HYPOTHESES ON THE ECOLOGICAL EFFECTS OF ALTERNATIVE FUEL REDUCTION METHODS

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ABSTRACT

Hypotheses on the consequences of prescribed fire and thinning/removal for fuel reduction are presented. Short and long term ecological response to four treatments (control, burn, thin, thin/burn) will be compared at the Hungry Bob study site in a ponderosa pine forest of northeastern Oregon. Core variables capture the response of the system most meaningful to forest managers, including soil and stand productivity, fuels, stand structure, bark beetle population dynamics, and wildlife-habitat relationships. These variables are discussed within the context of five hypotheses that focus on how the fuel reduction treatments will effect the system, and how that system effect will change over time.

KEY WORDS: Prescribed fire, thinning, historic fire regime

INTRODUCTION

In the Blue Mountains of Oregon and Washington, over 80 years of fire suppression and the selective harvest of ponderosa pine have resulted in stand structures and fuel levels that have set the stage for uncharacteristically severe wildfire over much of the lower elevation landscape (U.S.D.A. 1996). Managers have generally recognized this problem, and have for many years undertaken projects aimed at restoring historic stand structure of low elevation forests. Although the tools currently used to reduce fuels — prescribed fire and thinning/removal—are well established, forest managers lack comparative knowledge on their relative environmental effects. The goal of the proposed research is to provide a broad array of information on the consequences of applying these fuel reduction tools, so that managers can make more informed decisions on how they may be used operationally. This paper describes the Hungry Bob fuel reduction study and presents five key hypotheses that have helped frame the research.

STUDY AREA AND RESEARCH DESIGN

The study is part of the "Hungry Bob" fuel reduction project, located 20 miles north of Enterprise, Oregon, in ponderosa pine forest of the Wallowa Valley District of the Wallowa-Whitman National Forest. The area has been intensively managed since the early 1900's, including fire suppression and harvest of most of the larger ponderosa pine throughout the period 1910-1996 and some prescribed underburning in the past 20 years. These activities have resulted in stands with basal areas averaging about 27 m^2/ha, comprised for the most part of stems less than 25 cm in diameter. At present, down woody fuels average about 4000 kg/ha (10 tons per acre).

Four treatments were chosen to represent potential management choices for fuel reduction including control, burn, thin, and thin/burn. Thinning, which involved both felling and removing stems, was undertaken during the summer of 1998; prescribed fires will be applied in September or October 2000. No further management will occur for at least 10 years following the prescribed fire treatment. Sixteen treatment plots (4 replicates per treatment) averaging 10 ha in size, were

each chosen and assigned randomly to one of the four treatments. A 50m sampling grid of geo-referenced sub-plot centers was established systematically within each plot, and all variables measured in reference to this grid.

HYPOTHESES

Selection of core variables was intended to capture the responses that would be most meaningful to forest managers, including soil and stand productivity, fuels, stand structure, bark beetle population dynamics, and wildlife-habitat relationships. A total of 65 individual core variables will be measured in these disciplines, prior to treatment, during treatment and several times after treatment (1, 5 and 10 years). Variables will be discussed within the context of five hypotheses that focus on how the fuel reduction treatments will effect the system, and how that effect will change over time:

Hypothesis 1. The three active treatments (fire, thin, thin/fire) will create distinctly different standing vegetation and down woody structure in the short-term (<5 years post-treatment).

Hypothesis 2. Insects and disease will cause further divergence in standing vegetation structure among treatments in the intermediate term (5-10 years post-treatment) due to differences in vegetation mortality.

Hypothesis 3. The treatments will create different short-term responses in chemistry and the microbial food web of the soil and forest floor, which will lead to further divergence in standing vegetation structure for the intermediate term.

Hypothesis 4. The treatments will create different qualities in down wood in the short term, which will lead to a divergence in the insect fauna of down wood in the intermediate term.

Hypothesis 5. Wildlife species will track changes in stand structure and down wood in the short term, and will diverge even more at later stages as a consequence of among-treatment divergence in standing structure and down wood.

