Ecological silviculture for restoration and adaptation in conifer ecosystems of the Interior West

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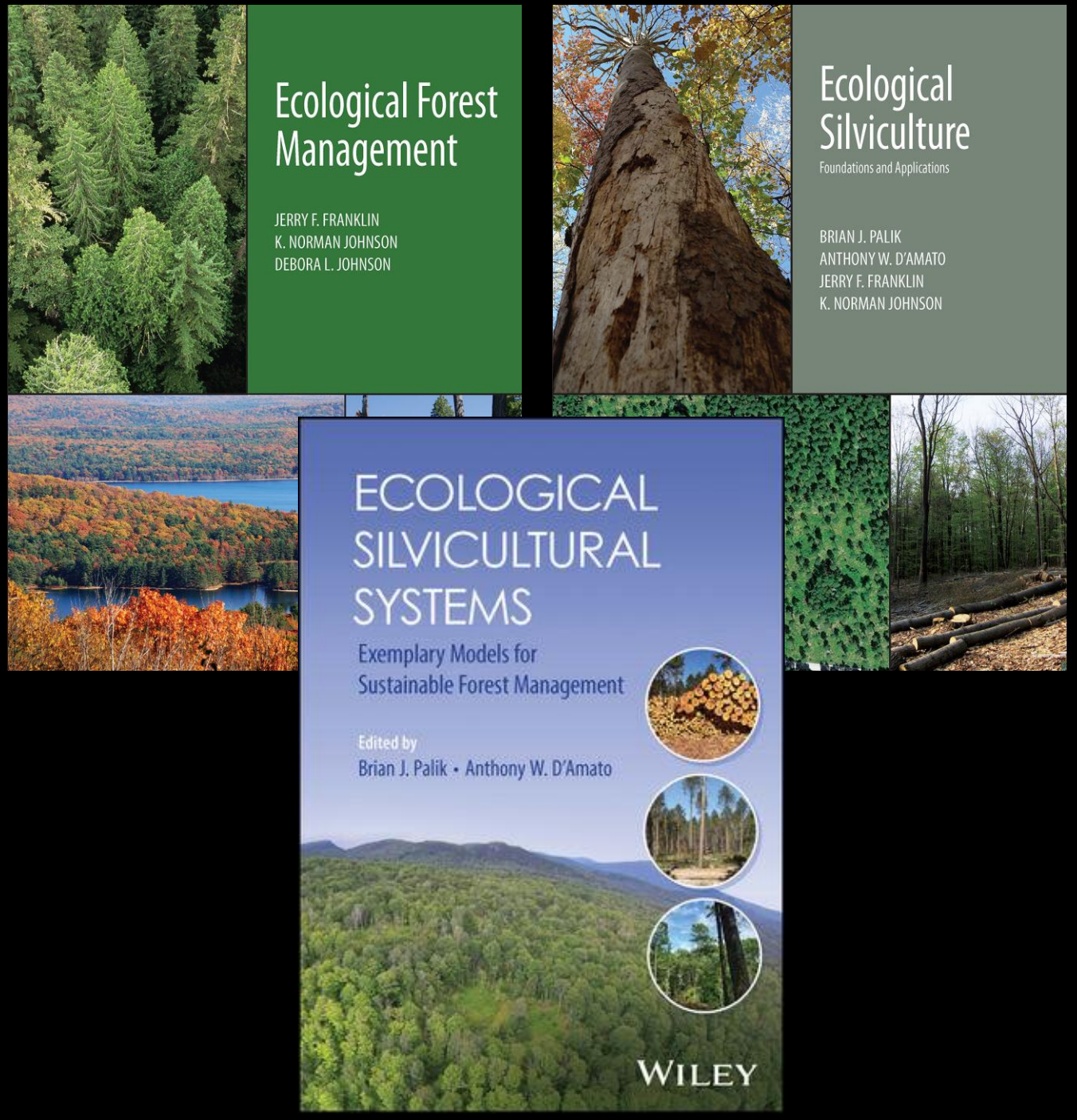
Ecological Forestry

- Draws on a foundation of ecological science
- Seeks to sustain ecosystem integrity and biodiversity
- Emulates and is compatible with the natural disturbance regime
- Emphasizes cash flows over maximizing ROI



Ecological Silviculture for Interior Ponderosa Pine and Dry Mixed-Conifer Ecosystems

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Ecological Silviculture for Interior Ponderosa Pine and Dry Mixed-Conifer Ecosystems

Andrew J. Larson[1] and Derek J. Churchill[2]

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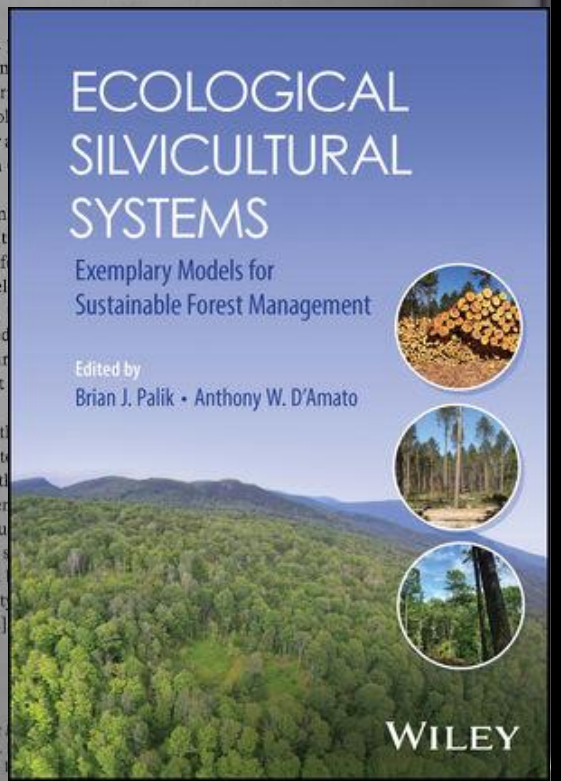
14.1 Introduction

Interior western ponderosa
ecosystems with a major pon
found throughout the inter
southern interior British Co
Great Plains. Mixed-conifer
nent occur in southwestern
the scope of this chapter.

This ecosystem was man
Euro-American settlement
focus after 1905 with the f
tury harvest focused on sel
In the post-WWII period,
silvicultural systems based
production. This agricultur
disturbance process that
resistant trees.

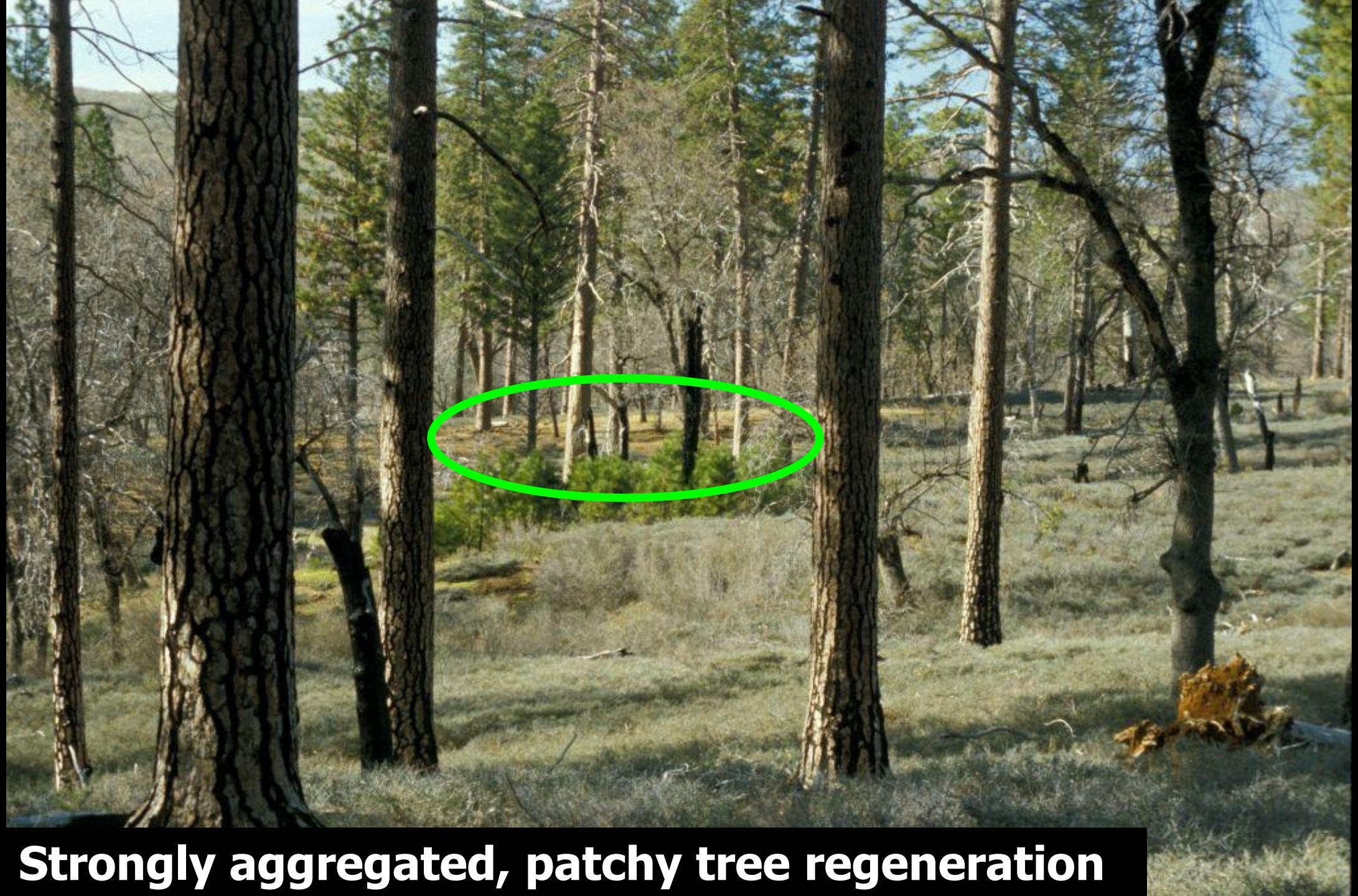
This chapter establishes t
silviculture in these ecosyst
wildfire, drought, bark beet
ing for an array of ecosyster
vicultural system that inclu
fire- and drought-resistant
ture in this forest type will
ience and adaptive capacit
large landscape strategy [2]



Ecological Silvicultural Systems:
First Edition. Edited by Brian J.

Ponderosa Pine and Dry Mixed-Conifer Forests

- **Fires every 5-35 years**
- **50-150 trees/hectare**
- **Fine-grain mosaic structure**

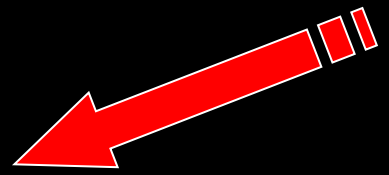


Strongly aggregated, patchy tree regeneration

Groups of mature trees die, often due to bark beetle attack.

Fire prepares a mineral soil seed bed.

Low surface fuel load initially protects seedlings.



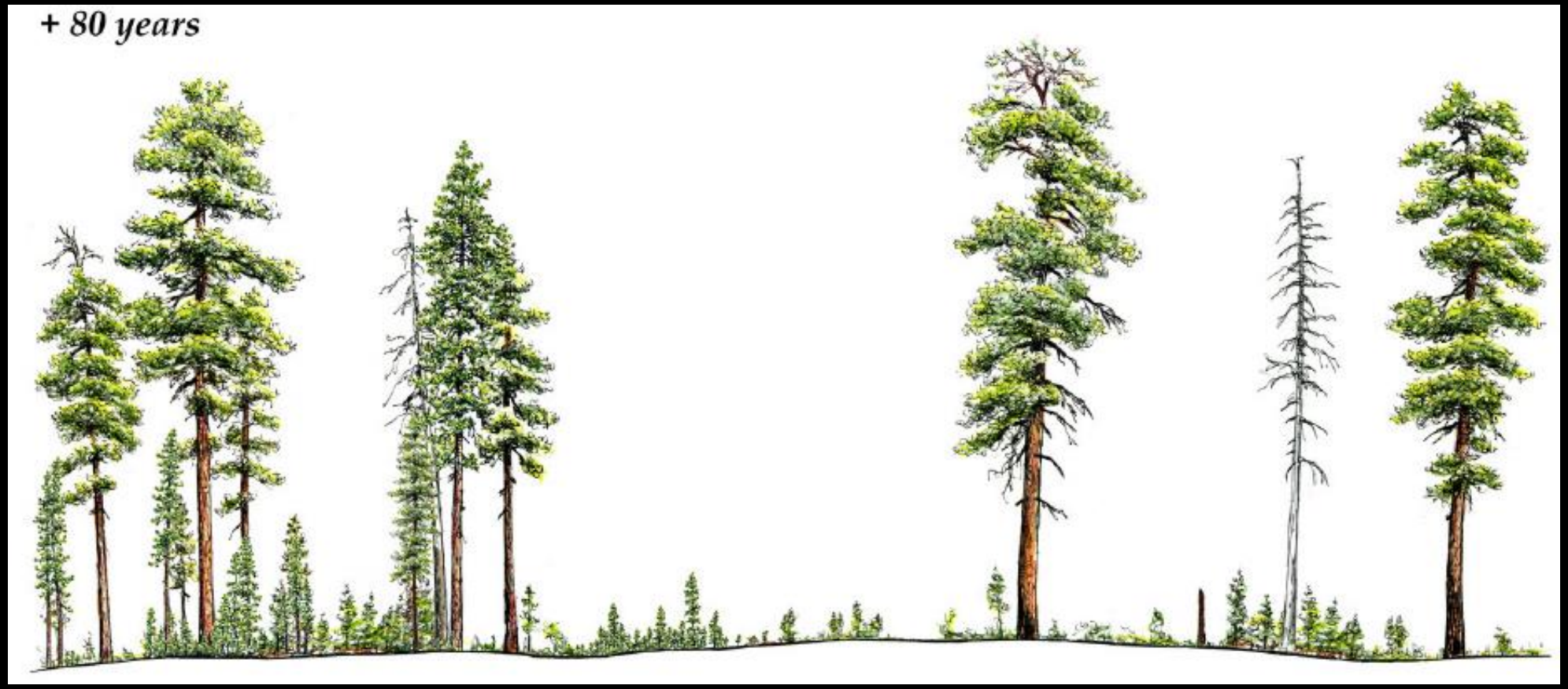
Low intensity fire **removes most saplings**, leaving stands dominated by large pines.

