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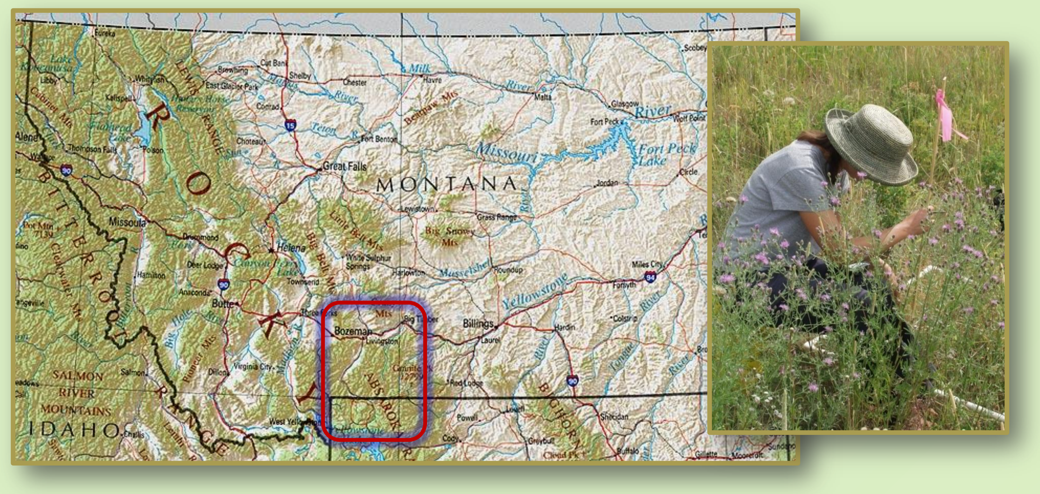
Assessing plant community and environmental covariates of *Bromus tectorum* presence.

The concept that the impacts of non-indigenous plant species (NIS) will vary across different environments has been supported in recent research. Understanding how biotic and abiotic conditions influence plant communities is an important step to predicting where on the landscape NIS are likely to have the greatest impact. We conducted an *in-situ* manipulative experiment to test the response of plant community richness to four treatments: manual removal of *B. tectorum*, ground disturbance to mimic that caused in the manual removal plots, herbicide application (fall application of Plateau at 10 oz/acre). We hypothesize that the response to treatments will vary across the landscape. In order to gain mechanistic and predictive insight into impact variability, eighteen covariates were examined in relation to community response to experimental treatments. Four treatments: control, manual removal, ground disturbance and herbicide application, were applied to replicated paired plots across four natural plant communities. The covariates were a combination of indirect or distal factors, such as aspect, and more direct environmental variables, such as soil nitrate levels. Significant positive relationships were found between the change in richness and diversity and the following variables: probability of NIS occurrence, aspect, soil pH, percent organic matter in the soil, nitrate (ppm) in the soil, and percent clay in the soil, meaning lower levels of these predictor variables were correlated with reductions in richness and diversity. Significant negative relationships were found between the change in richness and diversity and annual radiation, distance to road, and percent sand in the soil, meaning lower levels of these predictor variables were correlated with increases in richness and diversity. Non-significant relationships were found with elevation, slope, initial percent cover of B. tectorum, soil phosphorus, soil potassium, and percent silt in the soil. Identifying significant environmental correlates with NIS impact and response to treatment will help guide weed management prioritization, as well as provide mechanistic insight into plant community dynamics.



Assessing Plant Community and Environmental Covariates of Non-Indigenous Plant Impacts

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Background

What drives the impacts of non-indigenous species?

There is a long-standing ecological debate over the relationship between species richness and invasibility suggesting, on the one hand, that richness repels invasion[1,2,3], and on the other, richness facilitates invasion[4]. Biotic determinants of non-indigenous plant species (NIS) invasion may also influence NIS impacts. Species rich communities may experience greater impacts. Environmental variables[5,6] and resource availability[7] are also considered important factors in the establishment and impacts of NIS.

NIS = non-indigenous plant species

Rationale

Mechanistic insight

If impacts of NIS vary across the landscape and with biotic conditions, understanding the relationship between those variables and impact can provide insight into the mechanisms of NIS impacts in plant communities.

