Fire Applications in Ecosystem Management

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Abstract—Decades of fire absence from ponderosa pine/Douglas-fir forests has resulted in overstocked, unhealthy, and severe fire-prone stands requiring management attention. Prescribed fire can be used in three general situations during restoration management. First is when fuel loadings are excessive from either natural accumulation or harvest slash. Second is when dense understory conifers are thinned and burned. Third is when tree cutting is impractical or against policy and, therefore, applied fire may be the only practical option. Maintenance burning should be planned to coincide with future silvicultural activities or to maintain ecological processes.

Fire history records from low elevation ponderosa pine/Douglas-fir (*Pinus ponderosa*/*Pseudotsuga menziesii*) forests clearly indicate the important influence fire has had for centuries as an ecological process (Arno 1988). It functioned as a thinning agent, to stimulate herbaceous and shrubby vegetation, to prepare seedbeds, as a nutrient cycler, and to reduce forest fuels and the severity of inevitable wildfires (Harrington 1996). In the decades of fire absence, most, if not all, of these functions now require attention; therefore, in the overstocked, unhealthy, severe fire-prone stands of today, fire should be considered in the restoration process.

Surface and ground fuels commonly accumulate on these dry sites more quickly than they decompose, resulting in a dead fuel buildup. Additionally, natural regeneration and continuous subsequent growth occurs in the absence of disturbance primarily for shade-tolerant, highly flammable conifers, producing a ladder fuel stratum that can link a surface fire to the crowns of the overstory (Fiedler and others 1996). In most stand conditions with advancing succession and associated health and fire hazard concerns, fire alone is an imperfect, highly variable restoration agent. It is sometimes necessary to use fire alone, but generally some form of prefire thinning is desirable for greater control of stand conditions and fire behavior. With this in mind, there are three general situations in which fire can be considered in restoration management. Two situations include fire preceded by mechanical thinning, one does not.

In the first situation in which rather complete control of tree composition and structure is possible for hazard reduction and health improvement, a thoroughly planned silvicultural operation can be applied. Excess trees of merchantable size can be harvested as described by Fiedler (this proceedings), but resulting fuel loads need to be considered when prescribed burning is planned. If surface and ground fuel loading is high before harvesting, adding new slash may create a fuel condition, which, if burned, could lead to significant tree damage and severe soil impacts. The option to leave these fuels untreated is sometime taken because of the concerns of damaging fire effects and fire control. However, this additional fire hazard remains for years and without burning various fire processes such as small tree thinning, nutrient turnover, plant stimulation, and others are not realized.

If fire application is desired yet fuel loadings appear excessive, several options are available. Much of the potential slash from harvesting can be removed with the logs then piled and burned at safe log landings (Arno and Harrington 1998). Alternately, slash can be concentrated manually on the harvested sites for pile burning under moist conditions prior to broadcast burning.

The prescribed, broadcast burn should be conducted under moderate weather and fuel moisture conditions such that a majority of the fine fuels are consumed but much of the duff and large woody fuels remain. This will lessen the immediate fire hazard but keep fire severity low, minimizing soil heating and injury to stressed overstory, and herbaceous and shrubby understory plants. For example, the most successful EM burns in the Lick Creek Demonstration Area of the Bitterroot National Forest were conducted with fine fuel moistures of 9 percent, duff moistures averaging 50 percent, and large woody fuel moistures about 90 percent. Sixty-fire percent of the litter and small woody fuels were consumed along with 20 percent of the duff. Because adverse plant and soil impacts are caused not only by excessive amounts of fuel consumption, but also by excessive rates of fuel consumption, controlled ignition is important (Kilgore and Curtis 1987).

In the second situation in which harvesting of overstory trees is not possible or desirable, the understory conifers, which make up the ladder fuel component, are most efficiently and effectively removed by cutting followed by either pile burning or broadcast burning (Fiedler and others 1996). Heavy slash fuel elimination is best controlled and least impacting when burning in piles under moist, cool conditions. Prescribed broadcast burning should follow to allow the complete fire process. If slash fuels are not excessive, they could be burned in the prescribed fire along with the natural fuels, as long as ignition is controlled to maintain moderate fire intensity. Where old growth ponderosa pine and western larch (*Larix occidentalis*) are present, raking away the large duff mounds at tree bases may be necessary to reduce cambium and root injury. The efficacy of both pile and broadcast burning of understory ladder fuels will be tested on the Snowbowl Old Growth Stand in the Lolo National Forest. About 650 understory Douglas-fir/acre (Arno and others 1997) were slashed and either piled or scattered beneath old growth ponderosa pine and western larch for burning in the spring of 1999. Two key objectives

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are the elimination of the competitive, ladder fuel component and minimizing fire impacts on the old trees.

In the third situation, tree cutting of any kind may be impractical or against policy. These areas might be represented by steep, remote sites, wilderness boundaries, or sites primarily designated for wildlife habitat. Therefore, applied fire may be the only option for reducing severe fire threat and improving forest health through stand density reduction (Kearns 1998). Fire use with a thinning objective is very challenging and is accomplished under a rigid set of environmental and ignition conditions. Because the goal in this type of burning operation is generally to kill certain tree species and sizes and save others, a conservative approach will lead to little more than surface fuel reduction and yet a poorly planned and executed, bold application could lead to excessive damage. Relatively liberal application of fire is generally necessary to sufficiently scorch or consume tree crowns such that mortality of excess trees results. It is important to note that success of this kind of fire treatment leads to a different kind of hazard. As foliage, branches, and stems of the dead trees fall, an inordinate amount of surface fuel results over the next 5 to 10 years. So, even though relief from the ladder fuel hazard may be realized, the threat of a high severity wildfire increases as aerial fuels become surface fuels. Within 10 years another fire treatment would be recommended to reduce the new hazard (Thomas and Agee 1986). Two tests of fire without cutting have been conducted on the Bitterroot National Forest. The hand ignited prescribed burns in dense, Douglas-fir dominated stands resulted in up to 60 percent surface fuel reduction but little stand thinning (data on file, Missoula Fire Sciences Lab).

Whether mechanical thinning is conducted or not, the success of the prescribed underburns is determined by several factors. The amount of dead organic matter consumed is a primary objective that is readily discerned, with too much being as undesirable as too little. In these lower elevation forests with advancing succession, killing the advanced regeneration of the shade tolerant species is also an important goal that is quickly evaluated. Without burning, this cohort will respond to the newly open stand and grow quickly into codominance. This objective must be coupled with the goal of minimizing mortal injury to the favored species and size classes. Several years must pass before a concise appraisal of this goal is possible. A final, easily evaluated goal is the response of native understory vegetation and exotics, which can respond positively or negatively depending on physiology, burn severity, weather, and others.

In these three restoration situations, it is clear that large accumulations of both live and dead forest fuels, within stressed stands are the primary reason for a cautious but deliberate approach to fire application. This approach includes techniques to reduce potentially site-damaging levels of fuels prior to the desired, ecologically sound broadcast burn. Regardless of the effectiveness of these initial fuel and stand density reduction treatments, maintenance burning should be planned to either coincide with future silvicultural activities or be conducted alone to maintain the presence of the ecological fire process in these forest types. Because the stand structure and composition are dynamic, as trees grow and naturally regenerate, and as dead organic matter continues to accumulate, a departure from the desired forest condition occurs. A periodic return of cutting and/or fire simulates the natural fire regime that was primary in sustaining forest health. These regular cycles of purposeful disturbance are typically less challenging to conduct and less costly than initial forest entries because the stand density and fuel amounts are much less. Weather opportunities for maintenance burning are broader and should not conflict with initial fuel management operations.

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