Managing for Resilient Spatial Patterns:

From Reference Pattern to Prescriptions & Monitoring

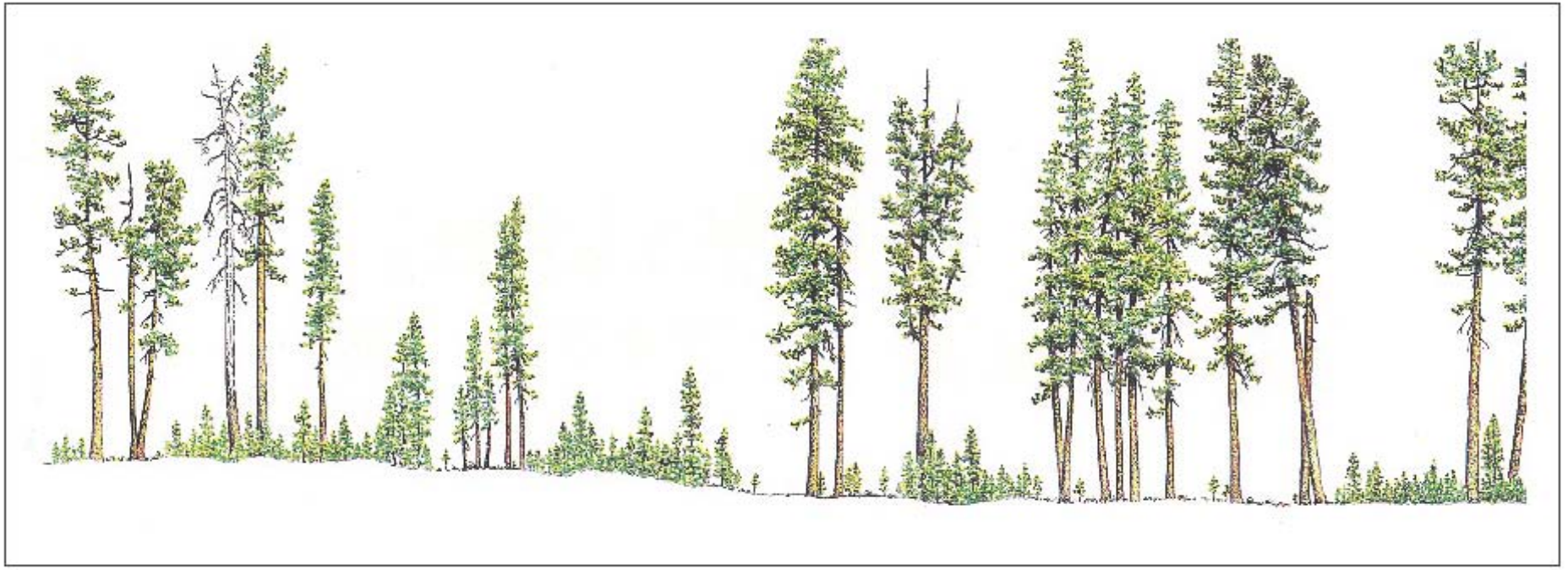

Illustration: Bob Van Pelt

Derek Churchill: University of Washington
Andrew Larson: University of Montana
Matt Dalhgreen: The Nature Conservancy

Carl Skinner

Figure 2—An example of the clumped tree distribution and canopy gaps produced by an active fire regime. The photograph is an aerial view of the Beaver Creek Pinery, which has experienced very little fire suppression.

Photo by Carl Skinner, from: North, M. et al., 2009. An Ecosystem Management Strategy for Sierran Mixed- Conifer Forests. *USDA Forest Service: Pacific Southwest Research Station. General Technical Report*, PSW-GTR-220.

White 1969

Tree Patterns in Central Oregon Ponderosa Pine Forests

ABSTRACT: *Four types of pattern in the structure of ponderosa pine forests of central Oregon can be recognized: (1) differences in relative density, dominance, and regeneration of ponderosa pine when competing with other species along a moisture gradient; (2) a mosaic pattern of relatively even-aged reproduction clusters averaging about 2/3 acre in size, produced by periodic fire in the past; (3) variations in stand density within an even-aged group primarily due to chance factors during establishment; and (4) a tendency toward regular dispersion of individual trees in a reproduction cluster produced by competition. The same types of patterns and their causes have been described for the ponderosa pine forests of Arizona. However, the Oregon forests exhibit a much larger scale of pattern in the reproduction clusters.*

- **42 studies of historical stand structure; 24 with spatial analysis**
- **Target for restoration and many fuel reduction treatments.**

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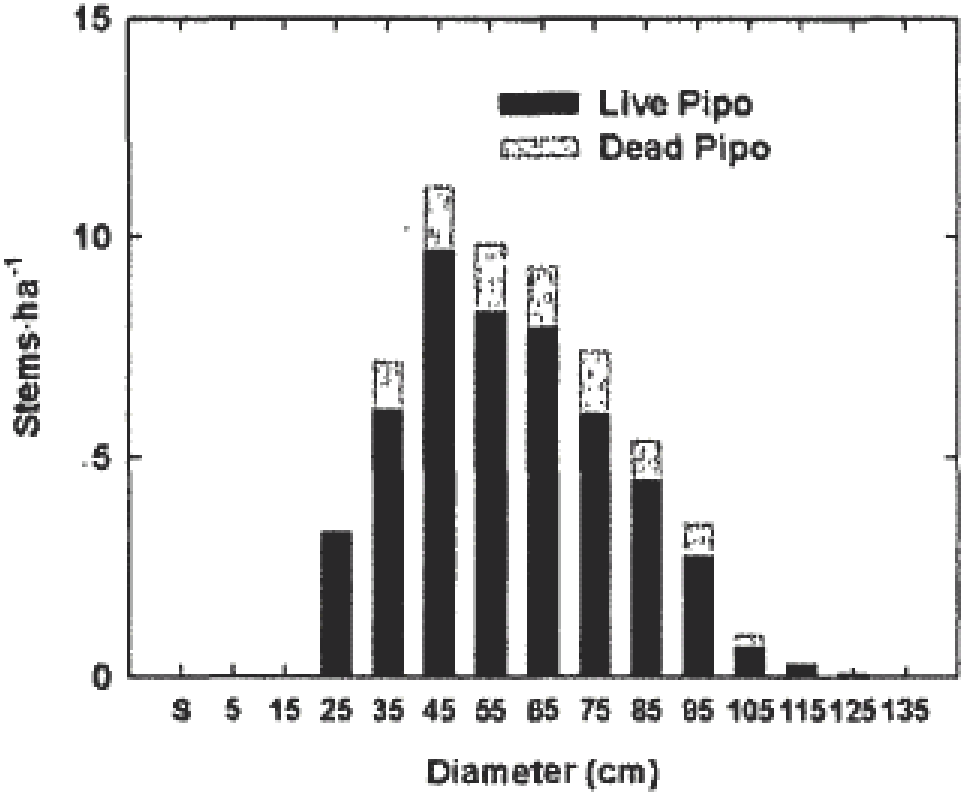
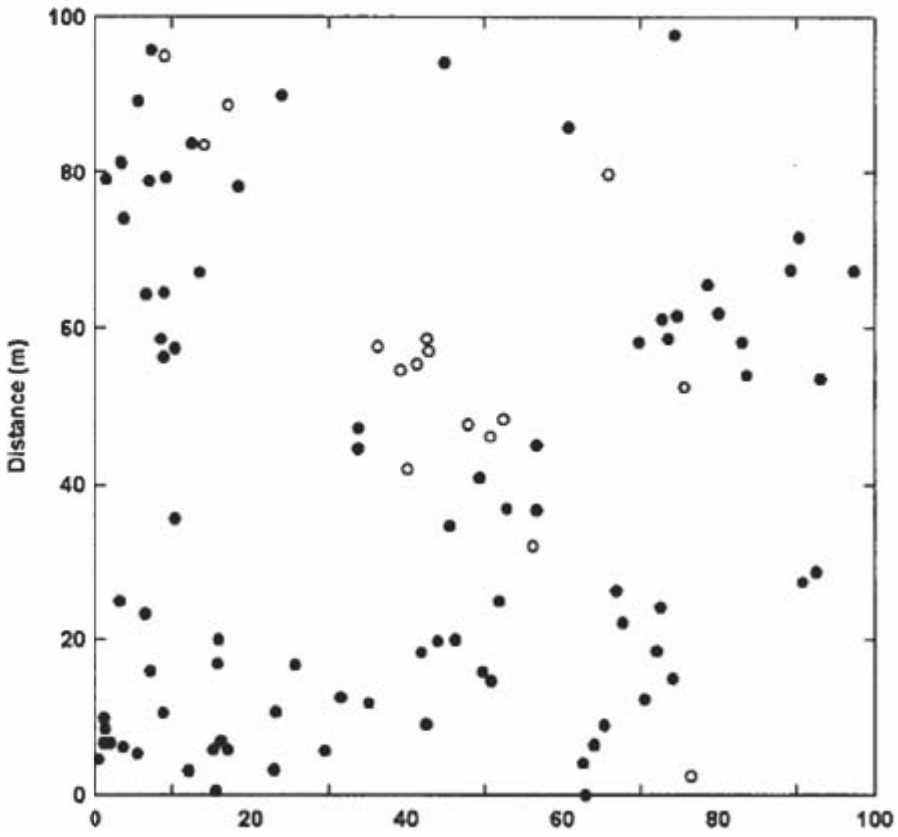
Stand structure in eastside old-growth ponderosa pine forests of Oregon and northern California

