Response of Western Thatching Ant (*Formica obscuripes*) Colonies to Mechanical Shrub Crushing and Livestock Exclusion in a Wyoming Big Sagebrush (*Artemisia tridentata wyomingensis*) Community

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Thatching ant mound of twigs, grass culms, and other vegetation ("thatch"). The well organized thatch indicates an active, healthy colony.

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INTRODUCTION

Western thatching ants are common to sagebrush steppe ecosystems, building conspicuous mounds of twigs and other vegetation (thatch) to establish and protect their colonies (**Cover Figure**). Thatching ants are important predators of many insects, such as grasshoppers and beetles, and aggressively defend aphids against other predators (Weber 1935, Heikkinen 1999). Aphid secretions ("honeydew") are an important energy source for the ants (McIver and Yandell 1998). Thatching ants and other insects are essential in the diets of greater sage-grouse (*Centrocercus urophasianus*) chicks as well as other passerine birds, small mammals, and lizards (Guyer and Linder 1985, Drut et al. 1994, Pyle and Crawford 1996).

The sagebrush steppe ecosystem has experienced substantial alterations across its range over the past 150 years with about 75% of the area considered irretrievably altered as a result of agricultural and rural development, wildfire and subsequent dominance by invasive annual grasses and forbs, and historical overgrazing ((Noss et al. 1995, Hann et al. 1997, West 2000). Greater sage-grouse as well as other sagebrush steppe dependent species (e.g., Brewer's sparrow [*Spizella breweri*], sage thrasher [*Oreoscoptes montanus*], and sage sparrow [*Amphispiza belli*]) have experienced substantial population declines in recent decades (Paige and Ritter1999, Connelly et al. 2000, Sands et al. 2000).

Land managers are anxious to develop methods to restore rangelands to healthy communities of sagebrush and vigorous native herbs. Current methods include prescribed fire, seeding native plants, planned grazing systems, and mechanical shrub treatments. Fire is risky in lower elevation sagebrush steppe due to the possibility of subsequent dominance by annual grasses, such as cheatgrass (*Bromus tectorum*), and time intervals potentially spanning decades before sagebrush recovers (Bunting et al. 1987, Pyke 2000). Fire and other disturbances that reduce the vegetation that supports insect prey and aphids can negatively impact thatching ants. Invasion of cheatgrass and other species that contribute to shortening the fire return interval in sagebrush steppe, thus removing shrubs from the community, eliminates many insect prey as well as the aphids that thatching ants depend on. Fire may reduce ant colonies by > 20% because the removal of shrubs in sagebrush steppe generally results in the loss of thatching ants (McIver and Yandell 1998). Mechanical shrub crushing is an appealing alternative to prescribed fire that is intended to restore the herbaceous component of sagebrush steppe communities while retaining young-age sagebrush.

In 2003, the Bureau of Land Management Challis Field Office implemented a project to evaluate methods to restore the herbaceous understory of a Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)/bluebunch wheatgrass (*Pseudoroegneria spicata*) community. Management treatments included mechanical shrub crushing, livestock exclusion, and seeding native bunchgrasses. Experimental units were sampled in summer 2003 prior to treatment and in 2 years following treatments (2005 and 2007) spanning 4 growing seasons. The mechanical shrub crushing was intended to substantially reduce sagebrush cover which could have negative consequences on thatching ant colonies. This report presents the responses of thatching ant colonies to the treatments.

