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Overcoming the Paradox In Managing Wildland Fire

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Although the use of fire in wildland management is sound conceptually, in practice it is often mired in a paradox: Long-term protection of land and natural resources from fire has altered vegetation and fuels, increased risk of severe fires and reduced resource values. This paradox is more important in some ecosystems than others.

This article discusses the paradox by examining the basis for wildland fire management and the barriers to its applications. It then presents possible approaches to restoring fire or appropriate alternatives. The focus is on western North America, where federal wildlands are abundant and where fire is a prominent natural disturbance and initiator of successional change.

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For thousands of years, fire shaped the composition and structure of North American forest, woodland, shrubland and grassland ecosystems (Pyne 1982). In a few areas, such as coastal Alaska and some Southwestern deserts, it was of secondary importance. Over most of North America, however, fire was a principal reason that seral (shade-intolerant) tree and shrub species remained abundant. Fire also kept shrubs and forests from encroaching into grasslands, and it favored herbaceous species and sprouting shrubs in the semiarid steppes.

Historical fire regimes were varied (Kilgore 1987) and included:

- Frequent surface fires (less than 25-year fire return intervals) in most grasslands, Southern pinelands and Western ponderosa pine forests
- Infrequent surface fires (25- to 100-year intervals), causing patchy mortality in some Eastern hardwood forests, coastal redwood and dry-site coastal Douglas-fir
- Infrequent stand-replacing fires (more than 50-year intervals) in some Rocky Mountain lodgepole pine forests and boreal coniferous forests

Fire suppression and other human activities have altered the historical fire regimes, characterized by fire frequency and the severity and pattern of burning, in much of North America. The structural characteristics of vegetational communities have often changed as a result (Christensen 1988). In the vast semiarid region of western North America, the primeval role of fire was altered in the mid-1800s by heavy livestock grazing, which removed fine fuels from much of the landscape, and by farming, irrigation and other development, which broke up the continuous fuel bed that had covered intermountain valleys and plateaus (Pyne 1982). Disruption of the American Indians' hunting-gathering lifestyle removed a major ignition source in some areas (Gruell 1985).

In other vegetation types, fire traveled through non-herbaceous fuels — chaparral, dense conifer canopies or ponderosa pine needle litter — and thus continued until coordinated fire suppression was organized in the early 1900s. By the 1930s, suppression was quite effective in most areas. Fires of low and moderate intensity were readily extinguished, and only the most severe fires burned across the landscape.

Suppression and other human-induced changes have produced successional changes in wildland vegetation and fuels. In short-interval regimes, historically characterized by frequent fires, woody fuels generally increase in the absence of fire. Grazing often removed fine herbaceous fuels, thus preventing fires from spreading, and also allowed conifers such as western juniper and inland Douglas-fir to invade and eventually develop dense stands. Without fine fuels, these stands can now burn only at long intervals in severe stand-replacing fires.

In long-interval regimes, such as high-elevation lodgepole pine, fire exclusion may initially reduce fuels and fire behavior potential because fire kills vegetation and creates fuel. Eventually, however, stands become overmature, and dead fuels accumulate (Brown and See 1981). Patterns of fuel accumulation also vary spatially because site conditions differ across the landscape.

Aldo Leopold (1924) expressed concern about successional changes in the mountains of Arizona and New Mexico in the early 1900s. Overgrazing had removed the luxuriant grass cover and halted the short-interval fire regime that perpetuated seral mountain grasslands. Within 40 years, a dense growth of mountain brush and trees had replaced the grasslands, accelerated erosion was widespread, and forage productivity had dropped sharply. Harold Weaver (1943), a government forester, described how interruption of a short-interval fire regime in ponderosa pine/mixed conifer types had resulted in hazardous fuel accumulations, development of stagnating conifer thickets and reduction of forage growth.

In coniferous forests of the Inland West, interruption of natural fire regimes often promotes dense growth of shade-tolerant tree species, with attendant epidemics of defoliating insects, bark beetles, dwarf mistletoe and root diseases that can cause stand deterioration and heavy fuel accumulation (Fellin 1980).

The most obvious successional changes with fire suppression are found in short-interval fire regimes, where the current fire-free interval is now much longer than any others in the past few centuries (Barrett 1988). Living and dead fuels continue to accumulate. Recent fires have been more severe and difficult to control (Steele et al. 1986).

