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

- **Class 2**
  - $n = 42$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 1**
  - $n = 17$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 3**
  - $n = 70$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 4**
  - $n = 84$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 5**
  - $n = 77$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 6 (old forest)**
  - $n = 38$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **Class 0**
  - $n = 28$
  - Age (yr): 0, 4, 8
  - Number of stems / subplot (100 m²): 0, 4, 8

- **No trees**
  - Age (yr): 20, 40, 60, 80, 140, 180, 220
  - Number of stems / subplot (100 m²): 0, 4, 8
Compositional changes

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

- NMS and age class centroids
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

- **Open meadow**
  - **Meadow species**
  - **Ruderal species**

- **Soil seed bank**
  - **Meadow species**
  - **Ruderal species**

- **Young forest**
  - **Forest species**
  - **Meadow species**

- **Old forest**
  - **Forest species**
  - **Meadow species**
  - **Ruderal species**
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 and Occurrence in the Vegetation

- Agrostis scabra
- Carex pensylvanica
- Epilobium watsonii
- Lactuca muralis
- Fragaria spp.
- Galium trilobum
- Senecio sylvaticus
- Circaea alpina
- Achillea millefolium
- Arenaria macrophylla
- Campanula scouleri
- Stellaria crispa
DCA Ordination

Subplots
- Open meadow
- Young forest
- Old forest

Seedbank species
- Ruderal species
- Meadow species
- Forest species

Open meadow (Class 0, 1)
Young forest (Class 2-5)
Old forest (Class 6)

Fragaria spp.
Gnaphalium microcephalum
Dant honia intermedia
Galium triflorum
Epi lobium watsonii
Circae a alpina
Lac tuca muralis
Senecio sylvaticus
Carex pensylvanica
Agrostis scabra
Achillea millefolium
Meadow, Forest, and Ruderal Species

### Richness

- **Meadow species**
  - $p = 0.630$
  - [Bar chart showing species richness](#)

- **Forest species**
  - $p = 0.082$
  - [Bar chart showing species richness](#)

- **Ruderal species**
  - $p = 0.002$
  - [Bar chart showing species richness](#)

### Density

- **Meadow species**
  - $p = 0.664$
  - [Bar chart showing density](#)

- **Forest species**
  - $p = 0.09$
  - [Bar chart showing density](#)

- **Ruderal species**
  - $p = 0.817$
  - [Bar chart showing density](#)
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!

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