

Chapter 2

Vegetation Management: to Burn or Not to Burn

The Rationale for Treatment

As discussed in Chapter 1 (*Introduction*), the need for management activities to correct the results of a century of fire suppression is clear. In considering the approach to developing management strategies, it might be useful to review the concept of fire and fire management in its broadest theoretical context.

Fire in the most basic sense is a chemical reaction, involving the rapid oxidation of combustible material and characterized by the release of energy in the form of heat and light. As schoolchildren learn, three components are essential to the oxidation process we know as fire: fuel, heat, and oxygen.

In the context of wildland fire, fuel is in reality the only one of these components over which humans can hope to exert any meaningful control. The characteristics of the fuel, considered in the context of topography and climate, determine the manner in which fire is likely to ignite, develop, and spread. This process of ignition, development, and movement through the habitat is termed *fire behavior*.

The approach to reduction of fire risk through management activities involves implementing actions that will modify fire behavior. The attributes of fuel that management activities can effectively address are, for all intents and purposes, limited to the quantity and arrangement of the fuel load. On the most basic level, vegetation and fuel management entails disarranging or reducing the quantity of the fuel to impede fire's ability to pass through the habitat. Continuity of the fuel can be disrupted vertically or horizontally; firebreaks can be created; fuel can be removed off site. The optimum strategy is governed by numerous variables, and the body of knowledge concerning fire ecology and fire management is continually expanding. The mechanics of fuel management are discussed in greater detail in Chapter 3 (*Nonburning Alternatives: Variables, Criteria, and Definitions*) and Chapter 4 (*Getting to Work: How to Build a Nonburning Strategy*).

Development of a reasonable vegetation and fuel management strategy must be predicated upon an understanding of the *desired future condition*. Attainment of the desired future condition, in turn, requires an understanding of the disparity

between historic conditions (i.e., the conditions that existed before fire suppression activities or other land use practices altered the vegetative conditions of the area under consideration) and current conditions (Figure 2-1). Such an understanding is important because at least some of the ecosystem processes that have shaped current conditions will likely continue to be an influence in shaping future conditions and will, accordingly, be important in developing the appropriate strategy to attain the desired future condition. The management strategy, then, is the roadmap for moving from current conditions to the desired future condition.

Typically, the objective of the management strategy is to restore forest health, to protect human life and property, or to protect natural resources (e.g., timber). While these objectives frequently overlap, such is not always the case. Restoration of forest health generally entails returning the habitat to its *historic fire regime*, defined by the natural patterns of frequency, predictability, seasonality, intensity, duration, and scale with which fire historically passed through the habitat. Protection of human life and property is frequently addressed by restoring the historic fire regime. However, some habitats are naturally subject to severe fire regimes; in such cases, additional treatment may be necessary to attain the *desired future condition*. Resource protection may not entail a restoration of natural communities, but rather the preservation of a valuable commodity.

Fire regimes have been classified into the five groups summarized in Table 1.

Table 1. Fire Regimes

Classification	Fire Return Interval	Severity	Example Habitats
Group I	0–35 years	Low	Ponderosa pine, other long-needle pine species, and dry site Douglas-fir
Group II	0–35 years	Stand replacement	Drier grasslands, tallgrass prairie, and some Pacific chaparral ecosystems
Group III	35–100+ years	Mixed	Interior dry site shrub communities such as sagebrush and chaparral ecosystems
Group IV	35–100+ years	Stand replacement	Lodgepole pine and jack pine
Group V	>200 years	Stand replacement	Temperate rain forest, boreal forest, and high-elevation conifer species

A corollary descriptor of fuel conditions addresses a fire regime's degree of deviation from historic conditions. These *condition classes* also measure general wildfire ecosystem risk; however, it is important to understand that the criterion of fire risk is based upon the loss of key components of the ecosystem. For example, a habitat with a naturally severe (i.e., stand-replacing) fire regime, while potentially posing a serious risk to human property, might be considered to have low ecosystem risk because the ecosystem is adapted to fire and would be likely to reestablish in accordance with historic patterns.



