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Diversity Post-Wildfire of Vegetational Understory in Rocky Mountain Ponderosa Pine Woodland and Montane Sagebrush Steppe

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Introduction

• In Montana, big sagebrush steppe, montane sagebrush steppe and rocky mountain ponderosa pine woodland take up over 16% of Montana’s 380,832 km² (16.45%).
• Studies have shown that habitats dominated by graminoids depend on species abundance and richness to regulate invasion.
• The invasion process can be facilitated by the removal of native perennial species and the accumulation of seed banks of invasive annual grasses. Wildfire can contribute to these factors.
• Climate change modifies growing seasons of habitats substantially.
• A wildfire near Big Saw-Mill Gulch on September 1st, 2016 offers an opportunity to compare diversity and richness in burned areas compared to unburned areas in rocky mountain ponderosa pine and montane sagebrush steppe.
• It is hypothesized that burned habitats will have lower values of diversity when compared to unburned habitats of the same ecosystem.
• Habitats with lower diversity are expected to have larger compositions of invasive species compared to habitats with higher diversity.

Methods

• The study site used was the Triple 8 ranch in Lewis and Clark County, MT. The Triple 8 ranch (46° 53.467’ N, 112° 18.693’ W) is usually facilitated by wildfire, its presence was only found in unburned sites. Future studies may reflect a larger composition of *Bromus tectorum* in burned habitats.
• The burned forest habitat had the largest portion of canopy cover made up of invasive species (1.33%). This may indicate that low diversity is allowing the proliferation of invasive species in burned woodland compared to either steppe habitat because of its low diversity.
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Bryce Walker, Travis Almquist PhD
Department of Biology, Carroll College

Results

• A two-factor Anova was carried out to identify differences in habitat diversity based on burned and unburned sites as well as differences in ecosystem. There was no effect on species diversity from either of the two factors (p=0.122).
• Variances were --unburned steppe:0.30, Burned Steppe:0.064, Unburned Forest:0.059, and Burned Forest: 0.0699.

\[ \text{Shannon Diversity Index} = - \sum (p_i \times \log_2 p_i) \]

Figure 1: Shannon Diversity Index values reflecting the evenness of each habitat.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Most Frequently Encountered Species</th>
<th>% Composition for Habitat</th>
<th>Frequency of Encounters</th>
<th>Coverage in Habitat (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steppe Burned</td>
<td>Idaho Fescue</td>
<td>30.2%</td>
<td>0.93</td>
<td>11.23</td>
</tr>
<tr>
<td>Steppe Unburned</td>
<td>Rough Fescue</td>
<td>41.6%</td>
<td>0.67</td>
<td>21.58</td>
</tr>
<tr>
<td>Forest Burned</td>
<td>Arenaria Fendleri</td>
<td>10.3%</td>
<td>0.59</td>
<td>2.53</td>
</tr>
<tr>
<td>Forest Unburned</td>
<td>Bluebunch Wheatgrass</td>
<td>17.4%</td>
<td>0.56</td>
<td>5.40</td>
</tr>
</tbody>
</table>

Figure 2: Graminoid Species Composition

**Grasminoid Composition**

<table>
<thead>
<tr>
<th>Species</th>
<th>Coverage in m²</th>
<th>Frequency of Encounters</th>
<th>% Composition for Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Festuca</td>
<td>30.2%</td>
<td>0.93</td>
<td>11.23</td>
</tr>
<tr>
<td>Festuca</td>
<td>41.6%</td>
<td>0.67</td>
<td>21.58</td>
</tr>
<tr>
<td>Elymus</td>
<td>10.3%</td>
<td>0.59</td>
<td>2.53</td>
</tr>
<tr>
<td>Poa secunda</td>
<td>17.4%</td>
<td>0.56</td>
<td>5.40</td>
</tr>
</tbody>
</table>

Species of Interest

- 59 total species were identified based off of characteristics of the samples collected.
- Diversity values were identified. Steppe Burned:1.08, Steppe Unburned:1.20, Forest Burned: 0.858, Forest Unburned: 0.974.
- Mean species richness for forest burned and unburned was 18 and 19 respectively, while burned steppe and unburned steppe was calculated at 13.8 and 17.8 respectively.

Conclusion

• Species richness and abundance has been known to regulate ecological invasion and a low evenness may indicate vacant niches that if left vacant can help facilitate invasion.
• Despite the higher degree of species richness in the forest habitats, the steppe habitats evaluated had higher diversity values based on the Shannon-Weiner Index (figure 1).
• While there was no significant difference in species diversity found between burned and unburned habitats or between steppe and forest ecosystems, the diversity values found in this study reflect a relatively low evenness in all evaluated ecosystems.
• While invasion by *Bromus tectorum* is usually facilitated by wildfire, its presence was only found in unburned sites. Future studies may reflect a larger composition of *Bromus tectorum* in burned habitats.
• The burned forest habitat had the largest portion of canopy cover made up of invasive species (1.33%). This may indicate that low diversity is allowing the proliferation of invasive species into the unburned forest habitat more than the other evaluated habitats.
• Repeated studies in this study site may reflect increased presence of invasive species in burned woodland compared to either steppe habitat because of its low diversity.

Acknowledgements

Thanks to the M.J Murdoch charitable trust for funding this project, Reegan Debruycker, and special thanks to the owners of the Triple 8 ranch for allowing us to use their property as our study site.