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Forging a Science-Based National Forest Fire Policy

A comprehensive policy should consider all aspects of wildfire management, not just fuels and fire suppression.

Large, intense forest fires, along with their causes and their consequences, have become important political and social issues. In the United States, however, there is no comprehensive policy to deal with fire and fuels and few indications that such a policy is in development.

Fire is, of course, a natural element of many wildlands. Forests are accumulations of combustible organic matter that can be set ablaze by lightning, a lit cigarette or match, or even sunlight focused through a lens. First to ignite are fine fuels such as pine needles, leaves, and twigs, but as heat accumulates, the bigger fuels such as shrubs and trees start to burn. If fuels are sufficient and environmental conditions, especially wind, are suitable, the fire will torch, move into tall tree canopies, and spread from tree to tree, producing a crown fire. Many of the fires that raged in the western United States during the summer of 2003 and in previous summers have been of this most destructive type.

A substantial amount of scientific evidence indicates that, in many North American forests, accumulations of fuels have reached levels far exceeding those found under “natural” or pre-European settlement conditions. These fuel accumulations result from human activities, including fire suppression, grazing, logging, and tree planting. Uncharacteristically high fuel levels create the potential for fires that are uncharacteristically intense. Millions of acres in western North America harbor these unprecedented fuel stores, although the total is probably less than the 190 million acres identified in the Bush administration’s Healthy Forests Initiative.

A national forest fire policy should cover every aspect of fire control: Managing fuels within forests and landscapes; fire suppression; and, ultimately, salvage and restoration treatments after wildfire. Currently in the United States, individual land management agencies such as the Forest Service and National Park Service have established fire policies and modify them periodically. But these are largely within-agency policies that have not been subject to public debate and review. Fire suppression activities on the local and national levels are coordinated among government organizations through formal agreements. Because of the different missions of these agencies,

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interagency policies are largely procedural checklists of actions that collectively constitute agency-specific fire management policies and goals.

De facto 20th-century national fire policy focused primarily on fire suppression rather than on the full array of relevant management tactics. During the past 40 years, some deviations from these policies have emerged, chiefly the adoption of natural fire and prescribed burning programs, particularly in national parks and wilderness areas. But aggressive suppression policies have continued to dominate. Indeed, they have actually been reinforced as a result of large intense fires that have invaded places where people live. As a universal panacea, however, suppression has failed. So the policy focus has shifted to another "universal" solution: the reduction of forest fuels via physical removal or prescribed burning.

Current efforts to develop national policies on fuels and fire include the administration's initiative and the Healthy Forests Restoration Act (H.R. 1904), which the House of Representatives passed in the summer of 2003 to implement the administration's proposal. However, these efforts focus on the short-term treatment of forest fuels rather than on developing a comprehensive national policy on fuels and fire management and identifying the scientific and social elements of such a policy.

Most of the provisions of the administration initiative and H.R. 1904, for example, deal primarily with reducing requirements for environmental analyses of fuel treatment projects, limiting public appeals, and requiring prompt judicial response to legal challenges. These are procedural matters and do not address substantive issues such as where, how, and why fuel projects are to be conducted. The assumption appears to be that if we free resource managers from procedural constraints, they will make the appropriate decisions about where, how, and why. Other elements of the proposals deal with important but peripheral issues, such as attempts to increase the value of forest biomass by creating biomass markets.

These efforts contribute little to either a definition of or a long-term commitment to a comprehensive national policy on forest fuels and fire management. They also address few of the scientific and technical elements underlying management programs. Indeed, the forest condition classification used in these initiatives to identify forests at risk is a modeled coarse-scale spatial analysis of fuels and potential fire regimes that has serious deficiencies as the primary basis for identifying forests that are vulnerable to uncharacteristic intense fires.

A comprehensive national forest fire policy should consider all aspects of wildfire management, not just fuels and fire suppression. This policy needs to deal with long-term management of fuels and wildfire and consider the full range of ecological and social values, including issues related to forest health and the well-being of communities and people. Fire and fuel policy should also be an integral part of an overall vision for stewardship and management of the nation's forests.

To be rational and effective, this fire policy should be grounded on scientific principles and data. Relevant scientific information already exists on three essential topics. First is knowledge of pre-European settlement fire patterns in the major forest types and regions of North America. Second is the effects of human activities on fuels and normal fire frequency. The third is forest ecology, including tree regeneration and succession after wildfire.

We have identified several scientific issues that should be considered in developing a national forest fire policy. Some of these issues, such as prescriptions for fuel treatments and landscape-level planning, are not appropriately considered at the level of national policy, but they are scientific and technical issues that need to be understood by those developing and debating national policy. Our objective is to make clear that there is a large base of scientific knowledge available for developing a national forest fire policy.