This photo of Great Basin juniper scrubland shows an extensive area (foreground) that has been manually treated to thin woody vegetation to historic conditions. The cut material has been scattered, and no subsequent treatment (i.e., prescribed burning) has been applied. The background shows much more densely vegetated terrain that has not been treated. Such encroachment of woody vegetation into open grassland and semi-arid habitats is a widespread problem associated with land-management practices such as fire suppression and grazing.

- Condition Class 1: Fire regimes in this condition class are mostly within historical ranges. Vegetation composition and structure are intact. The risk of losing key components of the ecosystem from fire is low.
- Condition Class 2: Fire regimes in this condition class have been moderately altered from their historic range, either by increasing or decreasing the fire frequency. The risk of losing key components of the ecosystem from fire is moderate.
- Condition Class 3: Fire regimes in this condition class have been significantly altered from their historical return intervals. Vegetation composition, structure, and diversity have been substantially modified. The risk of losing key components of the ecosystem from fire is high.

As mentioned above, treatment of a habitat may be appropriate to restore and maintain a habitat's health, as well as to protect human resources. Accordingly, areas in any of the condition classes may be suitable candidates for treatment. Conditions that indicate the need for treatment may be divided into two broad categories.

- An ecosystem in which the fire regime has been altered, increasing the risk of fire that could result in loss of ecosystem elements as well as in destruction of human life or property.
- An ecosystem in which the fire regime is naturally severe and may be treated to protect human life or property.

When an ecosystem has been substantially altered from its historic fire regime, efforts to restore that regime may be indicated; in other words, the management objective is to modify a Condition Class 2 or 3 ecosystem into a Condition Class 1 system. If ecosystem health is an object, such a strategy is considered to be a restoration activity.

However, whether or not the fire regime has been altered, risk of wildfire may often be addressed in areas near human resources. In the case of Condition Class 1 habitats (especially those with naturally severe fire regimes), the treatment would assume a different strategic character than a restoration activity; for example, treatment might entail creation of fire breaks or home protection zones.

An Overview of Prescribed Burning

It is important to understand the distinction between prescribed burning and naturally occurring fire. Although prescribed burning has been widely used in recent decades as a vegetation and fuel management tool, the mechanisms of prescribed and natural fire are often widely divergent. For instance, naturally occurring wildland fires tend to occur during fire season (i.e., summer through fall), whereas prescribed burning is generally implemented under conditions when spread of a naturally occurring fire would be slow (e.g., during spring and late fall/early winter). Such a difference in timing is a precaution against the risk

of escape; indeed, the disparity between natural and prescribed fire is intimately linked with the fact that, in many stands, it is the unnatural conditions created by past management decisions that necessitates treatment in the first place. Moreover, homes or other human values in or near areas in need of fuel management may impose severe constraints on the restoration of historical fire regimes, even in ecosystems that could otherwise sustain such regimes. It should be borne in mind throughout the ensuing discussions that, in many cases, *those areas that are most difficult to treat with prescribed fire are the areas in greatest need of treatment.*

The Functions of Fire

Fire—both naturally occurring and prescribed—in western ecosystems serves several ecosystem functions. Fire can slow invasions of nonnative species, thin vegetation, facilitate establishment of young plants, reduce competition among remaining plants, reduce fuel loads before they attain potentially catastrophic proportions, and recycle nutrients. Fire is an integral component of many western habitat types; indeed, some plant species require fire to reproduce.

Prescribed fire can accomplish many of the same functions as naturally occurring fire; however, as discussed above, the context of prescribed fire often differs from that of naturally occurring fire. Because of its controlled nature, prescribed fire does not entirely duplicate the ecological function of fire in the west, nor does it necessarily address all hazardous fuel conditions.

As suggested by the interviews and literature reviews conducted for preparation of this document, the reasons for implementing prescribed burning can be assigned to three broad categories: hazardous fuels reduction, habitat management, and ecological restoration. The functions listed below are those that land managers are most likely to cite for using prescribed fire.

- Reduction of fine fuels.
- Reduction of surface fuel loading.
- Mortality of ladder fuels.
- Release of nutrients.
- Reduction of canopy fuel loads.
- Improvement of wildlife habitat through stimulating regrowth and seeding.
- Control of some invasive nonnative species, pests, and diseases.

Use of prescribed fire in wildlands falls into two broad categories.

