Use of Prescribed Fire to Reduce Wildfire Potential[1]

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Abstract: Fires were a part of our wildlands prehistorically. Prescribed burning reduces fire hazard and potential fire behavior primarily by reducing fuel quantity and continuity. Fuel continuity should be considered on the micro scale within stands, the mid-scale among, and the macro-scale among watersheds or entire forests. Prescribed fire is only one of the tools which can be used to reduce fire hazard, but it can be effective at all scales.

Fire has been a part of many ecosystems, playing a large role in shaping them and leading to the adaptations of many plants and animals to different fire regimes. Without fires, many of the vegetative types and the associated fauna have changed drastically. The type may have become susceptible to changes from biotic or abiotic agents, and may lose its desirable characteristics for many years.

Removal of fire from many of our forest and range types has led to change in species composition and accumulation of excessive biomass; it has set the stage for high-intensity, high-fuel-consumption, stand-removal fires. The purpose of this paper is to discuss the use of prescribed fire to reduce the potential for such fires.

It should be noted that prescribed fires generally also accomplish other land management goals. These include maintenance of stand composition, increase in water quantity and quality, reduction of insect or disease damage, and increase in esthetic and recreation value. Few prescribed fires could accomplish all of these objectives, but most, when well planned and executed, could accomplish several of them. Today, with our limited operating dollars, multi-objective prescribed fires are the rule rather than the exception.

Prescribed fire is only one way to reduce wildfire potential. Fuels management, which is that branch of fire management dealing with the fuels, begins with vegetation management. Thus, the right vegetation in the right place is the first step in reducing wildfire potential. Biological, chemical, manual, and mechanical means may be used in conjunction with fire to modify fuels. The total job of managing fuels - fuels management - is the art or practice of controlling the flammability and resistance to control of wildland fuels through the means described above in support of land management objectives (Lyon 1984).

Reduction of wildfire potential is best described in terms of modifying potential fire behavior. In turn, fire behavior is influenced by the three elements of the fire behavior triangle--fuels, weather, and topography. Of the three, the only one we can easily and directly affect is fuel, the biomass, or more specifically, the phytomass. We will first describe the basic properties of fuels which are important to fire behavior and then look at what prescribed fires can do to fuels, and how this reduces the potential for large wildfires and increases our ability to control them.

BASIC CHARACTERISTICS OF FUELS

Fuels can be described by six basic characteristics, and these characteristics (Martin and others 1979) are chemistry, particle and density, moisture content, compactness, continuity, and quantity. Only the last two, continuity and quantity, are discussed in this paper, as they are most affected by prescribed burning.

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Continuity

Continuity expresses the degree or extent of continuous distribution of fuel particles in a fuel bed (or over the landscape). The parentheses indicate a broader concept of the definition, which I am adding. Continuity affects a fire's ability to sustain combustion and spread (Lyon 1984).

Continuity is important both horizontally and vertically. Surface fires need horizontal continuity to spread unless they can spot by embers dropped ahead of the fire into other fuels. Vertical continuity allows fire to move upward, most notably into the crowns of tall shrubs or trees. When fire moves into tree crowns, spotting distance for embers increases greatly, and fires become more uncontrollable. When one or a few tree crowns burn, we often refer to the phenomenon as torching, whereas when the fire continues to spread in the crowns, we would call it a crown fire.

As compared to other characteristics of fuels, continuity is difficult to measure in ways meaningful to fire spread. In large measure, this is because gaps in fuels have more or less significance depending on the nature of the fire.

Quantity

The amount of fuel per unit of area is an obvious characteristic of fuels in influencing fire behavior. Quantity is generally expressed in tons per hectare or tons per acre, but is also given in units of kilograms per square meter or pounds per square foot. The quantity of fuel must also express whether the fuel is live or dead, herbaceous or woody, and its size class.

REDUCTION OF WILDFIRE POTENTIAL

Prescribed fire affects fire potential primarily by modifying the continuity and quantity of fuels. These characteristics may be changed on a microscale within stands, on a midscale among stands, or on a macroscale throughout an entire forest or watershed.

