Impacts of Prescribed Burning on the Survival of Douglas-fir and Ponderosa Pine in the Boise National Forest

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Abstract: The exclusion of fire from forests that historically burned on a frequent basis has affected stand structure and forest health conditions at the landscape scale. Because of the build-up of fuel loads, stand replacing wildfires now occur in areas that historically underburned. The National Fire Plan identifies the use of prescribed fire as a tool to reduce fuel loads in our National Forests. Many land managers are uncertain of the effects of prescribed fire on the overall health of forests due to primary mortality directly attributed to fire and especially secondary mortality caused by bark beetles and other insects. The objectives of this study are to evaluate primary and secondary impacts of prescribed fire as it pertains to tree injury and mortality in a fire dependent ecosystem in the Intermountain Region. We have established 800 single-tree plots comprised of ten, two-inch size classes from seven to twenty-five inches dbh. Each size class has 40 trees each, of Douglas-fir and ponderosa pine. Coarse woody debris, vegetation, litter, and duff are measured on each plot to assess the fuel load that may affect each individual plot tree. Fuel loading will be related to fire intensity and severity, tree injury, primary mortality, and secondary insect related mortality. The results will provide needed information to resource managers who are concerned about the relationship between prescribed fire and primary and secondary tree mortality.

Study Sites

The Danskin/Gallagher project is located within the Payette River Basin in southwest Idaho. The project area encompasses 8,126 acres located approximately 12 miles east of Garden Valley on the Emmett Ranger District, Boise National Forest, Boise County, Idaho.

Approximately sixty-one percent of the project area consists of suited timberlands. Fire injury, resulting from either wildfire or prescribed fire, frequently predisposes ponderosa pine and Douglas-fir to bark beetle attack (Weatherby et al. 1994, 2001). Trees may be weakened by root injury (Ryan et al. 1988) that inhibits the ability of the tree to take up water and nutrients, bole injury that inhibits the ability of the tree to translocate water and nutrients to branches and needles, and by crown scorch (Peterson 1985, Peterson and Arbaugh 1986; 1989) that prohibits photosynthesis. Based upon observation, by Forest Service District personnel, significant amounts of tree mortality, above levels attributed directly to prescribed fire injury, have resulted from bark beetle attack in mixed conifer Douglas-fir and ponderosa pine forests. Primary and secondary mortality is of special concern to resource managers in order to assure that suited lands' continue to contribute to a non-declining, even flow of timber production.

Experimental Design

To assess the impacts of prescribed fire, 800 randomly selected single-tree plots within 4 treatment areas are being burned. Treatment areas 1 & 2 were established in 2001 and burned in 2002. Treatment areas 3 & 4 were established in 2002 and will be burned in 2003. Since the burns occur in a mosaic pattern, unburned plots will be used as unburned control plots. To examine the influence of fire impacts on tree size, individual study plots consist of ten two-inch size classes (7-25 in. dbh) containing ten trees each of Douglas-fir and ponderosa pine.

Sample plot radius is correlated with tree dbh, varying from 11.3 ft. to 17.6 ft. Within the sample plot beneath each tree the fuel load from the bole to the drip-line is being measured. Habitat type, fuel loads, fuel moistures , and tree attributes are being measured at each sample plot. The impact of prescribed fire is being evaluated for each tree-plot. Bark beetle activity will be monitored and correlated with fire injury. Mortality will be assessed each year for five years beginning in the fall following treatment (2002).

As part of a Master's degree thesis on the impact of prescribed fire on fine root and mycorrhizal mortality, a graduate student collected soil core samples from thirty plots within each of two treatment areas, 1 & 2, in 2001 (pre-burn) and in 2002 (post-burn) by taking samples at the drip line and midway to the bole of each plot tree. The distribution, density and biomass of fine roots and mycorrhizae are being measured in each soil horizon. In 2002, thirty additional pre-burn samples were collected from each of treatment areas 3 & 4. Post burn samples will be collected in 2003.

Post-Treatment Evaluation

Post-treatment crown scorch volume is visually estimated to the nearest five- percent. The percent girdled at the base is estimated by removing the bark on four sides of the tree using an increment borer or hammer to visually determine if the cambium is alive. Ground (Ryan and Noste 1985) and bole char (Ryan 1983) are evaluated by quadrant and classed by severity. Corresponding cambium mortality is evaluated from each quadrant as live or dead. Estimates of the probability of mortality are based on bark thickness and crown scorch (Ryan and Amman 1994).

Methods

Plot establishment

Plots are randomly assigned within a treatment area along a transect bisecting a treatment area. The selected sample tree represents the center point of the sample plot. The drip line of the crown was standardized by dbh as determined from Hann (1998) as indicated below.