Andrew Youngblood[a,*], Timothy Max[b], Kent Coe[a]





Functional Importance of within-Stand Spatial Pattern

1. Fire behavior

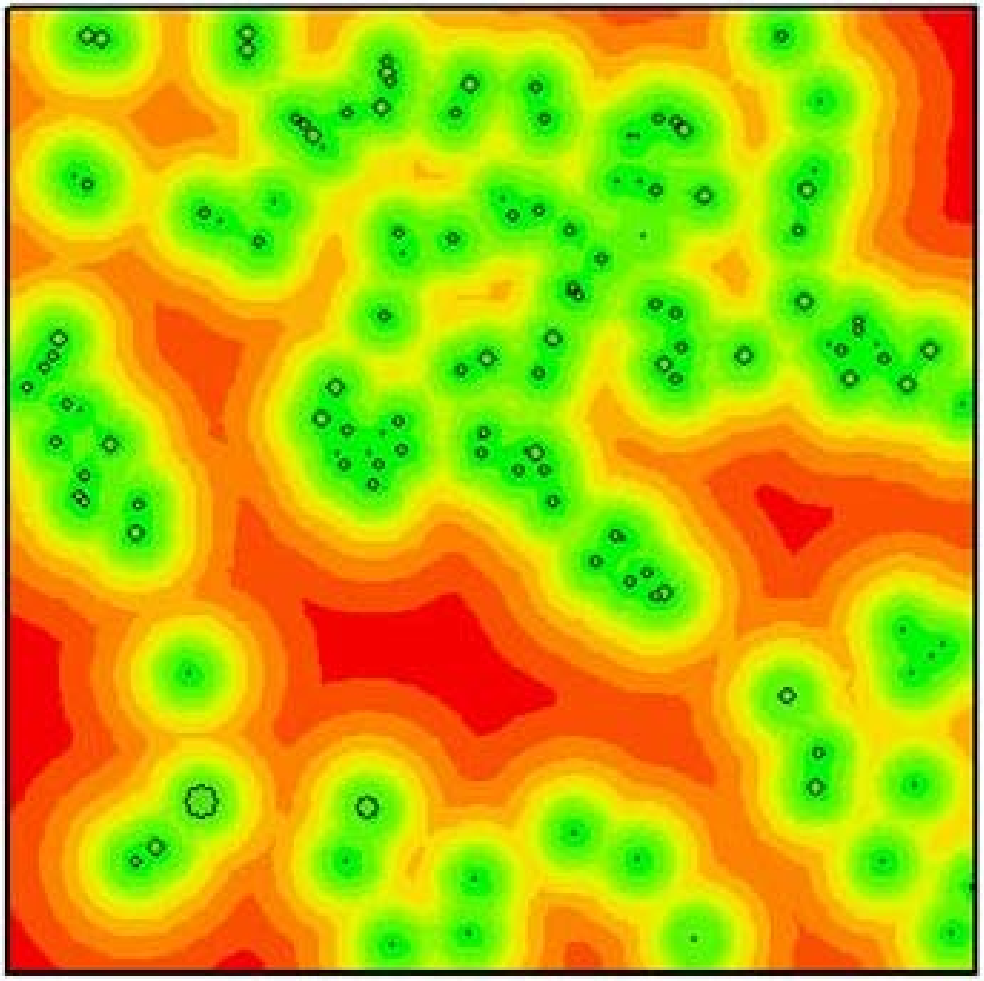
2. Habitat

3. Understory

4. Regeneration dynamics

5. Snow retention

6. Insect behavior



Pre-fire suppression structure and pattern was resistant to fire & sustainable over time

Wildcat Timber Sale

Study objectives

• Use spatial pattern information from reference conditions to guide and monitor prescription: Can we nudge stand into desired envelop of pattern?

• Compare to commonly used, traditional thinning approaches

Baseline conditions

• Dry Douglas-fir plant association with Ponderosa Pine & Douglas-fir

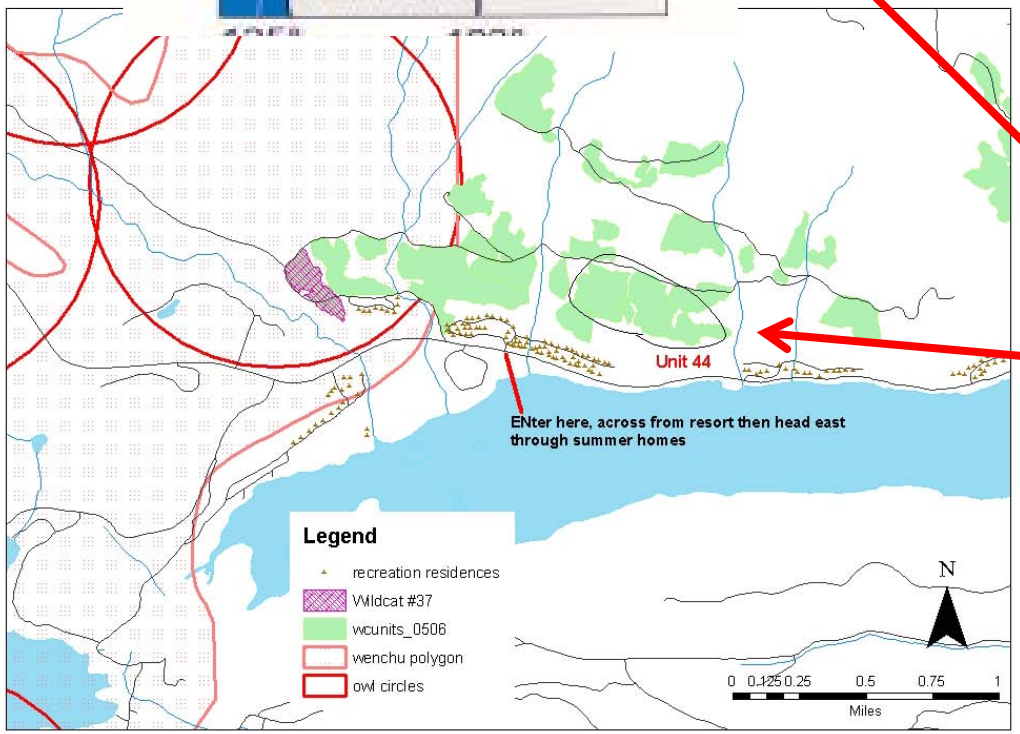
• Fire exclusion, grazing, selection logging, and FS partial harvest.

