to a peak of about $11.8 million in 1989 (see Figure 3b on page 15). Environmentalists charged that logging on the Apache-Sitgreaves was unsustainable, citing as support comments by area land managers from the U.S. Forest Service Lakeside Ranger District, Arizona Game and Fish Department, and U.S. Fish and Wildlife Service.[28] For instance, the Arizona Game and Fish Department had appealed the forest's management plan in 1988, noting that the Sitgreaves portion (where most of the Rodeo-Chediski fire burned) "currently has little remaining or existing old growth" except in inaccessible steep canyons.[29]



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An infrared photo of the Rodeo-Chediski fire, taken from space. The yellow and brown areas are burned, and the bright yellow areas show active fires.

In 1995, regional environmental NGOs filed a lawsuit on behalf of the Mexican spotted owl. In August of that year, Federal Judge Carl Muecke issued an injunction blocking any logging in southwestern national forests until the species had a designated habitat. The injunction restricted logging operations for about 16 months. By 2000, logging income had dropped to about $1.5 million in Apache County (see Figure 3b).[30] Annual income from logging in Navajo County dropped from $20.3 million in 1989 to $9.3 million in 2000. Because Navajo County includes tribal forests owned by the White Mountains Apache, the Fort Apache Timber Company in Navajo County was able to maintain a more consistent pace of logging. The injunction did not cover tribal forests, where Ponderosa forests cover about 1.1 million acres, roughly comparable in size to the national forest. Some area residents believe the 1995 injunction helped drive the private timber industry out of the White Mountains.

Another crucial moment came when Abitibi Consolidated, owner of the Snowflake pulp mill, decided to convert the mill into a plant that processed recycled materials instead of trees harvested from national forests (including the Apache-Sitgreaves). The 1995–1996 logging injunction led the company to seek materials from Mescalero Apache tribal lands in New Mexico, about a seven-hour drive to the east. This distance increased costs for transportation and payroll. By some accounts, the pulp mill owner perceived

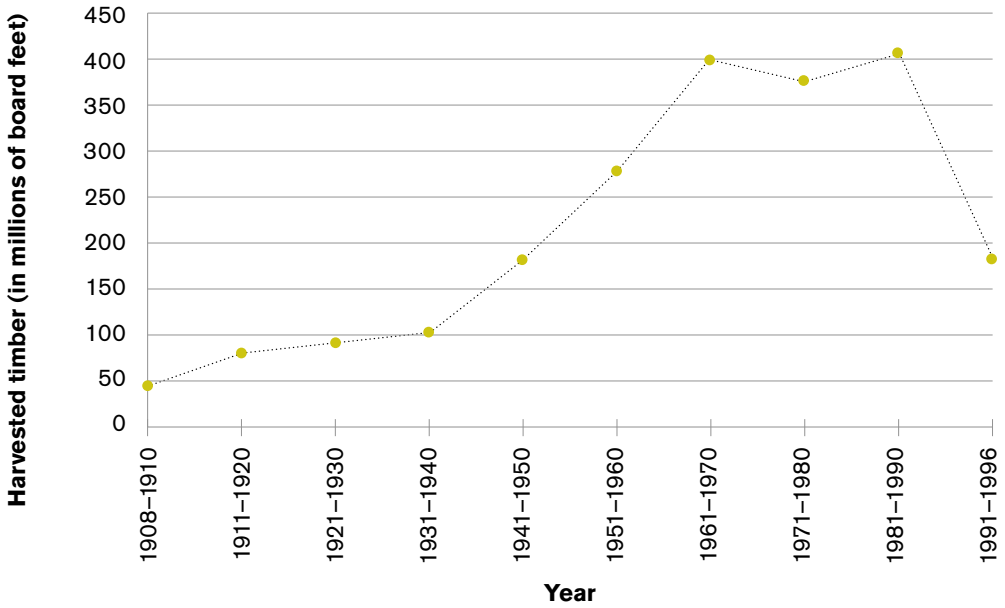
that a renewed long-term contract with the Forest Service was unlikely to be forthcoming. While profits dwindled, expenditures threatened to rise, at least given continued operation as a pulp mill for raw materials. The plant's original 30-year contract, which ended in 1989, had predated several key environmental acts. [31] Abitibi would have had to invest between $130 million and $150 million to retool the pulp mill to comply with the Clean Air Act and the Clean Water Act. By 1999, mill owners had decided to do the less-expensive retooling that would bring it into legal compliance if it converted to a paper recycling plant.[32] This decision affected several local sawmills as well, including those owned by Abitibi. Critics charged that most of Abitibi's profits actually came from sawtimber (logs from trees 12 inches in diameter and larger), rather than the small-diameter trees used for pulpwood. Still, the conversion of the pulp mill left the region without any ready market for small-diameter wood.

Harvesting sawtimber arguably can produce income for the Forest Service, at least on the books. When costs of administering timber programs are included in calculations, however, logging in the national forests generally costs taxpayers money.[33] New budgetary approaches make it more difficult to detect the cost of administering timber programs.[34] Yet the cost of thinning small-diameter trees is readily visible. Thinning treatments typically cost from $400 to $1,200 or more per acre depending on forest conditions and treatment type.[35] It is the small diameter trees that most increase the danger of crown fires, along with deep layers of needles and piles of branches and debris on the forest floor. Small trees can pull a surface fire into the canopy, igniting the uncontrollable wildfire typified by the Rodeo-Chediski. Unfortunately, small Ponderosa pines tend to warp more easily than mature trees, so it is a gamble to harvest them for sawtimber. The lack of a large-scale market for small-diameter material currently poses the greatest challenge for collaborative groups and managers attempting to reduce wildfire danger and improve forest health. In the White Mountains, the U.S. Forest Service and the Stewardship Monitoring Board have made it a priority to promote local business ventures using small-diameter wood, so the market is improving.