The primary management objectives of the Hungry Bob project are fuel reduction and thinning from below, both aimed at reestablishing stand structure characteristic of presettlement times. The assumption is that prescriptions written to obtain short-term structure objectives will after several entries result in attaining the long-term large structure goal, and that short term structure objectives will be the same regardless of whether fire or thinning is used to accomplish them. Despite this management objective, however, we expect that fire and thinning will have fundamentally different effects on most aspects of the system, starting with the immediate effects on standing vegetation and down woody structure (Hypothesis 1). The first hypothesis will be tested by measuring a suite of 20 vegetation and fuel variables, principally vegetation structure and composition (trees, shrubs, forbs, grasses), tree demographics, and both surface and vertical fuels. Post-treatment data on these variables will then be used to model crown fire potential, fuel consumption, and immediate fire effects in the context of fuel moisture, crown bulk density, and weather.

We expect that stand structure will diverge further after a few years due to qualitative differences in how treatments (including control) will influence the activities of insects and disease

(Hypothesis 2). Seven variables will be measured to test this hypothesis, including bole scarring, fine root damage, fungal biomass, crown condition, tree radial growth rate, root disease incidence, and tree mortality caused by bark beetles. Because bark beetle populations operate at spatial scales much larger than the average plot size, interpretation of the bark beetle response to treatment will also require information on recent historical and current bark beetle populations in the areas surrounding each of the plots.

The predictable effect of fire on soils and the forest floor (McNabb and Cromack 1990; Borchers and Perry 1990; Tiedemann et al. In press) is expected to cause divergence in several measures of stand structure and composition (Hypothesis 3) through changes in stand productivity. Twelve soil and forest floor variables will be measured representing nutrient capital, available nutrients, nutrient cycling, physical properties, biodiversity, and fine root production. Values of these variables, especially in the short term, will be used to predict the suite of stand structure variables described for the test of Hypothesis 1.

Down wood is a critical resource for many insect and wildlife species (Bull et al. 1997). Even if the three active treatments result in a similar *quantity* and *size distribution* of down wood, prescribed fire is expected to change the *quality* of this resource, in part through case hardening of the surface and heating of the interior. This may lead to changes in rates of colonization and persistence of key insect species, such as carpenter ants and wood boring beetles (Hypothesis 4). Four variables will be measured to test this hypothesis, including log abundance and distribution, and down wood insect abundance and diversity.

Modification of stand structure in this experiment is expected to effect vertebrate species, through changes in habitat quality (Thomas 1979). Hence structure modified by prescription in the short term will offer different opportunities for vertebrate species, and any structural divergence in the intermediate term is expected to change habitat quality accordingly (Hypothesis 5). Six variables will be measured to test Hypothesis 5 including small mammal species diversity and abundance, bird species diversity and abundance, bird nest productivity, and bird functional foraging responses. All vertebrate variables will be analyzed within the context of measurements of vegetation and down wood. Since many birds, even small-bodied species, have home ranges larger than the size of the study plots, interpretation of bird species diversity and abundance will also require information on the history, current treatment and current structure of the landscape surrounding each plot.

Test of the five hypotheses not only requires the measurement of a number of key variables, but also their integrated analysis and interpretation. The first step will be the analysis of each response variable for post-treatment year 1, with treatment as the independent variable. We expect that active treatments will differ the least in standing structure, down woody structure and in wildlife variables, and the most in stand damage, soil, and activity fuel variables. It is these latter three variables, set on diverging paths by different treatment effects, that are expected to cause further divergence in stand structure in the intermediate term. Hence they will be used as independent variables (along with treatment) for analysis of effects on stand structure and wildlife in the intermediate and long term. While the primary test of hypotheses will consider the plot as the experimental unit in analysis of variance, the common sub-plot sampling grid will also allow regression analysis to tease out linkages among variables at a smaller spatial scale. This should add insight on potential cause and effect relationships among variables, especially for the burn plots, where the treatment effect is expected to be particularly heterogeneous at the small scale.

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