Panel Discussion: Prescribed Burning in the 21st Century

Even though many legal, social, and organizational constraints affect prescribed fire programs, the ecological and social benefits of such programs encourage their continued existence (with or without modification). The form of these programs in the next 10 to 50 years is pure speculation; but we must speculate and project the programs, as well as associated benefits and costs, since the ecosystems we manage respond to fire on several time scales.

A panel chaired by Dr. Ron Wakimoto of the University of Montana was convened to discuss projections about the role and form of prescribed burning in the next century. The five panelists were Mr. Jerry Hurley, Plumas National Forest, Mr. Ishmael Messer, Santa Monica Mountains National Recreation Area, Mr. Stephen Botti, National Interagency Fire Center, Mr. Jay Perkins, Klamath National Forest, and Mr. L. Dean Clark, Chiricahua National Monument. Several current problems associated with prescribed fire as well as future opportunities were presented, such as prescribed fire as a landscape phenomenon involving multiple jurisdictions. The following five papers present a summary of this panel discussion.

Prescribed Burning in the 21st Century [1]

Jerry Hurley[2]

Abstract: Past experiences in prescribed burning are described, as well as important factors for the continuation and expansion of prescribed burning in California. These factors include: a) gaining public acceptance by better identifying, managing, and communicating risks, especially the risk of attempting to exclude fire from all ecosystems and the increasing risks associated with fires that escape initial attack and affect air and water quality, forest health and sustainability, habitats, costs, and firefighter safety; b) making operational improvements by learning from past mistakes and showing that we have learned to recognize and understand factors that are common to escapes; c) better prioritizing of areas in which to burn and broadening our views on project scale and focusing on landscape; and d) more communication, education, training, prioritizing, and burning.

Natural fire is an ecosystem component, and prescribed fire, often emulating natural fire, is a management tool to meet resource objectives. However, in the current state of some ecosystems, prescribed fire may be the worst tool to solve resource problems. Tools used in combination are best, especially thinning with underburning. Once agreements are reached on desired future conditions, tool selection becomes easier. In addition, fire suppression will also become easier if fire is considered part of the ecosystem, to reduce the damage from eventual wildfires, thereby allowing better use of resources.

The Fuel Problem

In 1989, on the east side of the Plumas National Forest, the cumulative effects of past timber management practices and fire exclusion policies became apparent, with consecutive water deficit years, resulting in large areas of insect-created mortality. Thousands of acres of dense, overstocked, dead, and dying white fir stands now exist where open pine stands existed at the turn of the century. Stand examinations showed mortality varying from 50 to 80 percent in an area that is the epicenter for lightning caused fires in California (Court 1960).

These dense and dying stands are now highly flammable, prone to torching and crowning, and the creation and reception of embers generate more spotfires, making fire suppression more difficult. With more fuel for constructing fireline, higher fire intensities keeping firefighters further back, and more fires to contain or control, acres burned will only increase. Fire modeling projections for areas with the mortality problem show resistance to suppression will become 3 times greater, acres per hour burned will increase 25 times, and spotting distances will be 1.2 times greater (Page and others 1991). This has been validated with two fires on the Forest in 1989 and 1990 in which both fires burned from 500 to 1,000 acres per hour during peak periods with extensive crowning and spotting. Demand for suppression resources is further compounded by urban-rural interfaces in which suppression strategies have changed from perimeter control that minimizes acres burned, to exposure protection focusing on structures.

A Partial Solution

Because of the mortality rates, capturing the merchantable timber value and reduction potential for catastrophic fire became the objectives for the Plumas National Forest. The USDA Forest Service began aggressive salvage actions to remove the rapidly accumulating fuels and capture a merchantable product. However, salvage operations alone would not reduce the potential for catastrophic fire because not all the dead and dying material would be removed. In many cases it was less than 30 percent of the boles removed with salvage. Areas and trees without merchantable sawlog salvage did not require removal. Complete removal of dead trees would not occur for reasons of economic viability, access, equipment limitations, resource constraints, low volumes per acre, large acre involvement, and rapid deterioration of wood value. In fact, based on our projections, fire potential was not reduced when salvage logging was the only fuel treatment (Page and others 1991).

To treat more of the fuel problem and to reintroduce fire into ecosystems, we proposed underburning as the preferred treatment following salvage. Underburning also treats the most acres for the dollar. We currently have about 80,000 acres covered by environmental documentation, including surveys for archaeology and wildlife, authorizing salvage logging and underburning. Of this, we currently have about 20,000 acres with approved burn plans.

In 1991 we began our fire reintroduction program. We have since burned more than 2,000 acres, getting nearly 1,000 acres per year and working towards a target of 3,000 to 5,000 acres per year. We have burned from the road to ridgetop on a southwest-facing slope for 7.5 miles along a road that parallels a major recreational lake. We begin ignition

[1]An abbreviated version of this paper was presented at the Biswell Symposium: Fire Issues and Solutions in Urban Interface and Wildland Ecosystems, February 15-17, 1994, Walnut Creek, California.

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in the spring, as the snow melts off the south slopes, working from the ridges down slope. On one occasion we were able to carry 1.5 miles of fire down the hill by using the workforce of only six people.

