

Evaluation of Plant Community Changes on Knapweed Plots after Hand-pulling and Seeding

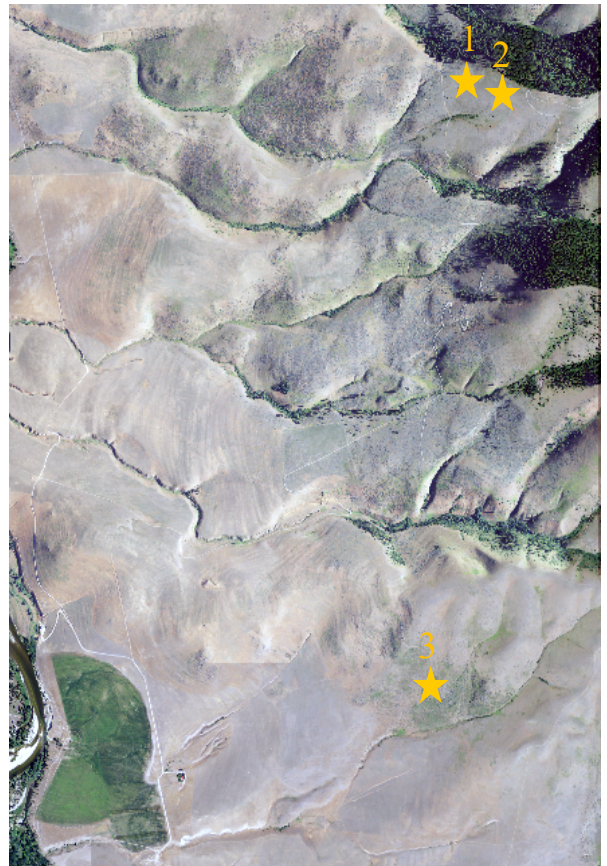
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Options for controlling spotted knapweed include herbicides, pulling by hand, selective grazing, biological control, and establishment of plant competitors (Knochel and Seastedt, 2009).

Herbicide treatments alone rarely result in long-term spotted knapweed control and can increase spotted knapweed abundance by reducing competition (Knochel and Seastedt, 2009). Properly timed mowing, analogous to grazing, can reduce spotted knapweed abundance (Story, 2002) but can stimulate seed production (Story et al., 2010). Hand-pulling is labor intensive and must be repeated often to eliminate seed production. Biological control has had some success and there is evidence suggesting that knapweed root weevils are responsible for spotted knapweed declines on low elevation sites in the Bitterroot Valley (Story et al., 2006). Spotted knapweed control can be increased when different methods are integrated.

Native plant communities are often impoverished on sites where spotted knapweed is abundant. This may result in seed limitations for native species establishment. Plots were established in 2010 to evaluate the efficacy of hand-pulling spotted knapweed and seeding in areas where knapweed root weevils are abundant (Staff Folders/Dan Mummey - Range restoration/Knapweed studies/knapweed plot3.pdf and knapweed plot3.pdf).

Mixtures of native grass, forb and shrub species were sown to determine which species establish and compete with spotted knapweed. Spotted knapweed was pulled on all plots in the summer of 2010 and again following plant community analysis in 2011. Seeds were broadcast in the fall of 2010. Plant communities were evaluated on all plots in the summer of 2010 and again in 2011.



Knapweed study plot locations

Summary of results

- Spotted knapweed cover decreased on two of three sites following hand-pulling.
- No native or introduced species other than spotted knapweed decreased significantly.
- Some native and introduced ruderal species increased after hand-pulling (figs p 4-6).
- Although most seeded species were observed in all study areas, Lewis flax was the only seeded species that increased significantly.



Fringed sage growing with spotted knapweed. Few other native species are present.

Discussion

Potential explanations for low seedling recruitment on our study plots include unfavorable conditions facilitated by spotted knapweed (i.e. soil physical and/or chemical conditions), unfavorable climate, seeds not finding safe sites, inappropriate plant materials, and seed predation. Most of these issues can be addressed by increasing the number of seeds sown. We will sow the same seed mixes into all study plots this fall at high rates (200 to 300 seeds ft⁻²) to increase the likelihood that at least some seeds will find safe sites and escape seed predators.

Little is known about what species are the best competitors with spotted knapweed and functional traits that confer resistance to knapweed invasion are not well characterized. A few groups have examined traits that confer resistance to allelopathic chemicals purportedly produced by spotted knapweed (e.g. Callaway et al., 2004; Perry et al., 2005; Alford et al., 2009). However, results of these lab and greenhouse studies have yet to be transferred to the field.