NRWG Case History

The logging injunction and decline in sawmill profits made it clear to some locals that business as usual was not

Figure 3a. Timber harvesting trends in the southwestern United States, 1908–1996



NOTE: The quantity of sawtimber extracted from Arizona and New Mexico forests increased over the 20th century, leading to a peak from 1970 to 1990. The quantities subsequently declined in the years for which data is available, 1991 to 1996.

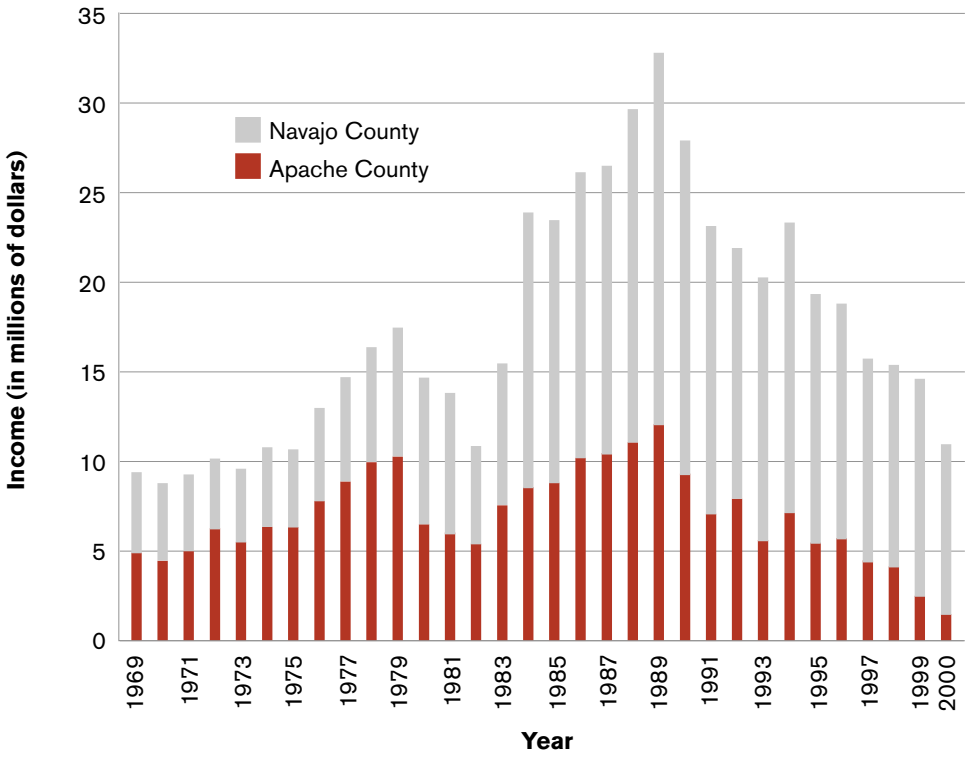
SOURCE: Data courtesy of the U.S. Forest Service Rocky Mountain Research Station as posted by the Ecological Restoration Institute.

working in the White Mountains. By 1996, income from lumber and wood had dropped to a little more than half its 1989 peak (see Figure 3b). Several interested parties began meeting informally over lunch in 1996 to talk about the changing situation.[36] By January 1997, these officials and anyone who wanted to join them began meeting officially as the White Mountains Natural Resources Working Group (NRWG). At that time, the Apache-Sitgreaves National Forest had released the recovery plan for the Mexican spotted owl, after repeated revisions since the plan's original release in 1988. Also in 1996, a series of forest fires around Arizona helped bring the problem home, including the Cottonwood fire near Pinedale.[37] Although its 1,400-acre size would pale compared to the subsequent 468,000-acre Rodeo-Chediski fire of 2002, the Cottonwood fire served as a warning to those in forested communities across northern Arizona's Mogollon Rim. Those living amid the trees included residents of Show Low (7,700 residents), Pinetop-Lakeside (3,580 residents), and the White Mountain Apache Reservation (12,430 residents).[38] The relatively small population in the region, with only about 60,000 of Arizona's 5.1 million residents, contributes to making inclusiveness manageable.

A key to the group's strength is the active participation of important decisionmakers in the region who can influence or enact decisions. NRWG members include mayors and county supervisors as well as representatives from the Arizona Game and Fish Commission, U.S. Fish and Wildlife Services, and the U.S. Forest Service. Collaboration with the White Mountain Apache occurs as issues of mutual interest are addressed, such as the community wildfire protection plan. Representatives from The Nature Conservancy and The White Mountain Conservation League regularly attend meetings, but NRWG also seeks and receives input from other regional environmental NGOs, including the Southwest Center for Biological Diversity and the Sierra Club.

The White Mountains NRWG spent nine months interacting before tackling any specific issues. The group debated for five months before agreeing on the definition of consensus: It would be

Figure 3b. Apache and Navajo County incomes from lumber and wood, 1969–2000



NOTE: The White Mountains region followed a trend similar to the rest of the Southwest. Data for annual income from lumber and wood for Apache and Navajo Counties peaked in 1989 and then declined in subsequent years.

SOURCE: Data courtesy of a web-based tool of the Bureau of Economic Analysis Regional Economic Information System, http://www.bea.gov/bea/regional/docs/reis2004dvd.asp.

considered reached when the majority supported a decision while no member actively opposed it. The group made it a goal to promote harvesting that would improve rather than harm forest health. But reaching agreement on the means to this end took many more months of meetings (see the box on page 17 for a summary of perception shifts undergone by NRWG members). Spelling out the details can tear apart the cohesiveness of any group when philosophies must intermingle. Yet in this case, what began as a contentious group of people with different ideas evolved through this process into a cohesive camaraderie.

