



Comparing Natural Area Herbicides for Residual Weed Control and Native Species Tolerance



Rachel Seedorf, Shannon Clark, Derek Sebastian, Scott Nissen, Jim Sebastian
Department of Bioagricultural Sciences and Pest Management, Colorado State University, Fort Collins, CO

Abstract

Downy brome (*Bromus tectorum* L.) is a competitive winter annual grass species, and is considered one of the most problematic invasive species in natural areas. A field trial was conducted to evaluate native species tolerance to indaziflam and other currently recommended herbicides used for downy brome (*Bromus tectorum* L.) and Dalmatian toadflax (*Linaria dalmatica* L.) control. A total of 10 herbicide treatments were applied at two separate locations. For each native species, total counts were conducted 1 and 2 years after treatment (YAT) across the entire plot area and analyzed as an increase or decrease compared to the non-treated control plots. Total species richness, downy brome control, and perennial grass response were also evaluated 1 and 2 YAT. Indaziflam treatments (5 and 7 oz/A) increased native species richness and provided 95-100% downy brome control. Imazapic treatments provided limited downy brome control and failed to increase species richness in treated plots compared to non-treated plots. Aminocyclopyrachlor and picloram treatments resulted in a significant reduction in species richness, with up to a 40% decrease compared to non-treated plots.

Rationale and Objectives

- Downy brome invasions have resulted in decreased species diversity, increased fire frequency, increased soil erosion, and depleted soil moisture and nutrients.
- Current herbicides being used have been inconsistent in providing long-term downy brome control and have injured native grasses and forbs.
- The main objective of this research was to evaluate desirable native grass, forb, and shrub response to Esplanade (indaziflam), Plateau (imazapic), Tordon (picloram), and Method (aminocyclopyrachlor).
- This research was also conducted to determine which herbicides provide long-term downy brome and Dalmatian toadflax control.

Methods

- Two sites consisting of downy brome and Dalmatian toadflax with a diverse native understory (grasses, forbs, shrubs) were established in 2015.
- 10 treatments and a non-treated control: Esplanade (indaziflam - 3.5, 5, 7 oz/A), Plateau (imazapic - 6 oz/A), Tordon (picloram - 32 oz/A), Method (aminocyclopyrachlor - 4 oz/A), Esplanade (7 oz/A) + Tordon, Esplanade (7 oz/A) + Method, Method + Plateau, and Plateau + Tordon
- Applied in June while native grasses, forbs and shrubs were actively growing.
- All treatments were applied as an RCB to 3 x 6 m plots with six replications
- All treatments were applied with a CO₂ pressurized backpack sprayer using 11002LP flat fan nozzles, calibrated to deliver at 187 L·ha⁻¹ at 207 kPa.
- All statistical analysis was performed in R; native species abundance was analyzed using PERMANOVA; species richness was analyzed using GLM; downy brome cover was analyzed using one-way ANOVA. Pairwise comparisons of means with a Tukey adjustment are represented by unique letters on the graphs.

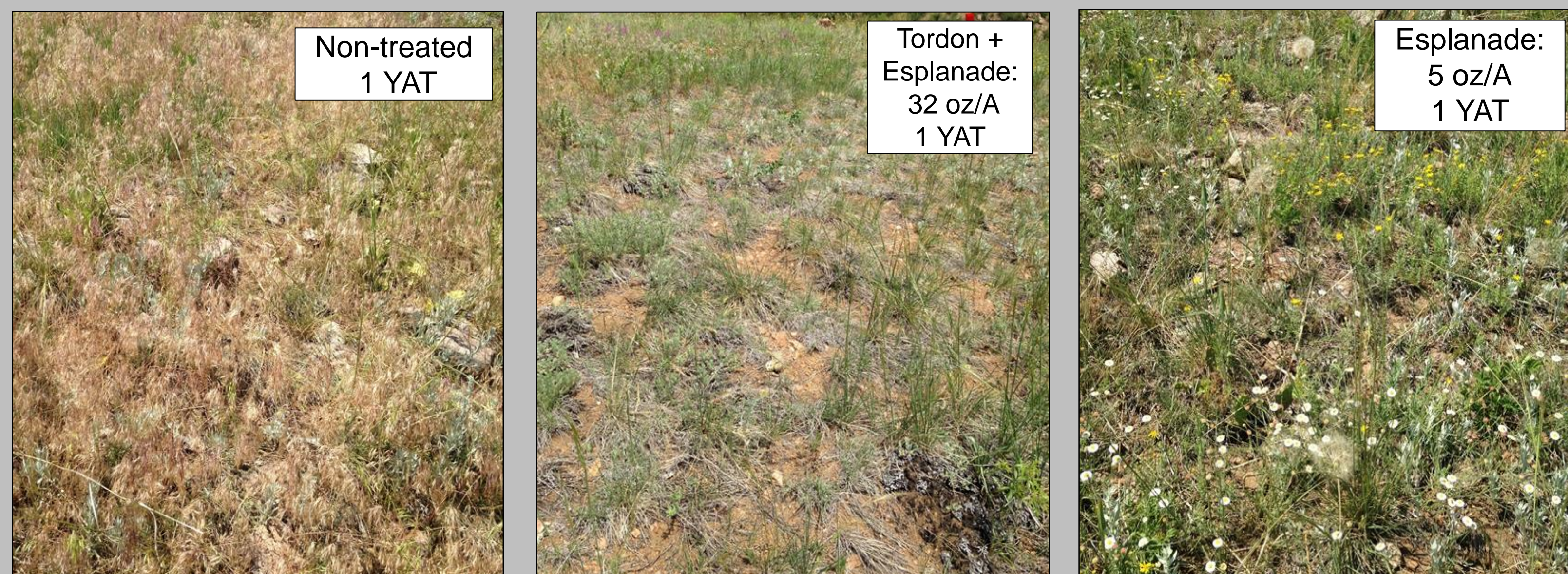


Figure 1. Species diversity occurring in the non-treated, Tordon, and Esplanade treatments 1 YAT.