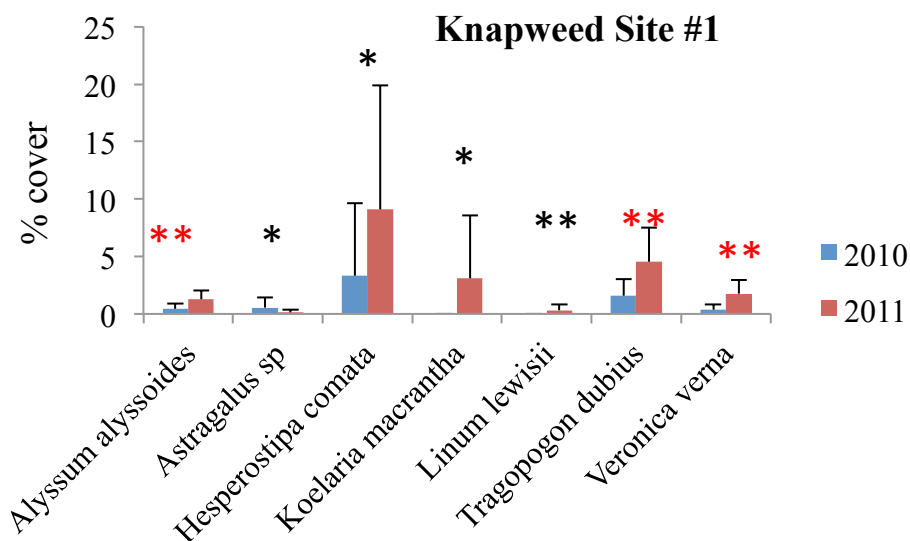
Different grass species or cultivars are known to differ in their ability to compete with spotted knapweed (Lesica and Atthowe, 2007). A few forbs and shrubs show promise. Lewis flax is reported to be a strong competitor against spotted knapweed (Callaway et al., 2004) and cheatgrass (Stevens and Monsen, 2004). Rapid establishment and spread allows the plant to fill open interspaces. The species may be valuable for capturing sites from spotted knapweed. Blanketflower is also reported to compete well with spotted knapweed (Callaway et al., 2004) and with other weed species when oversown (Simmons, 2005).

A strategy for selection of knapweed competitors is to observe which species are able to establish naturally in spotted knapweed patches. Legumes are often present in spotted knapweed patches and can at least resist spotted knapweed (Ridenour and Callaway, 2001). Fringed sage is common on spotted knapweed influenced sites on the ranch; however, the extent to which the species competes with knapweed is not known.

Herron et al., (2001) showed that annual rye can shift the competitive balance away from spotted knapweed towards bluebunch wheatgrass, presumably by tying up labile nutrients.

Annual sunflowers, and other allelopathic native species, may have value for reducing weed biomass (Perry et al., 2009) but have not been evaluated as knapweed competitors.

Figures on the next three pages compare abundance of the native, weedy, and planted species in the knapweed control plots between 2010 and 2011. Only significant results are shown. At site #1 the weeds that increased were mustard, salsify, and veronica. Two native grasses (needle and thread grass and june grass) increased. We broadcast a mix of native seeds at these plots, but only flax established in a measurable quantity.



* Native species ($P < 0.05$) * Introduced ($P < 0.05$)
 ** Native species ($P < 0.005$) ** Introduced ($P < 0.005$)

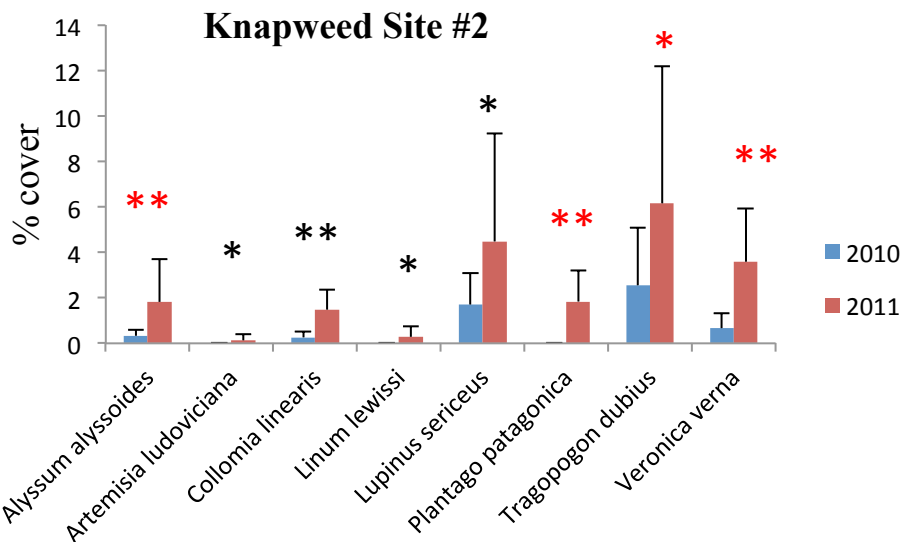
Differences in spotted knapweed cover between years were not significant ($F = 1.79$; $P = 0.189$).

Seeded species establishment

Lewis flax increased on seeded plots in 2011 ($F = 9.82$; $P < 0.001$). Differences between treatments were not significant for seeded species other than Lewis flax in 2011.