METHODS

Project Area

The project area was located in the Pahsimeroi Valley of east-central Idaho on lands managed by the Challis Field Office. Treatments occurred within a single large stand (about 2000 ha) of Wyoming big sagebrush extending across a broad, flat valley (elevation range within the project area = 2010 – 2075 m). Natural Resources Conservation Service (NRCS) range site guides indicate that the expected vegetation for this stand is dominated by bluebunch wheatgrass, comprising 40-50% of the composition (by weight), and Wyoming big sagebrush contributing an additional 15-25% (Natural Resources Conservation Service 2002). Other grasses and forbs constitute the remaining 25-35% of the community with as many as 16 forb species common to the community. However, for years prior to initiation of this project, Wyoming big sagebrush, Sandberg's bluegrass (*Poa secunda*), and Hood's phlox (*Phlox hoodii*) were the most abundant species in the stand with few other species particularly forbs present. Wyoming big sagebrush cover was not high ($\bar{x}$ = 17-22%). Bluebunch wheatgrass contributed only about 1-2% cover throughout the stand. Non-native plants including cheatgrass, although present, were not prevalent in the project area. Cattle were grazed within the allotment in a deferred rotation grazing system (~500 – 620 AUMs in 2003 – 2007) with cattle typically entering the treatment pasture in early July although cattle entered the pasture in mid June in 2007. Sampling occurred in 2003, 2005, and 2007 during the first week of July.

Treatments

An *a priori* power analysis determined that the number of treatment replications needed to achieve a power = 0.80 at $\alpha = 0.05$ with paired comparisons was 5 replicates of each treatment based on increasing bluebunch wheatgrass cover by about 10%. Three treatments were employed resulting in 15 experimental units: (1) mechanical brush crushing with a Lawson aerator augmented by seeding with native grasses using a rangeland drill ("seeded"), (2) mechanical brush crushing with natural seeding by resident plants ("no seed"), and (3) no treatment ("control"). Each experimental unit was 4 ha with half (2 ha) fenced to exclude livestock (yet permit access by wildlife, "fenced" plot), and the other half left open to livestock grazing ("open" plot). The experimental units were located within the project area using a systematic random sampling design with two restrictions: all sites were > 0.4 km from water troughs to avoid areas of excessive livestock use, and plots didn't straddle established roads including two-tracks. This approach provided random placement of each unit with good dispersion of units throughout the project area.

Experimental units were sampled in early July 2003 prior to treatment and fencing. In late fall 2003, 10 of the 15 units were treated with mechanical brush crushing in 2 parallel 200-m long by 30-m wide strips (with a 30-m strip in between so about 30% of each treated quadrat was impacted – see **Figure 1**) in an effort to stimulate productivity of native grasses and forbs. Bluebunch wheatgrass and Indian ricegrass (*Oryzopsis hymenoides*) were seeded on 5 of the treated units in fall 2003 immediately after mechanical crushing with the aerator. The seeding included 90% bluebunch wheatgrass and 10% Indian ricegrass at a seeding rate of 11-13 kg/ha. Fencing of the grazing exclosures was completed in spring of 2004. Subsequent sampling occurred in early July of 2005 and 2007.

Vegetation Cover

The effect of treatments on the vegetation community was evaluated by comparing changes in cover among treatments and among years – spanning 4 growing seasons. Vegetation canopy cover by species and ground cover (bare soil, litter, rock, and visible biological crust) were estimated within each half of the 4-ha experimental unit on 10 randomly-located, permanent transects (**Figure 1**). Fifteen point interceptions along each transect at 3-pace intervals were used to estimate cover (150 points/open or fenced plot).

Ant Colony Density

The number of active thatching ant colonies was counted within a 25-m radius circular quadrat (0.20 ha) centered within each plot (open or fenced) of each experimental unit (**Figure**

1). On treated quadrats, 28% of the area searched for ant colonies was impacted by the shrub crushing. Weber (1935) reported that thatching ants forage 20-50 m from their mounds so treated areas would be within the foraging range for all colony mounds. The quadrat was divided into 4 quadrants, and each quadrant was systematically searched. Thatching ants generally are most active in summer during morning and evening (Weber 1935). Thatching ant mounds are in a constant state of flux and repair by the colony so the size and extent of the thatch mound may not be a consistent indicator of its condition. During periods of high temperatures, typically afternoons, when ants became inactive, I dug into thatch mounds where no ants were evident to check whether the colony was still active.

