The Effects of Herbivory and Timber Harvest on Understory Production in Northeastern Oregon

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Introduction

Forested rangelands comprise a significant portion of the public land in the western U.S. Within the northwestern United States (Idaho, Montana, Oregon, and Washington) forested rangelands comprise approximately 35 percent of the total land area, and public ownership comprises 69 percent of these forested rangelands (Smith et al. 2002). Ponderosa pine (*Pinus ponderosa*) and grand fir (*Abies grandis*) are two forest types that are commonly found within the region. These forests are valuable for providing habitat and forage for livestock and wildlife, as well as wood products for human consumption. However, over the last 100 years, many of these forests have developed into dense stands consisting of more fire-sensitive and disease-susceptible species (Belsky and Blumenthal 1997), thereby reducing the overall productivity of the area. Many areas with high potential for timber harvest and forage production have the low output due to dense canopy cover (Hedrick et al. 1969).

In order to restore productivity in terms of forage and timber production to these dense stands, it may be necessary to open the canopy. Forage production response to overstory canopy cover is well documented (Young et al. 1967, Miller et al. 1986) and suggests that as overstory canopy cover decreases understory production (kg/ha) increases. Clary et al. (1975) also documented this relationship between canopy cover and forage production, but noted that there was an economic optimum between increasing forage production for cattle grazing and increased timber growth for harvest.

Although canopy cover influences understory structure and production, grazing or herbivory may also influence plant community structure and diversity within forested environments. Hobbs (1996) and Riggs et al. (2000) documented that herbivory can influence plant community structure and composition. Ungulate herbivory directly affects vegetation through selective feeding and the ability of a plant to recover from herbivory (Augustine and McNaughton 1998). However, plant species diversity was not consistently affected by grazing (Riggs et al. 2000), but individual species, at the local level, were affected by herbivory and logging. Herbivory had the greatest effect in altering plant community structure within clearcuts (Riggs et al. 2000).

As stated earlier, much is known about how quantity of vegetation responds to canopy cover and how herbivory can affect plant community structure. However, little is known about how plant communities are influenced by timber harvest, herbivory, and fuels reduction. Therefore, the objectives of these studies were to document the effects of timber harvest, herbivory and fuels reduction on individual species, plant community structure, understory production, and botanical composition of cattle diets.

Study 1. Hall Ranch Timber Harvest and Herbivory Study

The study area is located at the Eastern Oregon Agriculture Research Center's Hall Ranch, which is approximately 16 km east of the city of Union in the Wallowa Mountains of northeastern Oregon. Elevation ranges from 1050 to 1250 m and annual precipitation averages 66 cm with about 60 percent coming in the winter, whereas summers are usually dry.

The study was conducted as a replicated design. Three *Abies grandis/Pachistima myrsintes* (grand fir), habitat types, 22.5 ha each in size, and three *Pinus ponderosa/Symphoricarpos albus* (ponderosa pine) habitat types, 15 ha each in size, were selected to analyze the effects of herbivory and overstory canopy cover on understory plant community structure. Sites were randomly selected within areas of relatively homogeneous stand structure. The grand fir sites had three timber harvest treatments applied: 1) clearcut, 2) crown thinning and 3) uncut (Control) (Figure 1). Crown thinning consisted of removing co-dominant and some dominant trees. Harvest began in 1985 and was completed in 1986. The grand fir clearcuts were replanted in the

