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Influence of Mowing *Artemisia tridentata* ssp. *wyomingensis* on Winter Habitat for Wildlife

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Abstract Mowing is commonly implemented to *Artemisia tridentata* ssp. *wyomingensis* (Beetle & A. Young) S.L. Welsh (Wyoming big sagebrush) plant communities to improve wildlife habitat, increase forage production for livestock, and create fuel breaks for fire suppression. However, information detailing the influence of mowing on winter habitat for wildlife is lacking. This information is crucial because many wildlife species depended on *A. tridentata* spp. *wyomingensis* plant communities for winter habitat and consume significant quantities of *Artemisia* during this time. Furthermore, information is generally limited describing the recovery of *A. tridentata* spp. *wyomingensis* to mowing and the impacts of mowing on stand structure. Stand characteristics and *Artemisia* leaf tissue crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) concentrations were measured in midwinter on 0-, 2-, 4-, and 6-year-old fall-applied mechanical (mowed at 20 cm height) treatments and compared to adjacent untreated (control) areas. Mowing compared to the control decreased *Artemisia* cover, density, canopy volume, canopy elliptical area, and height ($P < 0.05$), but all characteristics were recovering ($P < 0.05$). Mowing *A. tridentata* spp. *wyomingensis* plant communities slightly increases the nutritional quality of *Artemisia* leaves ($P < 0.05$), but it simultaneously results in up to 20 years of decrease in *Artemisia* structural characteristics. Because of the large reduction in *A. tridentata* spp. *wyomingensis* for potentially 20 years following mowing, mowing should not be applied in *Artemisia* facultative and obligate wildlife winter habitat. Considering the decline in *A. tridentata* spp. *wyomingensis*-dominated landscapes, we caution against mowing these communities.

Keywords Wyoming big sagebrush · Recovery · Sagebrush · Mechanical treatment · Cover · Nutritional quality · Crude protein

Introduction

Artemisia tridentata Nutt. (big sagebrush) plant communities occupy vast portions of the western United States (Küchler 1970; Miller and others 1994; West and Young 2000). These communities provide important habitat for wildlife and forage for domestic livestock. Prior to European settlement, wildfires periodically shifted dominance from *A. tridentata* to herbaceous vegetation and created a mosaic of habitats across the landscapes (Miller and Heyerdahl 2008; Miller and Rose 1999; Wright and Bailey 1982). With the decrease in fire return intervals in some *A. tridentata* plant communities, increased levels of *A. tridentata* cover and density can reduce or eliminate the herbaceous component (West 1983). West (2000) estimated that ~25% of the *A. tridentata* steppe ecosystem is comprised of decadent, even-aged stands of *A. tridentata*. Long-term maintenance in an *A. tridentata* state has also been demonstrated to reduce resistance to exotic plant invasions (Davies and others 2008). As a consequence, there is a desire to increase the diversity of *A. tridentata* structural characteristics and understory productivity across

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landscapes to provide a mosaic of various habitats (Beck and others, in press; Connelly and others 2000; Crawford and others 2004).

Mechanical thinning of *A. tridentata* is a common method for reducing its cover and density to increase herbaceous production and habitat diversity (Dahlgren and others 2006; Hedrick and others 1966). Thinning *A. tridentata* stands might be beneficial to some *Artemisia* obligate wildlife species (Beck and Mitchell 2000; Crawford and others 2004). Stevens and Monson (2004) recommended that the shrub overstory need not be eliminated, but be reduced to lessen competition with understory species. Advantages of mechanical thinning treatments over burning include the ability to retain shrub and herbaceous components while controlling the size and shape of the treatment (Urness 1979). Mechanical treatments have been suggested to be more appropriate than burning in *A. tridentata* ssp. *wyomingensis* (Beetle & A. Young) S.L. Welsh (Wyoming big sagebrush) communities to enhance vegetation characteristics because *A. tridentata* probably has a more speedy recovery with mechanical treatments (Beck and others, in press; Watts and Wambolt 1996).

However, the impact of mechanical thinning *A. tridentata* ssp. *wyomingensis* on winter habitat for wildlife has not been evaluated. *A. tridentata* ssp. *wyomingensis* plant communities provide important winter habitat to many wildlife species because these plant communities are often at lower elevations and experience warmer temperatures and less snow accumulation than more productive adjacent summer habitats (Burke and others 1989; Connelly and others 2000; Homer and others 1993; Shiflet 1994). The length of recovery of *A. tridentata* ssp. *wyomingensis* is critical because it provides important hiding and thermal cover (Connelly and others 2000). *A. tridentata* ssp. *wyomingensis* is also an important dietary component for many wildlife species during the winter (Austin and Urness 1983; Patterson 1952; Wallestad and others 1975).