Weather

An automated weather station was placed in the center of the project area. Weather data were recorded from April 2003 through July 2007. Unfortunately, 14 months had gaps in the monthly record. These gaps resulted from inability to download data during winter months and problems with maintaining power to the data logger. The nearest National Weather Service station is located in the Pahsimeroi Valley at May, Idaho, about 35 km northeast of the project area. Precipitation and temperature data collected at May, Idaho were compared with data from the project weather station. Monthly precipitation at May was significantly correlated with precipitation at the project weather station ($r = 0.84$, $p < 0.0001$, n = 37 months). Likewise, average monthly temperatures were highly correlated between the two weather stations ($r = 0.99$, $p < 0.0001$, n = 37 months). Therefore, I used the May weather record to depict weather patterns for the project area.

Analysis

The average ant colony density per treatment was compared graphically among years. I used the Wilcoxon signed rank test or the Friedman repeated measures analysis of variance on ranks test (data were not normally distributed) to test for change between or among years, respectively. I chose $\alpha = 0.05$ to delineate statistical significance.

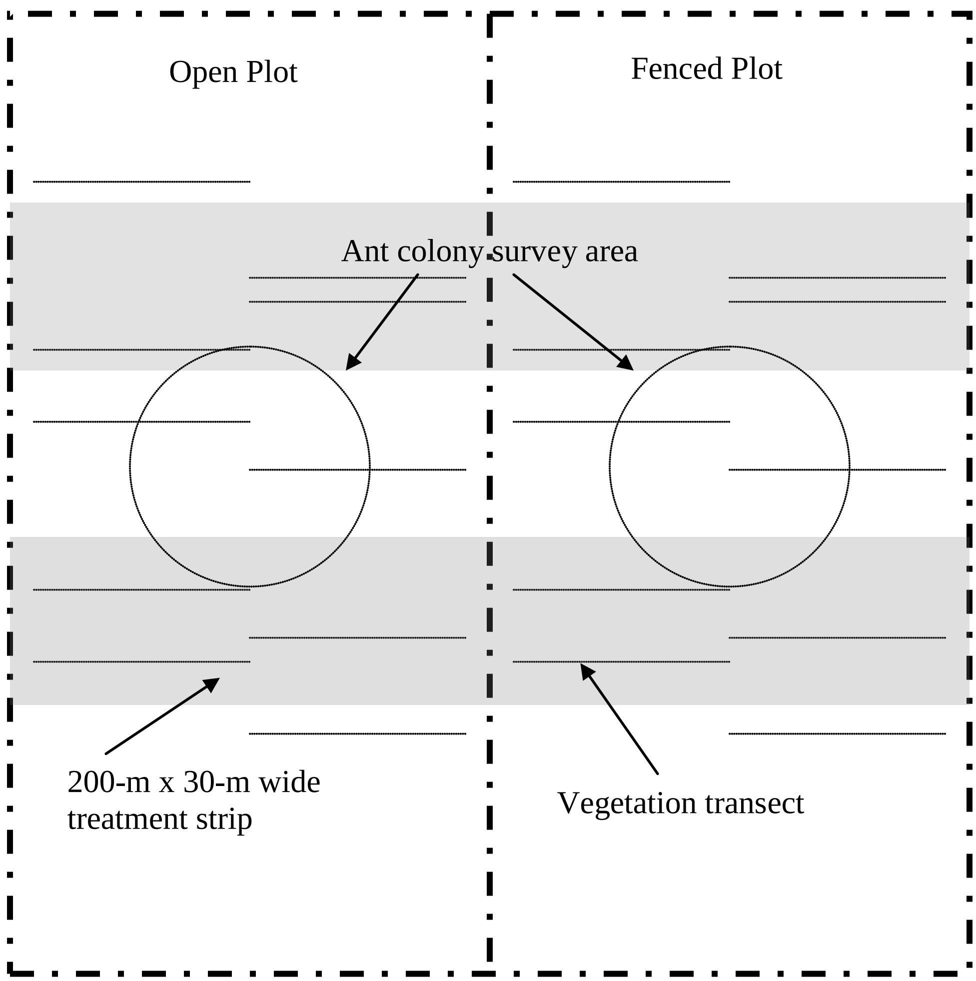

Figure 1. Transect distribution within both the fenced and open sides of the 4-ha experimental unit. Shaded strips are areas treated with the Lawson aerator in fall 2003. One half of the unit was fenced to exclude livestock, the other half left open to livestock grazing (although the open side was fenced with temporary electric fencing to exclude livestock for 1 year after treatment to allow seeding establishment).

