Good Fire, Bad Fire

How to think about
forest land management
and ecological processes

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SAVING THE LAST GREAT PLACES ON EARTH

The first rule of tinkering is to save all the parts, according to forester, philosopher, and hunter Aldo Leopold. Leopold was thinking about wildfire 50 years ago when he also was questioning his own role in exterminating large predators, wondering how their removal might affect forest ecosystems in the future. Leopold was well ahead of his contemporaries in ecological thought. Like predators, fire cleans and regenerates the systems it touches. A generation later, we're seeing the dramatic consequences of excluding fire from fire-adapted ecosystems.

Consequences

When Colorado's Hayman fire erupted on June 9, 2002, it did something no one had witnessed in the Front Range of the Rockies. The fire swept into a solid forest canopy of ponderosa pine and Douglas-fir and raced 19 miles in a single day, sending convection currents to 21,000 feet and sparking new blazes more than a mile ahead of its blistering front. Nothing like it had happened in Colorado's recorded history. No amount of air support or ground attack could stop it. Fire crews could only get people out of the way. Fighters couldn't contain the conflagration for the next 10 days. When weather finally slowed the fire, it had touched 138,000 acres and set an ominous record: 60,000 acres of nearly total forest destruction. While smaller-scale, stand-renewing fires appear throughout the tree-ring record in the southern Rocky Mountains, this was the worst known fire in at least 700 years.

Conditions were ripe. Rainfall had been well below normal for the previous four years, the result of a distant La Niña event in the southern Pacific. Relative humidity was about 5 percent and winds were 20 to 50 mph from a direction favoring rapid fire spread. But another factor that had nothing to do with the weather led to the blaze. The forest itself had built up to this for almost a century.

That something was awry in the forest escaped notice for a long time, partly because the problem had more to do with what wasn't happening. The forest had been operating for decades without all its systems intact, and the missing part was fire itself.

Without periodic fires the forest lost an important control mechanism, allowing excessive regeneration and a build-up of fuels beneath the forest overstory. Though obvious now, in the early 1900s people saw wildfire as a destroyer of forests, a threat to human safety, and an unacceptable waste. That fire might serve as an integral part of the forest machine, preserving its health, assuring its future, protecting the quality of our air and water, was unimaginable in the new West. So the natural fire cycle as a regulatory system was often deliberately or indirectly altered—and the wonderfully complex, self-running, self-correcting forest machinery broke.

The story was much the same throughout fire-adapted ecosystems of the West. In the semi-arid grasslands, ranchers have viewed wildfire as the greatest single threat. A range fire's appetite for grasses seemed surpassed only by that of the cattle. Fire threatened isolated houses and respected no property boundaries. Thus, every ranch became every other rancher's concern and fire exclusion became the highest priority—a matter of economic survival. But range fires are an important part of the prairie machine too, and when they were removed the machine sputtered. Aggressive shrubs, held at bay by recurring fires of the distant past, encroached upon grasslands. Eastern red cedar moved westward, usurping resources that once belonged to the prairie, and soon ranchers were spending their money trying to eradicate the invasive plants.

The lessons sifted from the ashes of 2002 are obvious. When the Hayman fire went haywire in Colorado because the forest machine had ran too long without all its parts, it ended up costing 132 homes, $42 million in suppression efforts, and incalculable loss of opportunity. It is clear that our social and economic well-being depends upon maintaining our ecosystems and that disruption of self-regulating processes can be disastrous.