Prioritization for management

Land managers need to know where NIS are likely to have the greatest impact in order to prioritize their management efforts. If a significant relationship exists between environmental variables or biotic conditions and impact, knowledge of where those predictive variables and conditions are found on the landscape can be used to prioritize management.

Hypotheses

Environmental variables (i.e. aspect) and, more generally, habitat suitability, are significantly correlated to NIS impact.

Biotic conditions (i.e. species richness) are significantly correlated to NIS impact.

high species richness, high habitat suitability
↓
high impact potential

low species richness low habitat suitability
↓
low impact potential

Objectives

1. Determine whether significant correlations exist between the impact of downy brome and environmental variables.
2. Determine whether significant correlations exist between the impact of downy brome and biotic conditions

Methods

Study Species

Selection criteria: presence across a range of environments, reported negative impacts, target of control programs

downy brome (*Bromus tectorum*)

- Monocot
- Annual grass
- Family: Poaceae
- Often invasive
- Fruits injurious to livestock
- May increase fire frequency

Manipulative field experiment

Two types of "neighbor manipulation" approaches are utilized to measure the competitive effects of NIS: weed removal and weed addition[8]. We conducted a weed removal experiment and measured the change in plant species richness, diversity, and exotic-to-native cover over time. For this analysis, **change in species richness was used as the metric of impact.**

Experimental sites stratified across a range of habitat suitability

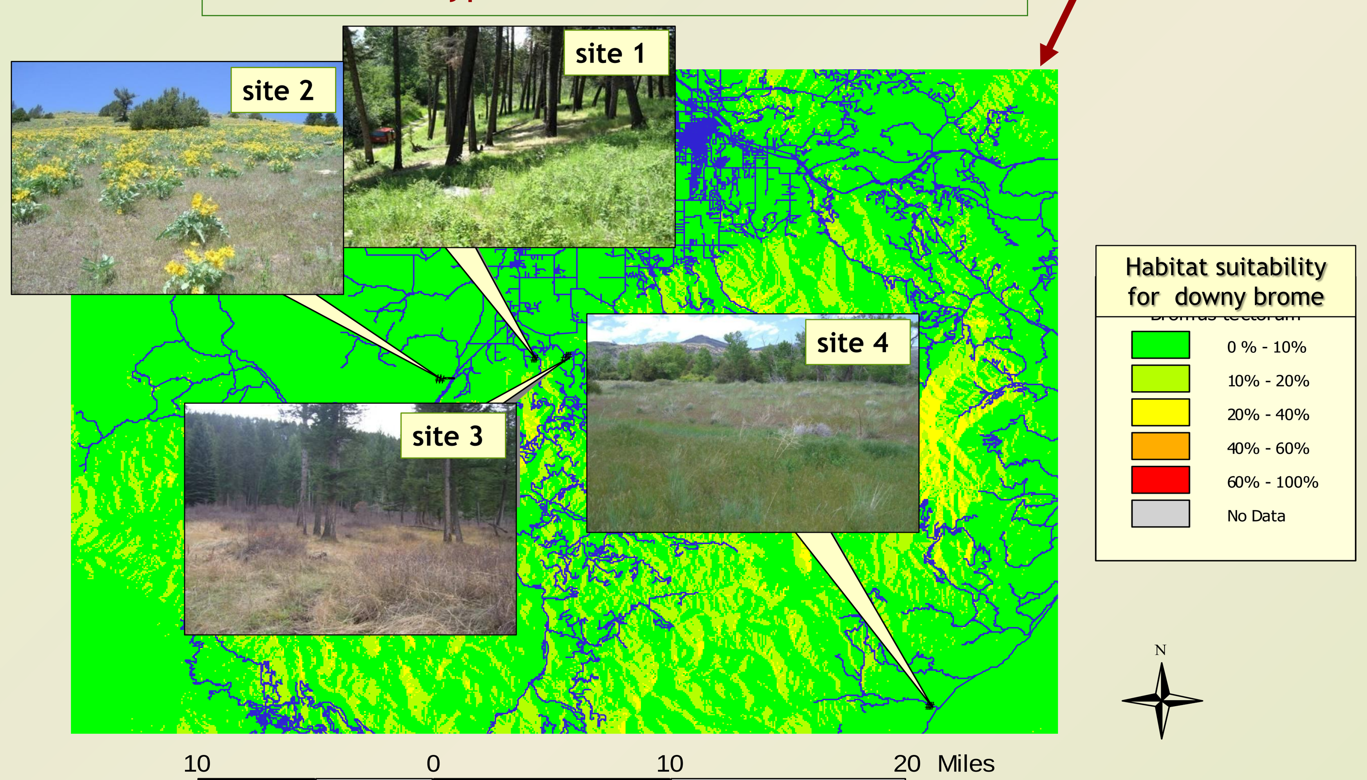
Using logistic regression, presence/absence data, and a suite of environmental variables, habitat suitability was predicted by Rew et al. (2005)[9] for downy brome. To explore the relationship between impact and habitat suitability, experimental sites were stratified across a range of suitability.

