Forest Disturbance Agents and Fire; What's the Connection?

Mt. Pine Beetle in BC
Credit: Matthew Brown, UBC, via Flickr.

Working group

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Photo Robert Mathiasen

Forest Disturbance Agents

- Also called Biotic Disturbance Agents (BDAs)
- Include insects, pathogens, and parasitic plants that cause tree decline and mortality
- Mammals and birds are not discussed here

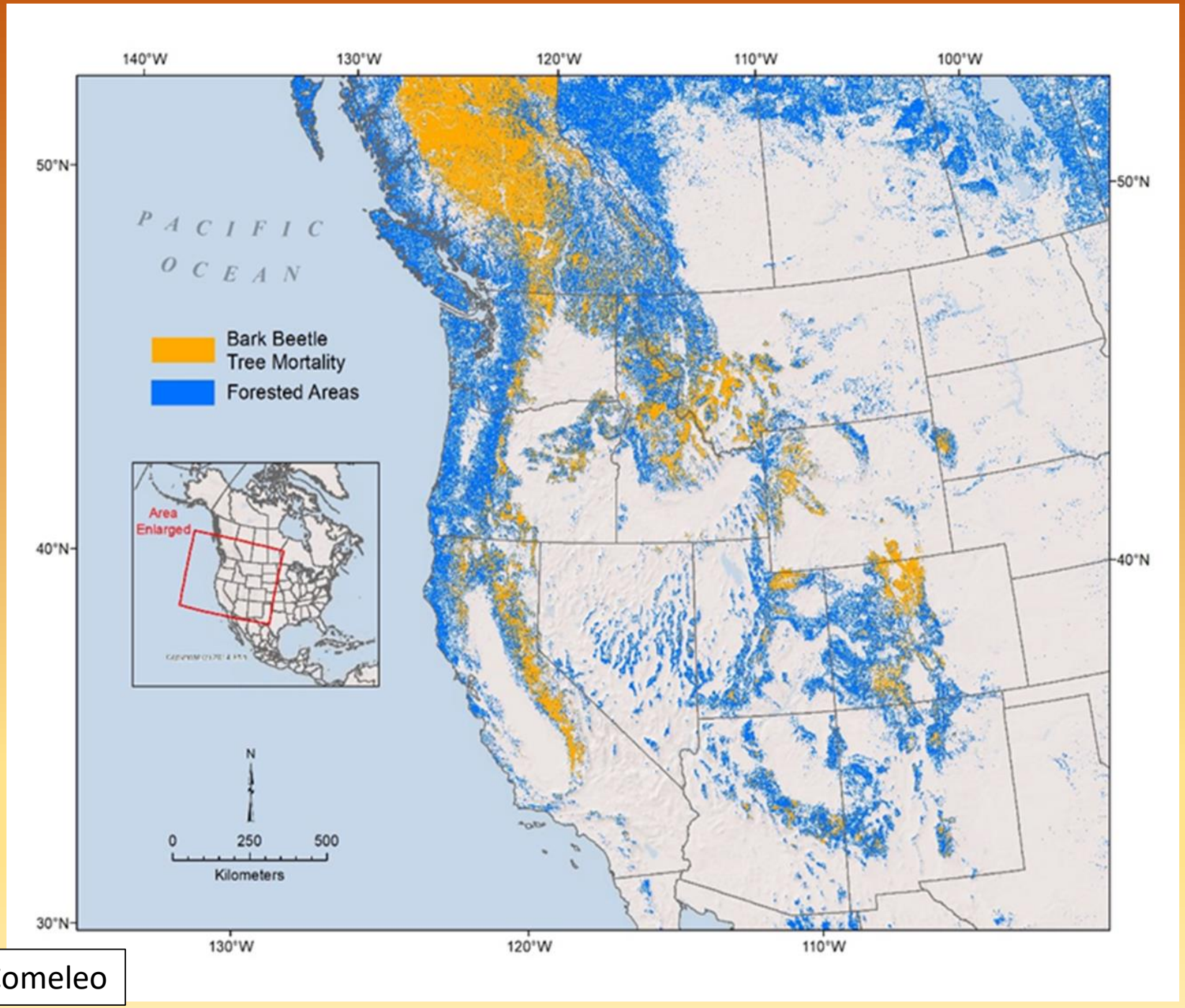
Laminated root rot of Douglas-fir

Central Questions

- How do forest BDAs influence fuels and fire in the western US?
- Do BDAs increase fire risk?

