The MT Adaptive Silviculture for Climate Change Study

Regeneration for the future at Coram Experimental Forest and Flathead National Forest

Managing post-fire vegetation workshop – 4 February 2021

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Christopher Keyes (UM)
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**Adaptive Silviculture for Climate Change (ASCC)**

**Project Goal:**

Co-develop robust, operational examples of how to integrate climate change adaptation into silvicultural planning and on-the-ground actions to foster resilience to the impacts of climate change and enable adaptation to uncertain futures.

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**Manage for Persistence:**

Ecosystems are still recognizable as being the same system (character).

**Manage for Change:**

Ecosystems have fundamentally changed to something different.

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*Sensu Millar et al. 2007*
Characteristic Forest Ecosystems in the Northern Rockies

**Location:**
Northwestern Montana, Flathead County

**Forest Ecosystem:**
Western Larch cover type (SAF Type 212), a.k.a. western larch-mixed conifer
Projected Climate Change Impacts

DIRECT impacts:
1. Temperature (+2.8 to 6.5 C)
2. Snowpack (higher winter max and spring min T)
3. Drought (maybe wetter winter but drier summer)

INDIRECT impacts:
1. Wildfire activity (freq, season, area burned)
2. Insects and disease (host stress, voltinism, spread)
3. Forest dynamics (replacement of sensitive species)

Joyce et al. 2017
Rehfeldt and Jaquish 2010
1. What endemic tree species and seed sources will thrive as the climate becomes warmer and drier?

2. Will assisted migration better maintain forested conditions under future conditions?

A Couple Pertinent Questions

Dumroese et al. 2015
Site Considerations:
- Representative of 1,000,000 acres in Forest Service Region 1
- Clearcut 50-60 years ago
- Natural western larch regen or augmented by planting
- Pre-commercially thinned 30-40 years ago
- Sites are located 40 miles apart
- Elevation: 3,720’ – 4,240’

Collaborating personnel from:
- Flathead National Forest
- Rocky Mountain Research Station
- University of Montana

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees (stems ac⁻¹)</td>
<td>261.0</td>
</tr>
<tr>
<td>Basal area (ft² ac⁻¹)</td>
<td>106.5</td>
</tr>
<tr>
<td>QMD (in)</td>
<td>8.7</td>
</tr>
<tr>
<td>Larix basal area (%)</td>
<td>70.8</td>
</tr>
<tr>
<td>Height (ft)</td>
<td>62.4</td>
</tr>
</tbody>
</table>
ASCC is Testing a Spectrum of Adaptation Options

Promote change

- Transition
  - actively facilitate change to encourage adaptive responses to changing and new conditions
- Resilience
  - allow some change in current conditions, but encourage an eventual return to reference conditions
- Resistance
  - maintain relatively unchanged conditions over time

Maintain current conditions

- Reduce climate change impacts
- Facilitate adaptive responses

actively facilitate change to encourage adaptive responses to changing and new conditions
**Desired Future Conditions**

Ideal future stand will be:
- Productive for local economy
- Most resistant and resilient to future drought
- Resistant to fire (able to avoid widespread crown fire and mature tree mortality)
- Resistant and resilient to insects and disease
- A provider of wildlife habitat and forage
- STRUCTURE: Two-aged, with improved structural and spatial heterogeneity
- COMPOSITION: Dominated by fire- and drought-tolerant species: western larch, western white pine, ponderosa pine

**Objectives**

Management objectives to reach DFCs:
- Increase or sustain tree and stand wood productivity
- Promote development of large-diameter, long-lived trees (10-16 TPA) for timber value and fire resistance
- Mitigate moisture stress
- Reduce probability of torching by reducing surface and ladder fuels
- Reduce probability of crowning by reducing canopy fuels
- Maintain or improve wildlife habitat and forage production
- Maintain or reduce presence of insects and disease in trees
- Enhance genetic diversity to buffer against insects and disease
- Enhance species and genetic diversity by increasing the proportion of future-adapted (to fire and climate.) species and genotypes through natural and artificial regeneration
- Enhance age-class, spatial, and structural heterogeneity to improve resilience to disturbances

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**How do we get there?**

- **Desired Future Conditions**
  - What are the broad stand characteristics that we want for the future?

- **Objectives**
  - What are the management objectives necessary to move the stand toward the DFCs?

- **Tactics**
  - What specific silvicultural activities (in the next 5 years) will we initiate to achieve these objectives?
ASCC is Testing a Spectrum of Adaptation Options

Promote change

- Seed tree with reserves. Increase proportion of fire- and drought-tolerant species via natural regeneration and planting.

Maintain current conditions

- Commercial thinning. Slightly increase proportion of shade-intolerant, fire-tolerant species.

