Ecological Effects of Thinning and Chipping Ponderosa Pine in the Southern Black Hills: 2009 Implementation Results

Purpose of Study:

Restoration and fuels reduction of ponderosa pine in the southern Black Hills presents a management challenge. Fire suppression and rapid natural regeneration have created overgrown forests dominated by small-diameter trees. These forests are at increased risk of catastrophic wildfire. Safe application of prescribed fire also becomes difficult in these overgrown forests. Traditional hazard fuels reduction involves mechanical thinning of stands, piling the thinned material, and burning piles with snow cover. Snowfall of the depth required to conduct pile burns does not occur reliably in the southern Black Hills. Distributing wood chips from mechanically thinned fuels, "thinning and chipping," provides an alternative to traditional thin and pile burning.

The ecological effects of distributed wood chips on forest ecology remain unknown. The goal of this study is to examine the effects of thinning and chipping. Specifically, we will examine the effects of distributed wood chips on forest understory plant communities and soils at Mount Rushmore National Monument and Wind Cave National Park. Treatments include: 1) mechanical thinning, 2) thinning and chipping, and 2) control, no treatment. Mechanically thinned fuels will be removed from plots in the first treatment. Wood chips will be distributed on the forest floor in the second treatment.

Research questions we hope to answer include: a) Do distributed wood chips suppress or enhance the understory plant community? b) Do wood chips favor certain plant strategies over others, e.g. seed size or dispersal, moisture requirements, N-fixation, or life form? c) Does thinning and chipping promote or reduce exotic species? d) Do wood chips decrease nitrogen availability in the soil? This research will provide fire and resource managers in the Black Hills with the information necessary to determine if thinning and chipping is a viable fuels management alternative in the ponderosa pine ecosystems they manage.

Timeline:

- Summer 2008. Pre-treatment data collection.
- Summer 2009. Project implementation and immediate post-treatment data collection.
- Summer 2010. Post-treatment data collection.
- Fall 2010 – Winter 2011. Thesis / manuscript preparation and results dissemination.

Methods:

Research plots and treatment units were established in 2008 at Mount Rushmore National Monument and Wind Cave National Park. Treatments included: control (no treatment), thin and remove, and thin and chip.

<u>Mount Rushmore National Monument</u>: 36 plots were installed in 12 treatment units (4 replicates x 3 treatments) in an area roughly 120 acres in size.

<u>Wind Cave National Park</u>: 18 plots were installed in 9 treatment units (3 replicates x 3 treatments) in an area roughly 60 acres in size.

Overstory trees (> 15cm/ 5.9in) and pole trees (≤ 15cm/ 5.9in, taller than 1.37m/4.5ft) were sampled to determine forest structure. The understory plant community was surveyed to assess the effects of wood chips on understory plant composition and cover. Finally, soil nitrogen availability was sampled to further understand the mechanisms driving post-treatment responses. Data collected include: overstory, pole, and seedling tree tallies; understory plant presence and cover by life form (grass, forb, shrub); litter, duff, and wood chip depths; ground cover; and nitrogen availability.

Treatment was successfully implemented April – July, 2009. All ponderosa pine trees ≤ 15cm/5.9in were hand-thinned in treatment units. Thinned trees in thin and chip units were chipped with a remotely-operated, tracked chipper. The tracked chipper, manufactured by Bandit©, has a swivel head for wood chip distribution, is 16.8 x 7.5 feet in size, and exerts an approximate force of 4-5 lbs/in^2.

Figure 1. Chipper equipment in action at Wind Cave.

Preliminary results:

2009 results provide a snapshot of the impacts of treatment implementation. Results of particular interest included wood chip depths/distribution and ground disturbance caused by chipping machinery.

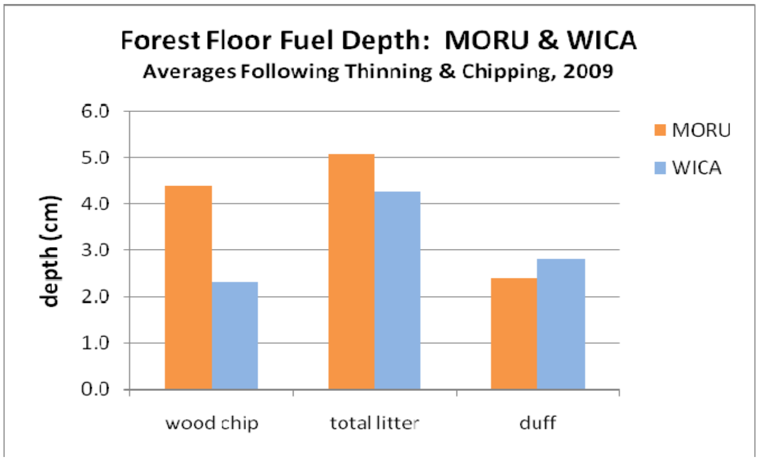

Fig. 2. Average wood chip, litter, and duff depths at both locations. Total litter includes both wood chip and litter depth.