Mt. pine beetle killed lodgepole pine, SC Oregon

- Forest Region considered in this study (blue)
- Western continental USA…and adjacent Canada
- Bark beetles caused mortality (golden) from 7 beetles (1990-2020):
  - Mt. Pine Beetle
  - Western Pine Beetle
  - Douglas-fir Beetle
  - Spruce Beetle
  - Engraver (Ips) Beetles
  - Fir Engraver
  - Western Balsam Bark Beetle



Figure, Randy Comeleo

Insect Groups

- Bark Beetles
- Defoliators
- Woodborers
- Sap-feeding insects
- Insect root, shoot and stem feeders

Western Pine Beetle

Sequoia Pitch Moth

Conifer Aphids

Pathogens

- Root pathogens
- Live wood decays
- Foliage pathogens
- Canker, branch and tip dieback fungi
- Rust Fungi
- Phytophthoras

Swiss needle cast in Douglas-fir

White pine blister rust in western white pine

Parasitic Plants: Mistletoe

- Leafy Mistletoe
  - Dispersed by birds
- Dwarf Mistletoe
  - Dispersed by explosive seed discharge

Fir mistletoe in white fir

Western dwarf mistletoe in ponderosa pine

Temporal and Spatial Scales of Disturbance

- Spatial Patterns
  - Individual Tree
  - Stand
  - Landscape
  - Region
- Temporal Patterns
  - Episodic
  - Chronic

Gouty pitchy midge caused tip dieback. May increase flammability.
But is only for a single season, and infestations don't last over several years

