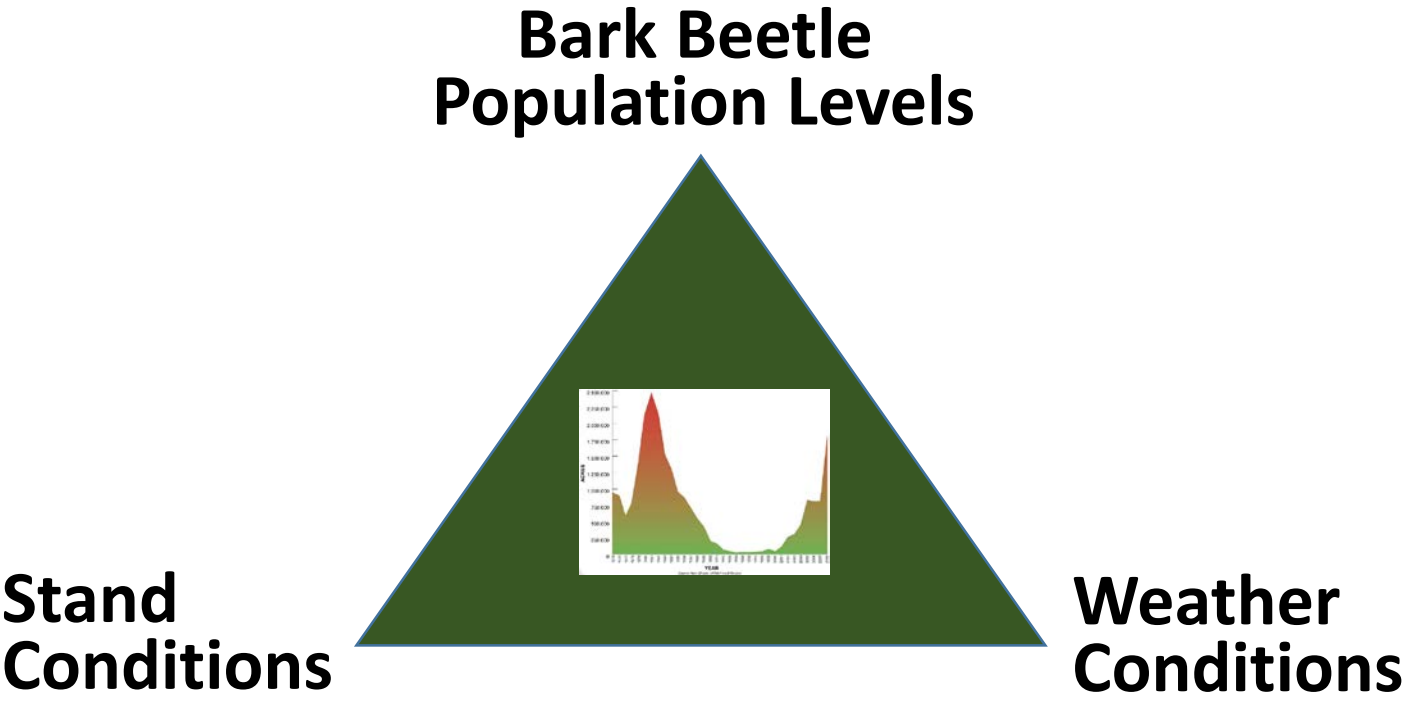
Thinning to Prevent Bark Beetle Attack: Does It Work?

Beth Willhite
Entomologist
R6 USFS Forest Health Protection

Thinning

Thinning has long been advocated in western forests by scientists and forest managers as a method to prevent unacceptable resource losses due to bark beetle activity.

Bark Beetle Activity



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Not Without Controversy

Black S.H., 2005. Logging to control insects: the science and myths behind managing forest insect “pests”. A synthesis of independently reviewed research. Portland: The Xerces Society for Invertebrate Conservation.

Six, D.L., Biber, E., Long, E., 2014. Management for mountain pine beetle outbreak suppression: Does relevant science support current policy? Forests 2014, 5, 103–133.

> “…outbreak suppression" is not the intent or objective of management strategies implemented for mountain pine beetle in the western United States…” Fettig et al. (2014)

2007 Synthesis Paper

Fettig, Christopher J.; Klepzig, Kier D.; Billings, Ronald F.; Munson, A. Steven; Nebeker, T. Evan; Negron, Jose F.; Nowak, John T. 2007. **The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States.** Forest ecology and management. 238(1-3): 24-53

2007 Synthesis Paper (cont.)

- ~ 350 citations, spanning 1925 to 2006
- Pacific Northwest, Rocky Mountains, Southwest, British Columbia
- Details evidence supporting thinning effectiveness based on studies of:
  1. Tree factors (diameter, age, vigor, crown attributes, phloem thickness, growth rate)
  2. Stand factors (stocking, amount of host, stand age, site quality)
  3. Thinning studies