Information describing recovery and structural characteristics of mechanically thinned *A. tridentata* ssp. *wyomingensis* is lacking. Historic mechanical treatments of *A. tridentata* were implemented to control *A. tridentata*, not to thin stands; for example, the objectives of Wambolt and Payne (1986) and Mueggler and Blaisdell (1958) were to remove *A. tridentata* as close to ground level as possible. Wambolt and Payne (1986) reported that mechanical control treatment of *A. tridentata* ssp. *wyomingensis* resulted in 13–15 years of lower *A. tridentata* cover relative to untreated areas. However, the *A. tridentata* cover in the untreated areas decreased drastically during the study and, thus, *A. tridentata* cover in the treated areas might take even longer to recover. Wambolt and Payne (1986) also did not report treatment effects on *A. tridentata* density, height, canopy elliptical area, or canopy volume. Furthermore, Wambolt and Payne (1986) mowed *A. tridentata* at 5.1–7.6 cm above ground level, which is very different than contemporary mowing projects designed to improve wildlife habitat. Contemporary mowing projects for wildlife are implemented to thin *A. tridentata* stands and create diversity in habitats, not eliminate (control) *A. tridentata*. In the northern Great Basin, mowing of *A. tridentata* is often at 20 cm above ground level to increase the survival of young *A. tridentata* and decrease the potential for blade contact with surface rocks. Mueggler and Blaisdell (1958) reported that 3 years after chain roto-beating, *A. tridentata* production was only 14% of the untreated area. Although not conclusive, herbaceous species data from their study suggest that they were treating *A. tridentata* ssp. *vaseyana* (Rydb.) Beetle (mountain big sagebrush) not *A. tridentata* ssp. *wyomingensis*. Most previous literature focused on *A. tridentata* control, rather than thinning *A. tridentata* ssp. *wyomingensis*.

Information is also lacking describing the influence of mechanical treatment on the nutritional quality of *A. tridentata* ssp. *wyomingensis* leaves. The nutritional quality of *A. tridentata* is important for many wildlife species that consume *Artemisia*. *Centrocercus urophasianus* (sage-grouse) diets consist almost exclusively of *Artemisia* leaves in the winter (Patterson 1952; Wallestad and others 1975), the total diet of *Antilocapra americana* (pronghorn antelope) in Oregon contained about 61% *Artemisia* (Mason 1952), and *A. tridentata* can comprise more than 50% of *Odocoileus hemionus* (mule deer) diets in January and February (Austin and Urness 1983). Mechanical treatment might influence leaf nutritional quality by decreasing the age of *A. tridentata* in the stand. Mature *A. tridentata* plants frequently suffer mortality from mechanical treatments, whereas younger, smaller individuals often survive (Wambolt and Payne 1986). Wambolt (2004) reported higher crude protein content in juvenile compared to mature *A. tridentata* ssp. *wyomingensis* plants, but crude protein content of other *A. tridentata* subspecies did not differ by age. Younger plants are generally more nutritious than older individuals (Marschner 1998). To better understand the implications of mechanical treatment of *A. tridentata* on winter habitat, the impacts of mowing on the nutritional quality of *A. tridentata* leaves needs to be investigated.

The purpose of this study was to evaluate the recovery and affects of mowing *A. tridentata* ssp. *wyomingensis* on stand characteristics during the winter. The objectives of this study were to (1) quantify the influence of mowing on *A. tridentata* ssp. *wyomingensis* stand characteristics, (2) determine the recovery of *A. tridentata* ssp. *wyomingensis* following mowing, and (3) ascertain if mowing influences nutritional quality of *A. tridentata* ssp. *wyomingensis* leaf tissue [crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) content].

Methods

Study Area

The study area encompassed 350,000 ha in the High Desert Ecological Province (Anderson and others 1998) in eastern Oregon. The dominant vegetation at all sites is *A. tridentata* ssp. *wyomingensis*. Common herbaceous species include *Pseudoroegneria spicata* (Pursh) A. Löve (bluebunch wheatgrass), *Achnatherum thurberianum* (Piper) Barkworth (Thurber's needlegrass), *Poa secunda* J. Presl (Sandberg's bluegrass), *Elymus elymoides* (Raf.) Swezey (squirreltail), *Astragalus* spp. L. (milkvetches), and *Crepis* spp. L. (hawksbeard). Climate across the study area is characterized by hot, dry summers and cool, wet winters. Average annual precipitation ranges between 250 and 300 mm across the study area (Oregon Climatic Service 2007). Regional precipitation was 115% of the long-term historic record in the 2005–2006 crop year (1 October–30 September) (Oregon Climatic Service 2007). Elevation of the study sites ranged between 1250 and 1520 m above sea level. Soils were also variable across the study sites and included Aridisols, Mollisols, and Andisols. Study sites were on flat to slight slopes with varying aspects.