All eight NRWG members interviewed by CLIMAS shared their advice for other groups wishing to form an effective working group (see the box on page 18). The four key elements they shared are worth repeating:

- Make the meetings open to anyone in the community who wishes to attend.
- Be sure to leave plenty of time to develop relationships and share philosophies before tackling any potentially controversial issues.
- Respect the viewpoints of others, even if you disagree with them. By extension, do not insult them outside meetings via the media either.
- Pick a defining issue that encompasses the common interests shared by members.[39]

Because collaborative groups like this depend on the development of trust over many months, it can be challenging to leave the door open for uninitiated members of the public, some of whom might have an axe to grind. However, members indicated that they dealt with grandstanding attempts or insistent promotions of an unpopular idea by responding with subtle gestures among members. The newcomer could then decide whether to work to blend in or go elsewhere to grandstand. In this way, NRWG members were able to maintain the group identity they had established. In contrast, the closing of some committee meetings of the Quincy Library Group contributed to a decline in its credibility among some members of the public.[40]

Picking a defining issue was relatively easy for the group. White Mountains area residents generally valued their forests, which are a relatively rare ecosystem for the American Southwest, usually limited to higher-elevation sites. Changing demographics were converting the regional economy from one of resource extraction to one identified by NRWG as an amenity economy.[41] In other words, earlier settlers who had lived for generations basing their economy on natural resource extraction (including timber, livestock, crops, water, and minerals) were outnumbered by new residents who valued the charm of these forested communities.[42] Population grew by 12 percent in Pinetop-Lakeside and 22 percent in Show Low just between 2000 and 2004.[43] NRWG seeks to help merge traditional uses like logging, ranching, and agriculture into comparable land usages that also support the amenity economy—producing, in the end, a symbiotic economy.[44]

While forests in the White Mountains were seen as an important amenity that drew tourists as well as residents to the region, the flammability of densely packed "thickets" of trees in forests throughout the Southwest posed a major concern that could affect every aspect of the local economy. To move toward improving forest health and reducing wildfire danger, NRWG helped facilitate a cooperative agreement in 1997 to implement a variety of forestry management practices in a 17,000-acre area known as Blue Ridge.[45] The stated goal reflected the values of the working group:

This agreement will allow for innovative approaches to achieving vegetative management strategies through the use of prescribed fire and through mechanical treatments, while providing for improved water quality and quantity, accelerating riparian restoration, mitigating impacts of catastrophic fire associated with drought, dealing aggressively with forest and rangeland ecosystem health for biodiversity, and promoting quality effective partnerships.[46]

A dozen agency and political officials had signed the cooperative agreement by mid-December 1997. Based on the results of an environmental analysis, group mem-

A 2005 photo of Juniper Ridge, part of the Rodeo-Chediski burn area.

bers settled on a cap that limited thinning in all treatments to trees with a chest-high diameter less than 16 inches—about the size an average person could encircle with hands grasping wrists. The group had agreed to test three distinctive treatments in the Blue Ridge Demonstration Project:

- The U.S. Forest Service plan, designed to maintain viable habitat for the Mexican spotted owl and the northern goshawk. The plan involved leaving protective dense habitat around nesting sites then thinning more extensively in other areas.
- A "pre-settlement" forest restoration plan put on the table by researchers with ERI.[47] The concept was to approximate historic conditions, when stands containing a few large Ponderosa trees amid meadow-like conditions were plentiful. However, the ERI group agreed to start with a less rigorous thinning program to the site to avoid the need to go back and amend the existing environmental analysis done under NEPA guidelines.
- A management technique prescribed by environmental NGOs, termed "natural processes restoration," with a focus on getting fire back in the system while maintaining viable wildlife habitat.[48]

Based on interview reports, the demonstration project appeared crucial in allowing members of the group and surrounding communities to reach a unified vision. However, it took several years of lobbying for funding for the projects and an additional push to obtain promised funding.[49] In 1999, the group encouraged the Forest Service to advertise three sale proposals to timber companies to commercially thin about 2,000 acres to defined standards. However, no companies responded, an indication that the economic approach to carrying out the group's vision would need some refinement. In what could be considered an example of the move from an extractive to a service-oriented approach, the U.S. Forest Service first had to contract for pre-commercial thinning. In 2000, the Forest Service paid $878,000 for the removal of trees less than 5 inches in diameter (4,900 acres); the creation of fuel breaks (200 acres); biodiversity monitoring (5,600 acres); and the introduction of prescribed burns (900 acres).[50]

NATURAL RESOURCES WORKING GROUP CONSENSUS BUILDING

Interviews with Natural Resources Working Group members helped reveal some of the inner workings of consensus building efforts. Only two of the eight members interviewed reported no major changes in their perceptions, and both had joined the group later in the process than the others. The six long-term members expressed some change in their perceptions in one or more of the following topics:

- stand thinning;
- fire on the landscape (wildfire, prescribed fire, fire use);
- managing forests for climate change; and
- protection of old growth forest/ large trees.

Perhaps most notably, the members who expressed a change in their perceptions of stand thinning (with two reporting "significant" changes) did not express a change in their perceptions of the value of protecting old/large trees, and vice versa.

Based on discussions, it seemed that several people came in with specific ideas of how stands should be thinned, then refined their views about keeping large trees based on input from other members. Similarly, other members used words like "intractable" to describe their positions about large trees but willingly altered other perceptions about thinning forest stands.

Regardless of whether their perceptions changed or not, members often reported that their time with the group left them "better informed" about these issues. All eight interviewed members expressed appreciation for their exposure to information about the scientific, economic, and policy-oriented aspects of the various topics.

