Sage-Oak 1 year Post Treatment Study Summary Report

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Introduction

In sagebrush (*Artemisia sp.*) ecosystems of Colorado, encroachment from Gambel oak (*Quercus gambelii*) may alter sagebrush ecosystem structure and composition and reduce suitable habitat for sage grouse (*Centrocercus sp.*). Gambel oak has a variable growth form across its range in southwestern USA, and in western Colorado it can grow as both a tree and shrub. Most of the current scientific knowledge on Gambel oak was produced in Arizona where it occurs as a tree. Gambel oak resprouts aggressively after being cut, mowed, or burned, so understanding how it can effectively be managed is important for future management considerations in sagebrush ecosystems, particularly where endangered or sensitive species are a concern. In Utah and Colorado, Gambel oak tends to have more ramets available in the root system for resprouting than in New Mexico and Arizona (Kaufman et al., 2016). On the Uncompahgre Plateau in western Colorado, Gambel oak in sagebrush ecosystems is a concern primarily because it encroaches into Gunnison sage grouse (*Centrocercus minimus*) habitat. Gunnison sage grouse has been listed as threatened under the Endangered Species Act since 2014. Currently, Gunnison sage grouse occupy 7% of their historic range. They require large areas of contiguous sagebrush year-round, with healthy riparian and wetland ecosystems and a diversity of grasses and forbs (US Fish and Wildlife Service, 2019).

Gambel oak is a species that has complicated interests for managers because while it may alter sagebrush ecosystems, it is also an important source of forage and habitat for many wildlife species. Young Gambel oak shoots are a preferred food source for ungulates and livestock. Managers on the Uncompahgre Plateau and in southwestern Colorado need locally relevant information on Gambel oak response to mowing treatments in sagebrush ecosystems to understand how these treatments impact understory grasses, forbs, and shrubs which provide important forage and habitat for many wildlife species.

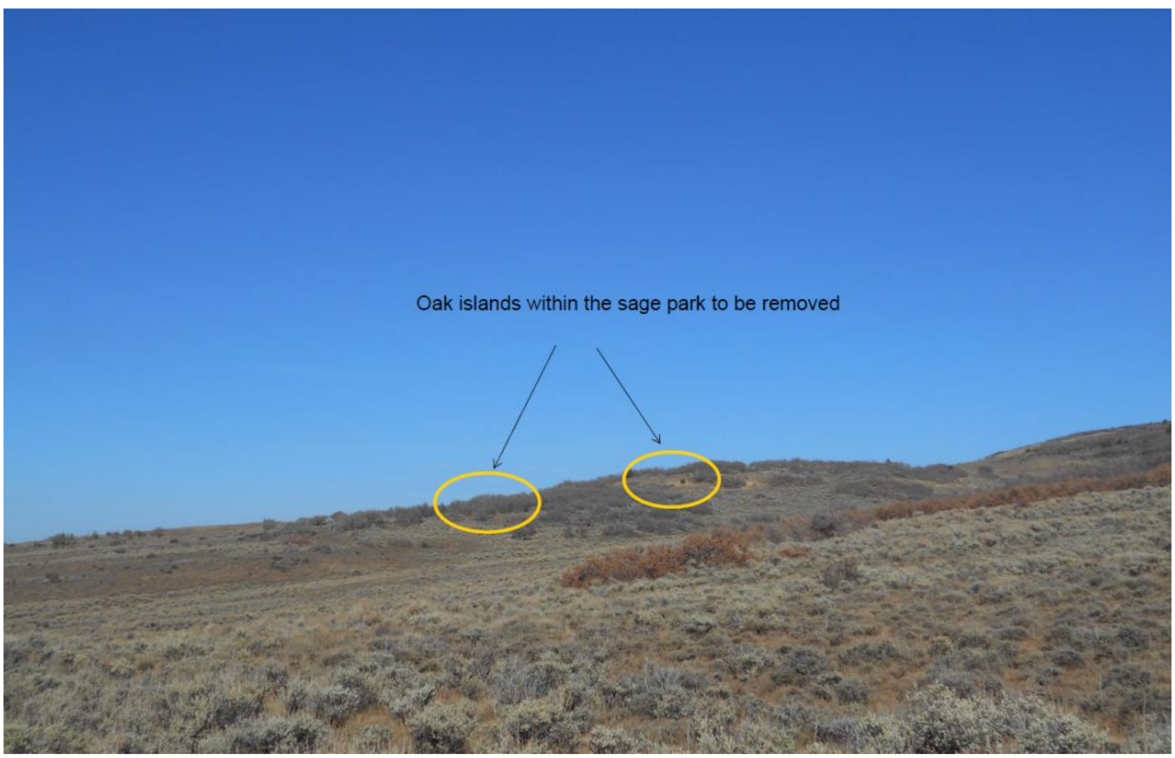

Figure 1: This landscape is locally dominated by sagebrush, with patches of Gambel oak.