<i>Alyssum alyss.</i>	Mustard	Weed
<i>Astragalus sp</i>	Vetch	Native
<i>Hesperostipa com.</i>	Needle and Thread	Native
<i>Koeleria mac.</i>	June Grass	Native
<i>Linum lewisii</i>	Flax	Planted
<i>Tragopogon dub.</i>	Salsify	Weed
<i>Veronica verna-</i>	Veronica	Weed

At site #2 several weeds (mustard, white sage, plantain, and veronica) increased in the pulled plots as did trumpet flower, and lupine. The planted flax again was able to establish.



* Native species ($P < 0.05$) * Introduced ($P < 0.05$)
 ** Native species ($P < 0.005$) ** Introduced ($P < 0.005$)

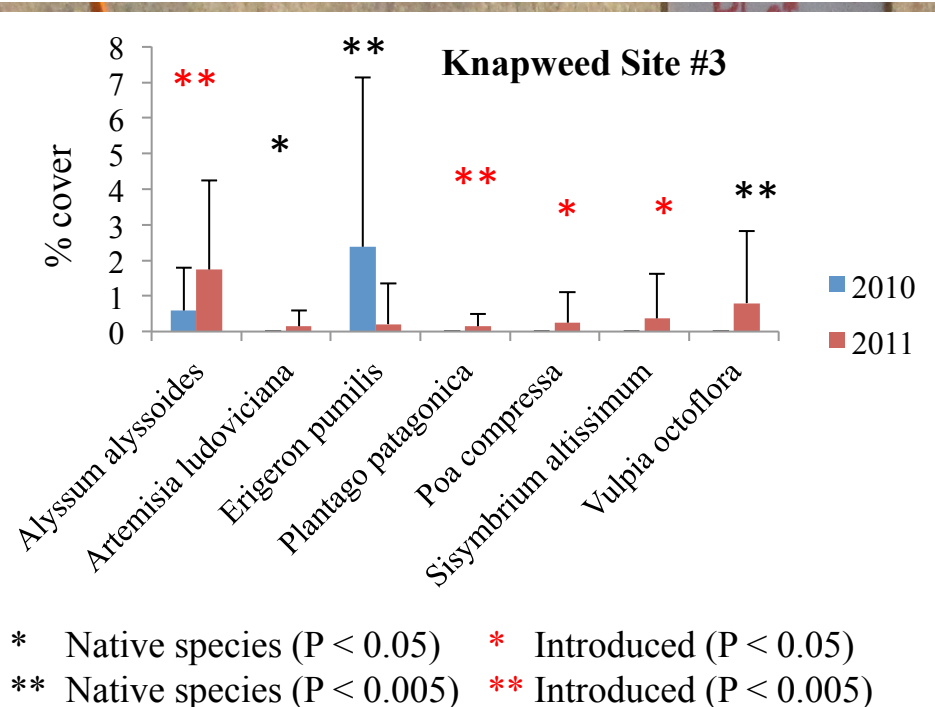
Spotted knapweed cover decreased from 28% in 2010 to 24% in 2011 ($F = 5.0$; $P = 0.03$).

Seeded species establishment

Lewis flax increased significantly in plots where it was planted in 2011 ($F = 5.47$; $P = 0.006$). Differences were not significant between treatments for other seeded species.

Alyssum alyss.	Mustard	Weed
Artemesia ludo.	White sage	Weed
Collomia linear.	Trumpet flower	Native
Linum lewisii	Flax	Planted
Lupinus seric.	Silky lupine	Native
Plantago patag.	Plantain	Weed
Tragopogon dub.	Salsifly	Weed
Veronica verna	Veronica	Weed

At site #3 we again saw non-natives moving in to occupy niches vacated by the pulled knapweed. Mustard, white sage, plantain, and bluegrass increased. One native flower, fleabane daisy decreased, and a small native fescue increased. None of the seeded species established.



Spotted knapweed cover decreased from 30% in 2010 to 25% in 2011 ($F = 5.58$; $P = 0.02$).

Seeded species establishment

No significant differences were found in plant species abundance, including seeded species, between different seed treatments in 2011.

Alyssum alyss.	Mustard	Weed
Artemesia ludo.	White sage	Weed
Erigeron pumil.	Fleabane daisy	Native
Plantago patag.	Plaintain	Weed
Poa compressa	Canadian bluegrass	Weed
Sisymbrium alti.	another Mustard	Weed
Vulpia octoflora	little fescue	Native

New Experiments

We set up three experimental plots to examine additional plant materials for spotted knapweed competition. Sites were selected to represent a range of conditions where spotted knapweed has been successful. As for knapweed plots 1, 2, and 3, high seeding rates (200 seeds / ft²) will be used. In addition to broadcast seeding, which has disadvantages to drill-seeding, seeds will be drilled into the corner of each plot.

Rational for plant materials selection on Sheepcamp and the high elevation sites are discussed previously. The lower site is a harsh south-facing slope. Plant materials for this site were selected because they are present on or near the site, or can establish under harsh conditions.



Sheepcamp and upper site plant materials

Lewis flax
Western yarrow
Blanket flower
Fringed sage
Silky lupine
Annual sunflower
Annual rye

Lower site plant materials

Needle and thread
Thickspike wheatgrass
Fringed sage
Western yarrow
Annual sunflower

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