Fire suppression has also affected intermediate-interval natural fire regimes. For example, in the relatively produc-

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1909

1927

1948

Successful replacement of ponderosa pine by Douglas-fir between 1909 and 1948 at a camera point on the Bitterroot National Forest, Montana. Photos U.S. Forest Service tive and short-lived lodgepole pine forests in the northwestern portion of Glacier National Park, amount of area burned declined dramatically after 1930, compared to the previous 300 years (Barrett et al. 1991). As a result, the lodgepole pine forests have reached maturity in most of the area. This set the stage for an unusually severe bark beetle epidemic in the 1970s, which created heavy fuel loadings over a broad area. In 1988, 27,000 acres of this forest burned in a severe wildlife, the Red Bench Fire, which killed most of the old-growth, fire-resistant ponderosa pine and western larch, both of which had survived numerous fires since the 1600s.

Even long-interval fire regimes can be influenced by fire suppression. As areas of mature and overmature forest become more extensive, the vegetational mosaics of these ecosystems change — including their structure, function and biodiversity. The implications of these changes are unknown.

Continuing fuel buildup is often accompanied by deterioration in forest health and wildlife forage (Hall 1976). It can also threaten homes and development in and near wildlands. Despite huge expenditures, fire control efforts can do little with severe fires in dense fuels (Anderson and Brown 1988). Fuel accumulation and drought are probably partially responsible for the marked increase in area burned by wildfire in the West since 1979. Natural fire programs contributed to the high acreage figure in 1988, but they had minor effects during other years. Van Wagner (1988) reported a comparable increase in area burned annually in Canada.

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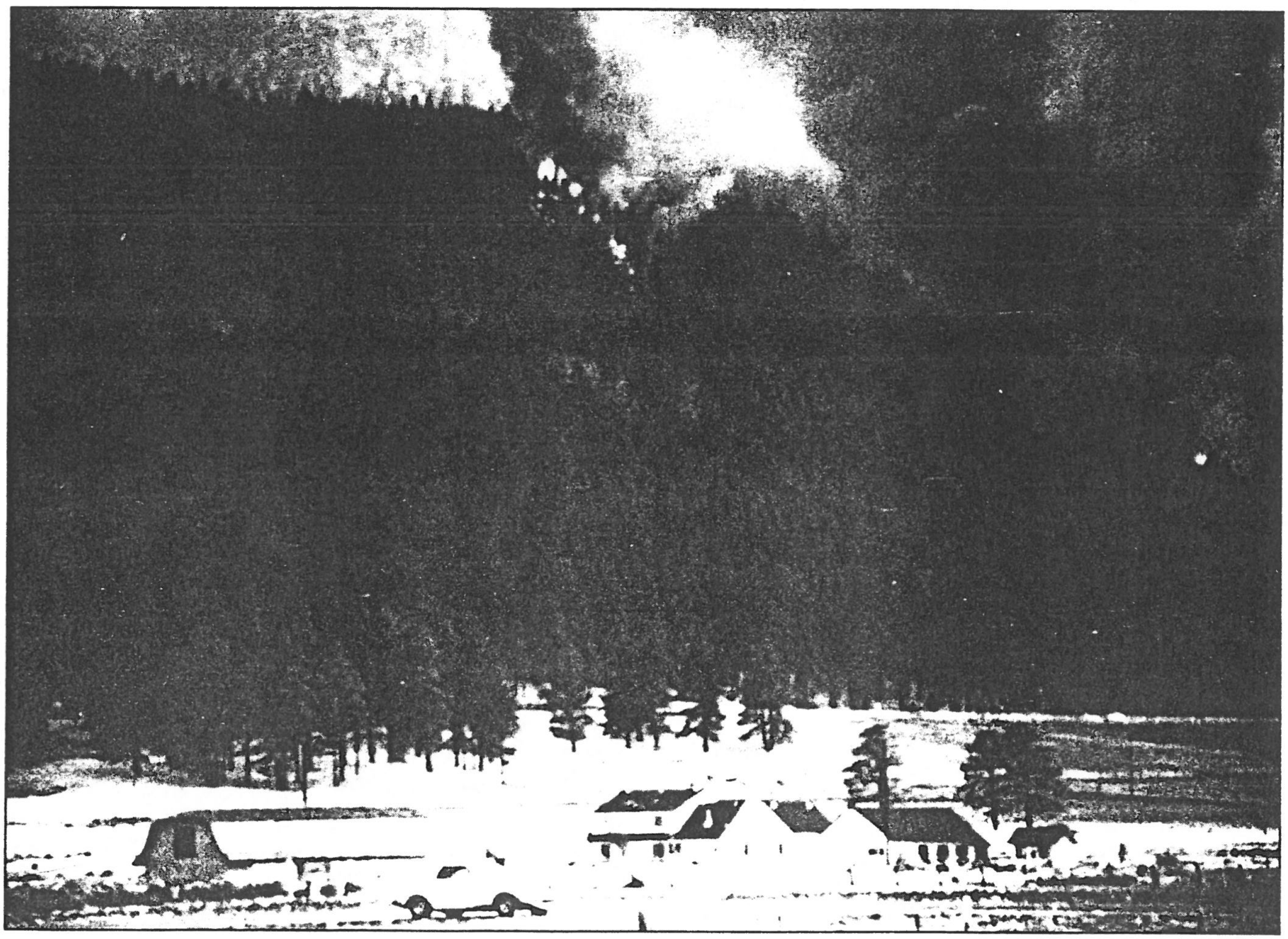
In many wildland areas, including national parks, managers are directed by policy and sometimes by law to maintain primeval conditions, including natural ecosystem processes. In these "natural areas," humans are to be only visitors, without disrupting the forces of nature. A major shortcoming of management in these areas is the continual manipulation of ecosystems that results from extinguishing natural fires.