2014 Synthesis Paper

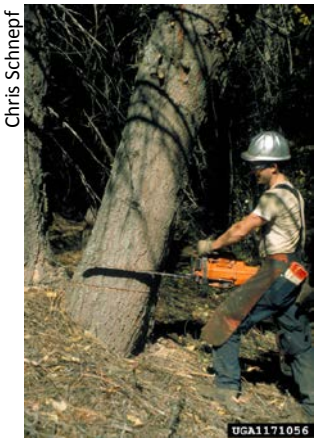
Fettig, C.J.; Gibson, K.E.; Munson, A.S.; Negrón, J.F. 2014. **Cultural practices for prevention and mitigation of mountain pine beetle infestations.** Forest Science. 60(3): 450–463.

Thinning ≠ Logging

- Logging: an act of cutting down trees for their wood, or the industry of logging.

-Cambridge Academic Content Dictionary
https://dictionary.cambridge.org/us/dictionary/english/logging

Chris Schnepf



David P. Shorthouse

Doug Page

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Thinning

Taylor Mahoney

A cultural treatment made to reduce stand density primarily to improve growth or enhance forest health.[1]

[1]Helms, J.A., 1998. The Dictionary of Forestry. Society of American Foresters, Bethesda, MD, 210 pp.

Development of Thinning for Bark Beetle Prevention

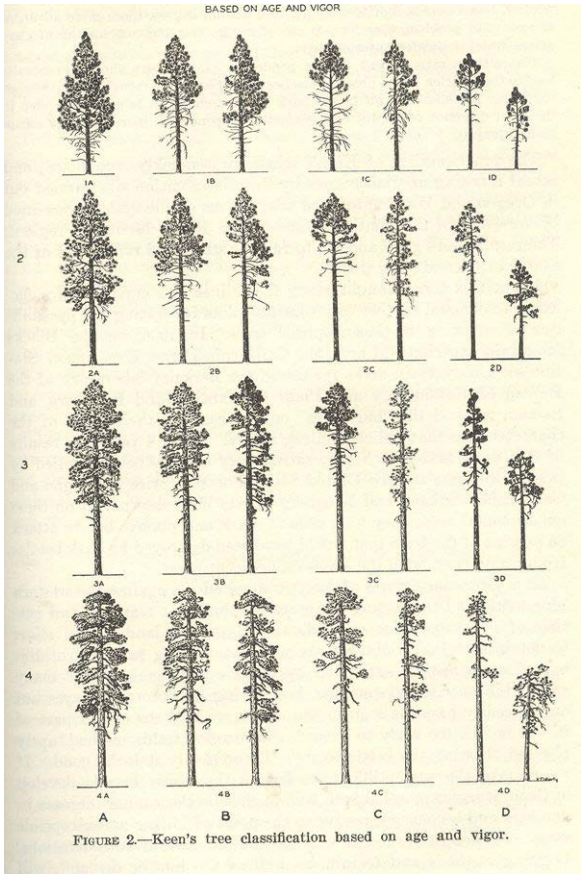


FIGURE 2.—Keen's tree classification based on age and vigor.

Keen's Tree Classification, 1936

- Slower growing trees more susceptible to western pine beetle attack (Craighead 1925; Miller 1926).