- **Ecosystem restoration.** Objectives include the reintroduction of fire into fire-adapted ecosystems, stimulation of regrowth of species desired for browse, creation of openings for early successional species, control of invasive species, and nutrient recycling.

- **Fuels management.** Objectives include cleaning up post-silvicultural residues, maintenance or creation of fuel breaks to protect resources, and preventing losses from catastrophic wildfire.

These objectives are not mutually exclusive, and often several objectives can be achieved through a single treatment strategy. For example, treatments designed to make natural stands of forestland more fire resistant can facilitate the return of fire into the ecosystem while protecting houses or other adjacent resources.

Challenges to Burning

Because fire is such an integral component of many western ecosystems, and because a key objective of many vegetation and fuel management programs is to restore habitats and ecosystem health (including conditions created by the historic fire regime), it is often assumed that prescribed burning is the most appropriate method to achieve such an objective. However, as mentioned above, the conditions under which prescribed burns are implemented may differ significantly from the conditions under which naturally occurring fires enter the ecosystem. For example, naturally occurring fires are likeliest during the summer or fall under conditions of low humidity, high temperatures and, frequently, high winds; prescribed burns, to the contrary, are generally implemented under carefully monitored conditions of higher fuel moisture, higher atmospheric humidity, moderate temperatures, and moderate winds to minimize the risk of escape.

Despite the benefits of prescribed burning for vegetation and fuel management activities, fire carries negative impacts and risks as well. Disadvantages of burning may include:

- particulate emissions that contribute to air quality problems, potential challenges to public health, and visibility impacts;
- potential loss of resources from escapes;
- loss of material that might otherwise be utilizable; and
- historically atypical fire effects on ecosystems.

Some of these impacts have the potential to contravene the regulatory requirements of the Clean Air Act (CAA) (although this is an uncommon occurrence), as well as the public's expectations for clean air and the aesthetic experience associated with outdoor activities or lifestyles. Others entail risk to resources and to the safety of landowners and firefighters. Moreover, there are logistic disadvantages to the use of burning, many of which can be avoided by the use of nonburning alternatives.

Air Quality

The CAA as amended in 1970 required the establishment of national ambient air quality standards (NAAQS) for air pollutants, known as *criteria pollutants*. Criteria pollutants are those pollutants that the EPA Administrator judged would cause or contribute to air pollution that could endanger public health or welfare and that are emitted from numerous or diverse mobile or stationary sources. The initial list of criteria pollutants comprised carbon monoxide (CO), ozone (O₃), total suspended particulate matter (TSP), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and lead (Pb). Periodically, the NAAQS are revised if scientific information indicates that different pollutants or levels of existing NAAQS are not sufficient to protect public health or welfare.

The TSP standard was replaced with a particulate matter NAAQS for PM₁₀ (i.e., particulate matter having an aerodynamic diameter of 10 microns or less) in July 1987. In July 1997, EPA promulgated a NAAQS for PM_{2.5}, while retaining the PM₁₀ standard. EPA has found that these fine and ultrafine particles are closely related to significant adverse health effects as well as welfare concerns (e.g., visibility). Accordingly, EPA has established a 24-hour average limit of 65 micrograms per cubic meter and an annual average limit of 15 micrograms per cubic meter. Controls for PM_{2.5} will probably not be established until 2005–2008.

The smoke released by wildland fires under current conditions contains large quantities of fine particulate matter, as well as many of the same chemical constituents found in urban smog. Wildland fire smoke also contains organic compounds, some of which are toxic and potentially carcinogenic. Because fine particles are readily inhaled and retained in the lungs, and because 80% of particulate emissions released by fires comprise fine and ultrafine (i.e., <2.5 micron) particles, these emissions represent a potential adverse impact on human health and the environment.

By implementing fuel management activities in fire-adapted ecosystems—especially by modifying Condition Class 2 or 3 habitats into Condition Class I habitats—the potential release of emissions in the event of wildland fire can be substantially reduced.

Risk of Escape

Fire control is of particular concern when using fire as a vegetation or fuel management tool (remember: *those areas that are most difficult to treat with prescribed fire are often the areas in greatest need of treatment*). Escaped fire can have serious consequences in the real world of land ownership boundaries, adjacent infrastructure, unnatural fuel load conditions, and political and financial liabilities.