Burning Into the Next Century—Gaining Public Acceptance

So how do we continue to expand prescribed fire programs into the next century, especially as our society becomes more pyrophobic and the struggle to clean up California's air becomes more difficult? Most importantly we must gain public acceptance and support. To accomplish this we need to learn from our mistakes, and initiate a number of concurrent actions, such as improving operations to reduce risk of adverse events, working on a larger scale, and better prioritizing projects for overall fire management effectiveness.

Gaining social acceptance of intensive fuels management with large scale burning as an alternative is crucial to reducing the number of catastrophic wildfires. Public perceptions ultimately drive public land management. This should be extremely clear to us in forest management after the controversial clearcutting issue. To help facilitate public acceptance we need to better identify, manage, and communicate risks to homeowners, air quality regulators, and legislators. In particular, we should emphasize the risk of attempting to exclude all fire from all ecosystems. The increasing risks associated with fires escaping initial attack and their effects on air and water quality, forest health and sustainability, habitats, costs, and firefighter safety must be emphasized. We can only expect fires to continue escaping initial attack, burning more acres and causing more damage. The reasons are clear: higher fuel loads create increased fire intensities causing more damage and lessening suppression effectiveness. We need to change the public's thinking from acres burned to damage incurred. Are 10 acres of non-renewable eastside forests equal to 10 acres of fast-growing, easily-regenerated westside forest, or 10 acres of great basin grass and sage? Do we care how many acres are burned, or are we more concerned about how many acres are damaged?

When we overcome the air quality hurdle, major opportunities will open up. I believe we can affect public perceptions through information and education. I think the public is smart enough to accept the differences between smoke management and smoke prevention. Not only has smoke been part of the ecosystem, but the volume and duration can be managed with prescribed fire. Wildfires, on the other hand, create more unplanned smoke because they burn much more area and fuel. Toxic pollutants are also generated and carried into convection columns when structures and their contents are involved. The public needs to know that wildfire smoke can be managed through fuels management.

Similarly we need to educate the public about wildfire effects on water quality, forest health and sustainability, and wildlife habitats. The public should not have to see these effects for themselves to make logical choices about forest health.

The public must understand the total costs of wildfires and alternatives to suppression and their costs. In 1989, the Layman Fire, on the Plumas National Forest, burned over 5,800 acres, most of which burned in the first 5 hours. It cost about $8 million for suppression, emergency rehabilitation, and reforestation, and about 30 percent of the timbered land became incapable of regeneration because of site degradation. For $8 million we could have easily burned all the high- priority ground on the Beckwourth Ranger District at least once.

The public should be aware of increased threats to firefighters. As our forests generate more dead trees and snags, the potential for loss of life from these silent killers will only rise. Today there is a higher threat for loss of life by firefighters from snags than from the threat of burnovers. Contrary to what we sometimes hear on television, we can predict fire spread direction and behavior. We can see buildups and changes in the weather and fire. We cannot predict where or when a snag will fall. At night we cannot even see them. In these forests, if you construct line, eat lunch, or take a drink of water, you may not even see, much less be safe from a falling snag. There is no black, or safety, zone as there is in a fire. How many acres will be burned if we cease to suppress fires at night (usually the most effective time), because of potential for firefighter fatalities from snags?

Thus, fire suppression—as represented in the figure of Smokey the Bear—and a driptorch are not mutually exclusive. They are both fire management tools to reduce loss and damage of property and forest resources to catastrophic wildfire. Just as we need Smokey the Bear for the fire prevention program to reduce ignitions, we need prescribed fire for the fuel management program to reduce damage caused by ignitions that escape initial attack and that we cannot eliminate. I think the public is capable of understanding "good fire versus bad fire." We have a responsibility to help educate them about the options, costs, and effects; and they should participate in risk decisions, because we cannot forget that public land managers work for the public.

Operational Improvements

We will have to make operational improvements that demonstrate we have learned from the past and from our mistakes. Some indicators common to prescribed burn escapes include:

- Planning Breakdowns—burn bosses should participate in burn plan participation and in planning firelines.
- Target Fixation—the pressure to blacken acres, to get trees in the ground, or to light because the crews are anxious, are reasons that burns have been ignited and have contributed to escapes. We must develop good resource and burn objectives

and good prescriptions and follow them. Just "black" is not an objective.

- Lack of Weather Information and Knowledge—We need to maximize use of remote weather stations and provide that information to our forecasting services. Burning has been performed without on-site weather from general forecasts and no consultation with fire weather forecasters, or worse, decisions were made by a person with little fire behavior or weather training.
- Lack of Planning for Wind Events—Although long-range weather forecasting is still an inexact science, we know that during certain times of the year we are prone to undesirable wind events, including frontal and foehn winds. With some experience and knowledge, we can generally predict when and where these events will occur. We can use that information in planning ignitions and follow-up actions.
- Complacency—This has been a factor in the planning, ignition, patrol, and monitoring phases. When we fail to follow the basics with test burns, or blacklines, or are complacent about patrolling or weather monitoring, the potential for escapes increases. Escapes, like fire fatalities, are not only the result of one breakdown, but a combination of events.

The application of prescribed fire is both art and science. The decision to burn is inherently risky. Agencies must provide the training, direction, and demonstrated support for their personnel who have followed that direction, followed approved burn plans, and made the decision with the best information they had, even when the undesirable occurs. I have never met a prescribed fire manager or burn boss who wants an escape, or undesirable event. Similarly, agency managers need to give equal emphasis to training and resource allocations for prescribed burning.