Methods

This study is part of the Uncompahgre Collaborative Forest Landscape Restoration Project and is a joint effort between the US Forest Service, Colorado Forest Restoration Institute at Colorado State University, and Colorado State University. The purpose is to assess how Gambel oak and understory species respond to cutting and mowing treatment in sagebrush systems. The study seeks to answer the following research questions:

1. How does understory vegetation respond to mowing treatment of Gambel oak in sage-oak systems in western Colorado?
2. How do Gambel oak and sagebrush regenerate following mowing treatments, compared to hand-cutting and stem retention treatments?
3. How does mowing affect ground fuels, particularly fine and coarse wood?

In 2018, paired plots were established in the Dominguez Creek area on the north end of the Uncompahgre Plateau in Western Colorado. Each pair of plots includes a control (un-mowed or uncut) plot, and a plot that would be either hand-cut, mowed, or treated with a stem-retention cut. The plots were measured prior to treatments in early summer of 2018, were treated later that summer, and then were re-measured in summer 2019.

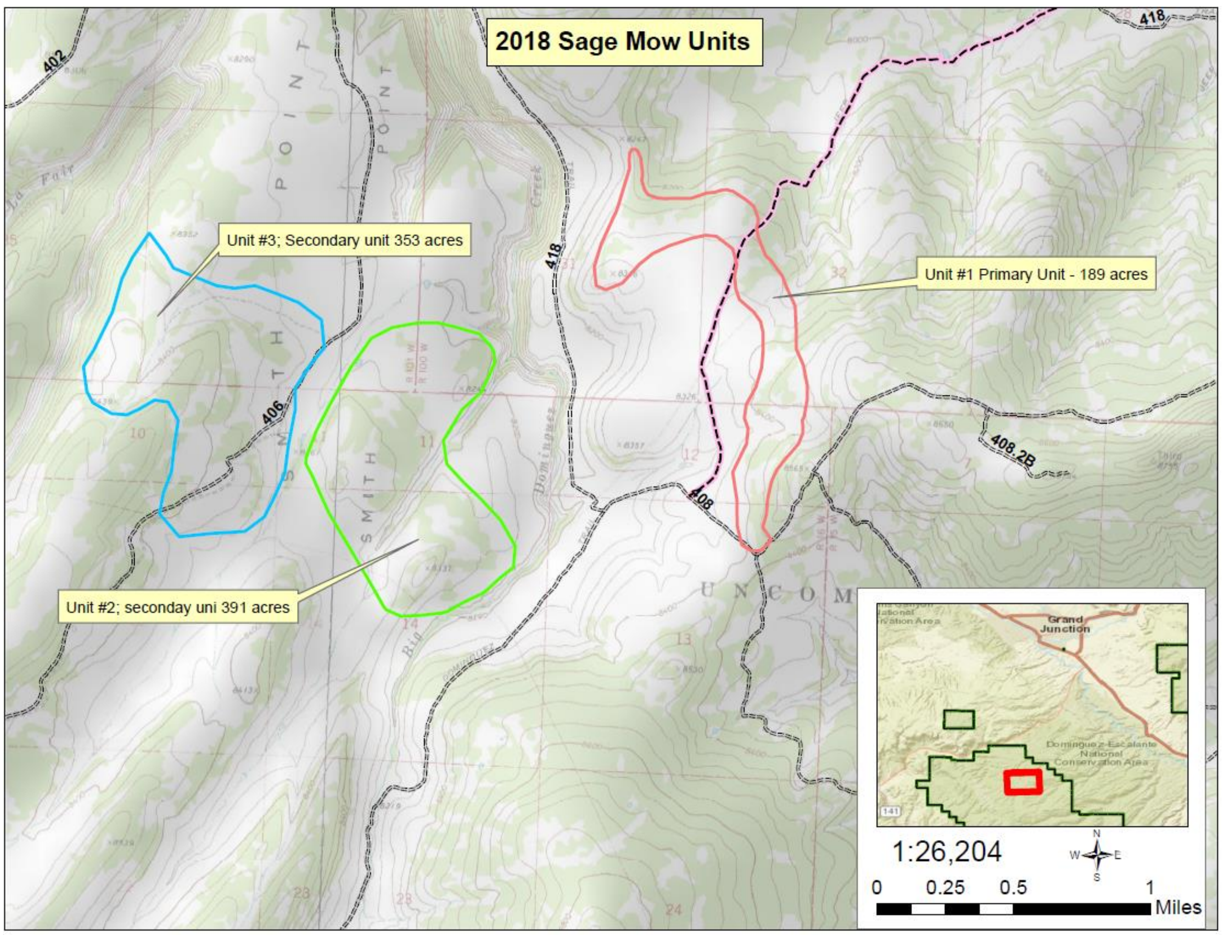

Figure 2: Map of mowing units in the Dominguez Creek area.

Mowing was contracted by the USFS Grand Valley Ranger District. The contract specified that the treatments should remove 85-100% of the trees and shrubs that were not sagebrush. Some “savannah-style” oak, with a heightened crown and Diameter at Root Collar (DRC) greater than 10 inches, were left un-mowed as they are rare on the landscape and provide important habitat. Savannah style oak with a smaller DRC were treated in order to have a greater size range available to study. The goal of the mowing treatments was to maintain sage parks for grouse habitat by removing Gambel oak, pinyon pine or juniper trees in the area.

Figure 3: Photos before (left) and after treatment (right) in a mowed plot.

To compare the effects of different kinds of treatment, some plots were treated with hand-cut and stem retention treatments. Gambel oak, along with the taller shrubs in the plot, were cut manually with a chainsaw and pruners, with the intent being to mimic the effects of mowing. The stem retention plots were similarly cut, but one or more stems were left intact. The stems that were left met certain criteria of being dominant or co-dominant, and healthy or in good form relative to the patch (Figure 4). The number of stems retained was determined by how many could fit into the patch area, with the distance between them equal to the height of the dominant oak stems in the patch. Because treating plots with hand tools is laborious and relatively expensive, the hand-cut treatment is not a proposed treatment option. The purpose of hand-cutting plots was to control for the effect of mastication equipment when evaluating the stem retention treatment.

Figure 4: Recently treated stem retention plot. A few dominant stems were left uncut, with the space between them approximately equal to their height.

Results and Discussion

Post-treatment monitoring after one year illustrated that shrubs and graminoids were heavily impacted by mowing while forbs were not. Shrub cover, which included sagebrush, serviceberry (*Amelanchier alnifolia*), wild rose (*Rosa sp.*), and chokecherrry (*Prunus virginiana*) was reduced by nearly half after mowing (Figure 5). While Gambel oak was the target of mowing treatments, the equipment is not precise enough to keep sagebrush and other shrubs from being mowed. Longer-term observation of these treatments is needed to understand shrub recovery, as there is a lack of information on this ecosystem in the literature. Graminoid cover decreased by more than half after treatment while forb cover nearly quadrupled. The increase in forb cover could be due to exotics coming in following disturbance. We did not measure understory plants to the species level due to capacity constraints so are unable to provide a clear explanation of an increase in functional groups. Based on qualitative observation, the dominant forbs were silver lupine (*Lupinus argenteus*), small-leaf pussytoes (*Antennaria parvifolia*), bracken fern (*Pteridium spp.*), and milkvetch (*Astragalus spp.*). The large decrease in graminoids is difficult to explain, as studies of understory vegetation following mowing treatments suggest that herbaceous cover - of both forbs and graminoids - increases following mowing in sagebrush systems (Davies et al., 2012). A limitation of our study is that two different observers were measuring plant cover during the separate (pre- and post- treatment) monitoring campaigns which may have resulted in some level of human error. Additionally, in hand-cut and stem retention treatments, woody debris tended to be coarser than what the masticator produced in the mowed treatments, and that debris could restrict herbaceous growth.