The difficulty of confining fire to a prescribed area bears an associated risk; the degree of this risk is influenced by the nature of adjacent resources that might be

susceptible to damage or loss, as well as by the kinds of conditions that influence fire behavior (e.g., weather, topography, fuel characteristics). While the vast majority of prescribed burns are accomplished without serious mishap, several large wildfires in recent years began as prescribed burns but escaped control, destroying infrastructure, natural resources, watersheds, and people's homes. In addition to the costs of these losses, a great deal of money was expended in fighting the fires. Financial liability can fall in many directions depending on location and jurisdiction; whoever must bear the cost, it is clear that escape of prescribed fire carries the potential for serious calamity.

Loss of Materials

Burning of material that might be used as a source of fiber for pulp, particleboard, or energy generation may not be the most efficient or judicious use of our natural resources. The increasing demand for wood and wood products in conjunction with limitations of timber harvest activities on public lands exacerbates concerns regarding potential loss of forest products.

Logistic Disadvantages

Because of concerns associated with the risks of escape, prescribed burning is constrained by rigorous conditions. For instance, burn plans specify very precise parameters of humidity, wind conditions, temperature, and moisture content of both live and dead fuel within which the burn may be implemented. These parameters, as well as regulatory restrictions (e.g., air quality requirements, Endangered Species Act considerations), can narrow the window of feasibility for a particular burn plan to as little as several days in an entire season. If for some reason those days are precluded, the window might close until the next season. As such opportunities are missed, fuel conditions can continue to worsen. Local air quality concerns may impose limits to ensure levels of emissions and ambient impacts (e.g., protection of NAAQS and visibility) acceptable to the public. For example, the presence of a stable air mass, which is the safest condition under which to initiate a burn, is also the least desirable condition for air quality concerns. Constraints such as these can combine and overlap to frustrate the most well-conceived projects.

It should be remembered that many areas in greatest need of treatment are areas of Condition Class 2 or 3; in such areas the vegetation structure and composition have been so modified that fire cannot likely be introduced without careful planning. By definition, areas of these condition classes are at risk of losing ecosystem components in the event of fire. Consequently, treatment necessitates a managed burn that is cooler—that is, less intense—than an uncontrolled fire would be. While such a prescribed fire poses less risk of escape than a typical uncontrolled fire would pose, it is also unlikely to achieve in a single treatment the desired future condition of the treatment area; to the contrary, such a fire is an intermediate step, presumably establishing conditions that would permit a subsequent entry, or entries, with fire to attain the desired condition. Each entry

entails additional cost, repeated risk of escape, and additional emissions of pollutants. Moreover, such treatments can emulate but do not duplicate natural processes.

Evaluating Nonburning Alternatives

In view of the challenges to prescribed burning discussed above, there are strong arguments to be made in favor of a careful evaluation of nonburning alternatives when developing a vegetation or fuel management strategy. Specific nonburning alternatives are discussed in greater detail in Chapter 3 (*Nonburning Alternatives: Variables, Criteria, and Definitions*); for the purpose of the current discussion, nonburning alternatives can be broadly defined as treatments employing manual, mechanical, chemical, or animal (i.e., managed livestock grazing) methods to address management of vegetation or fuel loads.

Nonburning alternatives must, if they are to be satisfactory treatments for fuel management or ecosystem restoration, mimic at least some of the effects for the achievement of which prescribed burning is typically implemented. At the same time, the need to minimize the emissions produced by prescribed fires continues to increase. To this end, fuel managers have developed a wide array of *emission reduction techniques* (ERTs). Some of the nonburning alternatives discussed in this document are also employed as ERTs. For a detailed examination of ERTs, the reader is referred to WRAP's *Annual Emissions Goals* guidance document.

In assessing nonburning treatments and the relative reasonableness of various alternatives, one must consider a spectrum of criteria to evaluate the potential impacts on fuels, the environment, and society. Often, an initially promising idea can have unforeseen consequences. The practice of fire suppression is a case in point: for many years, fires were suppressed with the objective of protecting both public and private forest resources for multiple uses; however, that management strategy has given rise to conditions inconsistent with its intent.

Accordingly, it is important to evaluate the *reasonableness* of potential nonburning alternatives. Reasonableness can be taken to reflect the likelihood of a treatment to achieve desired results; the relative absence of risk that unanticipated adverse effects will ensue; and the alternative's conformance to practical, technical, political, environmental, and economic constraints.