Results

Native Species Abundance Sites 1 and 2: All combinations that included Tordon significantly ($\alpha < 0.05$) impacted native species abundance at Boulder and Golden sites. At the Golden site, all combinations that also included Method significantly ($\alpha < 0.05$) impacted community species abundance.

Downy Brome Control Site 2: Treatments containing Esplanade (at all rates) significantly reduced downy brome for 1 and 2 YAT, compared to the non-treated check and other treatments. Site 1 had inconsistent downy brome in the check plots therefore the data was not able to be analyzed.

Species Richness Sites 1 and 2: Combinations that included Tordon significantly impacted species richness at Boulder and Golden 1 YAT.

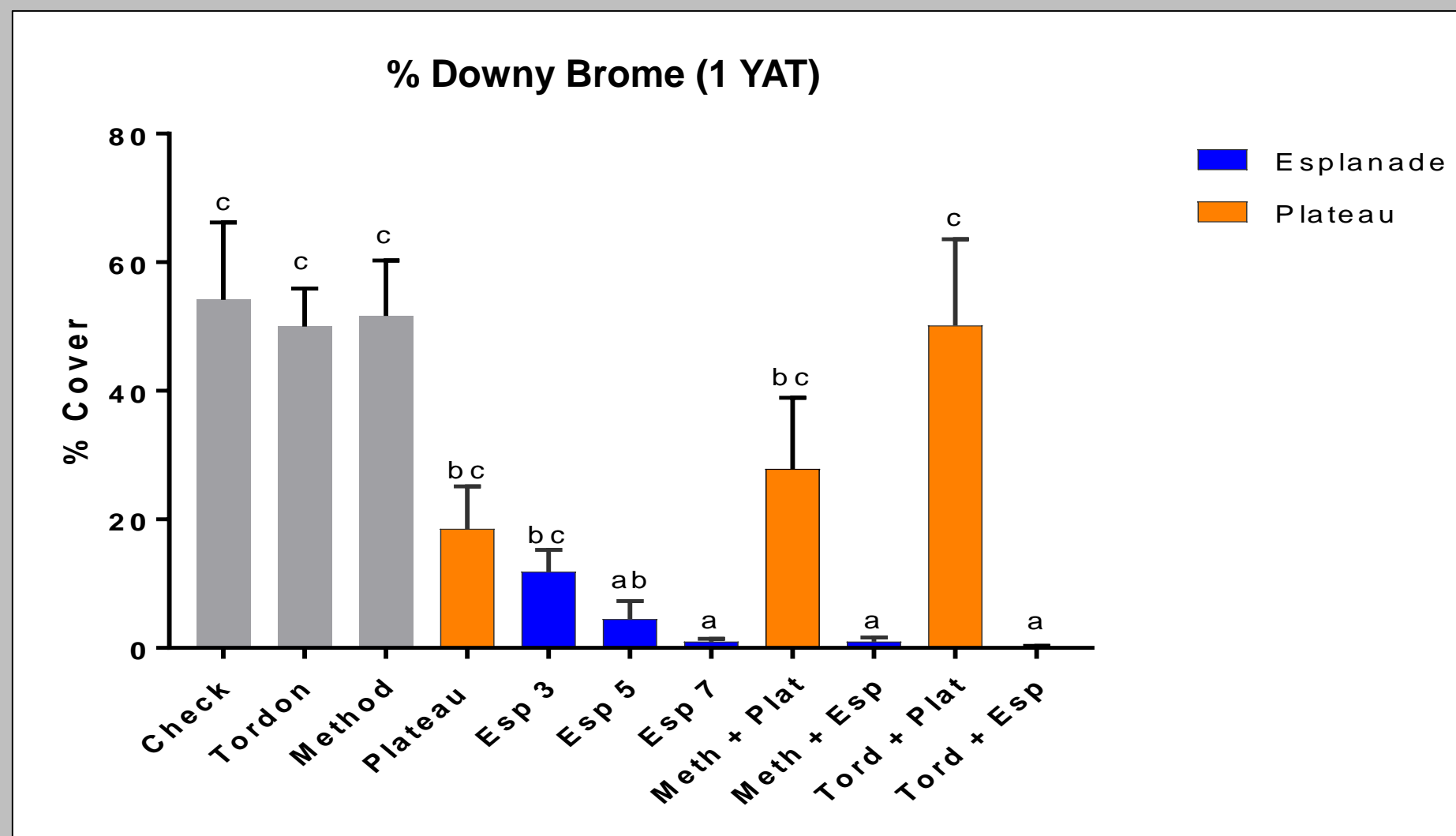


Figure 2. Percent downy brome cover at Boulder site 1 YAT.