All forests are not alike

The coastal rainforests of the Pacific Northwest and the arid pine forests of the Southwest are not comparable ecologically and present quite different opportunities and social risks. Why should they be governed by similar policies? The starting point for any rational fire policy is recognition that different forest types and regions vary widely in their characteristic or natural fire patterns. A science-based fire management policy must accommodate this variability.

Before effective fire suppression began early in the 20th century, many forests of ponderosa pine and mixed conifers in western North America were subject to frequent low- to moderate-intensity fires; fire return intervals of three years to two or three decades were common. Fire suppression programs have been so effective that they have allowed the fuel loads in these forests to accumulate to levels that create the potential for previously unknown intense stand-replacement fires, which kill all or most of the large trees.

Neither fire suppression nor treatment of forest fuels should be seen as a universal panacea.

Stand-replacement fires are characteristic of many other western and boreal forest types, however. Pacific slope forests of Douglas fir and associated species in the Pacific Northwest are an outstanding example; stand-replacement fires typically occur at intervals of 250 to 500 years in these forests. Most of the subalpine or high mountain forests of western North America—composed of spruce, true fir, and lodgepole pine—are also of this type. Fire suppression programs have not modified fuel loads and fire patterns significantly in these forests. Indeed, fuel treatments sufficient to modify fire behavior in these forests would produce very unnatural forest ecosystems. For example, treating fuels to eliminate stand-replacement fires in coastal Douglas fir forests would result in forests that no longer provided suitable habitat for northern spotted owls and many other old-growth-related species.

These differences in typical fire patterns among forest types should influence fire suppression as well as fuel treatment policies. Active efforts to suppress fire can be appropriate in forests subject to stand-replacement fire, particularly where important resources are at risk. Wildfire suppression will often be inappropriate, however, in forest types that were characteristically subject to frequent low- to moderate-intensity fire levels.

Variability in forest fire patterns can be very local as well as regional, and fire policies must recognize that. Many forest landscapes, particularly in western North America, are actually mosaics of forests with contrasting fire patterns. Forest conditions and characteristic fuel loadings, fire patterns, and suppression policies may differ sharply on adjacent north and south slopes or at different elevations in the same river valley, with low-intensity fires at low elevations and on south slopes and stand-replacement fires on north slopes and higher elevations.

Differentiating forest community types

Some have argued that it is impossible to address forest variability in devising national policy. Science-based stratifications are too complex to be comprehended and incorporated into legislation appropriately, they say. We say that it is not only possible but also imperative to recognize local variations and fundamental differences among forest types as a part of national policy.

Fortunately, there is already a national classification of forest types that incorporates characteristic fire patterns and fuel loadings and can be used as the basic stratification for implementing fire management policies. This is the comprehensive plant association or habitat type classification system developed for wildlands by scientists in federal agencies. There are hundreds of individual plant associations, but these are easily gathered into a much more limited number of plant association groups (PAGs) that have comparable fire patterns and appropriate fire management policies. A particular strength of the PAG classification is that it is just as relevant for national policies as it is for a resource manager planning a fuels management program within a local watershed. This classification can also be applied to other contentious issues, such as management of old-growth forests, where it can provide a solid scientific basis for policy decisions.

Transient conditions, such as classifications of fuel loadings, are not appropriate as the primary basis for developing and applying fire policies. An example is the wildland fire and fuel management spatial data set and current condition classification recently published by the Rocky Mountain Research Station in Fort Collins, Colorado. This is a coarse classification that was never intended for use at a local level. The five classes created to represent historical fire regimes also do not accurately portray conditions or risks in at least some forest regions, most notably western Washington and northwestern Oregon. The use of condition classes such as fuel loadings is most appropriate as a secondary stratification within the PAG classification.

A final important point is that, contrary to what one might expect, fire suppression has not necessarily had the greatest impact on fuel accumulations on sites and in forest types that historically have had the most frequent fires. After a century of fire suppression, a forest belonging to the Ponderosa pine PAG may be many fire-return intervals outside its historical range—perhaps 100 years without wildfire, where the historical pattern was a fire every 5 to 10 years. But the effects of 100 years of suppression on amounts and arrangements of fuels and the potential for an uncharacteristic stand-replacement fire actually may be much greater in a mixed conifer forest belonging to the white fir PAG, which is only three or four intervals outside its normal fire cycle of 10 to 60 years. This is because the white fir site is much more productive than the Ponderosa pine site, resulting in more rapid fuel accumulations and the development of white fir fire ladders between ground and crown fuels. Historic fire-return intervals are therefore not always the best basis for setting fuel treatment priorities.