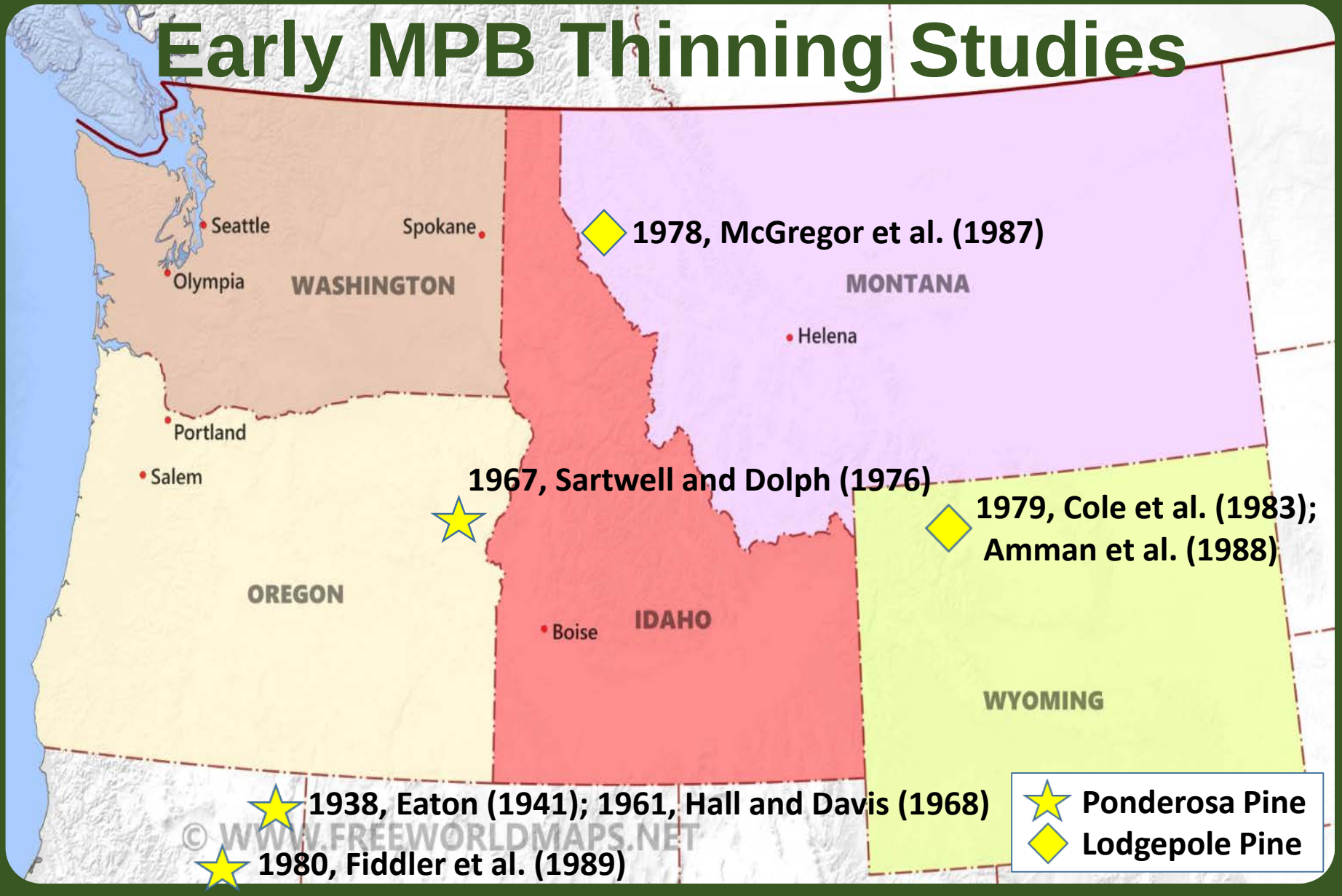
Development of Thinning for Bark Beetle Prevention

- Slow tree growth, crown ratios ≤30% characteristic of trees killed by mountain pine beetle (Sartwell 1971).

Development of Thinning for Bark Beetle Prevention

- Correlation between tree density and mountain pine beetle infestation (Amman et al. 1977; McCambridge et al. 1982).

Early MPB Thinning Studies



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These studies consistently showed reduced mortality in thinned areas, except when plot size was small and surrounded by extensive areas of unmanaged forest where mountain pine beetle populations were epidemic.

Thinning Overview by Forest Type

- Ponderosa pine
- Lodgepole pine
- Douglas-fir
- Eastside mixed conifer
- Legacy pines

Will not address thinning in:

- Coastal spruce/hemlock
- High elevation spruce-fir
- Whitebark pine

Ponderosa Pine Forests

Important bark beetle: Mountain pine beetle

- Rate of tree mortality increases with increasing stocking – thresholds may vary by region
- Thinning can significantly reduce mountain pine beetle activity, even during an outbreak

Ponderosa Pine Forests

Important bark beetles: Western pine beetle

- No thinning studies, but thinning has been generally applied with good outcomes except during prolonged severe drought.
- Tree mortality is associated with poor vigor, drought, slow-growing older trees, dwarf mistletoe and root diseased trees, and trees injured by lightning and fire.

Ponderosa Pine Thinning California Gulch, NE OR

- Study installed in 1967 by Sartwell and Dolph
- Two replicates (blocks) of four spacing treatments (12’, 15’, 18’, 21’) and control
- Each treatment area = 25 acres
- Sartwell and Dolph (1976) - 5 year results
- Dolph (1982) – noted 15 year results
- 50 year remeasurement field work completed in 2017

California Gulch Block B

Control, unburned

21’ x 21,’ burned

Photos taken in 2011

California Gulch Block A

Control, burned

21’ x 21,’ burned

Photos taken in 2011

California Gulch Block B

12’ x 12,’ western pine beetle activity in 2017

California Gulch Thinning Study

50 years - very low mortality = 18’ and 21’ spacing

Lodgepole Pine Forests

Important bark beetles: Mountain pine beetle

- Tree mortality correlated with increased stocking, diameter, stand age, and low vigor – thresholds can vary by region
- Thinning can significantly reduce mountain pine beetle activity, but may have little effect when in the path of an ongoing epidemic
- Thinning and regeneration treatments should aim to create a mosaic of ages, sizes, structures, and species compositions across the landscape

