COMPETITION BETWEEN UNDERSTORY AND OVERSTORY VEGETATION IN A PONDEROSA PINE FOREST IN NORTHEASTERN OREGON

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INTRODUCTION

Ponderosa pine (*Pinus ponderosa*) forests are widely distributed within the interior mountain ranges of the Northwest. These forests provide timber and forage for livestock and wild herbivores. In the Blue Mountains of northeastern Oregon, ponderosa pine forests comprise much of the economic land base where timber and forage resources are managed for multiple uses. Often these resources are managed independently, rather than simultaneously. Integration of forest and grazing management objectives has the potential to improve returns from both livestock grazing and timber yields on the same unit of land.

Understory production can be increased and species composition changed through overstory thinning, clearcutting or other methods of harvesting. Commercial thinning of ponderosa pine, allows for light of greater intensity and duration to reach the forest floor and increases soil moisture by reducing overstory competition and canopy interception of precipitation. Nutrient cycling is also changed as competition for soil nutrients from the overstory is reduced. Competition above ground takes the form of competition for available light that has filtered through the overstory canopy. Competition below ground involves root competition for available water and nutrients necessary for plant development. It has been proposed that moisture or competition for moisture is the dominant environmental resource controlling yield of understory vegetation in forested ranges in eastern Oregon. Response to increased levels of light, water, and nutrients will vary depending upon the physiologic tolerances and competitive ability of understory species.

Relatively little research has been conducted examining the effect of overstory on understory vegetation in the coniferous forests of the Pacific northwest. The majority of work has been done for forests in the northeast, southeast, north central, southwest, and Rocky Mountain states. What is known are general relationships, but research defining which resources light, water and/or nutrients are the primary factors controlling understory dynamics is very limited, particularly for the ponderosa pine forests of the Pacific Northwest. Determining which resources contribute to understory species response may allow for the prediction of successional trends after a disturbance such as fire, logging and grazing. It may also help us modify management practices to optimize productivity. The objective of this research was to determine the degree to which light, water and/or nitrogen influence understory composition and productivity.

METHODS AND MATERIALS

The study was conducted on the Hall Ranch of the Eastern Oregon Agricultural Research Center, located 12 miles southeast of Union, Oregon. The Hall Ranch is within the southern foothills of the Wallowa Mountains in the northeastern corner of the state at an elevation of 3500 ft. The climate is characterized by cold winters and hot dry summers with occasional thunderstorms. The majority of precipitation on the Hall ranch occurs between November and May in the form of snow. Mean annual precipitation is 24 inches.

Study sites were located in the ponderosa pine/snowberry community type. Pine dominates the overstory but can codominate with Douglas-fir (*Pseudotsuga menziesii*). Snowberry (*Symphoricarpos albus*), elk sedge (*Carex geyeri*), pine grass (*Calamagrostis rubescens*), and heartleaf arnica (*Arnica cordifolia*) dominate the understory. Soils series are Hall Ranch, Klicker and Tolo with surface soil texture from silt loam to silty clay loam. Soil depth varies from 15 to 36 inches. All soils series originated from pumicite parent material ejected from Mt. Mazama 6,600 years ago.

Three separate 12 acre blocks were studied. half of each block was commercially thinned from a density of 140 to 60 trees/ac. Within each thinned and nonthinned treatment 20x20 ft^2 plots were located randomly and half were trenched to bedrock to sever all incoming tree roots. Selection occurred so no trees were established within the plots. An additional set of plots were located to evaluate the response of understory plants to the addition of nitrogen, water and nitrogen + water. Amounts of water and nitrogen added, simulated increases in water and nitrogen on thinned and trenched plots. Measurements recorded were understory production, plant density and cover, plant and soil water status, soil and air temperature, tree canopy cover, soil nitrogen and plant nutrient content, and sunlight.

RESULTS AND DISCUSSION

Understory production responded to the reduction of tree root competition while increased light levels had little effect on understory productivity. These responses support the hypothesis that competition for belowground resources is a primary limiting factor in ponderosa pine forests in the Pacific Northwest. With tree root competition removed, understory biomass increased 53-94% during two growing seasons following treatment compared to plots where understory vegetation and trees were competing with one another (Figures 1 and 2). Cover and density of grasses, sedges, forbs and shrubs also significantly increased with tree root competition removed. Early and mid seral rhizomatous species contributed the most to understory response.