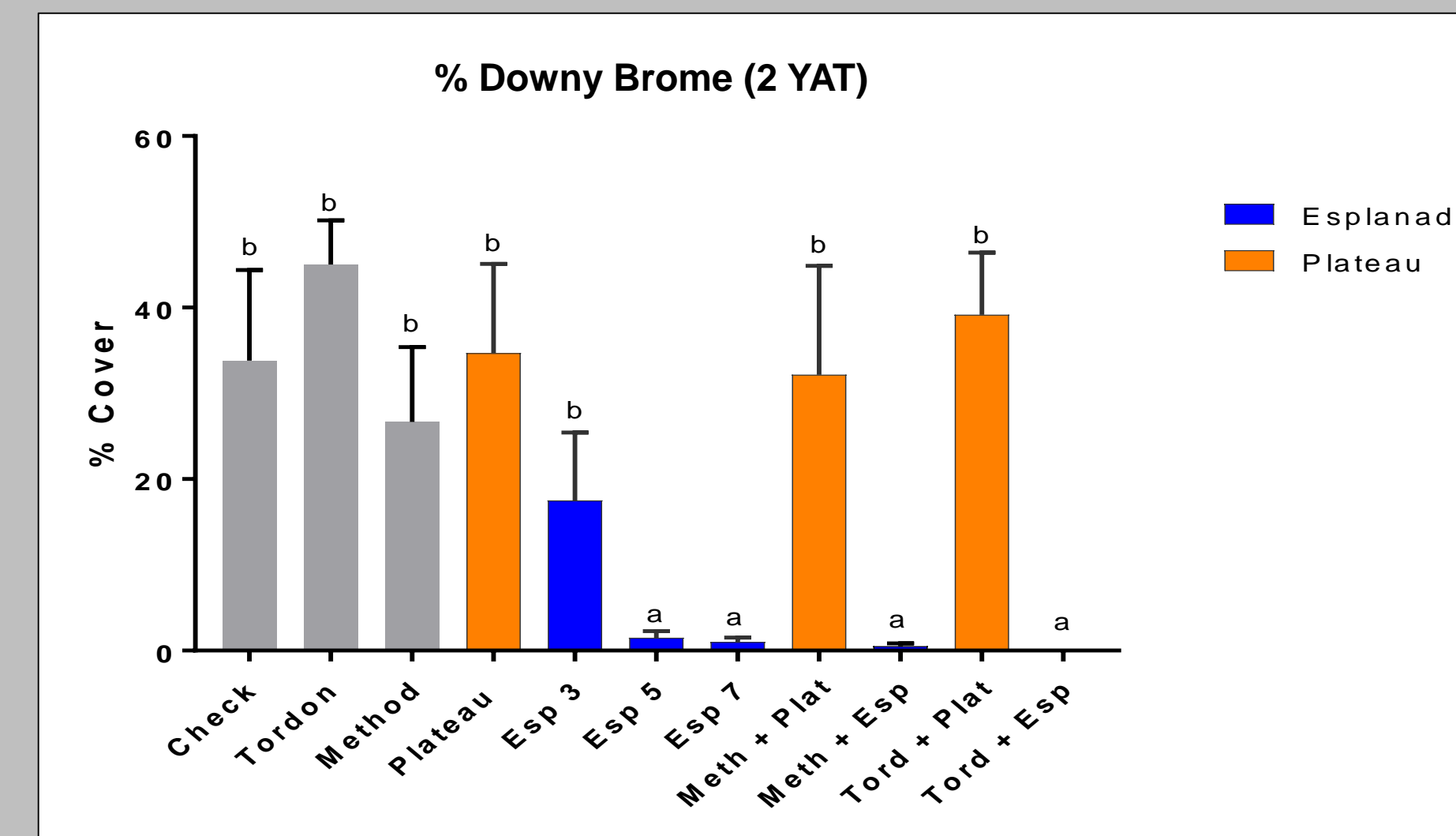


Figure 3. Percent downy brome cover at Boulder site 2 YAT.