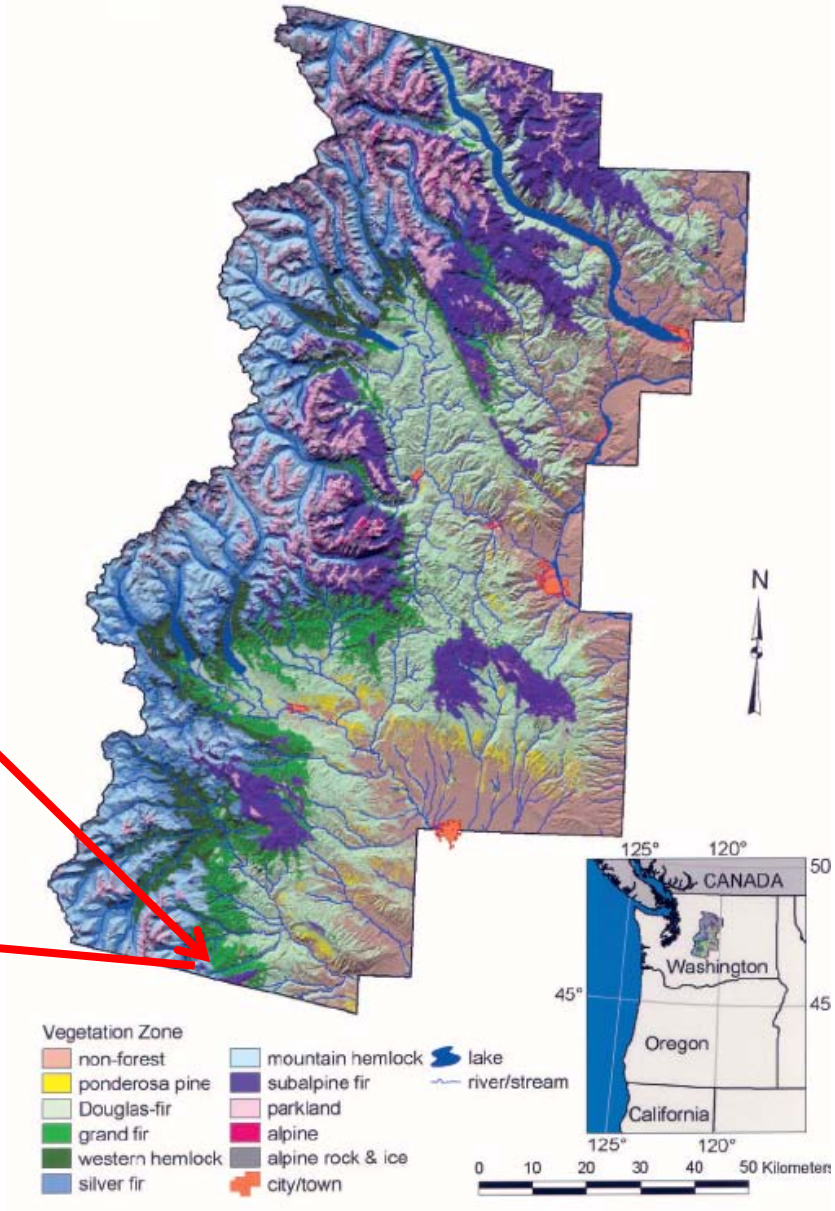
Treatment Objectives

• Restore old forest, open canopy structure

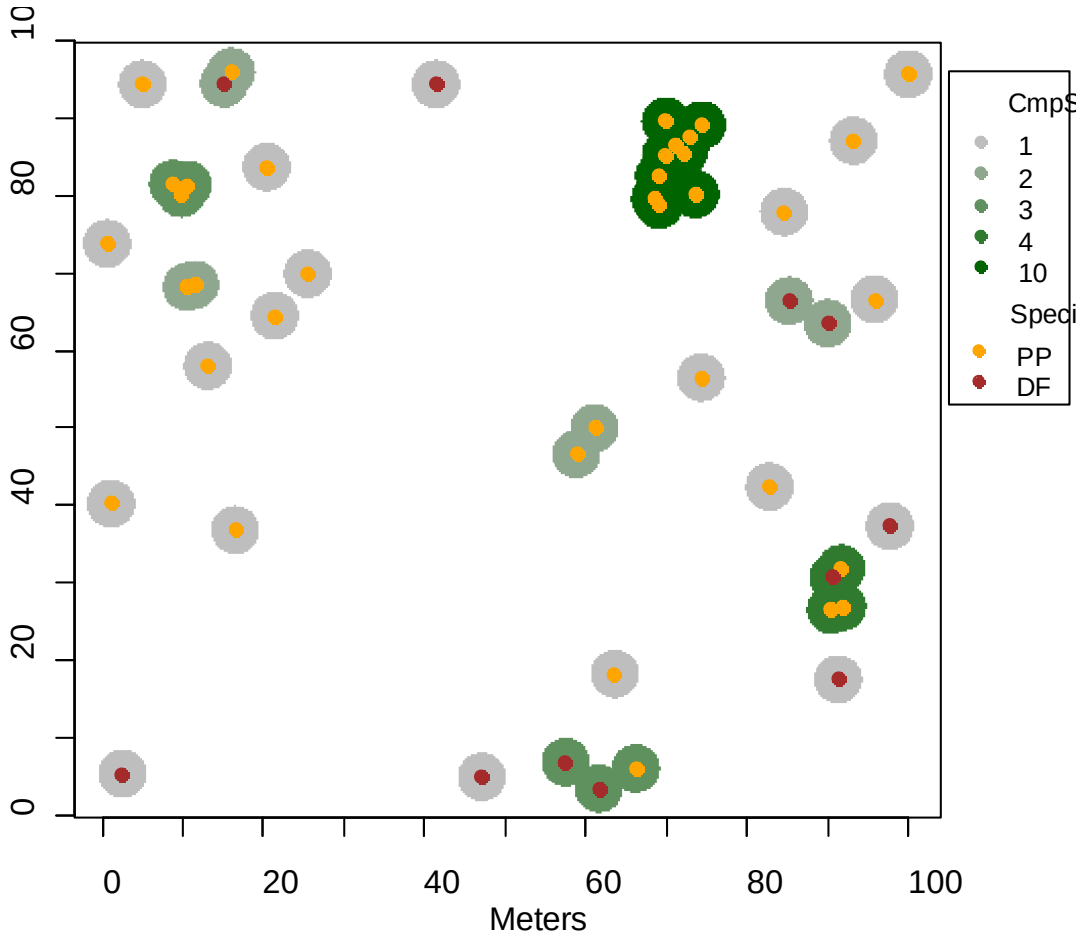
• Reduce fire risk to nearby cabins

Project Area



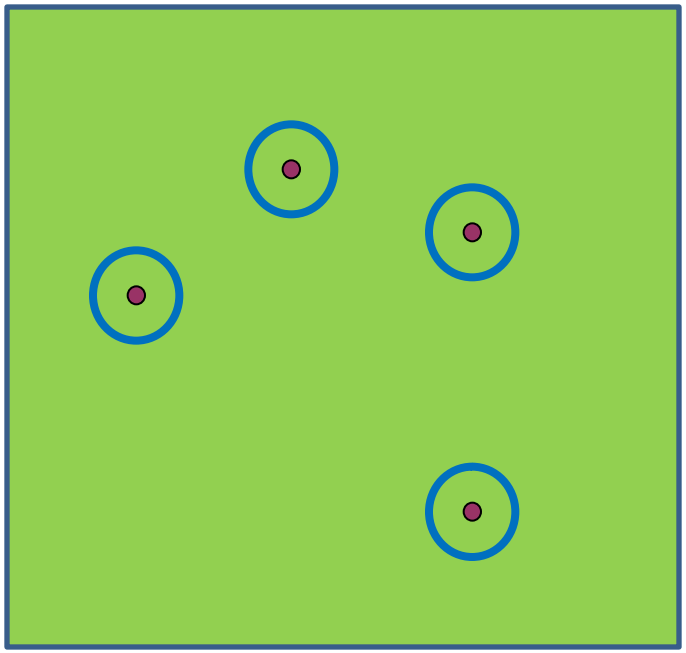


Reference Plot

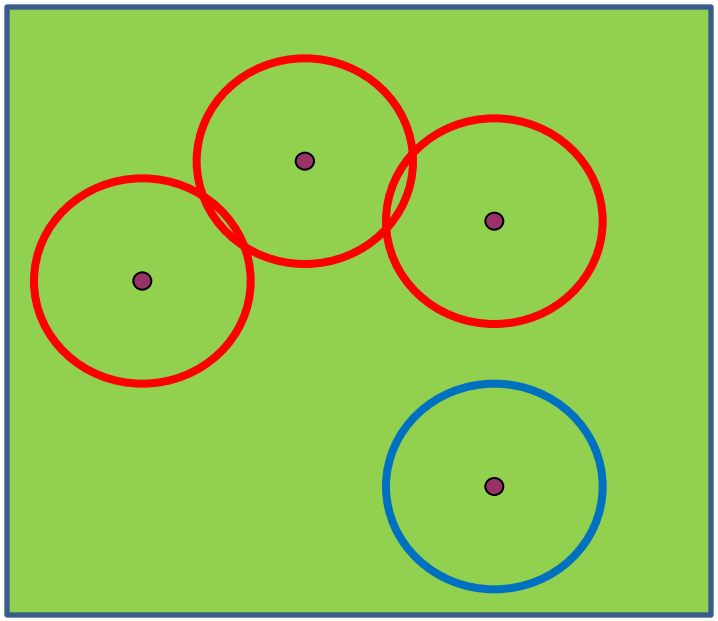


Plotkin Cluster Detection Algorithm

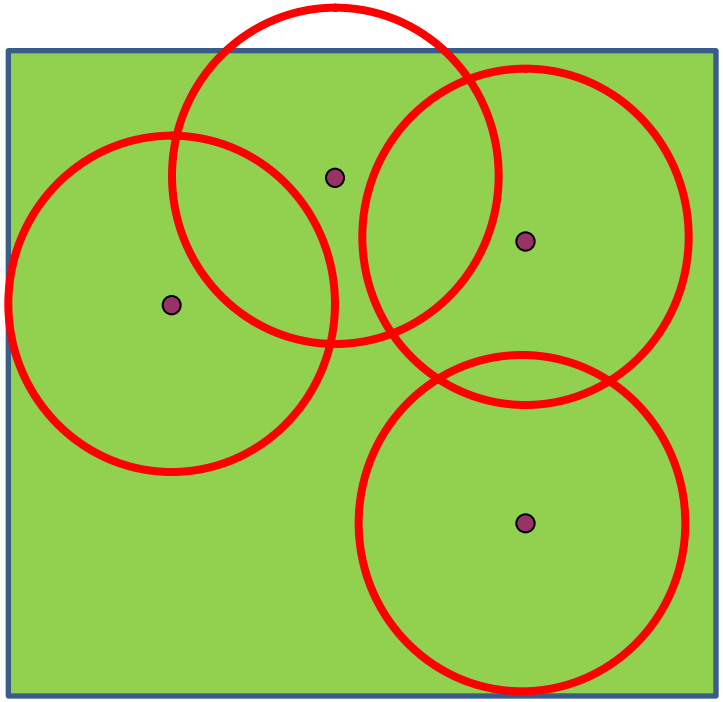
1m distance



2m



3m

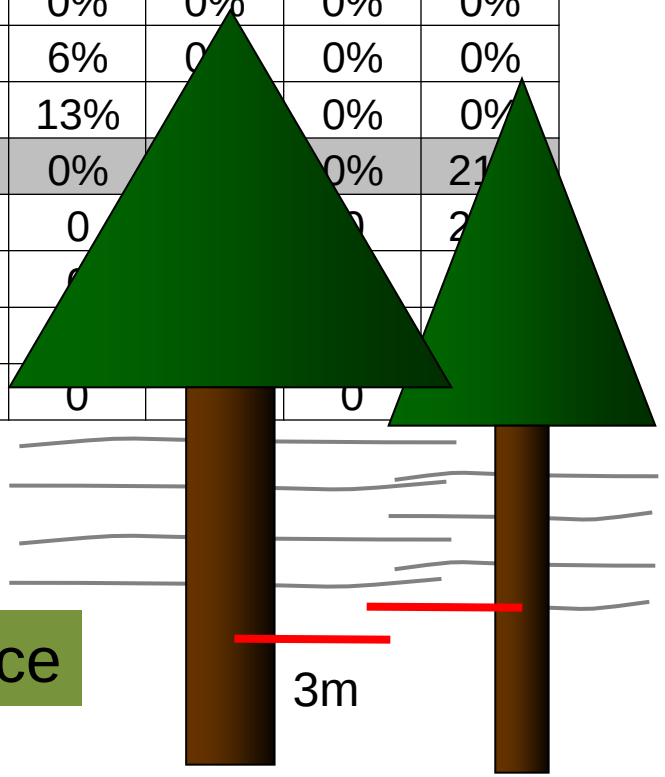


Plotkin et al. 2002

Proportional Clump Size Distribution

Percent of trees in clumps of different sizes

Intertree Distance (m)	Clump Size (# of trees) 1	2	3	4	5	6	7	8	9	10+
1	91%	9%	0%	0%	0%	0%	0%	0%	0%	0%
2	76%	19%	6%	0%	0%	0%	0%	0%	0%	0%
3	72%	19%	6%	4%	0%	0%	0%	0%	0%	0%
4	57%	20%	11%	0%	5%	0%	6%	0	0%	0%
5	52%	22%	6%	7%	0%	0%	13%		0%	0%
6	42%	17%	12%	8%	0%	0%	0%		0%	21
7	35%	17%	19%	8%	0	0	0		0	2
8	35%	17%	19%	8%	0	0	0			