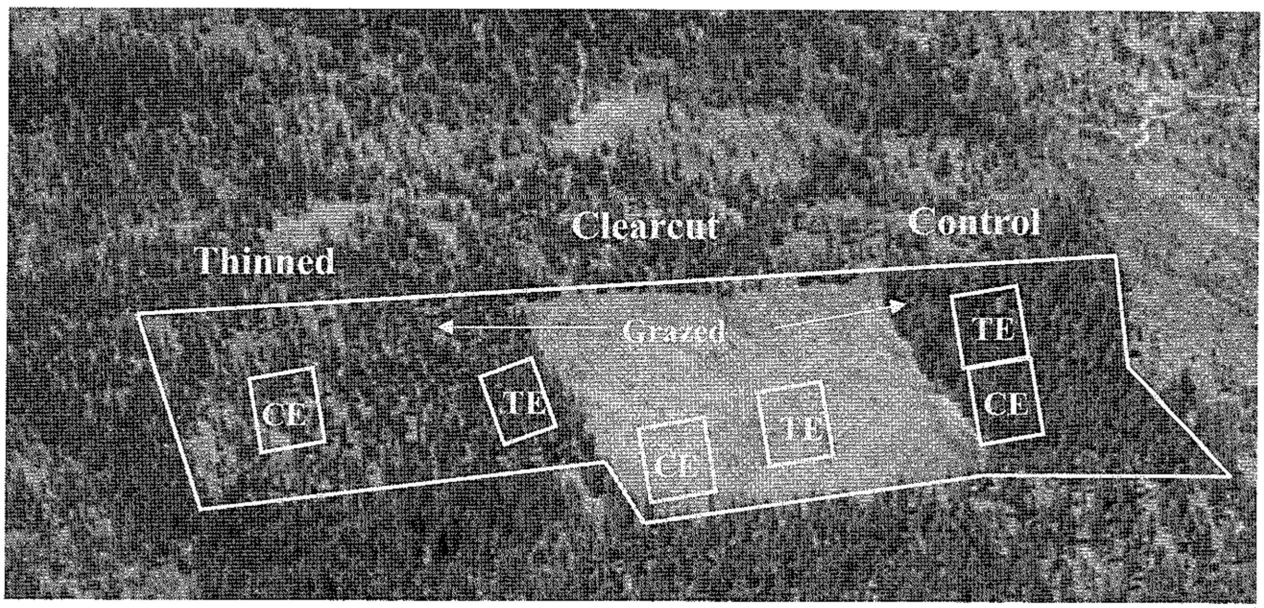

Figure 1. An aerial photo of a grand fir site demonstrating the layout of logging and grazing treatments. (Grazed - both cattle and big game grazing, CE - cattle grazing excluded; TE - cattle and big game grazing excluded)

spring of 1988 with ponderosa pine, Douglas fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*). Whereas, the ponderosa pine sites had two timber harvest treatments applied: 1) commercial thinning and 2) uncut (Control) (Figure 2). Ponderosa pine sites were thinned to achieve a basal area of 24 m^2/ha (tree spacing of approx. 8 m). Logging began and was completed in 1985. In order to protect herbaceous vegetation and soils and minimize the impact of skidding, spacing between skid trails was at least 120 feet if soils were not frozen and had adequate snow cover.

The following grazing treatments were applied to each grand fir and ponderosa pine timber harvest treatment: 1) grazing by cattle and big game (to achieve 60 percent utilization), 2) big game grazing with cattle excluded (cattle exclosure), and 3) exclusion of cattle and big game grazing (see Figure 2). Sixty percent utilization is considered heavy relative to current recommendations (Holechek 1995), but was used because it was the utilization rate employed by many industrial forests within the area at initiation of the study in 1985.

Herbaceous production was collected by clipping 1.0 x 0.5 m rectangular plots randomly placed within each treatment. Plots were clipped to a two-centimeter stubble height. Production was measured in 2003 for both ponderosa pine and grand fir habitats. Production clips were separated