Concerned environmentalists have the option of visiting treatment sites, and in May 2004, an arranged tour of the Blue Ridge Demo site attracted representatives from four local and regional environmental groups (not all of them active members of NRWG). A generally friendly exchange between Forest Service officials and environmentalists indicated that both sides were pursuing a view of the forest as a watershed with many features, rather than an income source for timber companies.[51] There were subtle differences in how the trees clustered (less on "pre-settlement" sites), how many small trees remained (more on "natural processes" sites), and how many dense sections were left for goshawk habitat (Forest Service plan). However, several environmentalists agreed that in many ways the three treatments led to similar results compared to the untreated "control": a more open forest that was easier for people to walk through and yet more difficult for crown fires to navigate.

Similar treatments are being undertaken as part of the 10-year stewardship contract. A 16-inch diameter cap was put in writing in the Blue Ridge contract. Although the stewardship contract contains no such clause, Apache-Sitgreaves Forest Supervisor Elaine Zieroth has publicly expressed her support for the 16-inch diameter cap. Still, there is an understanding that managers can occasionally decide to harvest a big tree if necessary for restoration or community protection. The fact that the contract has support from the environmental community speaks to the level of trust attained over the years given the open participation of the Forest Service. Verbal support for the stewardship project has included testimony at a White House conference and glowing op-ed pieces about the project by Todd Schulke of the Southwest Center for Biological Diversity.[52]

At this point, it is not legal challenges but economics that limit planned thinning efforts in the Apache-Sitgreaves National Forest.[53] The Rodeo-Chediski fire—coupled with timely efforts by NRWG, the Stewardship Monitoring Group, and other collaborations operating in the region—has increased residents' support for thinning on public lands. In addition, members

have helped city efforts to reduce wildfire danger. NRWG Chairman Stephen Campbell and forester Lloyd Wilmes, both University of Arizona cooperative extension professionals, help Show Low residents plan their own treatments. They even assist them in obtaining grant money for the work. Their work is part of the effort to provide a seamless treatment across landscapes, even in what has been called a "crazy-quilt of private, Indian, state, and federal holdings."[54]

The authority for federal agencies to undertake stewardship contracts came with Congress' 2002 budget. In fact, members of the White Mountains Natural Resources Working Group had played a role in convincing Congress of the need for such a clause. When the follow-up Healthy Forests Restoration Act passed in 2003, the Natural Resources Working Group was ready to facilitate the process of producing community wildfire protection plans (CWPP), a requirement before any grant money could be received.[55] Apache-Sitgreaves became the first national forest to have all adjacent at-risk communities covered by CWPPs. However, little additional federal funding has made its way into the White Mountains to support the 10-year stewardship contract. The Apache-Sitgreaves administration cobbles together budget money from its own timber, hazardous fuels, wildlife management, and vegetation management funds to support thinning treatments. So far, it has also been receiving funding from other forest districts.[56] Even at the low end of $400 per acre, the district must pull together $2 million to reach the minimum annual 5,000-acre commitment.

The number of acres treated can rise as costs are offset by forest product sales. Currently, the contributions of Future Forest LLC help keep thinning costs on the low end compared to other parts of the region. Even stewardship contractor Future Forest LLC is a collaborative venture. WB Contracting, owned by the Walker Brothers, fourth-generation area loggers, handles the harvesting and treatments. Forest Energy Corp., the other partner, purchases clean chips to produce pellet fuel for heating homes and offices. Forest Energy's pellet fuels burn several times more efficiently than raw wood—clean enough to use on smoke-restricted days. The lengthy treatment process uses no water. (In fact, the treatment involves removing moisture from the wood and promoting the binding of the material with the lignin it contains.) Products include Heat'rs, TerrAmigo, and Green Tree, virtually identical products except for the bags and marketing strategies. The use of this wood product has several environmental benefits:

• It supports local businesses and the individuals who run them. Future Forest LLC supports about 80 full-time

ADVICE FOR OTHER COMMUNITIES

"Do you have any advice for other communities wishing to form a natural resources working group or stewardship monitoring group?" This question, asked of eight members of the White Mountains Natural Resources Working Group during confidential interviews, elicited a variety of responses with several common themes.

• *Make the meetings open to anyone in the community who wishes to attend.* Everyone provided this answer in some form or another, making it the most cited and therefore, arguably the most important criterion. Variations on this theme included: everybody must be welcome at the table; get everybody on board; an open door is a must; keep the process open, even to fringe elements; and make it a collaborative process open to the public.

• *Build trust before tackling contentious issues.* Be sure to leave plenty of time to develop relationships and share philosophies before potentially controversial issues arise. Encourage diversity of ideas and people.

• *Respect the viewpoints of others, even if you disagree with them.* Although not cited quite as unanimously, those who mentioned this advice considered it key. Members are encouraged to listen respectfully to others, regardless of their philosophies, and anybody who attends a meeting is welcome to join the debate. However, attendees are also encouraged to share time appropriately (for example, by trying to avoid grandstanding).

• *Do not criticize other members, inside or outside of meetings.* An important corollary to respecting the opinions of others is that members are strongly discouraged from criticizing other members even outside of the meeting (such as to the press). This was identified as crucial to forming trust among group members. The group as a whole would chastise the member who occasionally strayed from this directive.

• *Find common ground.* Find the group's defining issue and stay focused on it. Develop a working group that covers all members' interests. Be willing to solve problems as a team. Be persistent—stick with it even through the difficult times.

• *Incorporate good science.* Making science the focus can help keep members on the same page. All group members reported that they became better informed about the scientific aspects of the issue by attending meetings, which served for some as an incentive to attend.