Lodgepole Thinning

Lemiti Butte, Mt. Hood NF

Study conducted by Bruce Hostetler, USFS Entomologist, retired

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Lodgepole Thinning

Lemiti Butte, Mt. Hood NF

- Stands operationally thinned 2002-2004
- Mature, 80-150 year old lodgepole
- MPB attacking adjacent unthinned stands in 2006
- Plots sampled in 2006, 2007, 2008

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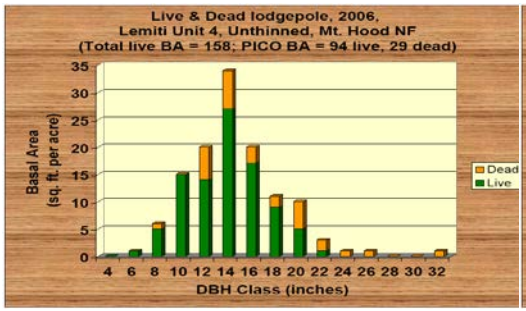
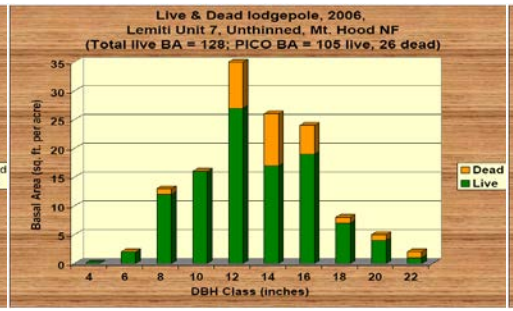
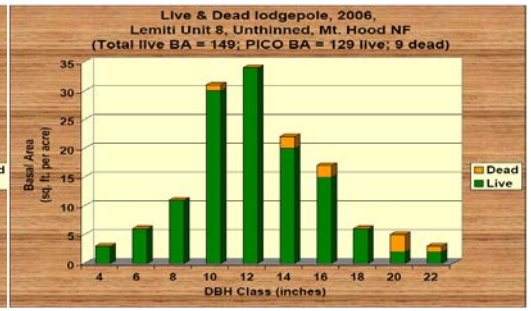
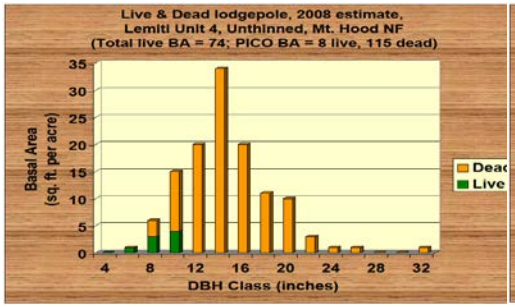
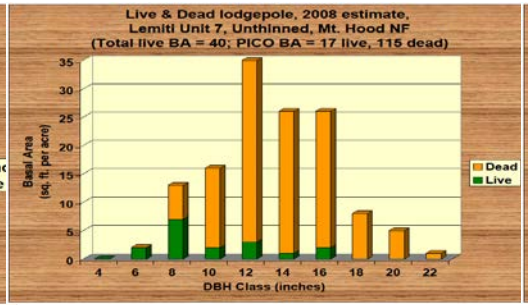
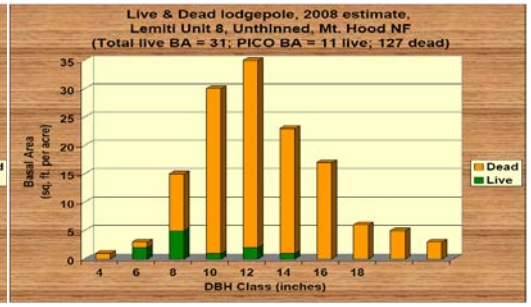
Unthinned