Photo by Ken Gibson

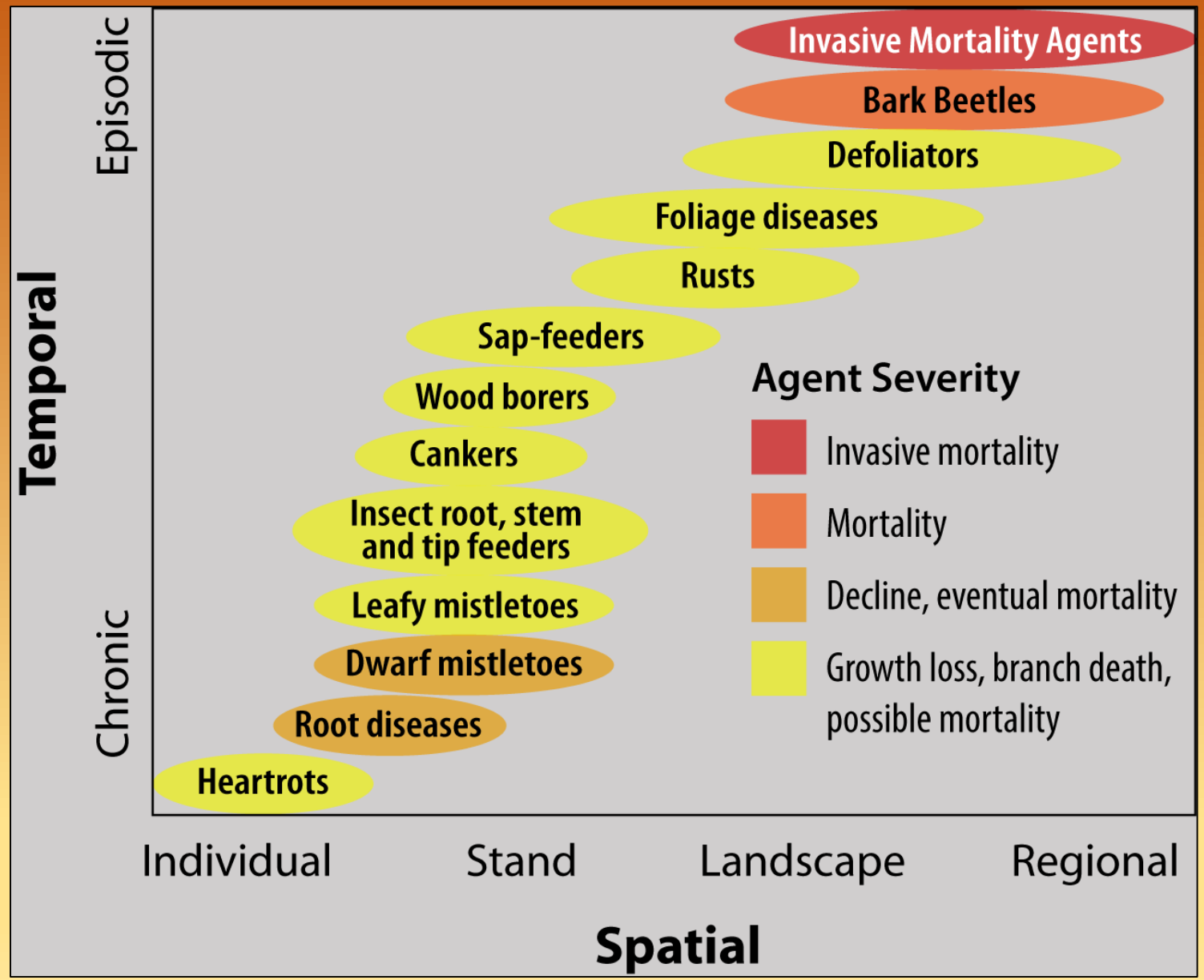


Figure Gretchen Bracher

- Hypothesized relationships with BDAs and their predominant effect on fuels

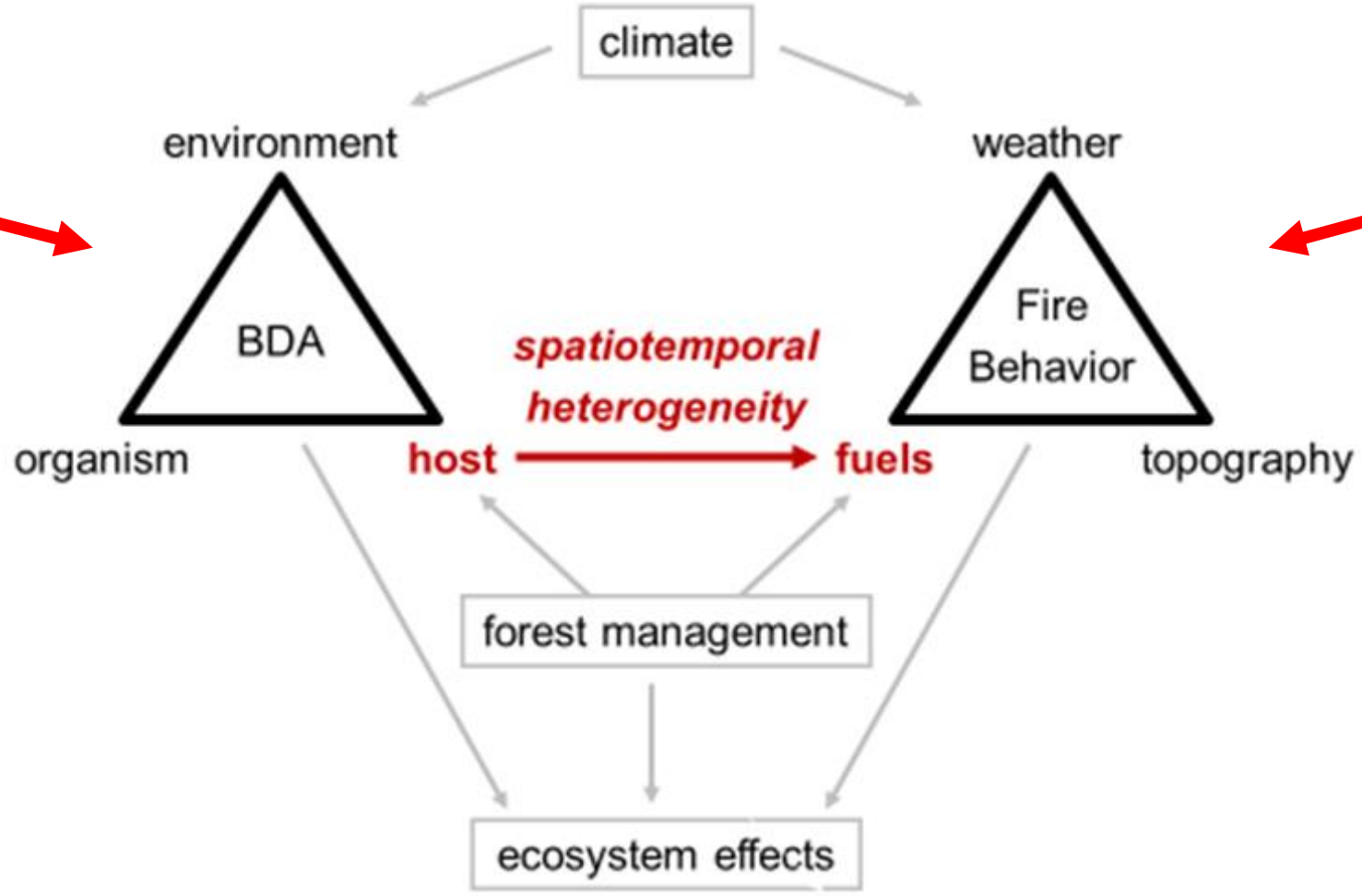
- Most BDAs are not studied with regard to fire

- Bark Beetles
- Defoliators
- Sudden Oak Death
- Dwarf Mistletoe

Influence of BDAs on fuels and fire behavior

Plant Disease (BDA) Triangle

Fire Behavior Triangle



Figure, Garrett Meigs

Bark beetles

- Time since outbreak defines effects
  - Pre-outbreak
  - Red-phase: trees actively dying, dead foliage more flammable
  - Gray-phase: standing stags no foliage
  - Old-phase: snagfall and regeneration
  - Overstory recovery-phase
- Proportion of the stand that are susceptible
- Severity of the mortality (all hosts killed?)
- Pre-outbreak vegetation structure (surface fuel bed)