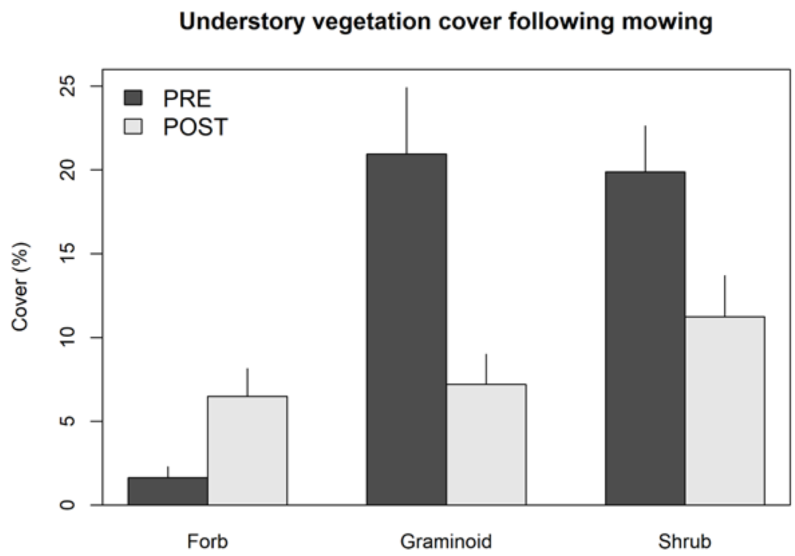

Figure 5: Bar plots depicting mean (±1 standard error of the mean) understory vegetation cover (%) by functional group in mowed stands only (shrub is composed of various mountain shrubs including sagebrush species, serviceberry, and chokecherry, but does not include Gambel oak).

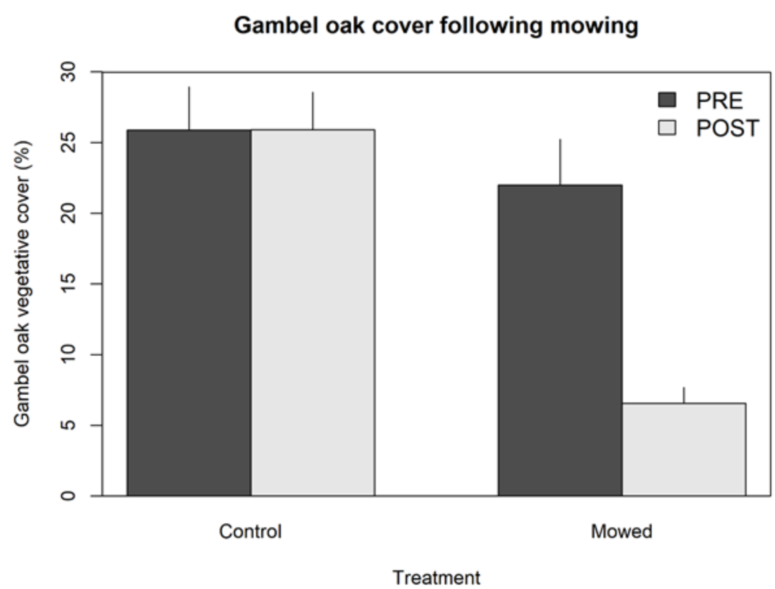

Figure 6: Bar plots depicting mean (±1 standard error of the mean) vegetative cover (%) of Gambel oak pre- and post- treatment in control and mowed stands.

Gambel oak regenerated vigorously following mowing and hand-cut treatments, and regenerated less vigorously following stem retention treatment. The mowing treatment decreased cover of Gambel oak (which included larger diameter and regenerating stems) by over two thirds - from 22.0% to 6.6% cover - in treated plots (Figure 6). However, Gambel oak more than doubled in density following mowing (Figure 6 & 7). In hand-cut plots, Gambel oak density doubled following treatment. Plots that received the stem retention treatment (where individuals were cut with a chainsaw leaving one or more dominant stems intact) had a 44% increase in density, which is the smallest increase of the treatments. None of these treatments could effectively remove Gambel oak from an area, and all of them caused an increase in regeneration density. Cutting and mowing treatments can temporarily alter the structure of the landscape, but the effects are unlikely to last more than 10 or 15 years (Kaufmann et al., 2016). Where the goal is to limit oak encroachment long-term, mechanical treatments of Gambel oak may be counterproductive. However, they can be effective for short-term changes to stand structure, and for creating heterogeneity on the landscape. These data suggest that the stem retention treatment encourages oak individuals to allocate more resources toward the dominant stems and less toward new sprouts. If this trend continues, then stem retention treatment could be used to accelerate the development of savannah style oak islands. Longer term monitoring of treated plots would yield more information on growth trends. For the three treatments, regenerating stems were all below 24 inches in height one year after treatment (Figure 8).