• *Be aware of leaders.* Pick a group leader who will track issues and cross boundaries. Find out who the informal and formal leaders in the community are and encourage them to attend meetings.

• *Understand the group's role.* Understand the real extent of the group's power without artificially inflating it. Collaborative groups generally depend upon agencies or government bodies to implement their ideas, so they tend to be advisory rather than decisionmaking groups. At the same time, understand that agencies need input from collaborative groups and so may make an effort to adopt ideas in order to encourage their continuation.

• *Recognize when the time is right for action.* The White Mountains Natural Resources Working Group spent years meeting and planning before having a concrete project to consider as a basis for further action. However, once the Rodeo-Chediski fire struck the area, members knew they had a window of opportunity to gain support from residents for their ideas on improving forest health.

employees, with a multiplier effect in the community equivalent to another 23 workers, according to an economic analysis by University of Arizona economist Lay Gibson.[57]

- It eliminates or reduces the need to burn fossil fuels for heating. Fossil fuels such as natural gas produce greenhouse gases that contribute to global warming. Although wood-burning also contributes greenhouse gases, it would have done so anyway upon its decay or natural combustion in the forest.
- It supports the thinning of small trees from overgrown southwestern forests. As noted earlier, small trees help spread the large-scale conflagrations that threaten western forests.
- It helps keep trees from being killed in large-scale fires. Trees, too, contribute to reducing greenhouse gases just by growing. In contrast, burning these trees in fires can release greenhouse gases. Arizona's 2002 fire season released about 2.7 million metric tons of carbon dioxide equivalents in wildfire emissions.[58]

Gibson's recently released economic analysis represents the first of several assessments to measure the economic impacts of the stewardship project. The Stewardship Monitoring Board is also assessing biological aspects of the treatments, including the Blue Ridge Demo project. For the latter, researchers will compare the three treatments and the control (the untreated forest) roughly every five years for the decade-long contract.

The stewardship contract calls for spending from $380 to $600 per acre thinned, at an eventual total cost of $20 million to $90 million over 10 years. (The actual amount depends on treatment type, stand density, and commercial value of the material removed.) As of April 2006, contractors had treated 10,000 acres, with 80 percent of the material removed having diameters less than 9 inches.

Finding markets for small-diameter wood is not a primary goal of NRWG, although it is a focus for the White Mountains Stewardship Monitoring Group. However, the topic does seem to come up at every NRWG meeting, as there is a great awareness that the extent of the success of the stewardship project depends on developing profitable uses for small-diameter wood to complement the pellet fuel plant. Another regional player involved with this aspect is the Southwest Forest Partnership, a coalition of forest product businesses and the agencies that assist them. Federal funding or grants supporting thinning treatments are generally hard to find. Perhaps federal funding for forest thinning will increase as proponents prove the approach's cost-effectiveness as compared to fighting wildfires.

Currently there's a Catch-22 in the nation's approach to forest management. As western wildfires grow in size and intensity, the budget for suppressing them burgeons as well. Meanwhile, there is almost no budget for treating forests to reduce the risk of large-scale wildfire. The Healthy Forest Restoration Act promotes collaboration but does little to change these budgetary dynamics.

Conclusion

Participatory decisionmaking has been hailed as capable of resolving many global and regional environmental problems that relate to sustainability. Yet it remains a sought-after ideal with many different interpretations. Types of participation include voting versus commenting; setting agendas versus choosing among pre-selected options; and having equal or differentially weighted decisionmaking roles among members.[59] Of these various approaches, the White Mountains Natural Resources Working Group tends to lean toward providing members with the most participation, with an open-door policy, a decisionmaking system based on consensus, and a potential role in setting agendas for technical as well as values-based decisions. Some NRWG members consider this level of openness as the only viable collaborative model.

Several studies have found openness to collaboration on the part of Forest Service and other agency officials to be crucial to the success of a collaborative group. In addition, the trust does not transfer easily from one manager to the next within the U.S. Forest Service. Human relationships are established between individuals, not organizations, as researchers found when examining 60 cases of collaborative ecosystem management.[60] Yet managers often transfer into new regions as they make their way up the Forest Service career ladder. The study found the continuation of established relationships to be one of four key factors to successful collaboration:

- continuity of key agency participants;
- the agency's commitment to the process;
- a compelling focus that framed the interaction; and
- a structured mechanism that encouraged continued communication.[61]

A similar finding came out of a 2003 workshop in Flagstaff, Arizona. The workshop brought together 20 seasoned members of collaborative groups across the country to discuss policy barriers. The group considered lack of agreement on expectations for collaborative forestry and "Forest Service culture" as the two most significant obstacles to cooperation.[62] Members reported that agencies sometimes seemed to view groups as consultants rather than collaborators. While agency members may be seeking to increase management efficiency, other partners may be seeking an experience of joint problem-solving. Participants also felt that collaboration became a hard sell when agencies limited the discretion of local field staffers or discouraged innovation. The participation of individual members of the Forest Service who can move beyond this cultural barrier can make or break a collaborative process.