Both horizontal and vertical continuity are reduced for a period after a burn. The horizontal continuity returns more rapidly, as trees put down more needles and branches. However,

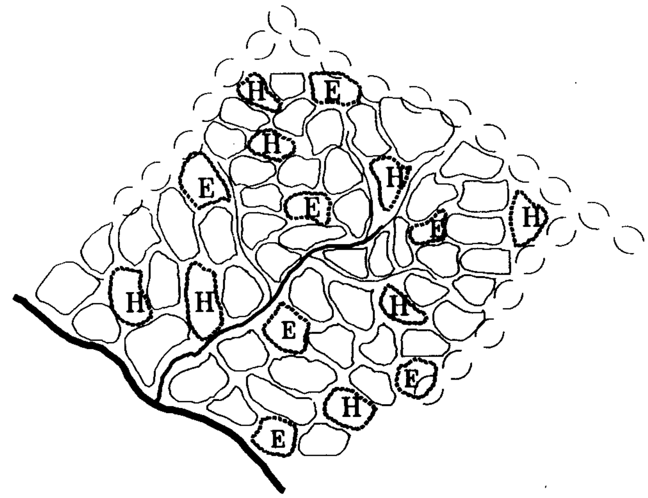

Figure 1.- The pattern of arrangement of high and extreme fire hazard and resistance to control among units of low and medium hazard is the key to reducing wildfire potential at the midscale.

vertical continuity is interrupted for a long period of time, sometimes until the end of stand rotation. Shrubs and understory trees may tend to restore vertical continuity, but the pruning effect of fire on the lower branches of trees will permanently move the crown fuels higher and thus less reachable by surface fires.

Continuity of fuels on a larger scale is also reduced. Within a small drainage, areas of high or extreme fire hazard may be isolated by burning of intervening stands. Seedling and sapling stands generally have crowns which are close to the surface and contiguous with surface fuels. Further, the young stands may be too sensitive to fire to use prescribed burning to reduce fuels there. It would then be important to isolate these stands in such a way as to reduce the potential for wildfire to spread from one to the other (fig. 1).

In fighting a fire, the decision may be not to fight the fire within the high or extreme hazard area but to keep it from spreading into adjacent units. Since only about 20 percent of a stand's rotation time is in the seedling and sapling stage, only about the same percentage of the total forest area would be in this stage. The individual units could be isolated, effectively reducing continuity on the midscale.

Fuel continuity can also be reduced on the macroscale by isolating various

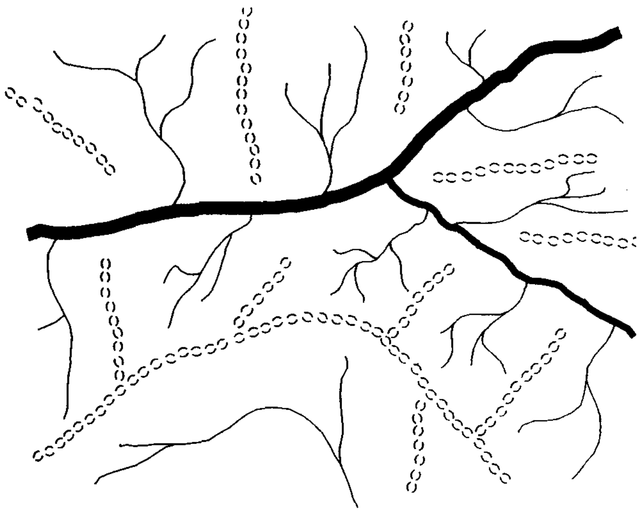

Figure 2.- Reducing continuity on the macroscale can be important in preventing fire spread from watershed to watershed or across a large segment of a forest.

parts of a forest or range by fuel modification areas. I don't use the term fuelbreaks here because these are defined very specifically and are often not effective in stopping high intensity headfires. Fuelbreaks, that is, fuel modification areas 100 to 300 feet wide, may be the beginning of effective fuel modification areas by serving, for example, as the backdrop against which prescribed burning can be done.