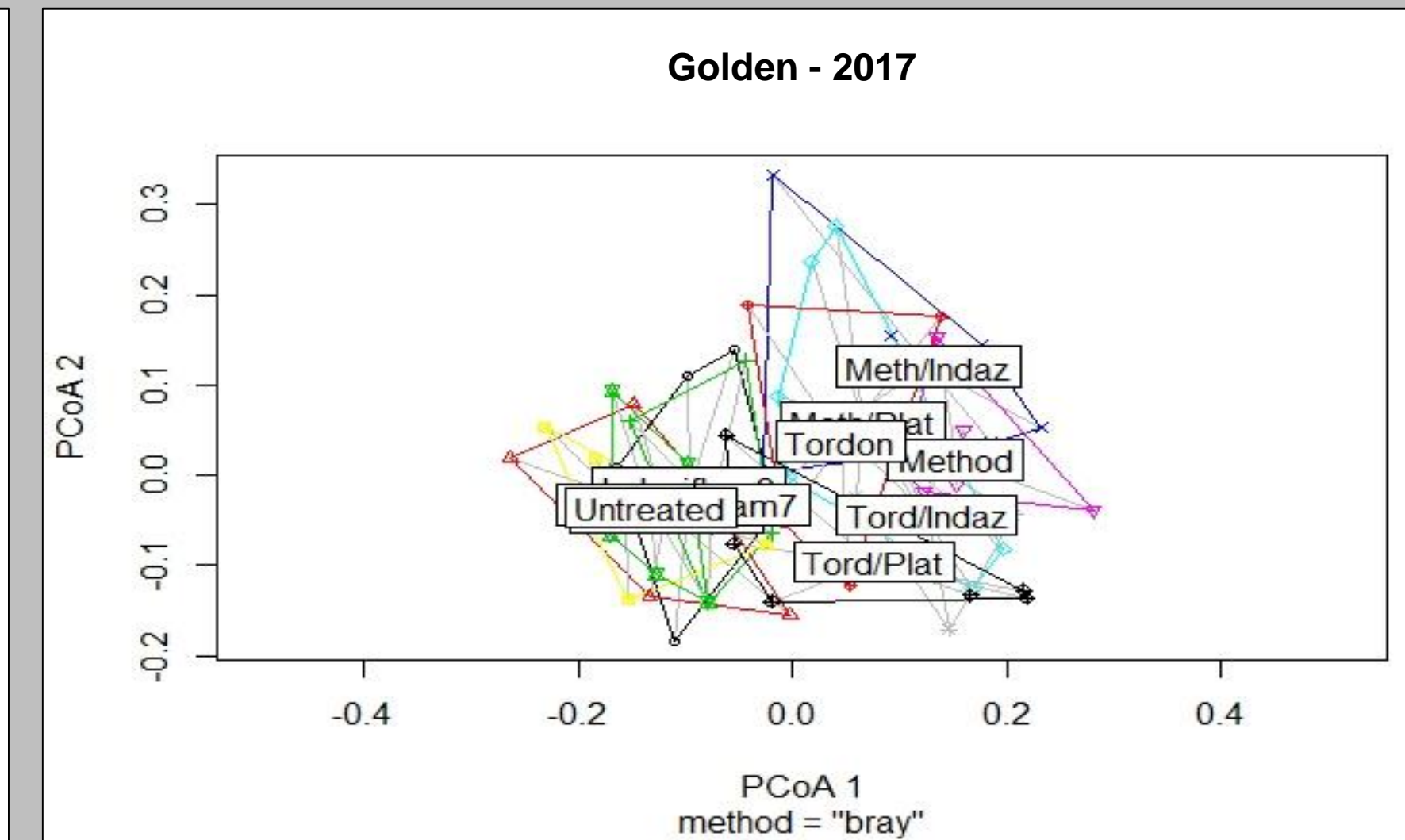