The value of tenure can be very important to lessen risks—not only tenure on the part of program managers, but also with agency managers. High turnover is often associated with a lack of skill, knowledge, or trust. Tenured managers can provide program continuity. Tenure can provide better local knowledge of weather and fire problems. Productivity can increase and costs decrease as personnel become more comfortable with prescriptions, ecosystems, and weather patterns. Agency managers may also require fewer constraints as their comfort and understanding increase with program personnel. Escapes, undesirable events, and consequential litigation can be reduced and risks lessened through information sharing, training, mentoring, and tenure.

Scale

We need to broaden our views on project scale and to better prioritize areas in which to burn through strategic planning. We should set priorities based on fire regimes, fire occurrence, and potential for catastrophic fire by watersheds so that the the dollars we are allocated protect the highest risk ground. My experience in fire management has shown me that pouring millions of dollars into small timber sale units for fuel treatment, or building non-strategically placed fuelbreaks to keep suppression forces funded has done little to affect large-scale fire. These small units did not alter the wildfire behavior or reduce fire intensities, and stands still suffered extensive damage. We need to develop projects that are cost competitive, allowing us to treat the most acres and the highest priority land.

Summary

The commemorative video took an important step with its message for Smokey's 50th anniversary by mentioning "that the absence of fire is (sometimes) bad; that fire needs to be part of the ecosystem." Smokey and prescribed burning are not mutually exclusive. Fire and fuel management were once the street sweeper in the timber volume parade, but have become the grand marshal of the forest ecosystem parade, because land management agencies and society are beginning to accept that fire and its related effects are components of the ecosystem.

We must better display the alternatives and effects. Although some air degradation may not be desirable, at least when it is over we still have a forest or a home. If we do not use all the fire management tools available to us, can we continue to accept the increases in costs, damage, and losses—including loss of firefighters—associated with wildfires? Can we ignore the dynamics of ecosystems by trying to manage them as if they were static; or by attempting to manage for a single species to the extinction of their habitat or the extinction of other species?

We have the information and the experienced personnel to learn from our past mistakes. If we are going to affect large-scale fires, we have to implement large-scale projects in the right places. Numerous case examples show that stands have survived loss to catastrophic fire when thinned and underburned before the wildfire. We must begin communicating, educating, training, prioritizing and burning. We have a tool—prescribed fire—that is economically and ecologically sound, and in some areas the public is demanding we use it. As Franklin D. Roosevelt said, "the only limit to our realization of tomorrow will be our doubts of today."

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Prescribed Burning in the 21st Century[1]

Ishmael Messer[2]

Multijurisdictional prescribed burning programs are the future of fuels management for numerous areas. Many agencies or departments have different mandates and policies. Burn programs are carried out according to these policies. These policies are often outdated and do not consider the current urban/interface mix issues. Without a complete understanding of the mission of our cooperators and assisting agencies, fire managers will never be able to burn the acres that need burning, including both the number of acres and strategic locations of the burn sites. Why is a particular burn project important? Will it truly protect natural resources or downstream values? Will the project make a significant difference in our protection program? Building resource data bases, specifically accurate field-based vegetation maps using satellite imagery, aerial photography, groundtruthing, and other sources of data should be a priority for any interagency ecosystem management plan. By combining resource data, resource management programs, land-use planning, development practices, and public education, opportunities exist to promote environmentally sensitive land use, while protecting resource values. For example, vegetation information combined with fire history data can be used to develop a more effective fire management and prescribed burning program to better meet ecological and property protection needs.

[1]An abbreviated version of this paper was presented at the Biswell Symposium: Fire Issues and Solutions in Urban and Wildland Ecosystems, February 15-17, 1994, Walnut Creek, California.

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Prescribed Burning in the 21st Century[1]

Stephen J. Botti[2]

Prescribed burning programs are likely to experience changes in the next 20 years as revolutionary as those experienced in the past 20 years. During the initial phase of developing prescribed burning programs for forested areas, researchers and managers generally believed that prescribed burning should be restricted to low-intensity surface fires, and that such fires could reestablish natural conditions while also reducing hazardous fuels to acceptable levels. It was only after managers started implementing long-duration prescribed burns covering several thousand hectares that they started to understand the degree of variability in fire behavior and effects that were both inevitable and desirable in trying to reestablish natural fire regimes. That variability increased the risks and potential liability of burning, and has produced a growing conflict between hazard fuel reduction goals and ecological prescribed burning goals. How this conflict is resolved will strongly influence the future course of prescribed burning programs. It could become increasingly popular to minimize risks by implementing hazard fuel reduction programs that do not promote a natural role for fire in Parks, and may produce permanent, unnatural ecosystem changes. This can be done by concentrating on the fuel complex without regard for the ecological consequences of the treatment. Constraints on prescribed burning, imposed to minimize smoke impacts, impacts to cultural resources, impacts to visitor use in wildlands, and impacts to wildfire suppression readiness, are likely to continue to increase, especially as the population continues to move into the wildland-urban interface and parks become increasingly isolated ecosystem remnants.

[1] An abbreviated version of this paper was presented at the Biswell Symposium: Fire Issues and Solutions in Urban Interface and Wildland Ecosystems, February 15-17, 1994, Walnut Creek, California.