During the past two decades, prescribed natural fires — lightning ignitions allowed to burn under approved conditions of weather, fuel moisture, time of year, etc. — and



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manager-ignited fires have been used in some Western national parks, wilderness areas and other areas managed to maintain or restore natural processes. For example, fire has been returned to giant sequoia groves in Yosemite, Sequoia and Kings Canyon National Parks; fire has also been allowed to maintain a vegetational mosaic across the rugged landscape in Idaho's Selway-Bitterroot Wilderness (Kilgore 1987). Manager-ignited prescribed burning is being tested as a substitute for lightning fires to maintain a landscape mosaic in Banff National Park, Alberta (Lopoukhine and White 1985). And managers are using prescribed burns to perpetuate natural plant communities in Everglades National Park (Kilgore 1987).

In contrast, harvesting of timber, pulpwood and fuelwood, as well as livestock grazing, are permitted on large areas of wildlands. In most public lands where harvest is permitted, the management goals are to maintain healthy, biologically diverse communities of indigenous plants and animals. In national forests of the interior Northwest, most notably Oregon, several thousand acres are underburned each year in ponderosa pine-mixed conifer forests (Kilgore and Curtis 1987). On clearcut units, moderate-severity broadcast burning is used to reduce fuel loadings and to regenerate seral tree and undergrowth communities (Harvey et al. 1989). High-severity slash burns, in which nearly all of the organic material on the forest floor is consumed, are now usually considered ecologically inappropriate. There are some ecologically questionable applications of fire in wet, coastal Northwest forests, where trees are grown on short rotation and followed by high-severity slash burns, in contrast to the long-interval natural fire regime (Kaufmann 1990).

Considering the vast extent of natural areas and managed wildlands in western North America, the effort to restore fire has been limited, although the area so treated has increased in the last 10 years (Simmerman and Fischer 1990). There is little funding available for prescribed burning or other fuel-reduction treatment, although funds for suppression of wildfire are virtually unlimited. This is somewhat ironic because such efforts are essentially futile during dry, windy weather. About $145 million was spent attempting to control the 1988 Yellowstone area fires, but these efforts were largely ineffective, except for protecting structures (Wakimoto 1989). If these funds were used instead for management of hazardous fuels, the costs of suppression and its unwanted side-effects might be reduced in the long run.