Modifying of fuel continuity on the macroscale would use terrain features and roads to isolate drainages from one another (fig. 2). Fuel modification areas follow ridges and streams as well as roads or other human artifacts. The fuels along ridges may already be reduced by rock outcrops or high elevation meadows. Where forests are present, the ridges may represent the lowest quality sites, so reduction in timber growth there to protect the forest would have the least effect on total production.

Areas along streams may be more moist or contain less flammable vegetation, providing a first step in developing a fuel modification area. Where stream bottoms are broad and in meadows or areas dominated by low flammability species, very little additional work may be needed.

In planning prescribed fires, it should be pointed out that reducing fuel continuity on the mid- and macroscale may not be effective if fuel continuity and quantity are not reduced within stands, as exemplified in the 1987 fire experience. Extreme fire weather and long distance spotting combine to overwhelm fire fighting organizations unless fuel modification has been done within individual stands.

EXAMPLES OF EFFECTS OF PRESCRIBED FIRE ON WILDFIRE POTENTIAL

To illustrate how prescribed fire reduces wildfire potential within stands primarily through reducing fuel continuity and quantity, I'll use prescribed fire sites in Washington, Oregon, and California (fig. 3). The sites vary considerably from each other. However, wildfires occurred in the same or similar stands, giving us the opportunity to compare wildfire behavior in unburned and burned stands. Additional replication is needed before this case study is extrapolated to other locales, although many fire managers and researchers have noted similar fire potential reduction by prescribed fire.

The stands have a wide range of characteristics and histories (Table 1). The Coyote Creek plots were burned three times by Harold Weaver, starting with thickets of pine seedlings (Weaver 1957). The results of his thinning with fire resulted in stands similar to those represented by the hand-thinned stands on the Kelsey and Lava Butte sites, which were burned in the late 1970's. The Lookout and Walker Mountain sites are older pine stands, and the Challenge and Blodgett sites are mixed conifer stands.

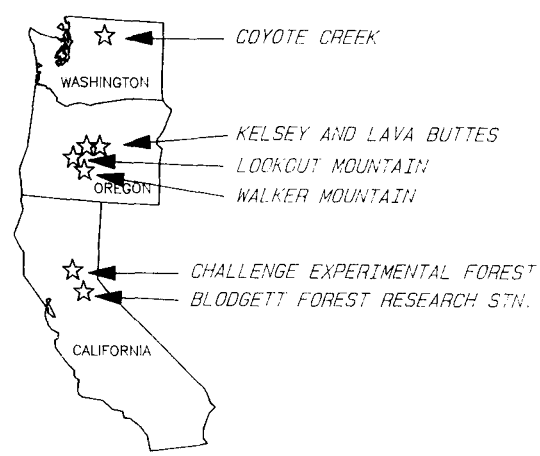

Figure 3.- Units used as examples for reduction of fire potential by prescribed burning are from Washington, Oregon, and California.

Table 1--Characteristics of the sites from which the effects of prescribed burning on wildfire potential were estimated.

Site Feature	Site: Coyote Creek	Kelsey Butte	Lava Butte	Lookout/ Walker	Challenge/ Blodgett
Type	Ponderosa pine Shrub Pine Grass	Ponderosa pine *Ceanothus velutinus* *Arctostaphylos patula*	Ponderosa pine *Purshia tridentata*	Ponderosa pine *Ceanothus velutinus* Hardwood Grass	Mixed conifer Hardwood *Ceanothus integerrimus* *Arctostaphylos patula*
Locale	N.C.WN	C. OR	C. OR	C. OR	N. CA
Site	Low	Low	Low	Medium	High
Quality	3 & 4	3 & 4	3 & 4	2	1
Age	60	70	70	150	65
Burned	1942-67	1978	1979	1976-82	1983-84

The differences between the stands point up the possibilities for multiple-fire prescribed burn programs that could reduce hazard and prevent potentially dangerous wildfires. Units are discussed in order from north to south.

Coyote Creek

This area was burned in 1942, 1954, and 1967 by Harold Weaver of the Bureau of Indian Affairs. The burn and control plots were pine thickets, and for the first burn were all less than 5 feet high, as indicated in photographs. Today, ponderosa pine on the burn plots ranges in diameter from 4 to 8 inches, whereas the unburned plots remain as stagnated thickets with stems from about 1 to 4 inches in diameter.