A variety of criteria can be applied during the evaluation process. This document emphasizes those criteria that identify generalized effects of specific treatment types. Criteria that can be evaluated only when considering site-specific information are not useful for the generic assessment of reasonableness that falls within the purview of this document. For example, potential impacts on wildlife, while extremely important to consider, are far too site-specific to address generally. All treatment types impact wildlife habitat; the degree and character of the impact, however, varies with existing conditions, desired future conditions, and the community of species that occurs on the target site.

A myriad of factors must be considered in developing any vegetation or fuel management strategy. This document adopts a simple division of the issues that land managers must address; however, as in all activities involving resource management, it is important to remember that the different issue areas are interconnected and that systems of organization are merely tools for the convenient processing and assimilation of information. The four issue areas used in this manual are:

- technical considerations,
- environmental considerations,
- economic considerations, and
- sociopolitical considerations.

The evaluation of nonburning alternatives should include a comparison of the fuel management and ecological effects, both positive and negative, of the nonburning treatment method under consideration with the effects that would result from the use of burning.

Finding Innovative Solutions

Economic considerations necessarily play a key role in designing any fuel management program; these considerations are addressed in some detail later in this report. However, a more conceptual economic question should be examined early on: namely, the valuation of an acre of land that has been treated.

Unfortunately, no methodology exists to assign such value. Traditionally, timberland could be assessed on the basis of the resource it would yield measured against the cost of extraction. But the valuation of treated land that is not managed as timberland—such as public land used for multiple recreational purposes—is a far more abstract undertaking. It may, for example, be based on the increased safety of adjacent residential property, on enhanced aesthetic qualities, or on ecological functions and values.

In developing fuel management strategies, the costs of treatment must be justified. This is particularly true of projects on public lands, where Congress must determine how to allocate taxpayer dollars. In other words, the cost of the operation must be less than the gain in value, which can be roughly equated as the pretreatment versus the posttreatment values of the land in question. Such a cost/benefit analysis is an integral part of any economic justification; however, this type of analysis is necessarily complicated by the subjective character of perceived risks and values. For example, a treatment project in the wildland-urban interface might be suitable for prescribed burning; but because of the perceived risk of escape, land managers might decide to implement a more expensive manual treatment project. Such a decision would follow upon the cost/benefit analysis that weighs the potential risk—or, possibly, the political cost—of a perceived risk against an actual cost. Similarly, the decision of

whether and where to treat, as well the level of resources committed to a treatment program, can also be strongly influenced by perceived values distinct from forest health conditions. For example, a wildland area's proximity to developed areas can increase the perceived value of the potential treatment site, whereas the same wildland area at greater distance from human development might warrant diminished funding, or even a decision to forego treatment altogether. These relative perceived values might suggest that the risk of failure to implement a fuel management project in the wildland-urban interface might outweigh the cost of even an expensive treatment prescription.

Such analyses become even more difficult in the absence of quantifiable standards of value to apply to qualitative characteristics such as aesthetics or ecological function. It may, accordingly, be necessary to develop an economic toolkit to assist decision makers in adequately assessing and prioritizing the less tangible values that treatment programs address (e.g., habitat function, aesthetics, hazard reduction, habitat preservation).

The interviews conducted in the preparation of this report suggested three broad trends regarding the choice of prescribed burning versus that of nonburning alternatives. Respondents inclined towards burning when cost was the determining factor. Nonburning alternatives gained support in situations where burning could not be conducted safely (i.e., risk of escape was perceived to be unacceptable, or community representatives were unconvinced of the controllability of prescribed fire), such as in the wildland-urban interface and in areas where pretreatment activities must be carried out prior to burning. Another consideration was the potential marketability of materials on the site.

Traditionally, vegetation and fuel management has been accomplished by one of two methods: harvesting and burning. Each method has gained staunch adherents and dedicated opponents; consequently, the entire issue has become tangled in emotional response and highly charged rhetoric, leading to considerable legal costs, impediments to progress, and self-perpetuating polarization. Nevertheless, it is generally understood that action must be taken to address a problem that has been a century and more in the making and that is becoming yearly more critical.