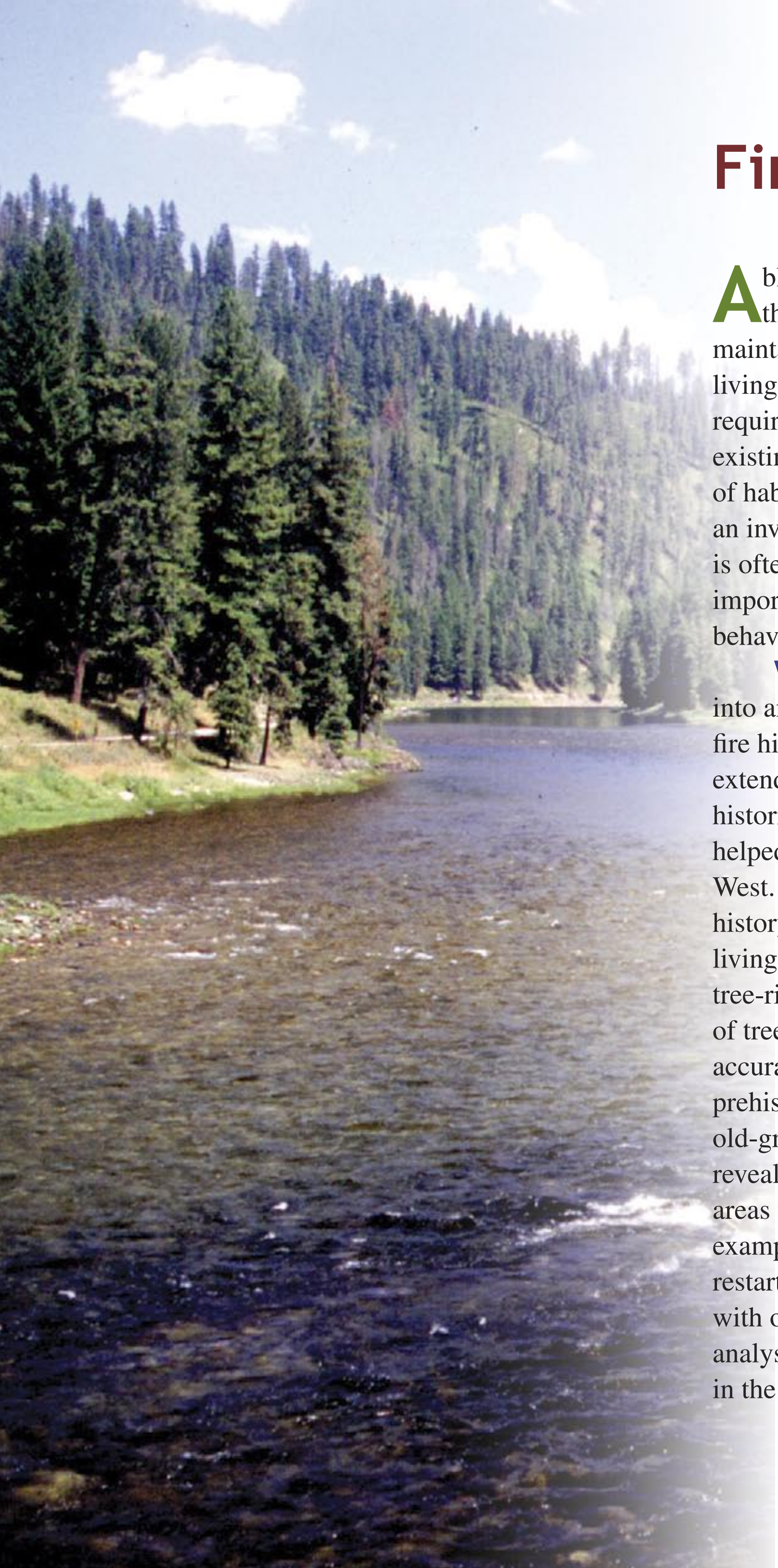
But we find ourselves now in a difficult position: that of having to manage complex landscapes without all the information we would like. We still don't know much about nature's regulatory processes, such as energy flows and nutrient cycling. Parts of the system interconnect in ways we cannot see or comprehend, and the functional roles of individual species are incompletely understood. As expressed by American ecologist Frank Egler, "Ecosystems are more complex than we think—they may be more complex than we can think." Here, however, is where the words of Leopold ring like a hammer on steel:

The first rule of tinkering is to save all the parts.

Sidebar: The Niobrara River-Nebraska Sandhills Region

The Niobrara River-Nebraska Sandhills region encompasses some 12 million acres of squelched slow-growing shrubs. The near elimination of wildfires in the last century has had many adverse effects including the accumulation of fuel hazards, changes in plant community composition, and lost range-management options. Ranchers now face far greater threats from fire than under previous natural conditions. In parts of northern Nebraska and southern South Dakota, ranchers have lost 60-70 percent of their productive rangeland to invading shrubs, translating into annual income losses of $20,000 or more for some.