9	33%	17%	19%	0	10%	0				
10	31%	17%	19%	0	0	12%	0		0	



6m: Max crown interlock distance

Prescription Steps

1. Choose Distance: 6m

2. Determine average density target: convert to TPA

3. Calculate TPA target for different size clumps

4. Group clump sizes together for Rx guidelines:
   - Calculate # of clumps
   - Adjust for higher mortality in clumps vs. individuals
   - Factor in prescribed fire

	Clump Size		
	1	**2-4**	**5-12**
Reference % (6m)	42%	37%	21%
Target TPA	18	15	8
Target # of clumps	18	5	2

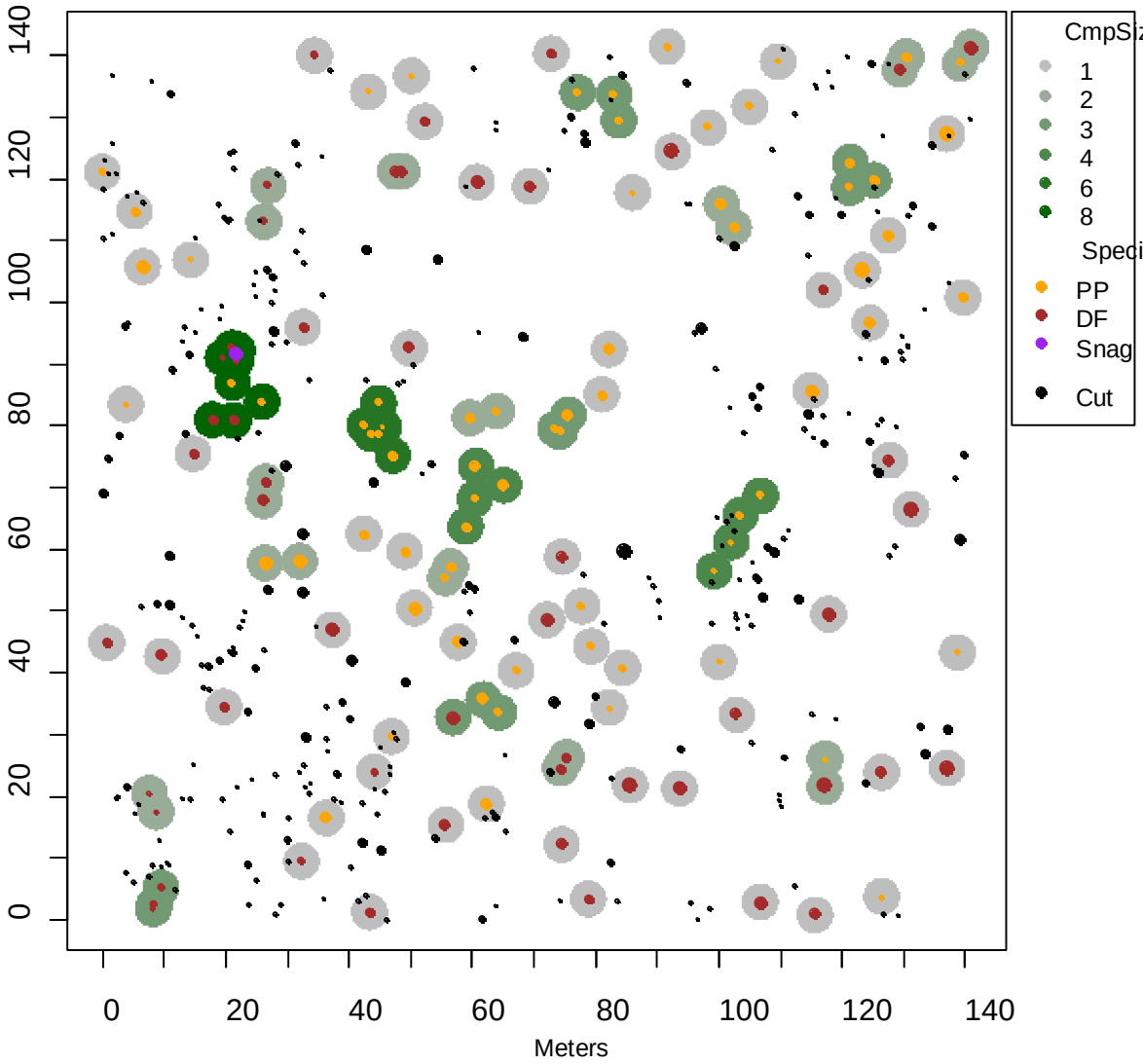
Translate into prescription and Mark

Rx:

- Leave 40 TPA
- Favor ponderosa pine over Douglas-fir
- Leave all old trees (>150 yrs)
- Thin primarily from below
- 1/10th ac openings & complex patches
- Isolate dwarf mistletoe

- Leave: *average per ac.*:

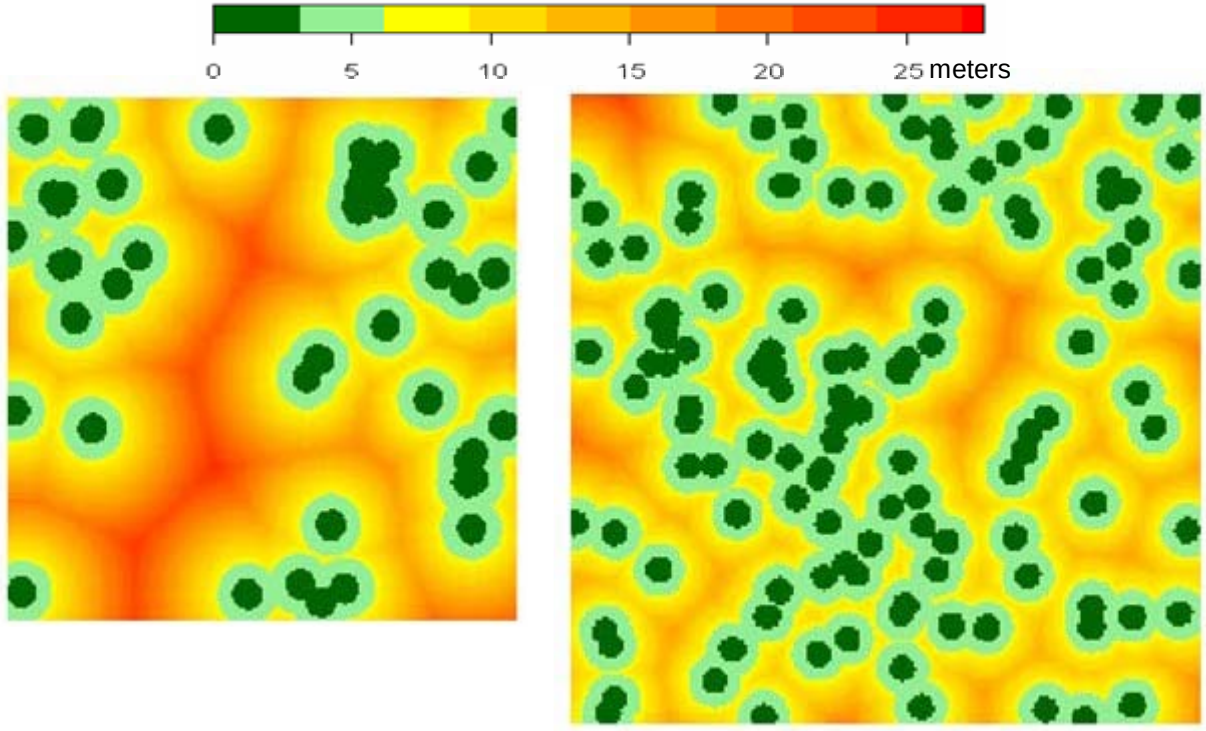
Clump Size	1	2-4	5+
Target Clumps/Ac	18	5	2