Time zero

Without fire suppression


+ 40 years


+ 60 years



Frequent fire maintains forest structure and composition by:

- **Consuming surface fuels**
- **Thinning small trees & fire-sensitive species**
- **Maintaining high live crown base and low stand density**
- **Limiting connectivity of canopy fuels**
- **Creating patchy regeneration opportunities**

Elements of an Ecological Silviculture System for Interior Ponderosa Pine and Dry Mixed-Conifer Ecosystems

1. Regenerate fire-tolerant tree species.
2. Recruit and perpetuate large and old (fire-resistant) tree populations.
3. Retain some dying and dead large-diameter trees as snags and logs.
4. Maintain low tree density with few ladder fuels.
5. Perpetuate a fine-grained spatial mosaic.
6. Maintain surface fuel loads conducive to low-severity fire.
7. Conserve native understory plant communities and broadleaf tree species.

1. Regenerate fire-tolerant tree species.

1. Regenerate fire-tolerant tree species.

2. Recruit and perpetuate large-diameter and old trees.

Photo: Mike Schaedel

3. Retain some dying and dead large-diameter trees as snags and logs.

Occupied Kestrel nest cavity in same snag as the Great Horned Owls!

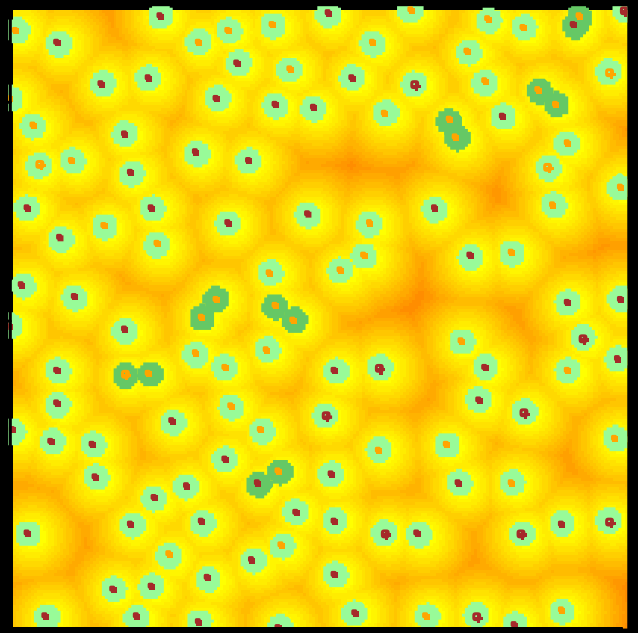
American Kestrel

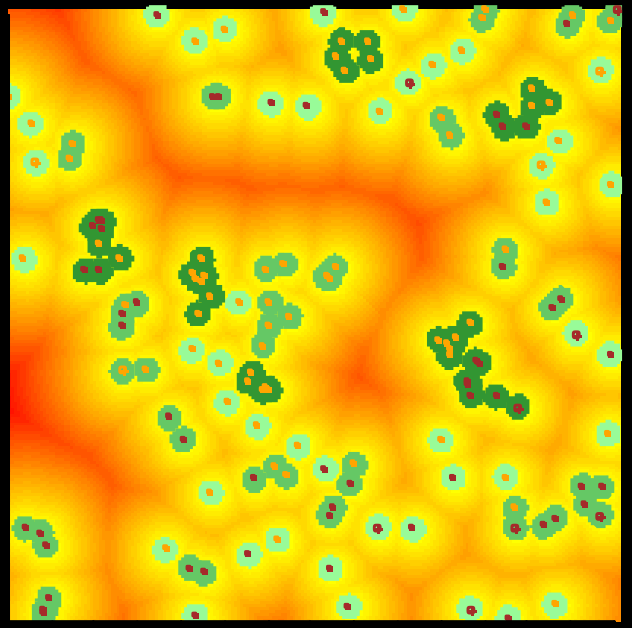
Retain some dying and dead large-diameter trees as snags and logs.

4. Maintain low tree density with few ladder fuels.

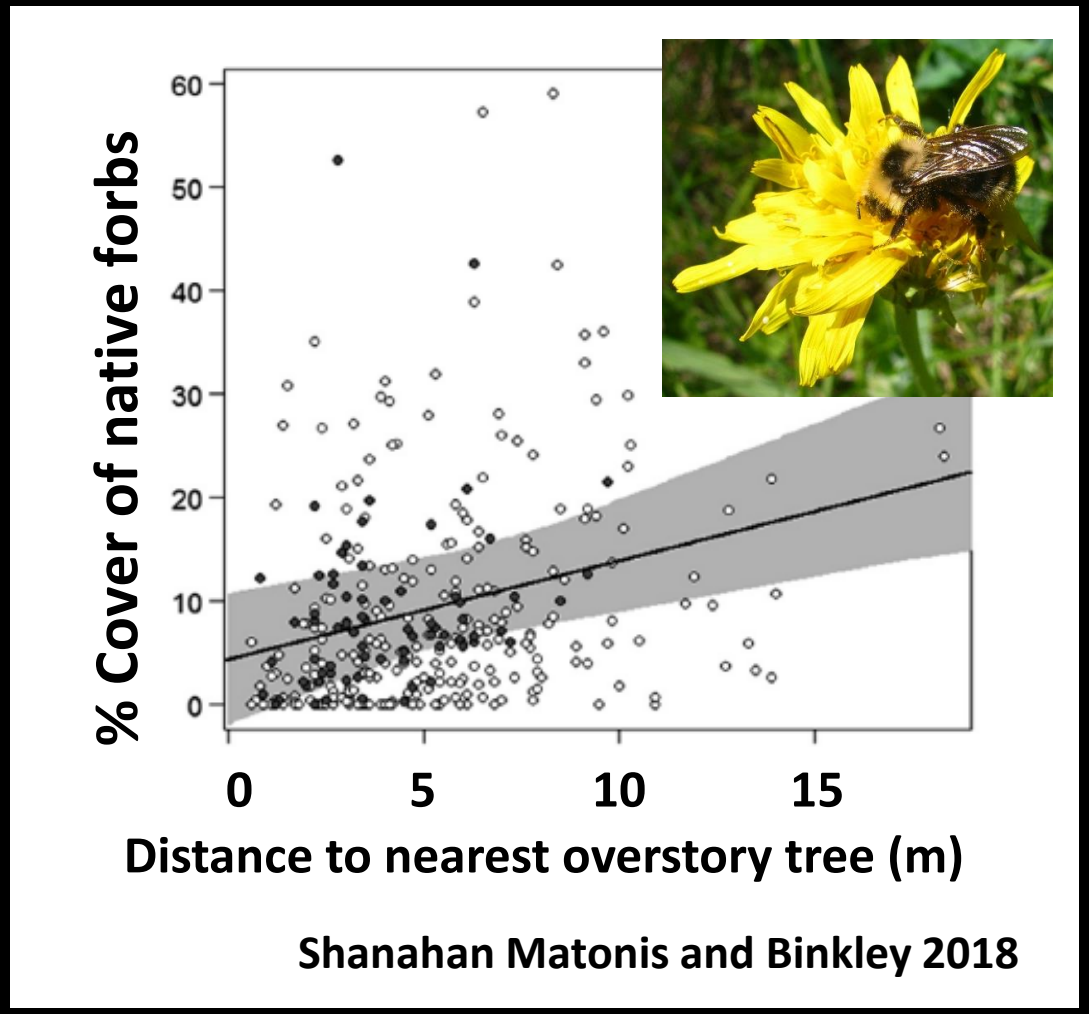
Target as low as 15% to 30% of max SDI.

5. Perpetuate a fine-grained spatial mosaic





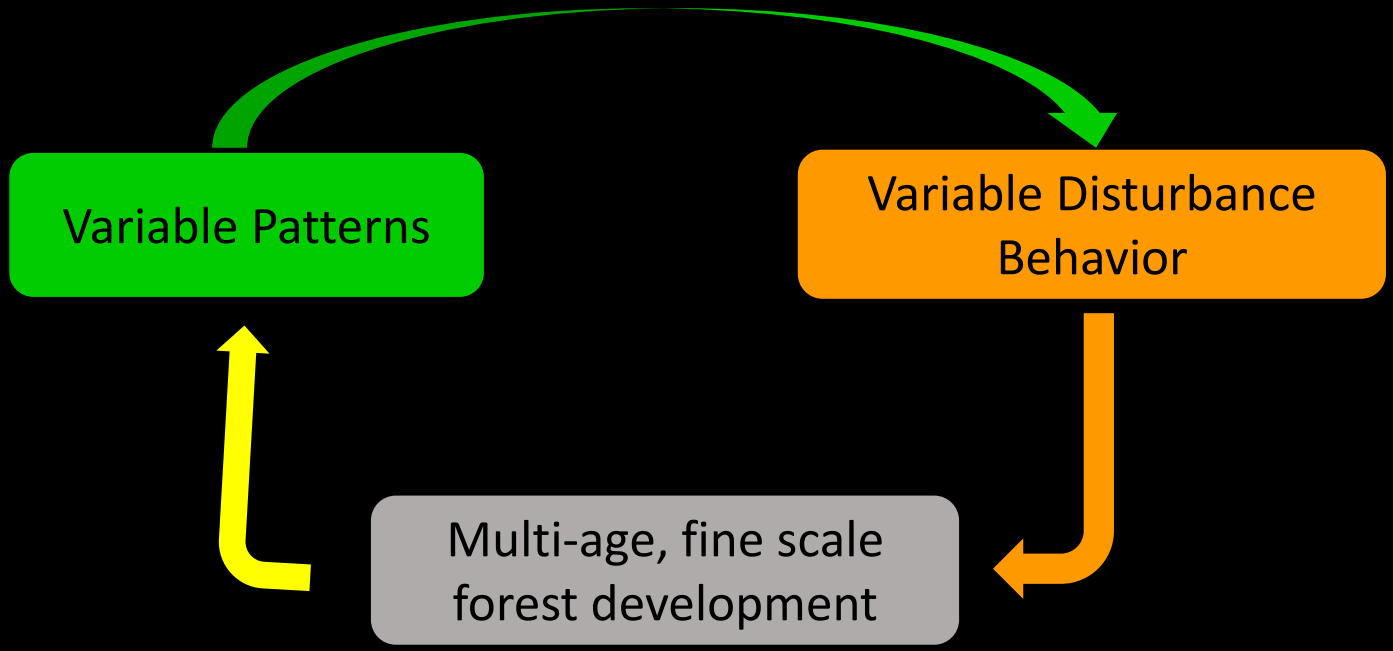
Why does pattern matter?

