Effectiveness and cost of shrub removal methods in degraded woodlands being converted to silvopasture

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Abstract. Transforming degraded woodlands to silvopasture is of interest in the Midwestern USA as it increases profitability of farms and benefits animal health. Invasive shrubs within woodlands, however, are a major obstacle to silvopasture establishment. Research was undertaken to evaluate the effectiveness, cost and resulting herbaceous canopy light interception of common brush-control methods when used alone or integrated over a two-year timeframe. Five treatments were established in a randomized complete block design. In the first year, treatments were either forestry mowed (mow) or rotationally grazed by goats (goats) at a stocking density of 5700 to 6000 kg per hectare. In the second year, mow and goat treatments were either grazed by goats again or shrubs were treated with a herbicide (herb). These were compared to a non-treated control. Costs of each treatment were calculated based on labor, equipment/supplies, and contracts. Vegetation composition and herbaceous canopy light interception were evaluated the summer after treatments were implemented. Forestry mowing followed by herbicide was the least expensive treatment at $1833/ha, while goats were 72% higher. Light interception by the herbaceous canopy was not reduced by goats, but mowing followed by goats increased light interception such that it was greater than repeated goat grazing ($p<0.05$). While shrubs were initially impacted by treatments, resprouting resulted in no differences in abundance compared with non-treated controls. Grass abundance was similar in control plots and treatments ($p>0.05$). Forb abundance remained similar in control and goat-grazed treatments but increased in mowed areas. Costs and effectiveness of multi-year treatments will continue to be evaluated through 2024.

Introduction

Transforming degraded woodlands to silvopasture is of interest in the Midwestern USA as it increases profitability of farms and benefits animal health. Invasive shrubs within woodlands, however, are a major obstacle to silvopasture establishment. These shrubs intercept light that prevents the establishment of desirable forages. While common methods are typically used for brush removal, no studies have directly evaluated the cost and effectiveness of shrub control when establishing silvopasture from degraded woodlands. To address this, experiments were established to evaluate the effectiveness, cost and resulting canopy light interception of common brush control methods when used alone or integrated over a two-year timeframe.

Methods and Study Site

Five treatments were established in a randomized complete block design in southern Wisconsin. Plot size was 50 x 40 meters, and plots were established in 2020. In the first year, sixteen plots were either forestry mowed (mow) or rotationally grazed by goats (goats) with the remaining left as controls. In the second year, mow and goat treatments were either grazed by goats again or shrubs were treated with a herbicide (herb) resulting in four replications for each treatment. Goat grazing was conducted twice in 2021 and 2022, at a stocking density of 5700 to 6000 kg per hectare where goats were allowed to browse for 28-34 days until woody leaves were 99% eaten. Mowing occurred in the winter of 2021-22 where all woody plants 13 cm diameter or less were shredded to the soil surface. A herbicide (Remedy Ultra) was applied to individual shrubs in August 2022, using foliar (5% solution in water) and cut stump methods (25% solution in basal bark oil).

Abundance of understory vegetation was evaluated by randomly placing a 1 x 1 m quadrat throughout each plot 20 times in June 2021 and June 2022, before the application of 2022 treatments. Presence or

absence of understory species and woody plants < 5 cm diameter was recorded, and plants were categorized as shrubs, grasses, and forbs. Photosynthetically active radiation (PAR) was measured using a ceptometer that was placed at the top of the herbaceous plants. Twenty four measurements were taken per plot in June, August and September 2022. Measurements were also taken outside the plots in full sun and used to calculate the percent light interception by the canopy. Costs of each treatment were calculated based on labor, equipment/supplies, and contracts. Labor in the grazing treatment included the set up and removal of electric fence. In the herbicide treatment, it included application of herbicide and cutting of shrubs. Analysis of variance was performed on light interception and vegetation abundance using PROC MIXED procedure in SAS with treatment as fixed effect and block as random effect. Comparisons of means were conducted using LSD test and were considered significant when $p \leq 0.05$.

Results and Discussion

Light interception

Light interception was not reduced by goats but mowing resulted in 17% greater light interception in early summer ($p < 0.05$). However, during the growing season vegetation resprouted and by August there were no significant differences. In September, after the second-year treatments were applied, minor differences were found among management approaches, but all treatments were similar to the control.