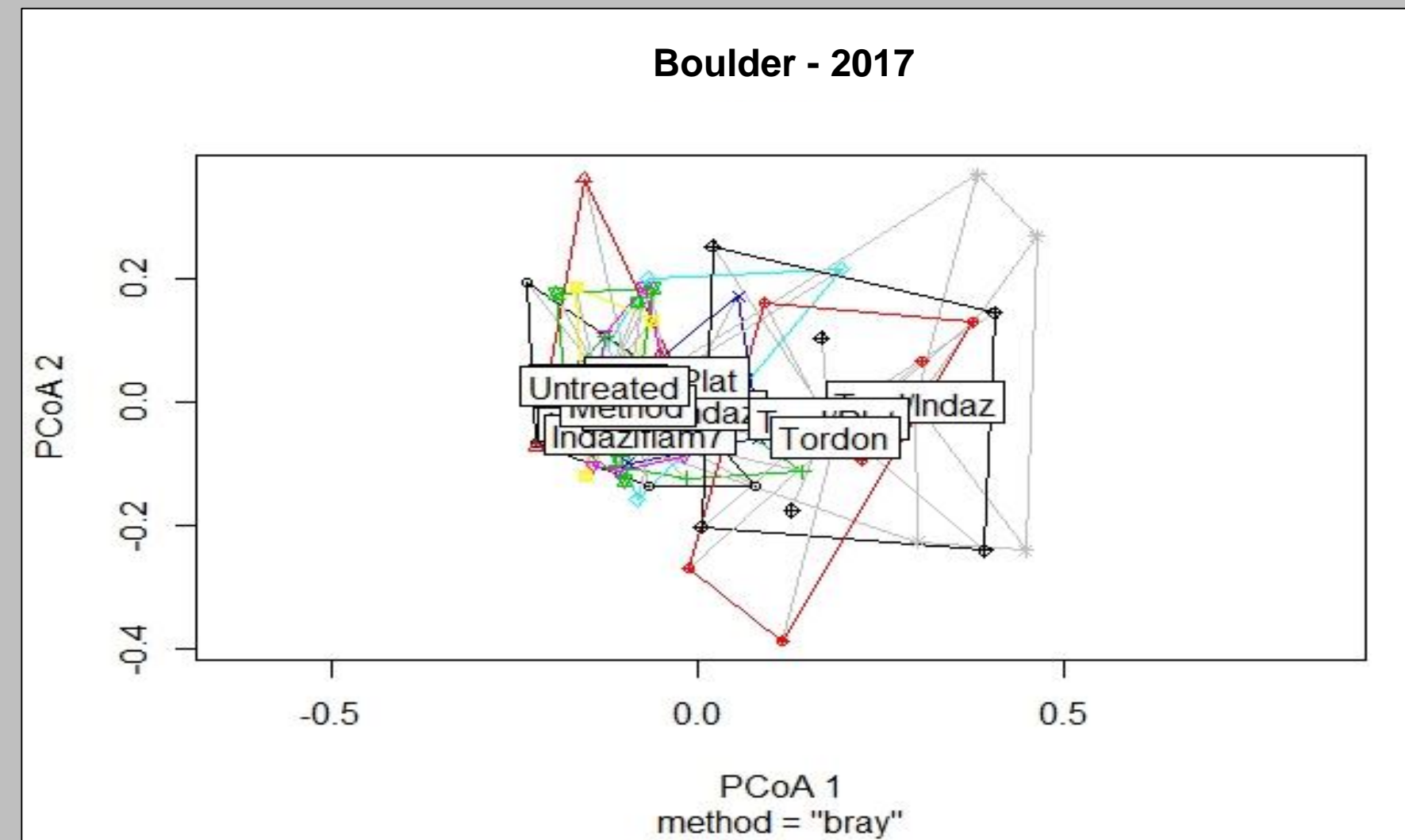
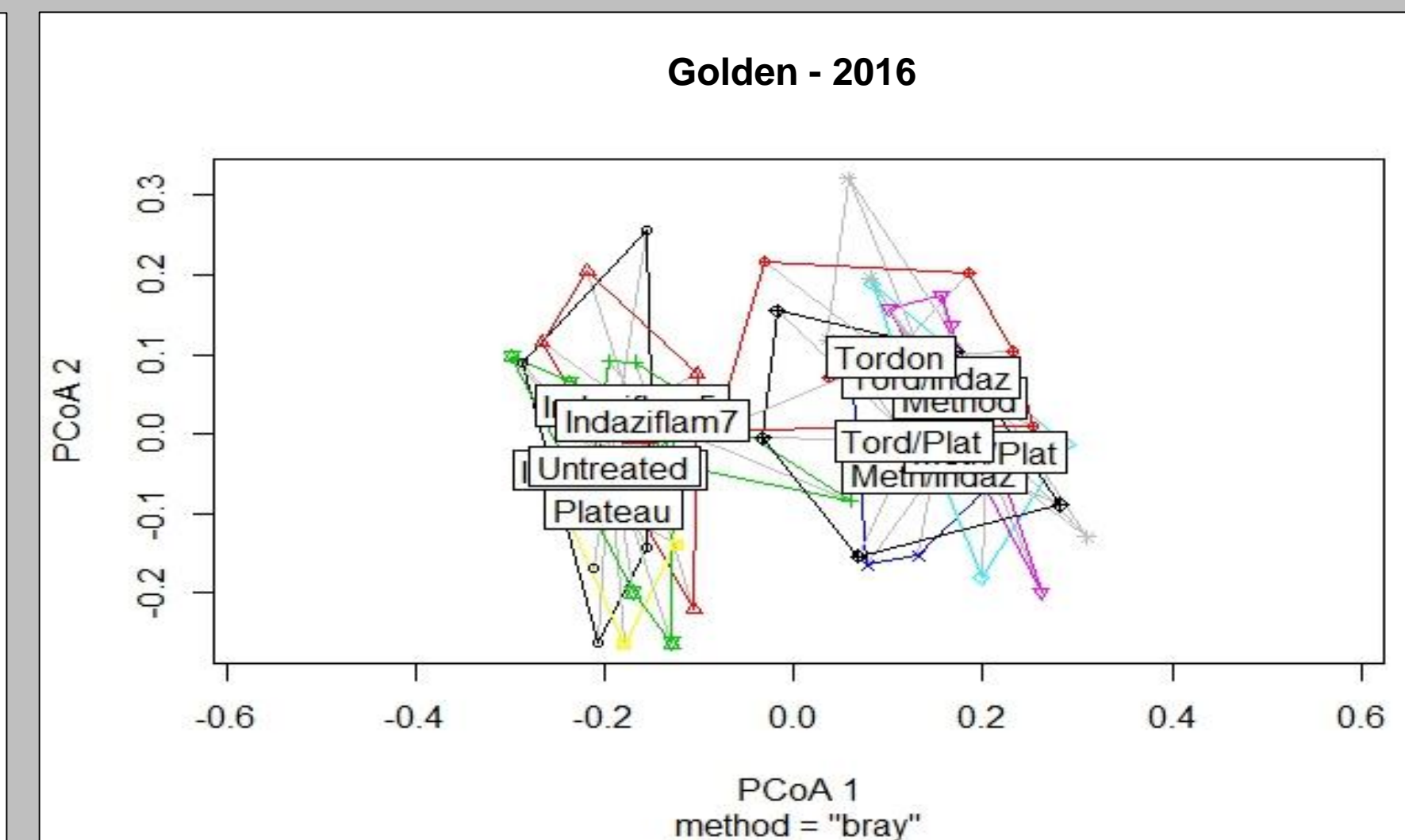