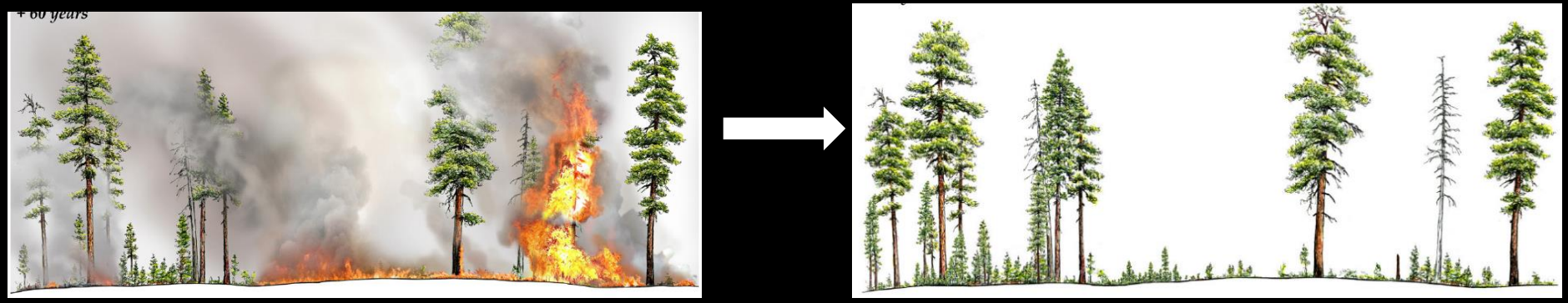


Pattern influences ecosystem function

- Snow retention
- Plant diversity & cover
- Bird and small mammal habitat
- Food web complexity
- Insect and pathogen spread

Variable patterns are a key driver of forest development





6. Maintain surface fuels conducive to low-severity fire. Prescribed fire is the best approach.

Immediate effects of the Bootleg Fire in southern Oregon, 2021. Photo: Steve Rondeau

7. Conserve native understory plant communities and broadleaf tree species.

Example Applications in Contrasting Initial Conditions

- High Density, Even-Aged
- High Density, Multi-Cohort with Fire- and Drought-Tolerant Species
- Recent Wildfire
- Low Density, Multi-Cohort

Even-aged, high-density initial condition

Generic Rx: VDT with explicit guidance to create spatial variability.

Individuals, Clumps, & Openings Method

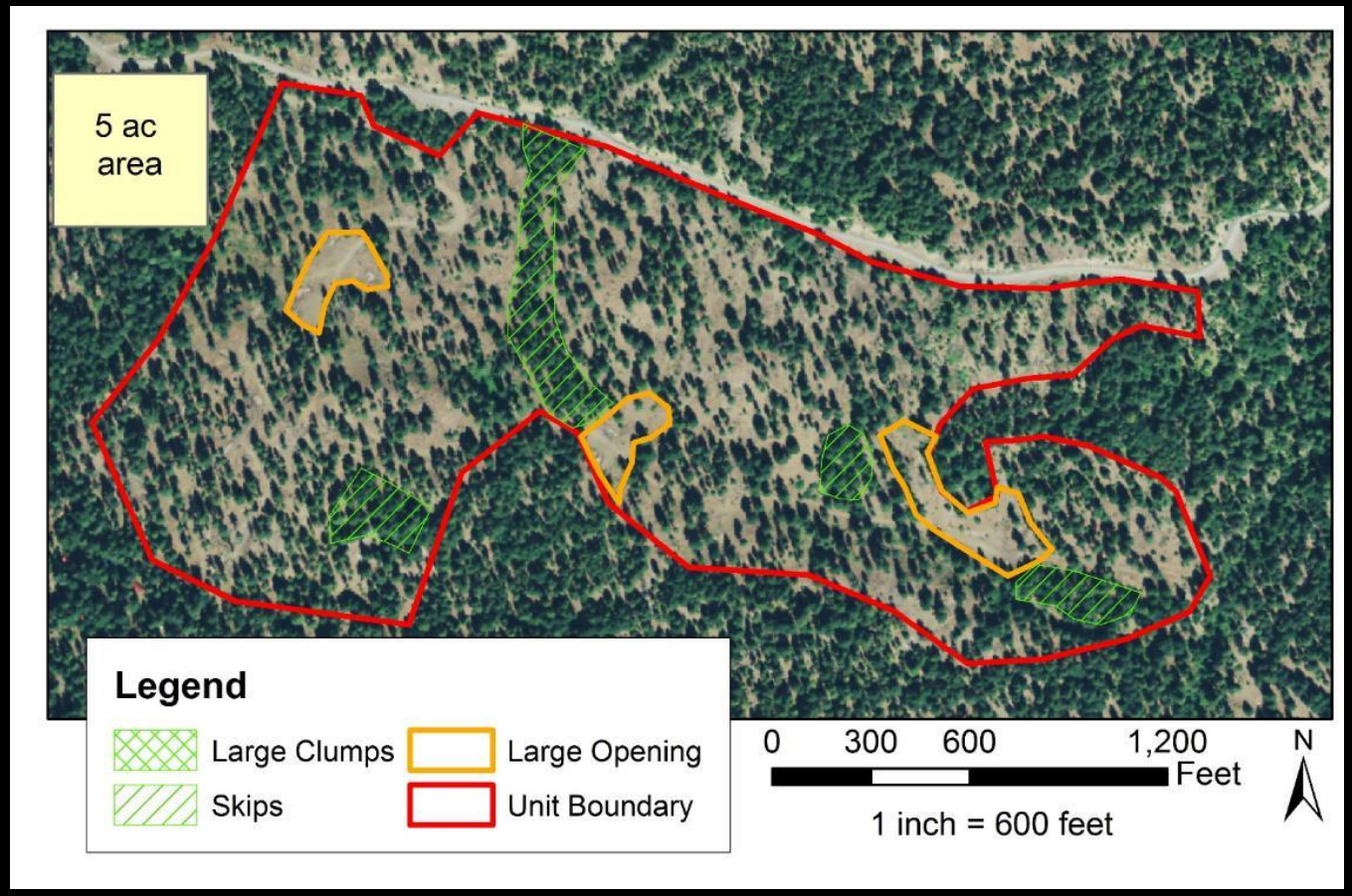
1. Consider skips and special areas
2. Consider openings
3. Determine target stand density
4. Set clump distance (6 m/20 ft)
5. Set clump proportions
6. Calculate clump targets for **whole unit**
7. Set leave tree criteria: species, size, age, crown form, etc.

ICO Silvicultural Approach

SAMPLE Rx for 10 ac unit:

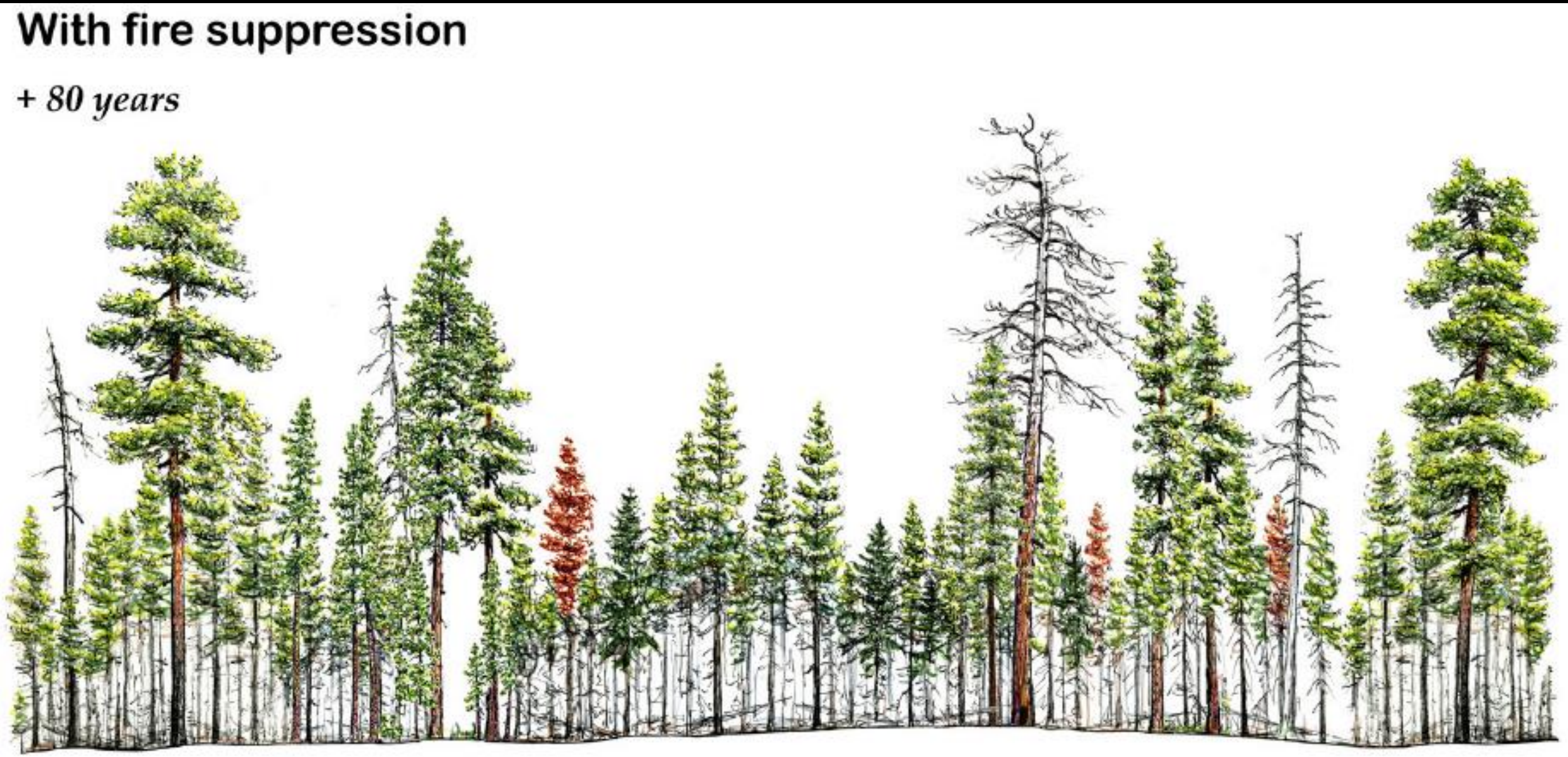
- ID & Layout skips & large openings
- Leave all old trees—don't thin clumps
- Favor ponderosa pine & larch
- Thin primarily from below
- Select for good crowns
- Leave up to 5 wildlife TPA
- Protect large snags & logs

- Leave 40 TPA in clump sizes below
- Clump targets need not be met on every acre—work with existing conditions



Clump Size →	Individuals 1	Small 2-4	Medium 5-10	Large 11-20+
Unit totals →	90	50	10	10

High Density, Multi-Cohort with Fire- and Drought-Tolerant Species



High Density, Multi-Cohort with Fire- and Drought-Tolerant Species

- Remove ladder fuels around existing large/old trees but don’t thin OG clumps.
- ICO or similar approach VDT to create spatial variability.

Implementation monitoring in real time.

Implementation monitoring in real time.

Follow green-tree treatments with Rx fire to manage surface fuels and treat activity fuels.

Recent Moderate- and High-Severity Wildfire

Wildfires often trigger a switch in management philosophy and approach

- Ecologically based management pre-fire
- Economically based management post-fire (salvage, plant, hazard)

https://www.fs.usda.gov/nfs/11558/www/nepa/108320_FSPLT3_4322117.pdf

“After the fire, the Center Horse project and its analysis were set aside…”

“Many of the proposed beneficial outcomes of this project are now foregone.”

Section 1.2. Rice Ridge Fire Salvage EA.

https://www.fs.usda.gov/nfs/11558/www/nepa/108320_FSPLT3_4322117.pdf

Rice Ridge Fire Salvage Project EA. Section 1.3 Purpose and Need for Action.

1. Recover economic value.
2. Focus on hazard reduction.
3. Plant to re-establish forest

https://www.fs.usda.gov/nfs/11558/www/nepa/108320_FSPLT3_4322117.pdf

Ecological Forestry, “emulates and is compatible with the natural disturbance regime”

Where did wildfire:

- Do beneficial work consistent with the natural disturbance regime?
- Make progress towards desired conditions, but leave need for follow-up?
- Overshoot and cause new issues due to uncharacteristic severity or patch sizes?