The need for successful collaboration increases as western forests continue to gain flammable material as a result of historical management practices and other factors. While grazing, logging, and fire suppression generally take the blame for creating modern forest conditions, climate change resulting from a buildup in greenhouse gases may also be increasing wildfire danger. As mentioned previously, rising temperatures and an increase in the

variability of precipitation can increase the likelihood for large-scale crown fires. Temperatures are rising faster in the west than in the world as a whole. Average annual temperature for the globe has increased by roughly 1 degree Fahrenheit since the beginning of the last century. In Arizona, however, average annual temperature has been rising at the rate of 1 degree Fahrenheit per decade since 1970.[63] Some climate change models project that similar rates could continue throughout this century, particularly in the Southwest.[64]

In addition, the greenhouse gas carbon dioxide can serve as a "fertilizer" to encourage extra growth in trees, including seedlings and saplings.[65] Researchers found an increase in carbon dioxide levels of about 150 parts per million led to an 84 percent increase in photosynthesis rates among Ponderosa pines growing in the San Bernardino Mountains.[66] Carbon dioxide levels in the atmosphere are about 90 parts per million by volume higher than they were at the end of the last Ice Age. The impacts of long-term wildfire suppression have a far greater impact on the increasing density of forests than any growth increases based on rising atmospheric carbon dioxide levels. However, it is worth noting that carbon dioxide fertilization also moves forests in the same direction as the other factors that increase forest density and susceptibility to wildfires during dry years.

In NRWG, the issue of managing the forest for climate change came up only within the last two years, but some members indicated they expected to tackle the issue more in years to come. Groups like this could prove crucial in guiding forest managers who are willing to consider how global warming will affect future forest management. Throughout the Southwest, U.S. Forest Service districts are in the process of preparing 10-year management plans for the public forests in their jurisdiction. Yet conditions in many national forests could be quite different by the end of the decade than they were at the beginning. If Arizona temperatures rise another degree Fahrenheit in the coming decade as some projections suggest, the Apache-Sitgreaves National Forest will respond to the change in predictable ways—greater frequency and intensity of fires, for example—and in many ways that scientists cannot predict.

Collaborative input could be particularly relevant to forest restoration in the face of the impacts of climate change. Forest managers must weigh the costs and benefits of attempting a post-fire restoration of a vegetation type already at the edge of its optimum environmental conditions. When a group of Ponderosa pines undergoes a stand-replacing fire in a location where ongoing temperature rise is expected to reduce soil moisture, should reseeding even be attempted? At this point, climate change predictions are rarely even attempted at the small scale of a tree stand. As a result, public perceptions may be an important guide to such policy issues. In areas where land managers are open to collaboration, such as the White Mountains of northern Arizona, input from working groups could lead to increased understanding among the community and its agencies on managing for climate change as well as wildfire danger in years to come.

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NOTES

1. J. Baeza, "BIA Recognizes Firefighters Who Make a Difference," *The White Mountain Independent*, 11 June 2004. The article also describes the experience of five heroes who were fighting the Aspen fire near Tucson in 2003. Two of them died in a helicopter crash on Aspen Ridge on 26 July 2003, while a third helped rescue the two survivors of the crash.

2. Although no direct deaths were recorded, the stress of the evacuation and overall loss may have led to the deaths of several elderly residents, neighbors reported. For example, residents of the Timberland Acres subdivision, which lost more than 100 homes to the fire, believed stress from the fire precipitated the deaths of seven of their neighbors in the weeks and months following the traumatic event.

3. W. R. Potapchuk, *Moving from Collaborative Processes to Collaborative Communities, Community Building Institute*, http://www.communitytools.net/cbi/collaborativecommunities.htm (accessed 27 April 2006). See also A. Moote, P. Kohany, K. Watters, and J. Schaffer, *Directory of Collaborative and Community-based Groups Restoring Forest Health in Arizona and New Mexico* (Flagstaff, Arizona: Ecological Restoration Institute, March 2003).

4. To gain insight on the behind-the-scenes efforts that led to this success story, the author attended board meetings and related functions during 2004 and 2005, and interviewed active members of the board during 2005. Eight members were willing to participate in the confidential interviews, which used a semi-structured protocol to get a wide range of response on several specific questions. It should be noted that the NRWG members, to some degree, represent what one person called "the Same Ten People," that is, active members of the community who are willing to meet and take on tasks as volunteers. So NRWG members often participate in other initiatives, boards, and committees as well.

5. White House Office of the Press Secretary, "President Bush Promotes Healthy Forests in Arizona," press release (Wahsington, DC, 11 August 2003).

6. National Interagency Coordination Center, *Wildland Fire Statistics: Total Wildland Fires and Acres* (1960–2005), http://www.nifc.gov/stats/fires_acres.html (accessed 4 April 2006).

7. U.S. Forest Service researcher Ron Neilson estimates modern values for acres burned in wildfire is about eight times lower than natural levels, based on models he constructed with Jim Lenihan and others as part of the Mapped Atmosphere-Plant-Soil System project.

8. White House Office of the Press Secretary, note 5 above.

9. United States Department of Agriculture (USDA) Forest Service in cooperation with the Western Forestry Leadership Coalition, *Western Bark Beetle Report: A Plan to Protect and Restore Western Forests*, (Washington, DC, 2002). The states considered for the evaluation include the 11 western states, the Dakotas, Nebraska, Kansas, and Alaska.

10. Although moist forests may erupt into catastrophic wildfire when exposed to an unusually hot, dry period, the management techniques described here will not necessarily improve the resiliency of these humid forests.

11. The fire environment triangle concept of weather, topography and fuels affecting fire behavior is described in C. M. Countryman, *The Fire Environment Concept*, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA (1972). To request a reprint of this publication, go to http://www.fs.fed.us/psw/publications/ or email Richard Schneider at rschneider@fs.fed.us.

12. A. L. Westerling, A. Gershunov, T. J. Brown, D. R. Cayan and M. D. Dettinger, "Climate and Wildfire in the Western United States," *Bulletin of the American Meteorological Society*, 84, no. 5 (2003): 595–604.

13. Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam, "Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity," *Science Express*, 6 July 2006, http://www.sciencemag.org/cgi/rapidpdf/1128834v1.pdf.