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Prescribed Burning in the 21st Century: The Role of Fire Planning[1]

Jay Perkins[2]

Abstract: Planning is an essential step in the process of getting fire "back into the ecosystem." The public needs to understand that fire is necessary for a healthy ecosystem and an essential ingredient in ecosystem management. The hazard of high fuel accumulations coupled with risk of fire starts must be portrayed so that the public understands what will happen when the next wildfire burns in our backyard. Decisions will need to be made so that the hazards will be mitigated and areas prioritized for treatment, despite limited budgets. All professionals, and the public, too, who are working to find the answers to healthy forests must work together to understand the role of the disturbance processes at work. Fire is a key disturbance that must be considered in practically every landscape.

The future is now. We must plan to obtain funding to implement the ecosystem management projects. Conceptually, we have made tremendous progress. Before ecosystem management became the current management operating norm for the USDA Forest Service, pioneers in the use and importance of fire blazed the trail. Those of us who will carry the ecosystem management torch must give thanks to the pioneers, such as Dr. Harold Biswell for his work in the California Sierras and Bob Mutch for his work on prescribed natural fire in the White Cap Wilderness in the Bitterroot mountains of Idaho and Montana.

Recently, the Klamath National Forest committed itself to determining the meaning of ecosystem management and preparing the Forest for the 21st century. Landscape Analysis and Design is the process that was developed because fire analysis fits comfortably within it. The key to fire's future success is the incorporation of fire planning processes within the context of ecosystem management—not as a separate process.

Predicting or projecting the future is a tremendous challenge. The technology age is expanding rapidly. Current research in modeling stand dynamics in conjunction with different fire scenarios will strengthen our ability to understand complex systems. The fire analysis used by the Klamath is part of the Landscape Analysis and Design process. The Klamath is confident that this approach will be useful in the future and can adapt to changing science.

This paper will discuss the use of the Landscape Analysis and Design process used on the Klamath National Forest.

[1]An abbreviated version of this paper was presented at the Biswell Symposium: Fire Issues and Solutions in Urban Interface and Wildland Ecosystems, February 15-17, 1994, Walnut Creek, California.

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Landscape Analysis and Design

The purpose of the Landscape Analysis and Design (LAD) process is to provide a means by which forest landscapes can be understood as ecological systems, and to use this knowledge to help shape the landscape patterns created through National Forest land management activities. Fire is recognized as an essential component of the Klamath; hence, fire is a primary element in the planning process.

The process is intended as a vehicle for implementation of forest planning direction while ensuring the ecological health of the resources. It provides the link between the National Forest Management Act (NFMA) and the National Environmental Policy Act (NEPA), by providing a method for defining the desired condition of a landscape and identifying opportunities to achieve and perpetuate the desired landscape character as portrayed in the Land Management Planning (LMP) document.

Summary of the LAD Process Steps

The first two steps in the process are designed so that the landscape is described in the context of ecological structures and functions. In the first step, the landscape elements are described in terms of the vegetative matrix, patches, corridors, and patterns. In the second step, the ecological phenomena (referred to as flows) that move across, or interact with, landscapes are identified. Fire, wildlife, humans, and water are some examples of flow phenomena that operate at a landscape scale.

Step three provides a sense of the complexity of the landscape by describing the interactions of the flows with the individual landscape elements, as well as the landscape patterns. Individual flow phenomena have a specific way of interacting with the landscape elements, and the landscape pattern in aggregate. This interaction provides insight into how the landscape functions as an ecological system.

Step four provides a framework for defining sustainability. Landscapes are not static; disturbance processes are an integral factor in ecosystem sustainability. Characterizing past conditions, processes that have created the present conditions, and processes likely to affect future conditions provides a sense of the range of variability.

In step five the desired condition is defined by first establishing the landscape patterns and objectives found in the Forest Plan. The applicable standards and guidelines are evaluated in the context of the historic range of variability defined in the previous step. The resulting desired condition encompasses understanding of ecological processes at work, as well as management direction.

Finally, step six identifies possible management opportunities, by contrasting the existing condition to the desired condition. Potential opportunities that achieve desired condition objectives are delineated. The outcome of the process provides a purpose and need for implementation of individual projects designed to achieve, or maintain, the desired condition of the landscape. This process can serve as a catalyst to identify a full range of resource opportunities; by reducing functionalism, planning efforts are better integrated to provide a balance of resource outputs.

Scale of the Landscape Analysis

Because the analysis process encompasses areas roughly between 10,000 and 100,000 acres, the level of detail will be general in nature but considerably more detailed than the analysis that led up to the Land Management Planning document. This assessment of the landscape conditions serves to refine the desired condition from the LMP, while defining management concerns and issues before initiating the NEPA process.

The analysis record serves as a source document for general characterization of landscape conditions and interactions. It can be used during the NEPA process to provide a framework for the generation of alternatives, and may make recommendations where additional information and data are needed to assess environmental consequences. Although a more detailed analysis may be necessary for NEPA sufficiency, that analysis can be focused on project- specific issues and potential effects in subsequent NEPA documents.