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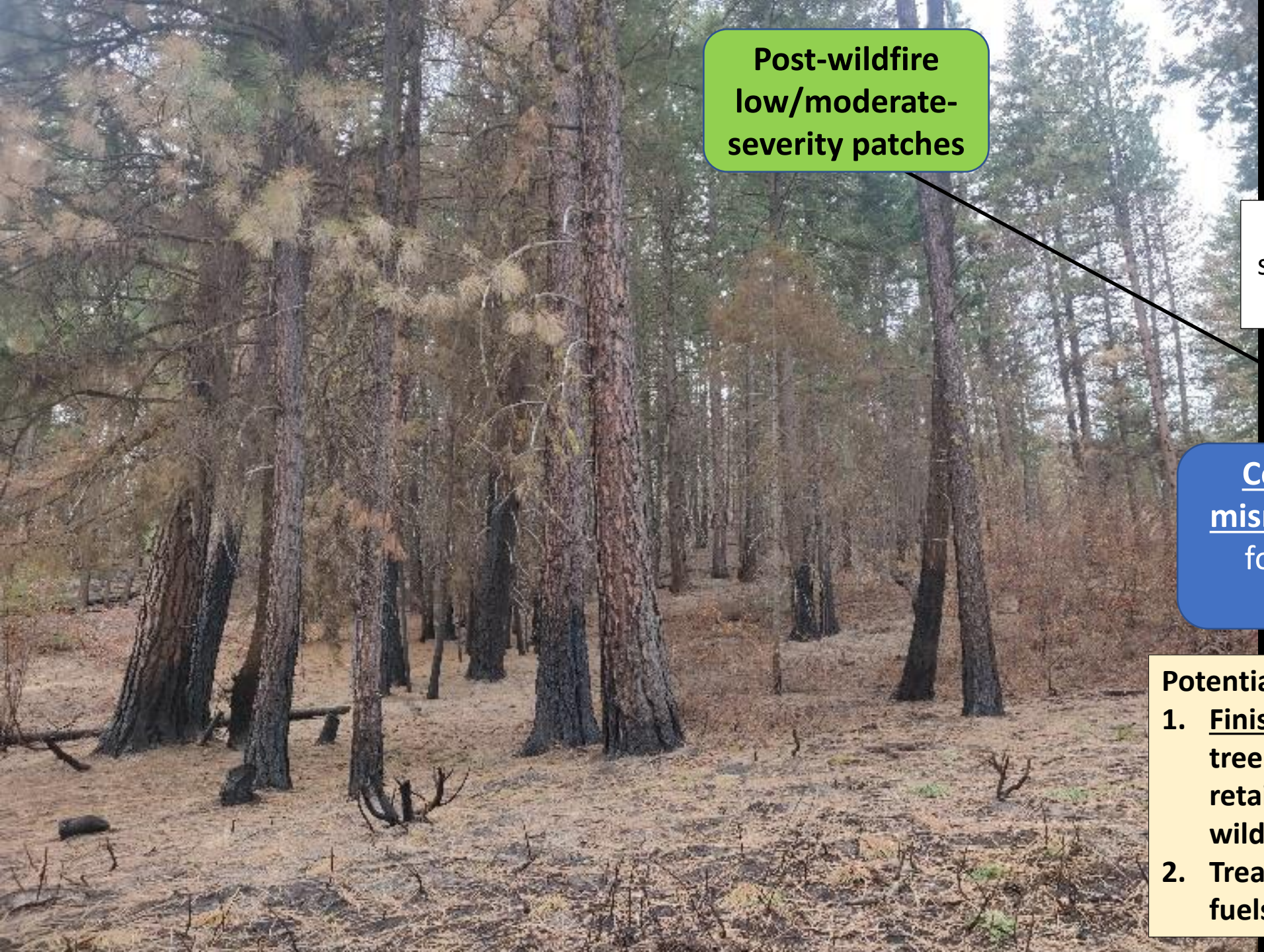
journal homepage: www.elsevier.com/locate/foreco

Tamm reviews

Tamm Review: Ecological principles to guide post-fire forest landscape management in the Inland Pacific and Northern Rocky Mountain regions

Andrew J. Larson [a,*], Sean M.A. Jeronimo [b,f], Paul F. Hessburg [c,f], James A. Lutz [d], Nicholas A. Povak [e], C. Alina Cansler [f], Van R. Kane [f], Derek J. Churchill [g]



Post-wildfire low/moderate-severity patches

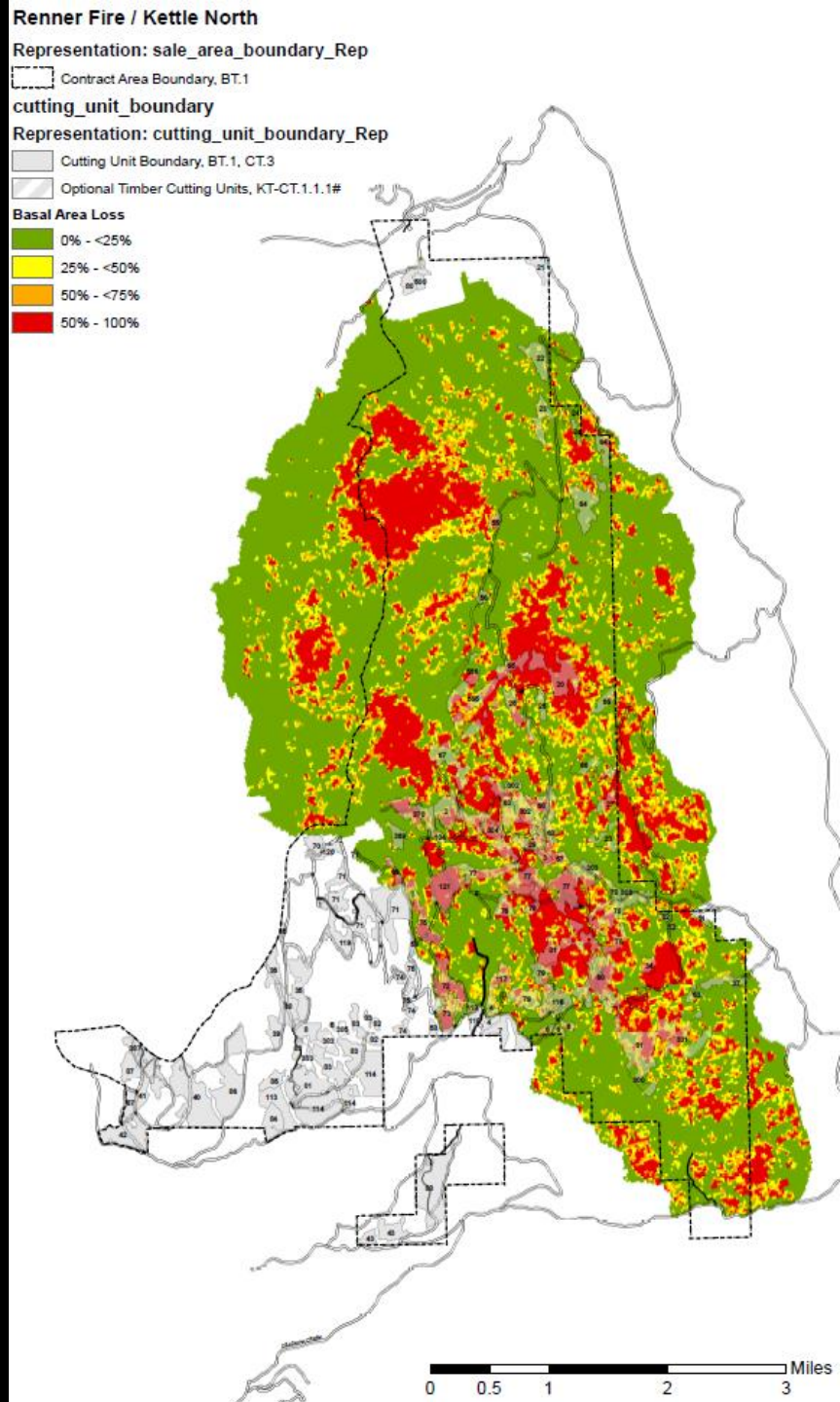
Too many fire-intolerant species or stem density/canopy cover too high

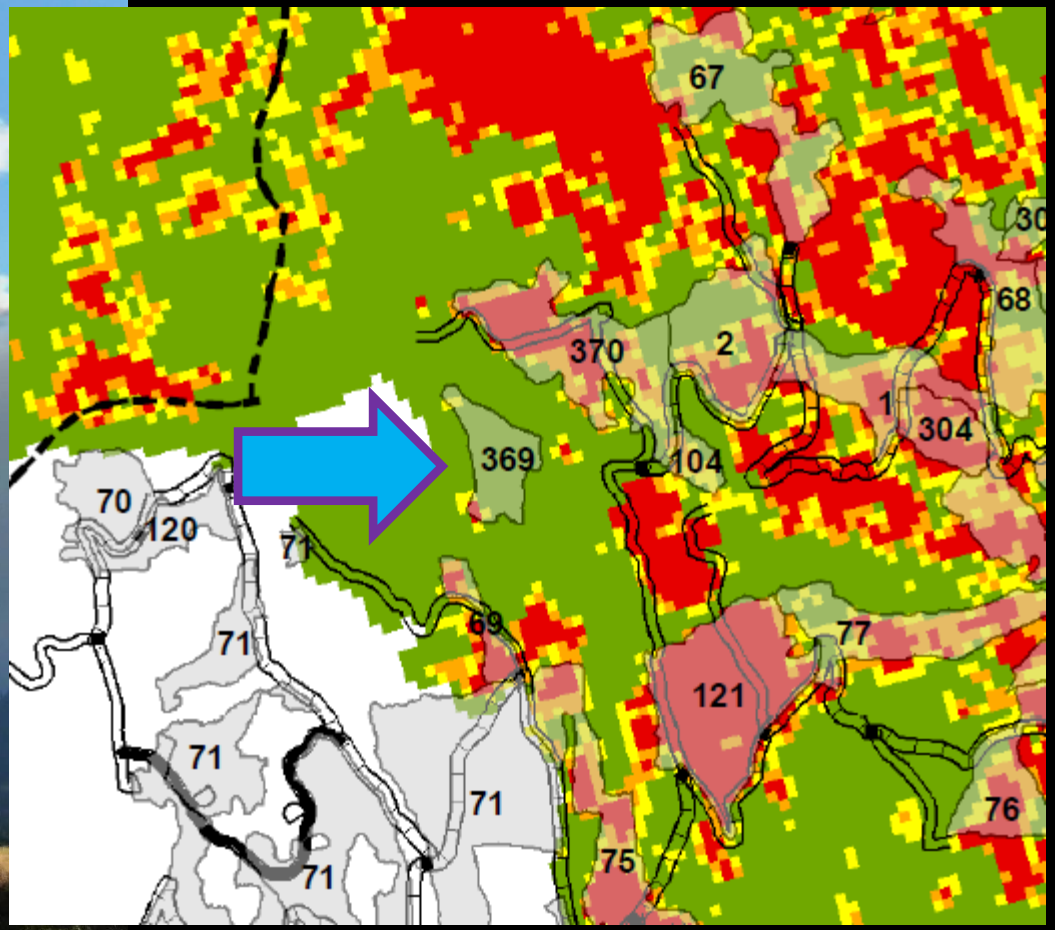
<u>Composition/Structure mismatch.</u> Potential priority for immediate post-fire treatment.

Potential Rx:

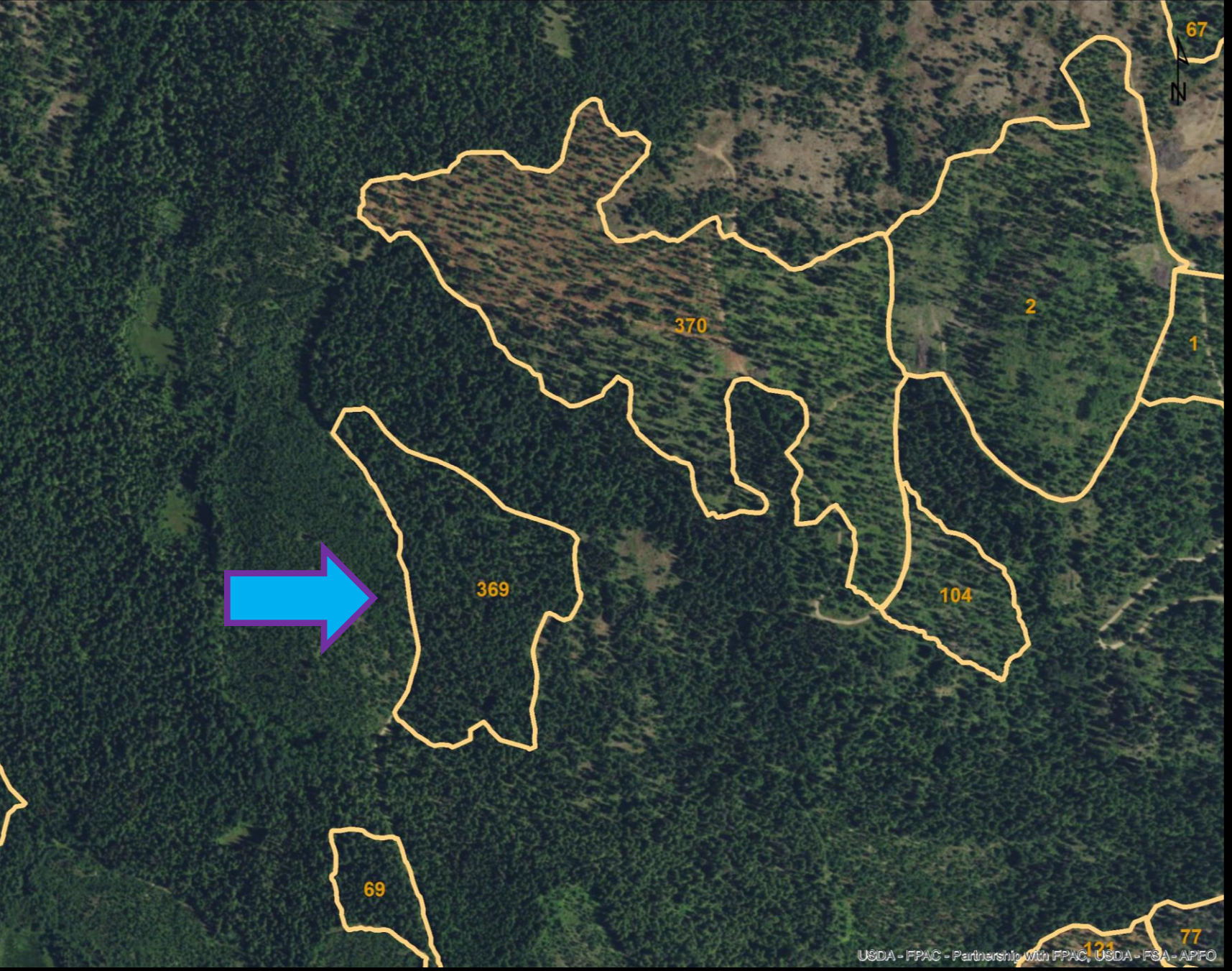
1. **<u>Finish the job</u> with green & dead tree harvest to reduce fuel while retaining appropriate snags for wildlife.**
2. **Treat fire-caused and activity fuels with Rx fire or pile burning.**

Photos courtesy James Pass, Silviculturist, Colville NF





Photos courtesy James Pass, Silviculturist, Colville NF



2015 Pre-fire

Photos courtesy James Pass, Silviculturist, Colville NF

2015 Post-fire

Photos courtesy James Pass, Silviculturist, Colville NF

Shelterwood with Reserves

James Pass, Silviculturist, Colville NF

- Leave all live trees ≥ 21” dbh regardless of species.
- Leave all live trees that had orange paint before the fire.
- Leave dead standing trees that had orange paint before the fire; fell these trees and leave them on the ground if they are a safety hazard.
- LTA – leave tops attached to reduce activity slash.