Experimental Design

A randomized block design was used to evaluate the recovery from mowing and the influence of mowing on *A. tridentata* ssp. *wyomingensis*. *A. tridentata* ssp. *wyomingensis* had been mowed at various locations across the study area 0-, 2-, 4-, and 6 years prior to sampling. Six blocks (sites) per posttreatment time interval were randomly selected for sampling. Each block consisted of a 50 × 80-m mowed treated plot and an adjacent 50 × 80-m untreated (control) plot. Within a block, treated and control plots had uniform soil and topography. Mowing treatments were implemented in September and October 0, 2, 4, or 6 years prior with a John Deere 1418 rotary cutter (Deere & Company, Moline, IL, USA). *A. tridentata* ssp. *wyomingensis* was mowed at 20 cm height above the soil surface. Response variables included *A. tridentata* ssp. *wyomingensis* cover, density, height, canopy elliptical area, canopy volume, and leaf nutritional quality, and *Chrysothamnus viscidiflorus* (Hook.) Nutt. (green rabbitbrush) density and cover.

Measurements

We sampled all sites in January and February of 2007 to evaluate the effects of mowing on winter habitat for wildlife. Sites were sampled in the winter because wildlife consumption of *A. tridentata* is greatest in the winter compared to other seasons and *A. tridentata* ssp. *wyomingensis* plant communities provide critical winter habitat for many wildlife species (Austin and Urness 1983; Connelly and others 2000; Homer and others 1993; Mason 1952; Patterson 1952; Wallestad and others 1975). We measured shrub cover by species using the line-intercept method (Canfield 1941) on four parallel 50-m transects spaced 15 m apart per treatment replicate. We measured shrub density by species by counting all individuals rooted in four 2 × 50-m belt transects. The 2 × 50-m belt transects were centered over the 50-m transects used to measure shrub cover. *A. tridentata* ssp. *wyomingensis* height, canopy elliptical area, and canopy volume were determined by measuring 50 randomly selected individuals per plot. We calculated percent recovery of *A. tridentata* ssp. *wyomingensis* structural characteristics for each block by dividing the treated plot value (i.e., height, elliptical area, and volume) by the control plot value and then multiplying by 100. We determined leaf nutritional quality (CP, ADF, and NDF) by harvesting branches from 50 randomly selected *A. tridentata* ssp. *wyomingensis* plants. We dried branches and then separated leaves from other materials and ground the leaves to pass through a 1-mm mesh. Analyses were limited to leaf tissue because wildlife species mainly consume this portion of the *A. tridentata* plants (Green and Flinders 1980; Patterson 1952; Shipley and others 2006; Wallestad and others 1975; Wambolt 1996; Welch and McArthur 1979). We determined nitrogen content (%) of leaves using a LECO CN 2000 (LECO Corporation, St. Joseph, MI, USA). We calculated crude protein by multiplying nitrogen content by 6.25. Crude protein was determined as a percent of total dry matter. We determined ADF (Goering and Van Soest 1970) and NDF (Robertson and Van Soest 1981) using procedures modified for an Ankom 200 fiber analyzer (Ankom Co., Fairport, NY, USA).

Statistical Analysis

We analyzed data for each posttreatment time interval using an analysis of variance (ANOVA) to test for treatment differences between response variables (S-Plus 2000; Mathsoft, Inc., Seattle, WA). Block and treatment were used as explanatory variables. We used a Fisher protected LSD to test for differences between treatment means. We considered differences between means significant if *P*-values were less than 0.05 ($\alpha = 0.05$). We used simple linear regression to determine the relationship between recovery of *A. tridentata* spp. *wyomingensis* characteristics and amount of time since treatment (S-Plus 2000; Mathsoft, Inc., Seattle, WA). Time since treatment was considered to significantly influence *A. tridentata* spp. *wyomingensis* recovery if *P*-values were less than 0.05 ($\alpha = 0.05$). Data did not violate assumptions of normality.