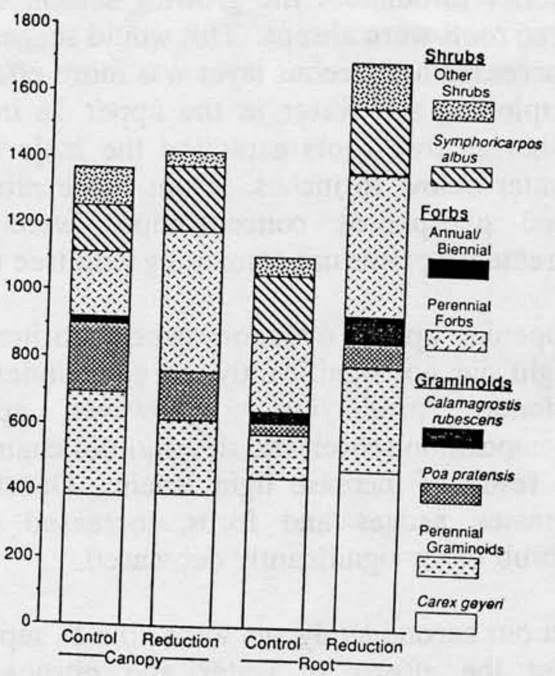

Figure 1. Understory biomass by species, life-form, and total by treatments in 1986 (first growing season after treatments were established).

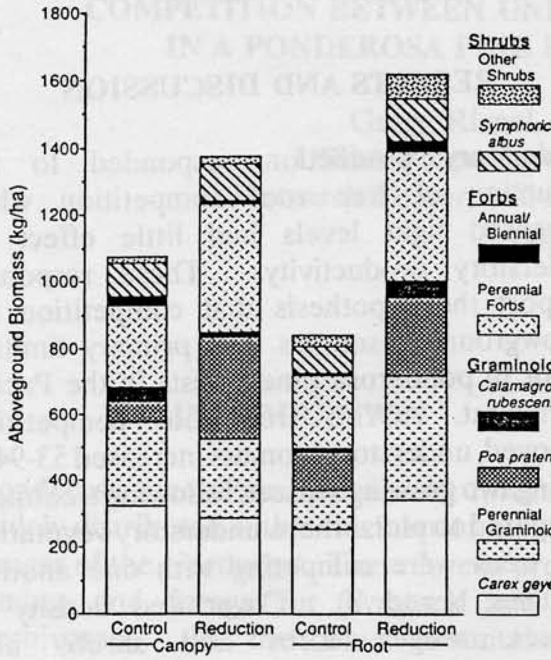

Figure 2. Understory biomass by species, life-form, and total by treatments in 1987 (second growing season after treatments were established).

Removal of tree root competition increased plant water status, the length of growing season and decrease soil water depletion rates. Below the 16 inch depth, soils were consistently wetter throughout the growing season where tree roots were absent. This would suggest the increased herbaceous layer was more effective exploiting soil water in the upper 16 inches, whereas tree roots exploited the majority of water below 16 inches. Plant tissue nitrogen and phosphorus concentrations were also greater in plants not competing with tree roots.

Opening up the overstory canopy to increase light did not significantly increase understory biomass production. However, species composition (cover and density) did change as a result of increase light levels. Density of grasses, sedges and forbs, increased while shrub cover significantly decreased.

In our second study, we were able to separate out the effects of water and nitrogen on understory productivity. Supplementation of water and nitrogen increased understory production particularly when both were applied. Plant response suggested, nitrogen is limiting during the first part of the growing season when soil water content is adequate. However, as the growing season progresses, soil water becomes the limiting factor rather than nitrogen. In the ponderosa pine forest studied in northeastern Oregon, nitrogen appeared to be equally as limiting as water.

Plant species response to treatment effects can be correlated to change in either canopy effected attributes (light, midday air temperature, and soil temperature) or root competition effected attributes (soil water potential, phosphorus and nitrogen). We conclude this research demonstrated that belowground resources were the primary controlling factors of understory production in ponderosa pine forests in northeastern Oregon. However, competition for limited resources, light, water, and nutrients does effect cover, density and species composition of the understory as evidenced by the response to increasing these resources.

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