Photos courtesy James Pass, Silviculturist, Colville NF

Shelterwood with Reserves

James Pass, Silviculturist, Colville NF

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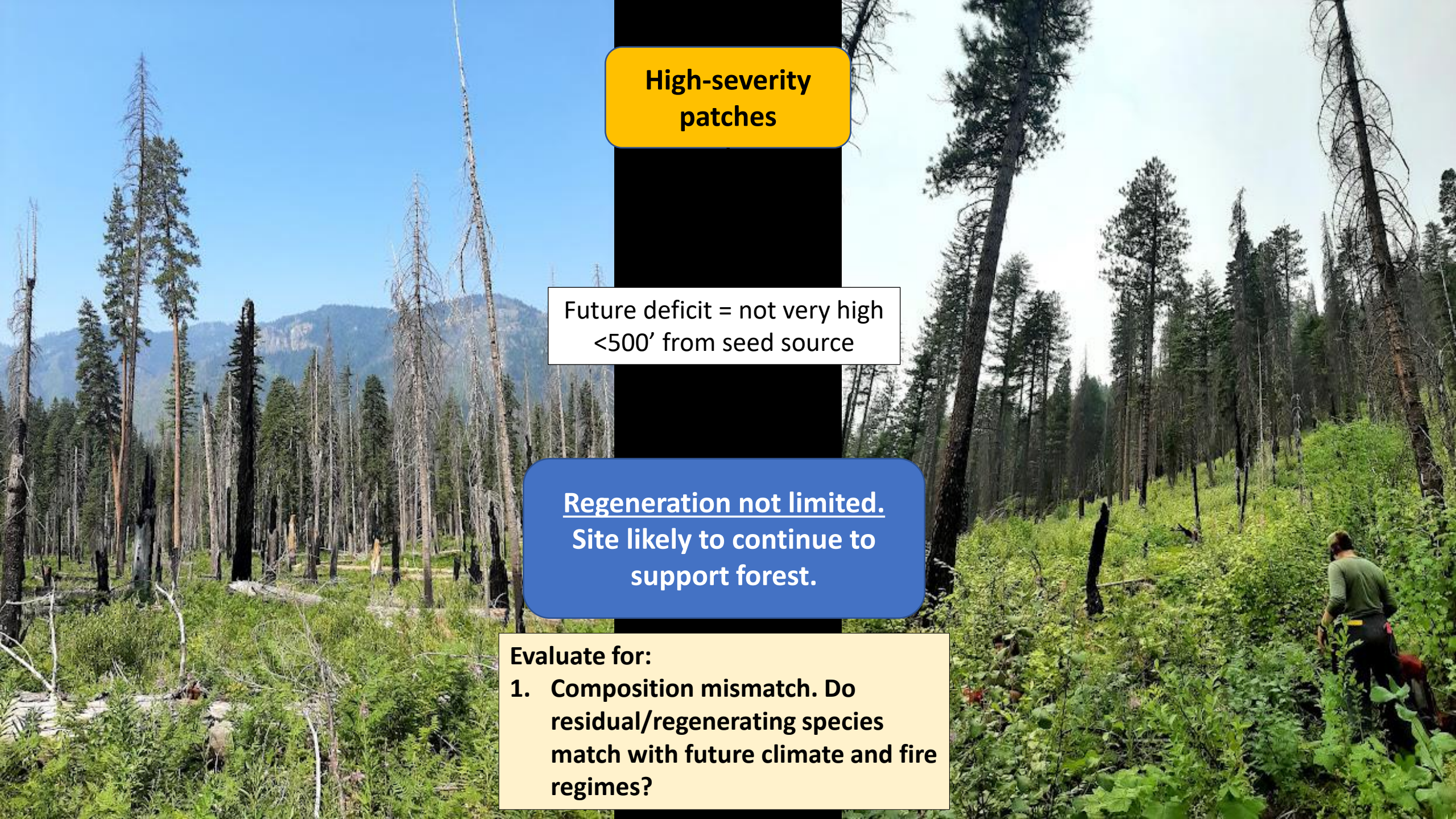
- LTA – leave tops attached to reduce activity slash.

Photos courtesy James Pass, Silviculturist, Colville NF


High-severity patches
Future deficit = very high
Climate limited. Site not likely to support forest. Low reforestation priority.
Potential Rx:
1. No action
2. Economic salvage
3. Invasive species mitigation



High-severity patches

Future deficit = not very high
<500’ from seed source

<u>Regeneration not limited.</u>
Site likely to continue to support forest.

Evaluate for:

1. **Composition mismatch. Do residual/regenerating species match with future climate and fire regimes?**

High-severity patches

Future deficit = not very high
>500’ from seed source

<u>Dispersal limited.</u> Site likely to support forest. Higher reforestation priority.

Potential Rx:

1. **Planting**
2. **Harvest to manage future fuels with snag retention for wildlife and attention to soils/aquatics.**
3. **No action if landscape low on early-seral, open**

Post-wildfire planting

- Tool to overcome dispersal limitation in large, high-severity patches

- Excellent option for RESIST and DIRECT adaptation strategies
  - Planted seedlings can survive on challenging sites where natural regen may not
  - Adaptively move species and genotypes

- Don’t restrict planting sites to locations where decision support tools predict 100% survival—massive missed opportunity

Maintaining the Desired Condition: Low Density, Multi-Cohort

- Use managed wildfire to maintain the natural disturbance regime and developmental model
- Most viable in Parks, Refuges, Wilderness, and remote areas

- Use managed wildfire to maintain the natural disturbance regime and developmental model
- Most viable in Parks, Refuges, Wilderness, and remote areas

- Multi-aged management: Individual and small group selection w/entries every 15-30 years
- Can maintain large/old tree population even while harvesting some groups to establish new cohorts
- Requires careful attention to provision of large snags and logs

- Group selection to create openings suitable to regenerate new cohorts of pine and larch

Use Rx fire to:

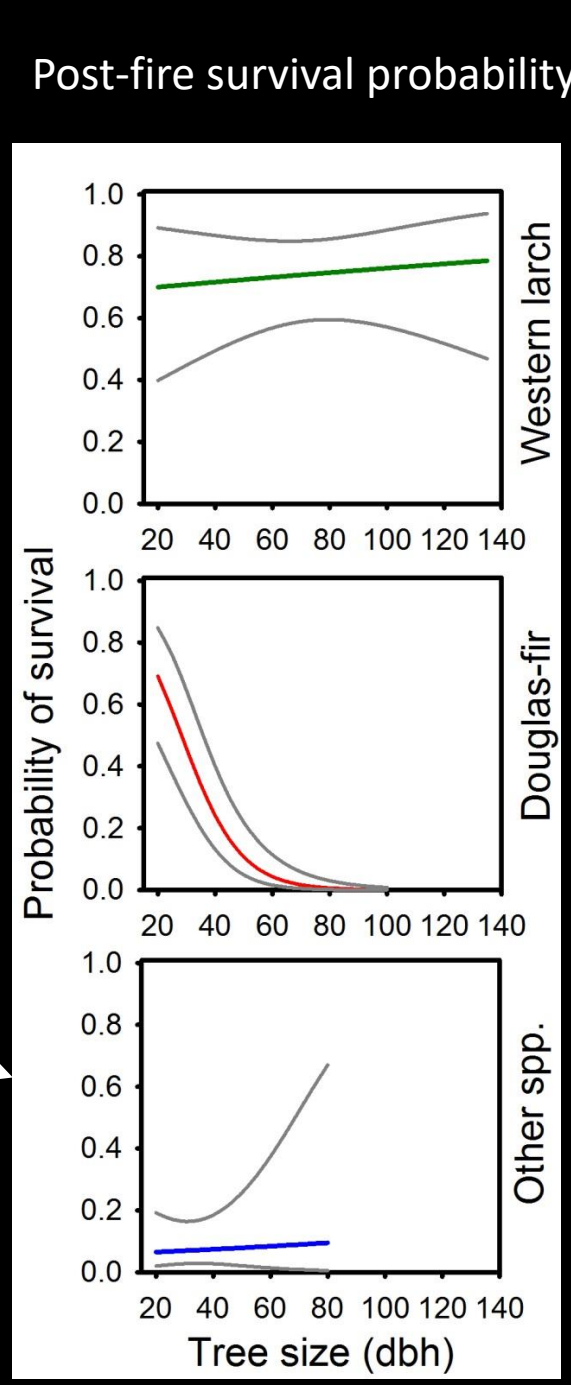
- Manage surface fuels, increase crown base height, reduce shade-tolerant regen abundance
- Create regeneration opportunities for pine and larch

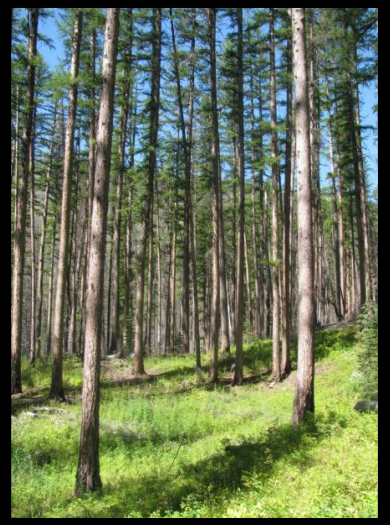
Questions on Ecological Silviculture for Ponderosa Pine and Dry Mixed-Conifer?

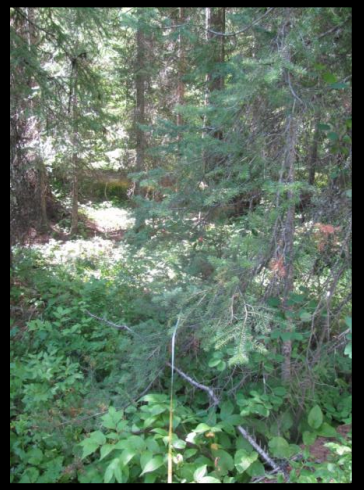
Adaptive Complexity Thinning in Montane and Subalpine Mixed-Conifer Ecosystems

Montane & subalpine mixed-conifer forest

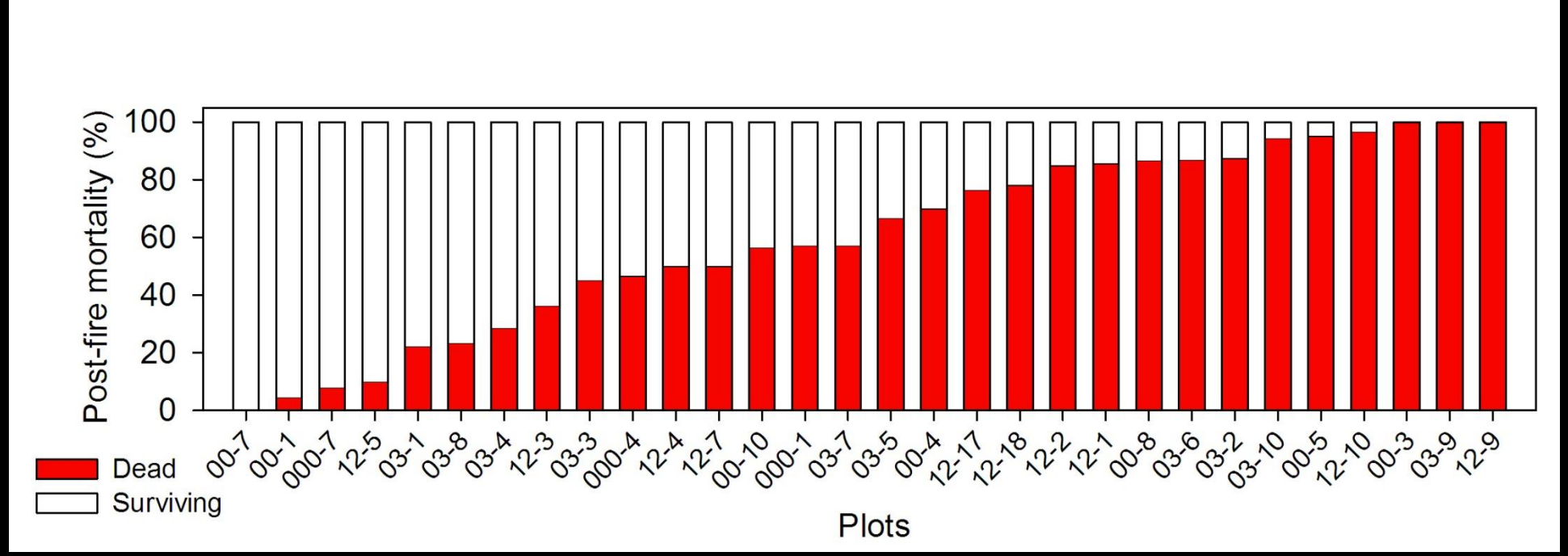
- *Larix occidentalis* (western larch)
- *Pseudotsuga menziesii* (Douglas-fir)
- *Pinus contorta* (lodgepole pine)
- *Picea engelmannii* (Engelmann spruce)
- *Abies lasiocarpa* (subalpine fir)