Lemiti Butte, Mount Hood NF

Year	Rep 1	Rep 2	Rep 3
2006			
2008			

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Thinned

Lemiti Butte, Mount Hood NF

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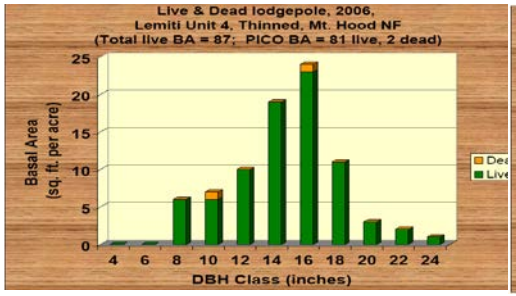
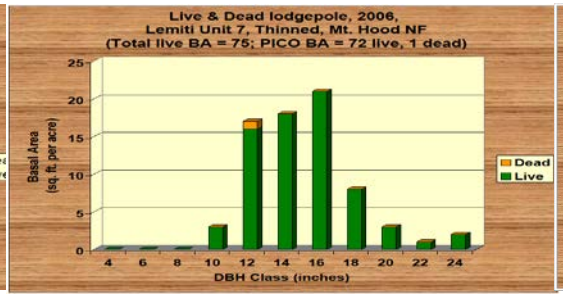
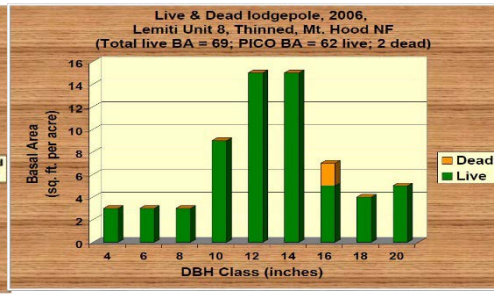
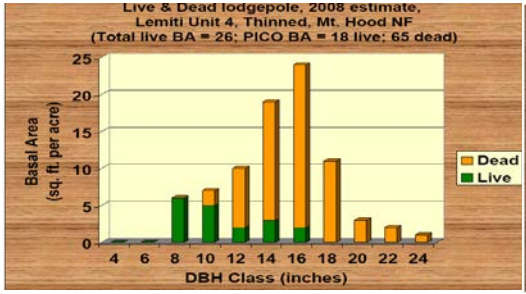
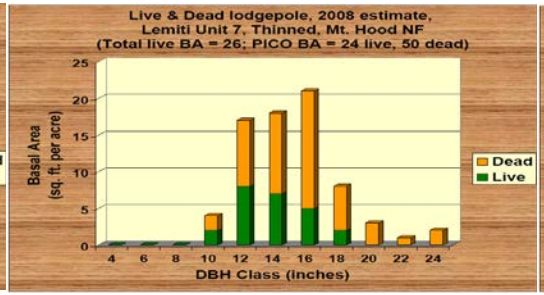
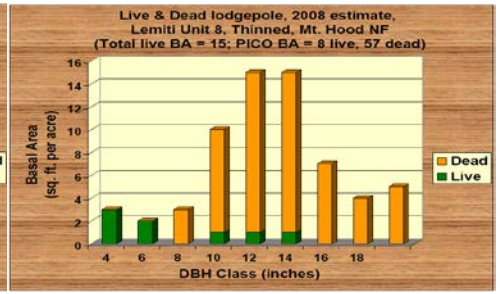
2006			
2008			

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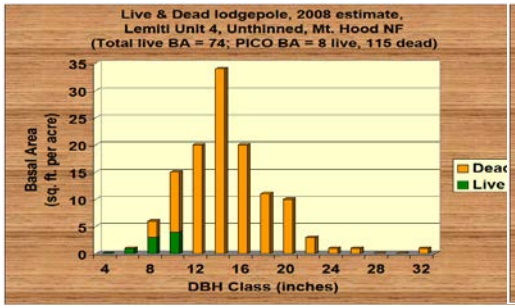
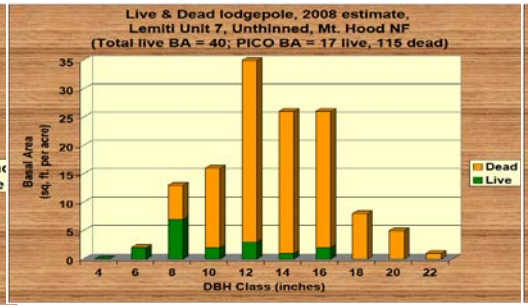
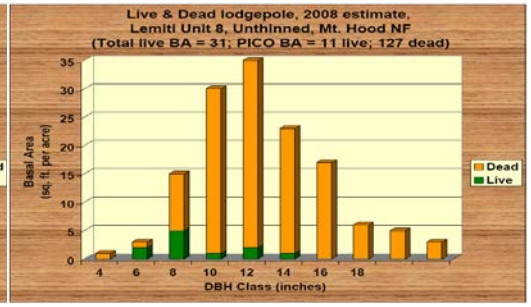
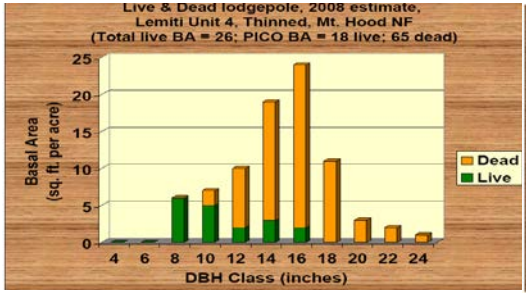
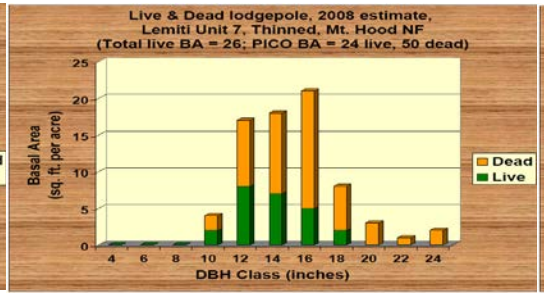
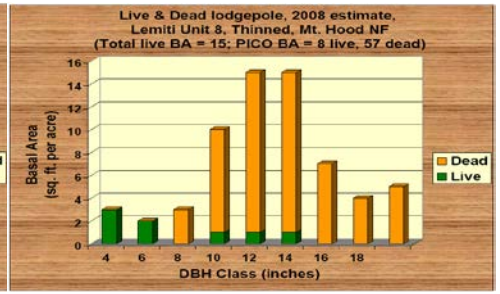
2008