Uncharacteristic patterns

The uncharacteristic live and dead fuel loadings, fire behaviors, and fire effects that the United States has experienced in the past few years are not just the result of fire suppression. They are also the result of human activities including grazing, logging, and planting dense strands of trees after green or salvage logging. The importance of these human activities varies with locale. Many sites have been affected by multiple activities that are often synergistic in their effects. Programs to correct these conditions probably also need to vary.

Humans create uncharacteristic fuel loadings both actively and passively. With wood production as a primary management objective, foresters have established dense, fully stocked forest stands on sites formerly occupied by open stands with fewer trees. In national forests on the western slopes of the Sierra Nevada, thousands of acres of open forests dominated by old-growth pine have been converted to dense single-age plantations during the past 50 years. In many areas throughout western North America, uncharacteristic stand-replacement wildfires have been followed by reforestation programs that recreate the dense young forests, providing the potential for yet another stand-replacement fires.

Fire management programs should also address the ability of a stand of trees to persist through a fire and to recover after one. Effective prescriptions for fuel treatments must, therefore, include both the amounts and spatial distribution of the fuels and the retention of the most fire-resistant trees. There are four key elements to consider: surface or ground fuels, ladder fuels, overstory canopy density or continuity, and large trees of fire-resistant species. National legislation is not likely to address technical details such as these, but individuals debating and formulating fire policy should at least know what kind of stand treatments actually influence fire behavior. Traditional commercial logging activities are focused on the removal of large saleable trees, not the amount and arrangement of these fuel elements.

The potential effectiveness of a proposed project to reduce fuels and alter fire patterns can be judged by whether the treatment deals with at least one or preferably all three of the fuel elements: surface fuels, ladder fuels, and canopy density. Surface fuels include grasses, shrubs, and tree seedlings, as well as litter and woody debris on the forest floor. Surface fuels are removed primarily to reduce potential flame lengths to acceptable levels. Ladder fuels typically consist of small and intermediate-sized trees, and treatment is aimed at reducing the ability of fires to move from the ground into the crowns of large trees. Overstory canopy density influences the ability of a fire to spread through the tree crowns, so the goal is to increase the spacing between them.

The scientific consensus is that large and old trees should generally be retained, especially fire-resistant species such as pines. Indeed, from an ecological perspective these are absolutely the last trees that should be removed. Large and old trees are the most likely to survive a fire and subsequently serve as focal points for recovery. Large and old trees are also critical wildlife habitat, in part because they are the source of the standing dead trees (snags) and logs where animals live. Large old trees are essentially irreplaceable because they take centuries to reach that state.

There is no agreement, however, on how best to incorporate the retention of large and old trees into policy and regulation. Proposed approaches have included diameter limits (cut no tree larger than "x"), age limits (cut no tree older than "x"), and leaving the top "x" percentile of the largest trees in the stand.

One complication is that the definition of a large and old tree varies because of differences in species and site productivity. Hence, large-tree retention guidelines need to accommodate site-to-site variability. Here, once again, the PAGs can help provide appropriate site-based guidelines.

Another complication is that removing large trees is sometimes necessary to achieve overall fuel treatment goals. Relatively large trees of shade-tolerant species such as white fir (those 21 inches or more in diameter at breast height) have developed on many productive mixed-conifer sites since fire suppression programs were instituted a century ago. These trees often provide the fuel ladders that put old-growth pine or giant sequoia trees at risk, as well as increasing overall stand canopy densities. Both conditions greatly increase the potential for stand-replacement fires. Restoring characteristic fuel loadings and wildfire behavior, to say nothing of prescribed burning programs, often requires removal of some of these larger but relatively young trees.

Although there is a large base of scientific knowledge available for developing a national forest fire policy, it is largely ignored in current policy proposals.

Retaining large and old trees is one of the most contentious ecological issues in the current debates over fuel reduction programs. Environmentalists often view large tree removal as motivated by economic goals rather than ecological objectives; a potential wedge for the resumption of large-scale commercial logging on public lands. Other participants in the debate, including the current administration, view the removal of large trees as necessary to pay for expensive fuel treatments and to provide wood to support local industries. Many managers view the issue simply in terms of balancing effective fuel treatments with other ecological or economic objectives.