$$P(y=1\,|\,x_j)=\frac{\exp(\beta_0+\beta_1x_1+\ldots\beta_ix_j)}{1+\exp(\beta_0+\beta_1x_1+\ldots\beta_ix_j)}$$

→ Determined best model using AIC → Map Habitat Suitability by Species

NIS presence

Slope, Aspect , Elevation, Veg. Habitat Type, Distance from road, Distance from trail, Disturbance type



Analyze downy brome impact (change in richness) against biotic and environmental variables

To determine whether significant correlations exist between downy brome impact and environmental and biotic variables, we examined pairwise correlations between the post-treatment change in richness and fifteen covariates.

Results

Change in richness after manual removal of downy brome was **positively** correlated ($p < 0.05$) with:

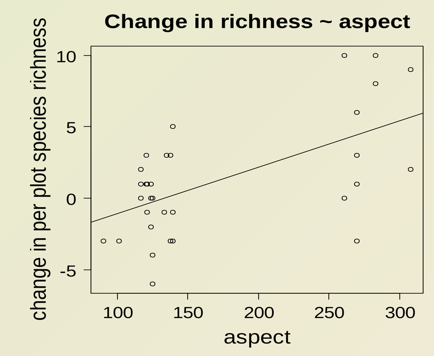
- aspect
- habitat suitability for downy brome
- initial species richness
- soil pH
- soil nitrogen
- soil organic matter
- percent clay in soil

Change in richness after manual removal of downy brome was **negatively** correlated ($p < 0.05$) with:

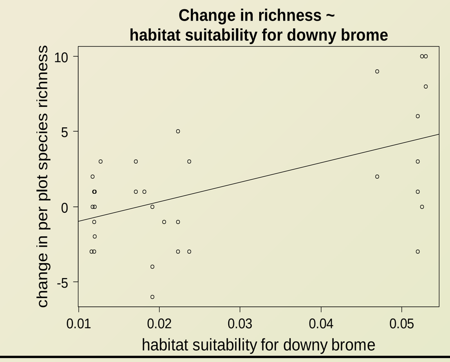
- percent sand in soil

Change in richness after manual removal of downy brome had **no correlation** ($p < 0.05$) with:

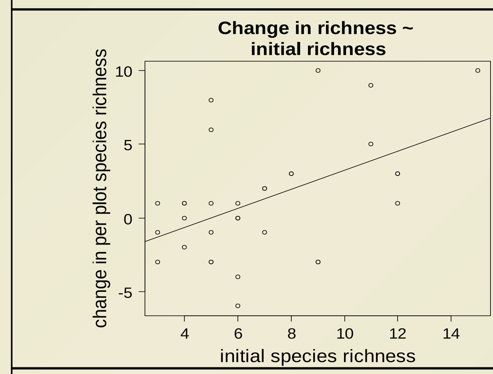
- distance to road
- elevation
- downy brome cover
- percent silt in soil
- annual radiation
- slope
- soil phosphorus