Mixed-interval, mixed-severity fire regime

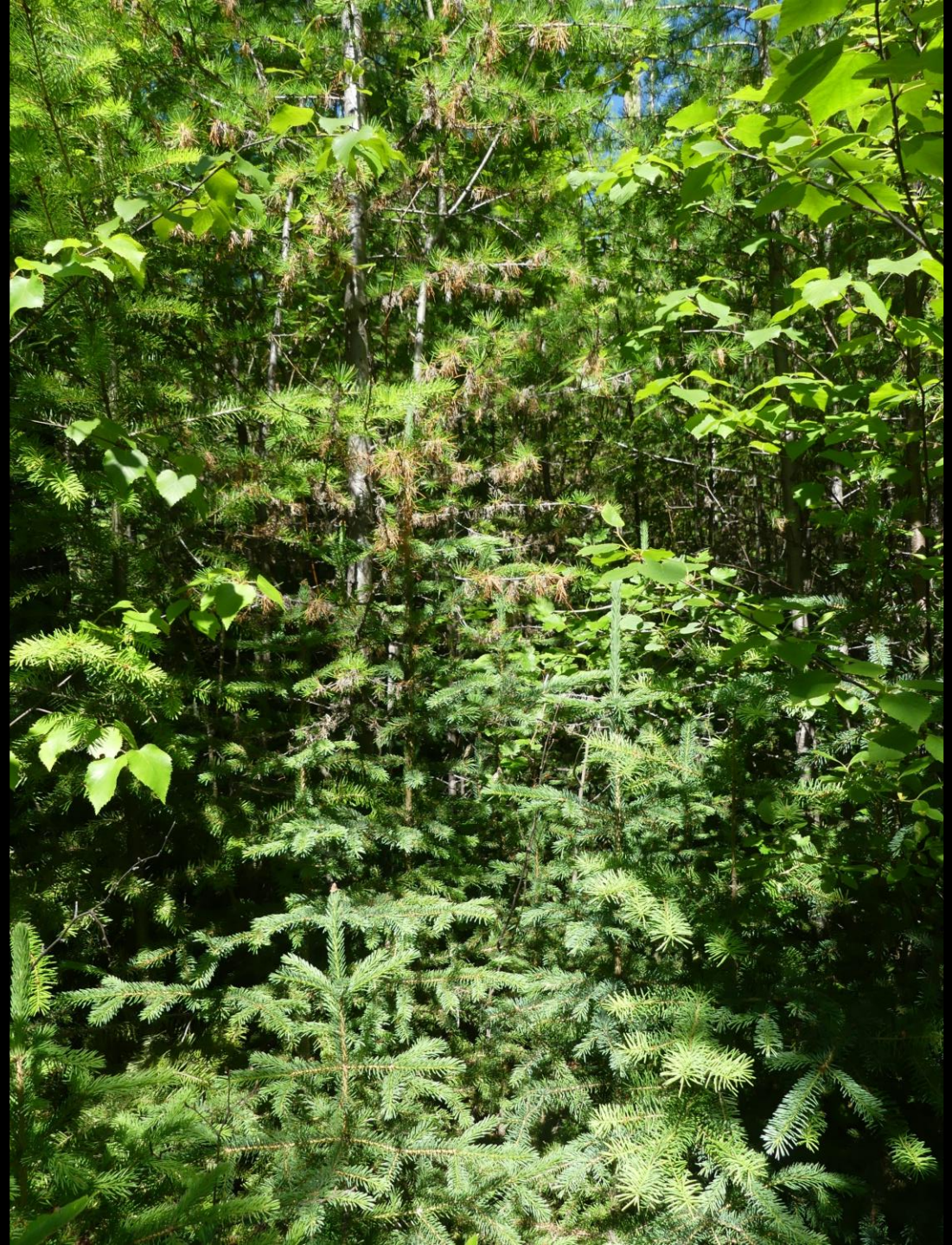


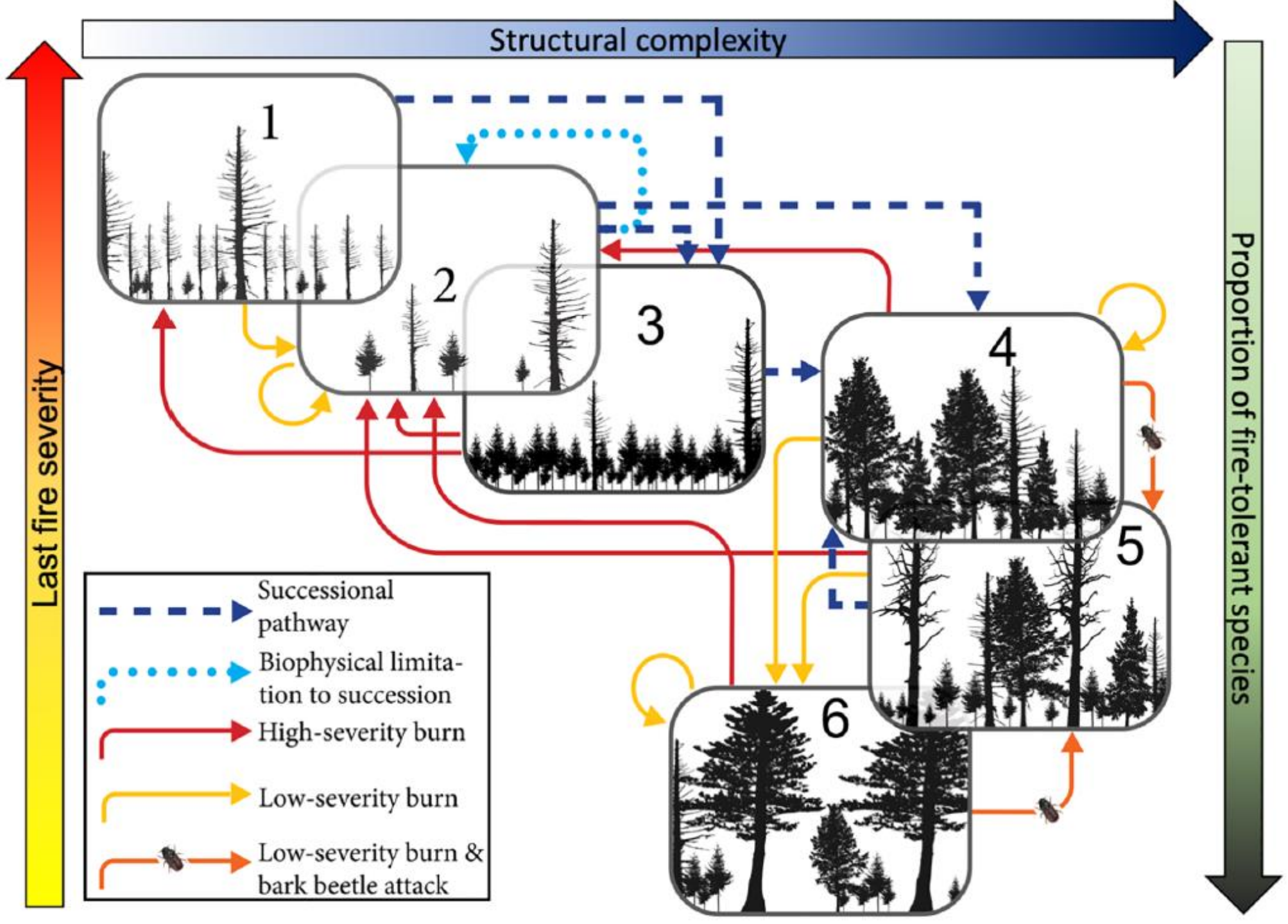
Unburned

21 % mortality

63 % mortality

99 % mortality





Berkey et al. 2021, FEM

Photo: Michael Schaedel, TNC

Photo: Andrew J. Larson

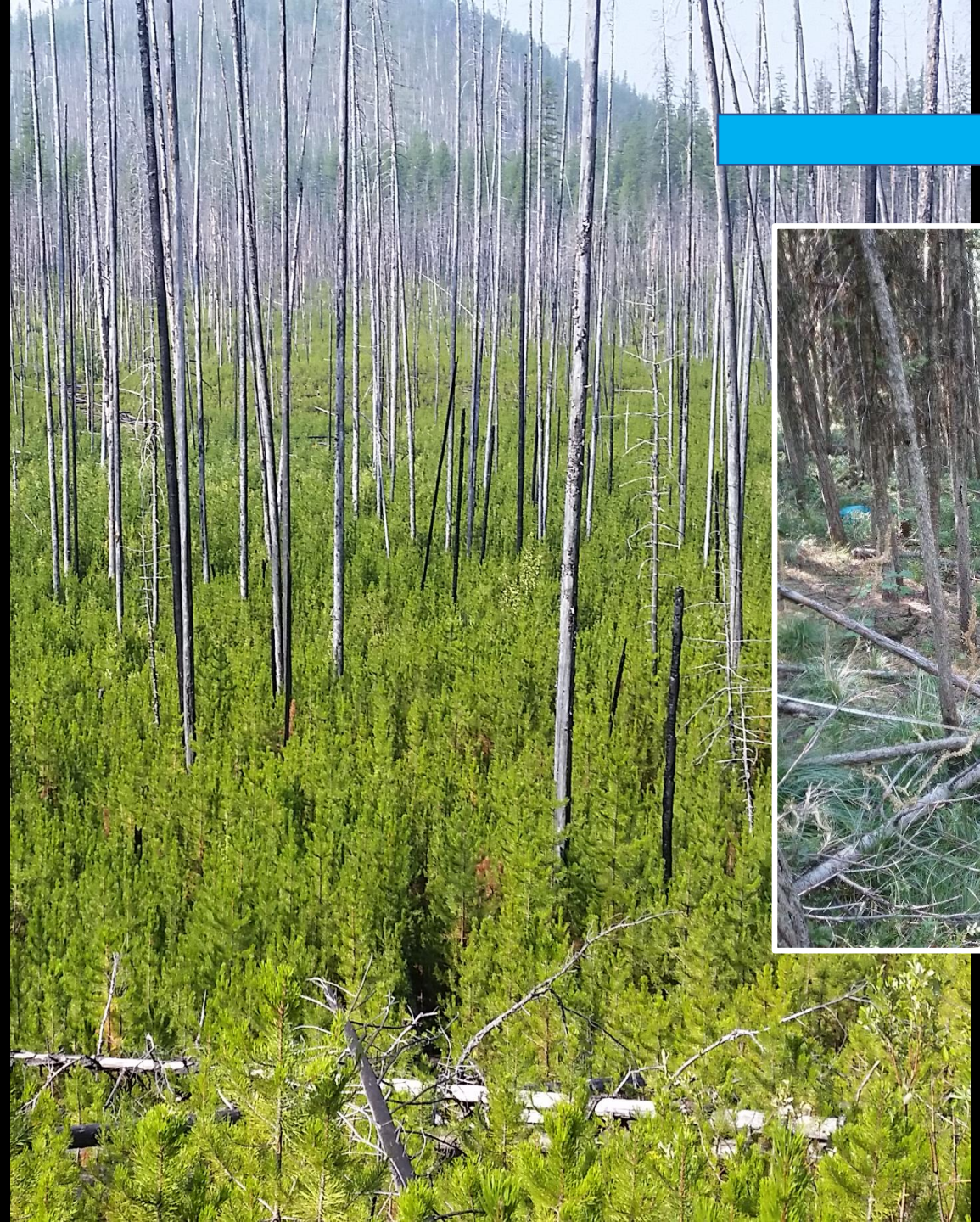


Photo: Swan Valley Connections

Natural forest development
Harvest or severe fire
Adaptive Complexity Thinning
Precommercial Thinning

Complex structure
Multi-layered canopy
Large trees and logs

Complex structure
Multi-layered canopy
Large trees and logs

Forest Structural Complexity

Simple structure
Single-layer canopy
Small diameter trees

Time

Natural forest development
Harvest or severe fire
Adaptive Complexity Thinning
Precommercial Thinning