Results

Cover and Density

Artemisia tridentata ssp. *wyomingensis* cover in the mowed treatments was less than the controls in every posttreatment time interval ($P < 0.01$; Fig. 1a). Recovery of *A. tridentata* ssp. *wyomingensis* cover was correlated positively to amount of time since the mowed treatment ($P < 0.01$; Fig. 2a). *A. tridentata* ssp. *wyomingensis* cover in the mowed treated plots increased from 11% to 41% of the control as the recovery period increased from 0 to 6 years. Time since treatment explained 74% of the variation in the recovery of *A. tridentata* ssp. *wyomingensis* cover ($R^2 = 0.74$). *Chrysothamnus viscidiflorus* cover did not differ between treatments in any posttreatment time interval ($P > 0.05$).

Artemisia tridentata ssp. *wyomingensis* density in the mowed treatments was less than the controls in every posttreatment time interval ($P < 0.05$; Fig. 1b). Recovery of *A. tridentata* ssp. *wyomingensis* density was correlated positively to the amount of time since treatment application ($P < 0.01$; Fig. 2b). By the sixth year posttreatment, *A. tridentata* ssp. *wyomingensis* density in the mowed treated plots was 75% of control plots. Time since treatment explained 42% of the variation recovery in *A. tridentata* ssp. *wyomingensis* density ($R^2 = 0.42$). *C. viscidiflorus* density did not differ between the mowed and control treatments in any posttreatment time interval ($P > 0.05$).

Height, Elliptical Area, and Volume

Artemisia tridentata ssp. *wyomingensis* height was less in the mowed treatment compared to the control treatment in all the posttreatment time intervals ($P < 0.01$; Fig. 3a). *A. tridentata* ssp. *wyomingensis* height recovery was correlated positively with the length of time since treatment ($P < 0.01$). The amount of time posttreatment explained 89% of the variation in recovery of *A. tridentata* ssp. *wyomingensis* height ($R^2 = 0.89$) (Fig. 4a). *A. tridentata*

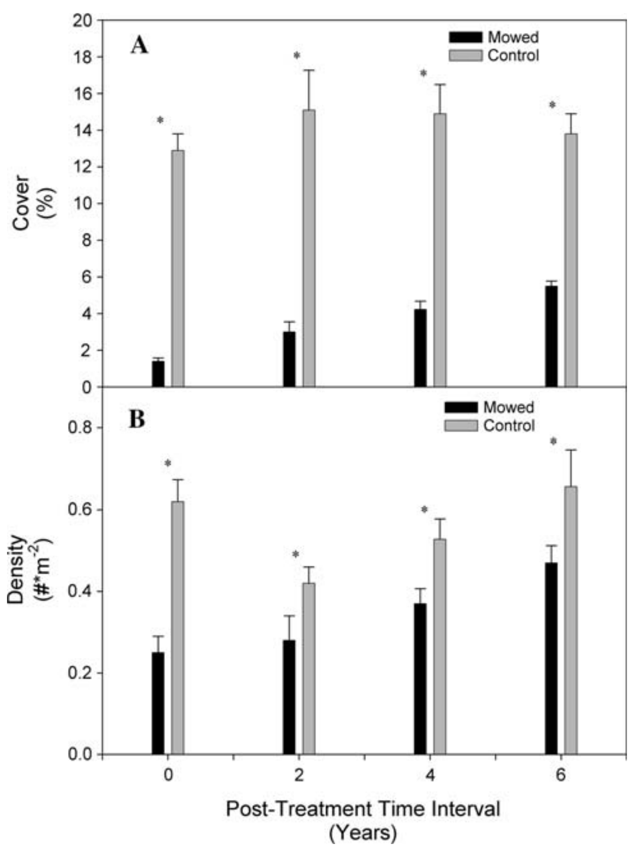

Fig. 1 *Artemisia tridentata* spp. *wyomingensis* cover (**a**) and density (**b**) (mean ± SE) in the mowed compared to the control treatment in 0, 2, 4, and 6 years posttreatment in southeastern Oregon in 2007. Asterisks (*) indicate significant difference between means ($P < 0.05$) for each posttreatment time interval