Basic Information Needs

For every landscape, baseline information is necessary to perform the analysis. Additional information that is needed will depend on the flows, uses, and functions characteristic of each individual landscape. The baseline information includes:

- Land Management Plan map—Defines spatially the management area allocations in each landscape. General knowledge of land allocations for adjacent landscapes is also necessary.
- Topographic map with transportation system—Serves as a point of reference for unique features or areas of concern, as well as general orientation of the landscape.
- Aerial photos—Serve as useful aids that show the latest flight lines as well as earliest photos; also show obliques, orthophotos, SPOT images, and flight lines taken just before and after major events.
- Vegetation map—(may be derived from timber type or ecological type data).
- Fuel Model map—(forest crosswalk based on timber strata characteristics).
- Fire Risk/Occurrence map—Based on Forest or District information from fire history atlas.
- Fire Hazard/Fire Behavior map—Developed from the fuel model map after initial field review; combines fuel model with topographic features of slope and aspect to show hazard potential.

Additional maps that will be of use throughout the process include:

- Geohazard map—An LMP product or district product in areas where additional field review has been accomplished.
- Order 2 Soils—Particularly helpful if regenerability or productivity is a concern; LMP information could be useful in a gross scale for identifying unsuitable or incapable grounds.
- Plantation map—In landscapes with higher proportions of managed plantations, silviculture background information is a useful tool.

The initial planning meeting should identify resource concerns specific to a landscape; including wildlife use, unique features or habitats, human use patterns, or sensitive resources (i.e., sensitive plants, soils, or cultural resources). Additional needed map layers will be determined from this initial meeting. This meeting should be scheduled well in advance of the analysis process to provide sufficient lead time for data and map preparation. This meeting is crucial also so that the first steps in validation of map outputs can occur.

Team Composition and Function

The Forest has identified the need to provide consistency to the process; hence, the formation of a core group. The core group is composed of five people: a team leader, a writer/editor, and three writers/specialists. This team goes to all of the meetings irrespective of the Ranger District/landscape.

Key to the process is the Districts' involvement. In brief, they are the owners of the process and need to be intimately involved in the process. Much of their project funding will hinge on the outcomes of this process. The Districts provide the ground specialization and "resource" area familiarization. They also provide a key District liaison to ensure the Districts' needs are being met from the initiation of NEPA through project implementation.

Fire Analysis

The fundamental information that is needed to analyze wildfire susceptibility is an understanding of the fire occurrence and the fuels (vegetation) situation on the landscape. With these two elements, plus a sense of the historic role of fire in pre-fire suppression, we can gain an understanding of the susceptibility of the landscape to fire and the likelihood of the severity of a wildfire when it does occur.

The elements of this fire analysis within the Landscape Analysis and Design process will center around the Klamath's most recent project, the Humbug landscape.

The Humbug landscape is situated due west of Yreka, California and is administered by the Oak Knoll Ranger District.

Fuel Modeling

The very first step is to characterize the fuels on the landscape. As mentioned previously, one of the very first LAD products is the preliminary fuel modeling map. This is built from the timber strata map from the LMP database through a geographic information system (GIS). A first approximation fuel map is created relating timber strata to fire behavior fuel models. Ground verification is the first task by the LAD team because the resolution of the timber strata is not always sufficient for the analysis. The fire behavior fuel models characterize surface fires. If the fires reach the forest canopy, then the understory needs to be analyzed so that surface fires that reach the forest canopy are better understood.

The dominant fuel models in Humbug include:

- Fuel Model 1 (grass)—Globally changed to fuel model 2, this model is still one of grass fuel but with a tree or brush overstory. It mostly occurs along the ridges of the landscape boundary. Fires typically burn quickly in late summer.
- Fuel Model 5 (brush)—Globally changed to fuel model 6, these fuel models are difficult to discern from the timber strata information. It becomes imperative to field verify as these two fuel models burn differently. Overall decadence in the brush types indicate model 6 would be the best descriptor. The brush patches would require more detailed assessment before implementation of a prescribed burning project. Fire can be fast and intense.
- NCF (non commercial forest)—Without being given a fuel model from the crosswalk, fuel model 6 best characterizes the NCF lands in this landscape.
- Fuel Model 11 (slash)—Attributed to older plantations (>30 years), this fuel model has fuel on the ground—probably from management activities. These had to be attributed on a polygon by polygon basis through use of the stand record card system or field verification.

General assumptions are:

- Thinned stands—Remained as fuel model 11 because thinning slash in untreated stands creates a slash fuel model.
- Poorly stocked stands—Combined with fuel model 6 because the assumption is the brush component is the fire carrier. For the most part these stands are >30 years old, presumed brush with decadence.
- Adequately stocked stands—Combined with fuel model 9 because we assumed the litter accumulation is the fire carrier. Stands went into fuel model 9 rather than 8 because the majority of area had a high component of ponderosa pine.
- Timber fuel models (models 8, 9, and 10)—These were left unchanged because they are highly variable and no consistent assumption could be applied to make changes. Stands will require further refinement to develop burning prescriptions that will successfully achieve objectives of cleaning up ground fuels or understory regeneration without exceeding acceptable levels of mortality in the overstory component.

Other Fuels Characteristics

A factor not tracked in Humbug is development of understory. Presence of an understory component in sufficient quantities would create ladder fuels that contribute to crown fire potential. This would place moderate hazard fuels (such as 8 and 9) into higher hazard classes. This is an essential piece of information that needs collecting. Many current systems do not adequately portray the understory situation. This item must be improved in the future. Crown fires are the most destructive and have a serious impact on many wildlife species that are currently protected by the Threatened and Endangered Species Act.