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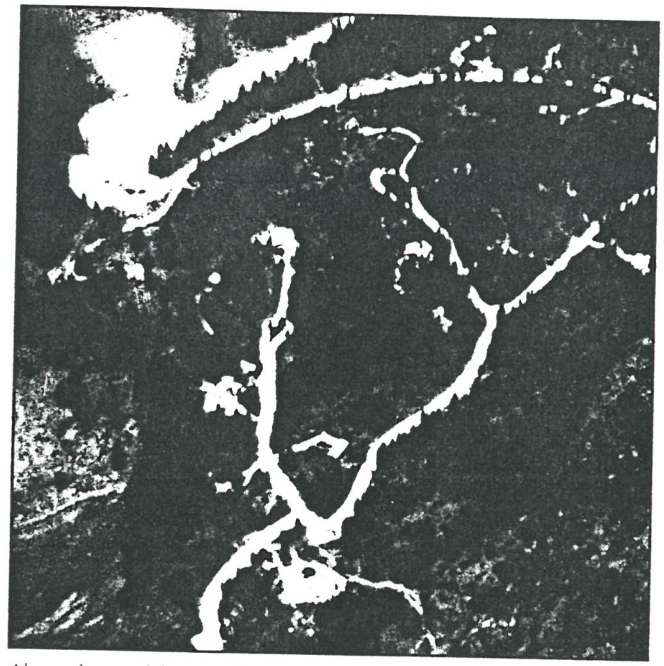
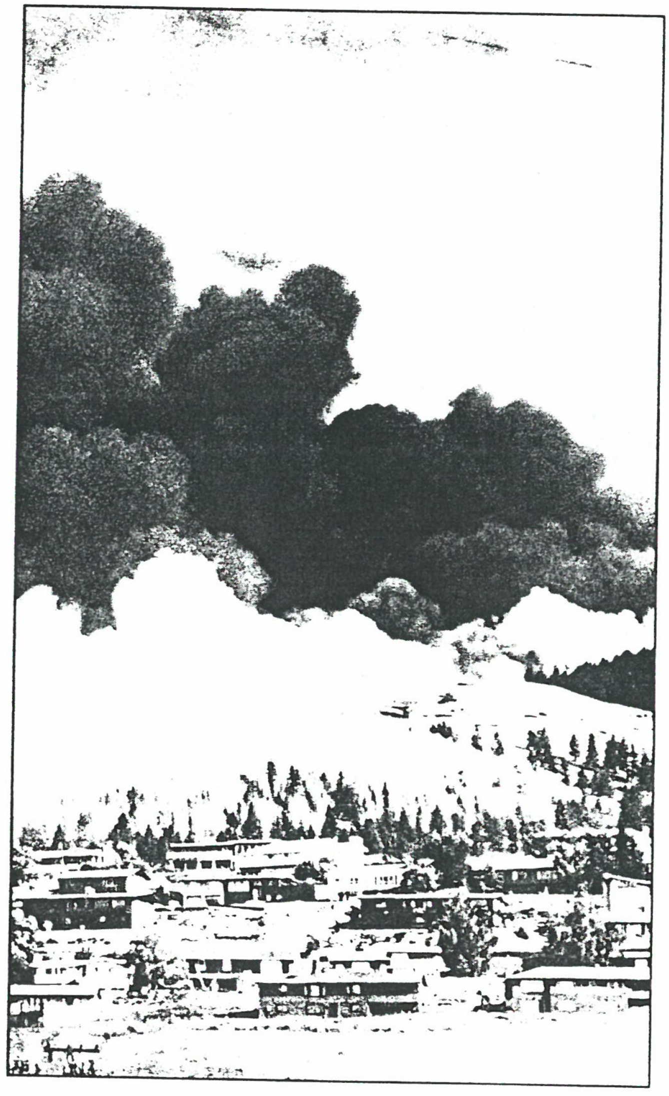
The relative size and remoteness of natural areas influence fire management alternatives. In large areas, prescribed natural fires can play a major role in restoring a mosaic of vegetation and fuels to near-primeval conditions. Since the 1970s, prescribed natural fires have been used more frequently in large wilderness areas — notably the Selway-Bitterroot, Frank Church-River of No Return and Bob Marshall complex — and in Yellowstone National Park.



Above: forest subdivision. Photo/U.S. Forest Service; below: forest fire near Missoula, Montana. Photo/Harley Hettick



Nevertheless, prescribed natural fires cannot completely replace primeval fires in large natural areas, for several reasons. First, many lightning fires must be suppressed because they threaten land, resources and development outside the natural area, or their smoke is unacceptable. The 1988 fire season illustrated that early and mid-season fires can escape large natural areas.

Second, naturally occurring fires that could spread into a natural area from outside it will continue to be suppressed. And, finally, accumulated dead and living fuels produced by past fire suppression may have created the potential for unusually severe fire behavior in some forest types. The latter favors high-intensity, stand-replacing fire, which may be inconsistent with historic fire regimes.