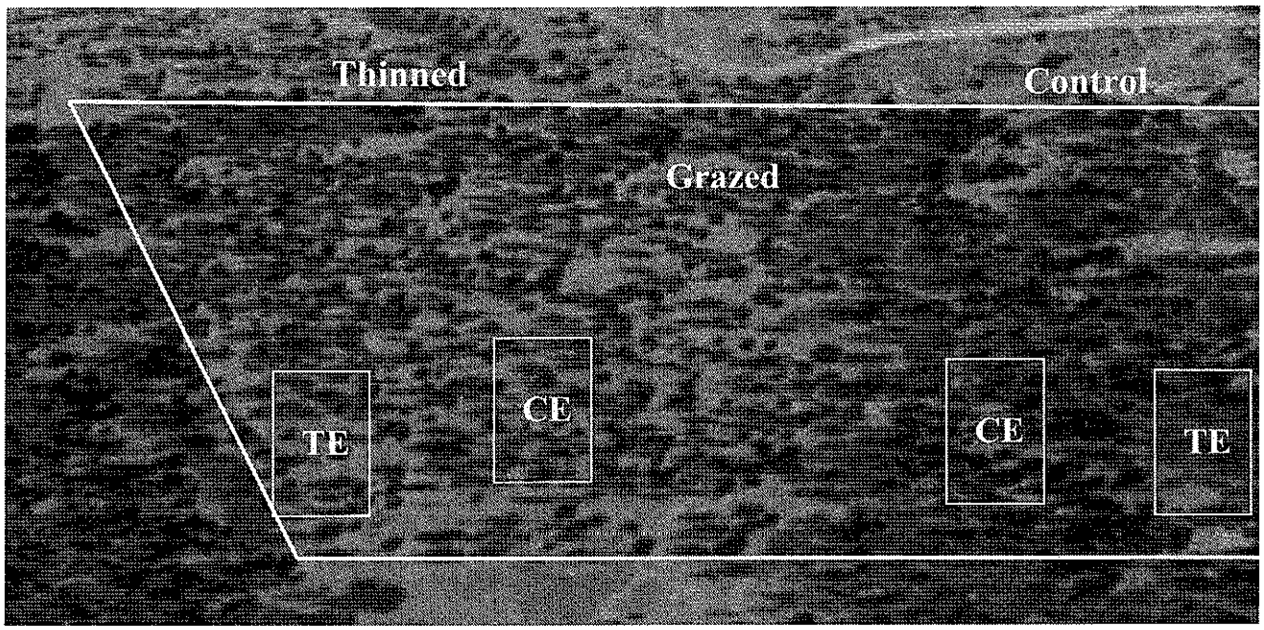

Figure 2. An aerial photo of a ponderosa pine site demonstrating the layout of logging and grazing treatments. (Grazed - both cattle and big game grazing, CE - cattle grazing excluded; TE - cattle and big game grazing excluded)

into the following forage classes for evaluation: elk sedge (*Carex geyeri)*, pinegrass (*Calamagrostis rubescens*), Kentucky bluegrass (*Poa pratensis*), other perennial grasses, perennial forbs, annuals and biennials, and shrubs.

Results

Production, within grand fir and ponderosa pine sites, were affected by both logging and herbivory (Table 1, 2) in 2003. Within the grand fir sites, production in the clearcuts was greater than either the thinned or controls. This is not unexpected, because within the clearcuts, understory vegetation production does not have to compete with the overstory for limited resources, mainly water and nitrogen. However, production in future years will decline and equilibrate with the controls and thinned treatments, in terms of total understory production, as juvenile trees continue to grow and begin out competing for limited resources. For most forage classes, production was greatest within the clearcuts. However, pinegrass production was greatest in the thinned treatments. Reduced production of pinegrass, within clearcuts, could be

Table 1. The effects of herbivory and timber harvest on production (kg/ha) in a grand fir habitat type.

	Timber Harvest Treatment			Herbivory Treatment*		
	Clearcut	Thinned	Control	Grazed	Cattle Exc	Total Exc
Total Production	1431[a]	1070[b]	831[b]	1107	1157	1068
Elk sedge	312[a]	172[b]	211	218	216	260
Pinegrass	212[ab]	302[a]	127[b]	293[a]	167[b]	181[b]
Kentucky bluegrass	243[a]	14[b]	53[b]	71[a]	120[b]	118[b]
Perennial grass	142[a]	197[a]	53[b]	142	166	84
Perennial forbs	220	170	175	194	218	153
Annuals/biennials	61	13	3	24	23	30
Shrubs	242	204	224	213	224	235

* Grazed refers to cattle and big game grazing; Cattle Exc refers to lack of cattle use but plots were grazed by large ungulates; Total Exc refers to lack of use by both cattle and big game.
[a,b] values with differing superscripts are different at $P<0.05$

Table 2. The effects of herbivory and timber harvest on production (kg/ha) in a ponderosa pine habitat type.