14. Branches and deadwood on the forest floor represent the "thousand-hour fuels" that take roughly 40 days to become dry enough to significantly impact wildfire behavior, if other conditions are conducive. For more on the role of temperature, see M. Lenart, "Rising Temperatures Bump Up Risk of Wildfires," *Southwest Climate Outlook*, April 2006, http://www.ispe.arizona.edu/climas/forecasts/swarticles.html.

15. T. J. Brown, B. L. Hall, and A. L. Westerling, "The Impacts of Twenty-first Century Climate Change on Wildland Fire Danger in the Western United States: An Applications Perspective," *Climatic Change* 62 (2004): 365–88; K. Hennessy et al., *Climate Change Impacts on Fire-Weather in South-east Australia*, (Commonwealth Scientific and Industrial Research Organisation, Victoria, Austrialia, December 2005).

16. N. P. Gillett, A. J. Weaver, F. W. Zwiers, and M. D. Flannigan, "Detecting the Effect of Climate Change on Canadian Forest Fires," *Geophysical Research Letters*

31 (doi: 10.1029/2004GL020876) (2004): L18211-1 to l18211-4.

17. For more on the physical reasoning behind the projected increase in precipitation variability, see M. Lenart, "Southwestern Drought Regimes Might Worsen with Climate Change," *Southwest Climate Outlook*, December 2003. This publication of the Climate Assessment for the Southwest is available at http://www.ispe.arizona.edu/climas/forecasts/swarticles.html.

18. One member of the White Mountains Natural Resources Working Group considered the wildland-urban interface to encompass any area within a day's reach of wildfire and noted the Rodeo-Chediski fire had traveled about 18 miles in one day.

19. The fire environment triangle concept of weather, topography, and fuels affecting fire behavior is described in Countryman, note 11 above.

20. B. A. Strom, "Pre-fire Treatment Effects and Post-fire Forest Dynamics on the Rodeo-Chediski Burn Area, Arizona," thesis for master of science in forestry, Northern Arizona University (May 2005). Posted at the following Web site: https://library.eri.nau.edu:8443/bitstream/2019/269/1/StromNAU2005.pdf (Last accessed April 20, 2006).

21. W. W. Covington, et al., "Historical and Anticipated Changes in Forest Ecosystems of the Inland West of the United States," *Journal of Sustainable Forestry* 2 (1994): 13–63.

22. Estimates of the number of trees in southwestern forests range from 300 to 900 trees per acre, but the larger values probably represent individual sites, while the average may be closer to 400 trees an acre, based on USDA Forest Service estimates.

23. T. W. Swetnam and C. H. Baisan, "Historical Fire Regime Patterns in the Southwestern United States Since AD 1700," in C. D. Allen, technical ed., *Fire Effects in Southwestern Forests*, USDA Forest Service General Technical Report RM-GTR-286 (Washington, DC), 11–32.

24. B. Tellman, R. Yarde, and M. Wallace, *Arizona's Changing Rivers: How People Have Affected the Rivers*, University of Arizona Department of Agriculture Issue Paper 19, (Tucson; 1997), 114.

25. R. Durrenberger, "The Colorado Plateau," *Annals of The Association of American Geographers* 62, no. 2 (1972): 211–36.

26. Photo posted on Northern Arizona University Web site at http://cpluhna.nau.edu/Change/logging.htm.

27. For instance, when one group was told they could not harvest trees because of concern about soil erosion given the wet conditions, they responded by paving part of the road so they could continue with their plans.

28. B. Segee and M. Taylor, *Prelude to Catastrophe: Recent and Historic Land Management Within the Rodeo-Chediski Fire Area* (Southwest Center for Biological Diversity, Sierra Club and Southwest Forest Alliance, July 2002), http://www.biologicaldiversity.org/swcbd/Programs/fire/r-c_report.pdf, (accessed 20 April 2006).

29. Arizona Game and Fish Department, *Statement of Reasons in Support of an Appeal of the Apache-Sitgreaves National Forests Land and Resource Management Plan*, 1988, as cited in Segee and Taylor, ibid.

30. Annual income from lumber and wood by county obtained using a Web-based tool of the Bureau of Economic Analysis Regional Economic Information System, using the selection for "Detailed Income and Employment Tables by SIC Industry 1969–2000. The tool is available at http://www.bea.gov/bea/regional/reis/.

31. The original owner of the plant, Southwest Forest Industries, sold the company to Stone Container when they moved out of McNary.

32. Most of the expenditure involved upgrading their waste-treatment processing to fully comply with the Clean Water Act.

33. E. Losos et al., "Taxpayer-Subsidized Resource Extraction Harms Species," *BioScience* 45, no. 7 (1995): 446–455.

34. C. McKinney and G. Miller, "GAO Finds Costs of Forest Service's Logging Program 'Impractical, if not Impossible' to Determine," public statement by U.S. Representatives Cynthia McKinney and George Miller, 24 October 2001), http://www.wildcalifornia.org/projects/natlforest/reports/mckinneymiller1001.html (accessed 30 April 2006).

35. Rates based on discussions and presentations at the Four Corners Sustainable Forest Partnerships workshop held in October 2004.

36. Charter members included longtime chairman Steve Campbell, Richard Remington, Martin Moore, Peter Schumway, and Todd Schulke.

37. Interviews with members of the Natural Resources Working Group. Also, Associated Press, "Fire Crews Gain Ground, Lose Some," *The Arizona Daily Star*, 26 June 1996.

38. Population numbers based on U.S. Census figures from 2000. Given the high rate of population growth in this area, the numbers have no doubt increased since then.

39. See note 4 above.

40. J. Braxton Little, "Quincy Library Group Bars Outsiders," *High Country News*, 26 April 1999.

41. The Natural Resources Working Group of the White Mountains, "Understanding the Differences and the Essential Balance Between Arizona's Amenity Economy and Resource Extraction Economies and the Essential Roles and Responsibilities of Collaborative Workgroups," paper adopted by the group on 25 May 2004.