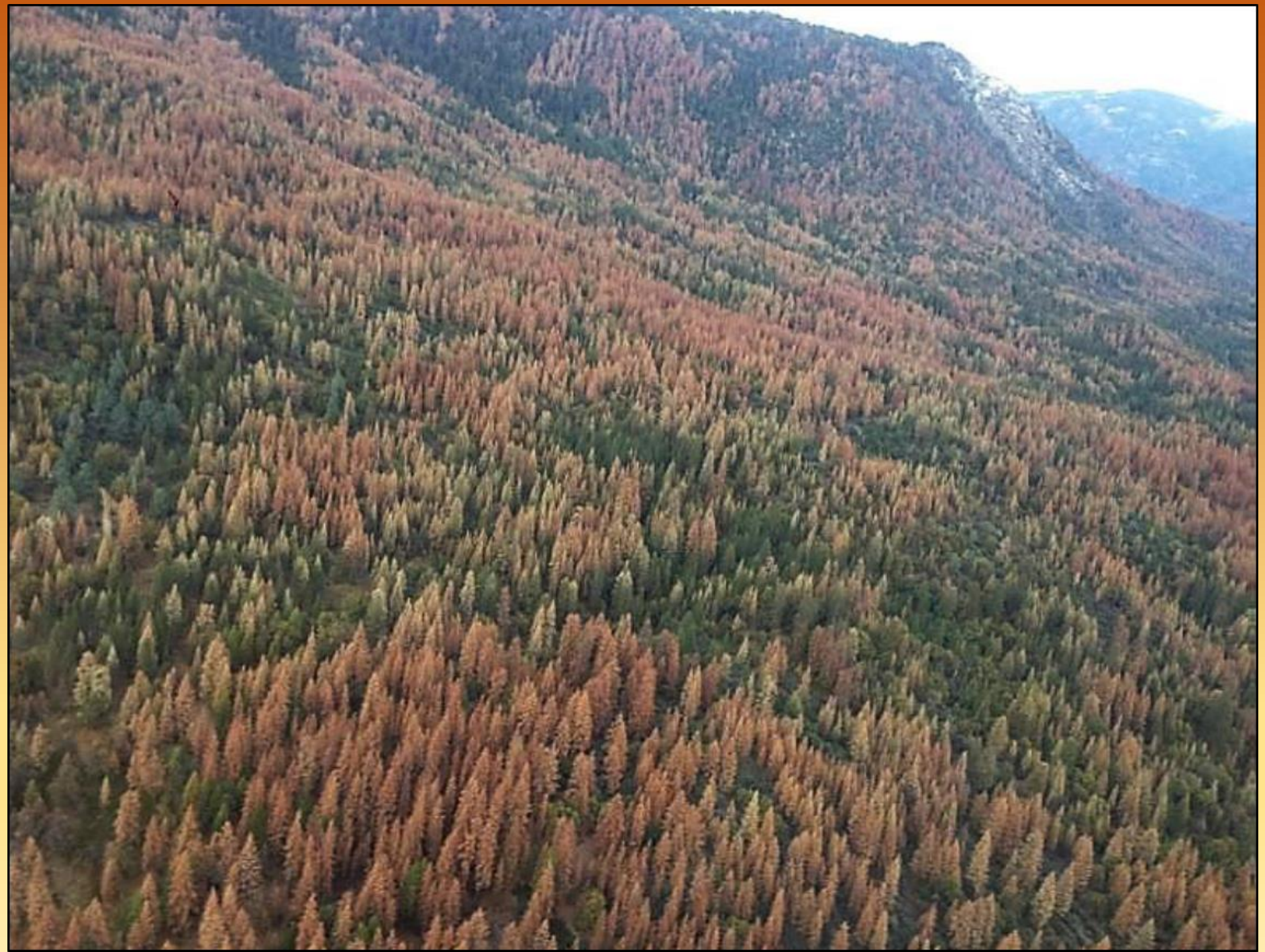
Mt. pine beetle in lodgepole pine, Central Oregon
Travis Woolly Photo. Between red and gray phase

Red phase

Drought and Western Pine Beetle

Ponderosa pine

California



Snag and snagfall phase

5-8 yr post drought and western pine beetle mortality

Ponderosa pine

Sierra Nevada Mt. Range

Red phase, Mt. Pine Beetle

Mt. Pine Beetle in Lodgepole Pine, British Columbia
Photo Canadian Forest Service