Logging as a part of fuel treatment programs is an issue that deserves serious consideration by everyone in the forest fire policy debates. On the one hand, traditional commercial logging operations are unlikely to improve fuel loadings significantly or alter potential fire behavior for the better. Such operations are not focused on the key ground and ladder fuels, and they also contribute additional ground and ladder fuels in the form of debris called slash. On the other hand, effective fuel removal is expensive when high densities of ground and ladder fuels exist, because at least some of them have to be removed, burned, or otherwise treated. Project costs can often exceed $1,000 per acre for an initial fuel treatment. Logging of small trees will rarely cover even the direct costs of fuel treatments because such trees currently have little economic value and are likely to have even less in the future. Hence, subsidizing fuel treatments by selling medium-sized trees that need to be removed anyway seems appropriate, given the scale of the challenge and the desire to reduce the impact on taxpayers.

No magic bullet

An effective national policy on forest fuels and fire management requires sustained long-term programs involving several treatments. Today's conditions have been developing for more than a century and generally cannot be corrected with a single treatment. In a stand with significant fuel accumulations, for example, an initial prescribed burn will typically generate additional fuel. A burn kills trees and shrubs but often does not consume them; instead, it turns them into dead fuel. Relatively prompt follow-up treatment, such as a second prescribed burn, may be needed to eliminate the new fuel.

Fire management programs require repeated treatments that are planned and implemented at appropriate spatial scales. Forests will continue to regenerate and, in the process, accumulate fuels, sometimes (as in the moist mixed-conifer zones) at high rates. Fuel treatments and prescribed burns must be at a sufficient scale to affect the behavior of the fire. Studies of recent fires such as the 1994 Wenatchee fires in Washington and the 2002 Hayman fire in Colorado show that small treated areas surrounded by areas with high fuel loadings and potential firestorms often do not survive, let alone significantly affect overall fire behavior. Designing treatments as part of a strategic landscape plan also is critical. One example is locating fuel breaks so as to limit fire spread and serve as anchor points for more widespread prescribed fire.

National policy must also take into consideration the fact that human habitation and development are increasingly intermixed with forests, making them potentially vulnerable during wildfires. The wildland/development interface is emphasized in current policy initiatives. However, fuel treatments of forests outside this interface are necessary to prevent significant losses of forest attributes that are important to society, such as wildlife habitat and watersheds. Large areas of the Sierra Nevada mixed-conifer forest, for example, are likely to experience uncharacteristic stand-replacement fires without active fuel treatments and prescribed burning programs, with the resulting loss of critical watershed and habitat for the California spotted owl and other endangered wildlife. Substantial restoration efforts will be needed outside of the wildland/development interface to protect them.

Some participants in fire management policy debates argue that wildland forests can and should be left to "natural" restorative processes. Unfortunately, today's ecological and social conditions differ greatly from past conditions, making many fires and their consequences undesirable. Large unnatural accumulations of fuels result in fires of unprecedented intensity; and exotic plants, pests, and pathogens alter recovery processes dramatically, further modifying a landscape in which critical habitat for native biodiversity is already severely limited. Nature will "correct" the unstable conditions that humans have created in the fire-prone wildlands, but the new landscape will not resemble presettlement forests. Letting nature take its course in the current landscape is certain to result in losses of native biodiversity and ecosystem functions and other social benefits.

No back to the future

The goals of restoration—sometimes described as a "desired future condition"—are often based on a hypothesized "natural" condition that existed before European settlement. The objective is to bring forest composition and structure, including fuel loadings, back within the range of conditions that existed before the fire suppression policy began. The wildland/development interface is an exception; management goals there relate to human health and welfare rather than the health and welfare of the forest.

But it is high time to consider desired future conditions that are unprecedented but ecologically sustainable. Restoring forests to an approximation of their state in the 19th century may be appropriate in some areas, but fire management policies need to consider a broader spectrum of possibilities. Today's fragmented landscapes and aggressive introduced organisms mean that 19th-century conditions can never be replicated precisely, although they might be approximated.

In addition, people prize forest attributes that are different from those of the past. They may value conditions that were not part of the presettlement forest, such as abundant browse for wildlife. They may abhor some normal presettlement conditions, such as pervasive smokiness. Some of these desires may be mutually exclusive, but others may be achievable and sustainable.

Thus, it is inappropriate to base management goals exclusively on some previous real or hypothesized condition, particularly outside of wilderness and other natural areas. Since we can't go home again, we must think seriously about working toward forests that differ, sometimes significantly, from those of the past. The potential for defining and evaluating alternative sustainable goals and, ultimately, managing to achieve the ones people want, is improved greatly by rapid recent expansions in scientific understanding of the natural history of species, forest ecosystems, landscapes, and disturbances.

After the fire

What are appropriate restoration treatment policies after a fire? The topic is contentious, involving matters such as timber salvage and seeding or planting of plant cover. But there, too, significant new scientific knowledge can be of help.