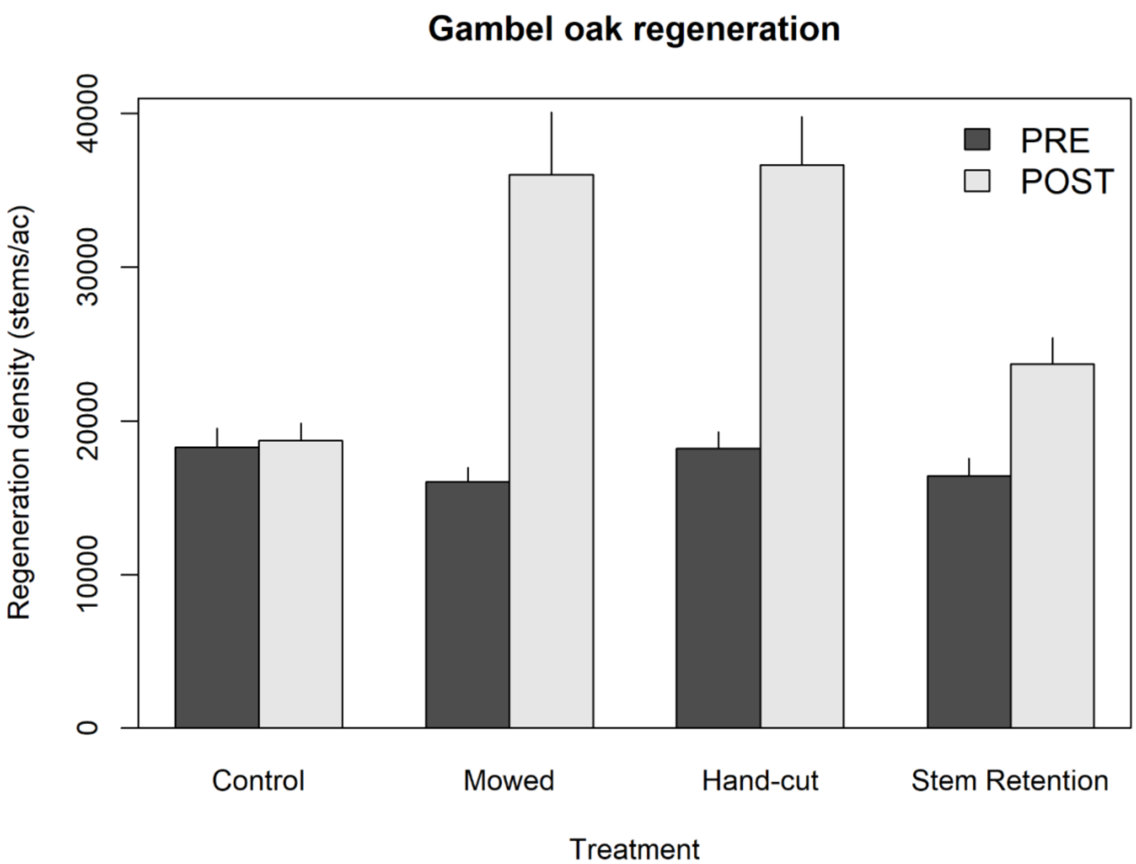

Figure 7: Bar plots depicting mean (±1 standard error of the mean) Gambel oak regeneration density in control, hand-cut, mowed, and stem retention plots pre- and 1 year post- treatment.