	Logging Treatment		Grazing Treatment*		
	Thinned	Control	Grazed	Cattle Exc	Total Exc
Total Production	1111[a]	873[b]	974	1016	986
Elk sedge	324	284	233	348	331
Pinegrass	81	82	37	110	98
Kentucky bluegrass	105[a]	48[b]	86	83	60
Perennial grass	116	121	207	103	44
Perennial forbs	260[a]	130[b]	205	186	194
Annuals/biennials	32	3	18	9	25
Shrubs	82	53	43[a]	55[a]	105[b]

* Grazed refers to cattle and big game grazing; Cattle Exc refers to lack of cattle use but plots were grazed by large ungulates; Total Exc refers to lack of use by both cattle and big game.
[a,b] values, within the same treatment, with differing superscripts are different at $P<0.05$

due to the abundance of Kentucky bluegrass. Kentucky bluegrass was able to rapidly increase in production following logging, within clearcuts, thereby filling open sites. However, Kentucky bluegrass production has subsequently declined from 1995 to 2003. It is interesting to note that 18 years following timber harvest, production of perennial forbs, annuals/biennials and shrubs were not different due to either timber harvest or herbivory.

Within the ponderosa pine sites in 2003, thinned treatments had approximately 240 kg/ha greater production than the controls. Again, with the removal of overstory, understory production can increase due to increased available resources. Production of Kentucky bluegrass and perennial forbs also increased with reduction of canopy cover by 2003. Limited production increases within thinned treatments may be due to shallower soils, as compared to the grand fir sites, and/or increased production of Kentucky bluegrass and forbs immediately following logging in 1985.

Even at 60 percent utilization, total production in 2003 was not affected on either the grand fir or ponderosa pine sites. However, within the grand fir sites, pinegrass and Kentucky bluegrass were affected by herbivory. Pinegrass production increased over 100 kg/ha in the grazed treatments as compared to the cattle and total exclosures. Whereas, Kentucky bluegrass production was reduced by 50 kg/ha in the grazed treatments as compared to the cattle and total exclosures. The only group that was affected by herbivory within the ponderosa pine sites was shrub production. In 2003, shrub production was reduced by 50 kg/ha in cattle and/or big game grazing treatments as compared to the total exclosures.

Study 2. The Sled Springs Biomass/Forage Quality Project

The Sled Springs Biomass/Forage Quality Project is currently in the third season of sampling biomass production and the second season of sampling forage quality. Caged biomass plots (1.5 m diameter) were established throughout the Sled Springs Wildlife management unit and were used to determine the effects of overstory successional stage and habitat types on understory production. These plots represented differing successional stages of dry grand fir sites, wet grand fir sites, ponderosa pine sites, dry Douglas Fir sites, wet Douglas Fir sites, and recently logged sites. Also, forage quality sampling began in early-May with subsequent samples taken in mid-June, early August, and final samples to be taken in mid-September.

Preliminary results suggest that overstory manipulation has a dramatic effect on understory production and diversity. Understory production ranged form 600 to 800 kg/ha for all habitat types during the 2003 sampling season (Figure 3A). However, production data irrespective of canopy age and structure does little to characterize species diversity and production in transitional forested rangelands.

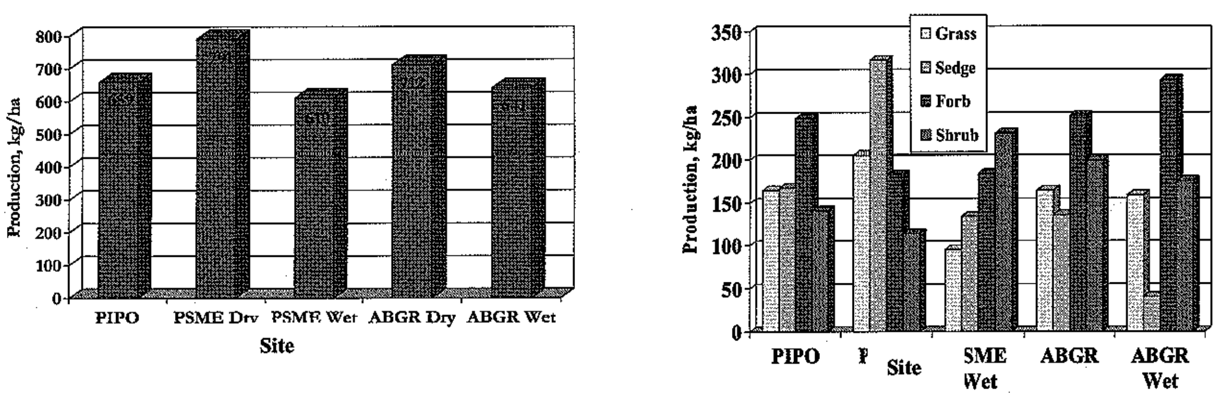

Figure 3. Understory production (A) and production by forage groups (B) in ponderosa pine (PIPO), Douglas fir (PSME), and grand gir (ABGR) forest types on the Sled Springs Wildlife Management Unit (2003 preliminary data). These results do not include production estimates for the grass/forb/shrub stage.