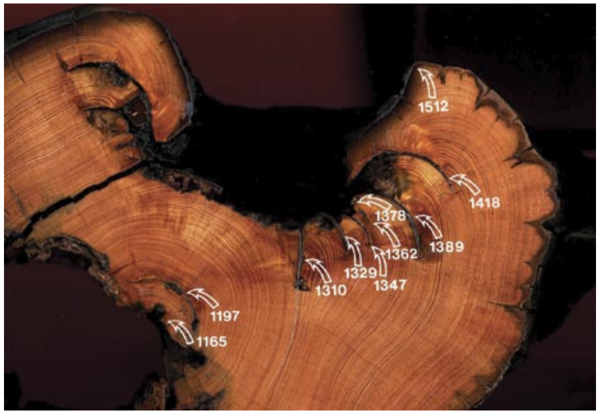
More ranchers in the Niobrara-Sandhills region are learning the benefits of returning fire to its natural role, thereby reducing forage losses and tree invasion. Consequently, a 12-member partnership of landowners and other stakeholders formed to create a new fire management paradigm. The partnership includes private landowners and commercial businesses, eight rural fire districts in four counties, several state and federal government agencies, and the Nature Conservancy. They focus on education and regional fire management infrastructure, including the funding and retraining of volunteer fire fighters in the tools and techniques of prescribed burning. Though independent stakeholders often have diffferent land management objectives, partners have identified common ground in a desire for restored ecosystem integrity through improved wildfire management and appropriate use of prescribed burns. Common benefits include community protection from severe fires, improved productivity of ranch land, and greater protection of plant and animal species.

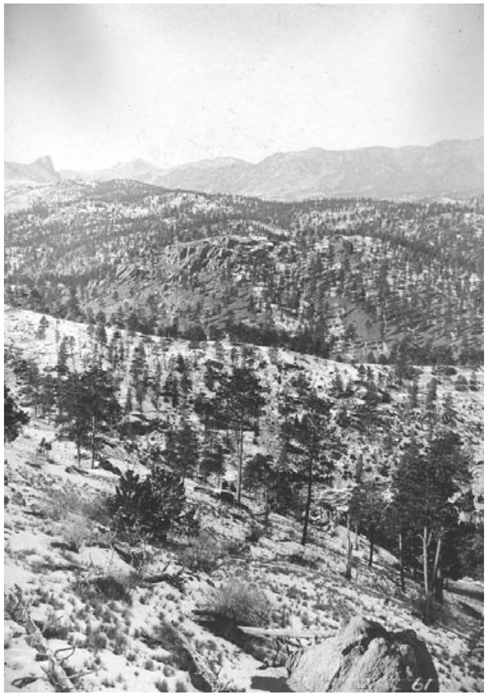


Fire as Process: Pre-settlement

A blackened forest doesn't appear to support much life, so fire exclusion might seem the first rule of saving all the parts. But the right kind of fire, as we have seen, helps maintain conditions necessary to support life. Certainly, in the short term, fire destroys many living organisms. But fire also creates opportunity. Plants and animals differ in their site requirements and competitive abilities. Many depend on the presence of openings in the existing plant cover to establish and complete their life cycles. Fire helps maintain a mosaic of habitat conditions in the landscape and thus preserves biodiversity. Just as diversity in an investment portfolio offers stability in the face of market fluctuations, diversity in nature is often the key to ecosystem stability and protection of rare or uncommon species. It is important to draw a distinction, however, between natural fire regimes and the altered fire behavior that we now witness.

What constitutes a "natural" fire regime? Much scientific probing has gone into answering this question. Through meticulous research, past forest conditions and fire histories have been reconstructed for some forest sites in the Colorado Front Range extending as far back as 1200 A.D. Detailed journals from early explorers, old photographs, historical forest inventories, logging records, and General Land Office surveys have all helped to piece together a picture of what our forests looked like when settlers arrived in the West. The greatest insights into past fire regimes have come from deciphering the permanent history of climate, forest fire, and insect outbreaks recorded in the annual growth rings of living and dead trees—the science of dendrochronology. By precisely dating fire scars in the tree-ring record and then mapping the locations of trees with scars of the same age, we gain an accurate picture of fire frequency and size in prehistorical times. Analyzing the age structure of old-growth stands in previously burned areas also reveals the severity of these fires, especially in areas that escaped earlier logging. Crown fires, for example, result in complete stand replacement and restart. All this information can then be compared with other historical records and current stand analyses to indicate how conditions have changed in the past century.





What have these investigations revealed? Today's forests are often very different in structure from pre-settlement forests. Forest fires behave much differently from the past as a result of changes in forest structure.