Fire Hazard/Fire Behavior

Fire hazard/fire behavior is a derived GIS layer that uses a slope map, fuel model map, and fuel model to crosswalk a fire hazard. The crosswalk is a way of entering a look-up table for the GIS database. This crosswalk and subsequent crosswalks will be used for building GIS layers.

Three slope classes are used, consistent with the slope classes used in the LMP geologic hazard classification (0 to 34 percent, 35 to 65 percent, and >65 percent). The Digital Elevation Model (DEM) information could be used to make different slope breaks if necessary.

Each fuel model/slope combination found on the landscape is run through the BEHAVE fire behavior program. This is a modeling program that uses fuel model, slope, and weather parameters to predict fire behavior and resistance to control for suppression purposes. The 90th percentile weather from district records are used to model late summer afternoons typical of late August and early September. These late summer parameters are used because they are the ones that cause the most intense problems, burn the most acres, and have the most significant consequences to firefighting capability and dramatic fire effects to other resources.

The final product is another crosswalk created within the GIS database in which flame lengths and rate of spread are evaluated to determine resistance to control. BEHAVE is used to build this crosswalk outside of the GIS system because this capability is not yet available. The output is a rating of low, moderate, or high fire hazard/fire behavior:

- Low—Flame lengths less than 4 feet and capable of direct attack fire suppression with hand crews.
- Moderate—Flame lengths of 4 to 8 feet and capable of direct-attack suppression efforts with equipment, dozers or engines. Hand crews are not effective for direct attack suppression efforts. Rates of spread greater than those that the handcrews can contain in the low category.

• High—Flame lengths greater than 8 feet and require air support or an indirect attack method of fire suppression.

Although flame lengths are generally used to define hazard, some fuel models will have low flame lengths but extremely rapid rates of spread, which will place them into a higher hazard class. For example, in Humbug, fuel model 2 is a grass/low brush fuel model that never exceeds 4 feet flame lengths, but the rate of spread is 114 chains per hour. This exceeds the ability of hand crews, or equipment, for direct attack without air support.

The derived layer incorporates the information into a spatial display of hazard assessment for the landscape providing the link to risk and the resource values.

Fire Risk/Occurrence

This map is based on Ranger District and National Forest fire atlas information. We are still working on getting this fire history process totally automated. The map displays location of starts over a 60 year period for the Humbug landscape.

Fire risk is based on the number of fire starts per 1,000 acres. Included in the calculation are the number of fire starts, number of years of historical information, and number of acres involved. The value derived corresponds to a likelihood of fire starts per 1,000 acres. The risk ratings and range of values used in the assessment include:

• Low Risk = 0 to 0.49—at least one fire expected every 20 or more years per thousand acres.

• Moderate Risk = 0.5 to 0.99—at least one fire expected in 11to 20 years per thousand acres.

• High Risk = >1.0—at least one fire expected in 0 to 10 years per thousand acres.

Potential Wildfire Susceptibility

This is the end product of the assessment. By incorporating hazard and risk, a matrix is developed that displays the likelihood an area will be affected by wildfire. The output is a tabular report identifying the number of acres in each category, and a spatial display generated by a GIS:

Potential Wildfire Susceptibility Matrix

Hazard	Risk		
	Low	Moderate	High
Low	1	1	2
Moderate	1	2	3
High	2	3	4

What Is Next

Evaluation of the various resource values and objectives along with the wildfire susceptibility matrix can be used to develop a fuels management plan that can best achieve the desired condition for the landscape. Because all areas cannot be treated at once, efforts may be focused on areas of greatest risk to wildfire. The fire maps can also be overlaid with other resource concern areas for the line officer to evaluate priority areas.

Other uses of these resources include:

• Budgeting and identifying needs for priority work, especially those that can meet several objectives in one treatment.

• Using the products of the system for educational purposes to display the importance of incorporating fire into the ecosystem.

• Demonstrating that more firefighting resources will not provide the desired output. Fire needs to be an ally in the management of ecosystems.

Summary

In addition to the fire planning process, we need to address other issues as well. For instance, budgeting processes must align themselves with the task of implementing ecosystem management. If Forest Service budgets remain resource-oriented, our publics may not be convinced that we intend to change our way of doing business.

In addition, dynamic fuel modeling will need to be integrated with temporal vegetation modeling. Traditional fuel modeling will have to change concurrently because of the greater need to study fuels vertically as well as horizontally.

Planning processes must follow the intent of NEPA and be implemented in an interdisciplinary fashion. Fire planners must share their knowledge of fire effects and fire dynamics so that we can have a better understanding of all of the interrelations that occur on a landscape. The search for knowledge must continue and that knowledge must be shared.

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Prescribed Burning in the 21st Century[1]

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Abstract: General Helmut Von Moltke defined strategy as "the practical adaptation of the means placed at a general's disposal to the attainment of the object in view." Three strategies are needed for a proactive posture of fire management in the 21st century. The first is to improve positional defenses of human values at direct risk of fire loss. This strategy addresses primarily fuels management at the interface. A second strategy is to improve safety and cost effectiveness of fire management activities on the exterior lines where rural and resources economics are the human values at risk. The third strategy involves the dilemna of cost effective wilderness fire management programs faced by land managers to improve command, planning, logistics, and financing of interior line prescribed fires (within administrative boundaries of public lands).