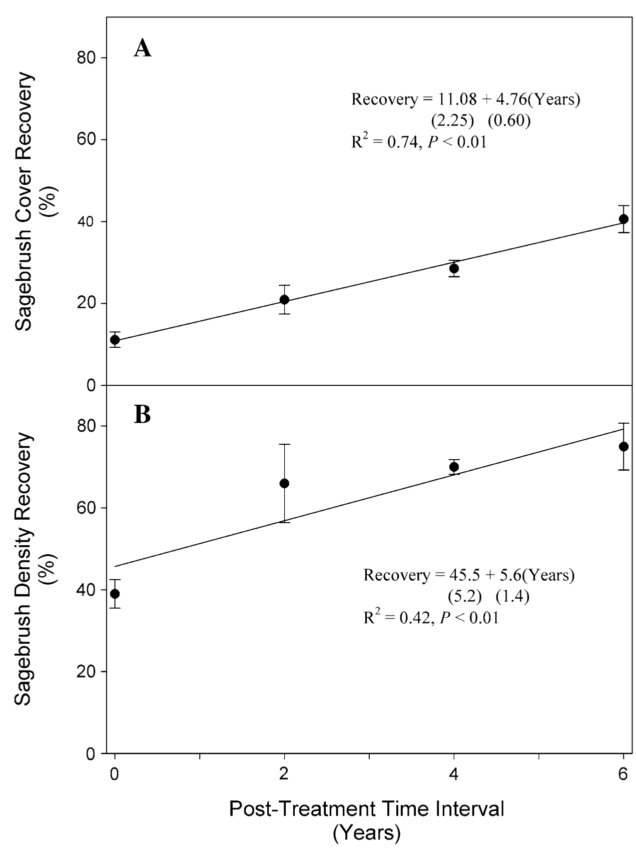

Fig. 2 Recovery of *A. tridentata* spp. *wyomingensis* cover (**a**) and density (**b**) (mean ± SE) in the mowed treatments at 0, 2, 4, and 6 years posttreatment in southeastern Oregon in 2007. Recovery is the percent the treated plots are of the control plots. Recovery regression is based on individual block differences

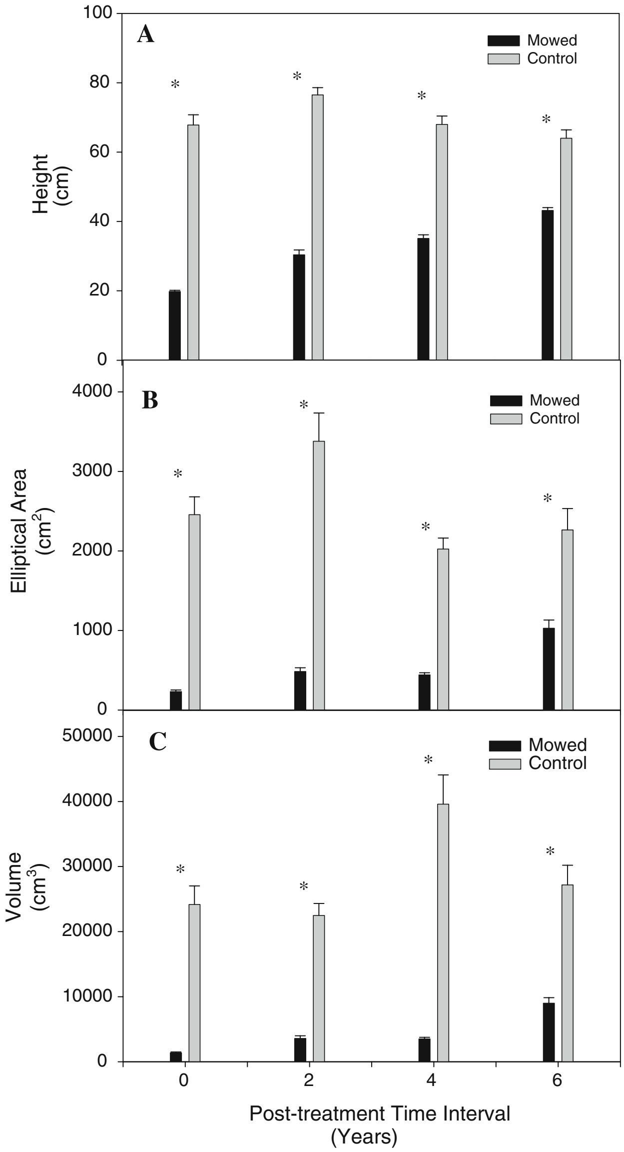

Fig. 3 Average *A. tridentata* spp. *wyomingensis* height (**a**), canopy elliptical area (**b**), and canopy volume (**c**) (mean ± SE) in the mowed compared to the control treatment at 0, 2, 4, and 6 years posttreatment in southeastern Oregon in 2007. Asterisks (*) indicate significant difference between means ($P < 0.05$) for each posttreatment time interval

ssp. *wyomingensis* height in the mowed treatment was 68% of the control by the sixth year posttreatment.

Canopy elliptical area of *A. tridentata* ssp. *wyomingensis* in the mowed treatment was less than half of the control treatment in every posttreatment time interval ($P < 0.01$; Fig. 3b). Recovery of the elliptical area of *A. tridentata* ssp. *wyomingensis* was correlated positively to time since treatment ($P < 0.01$). The length of time posttreatment explained 76% of the variation in recovery of the canopy elliptical area ($R^2 = 0.76$) (Fig. 4b).