Natural forest disturbances, including fire, kill trees but remove very little of the total organic matter. Combustion rarely consumes more than 10 to 15 percent of the organic matter, even in stand-replacement fires, and often much less. Consequently, much of the forest remains in the form of live trees, standing dead trees, and logs on the ground. Also, many plants and animals typically survive such disturbances. This includes living trees, individually and in patches.

These surviving elements are biological legacies passed from the predisturbance ecosystem to the regenerating ecosystem that comes after. Biological legacies are crucial for ecological recovery. They may serve as lifeboats for many species, provide seed and other inocula, and enrich the structure of the regenerated forest. Large old trees, snags, and logs are critical wildlife habitat and, once removed, take a very long time to replace.

From an ecological perspective, large, older, fire-resistant trees are the last ones that should be removed in any fuel treatment or post-fire restoration program.

Management of postburn areas, including timber salvage, needs to incorporate the concept of biological legacies. Salvaging dead and damaged trees from burns involves the ecology of a place, not simply economics and fuels. In addition to effects on postfire wildlife habitat, there are also effects of salvage logging on soils, sediments, water quality, and aquatic organisms. Significant scientific information exists on this topic as well as on biological legacies.

Biological legacies differ by orders of magnitude in natural forests, a fact that should guide restoration programs. Where stand-replacement fires are characteristic, such as with lodgepole pine and Pacific Coast Douglas fir forests, massive areas of standing dead and down trees are usual; salvage operations generally are not needed and do not contribute to ecological recovery, even though they do provide economic return. On the other hand, uncharacteristic stand-replacement fires in dry forests can produce uncharacteristic levels of postfire fuels, including standing dead and down trees. Removing portions of that particular biological legacy may be appropriate as part of an intelligent ecological restoration program, and not simply as salvage.

Policies regarding artificial revegetation after wildfires, such as seeding grasses or other plants and tree planting, also need to be based on credible current science. There are many tradeoffs. Seeding to provide rapid protective cover may interfere with natural recovery and introduce exotic plants. Native plants that regenerate from seed rather than by sprouting will suffer from competition with seeded grasses.

Decisions regarding planting trees need to be based on ecological and economic objectives as well as characteristics of the forest type. Where timber production is a primary objective and dense forest stands are characteristic, reestablishing plantations of commercial tree species is often appropriate. However, establishment of dense forests is inappropriate where they did not exist before. Doing so simply recreates the potential for uncharacteristic fuel loadings and fires. Such a naturally unsustainable condition is only appropriate if there is a serious long-term commitment to managing the site for intensive timber production. But this does not apply to many federal forests where intensive wood production is neither consistent with ecological goals nor economically sound.

Tree planting to reestablish closed forest cover on burned sites also may be a bad idea, depending on ecological objectives. Large disturbed areas, which regenerate slowly and include complete legacies of snags and logs, are often hotspots for regional biodiversity. The unsalvaged and unplanted areas devastated by the 1980 volcanic eruption of Mount St. Helens, for example, possess extraordinarily rich communities of birds, amphibians, and midsized mammal predators. Aggressive timber salvage and tree planting programs dramatically limit both the biological potential and the duration of this early successional stage.

In short, postfire treatment policies such as timber salvage, seeding, and replanting should incorporate current scientific findings, especially about how forest ecosystems recover from natural disturbances. We do not want to create new problems or perpetuate old ones by salvaging too much or too little or by establishing dense new plantations on burned sites where timber production is not a primary objective.

There is one way in which current administrative and legislative efforts, typified by the administration's Healthy Forests Initiative and HR 1904, do set fire policy. They assume that we will treat forest fuels in the wildland/development interface to reduce loss of structures and life. Although there is no stated national policy on dealing with fires in these intermixed landscapes, there has long been a de facto policy in the United States and Canada that human developments interspersed among wildlands will be protected from fire. In some mixed landscapes, requirements for safer building materials and clearing vegetation away from houses are emerging, but it is not clear who will enforce these rules or how. The assumption that human settlements will be protected no matter where they are has deep roots in history and is even backed by some case law, as in the protection of Southern California houses on chaparral-covered hillsides.

But aside from this underlying assumption, these proposals fail to incorporate most of the elements that we have identified as the basis for a scientifically credible forest fuels and fire management policy. They do not take account of the variability of natural fire patterns, and they do not recognize that fire policy needs to accommodate this variability. Most fundamentally, however, the initiatives set no goals for a comprehensive national forest fuel and fire management policy or for the long-term commitments necessary to implement such a policy.

Recommended reading

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