RESULTS AND DISCUSSION

Vegetation Response

Average Wyoming big sagebrush cover was reduced on treated areas from 20-22% in 2003 to 6-8% in 2005 (**Figure 2**). Sagebrush cover increased to 8-13% by 2007. Total live vegetative cover, both on control units and treated units, increased about 28% between 2003 and 2007 as a result of increased cover of grasses, principally from naturally occurring bottlebrush squirreltail (*Sitanion hystrix*) and seeded bluebunch wheatgrass (by 2007) (**Figure 3**).

Figure 2. Shrub reduction after treatment with Lawson aerator.

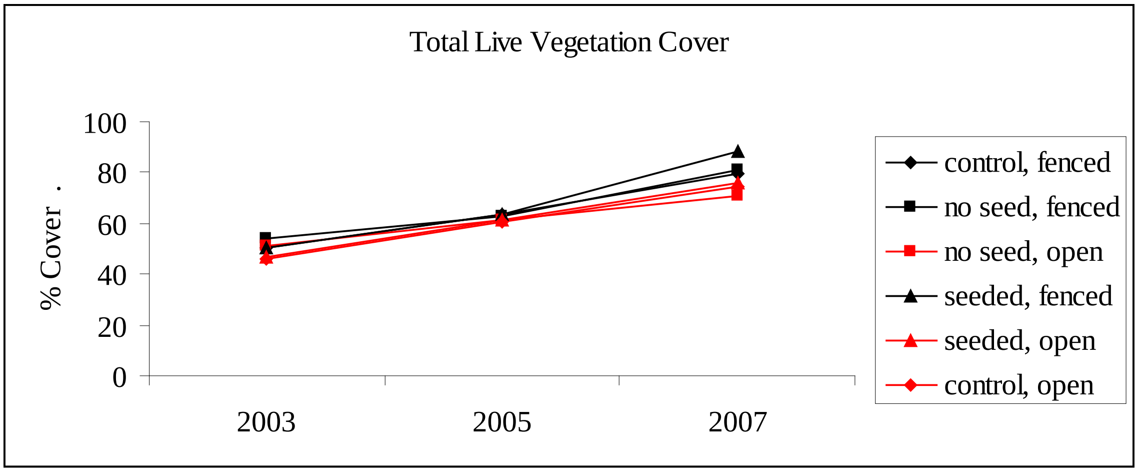

Figure 3. Comparison among treatments for cover of live vegetation among years.

Ant Colony Response

Control units and treatment units had similar densities of active colonies in 2003 prior to treatments (**Figure 4**). However, there was considerable variability among sites. Seven of the 30 experimental units had no active thatching ant colonies in any of the 3 sample years. In 2005, 2 growing seasons after treatments, the average number of thatching ant colonies on treated units was greater than on control units (P = 0.004). By 2007, the trend was a decline in active thatching ant colonies on treated sites and an increase on control sites. The average density of ant colonies on control sites in 2007 was half that on treated sites but statistically similar (P = 0.26; $\bar{x}_{\text{control}} = 0.5 \pm 0.98$ colonies/site, $\bar{x}_{\text{treatment}} = 1.1 \pm 1.48$ colonies/site).

The pattern observed for changes in thatching ant colony density wasn't consistent with changes in vegetation cover. MontBlanc et al. (2007) also did not find correlations between changes in ant populations and changes in vegetation or ground cover.