I met Professor Biswell at Pinnacles National Monument after he had written a USDI National Park Service (NPS) prescribed fire plan for that unit (Biswell 1976). My job was to implement that plan. Professor Biswell gave me a little advice at the Pinnacles before doing the controlled burning there: "Talk with the local ranchers—listen to what they have to say." My attention was turned to the winds (Schroeder 1961).

I presume to speak for those whose tongues are still. For I have followed their paths and the ancient paths before them. These words you may regard as an echo. An echo of what the winds have whispered to me. Because to understand the essential nature of fire, you must *feel* the winds. For it is by such means that fire will return to where you stand and listen. The "Cat-faced" trees are also a clue in my woods (Swetnam and others 1989).

Our cultural focus with fields and fire is that we will stop the fire if we do not want it or prescribe it as a treatment. We prescribe a fire. An interesting story is the one that the ancients of this land held, that Fire is in the Wood (Clark 1953). At the right time, by and by, it was let out. It went on and on that way for a long time. The fires started one way or another. The fact is fire was here, is here, and so are we.

What should be the form of these fires? Currently, we have two choices. Our direct defensive strategy (Clar and Chatten 1966) is to keep to a minimum the number of acres burned and the extent of property and human losses. The chances of success for our indirect offensive strategy depend on control of the timing and rate of progressive ignitions, or firing. Fire as a tool is used only as a last resort.

Our transformation of this landscape compels a redefinition of our prescribed fire strategies. Suppression alone is a defensive strategy. For fire suppression we must confine, contain, and control them (NPS 1991a). For prescribed burning we depend on either management or natural ignition. If tactics derive from strategy, then how do we reconcile our actions to our policies?

Fire suppression works most of the time, but does not work all of the time, particularly during the dry and windy extremes of a site's environmental range of conditions. During these times fire is the enemy; it can become the fire demon. We often must abandon exterior attacks upon fire flanks and must defend positions of developed properties. We are duty-bound to do so. The reassignment of firefighting resources to the protection of human life and property further complicates the control problems by an ever-widening perimeter of uncontrolled fire. The command and operational difficulties in these tactics are a recurring problem (Phillips 1971, USDA-USDI Task Force 1989).

We lack unified strategies to focus our uses of fire in other than suppression modes. General Helmut Von Moltke defined strategy as "the practical adaptation of the means placed at a general's disposal to the attainment of the object in view." Our lack is coordinated prescribed fire action on the offensive end. We can take the initiative and use time to our advantage. The firefighting tools and equipment we can buy are stronger, and more powerful than ever before. Our tools, and therefore our tactics, are evolving. But even with limited resources we can at least apply a limited aim strategy: for example, fuels management on key geographic positions when the weather elements align to our favor. The principle is to change weak fire defensive positions into strong (or anchor) points at times of advantage to a site's fire potential, such as doing "off-season" controlled burning. As General Patton used to say, "A good plan in time is better than a perfect plan that is too late."

The integrated STRATEGY I propose is a simple synthesis of three common strategies for prescribed fire management application. The use of these three strategic profiles can provide priority and essential flexibility for any jurisdiction to integrate with the suppression and prevention programs for more effective wildland fire management. The strategies serve equally well for suppression or for prescribed fires.

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Positional Defenses

This strategy directly protects life and property from fire. Tactics for this strategy are the most varied, and by the topography of most human developments, machine-accessible. The objective is to reduce fire hazards near properties that are at risk to fire loss. The California Public Resources Code 4291 specifies a vegetation clearance around structures in the wildlands. The rule is 30 feet or more and if uniformly enforced, it would work to reduce wildfire losses. This tactic can be done by anyone or by any public entity on owned lands, not just in California.

Many common problems of wildland fire protection occur on a small scale that can be solved before a wildfire (Moore 1981). The image of a design of concentric circles, or ellipses, can be applied to fuel reduction areas around structures, or developments, as fire protection buffer strips. This protection concept can apply to timber plantations, recreation sites, historic, natural or cultural resources as well. The widest, or deepest, strips of modified vegetation would be in the upwind, or to the downslope sides of the values at risk to fire.

The limited aim of this strategy is to turn the most vulnerable flanks of wildland exposures into positions of defensible space under the worst case conditions expected for a site. Use of public labor crews may be an option for some areas.

Exterior Lines

Perimeter fire control is the basic tenet for effective wildland fire suppression (Brown and Davis 1973). It is a lawful assumption for controlled burns. The basic principle to this direct strategy on the exterior line is to contain a fire. Wildfire losses will be held to the minimum through timely and effective suppression action consistent with values at risk (USDI 1990). This strategy generally protects life and property indirectly by stopping the spread of a fire.

The defined perimeter of each prescribed burn is the line of "control" beyond which the fire is no longer controlled. Currently, therefore, each controlled burn is an exterior line action with all of the associated expenses.

Cooperation between neighboring agencies to agree upon joint project areas on mutual boundaries can serve to "dissolve" administrative boundary lines. An example of this planning concept is the joint NPS-USDA Forest Service Lassen Park-Caribou Wilderness Fire Management Plan recently re-approved by Lassen National Forest and Lassen National Park. Others are in development throughout the west.