Resistance

- Group selection with reserves (1/3), thin matrix (2/3). Increase proportion of fire-tolerant species via natural regeneration and planting.

Resilience

Reduce climate change impacts

Facilitate adaptive responses
Structure modified, initiate regen flood!
Structure modified, initiate regen flood!

1. Natural regeneration

Understory light
Soil moisture
Temperature

Resilience

Transition

How much?
Structure modified, initiate regen flood!

Resilience

Understory light
Soil moisture
Temperature

Transition

1. Natural regeneration
2. Artificial regeneration

- Increase genetic pool
- Increase success
- Adjust species comp.
- Use “improved” stock
- Regulate spacing
300 TPA ≈ 12’ spacing
# ASCC: what should we plant?

## Reforestation-Revegetation Climate Change Primer

Incorporating Climate Change Impacts into Reforestation and Revegetation Prescriptions

<table>
<thead>
<tr>
<th>Habitat type group</th>
<th>Consider</th>
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<tbody>
<tr>
<td>Cool and moist</td>
<td>Lodgepole, spruce, subalpine fir. Avoid larch and white pine where dry, try Douglas-fir if not frosty.</td>
</tr>
<tr>
<td>Cool and moderately dry</td>
<td>Lodgepole. Larch and whitebark pine on moist microsites.</td>
</tr>
<tr>
<td>Moderately warm and moist</td>
<td>Ponderosa pine. White pine and larch on moister, cooler sites.</td>
</tr>
<tr>
<td>Moderately warm and moderately dry</td>
<td>Ponderosa pine. Western larch in deep soiled microsites.</td>
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ASCC: what should we plant?

- Future stands? Trees that perform well in future climate, resistant and resilient to future disturbance!
- Generally speaking, species expected to move up in elevation and latitude (Rehfeldt et al. 2006, Harsch et al. 2009, etc.)
- Alternatively, evidence that sometimes species move down in elevation (Crimmins et al. 2011; Flanary and Keane 2019)
- Adaptive management: question assumptions, diversify portfolio
ASCC: what should we plant?

Species Total
Larix occidentalis  72%
Abies lasiocarpa  7%
Pseudotsuga menziesii  7%
Betula papyrifera  5%
Pinus contorta  4%
Picea engelmannii  2%
Populus balsamifera  2%
Abies grandis  < 1%
Pinus monticola  < 1%
Populus tremuloides  < 1%
Pinus ponderosa  0%
ASCC: what should we plant?

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Elevation: 3,720’ – 4,240’

3 stock types
ASCC: what should we plant?

Resilience

- Understory light
- Soil moisture
- Temperature

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Elevation: 3,720’ – 4,240’

Transition

- 3 stock types
- 5 stock types

Elevation: 3,720’ – 4,240’

182 TPA

2150’

3800’

5500’

100 TPA

2150’

3800’

5500’

110 TPA

4650’

5300’
Benefits and implications of a flooded system

• Increase regeneration success
• Both natural and “improved” gene sources
  • De la Mata et al. 2017 – PP plantation genetics study
• Improved adaptive capacity
• Must monitor – this won’t be easy
• Must PCT – and this might not be either!
  • Selection attributes, ladder fuels
Initiating Climate Adaptation in a Western Larch Forest

Justin S. Crotteau, Elaine Kennedy Sutherland, Theresa B. Jain, David K. Wright, Melissa M. Jenkins, Christopher R. Keyes, and Linda M. Nagel

Western larch forests are iconic in the interior northwest, and as we document the precautionary steps that scientists and managers are taking to steward these forests into the future. Changing climates are forecast to have acute and chronic impacts on growth and resilience in western larch forests. A group of scientists and managers in the northern Rocky Mountains have teamed up with the Adaptive Silviculturists for Climate Change Network (ASCNet) to promote effective forest management for climate adaptation. The collaborative group developed a product of adaptive treatments (e.g., ecosystems, resilience, and transition) based on climate change scenarios and existing forest condition. A critical component of the treatment is the establishment of a seedstock baseline inventory to facilitate forest resilience and ensure long-term monitoring for adaptive experiments.

Keywords: Larch occurrence, adaptive management, experimental demonstration, silvicultural adaptation, Adaptive Silviculturists for Climate Change

Western Larch Forests

The western larch (Larix occidentalis Nutt.) forest type is a significant area in the interior northwest, occupying 1.7 million acres (4.2 million hectares) in great swaths of cool and moist, midelevation sites (Oswald et al.). Extensive western larch forests in the northern Rocky Mountains provide many ecosystem benefits such as carbon sequestration, cultural significance, timber for local communities, habitat for wildlife, recreation opportunities, and clean water. Historically, western larch forests have been both resilient to and

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adaptivesilviculture.org