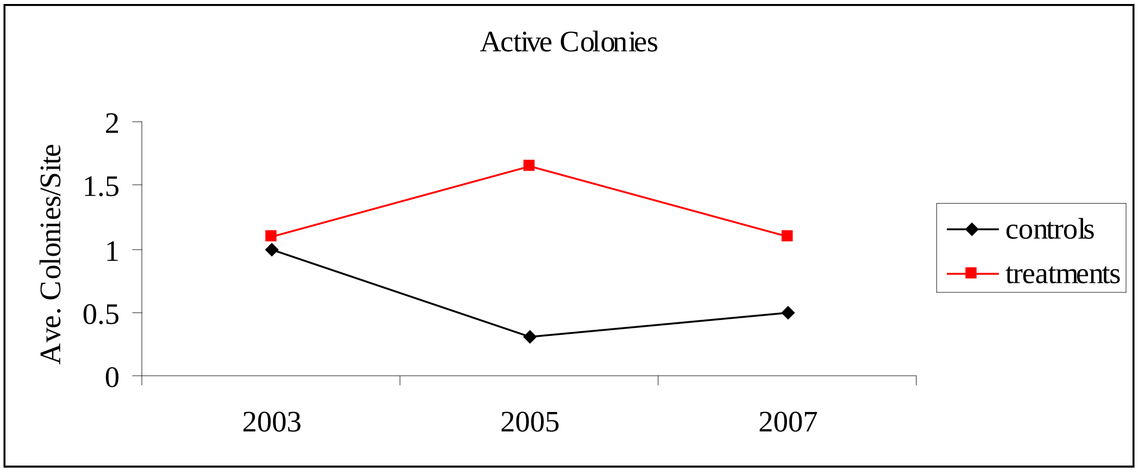

Figure 4. Changes in the average density of active thatching ant colonies/site comparing between control units (n = 10 units) and treatment units (n = 20 units).

Beever and Herrick (2006) cautioned that domestic grazers could have negative impacts on thatching ants. They found that thatching ant colonies were 3.3 times more abundant on areas where the principal grazer (feral horses) were removed compared to areas where horses were present. The pattern of thatching ant colony response to livestock exclusion reported here doesn't indicate impacts by cattle grazing during the timeframe of the study. Although in some cases there were differences in the initial density of colonies in 2003, the pattern of change in average colony density between open and fenced sites for each of the treatments was similar in the subsequent 2 sample periods (**Figure 5**).

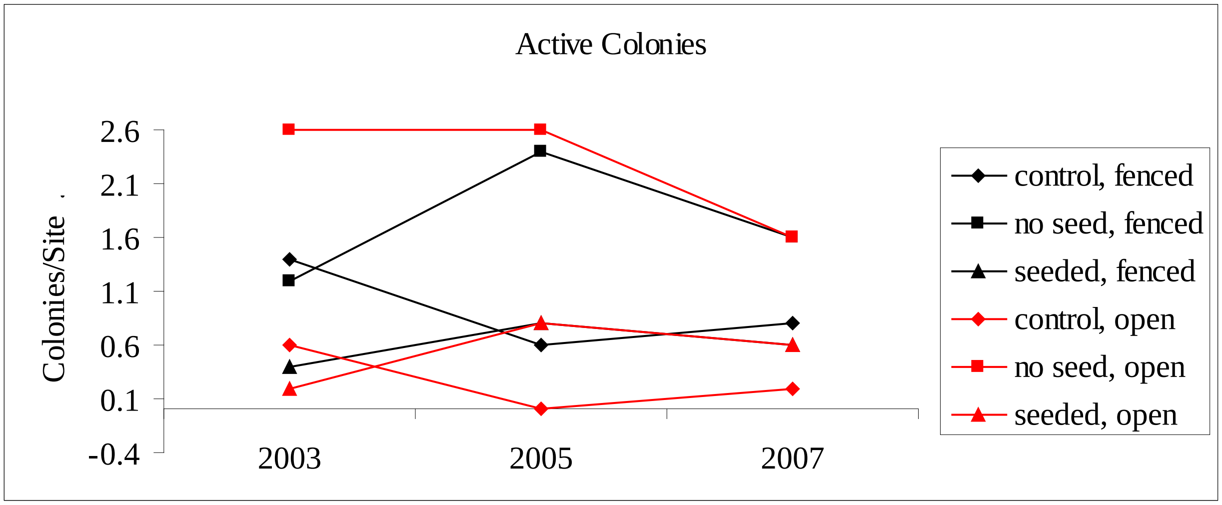

Figure 5. Changes in the average density of active thatching ant colonies among treatments in fenced and open experimental units.