Achieving a completely natural fire process is not a realistic goal in natural areas, except in portions of Alaska. But a program of prescribed natural fire could help restore fire as an ecological process in large wilderness areas and national parks. Such a program could be used to deal with high risk situations, such as hazardous fuels near facilities and sensitive administrative boundaries. Lightning fires that must be extinguished early in the fire season because they are likely to escape could be reignited later, when risk of escape is acceptable.

Most natural areas are too small and closely confined by private lands to rely on lightning ignitions for restoring fire as a process. Manager ignitions would be necessary in these areas. Although manager ignitions are being used in some national parks, wildlife refuges, Nature Conservancy reserves and in New Mexico's Gila Wilderness, most smaller areas have no plan for restoring fire. The major obstacles are concern that manager ignition would be "unnatural" and lack of funding.

The recent campaign to protect old-growth forests focuses largely on preservation of subclimax tree communities such as coastal Douglas-fir, ponderosa pine, western larch, interior Douglas-fir and western white pine, which are heavily dependent on natural fire (Habeck 1988, Morrison and Swanson 1990). Primeval fire intervals in subclimax old-growth types ranged from less than five years in Southwestern ponderosa pine to a few centuries in wet-site coastal Douglas-fir. The fires influenced the condition of old trees, the composition and structure of stands and the stand mosaic patterns.

Where management goals are to maintain subclimax old-growth ecosystems, prescribed fire will probably be necessary. For example, low-intensity surface fires would be used in ponderosa pine types. Here, excessive accumulation of organic matter would require particularly skillful fire application to avoid killing large trees. In contrast, stand-replacement fires might be necessary to perpetuate some old-growth types, such as seral lodgepole pine and whitebark pine (Arno and Hoff 1989).

It may be impractical to use natural fire for maintaining ecosystem processes in some natural areas. Alternatives such as sawing and removing excessive understory thickets, combined with prescribed burning, might be used instead. One example is giant sequoia groves, where felling understory trees and broadcast burning are used to recreate pre-1900 fuel loadings and the open condition that perpetuated sequoia and accompanying seral species (Kilgore 1987). Similar approaches might be considered in other short-interval fire regimes, such as the northern winter range of Yellowstone National Park, where trees have invaded the grassland and have grown large enough to resist surface fires (Gruell et al. 1986).

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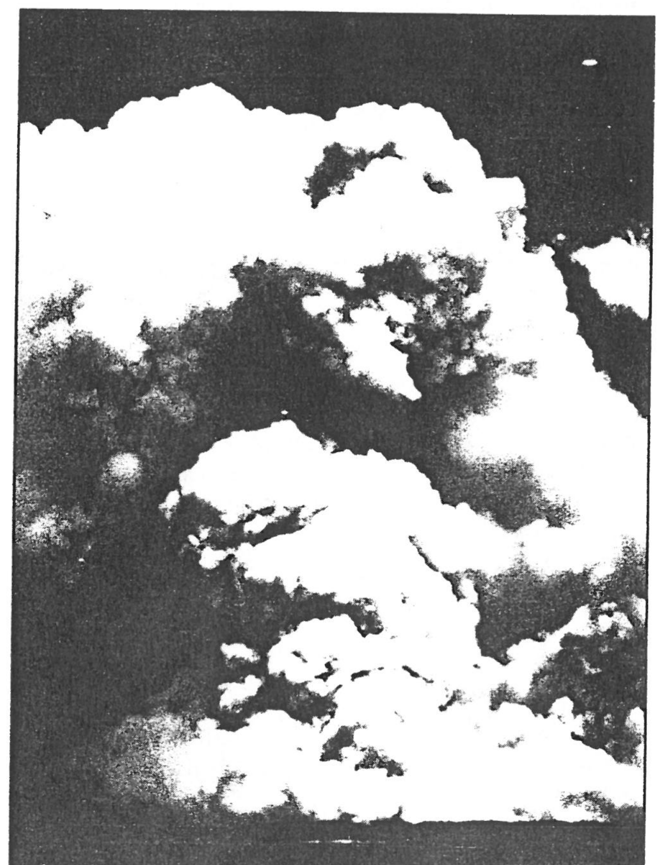
Most managers of non-wilderness wildlands recognize that fire once played an important ecological role. Many also realize that attempts to exclude fire can lead to undesirable changes in vegetation or give rise to severe wildfires. Nevertheless, integration of fire and fuels management into resource management has been slow. An example is the use of fire in management of fire-resistant seral trees such as ponderosa pine, western larch and Douglas-fir (Kilgore and Curtis 1987). Although these techniques are employed at a number of locations, many administrative units lack the expertise and/or funding to support these and other fire management practices.