DBH range (in.)	Mid-point(in.)	Plot area (ac)	Plot radius (ft.)
6.0-7.9	7	1/100	11.3
8.0-9.9	9	1/100	11.3
10.0-11.9	11	1/100	11.3
12.0-13.9	13	1/100	11.3
14.0-15.9	15	1/80	12.5
16.0-17.9	17	1/50	15.9
18.0-19.9	19	1/50	15.9
20.0-21.9	21	1/50	15.9
22.0-23.9	23	1/40	17.6
>24	25	1/40	17.6

Site characteristics for sample trees (see Common stand exam users guide)

For each sample tree record the following site characteristics:

1. Habitat type
2. Aspect in degrees
3. Slope in percent
4. Basal area using a relascope
5. Elevation
6. Stand structure
7. Tree position or crown class
8. Fuel model
9. Slope position
10. Slope horizontal shape

Conifers

Record conifers less than 6 inches dbh by species, in the following classes:

a. <0 inches (that is, less than 4.5 feet tall);
b. 4.5 feet tall and greater-1.9 inches;
c. 2.0-3.9 inches;
d. 4.0-5.9 inches;

canopy coverage (percent) by class (see by count tally number live and dead, and ocularly estimated table 1) live and dead, in the sample plot.

Shrubs

Record:

1. Ocularly estimated canopy coverage (percent) by species and class (see table 1), in the sample plot.
2. Percent of estimated canopy coverage that is dead.
3. Average height to the nearest 3 inches.

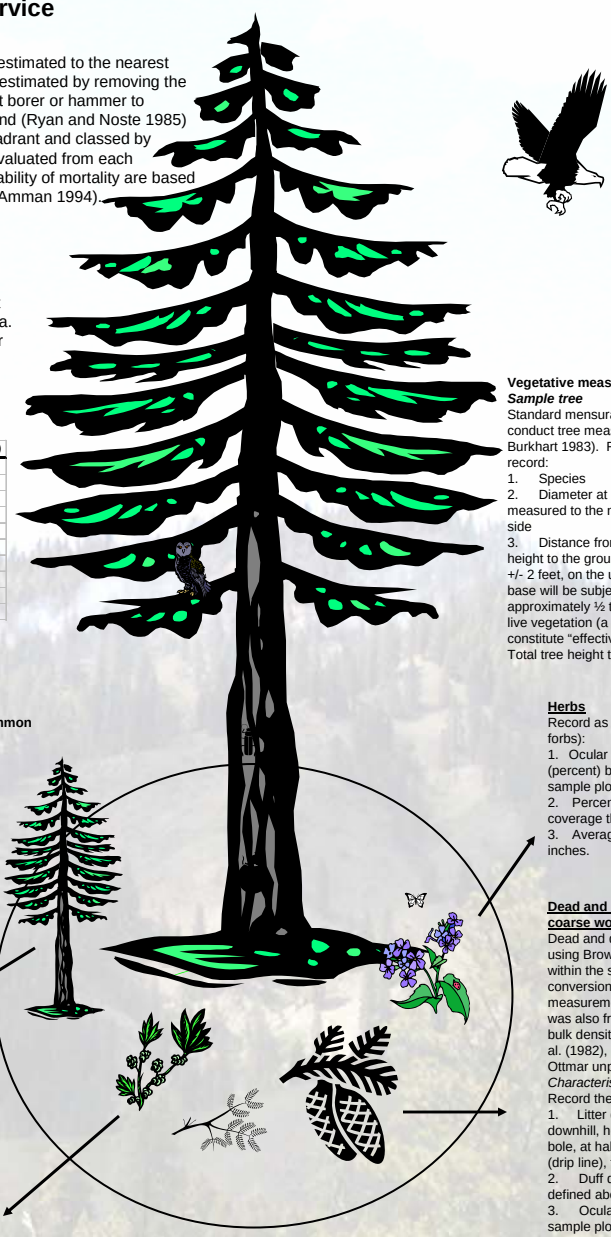

Figure 1. Sampling plot design.

Vegetative measurements

Sample tree

Standard mensurational techniques are used to conduct tree measurements (Avery and Burkhart 1983). For each sample tree we record:

1. Species
2. Diameter at breast height (4.5 feet), measured to the nearest 0.1 inch, on the uphill side
3. Distance from "effective" crown base height to the ground, measured to the nearest +/- 2 feet, on the uphill side. "Effective" crown base will be subjectively estimated where approximately ½ the crown area is occupied by live vegetation (a single live branch does not constitute "effective" crown base).

Total tree height to the nearest foot.

Herbs

Record as a group (graminoids and forbs):

1. Ocular estimate of canopy coverage (percent) by class (see table 1), in the sample plot.
2. Percent of estimated canopy coverage that is dead.
3. Average height to the nearest 3 inches.

Dead and down material (fine and coarse woody debris)

Dead and down material is sampled using Brown *et al.* (1982) techniques within the sample plot. Calculations for conversion of litter and duff measurements in inches to tons/acre was also from Borwn *et al.* (1982). Duff bulk density was taken from Brown et al. (1982), litter bulk density was from Ottmar unpub. (*Preliminary Fuel Characteristic Classification Defaults*). Record the following:

1. Litter depth at 12 points: uphill, downhill, horizontal left and right at bole, at half the radius, and at radius (drip line), to the nearest 0.1 in.
2. Duff depth at same points as defined above.
3. Ocular estimate of percent of the sample plot covered by litter or duff.
4. Count tally of dead material by fuel class:
   b. 10 hour (.25-1.0 in.)
   c. 100 hour (1.0-3.0 in.)
   d. 1000 hour (3.0-6.0 in.)
5. Record diameter, length and condition within the sample plot of all dead material 6.0 inches in diameter and greater.