Scientific reconstructions show fire to have played a recurring role in shaping plant communities in almost every forest and grassland ecosystem in the western United States, as well as in the oak-shrublands and pine forests of southern and eastern regions. In prairie and savanna ecosystems the natural return interval for fire pre-historically may have been as short as 1-4 years. Even in oak woodlands and southern shortleaf-pine forests, a return interval of 5 years was not uncommon. In many mid-elevation ponderosa pine forests, particularly in the Southwest, the natural fire return interval ranged from 6-20 years. Only in the moist spruce-fir forests of higher elevations or in the dry piñon-juniper woodlands of western foothills (where widely spaced trees and a lack of groundcover carried fire poorly) did the average fire interval stretch out to 200 or 400 years or more.

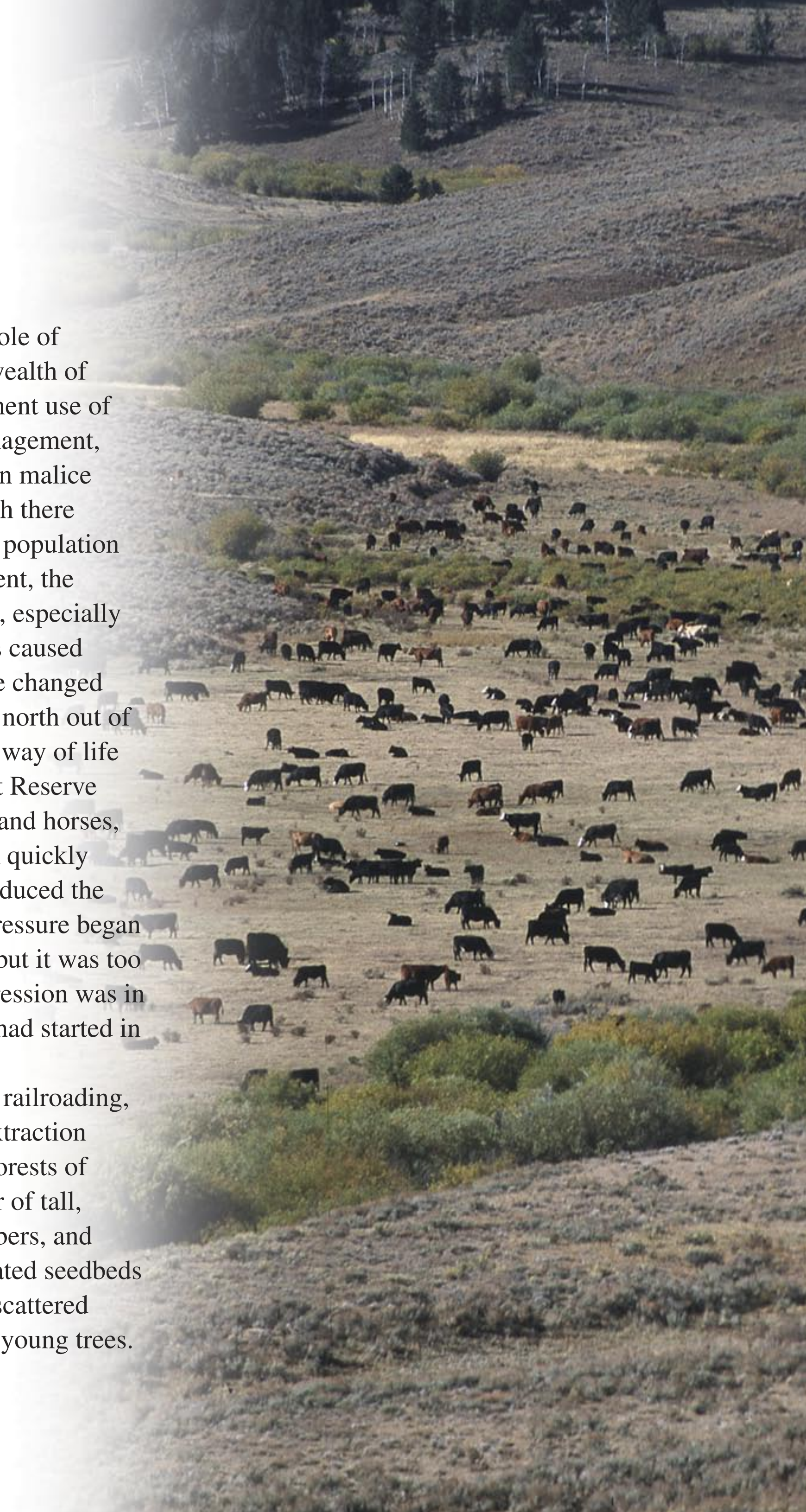
This does not mean, however, that all oak woodlands burned every 5 years, or that a ponderosa pine forest was "overdue" if it had not experienced fire for 20 years. In one of the most extensive investigations of its kind, studies in central Colorado's ponderosa belt—in the very place where the uncharacteristically severe Hayman fire burned—revealed a total of 77 fire years between 1197 and 1963 (the latter being the most recent fire year until 2002). Fires ranged in scale from thinning of small stands of trees to scorched hillsides across the forest landscape. However, intervals between individual fires were highly variable, between 3 and 58 years in one stand to over 100 years in others. And though the average fire return interval for the entire 10,000-acre study area was only 9 years, intervals for individual areas were about 50 years. Large portions of the landscape did not burn for a 128-year period between 1723 and 1851.