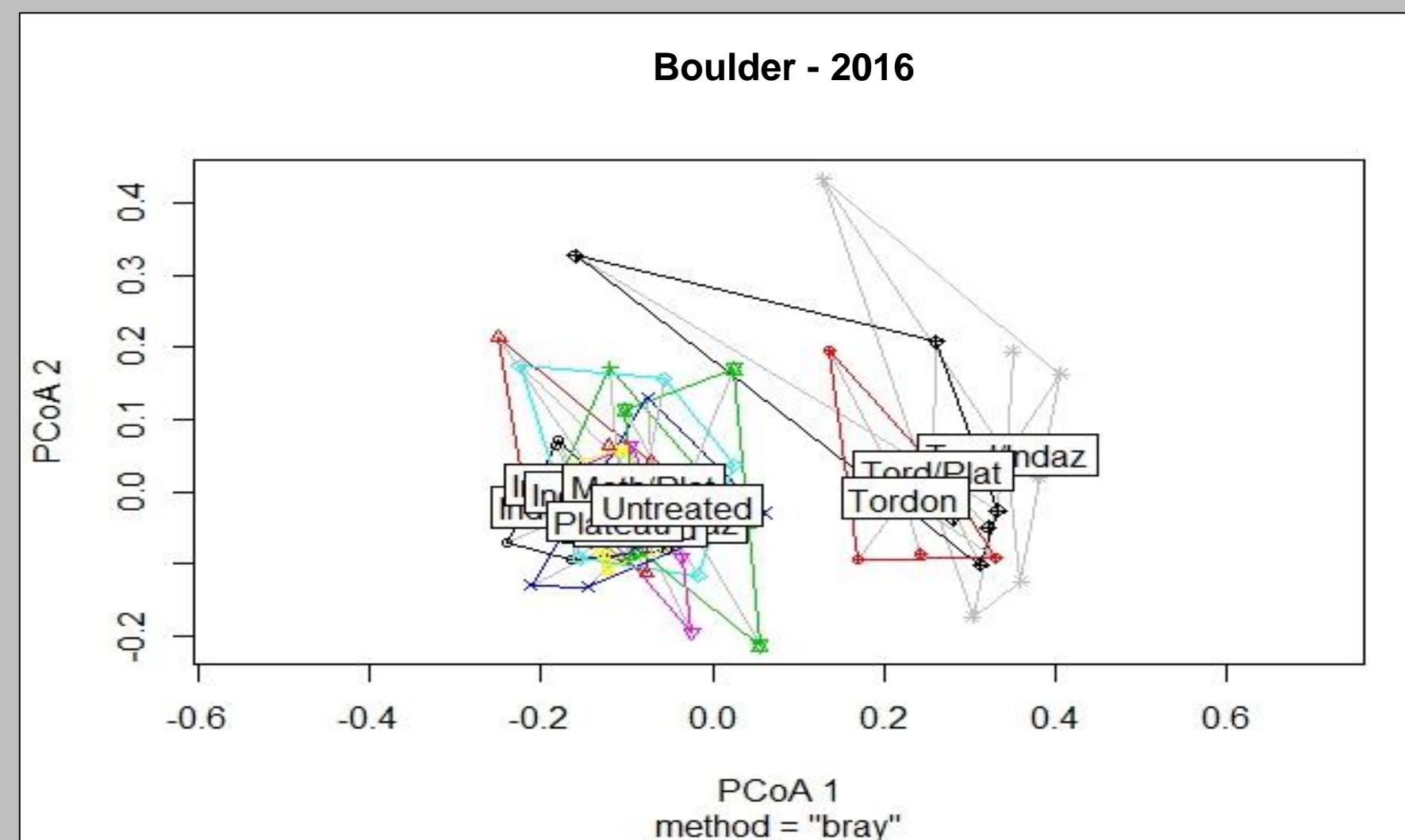