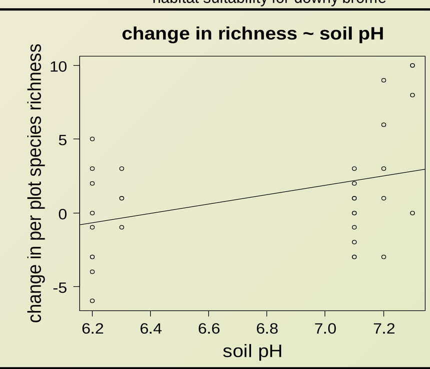
$y = 0.3236x - 4.313$
$R^2 = 0.3523$
$p = 0.000272$



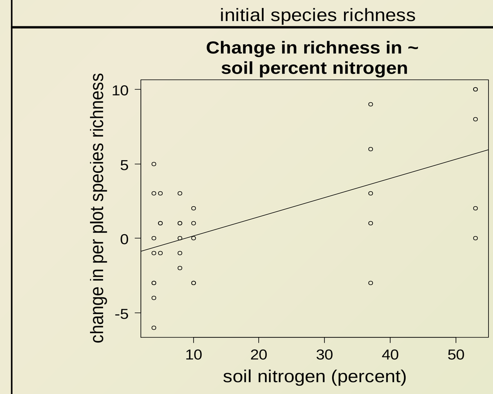
$y = 129.5x - 2.276$
$R^2 = 0.3523$
$p = 0.00105$



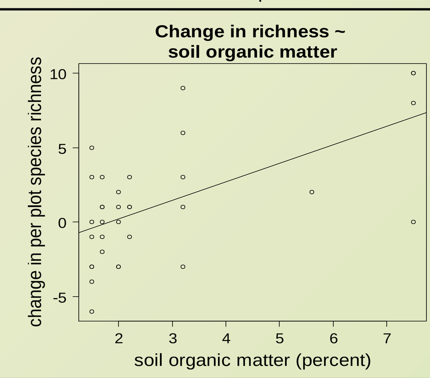
$y = 0.6482x - 3.266$
$R^2 = 0.2454$
$p = 0.00338$



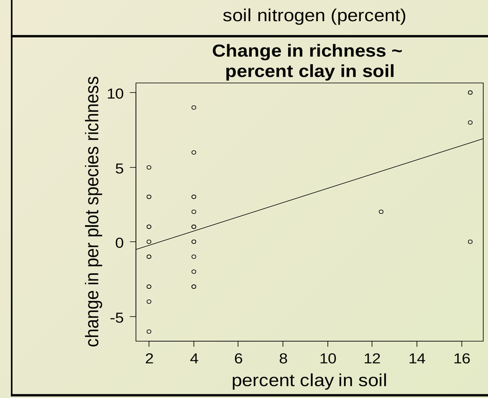
$y = 3.189x - 20.467$
$R^2 = 0.1398$
$p = 0.0321$



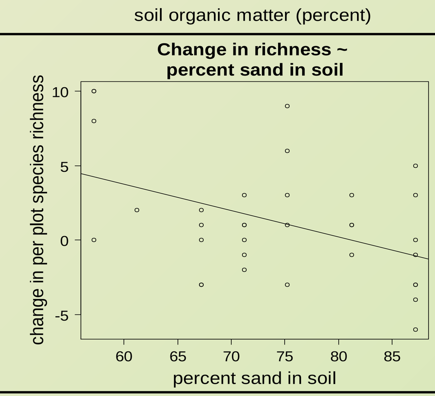
$y = 0.12846x - 1.123$
$R^2 = 0.3523$
$p = 0.000237$



$y = 0.1.249x - 2.2917$
$R^2 = 0.3731$
$p = 0.000160$



$y = 0.4764x - 1.184$
$R^2 = 0.3099$
$p = 0.000766$



$y = -0.177x + 14.393$
$R^2 = 0.1955$
$p = 0.00998$

Conclusions

One year after removal, we found significant correlations between the impact of downy brome and site richness, habitat suitability, aspect, and soil physical and chemical properties. These data suggest habitats more amenable to downy brome, with greater species richness and more resources, are more likely to experience a greater impact from its establishment.

Future Directions & Implications

We will continue to monitor the response to downy brome removal over time. Future results will strengthen our understanding of the mechanisms behind downy brome impact and be used to help guide management decisions.

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