Short-term changes in plant communities in arid Wyoming big sagebrush ecosystems from fuel treatments

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Thresholds of resilience
Fuel Reduction & Rangeland Practices

Untreated

Prescribed fire

Herbicide – tebuthiuron & imazapic

Mowing
Research Questions & Preliminary Results

- What plant community elements change with fuel treatments?

- Does *B. tectorum* dominance (foliar cover) relate to native plant distances or cover? 
  - Easy tool to monitor resilience?

- Can distances among perennial plants predict thresholds of *B. tectorum* dominance?
Overview

- **7 sites**
  - 2 Washington
  - 2 Oregon
  - 1 Nevada
  - 1 Idaho
  - 1 Utah

- **A. tridentata ssp. wyomingensis communities**

- Loamy soils
Methods

- Four treatments/site (fire, mow, herbicide & control)
  - 18 pre/9 post-treatment subplots/trmt (30x30 m)
  - Plateau nested within each treatment

- Response variables
  - Foliar cover using line-point intercept
  - Basal gaps among perennial plants
Pre vs Post Total Per. Grass Cover

Year * Treatment

Year * Plateau

No Plateau
Plateau

Fire

Plateau
Fire

Sagebrush Steppe Treatment Evaluation Project
Wyoming big sagebrush cover

Year * Treatment

% ARTRW8 Cover

- 2 -1 0 1 2

Fire
Control
Teb
Mow

Fire & Mow
Basal Gaps by Treatment

**Year * Treatment**

- **Fire**
- **Fire + Plateau**
- **Fire vs. Control**

![Graph showing mean gap (cm) over years for different treatments.](image-url)
Pre vs Post Cheatgrass Cover

Mow vs. Control

Year * Plateau

Fire vs. Control

Mow + No Plateau

No Plateau

Fire + No Plateau
Total Annual Forbs

Year * Plateau

Year * Treatment

No Plateau

Mow & Fire
Basal Gap Size vs. Perennial Grass Cover

- Gap = 28 cm
- Gap > 500 cm

Correlation:

\[ r^2 = 0.69 \]
Conceptual *a priori* model of ecosystem invasibility

From Reisner 2011
Study Design

- 75 sites; 3 grazing allotments; sampled over 2 years
- Stratified random sampling design to capture:
  - Herbivory Stress – Distance from water & cow pies
  - Water stress – driven differences soil texture
    - Five different Ecological Sites
    - Fine soil texture = low water stress
    - Coarse soil textured soil = high water stress
    - Quantified: soil texture and depth
  - Heat stress – driven by slope and aspect

![Loam](image1.jpg)  ![Clay loam](image2.jpg)  ![Sandy Loam](image3.jpg)  ![North Slopes](image4.jpg)  ![South Slopes](image5.jpg)
Catastrophic regime shift

Decreasing resilience to disturbance and stress and decreasing resistance to non-native invasions

Intact phase dominated by natives
At-risk Natives with cheatgrass

Cheatgrass and *Poa secunda*
Cheatgrass and *E. elymoides*

Patterns of Invasibility

Annual grassland

Catastrophic regime shift

31% of study sites (intact 1 & 2)
25% of study sites (Phase-at-risk)
23% of study sites (state 2)
21% of study sites (state 3)
Stress & Community Relationships

From Reisner 2011
Stress & Sage Facilitation

Low Stress Group

High Stress Group

Focal species

<table>
<thead>
<tr>
<th>Species</th>
<th>Low Stress</th>
<th>High Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. elymoides</td>
<td>(0)</td>
<td></td>
</tr>
<tr>
<td>P. secunda</td>
<td>(0)</td>
<td>(+ +)</td>
</tr>
<tr>
<td>A. thurberianum</td>
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<td>(+)</td>
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<tr>
<td>P. spicata</td>
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<td>H. comata</td>
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<tr>
<td>A. hymenoides</td>
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<td>(0)</td>
</tr>
<tr>
<td>B. tectorum</td>
<td>(-)</td>
<td>(0)</td>
</tr>
<tr>
<td>L. perfoliatum</td>
<td>(-)</td>
<td>( - )</td>
</tr>
</tbody>
</table>

Focal Species Cover | Interspace | Under Shrub
Methods
Structural Equation Modeling

- Ecosystem invasibility = cheatgrass cover

- Bunchgrass community composition = bunchgrass cover NMS and used the axes as indices

- Community structure = % of transects covered by large basal gaps (>200cm)

- Safe sites = BSC cover and % bare soil cover
Cheatgrass cover

Community structure

% of large basal gaps between perennial vegetation

Native bunchgrass cover

Bunchgrass community composition

Axis 1
$R^2 = 0.37$

Axis 3
$R^2 = 0.05$

BSC cover

% bare soil

R2 = 0.50

Cheatgrass cover

% of large basal gaps between perennial vegetation

Community structure

Bunchgrass abundance

Chi-square = 11.73 (p = 0.59)

From Reisner 2011
Fuel Treatment Preliminary Conclusions

Decreases

- Fire
  - Shrubs
  - Perennial grasses
  - Mosses
- Mowing
  - Shrubs
- Plateau
  - Cheatgrass
  - Perennial grasses
  - Annual forbs

Increases

- Fire
  - Basal gap size
  - Bare ground
- Mowing
  - Cheatgrass
  - Perennial grasses
- Plateau & Fire
  - Bare ground
  - Basal gap size
Stress & Resilience
Preliminary Conclusions

- Spatial structure of perennial plants (gaps) is directly related to cheatgrass dominance.
  - High livestock grazing intensity plus heat and water stress indirectly create these gaps
  - Fire & Plateau also increases gaps

- Perennial grasses associate with shrubs with high stress

- Fire kills shrub and grasses and increases basal gaps

- Monitoring gaps between perennial plants may provide a fast early warning indicator of invasion potential.
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  - USFWS, TNC, USDA ARS NGBER

◆ Field Assistants
  - Field crew members with USGS, OSU & USU