Where resource objectives are to maintain biological diversity and productivity, fire should be considered an impor-



Photo/National Park Service

tant ecosystem process to achieve these objectives. Many alternatives are available to help meet them, including silvicultural cutting, coupled with fuel removal or prescribed burning. The use of fire can be integrated into stand management to help maintain the desired vegetation composition and structure. Silvicultural cuttings should be planned with consideration of fire as a follow-up treatment, both to reduce the wildfire hazard and undesirable understory trees and plants and to stimulate regeneration of desirable tree and undergrowth species.

A common harvesting procedure in the Inland West is to remove the overstory without treating understory trees or the shrub and herbaceous layers. This practice fails to mimic the fire disturbances that helped maintain these forest ecosystems for thousands of years. It often promotes dominance by late-successional, shade-tolerant species that are susceptible to insect and disease epidemics (Carlson and Schmidt 1989). Unlike post-fire regeneration, these residual understory trees are often old individuals, and many have sustained logging injuries that invite stem or root decay.

Even where understory treatment is done, it may diverge considerably from the effects of natural fires. For instance, bulldozer scarification is commonly done with piling and burning of slash. This technique produces a mosaic of scraped mineral soil, patches of untreated ground and, sometimes, severely burned soil under the slash piles. It is unnatural compared to well-designed prescribed burns, which produce less soil compaction. Compared with dozer scarification, prescribed burning is also less conducive to colonization by introduced weeds. Dense stands of small conifers — living fuels — have developed as a result of past harvesting and absence of fire; these and other untreated fuels complicate the application of prescribed burning. Dense stands can also occupy big game winter range, but they provide scant forage. Prescribed fire can be an inexpensive means of replacing these stands with forage-rich seral grass and shrub communities (Weaver and Benscoter 1989).

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During the past two decades, more and more residences, resorts and other developments have been built in or adjacent to wildlands. Such areas are usually occupied by several types of fire-dependent vegetation. The value of homes, other developments and the aesthetically pleasing land they occupy is extremely high in these areas. When wildfires start in these "residential wildlands," fire management focuses on protecting homes and developments.

Owners of homes in cities customarily cut their lawns and other vegetation. In contrast, wildlands homeowners often feel no need to control the vegetation in their living environment. In fact, they often try to preserve a dense growth of wildland vegetation. Structures frequently compound the problem because they are built with highly flammable fuels — cedar shingle roofs and siding, stacks of firewood and tree bark mulch.

This kind of landscaping can produce hazardous fuels that support intense, uncontrollable fires. Homeowners who

Grass and shrub fuels around wildland home *Photo/U.S. Forest Service*

allow hazardous fuels to accumulate on their property should share the responsibility and costs for wildfire control by paying insurance premiums that accurately reflect their real risk.

Flammability can be greatly reduced by removing dead fuels and limiting living fuels. Fuels can be modified by thinning, pruning and burning to produce an aesthetically appealing setting and vigorous trees (Scmidt and Wakimoto 1988). For example, shaded fuel breaks (open stands with minimal understory or surface fuels) can be created by treating fuels in a 500- to 1,000-foot-wide forest belt around homes and developments. Breaks in fuel continuity lower the intensity of an approaching wildfire and aid suppression.

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Paradoxically, long-term fire protection can produce ecological aberration and increased risk of severe fires. This paradox can be ameliorated with a system of vegetation and fuels management based on wildland fire ecology. Such an approach can help protect natural ecosystems, harvestable natural resources, site productivity and homes and developments, without undesirable ecological consequences.

A number of strategies and techniques are available for wildland fire management, depending on management goals and the characteristics of vegetation, fuels, climate and terrain. Generally speaking, more manager-ignited prescribed fires are needed in natural areas. In management of wildlands where timber harvest is allowed, fire should be recognized as an important ecological process to maintain diversity and productivity. In residential wildlands, the emphasis should be on managing vegetation and fuels to avoid hazardous accumulations.

There are some constraints on the use of prescribed fire, including air quality, costs, risk of escape fire and uncertain public attitudes. More emphasis on providing information about fire ecology to resource managers, politicians and the concerned public could help satisfy questions among these groups. Biologists and natural scientists can help by explaining that successional change and disturbance in the forest are inevitable and necessary processes, and that they can be guided through ecologically sensitive management.

Photo/Jeff Henry

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