Combined Herbivory by Targeted Sheep Grazing and Biological Control Insects to Suppress Spotted Knapweed

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IMPACT STATEMENT

Biological control insects alone can suppress spotted knapweed in places where few spotted knapweed seedlings establish and transition to adult plants. However, the use of biological control insects likely needs combined with targeted livestock grazing to suppress spotted knapweed wherever spotted knapweed seedlings and juvenile plants thrive.

SUMMARY

Biological control insects are useful tools for suppressing spotted knapweed, but biological control insects have not achieved widespread suppression of this noxious weed in North America. We investigated whether targeted sheep grazing and biological control insects applied together would provide greater control of spotted knapweed than biological control insects alone. We evaluated 3 treatments: 1) biological control insects only, 2) biological control insects + targeted sheep grazing applied in late July, and 3) biological control insects + targeted sheep grazing applied in mid-August. After 4 years of treatment, spotted knapweed plant density was 86% less in July-grazed areas and 61% less in August-grazed areas than in areas treated with biological control insects alone. Treatment with biological control insects alone reduced adult plant density of spotted knapweed but did not prevent compensatory recruitment by seedlings and juvenile plants. Combined herbivory by targeted sheep grazing and biological control insects similarly reduced adult plant density of spotted knapweed, but combined herbivory by targeted sheep grazing and biological control insects also prevented compensatory recruitment by spotted knapweed.

INTRODUCTION

Spotted knapweed (*Centaurea stoebe*) is a non-native, perennial noxious weed that currently infests more than 7.4 million acres of North American rangeland in 46 US states and 7 Canadian provinces. Previous research has documented that the knapweed root weevil (*Cyphocleonus achates*), the knapweed flower weevil (*Larinus minutus* and *Larinus obtusus*), and the sulfur knapweed root moth (*Agapeta zoegana*) can suppress spotted knapweed (Knochel et al. 2010; Gayton and Miller 2012; Story et al. 2006). However, despite localized successes in Colorado, British Columbia, and Montana, biological control insects have not achieved widespread suppression of spotted knapweed in North America and it continues to spread exponentially (Duncan 2005).

One opportunity to increase the efficacy of biological control insects is to combine them with targeted livestock grazing. Previous research and application has demonstrated that targeted sheep grazing can suppress spotted knapweed (Olson et al. 1997). Targeted sheep grazing is best applied when spotted knapweed is in either the late bud-early flower stage or the full-flower stage (Benzel et al. 2009; Henderson et al. 2012; Surber et al. 2011; Thrift et al. 2008).

It is unknown whether targeted sheep grazing and biological control insects applied together provide greater control of spotted knapweed than biological control insects alone.

PROCEDURES

Our field experiment was conducted on foothill rangeland of the Salish Mountains near Polson, MT. The knapweed root weevil, the knapweed flower weevil, and the sulfur knapweed root moth were prevalent on the study site. We applied targeted sheep grazing during 4 consecutive years. Four small pastures were grazed by sheep when spotted knapweed was in the late bud-early flower stage (late July treatment), and four small pastures were grazed when spotted knapweed was in the full-flower stage (mid-August treatment). Consequently, we applied targeted sheep grazing each year before spotted knapweed had produced viable seeds. Four other small pastures were not grazed by sheep, representing the effects of biological control insects alone.

We measured spotted knapweed plant density in all 12 pastures immediately before the July grazing treatment each year. We collected spotted knapweeds seeds in late August each year before spotted knapweed seed-heads dehisced. In the laboratory, we counted spotted knapweed seeds and tested them for viability.

RESULTS AND DISCUSSION

Targeted sheep grazing removed 96% and 98% of spotted knapweed buds, flowers, and seed-heads in July and August, respectively, and spotted knapweed produced 93% to 98% fewer total seeds and 96% to 99% fewer viable seeds in sheep-grazed areas than in areas treated with biological control insects alone. Seed production by spotted knapweed in the sheep-grazed areas averaged 2 seeds per square foot, below the threshold of 4 seeds per square foot needed for a spotted knapweed population to sustain itself. In contrast, total seed production by spotted knapweed averaged 46 seeds per square foot in areas treated with biological control insects alone, well above the minimum amount needed for a spotted knapweed population to sustain itself.

After 4 years of treatment, total spotted knapweed plant density (seedlings, juvenile, and adult plants) was 86% less in July-grazed areas and 61% less in August-grazed areas than in areas treated with biological control insects alone. Much of this reduction occurred among spotted knapweed seedlings and juvenile plants. While the biological control insects primarily attacked the roots and seed-heads of adult spotted knapweed plants, the sheep readily consumed the buds, flowers, and seed-heads of the adult plants and also consumed spotted knapweed seedlings and juvenile plants.

Treatment with biological control insects alone reduced adult plant density of spotted knapweed but did not prevent compensatory recruitment by seedlings and juvenile plants. Combined herbivory by targeted sheep grazing and biological control insects similarly reduced adult plant density of spotted knapweed, but combined herbivory by targeted sheep grazing and biological control insects also prevented compensatory recruitment by spotted knapweed. Our results and those of Maines et al. (2013a, b) indicate that biological control insects alone can suppress spotted knapweed in places where few spotted knapweed seedlings establish and transition to adult plants. However, the use of biological control insects likely needs combined with targeted livestock grazing to suppress spotted knapweed wherever spotted knapweed seedlings and juvenile plants thrive. Complete details about our study are published in Mosley et al. (2016).

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