Lemiti Butte, Mount Hood NF

Tmt	Rep 1	Rep 2	Rep 3
U			
T			

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Results

- Thinning failed to prevent severe mortality of residual lodgepole pine.
  - Lodgepole BA - reduced by 91% (unthinned) and 81% (thinned).
  - Total BA- reduced by 69% (unthinned) and 76% (thinned).
- Largest trees were killed (classic pattern).
- Landscape-level MPB outbreak overwhelmed thinned units with residual older, large-diameter lodgepole pine.

Douglas-fir Forests

Important bark beetles: Douglas-fir beetle

- No thinning studies
- Mortality associated with mature stands, high percentage of Douglas-fir, high stocking, large diameters, poor growth
- Outbreaks triggered by high inputs of fresh down woody material
- Westside forests do not require thinning for Douglas-fir beetle; considered beneficial in Eastside settings

Eastside Mixed Conifer Forests

Important bark beetles: Fir engraver, Douglas-fir beetle, mountain pine beetle, western bark beetle

- Tree mortality is associated with poor vigor, dense stocking, drought, root disease, and trees injured by defoliation.

Eastside Mixed Conifer Forests

Important bark beetles: Fir engraver, Douglas-fir beetle, mountain pine beetle, western bark beetle

- No thinning studies for fir engraver/true fir host system, but thinning is generally applied with good outcomes except during periods of prolonged drought, defoliation, or high levels of root disease.
- Early seral species are generally preferred over true fir during thinning activities in the eastside mixed conifer type.

Big Pine" - killed by western pine beetle in 2015

Legacy Pine Maintenance

Individual Tree Thinning

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Other Thinning Considerations

- Management objectives
- Insects that build up in slash – slash management
- Root disease
- Risk of windthrow

Why does thinning work?

Not fully understood, however:

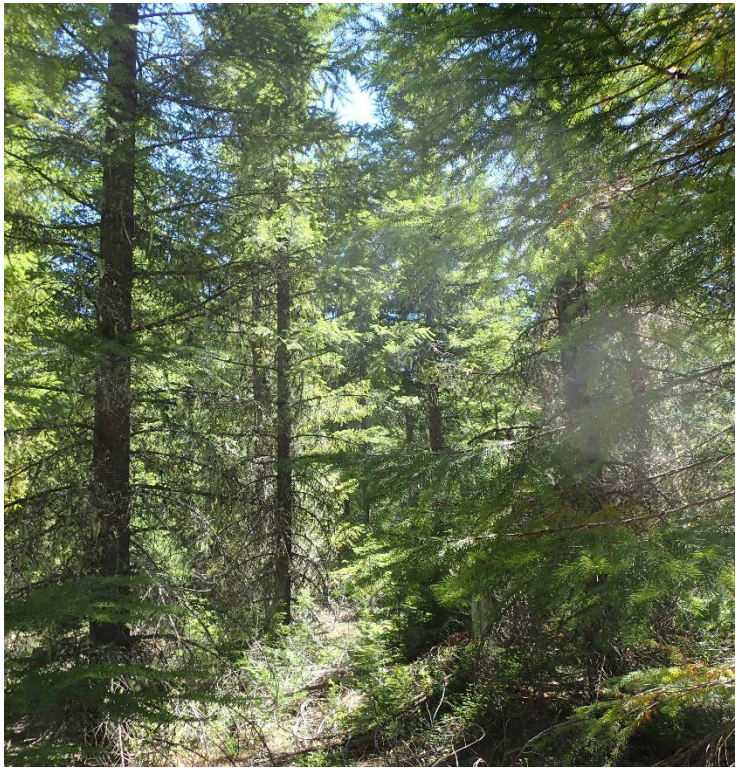
- Tree vigor improves
- Physical changes in stand environment negatively affects the beetles