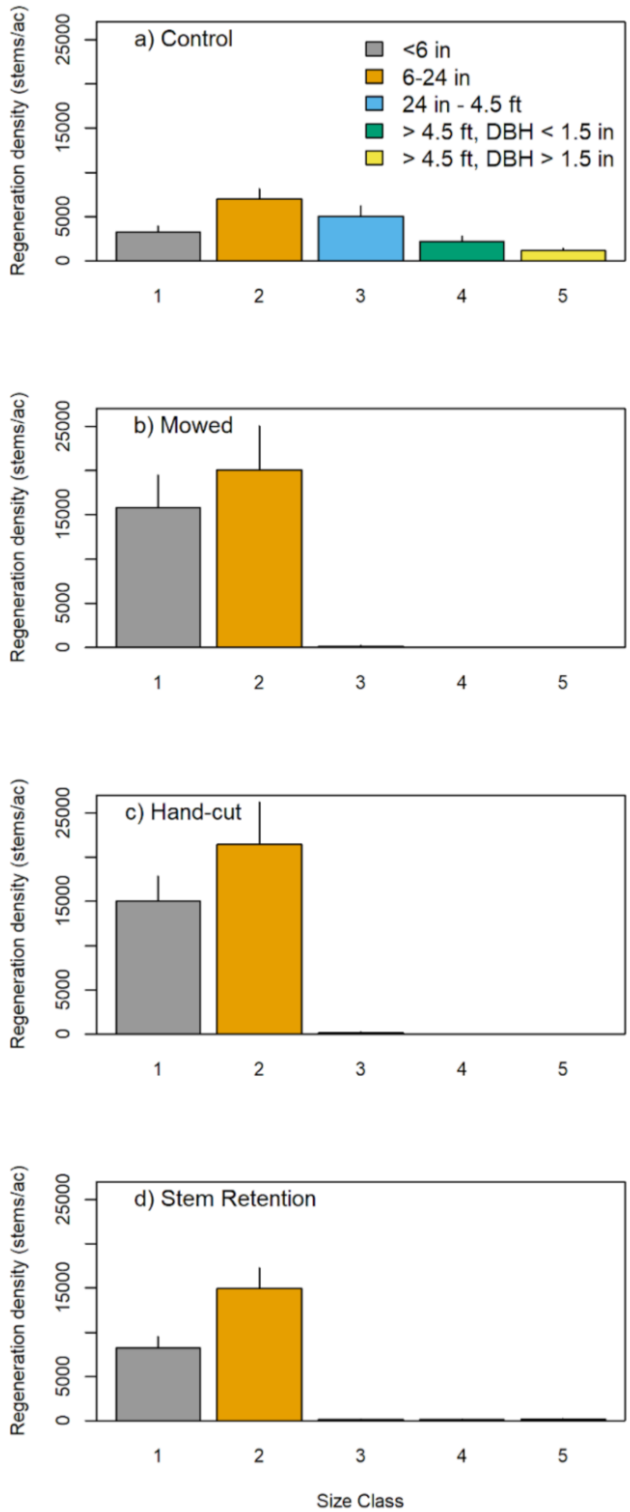

Figure 8: Bar plots depicting mean (±1 standard error of the mean) Gambel oak regeneration density by size class in control, mowed, hand-cut, and stem retention plots. Sample sizes range from 12-15.

Compared to Gambel oak, sagebrush regeneration is much slower following treatment. In the control plots, the density of sagebrush nearly doubled (Figure 9). Some increase in sagebrush density would be expected in control plots, but it is difficult to explain this enormous increase. As previously mentioned, two different observers collected data between pre- and post- treatment, which likely resulted in a measurement error. In all treated plots, the density of sagebrush decreased. The hand-cut treatment had the largest decrease, resulting in sagebrush density one third of pre-treatment density. Mowed and stem retention treatments both resulted in sagebrush density being reduced by approximately half. Studies have found that sagebrush responds slowly to disturbances such as mowing (Davies et al., 2012). Sagebrush stems in the hand-cut and stem retention treatments were generally taller than in the mowed treatment (Figure 10). Because of the precision a chainsaw has relative to a large mower, stem retention treatments allow for less damage to sagebrush.