Figure 4. Principal Coordinates (PCO) Analysis of native forb species community abundance. The first two axes of PCO ordination are shown based on a matrix of "Bray-Curtis" distances by herbicide treatment.

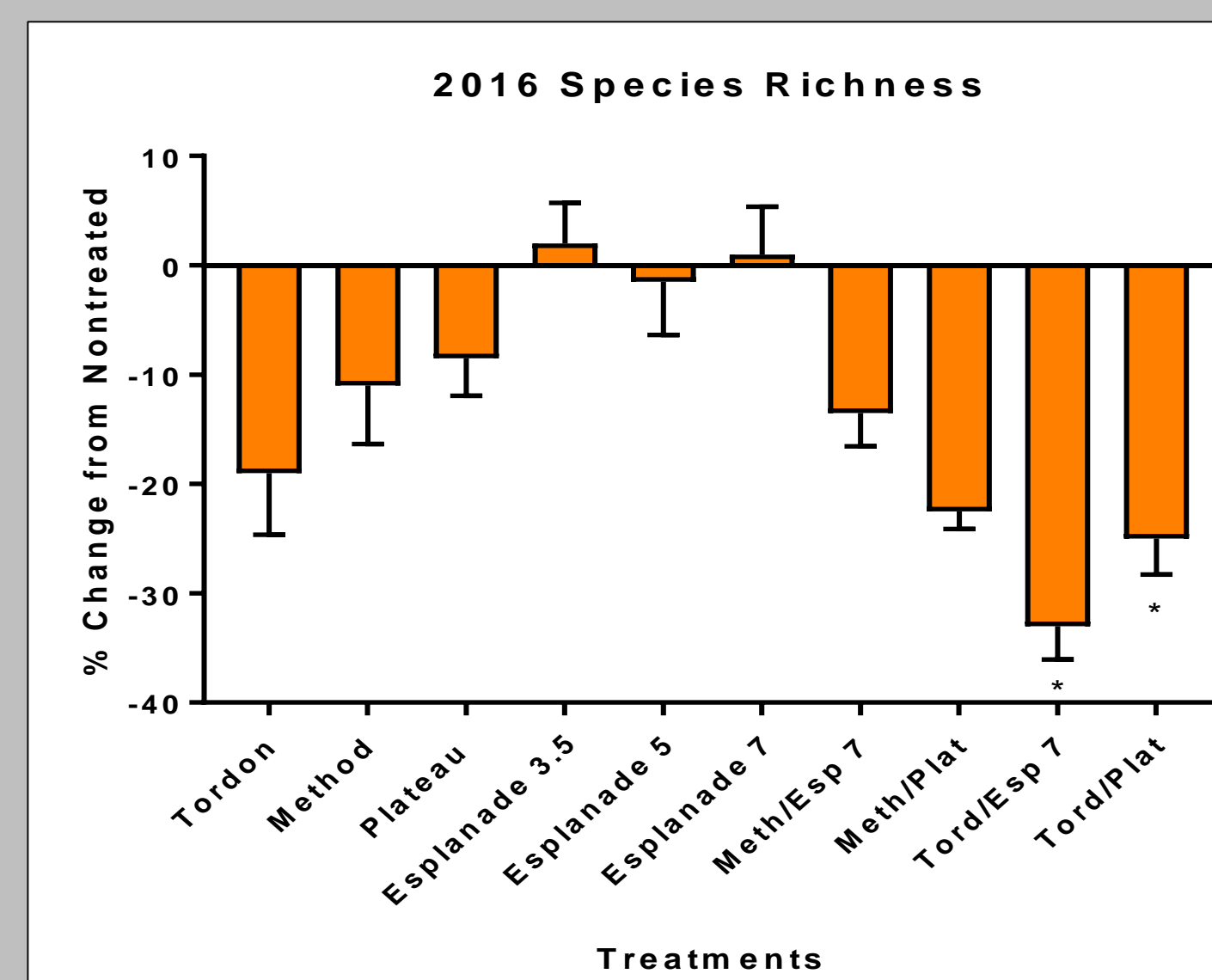


Figure 5. Percent change in species richness 1 YAT compared to the non-treated plots. Data is combined across sites.

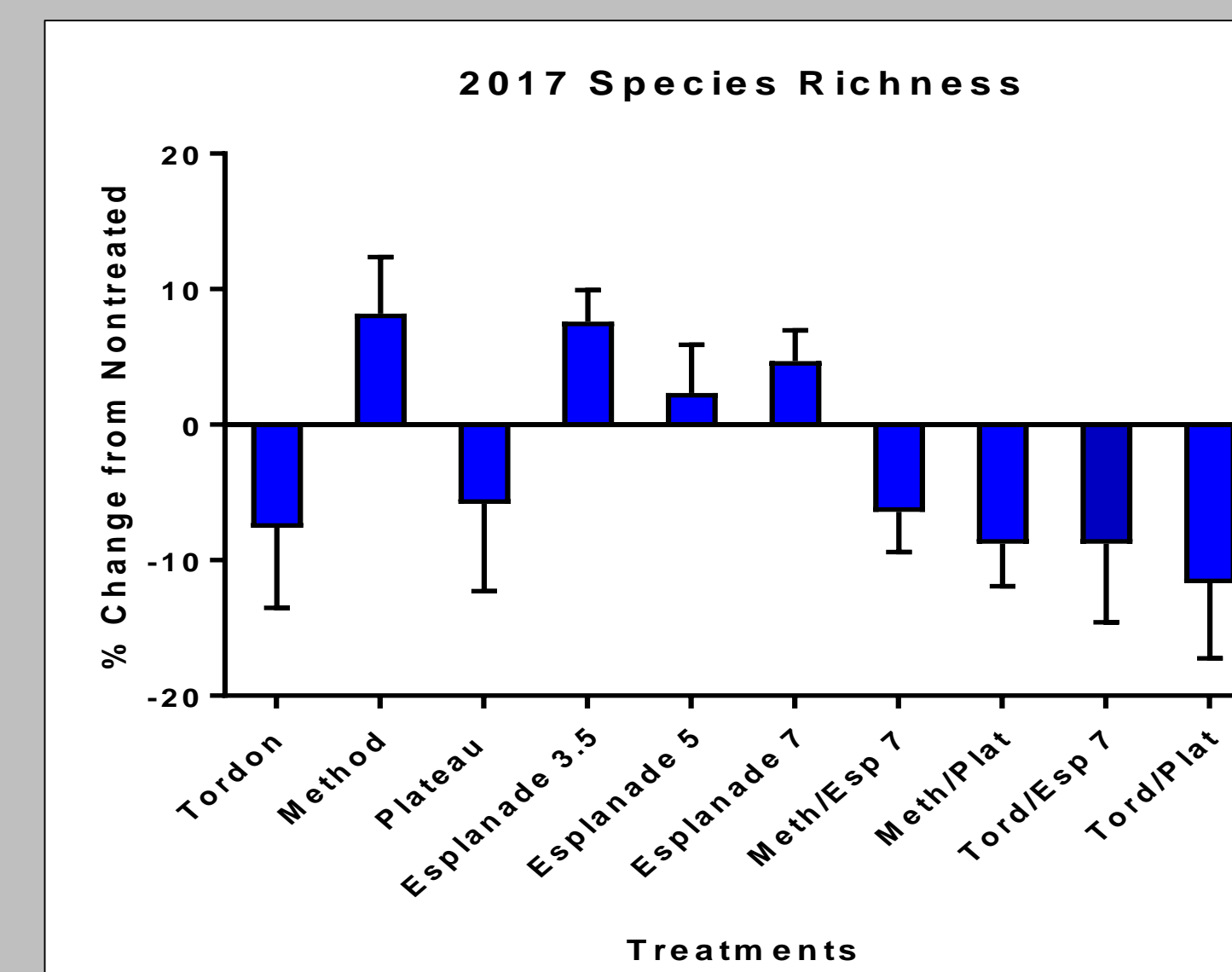


Figure 6. Percent change in species richness 2 YAT compared to the non-treated plots. Data is combined across sites.