Complex structure
Multi-layered canopy
Large trees and logs

Complex structure
Multi-layered canopy
Large trees and logs

Forest Structural Complexity

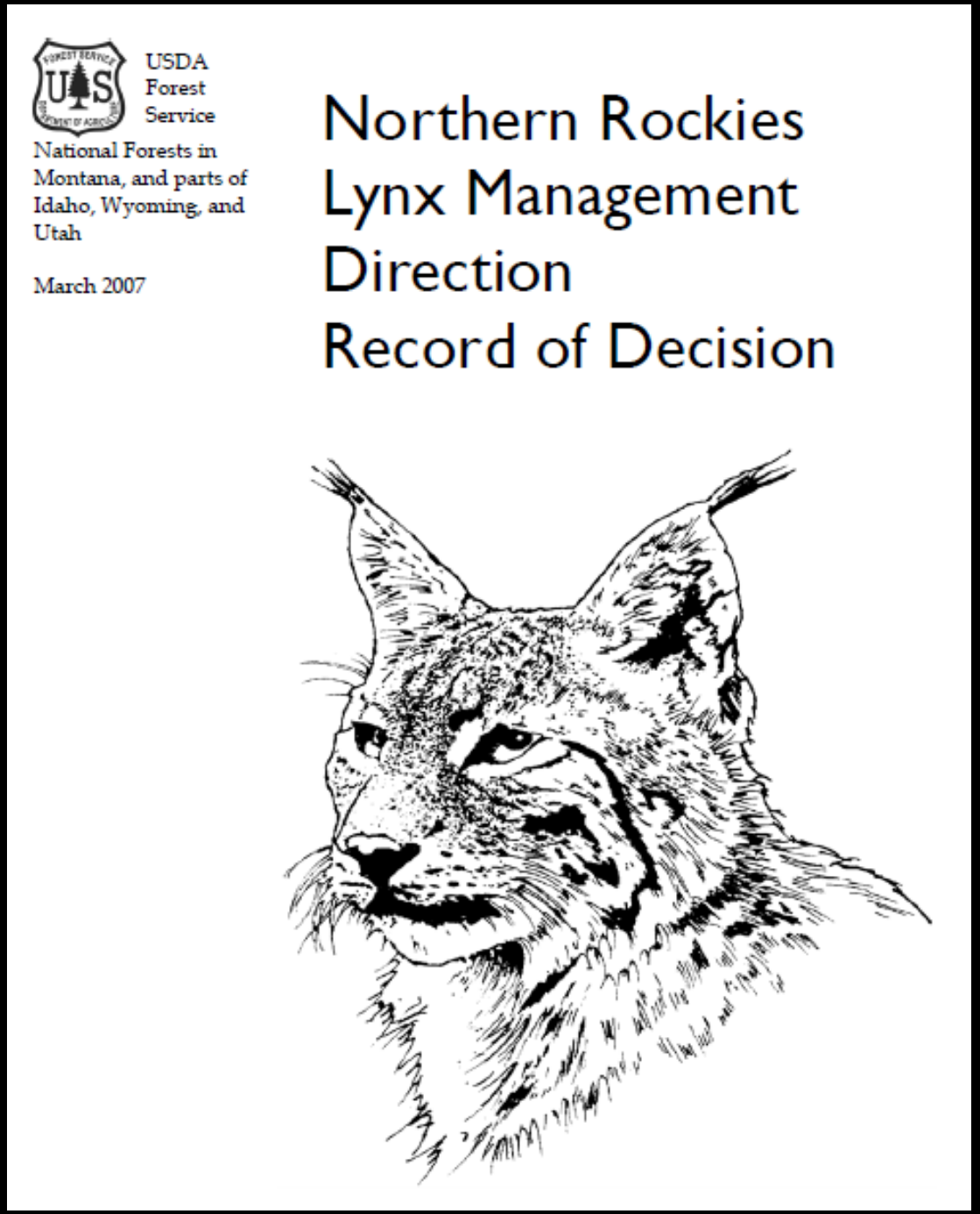
Time

Precommercial Thinning
Accelerated tree growth
Single canopy layer

Simple structure
Single-layer canopy
Small diameter trees

PCT only allowed in winter hare habitat (Standard VEG S5):

- WUI fuels reduction
- W/in 200’ of administrative sites
- For research studies
- If new peer reviewed information suggest short-term adverse but long-term positive effects to lynx & habitat
- Aspen conservation
- Daylighting rust-resistant WWP
- WBP restoration



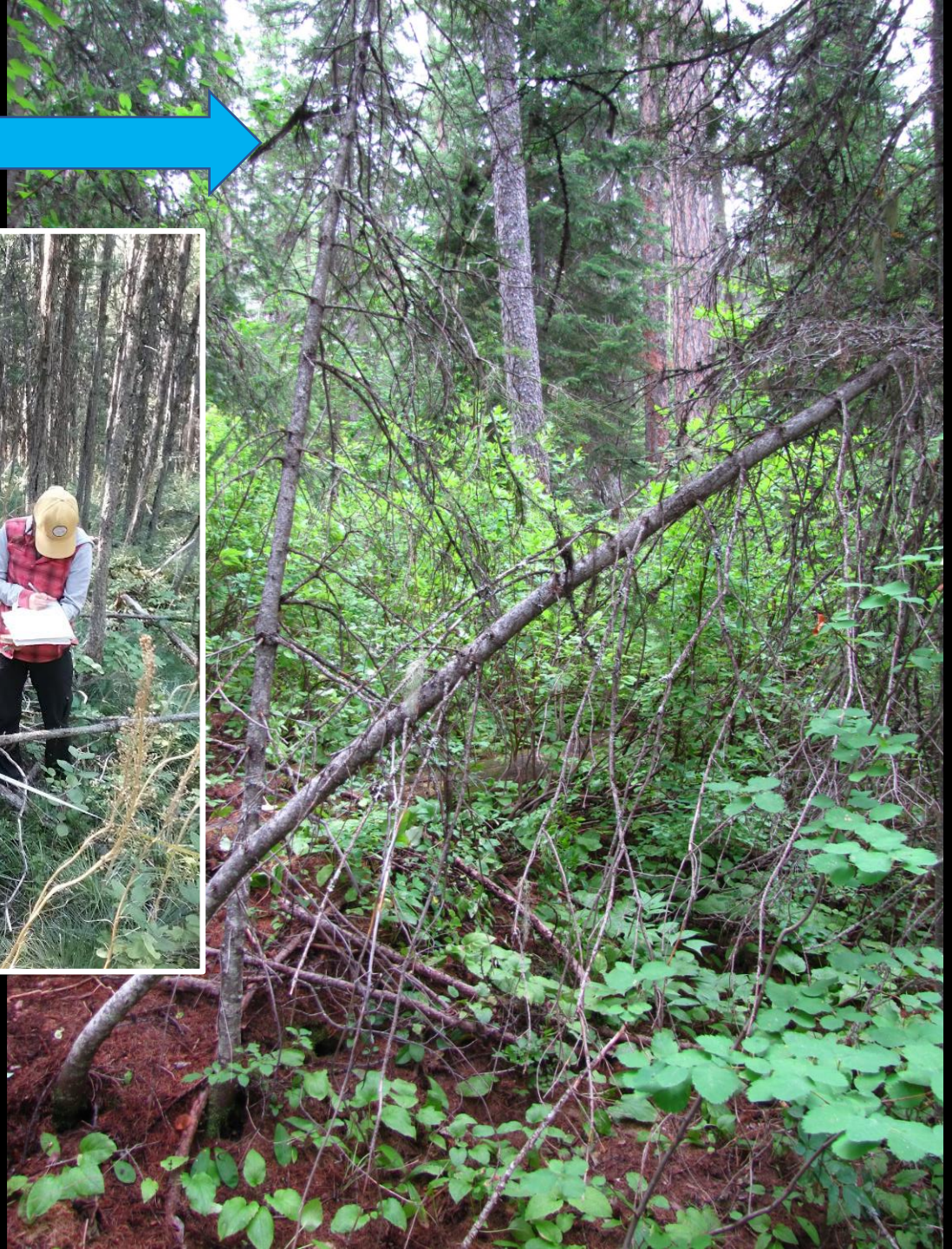


Photo: Scott Mills, U. Montana

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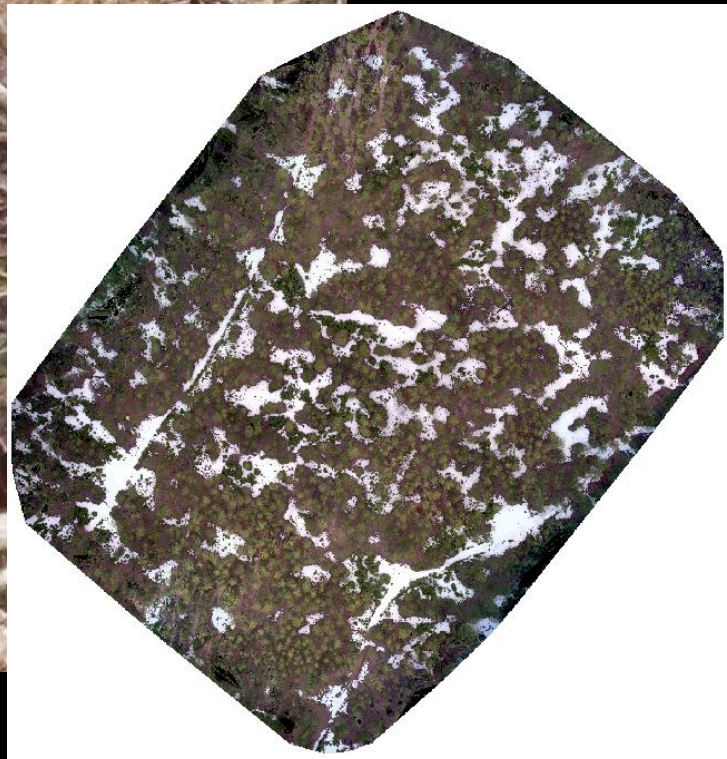


- Open growing space for residual overstory trees
- Accelerate development of multiple canopy layers
- Prolong snow cover to reduce coat color mismatch
- Maintain hiding cover for snowshoe hare

Natural forest development
Harvest or severe fire
Adaptive Complexity Thinning
Precommercial Thinning

Complex structure
Multi-layered canopy
Large trees and logs

Adaptive Complexity Thinning
Accelerated forest development
w/patchy, multi-layer canopy

