Conifer encroachment of montane meadows: effects on vegetation, seed banks and potential for restoration

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Photo: Jim Lutz
• Value of unique, open meadow communities
  - Biodiversity
  - Wildlife habitat
  - Cultural resources
The problem...

- Conifer invasion of meadow habitat
- Widespread across PNW
- Concern over the loss of unique meadow habitat
The problem...

• Focus on the causes
  - Fire suppression
  - Climate change
  - Grazing
The problem...

- Very little understanding of:
  - Vegetation dynamics
  - Restoration potential
  - Effectiveness of restoration treatments
Bunchgrass Ridge, OR

- Dry, montane meadow
- Willamette NF Special Habitat Area
• 1120 m to 1375 m
• History of conifer invasion
  – Grand fir (*Abies grandis*)
  – Lodgepole pine (*Pinus contorta*)
• Meadow soils
1. Vegetation Dynamics – R Haugo
2. Seed bank Dynamics – N Lang
3. Experimental Restoration – In progress
Vegetation Dynamics

- Temporal changes in vegetation
  - Community composition
  - Meadow and forest species
    - Abundance (cover)
    - Richness

_Erigeron aliceae_
Vegetation Dynamics

- Relationship between vegetation and environmental changes
  - Light levels and stand structure

*Erigeron aliceae*
Field sampling

• 4, 1 ha blocks
• 356 10 x 10 m subplots
  – Basic sample unit
• Census of all overstory trees
  – Species, size, age, location
• Light levels
• Vegetation sampling
Chronosequence

- Temporal changes
  -> space for time substitution

- Seven encroachment classes
  - Class 0 (open meadow) to Class 6 (old forest)

Aquilegia formosa
Encroachment Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of Stems/Subplot (100 m²)</th>
<th>Age (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 0</td>
<td>no trees</td>
<td></td>
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<tr>
<td>Class 1</td>
<td></td>
<td></td>
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<tr>
<td>Class 2</td>
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<td>Class 3</td>
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<td>Class 4</td>
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<tr>
<td>Class 5</td>
<td></td>
<td></td>
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<tr>
<td>Class 6 (old forest)</td>
<td></td>
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</tr>
</tbody>
</table>

- Class 2: \( n = 42 \)
- Class 1: \( n = 17 \)
- Class 0: \( n = 28 \)
- Class 3: \( n = 70 \)
- Class 4: \( n = 84 \)
- Class 5: \( n = 77 \)
- Class 6: \( n = 38 \)
Compositional changes

- Nonmetric Multidimensional Scaling (NMS) ordination
- Strong meadow to forest gradient
Compositional changes

- NMS and age class centroids

![Graph showing NMS and time](image)
Composition and Environment

- Spearman rank correlations
Meadow / Forest Cover

- Threshold response for meadow cover
- Gradual increase in forest cover
  - Low overall cover
Meadow / Forest Richness

- Progressive meadow decline
- Not completely lost
- More rapid forest increase
- Decline from Class 5 to 6
Class 6 - Old Forest

- Distinct composition (NMS)
- Dominated by strongly clonal species
  - Limits cover / richness of other species

*Smilacina stellata*
• Strong meadow to forest gradient
  – Clear progression over time
  – Closely related to lodgepole pine to grand fir transition
• Rapid decline of meadow vegetation
  – Threshold response in cover meadow cover
  – Mode tree age of 40 – 60 years
• Did not experience complete extirpation
• Decline of meadow vegetation
  – Closely related to light levels and forest structure

• Colonization of forest species
  – Weaker relationship with light and structure
  – Distinctive old forest understories
• Management and Restoration?
  – Early removal of trees
  – Persistence of meadow species
  – Potential for regeneration from the seed bank?
Seed Bank Response

• Temporal changes in composition of the soil seed bank
  - Open Meadow
  - Young Forest
  - Old Forest
Seed Bank Response

- Relationship between the seed bank and above ground vegetation
Conceptual Diagram of Seed Bank Dynamics at Bunchgrass

- Ruderal species
- Meadow species
- Forest species

Above-ground vegetation

Open meadow

Soil seed bank

Old forest
Seed Bank Methods:

• 209 10 x 10m subplots sampled

• 3 soil plugs per subplot

• Age classes
  • Open meadow
  • Young forest
  • Old forest

• Greenhouse germination
Primary Seed Bank Species

Frequency (%)

Agrostis scabra  70%
Carex pensylvanica  60%
Epilobium watsonii  40%
Lactuca muralis  30%
Ranunculus urticatus  20%
Fragaria spp.  10%
Galium triforum  5%
Senecio sylvaticus  5%
Circaea alpina  5%
Achillea millefolium  5%
Arenaria macrophylla  5%
Campanula scouleri  5%
Stellaria crispa  5%
Primary Seed Bank Species and Occurrence in the Vegetation

![Bar chart showing frequency of seed bank and vegetation occurrence for various species.](chart.png)
DCA Ordination

Subplots
- Open meadow
- Young forest
- Old forest

Seedbank species
- Ruderal species
- Meadow species
- Forest species

Species:
- Fragaria spp.
- G. microcephalum
- Danthonia intermedia
- Galium triflorum
- Epilobium watsonii
- Circaea alpina
- L. muralis
- S. sylvaticus
- Agrostis scabra
- Achillea millefolium
- Carex pensylvanica
Meadow, Forest, and Ruderal Species

**Richness**

- Meadow species: $p = 0.630$
- Forest species: $p = 0.082$
- Ruderal species: $p = 0.002$

**Density**

- Meadow species: $p = 0.664$
- Forest species: $p = 0.09$
- Ruderal species: $p = 0.817$
Seed Bank Conclusions:

1. The seed bank composition is dominated by ruderal species, with limited contribution from meadow and forest species.

2. The seed bank does not closely resemble the above-ground vegetation.

3. Few meadow species persist under meadow or forest vegetation.
Meadow Restoration?

- Is restoration of invaded meadows possible?
- Impacts of forest age?
- Is fire a necessary component of meadow restoration?
Treatments

- Control
- Cut + broadcast burn
- Cut only (cut + pile/burn)
- Reserve (for future treatment)
• Harvest
  – Winter ’05-06
  – Summer ’06
• Burn
  – Autumn ’06
Thanks!

- Fred Swanson, Joe Antos, John Cissel
- 2003, 2004, 2005 field crews
- McKenzie District, Willamette NF - Cheryl Friesen and many others
- Joint Fire Sciences Program