Artemisia tridentata ssp. *wyomingensis* canopy volume was less in the mowed treatment than the control treatment in all posttreatment time intervals ($P < 0.01$; Fig. 3c). Mowed treated *A. tridentata* ssp. *wyomingensis* canopy volumes were between 5% and 39% of the control treatments. Recovery of *A. tridentata* ssp. *wyomingensis* canopy volume increased with increasing time since treatment ($P < 0.01$). The length of time since treatment accounted for 75% of the variation in canopy volume recovery ($R^2 = 0.75$) (Fig. 4c).

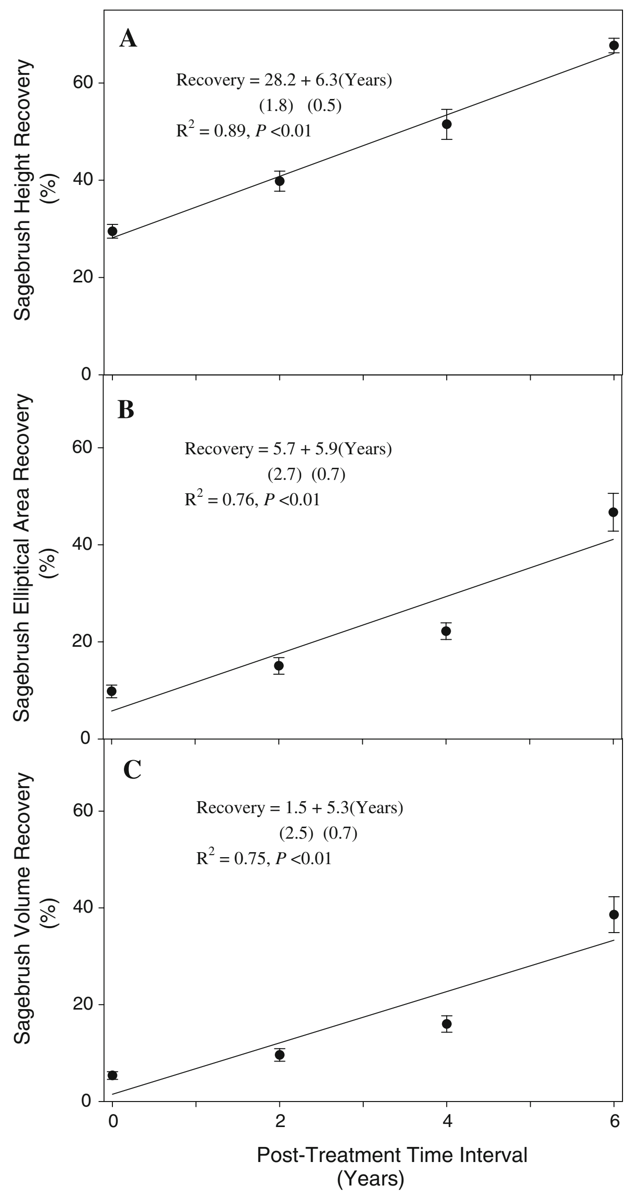

Fig. 4 Recovery of *A. tridentata* spp. *wyomingensis* height (**a**), canopy elliptical area (**b**), and canopy volume (**c**) (mean ± SE) in the mowed treatments at 0, 2, 4, and 6 years posttreatment in southeastern Oregon in 2007. Recovery is the percent the treated plots are of the control plots. Recovery regression is based on individual block differences

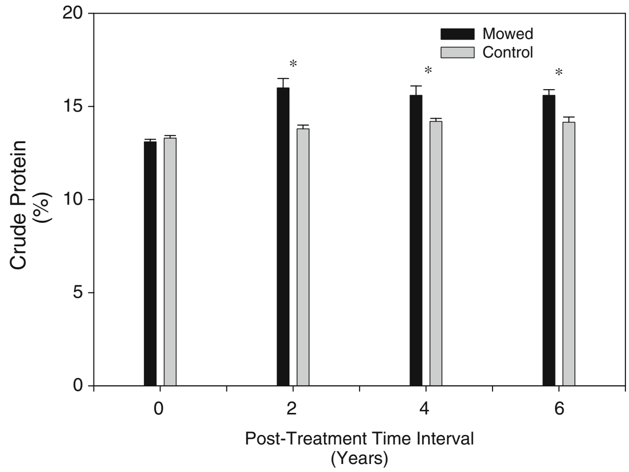

Fig. 5 Average *A. tridentata* spp. *wyomingensis* leaf crude protein percent (mean ± SE) in the mowed compared to the control treatment at 0, 2, 4, and 6 years posttreatment in southeastern Oregon in 2007. Asterisks (*) indicate significant difference between means ($P < 0.05$) for each posttreatment time interval