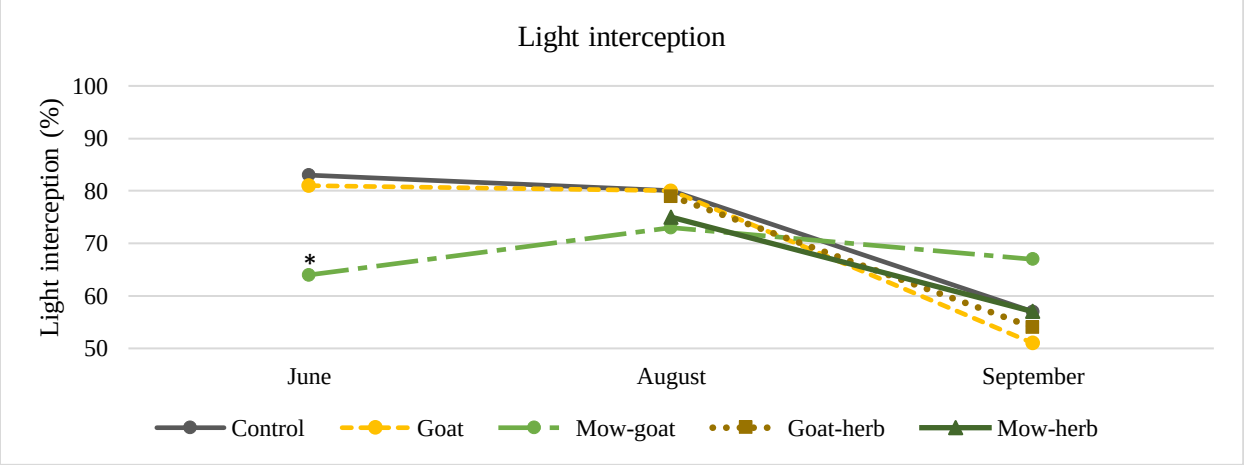

Figure 1. Light interception of the herbaceous canopy as a result of treatments. The asterisk shows significant differences with the control ($p < 0.05$).

Plant Class Abundance

At the initiation of the experiment shrub (73%), grasses (71%) and forbs (99%) were abundant in the understory. After first year treatments were applied, abundance of brush decreased between 11-27% but did not differ among treatments ($p>0.05$) (Figure 2a). Grass abundance remained similar in control plots. While it increased in mowed and goat treatments it was not significantly different than the control ($p>0.05$). Forb abundance remained similar in control and goat-grazed treatments but increased in mowed areas. Increase in forb abundance in mowed areas is likely from increased light available in spring following mowing in the first year.