Results

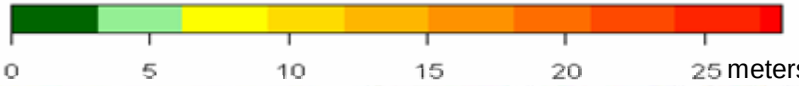

Cluster Size
1
2-4
5+
Reference
Treatment 2Ha
Treatment Unit
Proportion of Trees
1.0
0.8
0.6
0.4
0.2
0.0
2
4
6
8
Inter-Tree Distance(m)

Reference



Treated:

- BA:80 ft2/ac
- TPA: 29
- 30% max stocking



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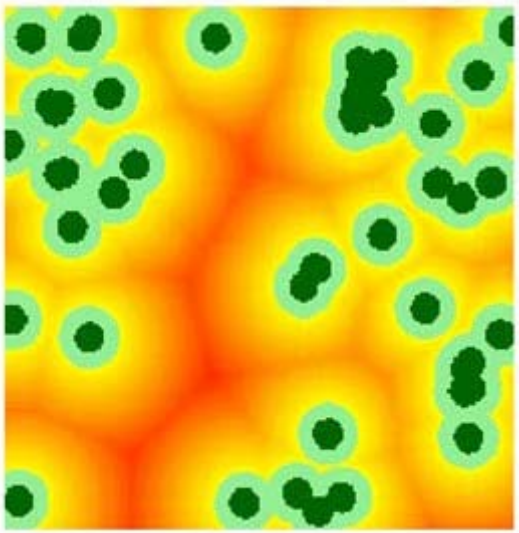

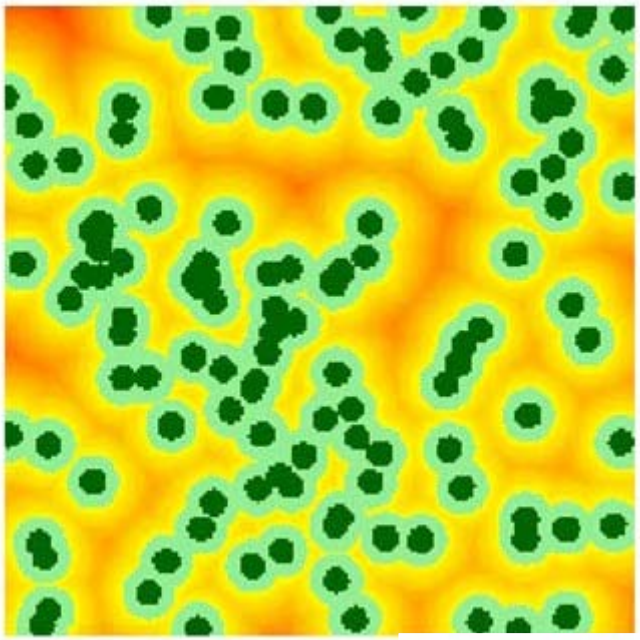

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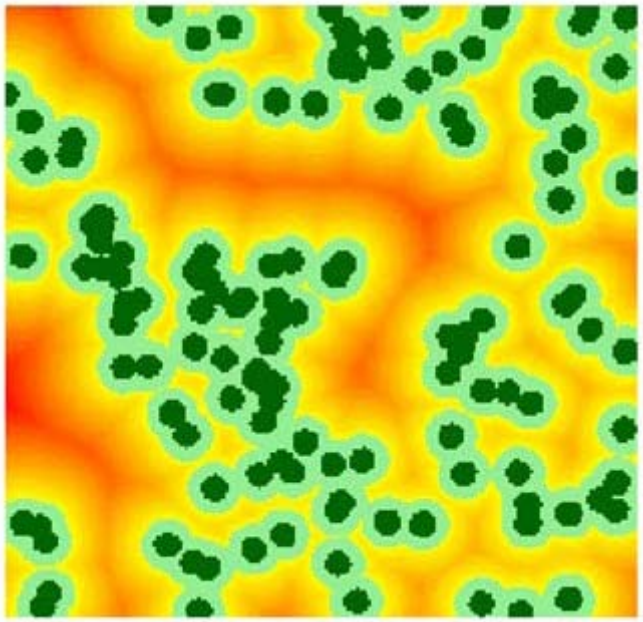
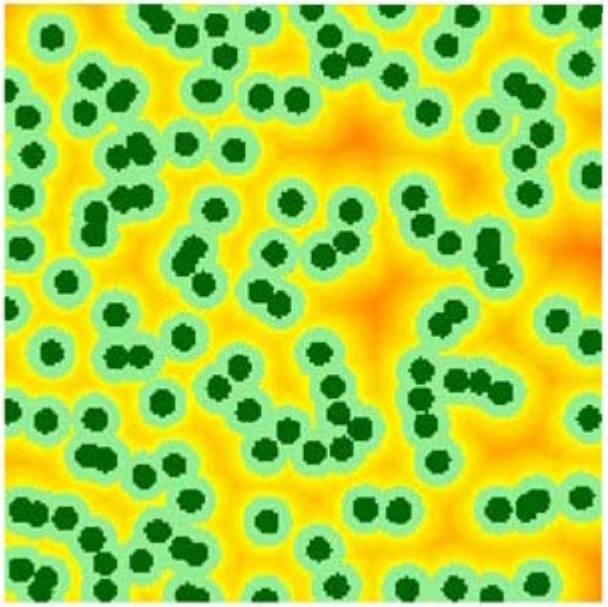
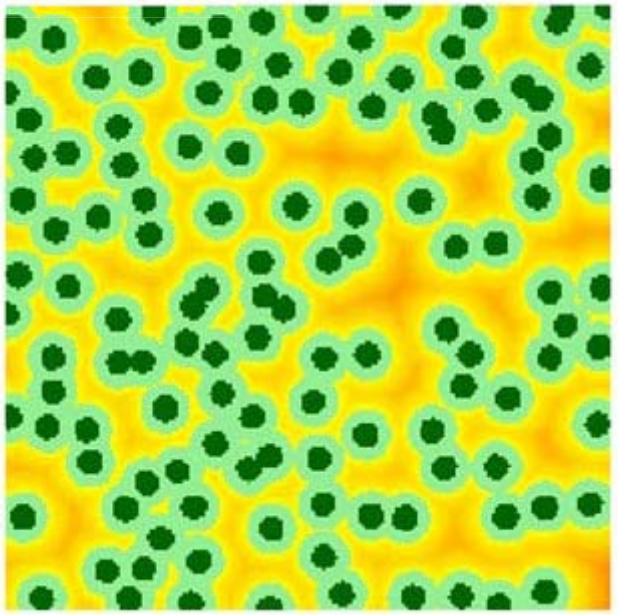