CP, ADF, and NDF

Crude protein concentration in *A. tridentata* ssp. *wyomingensis* leaves was greater in the mowed compared to control treatments in all posttreatment time intervals ($P < 0.05$), except for the winter immediately after treatment ($P = 0.09$). Averaged across the 6, 4, and 2 years since treatment, CP was 15.7 ± 0.26% and 14.0 ± 0.13% in the mowed and control treatments, respectively (Fig. 5). ADF was less in the mowed treatments in all posttreatment time intervals ($P < 0.05$), except for the winter immediately after treatment ($P = 0.10$). Averaged across the 6, 4, and 2 years since treatment, ADF was 21.3 ± 0.22% in the mowed treatment and 22.3 ± 0.17% in the control treatment. Variation in CP and ADF were not correlated to the time since treatment ($P > 0.05$). NDF did not differ between treatments in any of the posttreatment time intervals ($P > 0.05$).

Discussion

Mowing of *A. tridentata* ssp. *wyomingensis* decreased all measured stand structural characteristics for greater than 6 years posttreatment. The influence of this mechanical thinning treatment on stand structure appears to be limited in duration, because all structural characteristics measured were recovering. *A. tridentata* ssp. *wyomingensis* density was almost fully recovered in the mowed treatment after 6 years, whereas cover was still less than half of the control treatment. Assuming the current rate of recovery, *A. tridentata* ssp. *wyomingensis* density, height, cover, and volume will be fully recovered in ~9.7, 11.4, 18.7, and 18.6 years posttreatment, respectively. The initial decrease in *A. tridentata* ssp. *wyomingensis* cover from mowing was similar to Wambolt and Payne's (1986) results; however, initial recovery of cover occurred more rapidly at our sites. Our sites were probably able to initially recover faster because Wambolt and Payne (1986) mowed at 5.1–7.6 cm compared to 20 cm above the soil surface. Mowing higher above the ground probably increases the survival of *A. tridentata* ssp. *wyomingensis* plants.

Although by the sixth year posttreatment *A. tridentata* ssp. *wyomingensis* height in the mowed treatment was 68% of the control treatment, the overall size of *A. tridentata* spp. *wyomingensis* individuals were considerably smaller in the mowed compared to the control treatment. *A. tridentata* ssp. *wyomingensis* canopy volume and elliptical area were more negatively affected by mowing than height and subsequently have further to recover. *A. tridentata* ssp. *wyomingensis* production would probably also be much less in the mowed treatments compared to control treatments, which could have significant implications to wildlife species that consume large quantities of sagebrush. *A. tridentata* ssp. *wyomingensis* production is strongly correlated positively with canopy volume (Davies and others 2007; Rittenhouse and Sneva 1977). However, because the correlation between *A. tridentata* ssp. *wyomingensis* canopy volume and biomass production varies by year (Davies and others 2007), the most accurate regression equation also varies by year. Regardless, mowing probably resulted in decreased *Artemisia* production as long as canopy volume was less in the mowed compared to control treatment.

The lack of measured treatment effects on *C. viscidiflorus* density and cover does not necessarily imply that mowing does not have an effect on *C. viscidiflorus*. The majority of sites ($n = 13$) sampled did not have *C. viscidiflorus* in the control or mowed treatments, thus its response was not adequately tested. However, these results suggest that if *C. viscidiflorus* is absent prior to mowing, it will probably not become a significant component of the posttreatment plant community.

Other than the winter immediately after treatment, mowing appears to slightly increase the nutritional value of *A. tridentata* ssp. *wyomingensis* plants. The decrease in ADF with mowing suggests that mowing increased digestibility and energy content. Lower ADF indicates forage is potentially higher in energy and more digestible (Reid and others 1988). The increase in CP leaf concentration with mowing was probably caused by a decrease in the age of the *A. tridentata* ssp. *wyomingensis* stand. Younger *A. tridentata* ssp. *wyomingensis* plants often survive mechanical treatments (Wambolt and Payne 1986) and this age class has higher leaf tissue CP than older individuals (Wambolt 2004).