Growing Space

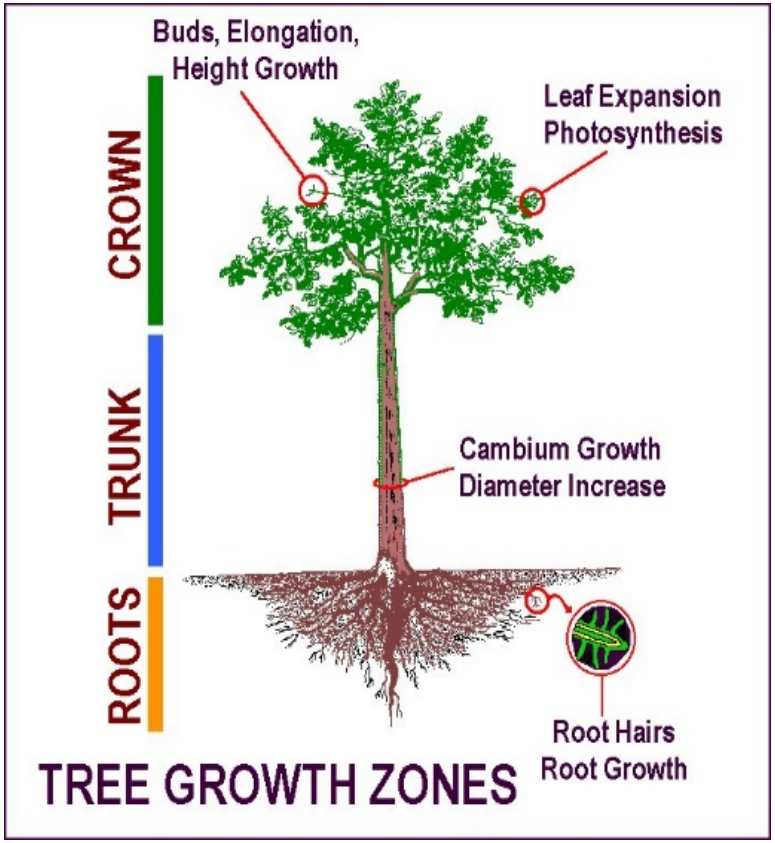
- Available capacity for tree growth
- Growth continues until an essential factor becomes limiting – water, sunlight, nutrients
- Determined by:
  - oImmediate environment
  - oCompetition
  - oLimiting factors

Growing Space

- Differs - among species and individuals
- Dynamic – fluctuates across time and space



Tree Priorities for Allocating Photosynthates



Bill Cook, Michigan State University Extension

1. Respiration
2. Fine root and needle growth
3. Reproduction (flower and fruit growth)
4. Height growth
5. Diameter growth
6. Insect and disease resistance mechanisms

adapted from Oliver and Larson (1996)

Tree Defense

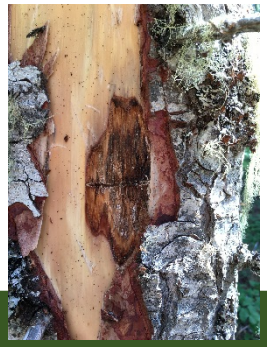
Two types:

1) Constitutive – always present
2) Induced – reaction to damage or stress

Tree Defense Against Bark Beetles

Constitutive

- Preformed resin in ducts:
  - Quantity
  - Chemical composition
  - Exudation pressure
  - Crystallization rate



Induced

- Increased resin flow
- Changes in resin chemical composition
- Traumatic resin duct formation
- Necrotic lesion formation

How Tiny Bark Beetles Kill Huge Trees

PaDIL

Chris Schnepf

With amazing olfactory abilities…

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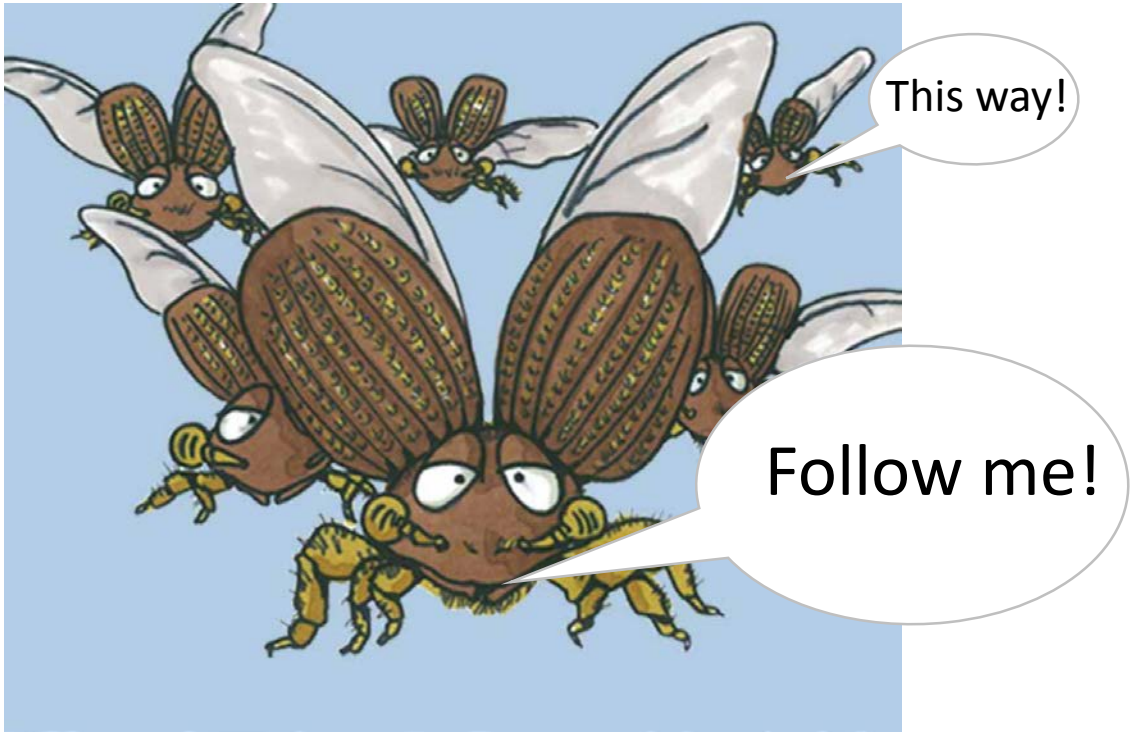
How Tiny Bark Beetles Kill Huge Trees