Adaptive Management



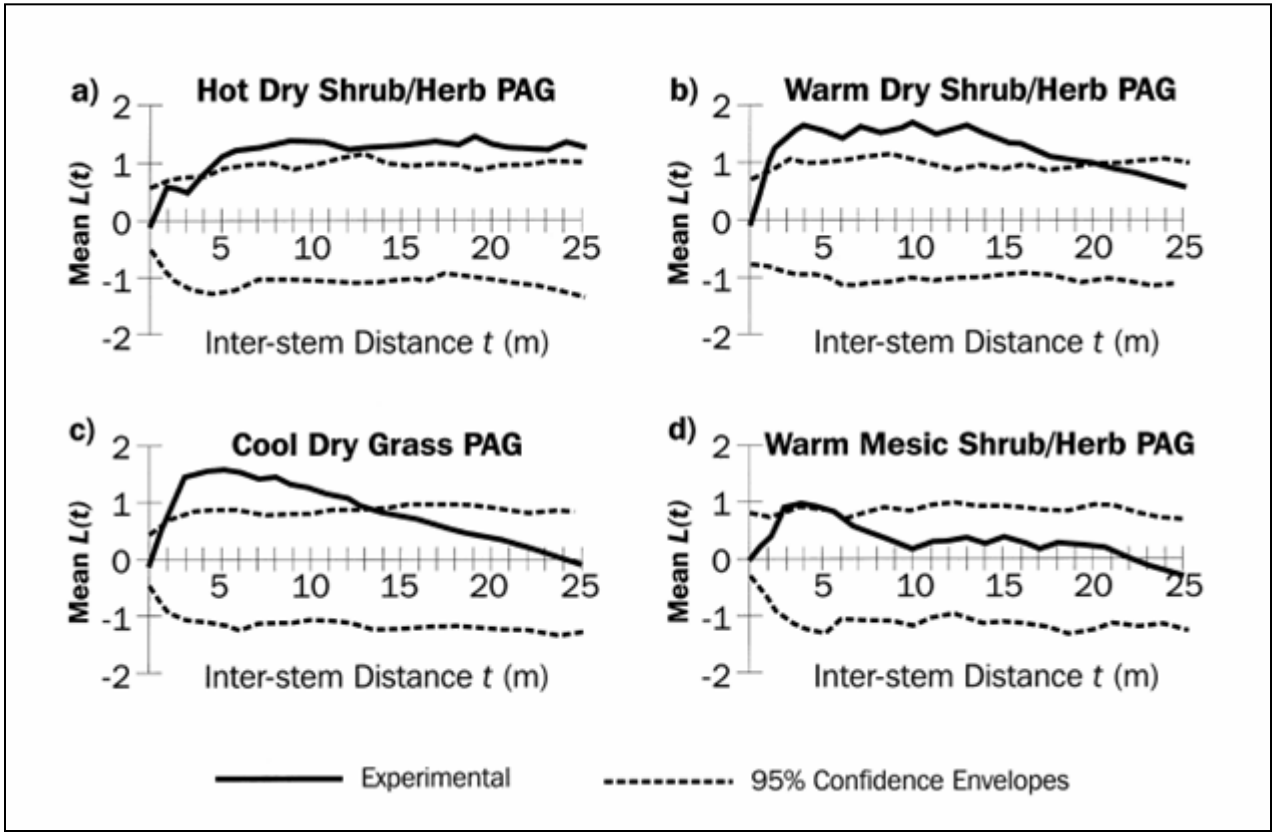
Basal Area 80



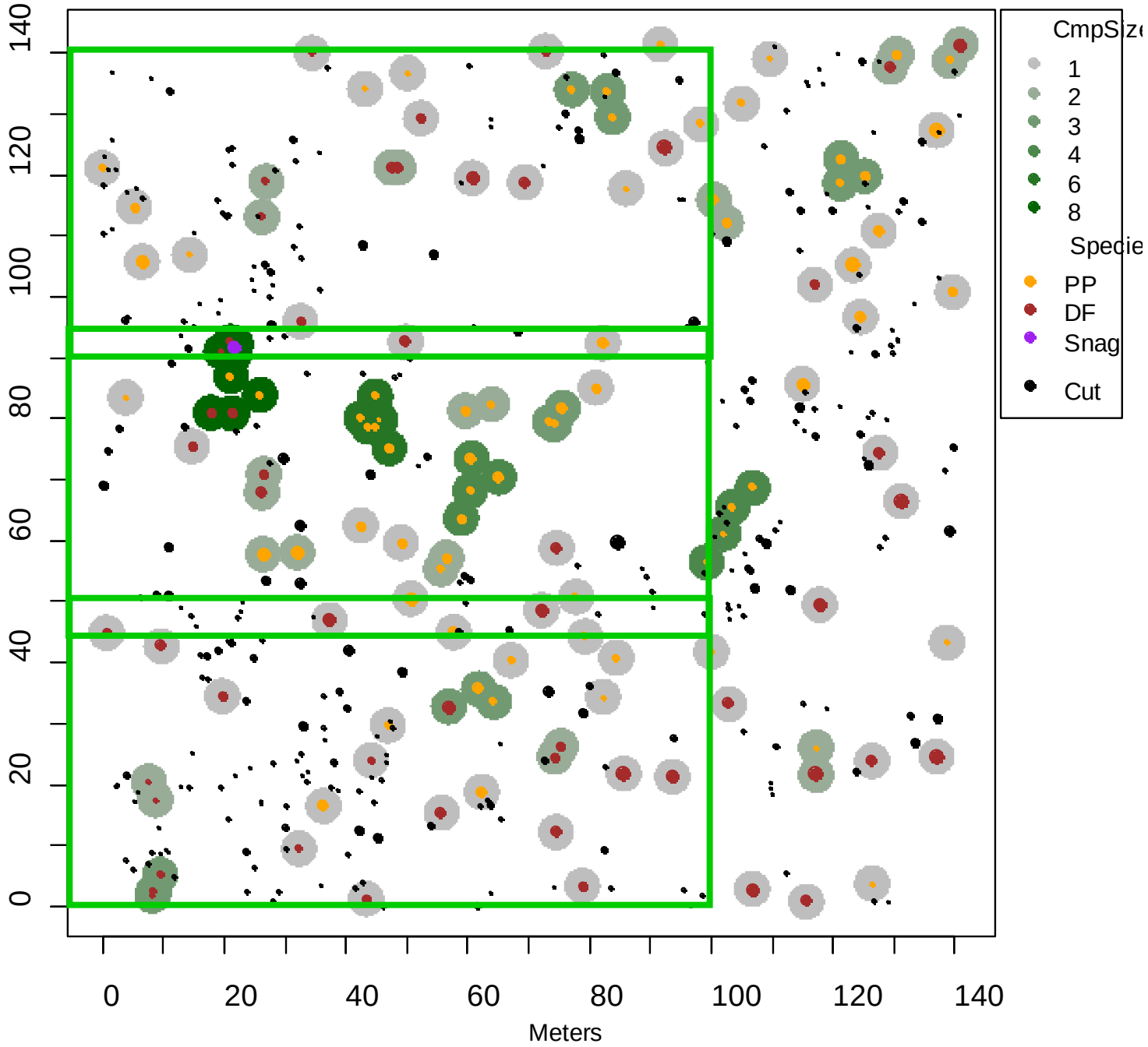
Spacing: DxD 22’

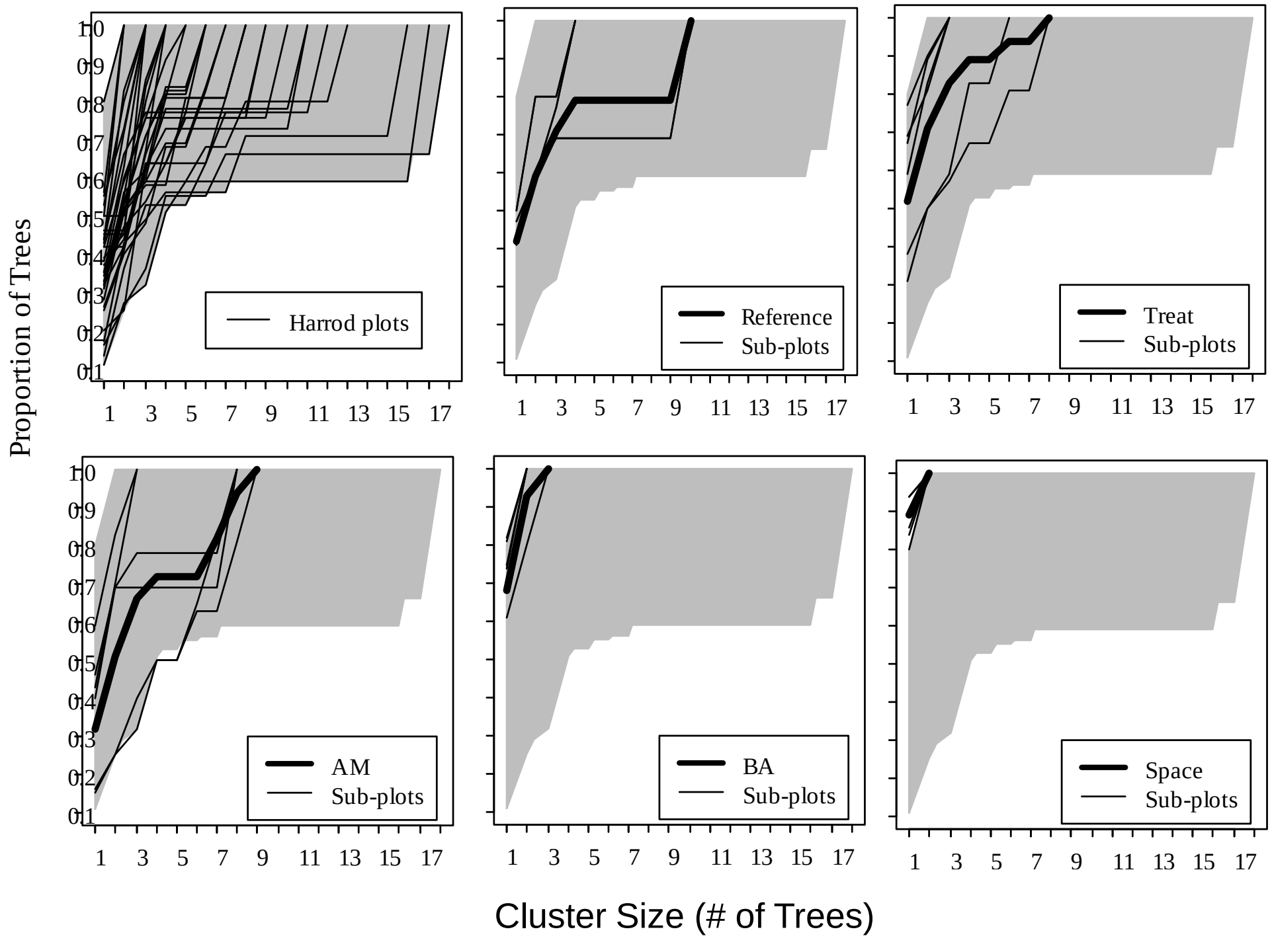
Historical stand reconstruction in ponderosa pine forests to guide silvicultural prescriptions