42. Transfer payments, including retirement benefits, account for more than 39 and 32 percent of personal incomes, respectively, in Apache and Navajo Counties. Government jobs provide another major source of income for both counties, based on county-level economic data for 2002.

43. T. Finger and B. Morehouse, "An Environmental History of Climate and Water Management in the Upper Little Colorado Watershed," unpublished paper produced by the University of Arizona Institute for the Study of Planet Earth, 2006.

44. Ibid., page 3.

45. Technically referred to as the Blue Ridge-Morgan Ecosystem Management Area in the environmental analysis that led to the National Environmental Policy Act decision in April 1997.

46. Ecosystem management pilot testing project cooperative agreement between USDA Forest Service, Apache-Sitgreaves, Coronado and Tonto National Forests, U.S. Fish and Wildlife Service, Arizona Game and Fish Commission, Office of the Governor, Arizona Board of Regents on behalf of University of Arizona College of Agriculture, and Eastern Arizona Counties Organization, 12 December 1997.

47. The pre-settlement forest concept stems from ideas developed by Northern Arizona University's Ecological Restoration Institute (ERI) Director Wallace Covington and colleagues. Northern Arizona University's Dave Garrett served as a consultant for the Blue Ridge project.

48. Although some Forest Service employees initially balked at applying the term "natural processes restoration" to a managed forest type, they relented in favor of encouraging environmentalists to be involved in the restoration process.

49. Unlike the USDA Forest Service, collaborative groups are allowed to lobby members of Congress.

50. J. Baeza, "Tree Thinning in High Gear on Blue Ridge," *The White Mountain Independent*, 27 October 2000.

51. Tour of treated sections in the Blue Ridge Demonstration Project of the Apache-Sitgreaves National Forest attended by the author, Arizona, 19 May 2004.

52. Todd Schulke of the Southwest Center for Biological Diversity (CBD) testified in support of the stewardship contract at the 2005 White House Conference on Cooperative Conservation, held in St. Louis, Missouri, in September. Schulke also wrote an op-ed piece supporting the project. CBD had been one of the plaintiffs on the Mexican spotted owl lawsuit.

53. However, nongovernmental organizations have indicated that legal challenges would still have loomed if the Forest Service had awarded the stewardship contract to Louisiana Pacific, another company that had put in a bid for the project. District managers indicated they preferred a contract that supported local business interests, given the attention to economic sustainability.

54. Durrenberger, note 25 above.

55. The Healthy Forest Restoration Act requires that all lands, regardless of jurisdiction, within the Community Wildfire Protection Plan (CWPP) be evaluated as to fire regime condition class and that a treatment priority and plan be developed and implemented under the oversight of a CWPP board and a plan administrator. If a community fails to meet these requirements it will no longer be eligible for federal grant funding for forest health, fuel reduction, or certain fire assistance grants.

56. By supporting the White Mountains Stewardship Contract, the donating district can help count treated areas in its own established targets for thinning treatments.

57. L. J. Gibson, *2005 White Mountain Stewardship Project Economic Assessment, Final Draft*, 24 April 2006, page 13.

58. Raw values for carbon dioxide and other greenhouse gases (calculated as carbon dioxide equivalents) tallied by the author using the following dataset: Western Governors Association, Western Regional Air Partnership, *2002 Fire Emission Inventory for the WRAP Region, Phase II*, *Final Report,* 22 July 2005. Documents and datasets for this project (no. 178-6) are available online at: www.wrapair.org; Conversion to carbon dioxide equivalents based on: J. Houghton et al., eds., *Climate Change 2001: The Scientific Basis* (Cambridge, UK: Cambridge University Press, 2001).

59. H. J. Schellnhuber, P. J. Crutzen, W. C. Clark, and J. Hunt, "Earth System Analysis for Sustainability," *Environment* 47, no. 8 (October 2005): 10.

60. J. Wondolleck, *The Collaborative Dimension of Ecosystem Management* (Ann Arbor, Michigan: University of Michigan Ecosystem Management Initiative, 2001), http://www.snre.umich.edu/ecomgt/events/sympo97/wondolleck.htm (accessed 27 April 2006).

61. Ibid.

62. A. Moote and D. Becker, *Exploring Barriers to Collaborative Forestry* (Flagstaff, Arizona: Ecological Restoration Institute of Northern Arizona University, December 2003), https://library.eri.nau.edu:8443/bitstream/2019/116/4/MooteNAUERI2003.pdf (accessed 27 April 2006).

63. M. Lenart, "Is Global Warming Creeping into Southwest Forests? Evidence Building That Warming Is Already Affecting the Region," *Southwest Climate Outlook*, February 2005. This publication of the Climate Assessment for the Southwest is available at http://www.ispe.arizona.edu/climas/forecasts/swarticles.html.

64. For instance, the Intergovernmental Panel for Climate Change projects average annual temperature will rise by between 3 and 10 Fahrenheit by 2100. National Oceanic and Atmospheric Administration researchers Martin Hoerling, Jon Eischeid, and Gary Bates project southwestern winter temperatures could climb by about 3.5 degrees Fahrenheit by 2050.

65. R. J. Norby, S. D. Wullschleger, C. A. Gunderson, D. W. Johnson and R. Ceulemans, "Tree Responses to Rising CO_2 in Field Experiments: Implications for the Future Forest," *Plant, Cell and Environment* 22 (1999): 683–714.

66. K. Green and R. Wright, "Field Response of Photosynthesis to CO_2 Enhancement in Ponderosa Pine," *Ecology* 58 (1977): 687–692.