What were the ecological effects of recurring fire in these ecosystems? Where return intervals were short—such as ponderosa pine forests of the Southwest—ground fires of low intensity removed seedlings and saplings, consumed accumulated tree litter, and accelerated the return of nutrients to the soil. This was nature's population control, maintaining open, park-like forest stands with a continuous ground cover of grasses, herbs, and shrubs beneath the forest canopy. Overstory trees surviving the ground fires were fewer and larger, in some old-growth forests numbering 40 trees or less per acre. Where return intervals were longer—perhaps one or two fires a century as in ponderosa pine in the Hayman fire area in Colorado—"mixed severity" fires spread into the canopy in some stands. In other stands, fire burned only fuels on the ground. Mixed severity fire left behind a much more complex forest landscape. When this happened, temporary openings were created in the forest, some of which would persist for many decades while others were soon colonized by nearby seed sources. The record shows that these pulses of tree recruitment occurred on average every 50 or 60 years. Thus, the most important result of this pre-historical, mixed-severity fire regime was the creation of a diverse, ever-changing mosaic of forest habitats. This fire regime supported maximum biodiversity, ecosystem sustainability, and watershed protection over large areas.

The Changing Landscape: The Last Two Centuries

Three things happened in the last two centuries to change the natural role of fire: The first, oddly enough, was the loss of human-caused fires. A wealth of archaeological evidence, ethnographical studies, and oral histories document use of fire by Native Americans in many parts of the country—for resource management, pest control, land clearing (sometimes for fire-proofing villages), and even malice and warfare. Fire probably escaped to burn far more than intended, though there also were areas where Native American burning was uncommon because population densities were low. With the spread of Euro-Americans across the continent, the fires of indigenous peoples were gradually quelled (though in some areas, especially where mining and railroad construction occurred, Euro-American settlers caused accidental fires). As the indigenous fires were extinguished, the landscape changed in other ways. When Juan de Oñate led his troop of settlers and livestock north out of Mexico in 1598, the animals spread faster than range fire, and a different way of life was established for the West. By the time the Sacramento National Forest Reserve in southern New Mexico was created in 1907, an estimated 17,000 cows and horses, 10,000 sheep, and 40,000 goats grazed the forest. Free-roaming livestock quickly cropped the native grasses in the forest understory, and the lack of fuel reduced the frequency and effectiveness of lightning-sparked ground fires. Grazing pressure began to diminish in the prolonged droughts of the late 1800s and early 1900s, but it was too late for the fire-deprived forests. By then a policy of aggressive fire suppression was in place throughout much of the West. Tinkering with the forest ecosystem had started in earnest and fire was the first piece of the green machine to be dropped.

Western forests also were seen as a ready source of timber. Mining, railroading, and the rapid growth of communities in the West resulted in more than extraction of minerals from the earth. Vast areas were subjected to logging. Virgin forests of ponderosa pine and other species provided a seemingly unlimited frontier of tall, straight trees for lumber. Smaller trees provided railroad ties, mining timbers, and fuel. Logging removed many of the old trees, and just as importantly created seedbeds for millions of new seedlings to be established. In short order, forests of scattered large ponderosa pine trees were replaced by denser forests dominated by young trees.