Production by forage groups (grass, grasslikes, forbs, and shrubs; Figure 3B) shows dramatic differences among habitat types.

Our preliminary results also suggest that understory production is strongly influenced by successional stage (stand age) and forest type (Figure 4). Forage production in ponderosa pine habitats is relatively high up through the small log stage of succession. In contrast, Douglas fir habitats show declining understory production after the sapling stage with the substantial declines early in the wetter habitats. Production in wet Douglas was highest in sapling stand ages and declines rapidly to remain relatively stable for pole, small saw log and saw log stand ages. Wet Grand Fir ecotypes appear to show a quadratic response with mid age stands (pole and small saw log) having greater production than early or late stand ages.

Study 3. Fuels Reduction at Starkey Experimental Forest and Range

In recent years, the financial and ecological impacts of catastrophic wildfires in the Western United States have become a major issue in forest land management. Forest fire suppression has led to the buildup of understory and ladder fuels in forest stands which has greatly increased the

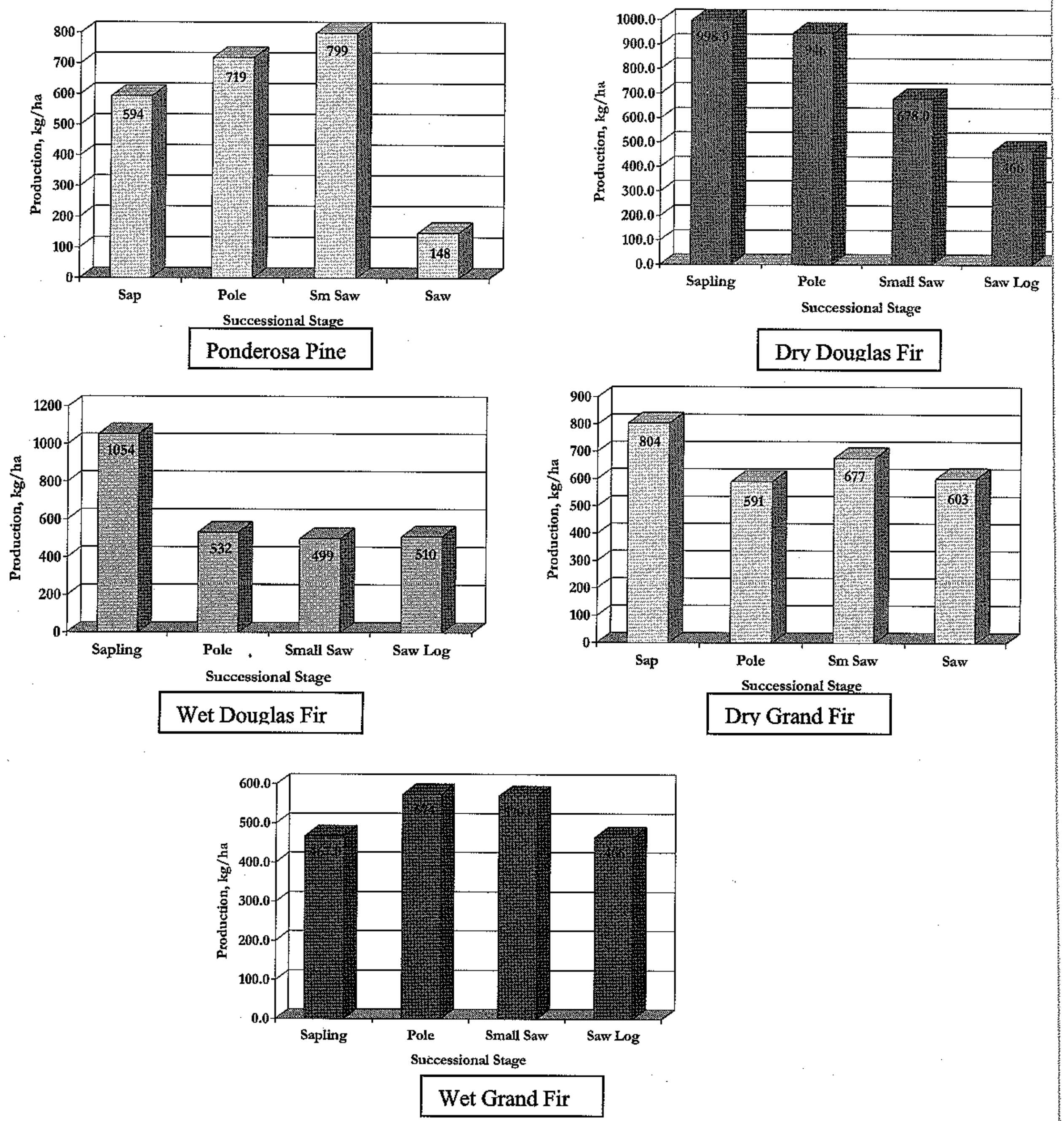

Figure 4. The influence of sucessional stage (stand age) on understory production in ponderosa pine, dry Douglas fir, wet Douglas fir, dry grand fir, and wet grand fir forest types (2003 preliminary data). These results do not contain production estimates for the grass/forb/shrub stage (seedling establishment).

risk of large stand-replacement wildfires. The importance of fire as a natural component of ecological systems is now recognized by scientists and managers who have developed methods, using prescribed fire and the mechanical removal of trees, as a means of preventing catastrophic wildfires. Since ungulates feed selectively and can alter the plant species composition of a community (Augustine et al. 1998, Riggs et al. 2000), the subsequent effect of herbivory following prescribed fires may result in species replacement and possibly a change in the successional pathway. Therefore, it is important to understand how herbivory can affect vegetation following fuels reduction treatments. The nature and extent of these herbivory effects are currently unknown. Because there are dietary differences between species, large scale experiments that observe different species of herbivores at different densities are needed in order to document these changes in successional pathways (Riggs et al. 2000). As part of this documentation, the changes in herbivore diet selection and diet quality after fuel reduction treatments need to be recognized. These dietary changes should be measured seasonally, at different levels of utilization, within treatment, between treatment and control, as well as over time. In order to better understand how herbivory can affect vegetation following fuels reduction treatments and to see what effects fuel reduction treatments have on diets of cattle, we will pursue the following objective.

