Bunchgrass Ridge: Understanding the past to guide the future

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Outline

• Mountain Meadows, Tree Invasion and Restoration
• Intro to Bunchgrass Ridge
• Retrospective Studies
• Restoration Experiment
Mountain Meadows of the Pacific Northwest
Tree Invasion

- Widespread both PNW and western US
- Rapid 20th century changes
Loss of Biological Diversity
Tree Invasion

• Variety of possible causes
• Both human and “natural”
  – Grazing, fire suppression, climate change
  – Highly variable among locations
Tree Invasion – Three Sisters

Miller and Halpern 1998
Meadow Restoration

• Interest in maintaining and restoring openings

• Biological, cultural, aesthetic reasons for restoration
Meadow Restoration

• Advantages
  – Many good reference points for composition / structure
Meadow Restoration

• Challenges:
  – Uncertain role of natural disturbance and other ecological processes
Meadow Restoration

• Is restoration possible?
• If so, by which methods?
• Which factors limit restoration?
Bunchgrass Ridge

- Collaborative research center
- Dynamics and restoration of montane meadows
Bunchgrass Ridge

• Retrospective studies
  – Patterns and consequences of encroachment
  – Implications for restoration

• Restoration experiment
  – Is restoration possible?
  – Is fire necessary?
  – Do initial conditions affect outcome?
Bunchgrass Ridge

1959

1997
Bunchgrass Ridge
Bunchgrass Invasion History - 1934

The graph shows the invasion history of three species: Abies grandis, Pinus contorta, and Other species. The x-axis represents time in years, ranging from 0 to 100. The y-axis represents the percentage of each species. The data points indicate the relative abundance of each species over time.

- **Abies grandis** is represented by green dots.
- **Pinus contorta** is represented by yellow dots.
- **Other species** is represented by red dots.

The graph visually captures the invasion patterns and the dominance of each species during the 1934 period.
Bunchgrass Invasion History - 1974

Abies grandis
Pinus contorta
Other species
Bunchgrass Invasion History - 2004
Bunchgrass Invasion History

![Graph showing the invasion history of Abies grandis, Pinus contorta, and other species over time.](image-url)

Abies grandis
Pinus contorta
Other species


Number of stems. ha$^{-1}$.
Bunchgrass Invasion History

- Edge expansion and from new foci
- Lodgepole facilitation of grand fir
Ecological Limitations

- Influence of invading trees on meadow soils - Griffiths et al. 2005
  - Bacterial to mycorrhizal soil communities
  - Accumulation of needle litter
  - Alteration of nitrogen cycling
Ecological Limitations

- Ideal: vegetative recovery of meadow species
- Rapid loss of meadow species
Ecological Limitations

- Rapid loss of meadow species

Modal tree age

~ 40 yrs

Open Meadow  ➔  Old Forest

Haugo & Halpern 2007
Ecological Limitations

- Soil seed bank
Bunchgrass Soil Seed Bank

Dominant Understory/Meadow Vegetation and Occurrence in the Seed Bank

- Fragaria spp.
- Carex pensylvanica
- Osmorhiza chilensis
- Viola gladella
- Arenaria macrophylla
- Bromus vulgaris
- Hieracium albiflorum
- Achillea millefolium
- Iris chrysophylla
- Anemone oregana
- Galium triflorum
- Erigeron aliceae
- Smilacina stellata
- Campanula scouleri
- Elymus glaucus
- Melica subulata
- Lactuca muralis

Frequency (%)

Lang and Halpern 2007
Ecological Limitations

• If species are not present in seed bank…
  – Seed dispersal
    • Not all species flower, dispersal distances are short
  – Vegetative spread
    • Slow
  – Artificial seeding
    • Genetic comparability
    • Logistics of seed collection, storage, distribution
Ecological Limitations

- Competition with forest herbs
Ecological Limitations

- Competition with forest herbs

![Graph showing encroachment classes and forest species cover over time]

- **Modal tree age**: ~ 20 yrs
- **Forest Species**
- **Cover (%)**
- **Encroachment class**

Haugo and Halpern 2007
Hope for Restoration?

- Limited influence of lodgepole on meadow spp
- Small meadow “pockets” – foci for recovery?
Bunchgrass Restoration

- Tree removal with and without fire
- Range of tree ages / densities
Operational Considerations

• Roadless designation
• Potential for damage to meadow soil
  – Felling and skidding on snow…
Operational Considerations
Operational Considerations

- Slash disposal
  - Broadcast Burn – “Burn” Treatment
  - Pile + Burn – “No Burn” Treatment
Broadcast Burning

• Advantages
  – No further manipulation of slash

• Disadvantages
  – Weather conditions – highly restrictive
  – Risk of fire spread
  – Need for fire lines, water access, etc.
  – Significant soil disturbance
  – Increased nutrient availability
Pile + Burn

- Advantages
  - Can occur during low fire danger
  - Less operational support

- Disadvantages
  - Labor intensive
Pile Burning

- Highly disturbed soils
  ~ 10% of plot surface area
- Greatly increased nutrients
- Vegetation recovery?
1st Year Vegetation Responses
1st Year Vegetation Responses

• Meadow species
  – No change in richness, abundance

• Forest species
  – Declines in richness, abundance
1\textsuperscript{st} Year Vegetation Responses

**Meadow species**

- Control
- No burn
- Burn

Change in total cover (%)

\[ p = 0.439 \]

**Forest species**

- Control
- No burn
- Burn

Change in total cover (%)

\[ p = 0.021 \]
1st Year Vegetation Responses

- Weedy species – limited presence
- Will this last?

Rumex acetosella

Phacelia heterophylla
1st Year Vegetation Responses

- Conifer establishment: Burn > No burn
- Legacy of tree – soil effects?

![Conifer seedlings (0 - 1 m tall)](image)

- Conifer seedlings: $p = 0.006$
  - Control
  - No burn
  - Burn
Summary - Retrospective

• Lodgepole – grand fir facilitation

• Rapid changes:
  – Soils
  – Vegetation

• Lodgepole – grand fir differences

• Weedy seed bank

• Recommendations:
  – Early intervention!!
Summary - Experiment

- Effective harvest over snow
- Broadcast burning
  - Soil disturbance and increased N
- Pile burning
  - Intense local disturbance
- Tree removal benefits meadow species
  - With or without fire
- Limited weedy response in 1st year
- Long term success???
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2003-2007 Bunchgrass Ridge field crews
http://depts.washington.edu/bgridge/