	Depth (cm)	
	MORU	MORU
wood chips	3.6 - 5.2	1.9 - 2.7
litter	4.2 - 5.9	3.7 - 4.8
duff	1.8 – 3.0	2.2 - 3.5

Table 1. 90% confidence intervals for average wood chip, litter, and duff depths at each location.

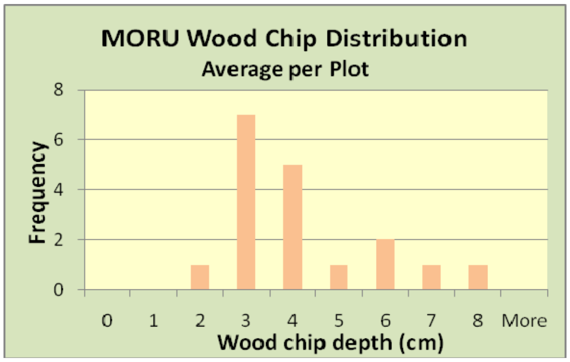

Figure 3a. Distribution of plot average wood chip depths at MORU

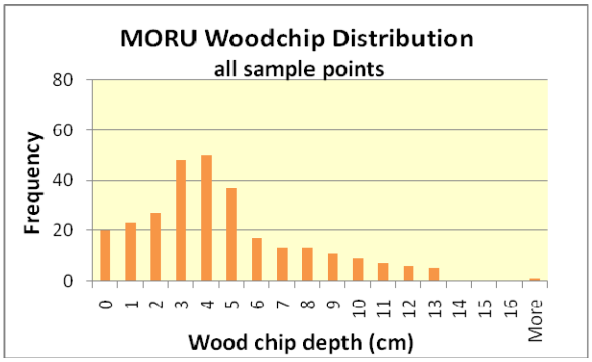

Figure 3b. Distribution of wood chip depths from all sample points at MORU

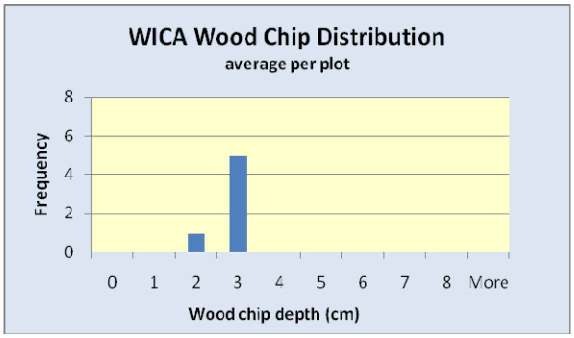

Figure 4a. Distribution of plot average woodchip depths at WICA. Figure

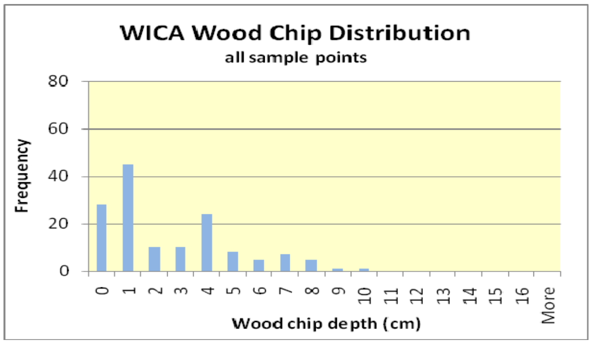

Figure 4b. Distribution of wood chip depths from all sample points at WICA.

Wood chip depth is of ecological interest, because deeper wood chip depths retain more soil moisture and may reduce vegetative cover (Binkley et al. 2003, Homyak et al. 2008, Wolk and Rocca 2009). Wood chip, litter, and duff depths were collected from 24 sample points per plot at 18 thin and chip treatment plots across both locations. Average wood chip depth measured 4.4 cm (1.7 in) at Mount Rushmore and 2.3 cm (1.5 in) at Wind Cave (Fig. 2, Table 1).

In contrast with reporting average wood chip depth over entire treatment sites, reporting the distribution of sampled depths displays fine scale treatment application. Wood chip distribution can be shown as plot averages (Figures 3b, 4b) or as individual sampling points (Figures 3b, 4b). A greater range of wood chip depths were sampled at Mount Rushmore than at Wind Cave. Plot average wood chip depth ranged from 2-8 cm (0.8-3.2 in) at Mount Rushmore (Figure 3a). Depths measured at sample points ranged from 0-16.5 cm (0-6.5 in) (Figure 3b). Average wood chip depth ranged from 2-3 cm (0.8-1.2 in) at Wind Cave (Figure 4a). Individual points within plots ranged in depth from 0-10 cm (0-3.9 in) (Figure 4b).

At both locations, no relationship was found between the number of trees thinned and the resulting average chip depth on plots (Figure 5). This lack of relationship indicates that the equipment operator had the ability to control wood chip distribution and form a relatively even layer of wood chips at broad scales. Differences in wood chip depth and distribution between project locations, but no difference in the number of trees thinned (90% confidence data not shown), provides additional evidence for distribution control.