Richy J. Harrod*, Bradner H. McRae, William E. Hartl

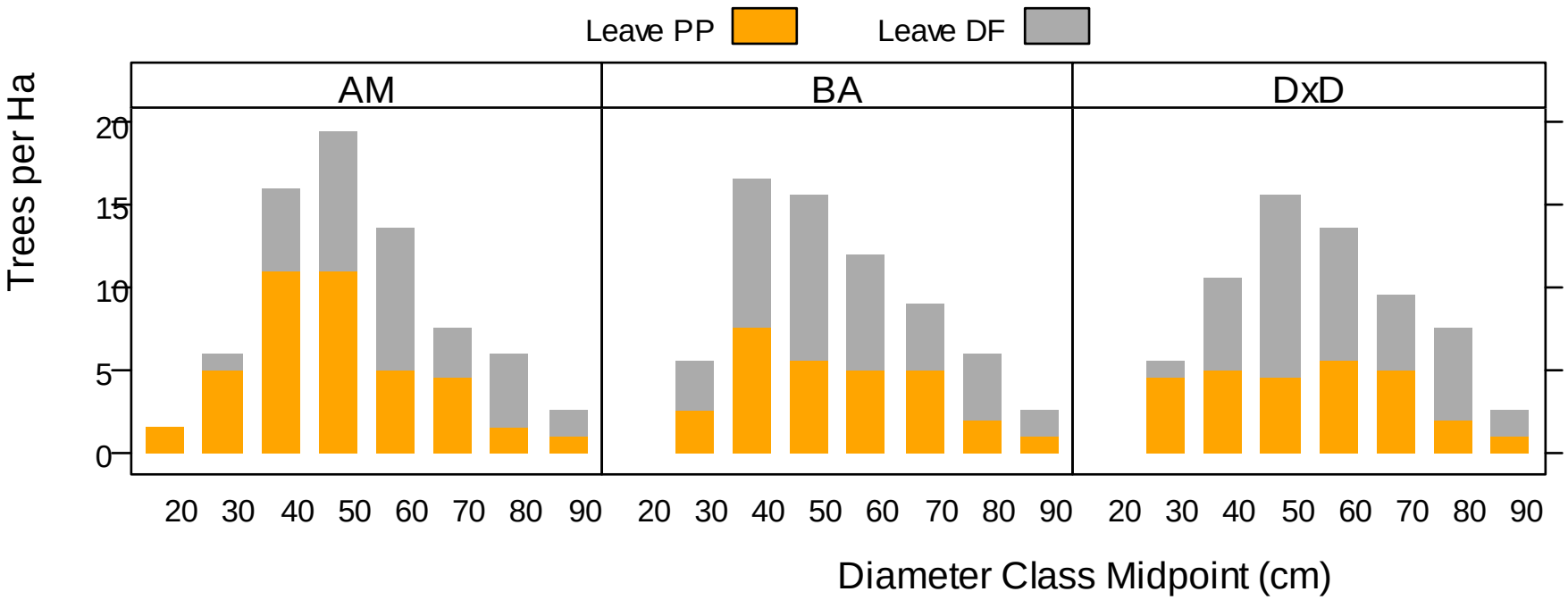


48 x 1 acre plots: 100m x 50m


CmpSize
1
2
3
4
6
8
Specie
PP
DF
Snag
Cut
0
20
40
60
80
100
120
140
Meters


Proportion of Trees
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
1 3 5 7 9 11 13 15 17
Harrod plots
Reference
Sub-plots
Treat
Sub-plots
AM
Sub-plots
BA
Sub-plots
Space
Sub-plots
Cluster Size (# of Trees)

Species Composition and Diameter Distribution

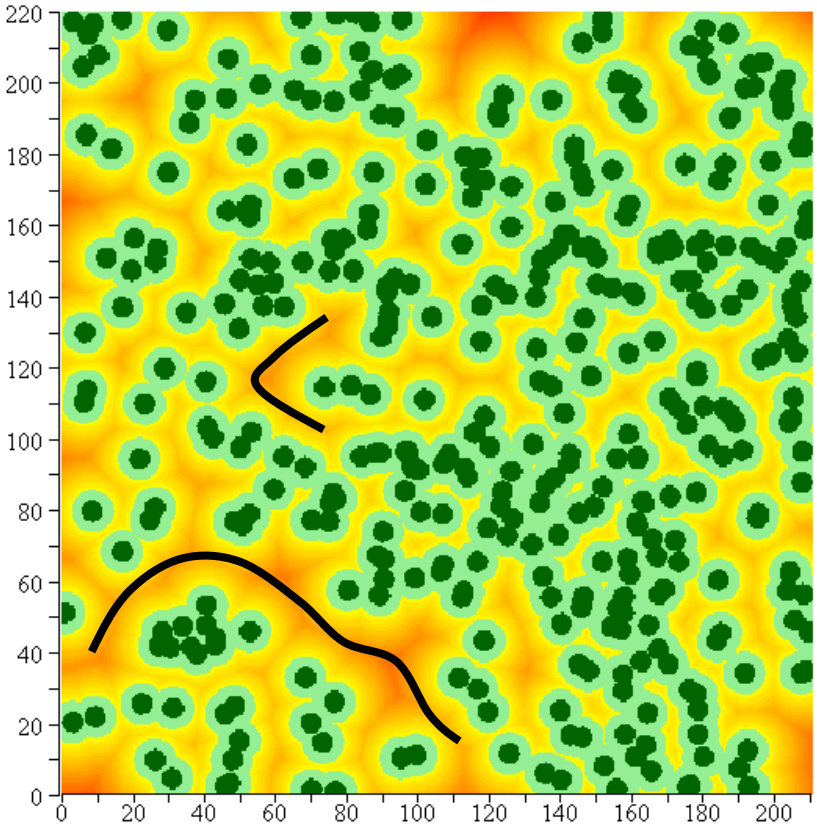


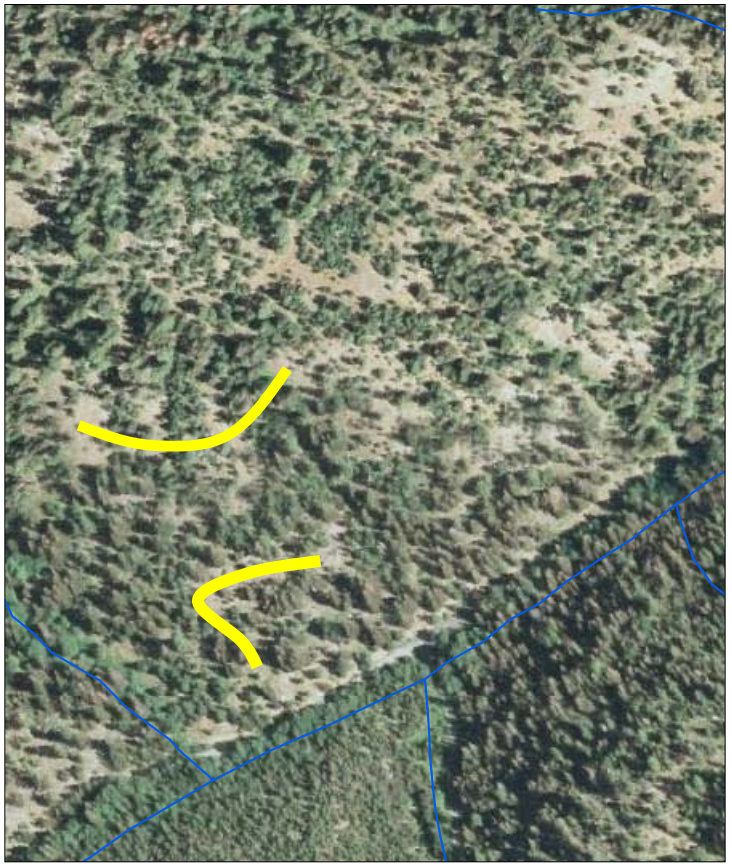
Tradeoffs:

- Leaving largest trees
- Openings
- Shift towards Ponderosa Pine

Adaptive Learning: Subsequent Projects

- Large openings: line method





Remove trees 33-66’ from flag line

Adaptive Learning: Subsequent Projects

- Tracking: direct monitoring

Clump Size	Target Acre	Unit Target	Count
1	23	575	
2-4	6	150	
5-8	2	50	
9-15	1	25	

- Rapid assessment of stands

Conclusions

Cluster Method Works Well in:

- Even aged stands with few old trees
- High graded stands with some old trees
- Plantations: PCT

Conclusions

Cluster Method may not be as useful in:

- Stands with major tree health issues
- Stands where most of desired density is comprised of old trees

Retain old trees!!