The burned plots have an effective break in vertical continuity with an understory of pinegrass and some shrubs, mostly a wild rose. Wildfires under moderate conditions would do no damage in the stand, and under extreme conditions would do little damage and be easy to control. In the unburned plots, wildfire under any conditions would torch almost all the crowns and present control and spotting problems. The entire stand would be destroyed. In addition to the benefits to tree growth and fire management, the burned stands provide grazing not available in the unburned stands.

The burned stands need further thinning by hand to obtain more ideal spacing and to remove those trees which were scarred during the burning operations.

Kelsey Butte

These plots were burned only once under very moderate conditions because of the high fuel loads, the shrub understory, and the low crowns. The stands had been thinned 8 to 10 years before burning, and the thinning slash persisted in the dry Central Oregon climate. The first burn was designed to reduce the fine fuels and to reduce the vertical fuel continuity, with the idea that the second and third burns would be needed to make the stands reasonably firesafe.

A wildfire ran into the stands before followup burns could be conducted. In the unburned stands, the wildfire torched out most trees and continued to move unchecked. In the burned stands, the fire dropped to the ground with only an occasional tree torching out. The burned plots were used to control one flank of the fire, and a small percentage of the trees survived.

Increment borings of burned and unburned stands indicated no effects on growth from the prescribed burns.

Lava Butte

The Lava Butte plots were burned to study the effects of prescribed burning on nutrients, understory vegetation, and ponderosa pine growth (Landsberg and others 1984). About half were burned for high fuel consumption, removing 80 percent or more of the down and dead fuels and of the litter (01) and duff (02 and 03 layers) . The moderate fuel consumption burns consumed around half the fuels, although the results were variable.

Based on observed fire behavior in other areas, the high fuel consumption units could probably survive a wildfire under extreme conditions with moderate damage and almost no torching of trees. Under moderate conditions a wildfire would have little effect on the stand. In contrast, the moderate consumption units would involve some torching and fairly high crown scorch under extreme wildfire conditions, but only moderate damage would occur under moderate wildfire conditions. The unburned controls would be mostly destroyed under both moderate and extreme wildfire conditions, and with many trees torching, spotting, and presenting difficult control problems.

The stands which received moderate and high fuel consumption prescribed burning treatments demonstrated 4 and 20 percent growth reductions in comparison to the unburned control in the first 4 years following burning (Landsberg and others 1984). The duration of the growth differentials is unknown.

Lookout and Walker Mountains

These sites are quite similar and will be covered together. They are older stands on sites which are quite good for Central Oregon ponderosa pine. They are even-aged, probably originating after wildfire. Since they are better sites and higher in elevation, Indian and lightning fires occurred less frequently than on the lower sites, thus allowing for a greater probability of fuel accumulation and of stand-replacement fires.

Fuels reduction by all prescribed burns reduced fuel loads and continuities to the extent that wildfires would do low to moderate damage, depending on conditions, and present only moderate resistance to control. Without prescribed burning, wildfires under moderate conditions would scorch greater than 50 to 100 percent of the crowns of most trees but present only moderate resistance to control. Under extreme wildfire conditions, crown scorch would be high in all cases, and perhaps up to one-third of the crowns would torch, making control problems more difficult.

Blodgett and Challenge Sites

These are high quality sites, and even though there are differences between them, they are similar in fuel characteristics. Prescribed burning was conducted once or twice to reduce stored shrub seed in the soil and duff and to kill established shrubs and hardwoods, with the aim of reducing competition with a new stand (Kauffman 1987, Kauffman and Martin 1987). The first burns were designed to accomplish either moderate or high duff consumption, whereas the second burns were designed for high fuel consumption.

The stands are of mixed age, and all first burns reduced wildfire potential. On the moderate consumption burn sites, wildfires would be more likely to do stand damage and to torch out crowns with the attendant spotting. High consumption burns and the second burns would lead to successively less wildfire damage and potential fire behavior. In contrast, potential fire behavior on the unburned control would lead to extensive torching and spotting and thus high resistance to control. The 1987 wildfires in California are illustrative of the difficulty in controlling fires in this type.

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