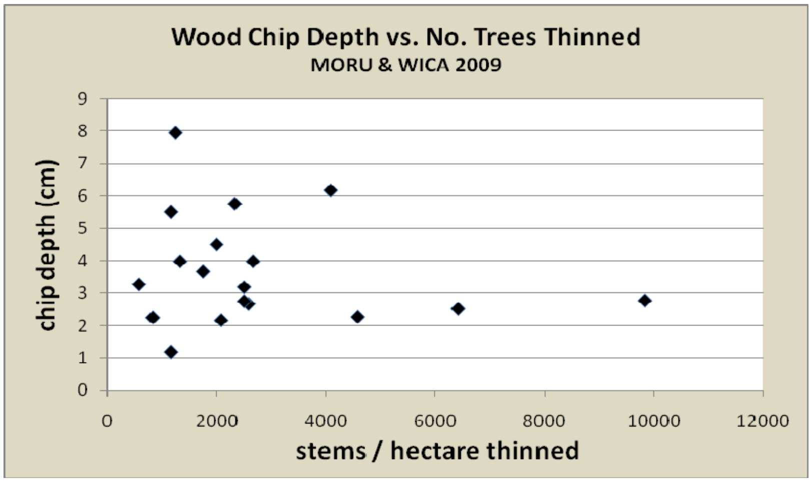

Figure 5. Average wood chip depth vs. stems/hectare of trees thinned by plot. MORU and WICA data combined. 1000 ha = 2471 ac.

Cover of bare ground and chipper (equipment) tracks were estimated as proxies for ground disturbance. Because bare ground cover was very low prior to treatment, it was assumed that any increase in bare ground would be due to disturbance from thinning or chipping activities. There was no difference between pre- and post- treatment cover of bare ground for all thin and chip plots, paired t-test $p = 0.0804$. Average cover of bare ground both pre- and post- treatment was ≤ 2% for all plots. Visual estimation of chipper tracks was used to approximate ground cover potentially disturbed by machinery. Average plot cover of sampled chipper tracks ranged from 0 – 19% at Mount Rushmore and 0 – 9% at Wind Cave (Figure 6).

Although chipper tracks were detectable, they rarely resulted in bare ground exposure. Thus, our results do not provide evidence for significant ground disturbance as a result of thinning and chipping activities. The possibility exists that wood chip cover obscured an increase in bare ground, but was not be detected with our sampling method. Additional methods, such as measures of ground compaction would provide a more comprehensive indication of ground disturbance by machinery.

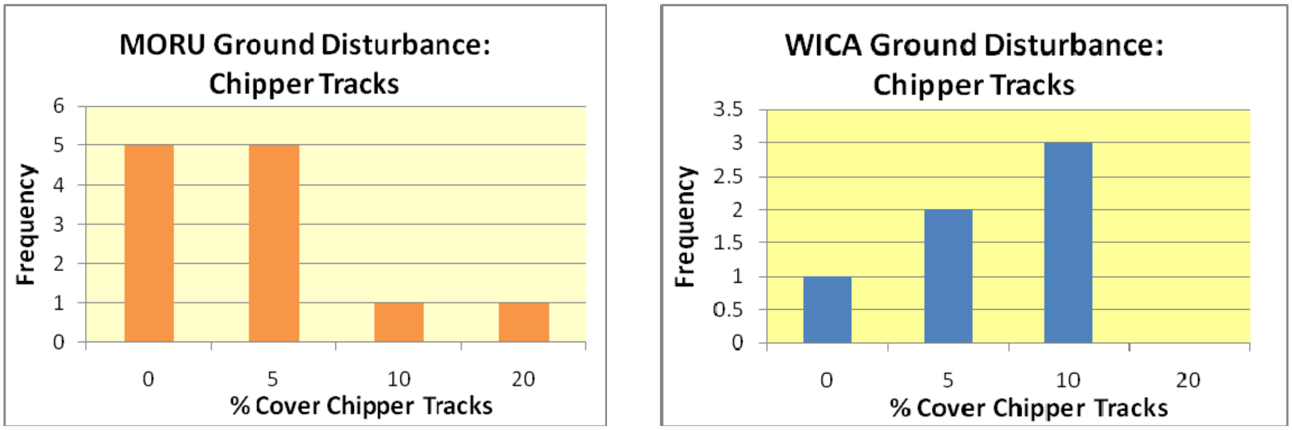

Figure 6. Plot average cover of chipper machinery tracks as a proxy of ground disturbance at MORU and WICA, respectively. Plot averages were derived from 12 – $1 m^2$ samples per plot.

Literature Cited

Binkley, D., S. Bird, M. G. Ryan, and C. C. Rhoades. 2003. Impact of wood chips on forest soil temperature, moisture, and nitrogen supply. Report to Interior West Center for the Innovative Use of Small Diameter Wood.

Homyak, P. M., R. D. Yanai, D. A. Burns, R. D. Briggs, and R. H. Germain. 2008. Nitrogen immobilization by wood-chip application: Protecting water quality in a northern hardwood forest. Forest Ecology and Management **255**:2589-2601.

Wolk, B. and M. E. Rocca. 2009. Thinning and chipping small-diameter ponderosa pine changes understory plant communities on the Colorado Front Range. Forest Ecology and Management **257**:85-95.