… good communication…

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How Tiny Bark Beetles Kill Huge Trees

USFS

…sheer numbers…

Steve Katovich

US Forest Service
Forest Health Protection

How Tiny Bark Beetles Kill Huge Trees

Sandy Kegley

…and help from symbiotic partners!

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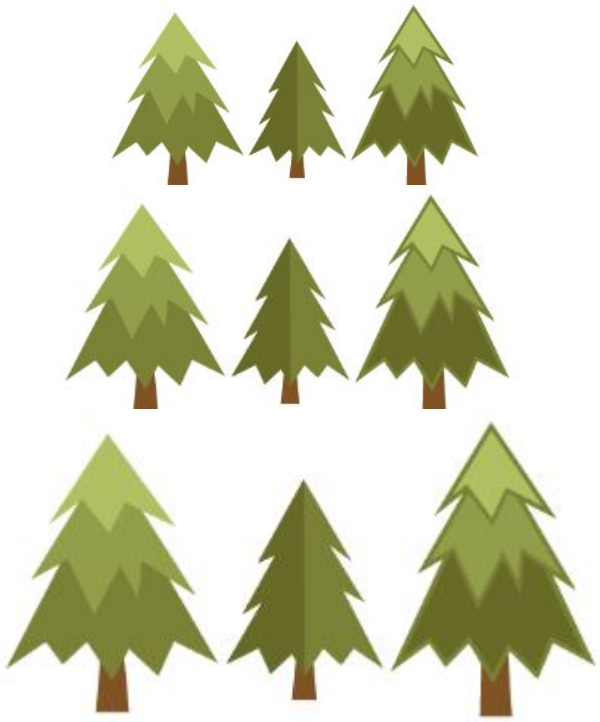
Physical Changes in Thinned Stands That Negatively Affect Bark Beetles

- Reduced amount of host
- Increased wind speeds
- Increased solar radiation
- Increased temperatures
- Increased inter-tree spacing



When Thinning Doesn't Work

- Stocking levels not reduced enough
- Wrong trees are left as residuals
- Weather conditions reduce growing space (e.g. prolonged hot drought)
- Scale too small
- Severe landscape-level outbreak – all stands can be affected
- It is not understood how large beetle populations need to be before vegetation management is not successful

Consistent Scientific Evidence

The body of scientific literature on stand conditions associated with bark beetle activity consistently identifies the following stand characteristics as primary factors influencing susceptibility to bark beetles:

- Stocking levels
- Tree diameters
- Amount of host

Jose Negron, http://caforestpestcouncil.org/wp-content/uploads/2006/11/1515%20Negron_veg_mgmt_bb.pdf

Conclusion

Reductions in stand densities through vegetation management can reduce the likelihood of bark beetle attack and the extent of mortality.

Thinning to Prevent Bark Beetle Attack: Does It Work?

Yes!

Thinning to Prevent Bark Beetle Attack: Does It Always Work?

No!

Summary

- Bark beetles generally are attracted to stressed trees growing at high densities. Some species also are attracted to older, larger trees.
- Thinning typically increases tree vigor, defenses and growth, and changes stand physical characteristics in ways that interfere with bark beetle host-finding ability and mass attack success.
- Thinning works most reliably to prevent mountain pine beetle in ponderosa pine.
- Scale is important.
- Not one-size-fit all. Consider management objectives, forest type, and other constraints when deciding whether to thin to deter bark beetles.

Acknowledgements

Fettig, Christopher J.; Klepzig, Kier D.; Billings, Ronald F.; Munson, A. Steven; Nebeker, T. Evan; Negron, Jose F.; Nowak, John T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest ecology and management. 238(1-3): 24-53

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Negron, J.F. 2006. Vegetation management and susceptibility to bark beetles [Powerpoint slides]. Retrieved from *http://caforestpestcouncil.org/wp-content/uploads/2006/11/1515%20Negron_veg_mgmt_bb.pdf*