Restoring Historic Landscape Patterns Through Management: Restoring Fire Mosaics on the Landscape

Cathy Stewart

Seral, fire dependent lodgepole pine (*Pinus contorta* Dougl.) communities are an important component of upper elevation forests throughout the Northern Rockies, where they cover 4 million acres, or about 17 percent of the land base. On the Bitterroot National Forest, lodgepole pine occurs mostly between 5,500 and 7,500 feet.

Two factors strongly influence the fire regime in the lodgepole pine types: cone serotiny and mountain pine beetle epidemics. Serotinous cones have scales that are sealed with resin. The seeds are stored in these cones for many years until they are exposed to heat that melts the resin and allows the scales to open. This allows the tree to disperse the maximum amount of seeds when the conditions are optimum for germination—namely, in the ashes immediately after a forest fire. Cone serotiny is a genetically controlled trait. It is estimated that 70 percent of the lodgepole pine type on the Bitterroot National Forest has predominantly serotinous cones.

Mountain pine beetle (*Dendroctonus ponderosae* Hopk.) plays another integral part in the ecology of lodgepole pine. The adult beetles produce galleries under the bark of the tree and lay eggs. When the eggs hatch, the larvae carve horizontal galleries which girdle the tree and can kill it. Population outbreaks occur on roughly a 20 year cycle (Amman 1978). There were extensive outbreaks of mountain pine beetle populations in the 1970's and 1980's. In Montana, over 800,000 acres of lodgepole pine were infested in 1979 alone (Bennett and others 1979). These outbreaks created heavy fuel loads that, along with drought, helped produce the severe fires of 1988 in Yellowstone National Park.

In the Greater Yellowstone Area, 1.4 million acres burned in 1988. Of these, 61 percent were fires that burned in the forest canopy and 34 percent burned on the ground surface only (Greater Yellowstone Post-Fire Resource Area Survey Team 1988). Additionally, many unburned patches helped create a fire mosaic on the landscape. There has been continuous professional discussion that the intensity of the 1988 fires was within the historical range of fire behavior, but that the scale may have been enlarged due to many years of fire exclusion.

The characteristics used to analyze the historical range of fire activity include fire intensity, frequency, and size (or scale) of fire events. Intensity is characterized by four levels: (1) crown consuming fire; (2) severe surface fire; (3) mixed severity fire (some trees survive); and (4) low intensity surface fire. Stand replacing fires (levels 1 and 2) kill the majority of trees in their path with occasional patches of live trees surviving. Some larger trees, and especially the fire resistant species, survive in mixed severity fires. Most overstory trees survive low intensity surface fires. The fire intensity in the lodgepole pine type on the Bitterroot National Forest is variable with many sections of stand replacing fire (1 and 2) on steeper slopes bordered by areas of lower intensity fire (3 and 4) on gentler topography. Single or multiple fire scars occur on lodgepole pine in some stands indicating the lower intensity fires.

Fire frequency is indicated by the average interval between fires. Frequent fires in some forest types can maintain reduced fuel levels, resulting in low intensity impacts. Infrequent fires (intervals >50 years) are characterized by higher fuel levels and intensity leading to higher mortality. The four intensity levels can create a pattern of variable intensities over time and across the landscape. Average fire intervals on the Bitterroot National Forest have been measured as being between 32 and 112 years in different lodgepole pine study areas (Arno and Petersen 1983; Brown and others 1994).

All factors of historic fire regimes, including the size of fire events, have been altered due to fire exclusion policies that were instituted early in this century (Brown and others 1994). Surface and ladder (understory trees) fuels have increased. Extensive areas of older forests have developed over time without fire events to break them into a finer mosaic pattern (Arno and others 1993). Fires that have occurred in the region have been observed to have higher intensities due to the increased fuels (Barrett and others 1991; Brown and others 1994).

To characterize the effects of fire on landscape mosaics on the Bitterroot National Forest, an intensive study of historic photos will be done to determine the historic intensity, frequency, and size of fires. Aerial photos from 1937 will be interpreted for stand structure and disturbance mosaics. Patches of similar tree species (forest composition), size classes, and densities (stand structure) will be delineated. The delineations will then be laid over the systematic grid of field plots taken by Mike Hartwell (Hartwell, this proceedings). Field plot information includes tree measurements, stand history, and fire history. The field plots will be matched with air photo patches to determine the fire intervals and intensity of pre-1900 disturbance events within the patches. Measurement of the actual delineations on photos will determine size of individual fire events. The integration of fire intensity, frequency, and patch size information will help characterize and quantify the pattern of mosaics across the landscape of lodgepole pine community types.

In: Hardy, Colin C.; Arno, Stephen F., eds. 1996. The use of fire in forest restoration. Gen. Tech. Rep. INT-GTR-341. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Cathy Stewart is a Silviculturist with the Bitterroot National Forest, USDA Forest Service, Stevensville, MT.

A land management goal is to develop treatments that restore the stand structure, composition, and patterns of the presettlement disturbance regime. Fire frequency information will help us plan the interval of future management activities. This information will be used to update the Bitterroot National Forest's Plan, which is revised each decade. Specific information relating to disturbance size and intensity will aid in the creation of treatment prescriptions. Size of treatment units could be planned to reflect the range of historic events if that is acceptable relative to modern goals for these publicly owned lands. The fire intensity information can help determine the number and species of residual trees that should be left on the site when trying to simulate historic fires.

Fire cannot immediately be returned to all sites as they currently exist and still meet other management objectives. Ladder and surface fuels have increased beyond historic levels and may hamper the direct application of prescribed fire. Pretreatment to remove some trees will be required to reduce fuels to a manageable level before prescribed burning can occur. Understory ladder fuels may also require slashing, piling, and burning before prescribed ignition. Once fuels are reduced, fire can be applied on a larger scale but perhaps not at the historic landscape scale.

Demonstration treatments that are developed on the Bitterroot National Forest will be applied on the Tenderfoot Creek Experimental Forest in central Montana in collaboration with Ward McCaughey, Intermountain Research Station, Bozeman, Montana. The array of treatments will include use of commercial harvest methods with low, medium, and high levels of tree removal. Harvests will be applied with and without prescribed fire. Controls will also be established for comparison. These treatments will provide detailed monitoring and comparison that will provide valuable information for future management.

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