What were the consequences of these changes in natural fire regime and structure of the forests? The conflagrations of 2002—in Colorado, Arizona, and Oregon—tell much of the story. As decades of fire exclusion and repeated logging allowed successive crops of new seedlings to gain a foothold, the understory began to fill in. Gradually the composition and structure of our forests changed. Fire-sensitive Douglas-fir often became prominent in ponderosa forests and stand densities reached new highs. Rather than having 40 or 50 trees per acre, our mountain slopes were soon supporting upwards of 200-400 trees per acre—often 10 or more times the normal density. Openings no longer were created by small and isolated stand-replacing fires, and those previously existing gradually filled in. The forest canopy, once a diverse mix of stands of differing ages, was soon uninterrupted over hundreds of square miles.

This set the stage for fires with very different behavior. As the forest canopy closed overhead, young trees reaching for light became fuel ladders, carrying ground fires quickly into the crowns of trees. And, once into the crowns, a ground-clearing fire is transformed into an all-consuming rage. Witness the record-breaking Hayman fire in Colorado: there is no evidence in the scientific record that any fire in pre-historical times produced such extensive stand destruction. The diverse patchwork maintained by recurring smaller or less severe fires would likely have prevented such from happening. These threats were not limited to ponderosa pine forests either. Similar alterations were occurring in other ecosystem types across the United States where natural fire was a frequent visitor, clearing the way for invasions of destructive non-native species better-adapted to the new fire regimes and hence able to often crowd out natives.

Tough Love: Realigning Our Ideals With Ecological Reality

Science and history tell us that much of the western landscape we grew up knowing and loving is an artifact of human management from the late 19th century. With fire removed from ecosystem processes, and nothing to limit shrub invasions in prairies or millions of seedlings in forests, our landscape has become unnatural and unsustainable. When fire strikes now, it's a different problem because the land has been too long without. The first step in redressing this situation may be the most difficult--that of changing our collective perception of what a healthy and sustainable forest or prairie looks like. We have to learn to understand what we see, for we have grown up accepting our experience, believing the forests we see today are natural. To deliberately alter them seems contrary to the very ethic of good environmental stewardship. But good stewardship, and good ecology, often means realizing that many of today's forests are not natural at all. Here the scientific community can help. Carefully done science can provide common ground for agreement among different stakeholders, enabling communities to unify.

Can we remedy the situation by reintroducing fire? Yes, at least partially.

Can we simply allow natural fires to burn again and let nature take over from there? As a general rule, no. In many cases our forests, due to our tinkering, have become too vulnerable to runaway crown fires. Even the most carefully planned "controlled" burns may constitute unacceptable risk to the many people who live in or near the forest, at the wildland-urban interface. The best science available tells us that at some point we must reinstall this missing ecosystem process so the natural machinery functions properly again. We have to do it cautiously until our forests are restored to a more natural condition, and we may need treatments other than fire to reduce the risks of reintroducing fire. In

many other places, such as some prairies and shrublands, it is only our perception of the role of fire that we must overcome to restore normal ecosystem processes. Fire can threaten ranch structures, but lack of fire can be a greater threat to long-term ranching livelihood. The larger questions then become: **What does restoration involve, on what scale is it needed, and how will we accomplish it?**

Short of rekindling primordial fires, the best way now to reduce the density of our forest stands that currently support many more trees per acre than in historical times is through mechanical thinning. For many people, however, the prospect of removing half or more of the trees from our forests might seem untenable. Objections often come down to questions like: **What will the new forest look like? Who will profit from thinning? Where is thinning ecologically appropriate?**

In light of past experience, these are legitimate questions. Most of us treasure the forests we grew up with, even if they are ecologically "out of whack." Suspicion of land management agencies as a result of past contracting practices on public lands has not always been unjustified. There is some uncertainty as to where logging is warranted. Not all forests—for example, high-elevation spruce-fir or lodgepole pine with naturally long fire return intervals—have been altered in the same way, so they need different types of restorative treatments.

Photo series: Reducing forest density may promote larger and healthier trees, fewer disease and insect outbreaks, and greater biodiversity.

Still, evidence from recent research in the Pacific Northwest, as well as in Colorado and the Southwest, indicates that less dense forests may promote larger and healthier trees, fewer disease and insect outbreaks, and greater biodiversity. This translates into several social and economic advantages: robust game and non-game wildlife populations, enhanced wildland recreational values, and watershed protection. There may be some short-term ecological costs; logging on any scale temporarily disrupts natural communities, shifts competitive balances between species, and alters energy flows and nutrient cycles. Access roads may increase erosion and sedimentation in watersheds, allow greater human entry into previously roadless areas, and provide conduits for exotic species invasions. Nonetheless, carefully planned and executed mechanical thinning may be the only way back to restoration of self-regulating ecosystem processes, guaranteeing future generations all the physical and spiritual benefits of a diverse and healthy forest environment.