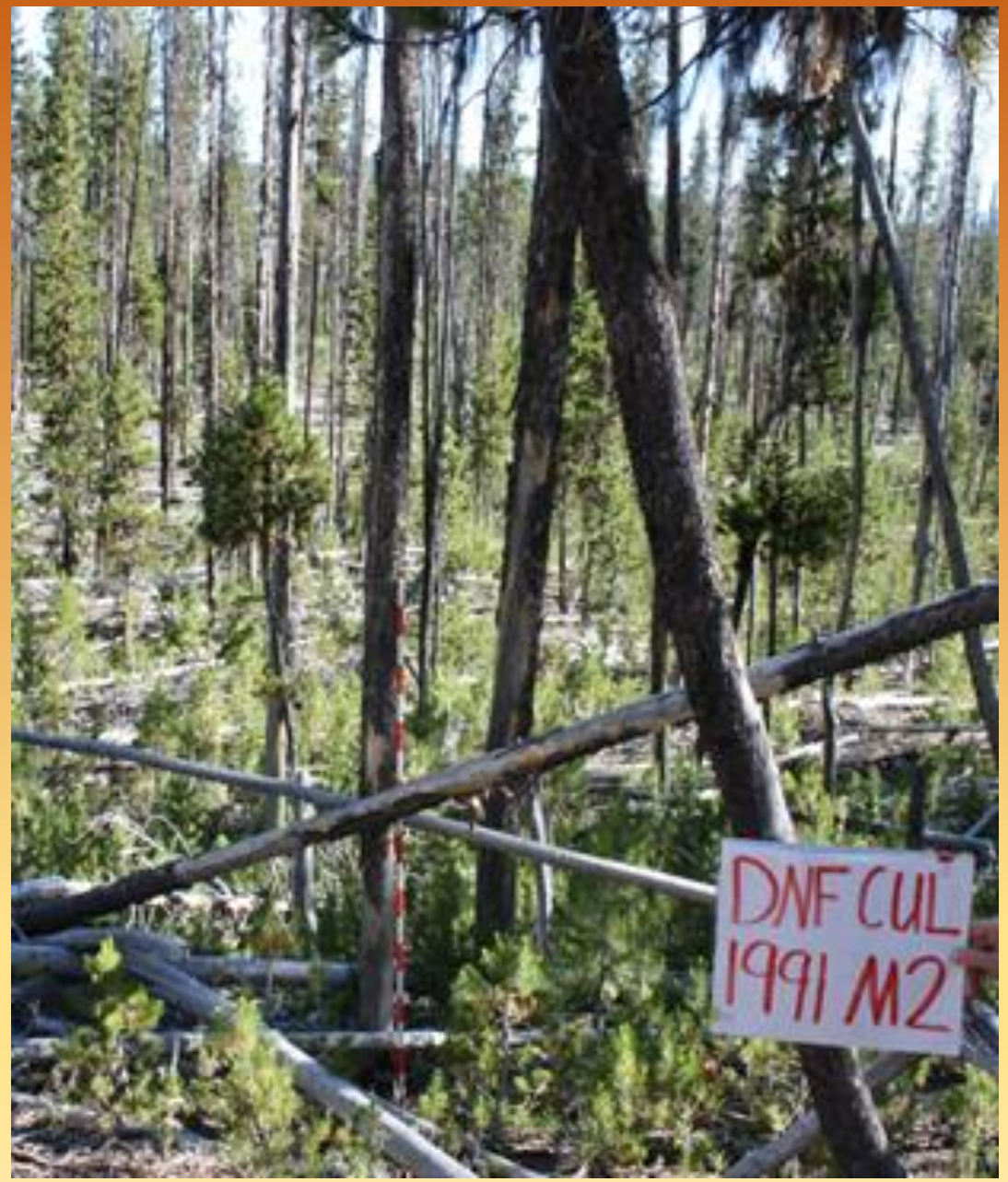
Late red phase, mt. pine beetle and lodgepole pine SC Oregon