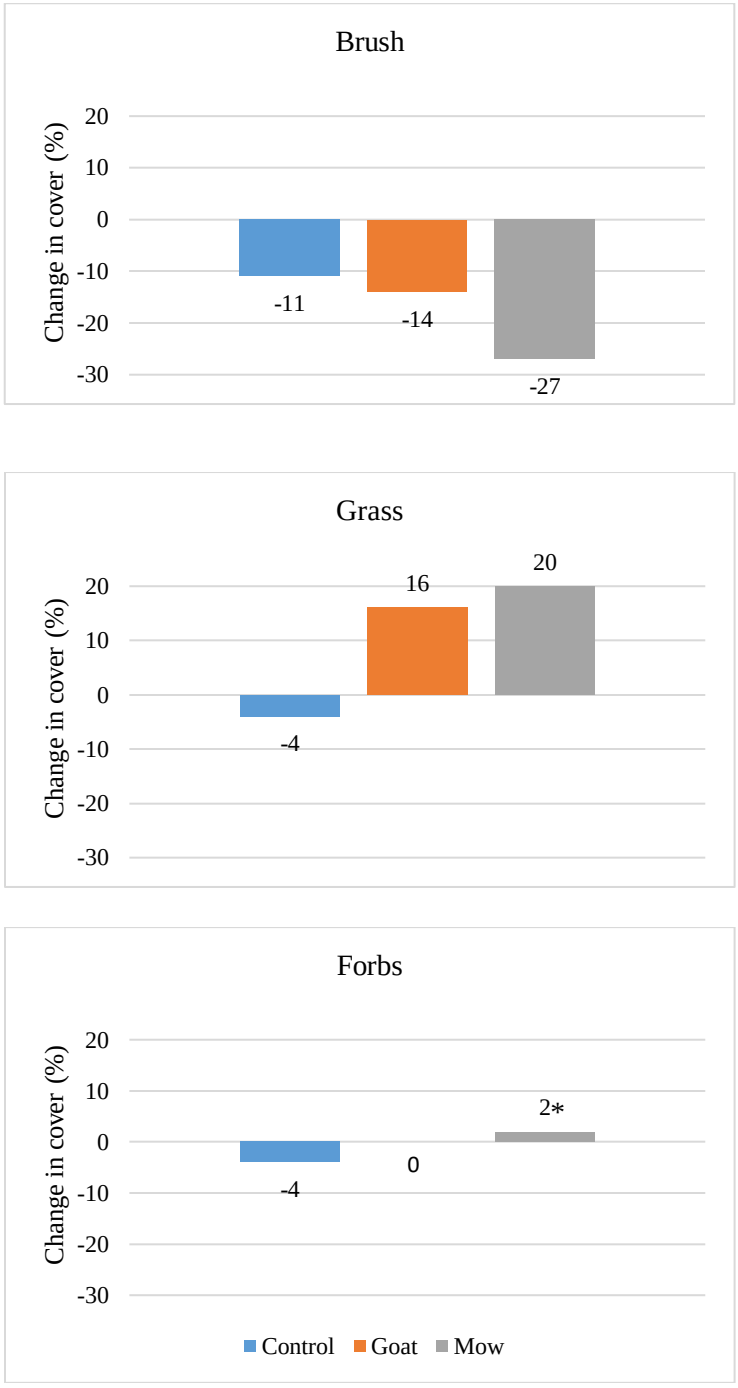

Figure 2. Change in vegetation abundance between 2022 and 2021. The asterisk shows significant differences with the control ($p < 0.05$).

Cost

Costs estimated for management include supplies and labor cost and are summarized over two years. Forestry mowing followed by herbicide was the least expensive treatment, costing $1833/ha, and the most expensive treatment was goat grazing, at $6730/ha. Costs from goat grazing were mostly from the contract with a grazer. This cost would be reduced if a farmer owned goats that could be used for brush control. Figure 3 shows the cost per hectare of the different treatments.

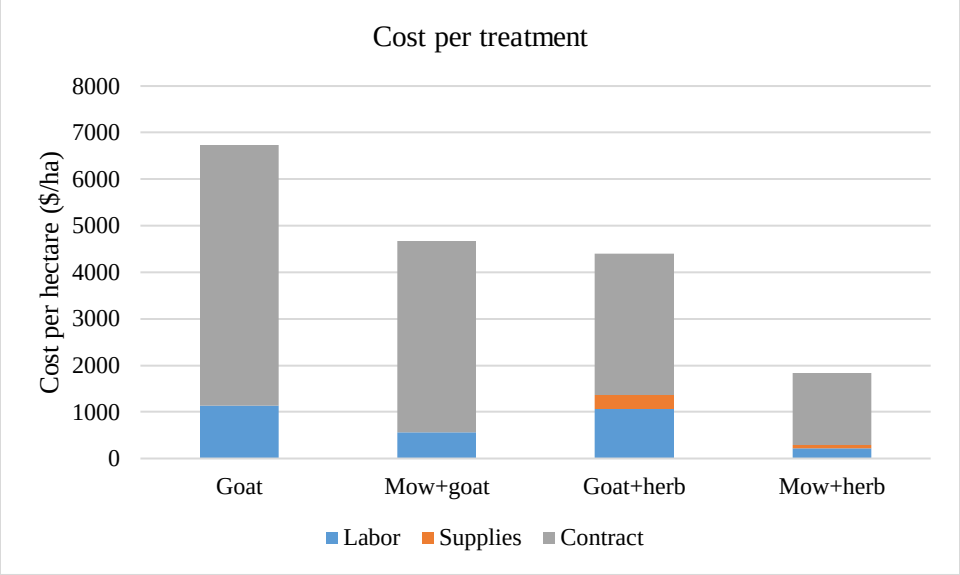

Figure 3. Cost per hectare for the different treatments in years 2021 and 2022.

Conclusions

Continued application of treatments will be necessary to observe differences in light interception and vegetation cover. Transforming degraded woodlands to silvopasture is a long-term effort, and costs vary according to the method chosen. Grass cover increase due to treatments was not to support its use as forage, therefore the grass will be seeded in Spring 2023. Costs and effectiveness of multi-year treatments will continue to be evaluated through 2024.