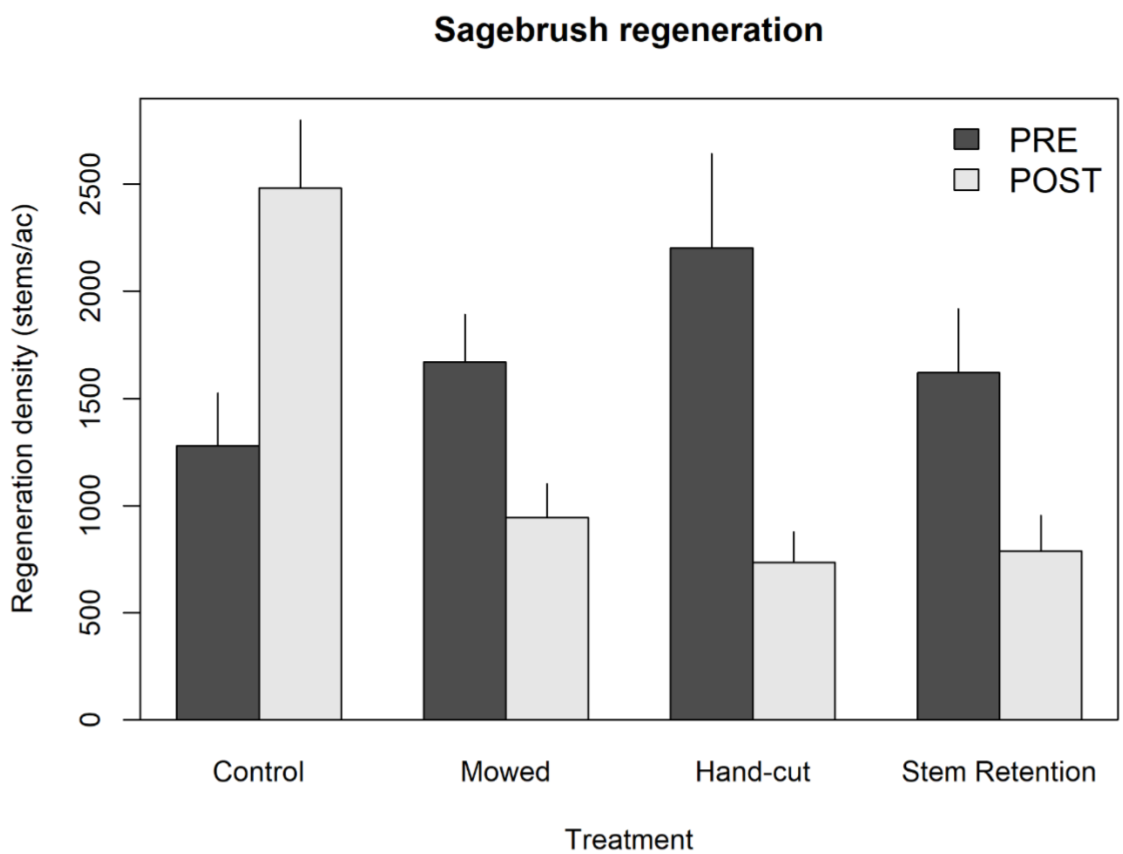

Figure 9: Bar plots depicting mean (±1 standard error of the mean) sagebrush regeneration density (stems/ac) in control, hand-cut, mowed, and stem retention plots pre- and 1 year post- treatment.

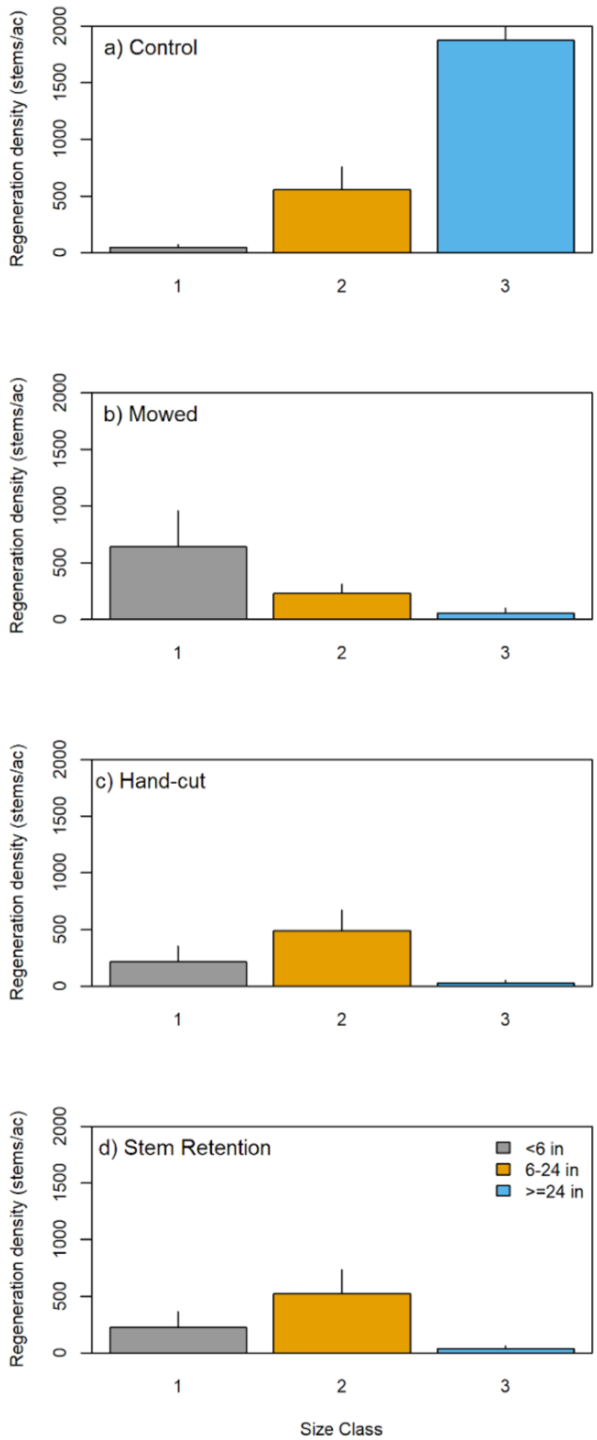

Figure 10: Bar plots depicting mean (±1 standard error of the mean) sagebrush regeneration density by size class in control, mowed, hand-cut, and stem retention plots. Sample sizes range from 9-14.