Native Species-Site 1		Native Species-Site 2	
Scientific Name	Common Name	Scientific Name	Common Name
<i>Viola nuttallii</i>	Nuttall's violet	<i>Viola nuttallii</i>	Nuttall's violet
<i>Lomatium orientale</i>	Salt and pepper	<i>Lomatium orientale</i>	Salt and pepper
<i>Pancreatium maritimum</i>	Sand lily	<i>Pancreatium maritimum</i>	Sand lily
<i>Astragalus shortianus</i>	Short's milkvetch	<i>Astragalus shortianus</i>	Short's milkvetch
<i>Erigeron flagellaris</i>	Trailing fleabane	<i>Erigeron flagellaris</i>	Trailing fleabane
<i>Euphorbia brachyocera</i>	Shorthorn spurge	<i>Penstemon secundiflorus</i>	One-sided penstemon
<i>Nocca fendleri</i>	Fendler's pennycress	<i>Penstemon secundiflorus</i>	One-sided penstemon
<i>Penstemon secundiflorus</i>	One-sided penstemon	<i>Allium bisceptrum</i>	Wild onion
<i>Castilleja integra</i>	Wholesale Indian paintbrush	<i>Heterotheca villosa</i>	Hairy golden aster
<i>Penstemon virens</i>	Bluemist penstemon	<i>Psoraleum tenuiflorum</i>	Slender-flowered scurpea
<i>Allium bisceptrum</i>	Wild onion	<i>Encelia californica</i>	Bush sunflower
<i>Descurainia pinnata</i>	Western tansymustard	<i>Opuntia macrochiza</i>	Bush sunflower
<i>Heterotheca villosa</i>	Hairy golden aster	<i>Opuntia macrochiza</i>	Prickly pear cactus
<i>Psoraleum tenuiflorum</i>	Slender-flowered scurpea	<i>Ambrosia psilostachya</i>	Western ragweed
<i>Encelia californica</i>	Bush sunflower	<i>Artemisia ludoviciana</i>	Prairie sage
<i>Opuntia macrochiza</i>	Prickly pear cactus	<i>Toxicodendron radicans</i>	Poison ivy
<i>Rosa woodsia</i>	Wood's rose	<i>Hesperostipa comata</i>	Needle and thread
<i>Ambrosia psilostachya</i>	Western ragweed	<i>Poa compressa</i>	Canada bluegrass
<i>Artemisia ludoviciana</i>	Prairie sage	<i>Koeleria macrantha</i>	Prairie junegrass
<i>Toxicodendron radicans</i>	Poison ivy	<i>Andropogon gerardi</i>	Big bluestem
<i>Hesperostipa comata</i>	Needle and thread	<i>Bouteloua gracilis</i>	Blue grama
<i>Poa compressa</i>	Canada bluegrass	<i>Oenothera suffrutescens</i>	Scarlet gaura
<i>Koeleria macrantha</i>	Prairie junegrass	<i>Pascopyrum smithii</i>	Western wheatgrass
<i>Andropogon gerardi</i>	Big bluestem	<i>Ratibida columnifera</i>	Prairie coneflower
<i>Bouteloua gracilis</i>	Blue grama	<i>Iris missouriensis</i>	Rocky Mountain iris
<i>Oenothera suffrutescens</i>	Scarlet gaura	<i>Toxicaria arvensis</i>	Field mouse ear
<i>Pascopyrum smithii</i>	Western wheatgrass	<i>Oligosporus pacificus</i>	Worm wood
<i>Ratibida columnifera</i>	Prairie coneflower	<i>Senecio spartioides</i>	Broom groundsel
<i>Iris missouriensis</i>	Rocky Mountain iris	<i>Liatris spicata</i>	Gayfeather
<i>Toxicaria arvensis</i>	Field mouse ear	<i>Andropogon umbellatum</i>	Sulphur flower buckwheat
<i>Oligosporus pacificus</i>	Worm wood	<i>Hackelia virginiana</i>	Virginia stickseed
<i>Senecio spartioides</i>	Broom groundsel	<i>Eriogonum alatum</i>	Winged buckwheat
<i>Liatris spicata</i>	Gayfeather	<i>Cymopterus lemmonii</i>	Mountain parsley
<i>Andropogon umbellatum</i>	Sulphur flower buckwheat	<i>Senecio spartioides</i>	Broom groundsel
		<i>Liatris spicata</i>	Gayfeather
		<i>Eriogonum umbellatum</i>	Sulphur flower buckwheat
		<i>Cirsium undulatum</i>	Wavyleaf thistle

Figure 7. Species composition at Boulder (site 1) and Golden (site 2).

Conclusions/Implications

- Tordon was the only herbicide that significantly decreased species richness 1 YAT. After two years, species richness was not significantly impacted by any treatments.
- Only treatments including Esplanade at 5 and 7 oz/A continued to provide significant downy brome control compared to the non-treated plots 2 YAT.
- Treatments containing Tordon had a significant negative impact on native species community abundance at both sites; Method negatively impacted community abundance at one site.
- With over 50 million acres in the western U.S. infested by downy brome, Esplanade could be used as a tool by land managers to restore invaded sites without harming native species.
- Long-term downy brome control could be key to the release of native species at invaded sites and in turn, a transformation back to a native species dominated site.

Future Research

- Conducting tolerance studies at sites where native species are grown in a production setting.
- Determining impact of residue accumulation and burning to the native species community.
- Evaluating management options and native tolerance to Esplanade at high elevation sites.

Acknowledgements

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