Conclusions

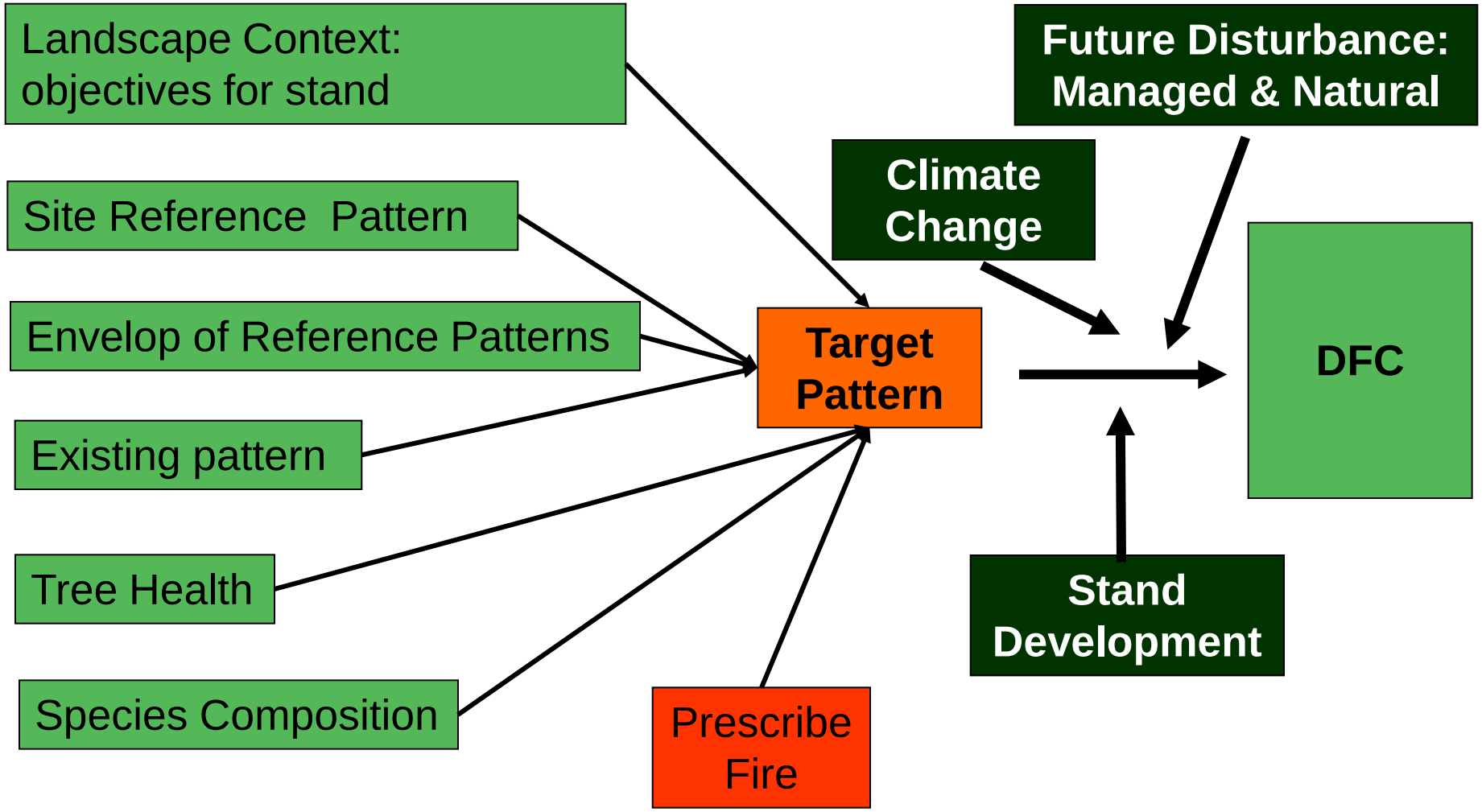
• Operationally practical method to define “clumpiness” based on reference conditions. Working on companion method for large openings

• Tradeoffs between large trees, species composition, & openings

• Tool for monitoring and adaptive management

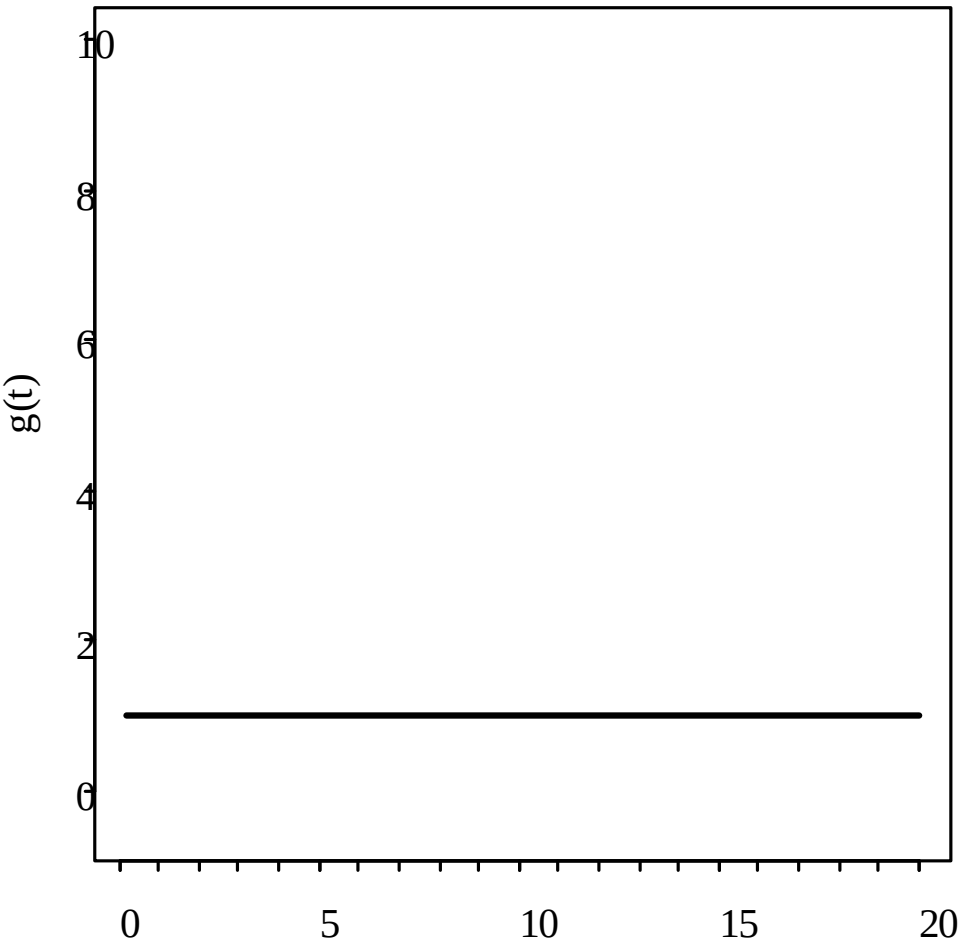
• Reference stands studies tells us what not to do

Conclusions



Acknowledgements

- UW Bioenergy IGERT program
- Okanagon-Wenatchee National Forest
- The Nature Conservancy
- Washington State Department of Natural Resources
- University of Washington: Forest Ecosystem and Function Lab


g(t)
10
8
6
4
2
0
0
5
10
15
20

Marking Guidelines

Target Density:

• Leave an average of 40 trees/ac >5” dbh

• Leave 18 individual trees per acre. Individual is defined as a minimum of 21’ from any other leave tree.

• Leave: - 5 clumps/ac w/ 2-4 trees
- 2 clump/ac w/5-12 trees (clumps with 8+ trees count as 2).
- Clumps have trees within 20’ of another tree in clump

• Targets for clumps and individual trees are across the unit. Work with stand to align leave tree criteria with clumps, and openings.

• Keep track as you mark via LTM

Leave tree criteria

1. Leave all old trees
2. Favor PP over DF
3. Leave all PP > 20” and DF > 25” unless specifically cut for a large opening.
4. Isolate large DF with dwarf mistletoe
5. Thin primarily from below

Density and Size						
Trees per acre	19	89	25	28	27	26
Mean dbh (in)	30.5	15.9	21.9	20.9	21.5	22.9
Basal Area (ft^2/ac)	109	142	73	74	74	76
% Max Stocking[1]	40%	64%	30%	31%	30%	31%
Species Composition						
(% BA)	74%	35%	49%	48%	42%	39%
(% BA)	26%	65%	51%	52%	58%	61%
Pattern Type (	Clumped	Clumped	Random	Clumped	Uniform	Uniform