Convergence of planning for wildfires and prescribed fires can use existing escaped fire situation analysis (EFSA) format as a basis for safer, more cost-effective resources decisions. For multi-jurisdictional situations, the documents must reflect the unified command structure of the planned incident, and thereby provide strategic agreement in advance of the inevitable need. These are "pre-attack" fire presuppression plans and can be prepared as contingency for planned or even on-going prescribed fires of concern to managers. Powerful new tools using remote sensing technology can help managers identify realistic fire management planning units based on fuels and projected fire behavior.

The concept of fuelbreaks as a pre-attack measure for area fire protection can be beneficial (Green 1977). Fuelbreaks emplaced upon geographic features such as ridges, particularly along administrative unit boundaries, serve dual purposes. The access to fires is at least safer for firefighters, as well as being a clearly defined edge of a management unit or a jurisdiction such as at Whiskeytown National Recreation Area, and on the Stanislaus, Sequoia, and Sierra National Forests. A successful example of this principle working in practice was on the "Powerhouse" fire on the Sierra National Forest in 1989. A flank of that fire was contained when it burned into Jose Basin, a part of of the "Sugarloaf" type-conversion project from the 1960's.

Area conflagration control and wildfire reduction on an area could be improved by treating the areas contained within the fuelbreak perimeters with controlled burning such as on the "Grindstone" project on the Mendocino National Forest. There are a multitude of resource benefits from such programs on public lands in addition to fire hazard reduction.

Interior Lines

Interior lines as a strategic concept applies primarily to large blocks of public lands. Areas that have few high-value economic elements, and have high ecological significance, such as wildernesses, parks, and monuments, are logical for applications of large-scale prescribed fires. Indeed, both Sequoia-Kings Canyon and Yosemite National Parks have been at the vanguard of the use of fire as a tool in ecosystem restoration and maintenance. Several Forest Service wildernesses such as the Selway-Bitterroot, and the White Cap in Montana are active with prescribed natural fire (PNF).

Wilderness should permit the role of natural processes to the fullest extent possible without interference from man. Yet each wilderness fire must be guided by a plan! We should plan the fires to our capacities, for instance, scheduling the ignitions in certain areas, at certain times where natural ignitions and suppression activities have resulted in unprecedented fuel accumulations. The strategy of the interior line has a broad scope of application in the medium sized and smaller units of the public lands. The use of an interior line strategy will work, but some objectives and procedures need to be refined. On the interior lines of remote areas, the ecological processes may be served within the span-of-control of modest-sized forces, by using moderate burning conditions, with some time allowed to do the job patiently and carefully.

Formation of mobile tactical teams of specialized fire management resources able to move from job to job as reinforcement (but *not* replacement) to local fire forces could enable this work. Simplified command, operational, and administrative procedures could empower the field fire commanders. Most of the NPS areas in the western United States have comprehensive fire management plans prepared and on file (NPS 1992). Working strategies are lacking, however, as well as essential resources and field flexibility. Many opportunities exist for human-ignited prescribed fire programs in smaller wildernesses. Thus, many of the present difficulties with naturally occurring prescribed fires may be resolved. Smoke management can be a protracted problem for small areas, too.

Point/Counter-Point

Legal issues surround the use of prescribed fire in the next century. Guidance in the form of United States Code (18 USC 1855, 1856) covers issues such as fires kindled, left unattended, or unextinguished by Federal agencies (U.S. Code 1982). The internal administrative discussion about prescribed fires, the external regulatory climate, and interagency distrust following Yellowstone 88 all combine to deflect attention from the focus of the IC/burn boss to the forces that make or break successful fires on the fire ground. Land managers are well-advised to await a wildfire rather than bother with all of the prescribed burn risks and headaches. Individual commitment must be to a shared responsibility (Mutch 1977) for total fire management.

"Mobile Tactical Teams" that are specially trained and equipped to initiate and see through prescribed burning projects (USDA-USDI 1989) may encounter several barriers. Most are fiscal and administrative concerns.

Dr. Biswell once stated that fire control agencies should balance the money used in the fire program in thirds: suppression, prevention, and controlled burning. This idea did not really work. Perhaps the concept could be applied in reverse. "Base" fire management funds "saved" by efficient operations could be designated for prescribed fire operations, if such operations have been targeted in a plan. This approach is an incentive to save funds to get more fuels/vegetation work done.

We do need sensible and sustainable funding sources to pay for the integrity of natural processes. A potential source is a percentage of the Land and Water Conservation Fund (P.L.88-578, September 3, 1964, and as amended) in proportion to wilderness use for the NPS, the USDI Bureau of Land Management (BLM), and the USDI Fish and Wildlife Service (FWS). The Forest Service might assess a special user fee permit for each wilderness entry.

My thesis is that tactics derive from strategy and our strategies are deficient. I have proposed an integrated strategy for prescribed fire management actions. Interior line actions await refinements of strategic interagency cooperation, and our resolve to act. I have the patience to wait, but the problems are not going away. And the fire is still in the wood. The decisions must be on the ground and in time to work well. We must do fire work like we walk, a step at a time. For the winds will return where I walk. It is not if, but when, the fire shall return, and return once again.

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