The objectives of this phase of the study are to first determine the initial effects of fuels reduction on the botanical composition of cattle diets at different levels of forage utilization and, secondly, to determine the initial effects of fuels reduction on the diet quality of cattle at different levels of forage utilization.

This study, which will be conducted in 2005 and 2006, will yield critically needed information about how vegetation responds after fuel reduction treatments. The success of future fuel treatments, and even the ability to complete such treatments, will be greatly enhanced if we understand how herbivory affects the vegetation of sites treated with fuels reduction. Without this understanding, we may unknowingly alter the vegetation of treated sites with the mismanagement of cattle grazing. This mismanagement could ultimately lead to an increase in weedy plant species, reduced cattle grazing efficiency, and lower quality wildlife habitat. Proper timing of grazing and grazing at optimum utilization is essential for sustainable livestock grazing. The results of this study will be used as part of a larger long term study that will provide information and models on the effects of ungulate herbivory to inform and guide the management of multi-use forests.

Conclusions

Low impact logging, as represented with the Hall Ranch study, may not have a profound effect on changing plant communities. The results from this study indicate that following timber harvest, forage production increased. This increase on production was mainly due to the increase in perennial grass and perennial forbs species. Timber harvest had a greater effect on understory production than did herbivory even though cattle grazing would be considered heavy on these sites. Elk and deer also influenced shrub production within ponderosa pine sites.

Our combined data sets will quantify species responses to habitat, successional stage, and tree density. We believe, that these data sets will provide the most thorough characterizing of Blue Mountain forested region and how overstory manipulation changes the understory vegetation, biological diversity of vegetation, and nutritional opportunities for grazing herbivores. In fact, these data will provide a solid basis that demonstrates overstory manipulation and, in turn, the creation of early and mid-seral vegetation is critical for developing ideal habitat for grazing herbivores.

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