However, the increase in CP and decrease in ADF from mowing probably is not biologically significant. Wambolt (2004) speculated that a difference of 1.2% CP between younger and mature *A. tridentata* ssp. *wyomingensis* leaves was not biologically significant because both exceeded the CP requirements for *O. hemionus* maintenance and gestation. For *Centrocercus urophasianus* (Patterson 1952; Wallestad and others 1975), *Brachylagus idahoensis* (pygmy rabbits) (Green and Flinders 1980; Shipley and others 2006), and other animals with diets high in *Artemisia* leaves, minor increases in digestibility and CP would not be important. However, for animals' diets not solely dominated by *Artemisia*, the answer is not as definite, but probably the same; for example, *Artemisia* averaged 7%, 16%, and 23% of *Ovis aries* (sheep), *O. hemionus*, and *Cervus elaphus* (elk) diets, respectively, in south central Colorado (MacCracken and Hansen 1981). In Utah, Austin and Urness (1983) reported that *A. tridentata* comprised 52.7% of *O. hemionus* diets in January and February. In Oregon, *A. americana* most important food source was *Artemisia*, comprising 61% of their total diet (Mason 1952). Whether or not increases in CP from mowing *A. tridentata* ssp. *wyomingensis* are biologically significant might depend on the amount of *A. tridentata* ssp. *wyomingensis* consumed and the quality of other forage ingested. However, for wildlife species for which the majority of their diet is *A. tridentata*, there would not be any advantage of increased nutritional quality because of the high nutritional quality of untreated *A. tridentata* spp. *wyomingensis* and the large reduction of *A. tridentata* ssp. *wyomingensis* with mowing. The influence of mowing on wildlife species winter habitat would vary by species and size of the area treated, but, in general, mowing would probably negatively impact wildlife species dependent on *A. tridentata* ssp. *wyomingensis* for winter habitat.

Greater CP and decreased ADF concentrations in leaf tissues in 2, 4, and 6 years posttreatment apply to perennial *A. tridentata* ssp. *wyomingensis* leaves but not ephemeral leaves because sampling occurred in the winter. By November, only perennial leaves remain on *A. tridentata* ssp. *wyomingensis* plants and new leaves are not generated until spring (Miller and Schultz 1987). The lack of difference in *A. tridentata* ssp. *wyomingensis* leaf tissue CP and ADF concentrations between treatments in the winter immediately after treatment was the result of *A. tridentata* ssp. *wyomingensis* plants not having an opportunity to respond to the treatment. New *A. tridentata* ssp. *wyomingensis* ephemeral and perennial leaves are initiated in the spring (Miller and Schultz 1987).

Depending on which characteristics are measured, the impact and recovery of an *A. tridentata* spp. *wyomingensis* plant community from mowing could be interpreted very differently; for example, density of *A. tridentata* spp. *wyomingensis* will be recovered to control levels in approximately half the time it will take the cover to recover. Similarly, the increase in the nutritional quality of *A. tridentata* spp. *wyomingensis* leaves without measuring the impact of mowing on density, cover, and volume of *A. tridentata* spp. *wyomingensis* could be interpreted that mowing could be beneficial to wildlife, but in fact the large reduction in *Artemisia* would negatively impact wildlife species dependent on these plant communities for habitat. This stresses the need to evaluate several characteristics to determine recovery and impact, even when evaluating a single species response.

Conclusions

Mowing influences stand structure by decreasing *A. tridentata* ssp. *wyomingensis* cover, density, canopy volume, height, and canopy elliptical area. These effects are not permanent because of evident *A. tridentata* ssp. *wyomingensis* recovery in all measured characteristics. Caution should also be exercised when considering mowing treatments because our results suggest that mowing reduces the cover and volume of *A. tridentata* ssp. *wyomingensis* for ~20 years. Although mowing *A. tridentata* ssp. *wyomingensis* increases its leaf nutritional quality, it is doubtful that this is biologically significant enough to offset the negative impacts of long-term reductions in sagebrush cover, density, and biomass production for most wildlife species. Mowing as a tool to improve wildlife habitat in *A. tridentata* ssp. *wyomingensis*-dominated plant communities must be further evaluated because of the potential to negatively affect wildlife species, especially during the winter, when many species consume high levels of *A. tridentata* (Austin and Urness 1983; Patterson 1952; Wallestad and others 1975). A distinct benefit of mowing *A. tridentata* spp. *wyomingensis* to *Artemisia* obligate wildlife during the winter is lacking and this study suggests that mowing in winter habitat could have significant negative impacts for almost 20 years posttreatment. Furthermore, with the decline in *A. tridentata* spp. *wyomingensis*-dominated landscapes (Miller and Eddleman 2000); reducing *A. tridentata* spp. *wyomingensis* might exasperate the blight of *Artemisia* obligate and near-obligate wildlife species. Thus, we advise caution in the mowing of *A. tridentata* spp. *wyomingensis* because of its negative impacts on winter habitat for a variety of *Artemisia* obligate and facultative wildlife species.

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