And we must recognize this too: doing nothing may result in even greater long-term ecological costs associated with unnaturally large and severe fires. Catastrophic fires can set back forest recovery many centuries, cause massive erosion in watersheds, reduce habitat for threatened or endangered species, and irreversibly spread non-native species.

Sidebar: The Jemez Mountains Fire Restoration Project

The Jemez Mountains Fire Restoration Project is situated in northwestern New Mexico and encompasses 987,000 acres of mid- to upper-elevation piñon-juniper, ponderosa pine, and montane mixed-conifer forest, with fire-adapted grassland and shrub communities intermixed. Homes are dispersed widely throughout the area, with 37,000 acres classed as wildland-urban interface. The project area falls within 10 different federal, state, and tribal jurisdictions.

Several large, high-intensity fires in recent years (e.g., Cerro Grande) have seriously impacted forest ecosystems, archaeological resources, and the economic well-being of the region, raising public awareness of the ecological issues involved. With assistance from The Nature Conservancy, a team of academic advisors, private consultants, and government agency personnel has been assembled to implement a new fire management policy to make communities safer and ecosystems healthier. The team has identified the following priority tasks:

- Gather and organize baseline ecological and social information.
- Integrate fire risk-reduction with ecological restoration and maintenance.
- Create partnerships that include federal, state, and local agencies and organizations and private landowners.
- Build connections between the scientific community and land managers to ensure that policy decisions are informed by the best science available.
- Provide a framework for adaptive management - planning, implementation, monitoring, and evaluation - within and across administrative and political boundaries.

The team has compiled and refined data layers showing fire history and past, current, and planned fuel-reduction treatments of the Jemez Mountains. They have also constructed models of ecological function for each fire-adapted ecosystem. From this information the team has assessed threats to, and measures of the ecological integrity of the Jemez landscape.

Now, the goal of the Jemez Mountains Fire Restoration team is to build consensus for a coordinated landscape-scale approach to ecological restoration, and then work with community leaders on watershed-scale fire management planning.

Our Task

Our task will not be easy. The fires of 2002 and others in recent years demonstrated a landscape-scale problem, and isolated small-scale corrective measures are likely to be completely overwhelmed in a large burn as they were in the Hayman fire. Thinning on a large scale will require commitment and innovation from the private sector. The land area, public and private, requiring restoration is now vast. Most trees that must be removed from our forests are of small diameter and presently non-merchantable— thus requiring imaginative new-product development and financing. Though this may sound formidably difficult and expensive, we as a people have never shied away from innovation. We have seen repeatedly in recent years that more sustainable management of our resources has led to significant economic and social benefits.

The problem facing us today did not occur overnight, and it's not likely to be corrected overnight. Complex problems are rarely solved with little effort. This shouldn't discourage us, however, from taking steps toward a solution, for the road may turn out smoother than we think. Good ideas evolve as we gain new ecological insights and adjust management activities accordingly. We don't need all the information available to get started, provided that management decisions are continuously re-evaluated with new information and experience.

Starting simply can yield incalculable benefits in the long run—and a good start might be to expand on Aldo Leopold's admonition. **Save all the pieces—save all the processes.** Ecosystems must have the potential for supporting all naturally occurring organisms and their assemblages—the pieces—in the system, along with the physical environment needed to support them, regardless of whether their role in the system is understood. In addition, ecosystem processes and their frequency, distribution, and intensity must be retained or restored to allow ecosystems to self-regulate. These processes include natural disturbances such as floods and fire. To this short list we might add **think long term**. Ecosystems function in time scales well beyond the normal human experience. Soils develop over millennia and forests require centuries to mature. Some management goals will be accomplished only over generations of leadership. But small steps make for great strides. What matters most now is getting started and using the best science available to guide the process.

What can you do?

- Get involved in a community-based conservation group working on local landscape restoration projects.
- Educate yourself about the role of fire in your local ecosystems.
- Provide feedback on National Forest, BLM, or other agency land management plans.
- Consult with regional experts or The Nature Conservancy on how to safely reintroduce fire to your ranch or land holding.
- Participate in local Firewise workshops to learn how to treat fuels around your home and create defensible space (www.firewise.org).

Start simply. But start.

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