Complex structure
Multi-layered canopy
Large trees and logs

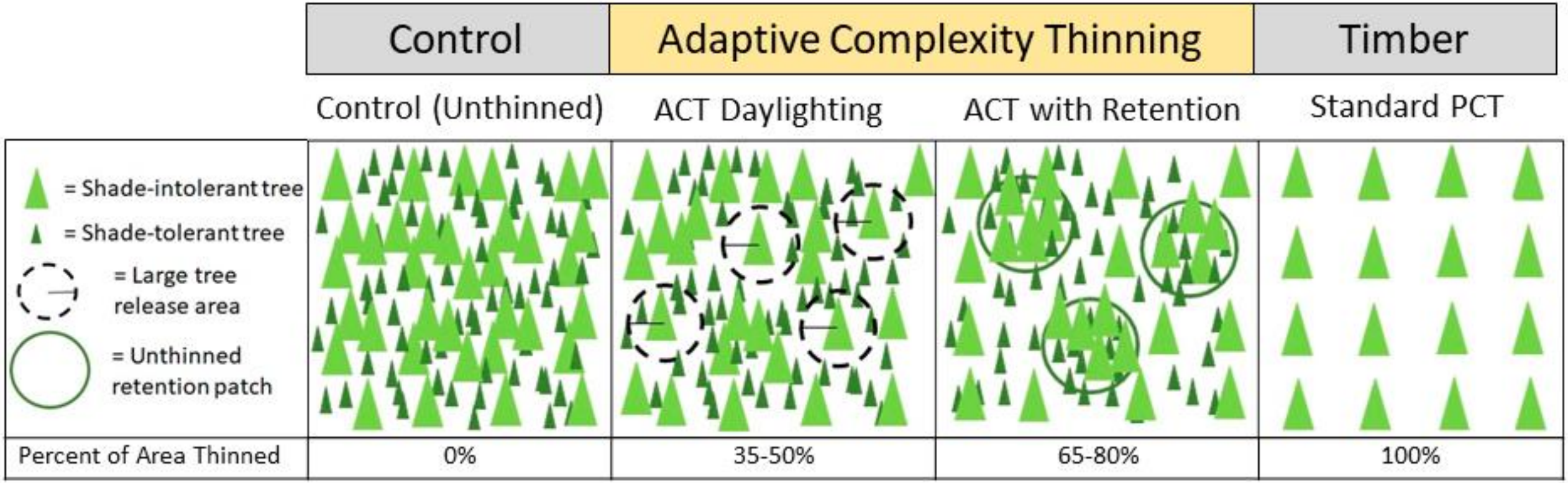
Forest Structural Complexity

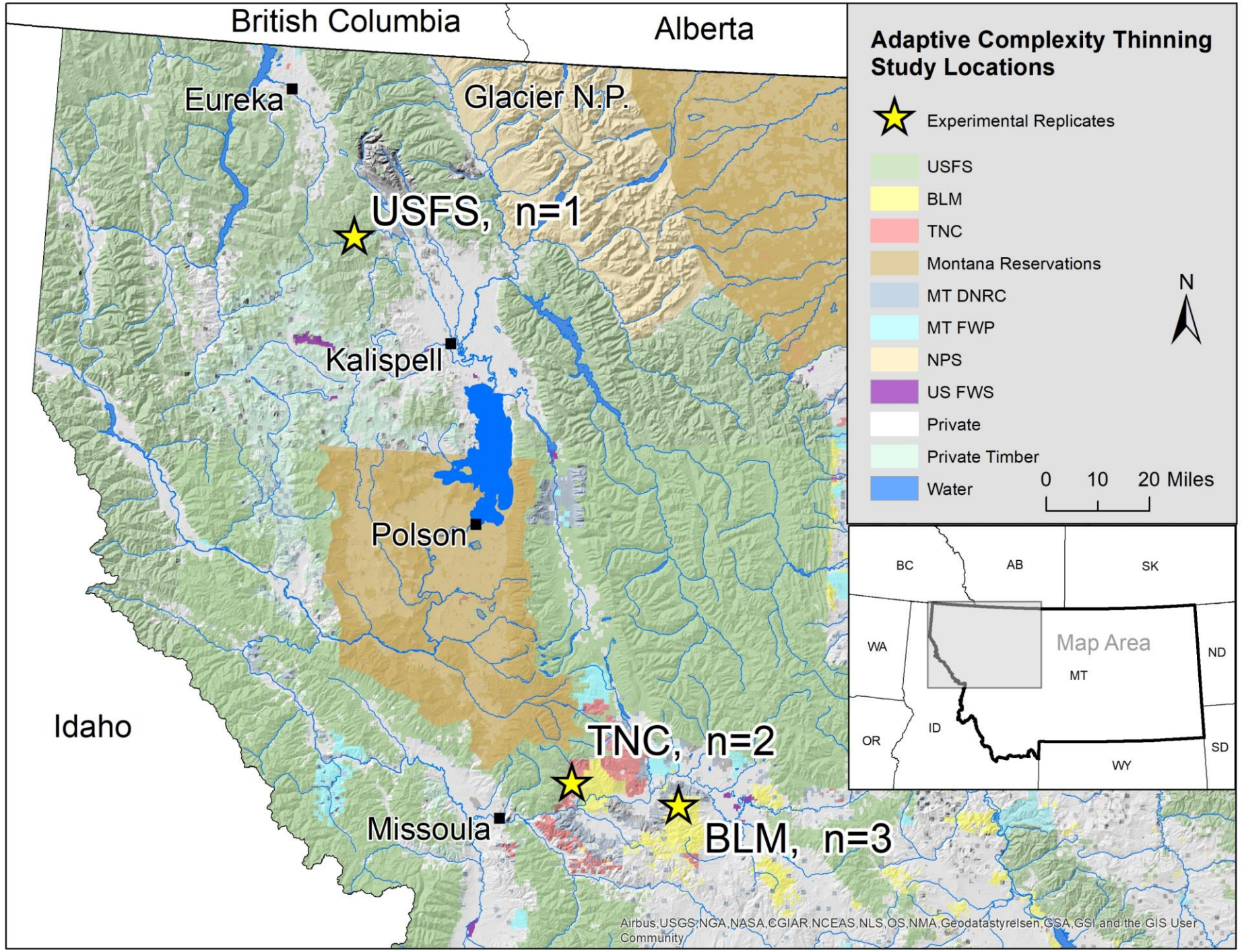
Simple structure
Single-layer canopy
Small diameter trees

Precommercial Thinning
Accelerated tree growth
Single canopy layer

Time

- Open growing space for residual overstory trees
- Accelerate development of multiple canopy layers
- Prolong snow cover to reduce coat color mismatch
- Maintain hiding cover for snowshoe hare




British Columbia
Alberta
Eureka
Glacier N.P.
USFS, n=1
Kalispell
Polson
Idaho
TNC, n=2
BLM, n=3
Missoula
Adaptive Complexity Thinning Study Locations
Experimental Replicates
USFS
BLM
TNC
Montana Reservations
MT DNRC
MT FWP
NPS
US FWS
Private
Private Timber
Water
N
0 10 20 Miles
BC
AB
SK
WA
Map Area
MT
ND
OR
ID
SD
WY
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

Pretreatment measurements

- Stem density and size structure
- Horizontal cover
- Hare pellet counts

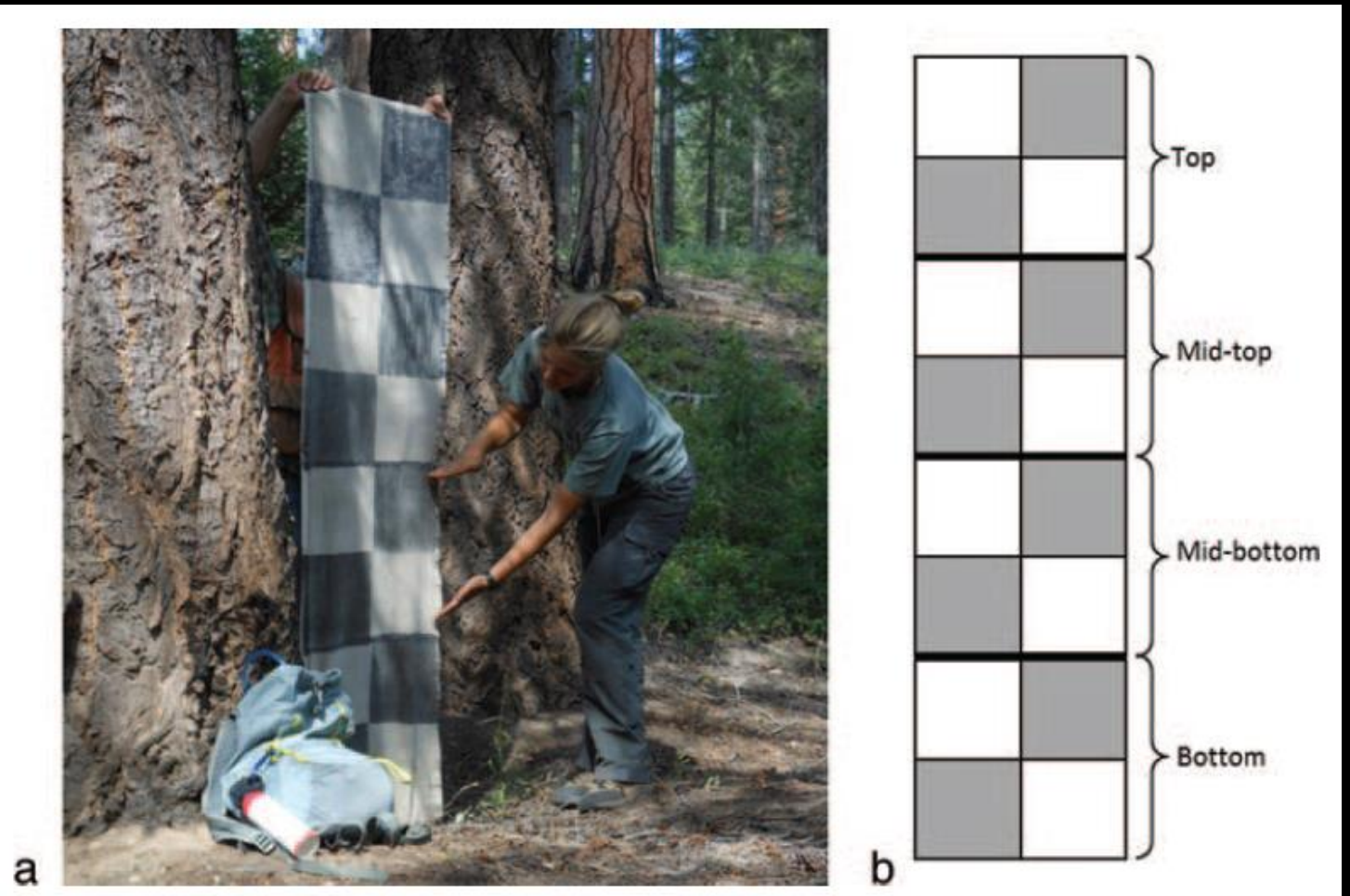


Figure 2. Demonstration of training use of the horizontal cover board (a) and dimensions of the horizontal cover board (b).

Photo courtesy of The Nature Conservancy of Montana

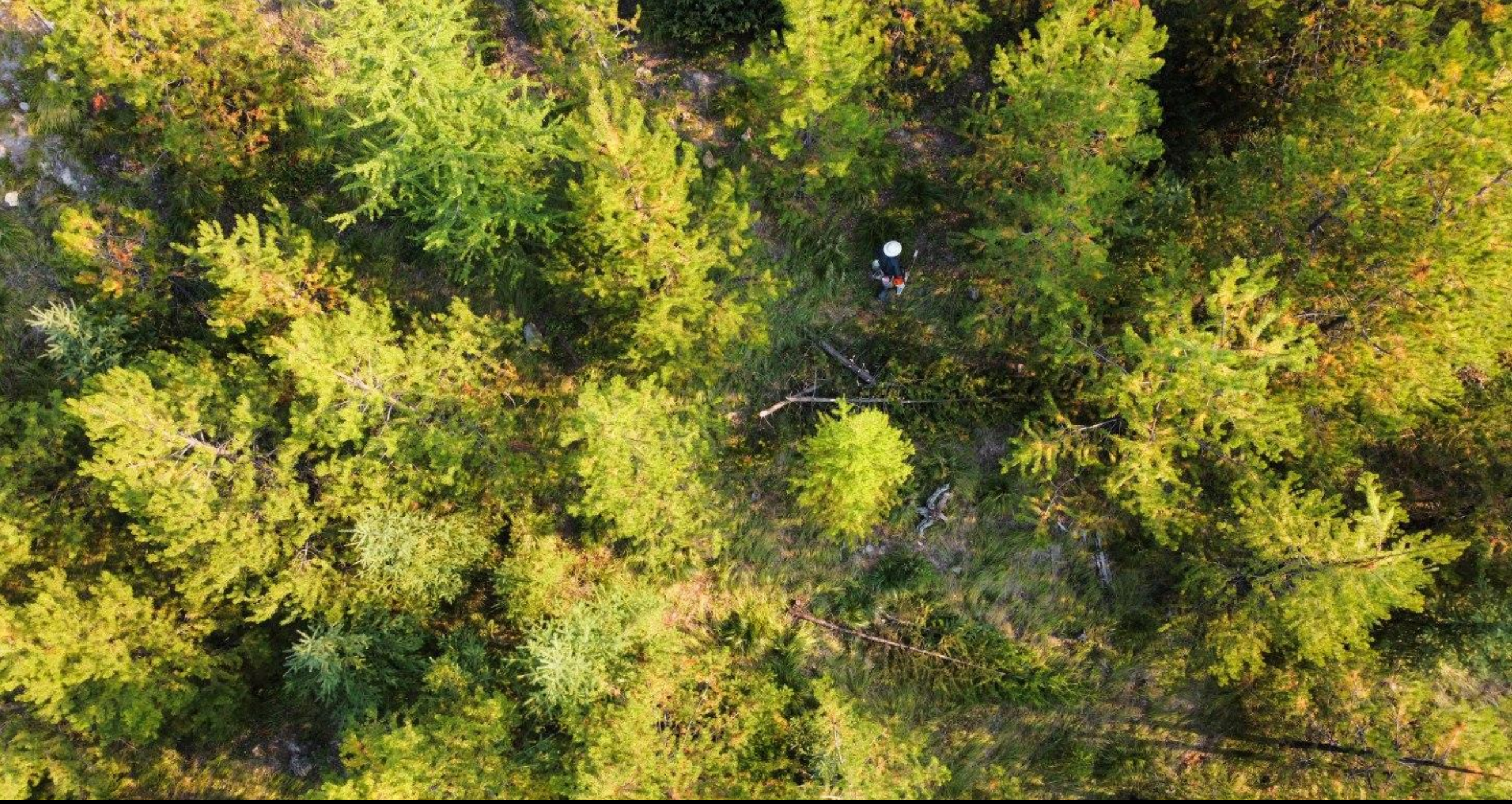


Photo: Andrew Reed, USFS

Photo: Michael Schaedel, TNC

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Response variables and measurements

- Vegetation plots—stand structure & cover
- Winter hare pellet plots to assess relative abundance and fine-scale habitat use
- Remote camera network:
    - Snow depth and snow cover duration
    - Hare coat color phenology and (mis)match

Adaptive Complexity Silviculture

- **Ecologically based:** Disturbance regime & natural forest development provide the template
- **Complexity:** Structure-function rlns. informs Rx & stand development goals
  - Hare/lynx habitat
  - Canopy-snow dynamics
- **Adaptation:**
  - Diminished abundance of multi-story
  - Changing snowpack
  - Hare coat-color mismatch

Photo: Scott Mills, U. Montana