In mowed plots, there was a large increase in cover of woody debris, particularly in fine wood (Figure 11). Gambel oak plots had minimal cover of fine and coarse wood pre-treatment, with no coarse wood the first year and 1.3% cover of coarse woody debris post-treatment. Fine woody debris increased from 3.3% to 52.9% cover between pre- and post- treatment. Because mowed areas have fairly continuous woody debris, they may be more likely to carry groundfire, which may increase fire hazard potential in sagebrush ecosystems where Gambel oak has been mowed, at least in the short term following mowing. Ground fuel cover was not measured in stem retention or hand-cut plots due to capacity constraints. Little research exists on the effect of fine woody debris on understory vegetation in this system. In nearby piñon-juniper systems, mastication treatments that reduced overstory cover and increased woody debris caused increases in cover of grasses, forbs, and shrubs, with notable increases in non-native richness and cover (Coop et al., 2017).

Pending future funding, remeasurement of these plots could take place. The 2019 visit captured conditions one year following treatment, and another revisit will provide better insight into understory and regeneration trends in this little-studied system.

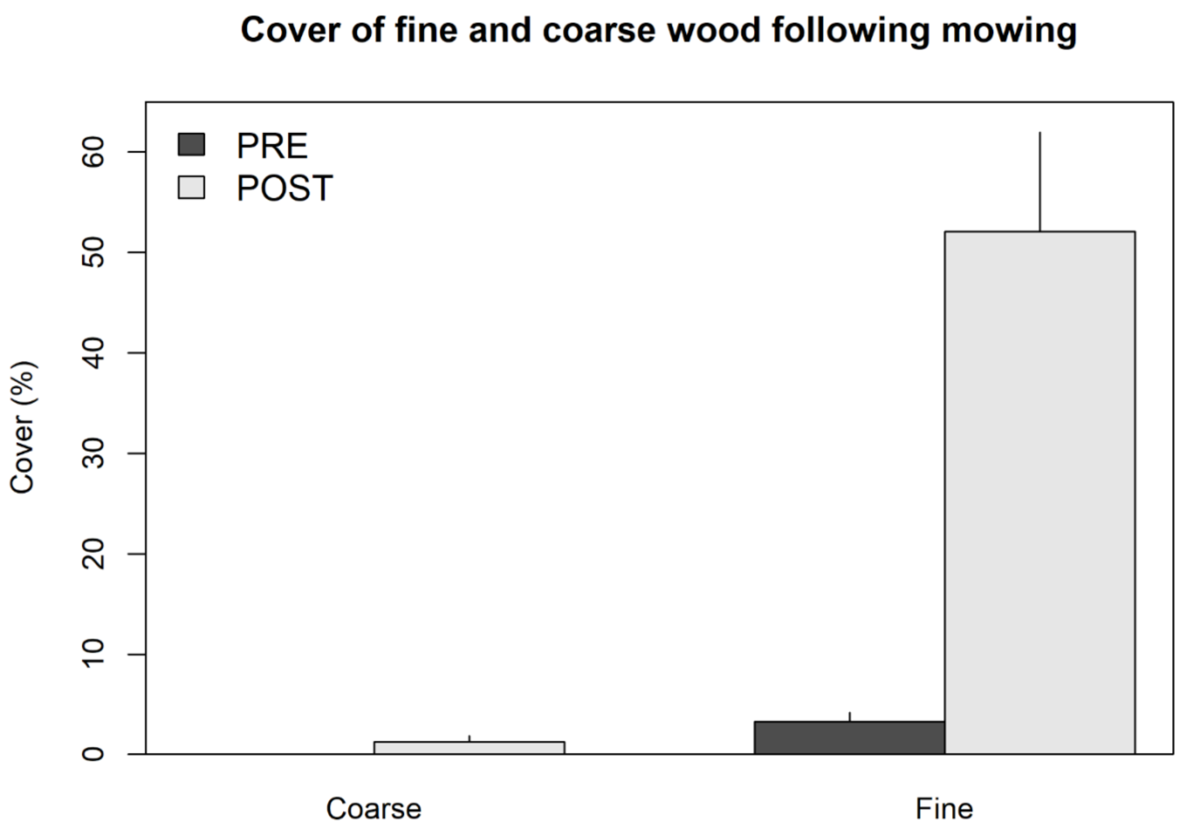

Figure 11: Bar plots depicting mean (±1 standard error of the mean) coarse and fine wood cover pre- and post-mowing treatments. Woody debris with a diameter >3” is considered coarse, and anything smaller than that is considered fine.

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