Weather

Climate diagrams (Walter et al. 1975) are useful for depicting average climate conditions for an area, and the pattern of arid and humid periods throughout the course of a year. Consecutive annual climate diagrams for the May weather station from 2001 through summer 2007 describe changes in the availability of water for plant growth (**Figure 6**). The years 2004 and 2005 had robust peaks of rainfall during the spring, and 2005 and 2006 had comparatively short arid periods indicating that plant growth conditions were more favorable than in the previous period 2001 – 2003. A long and severe arid period also was evident in 2007 with very limited rainfall prior to summer. So the sample years 2003 and 2007 were substantially more xeric than 2005.

Changes in thatching ant colony density among years and treatments seem most consistent with changes in weather – the amount of spring moisture combined with the duration of the arid period. The summers of 2003 and 2007 were drier and hotter than 2005 (or 2004). In 2004 and 2005 spring peaks of rainfall (as did 2006) were higher than in the other years reported here (**Figure 6**). Colony increases in 2005 on treated areas may be a response to favorable weather in combination with increased cover of vegetation, and soil disturbance from the aerator. Yet, except for the soil disturbance, favorable weather and increased cover of vegetation (albeit at lower levels) also occurred on control sites. The declines of colony density observed in 2007 on treated sites may be a response to the combination of a leveling off of grass cover and very hot, dry weather.

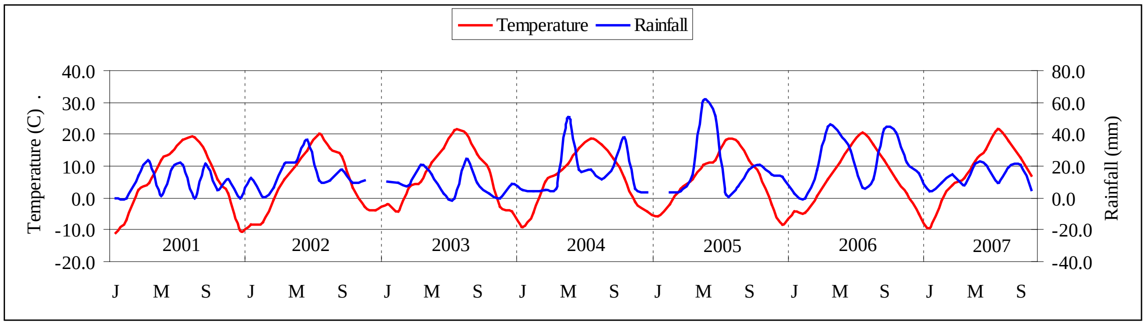

Figure 6. Continuous climate diagram of data from May, Idaho, using the methods of Walter et al. (1975). Within each year, those intervals when the temperature exceeds rainfall indicate arid periods. The horizontal extent of the arid period identifies the time when evaporative loss exceeds water recharge, and the vertical extent of the arid period signifies the severity of the relative drought period. Months depicted on the x-axis are: J = January, M = May, S = September.

Thatching ant nests have been known to exist for 10 – 30 years (Weber 1935). The short duration of this study, although spanning 5 years, reflect only 3 years of data. So the long-term pattern of response by thatching ants to the treatments may be quite different than the data suggest. Or the disturbance from the mechanical shrub crushing may not have been sufficiently large or extensive enough to impact thatching ant colonies. Whitford et al. (1999) found ant populations did not respond to disturbance on rangeland ecosystems, and concluded ants were not useful indicators of ecosystem stressors or restoration success.

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