Gray phase

Mt. Pine Beetle

Klamath Area

Photo Robbie Flowers



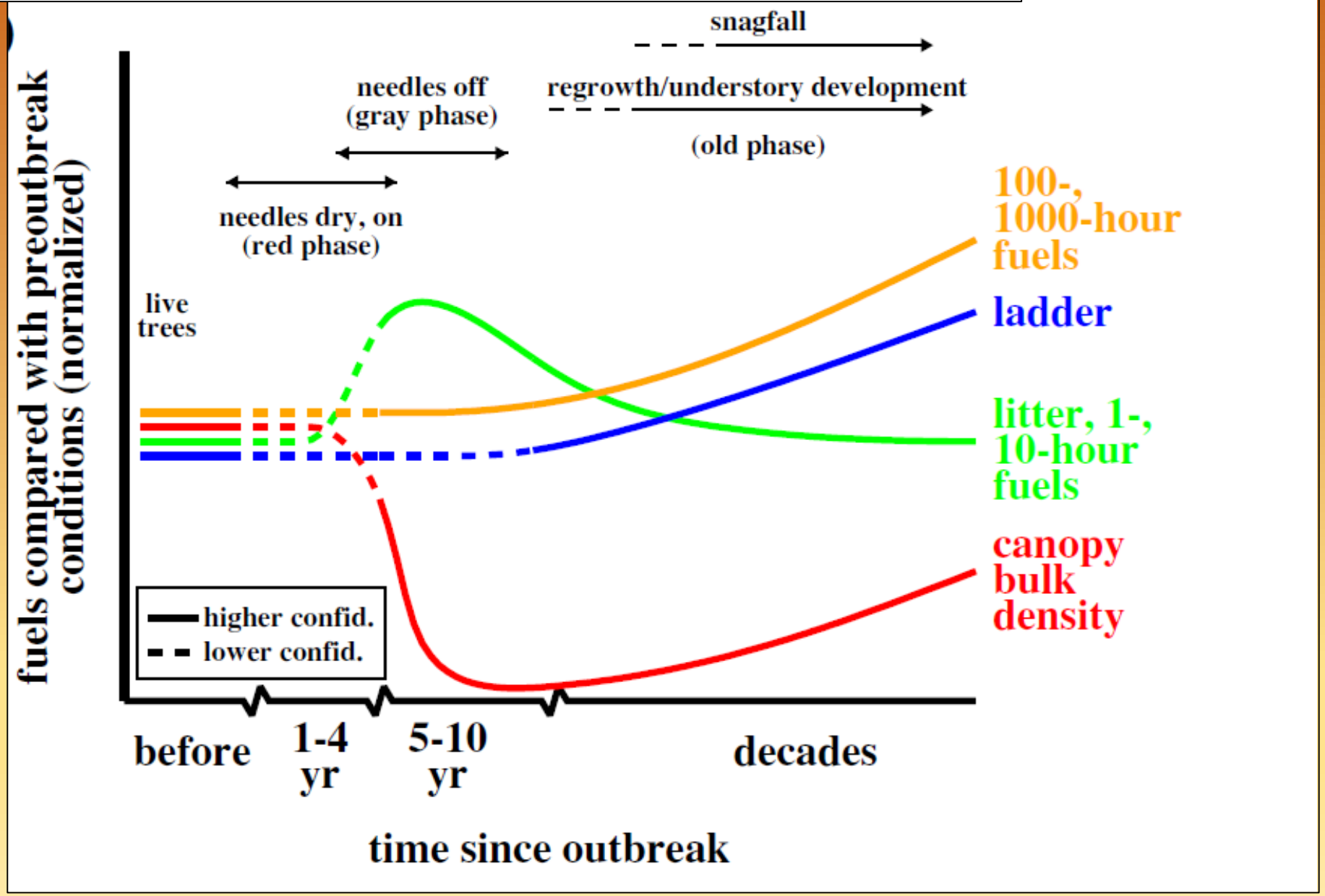
Gray phase or Snag and Snagfall phase ~19 yrs post MPB

Lodgepole pine SC Oregon

Regeneration Phase
~ 27 yr post MPB
Lodgepole pine SC Oregon

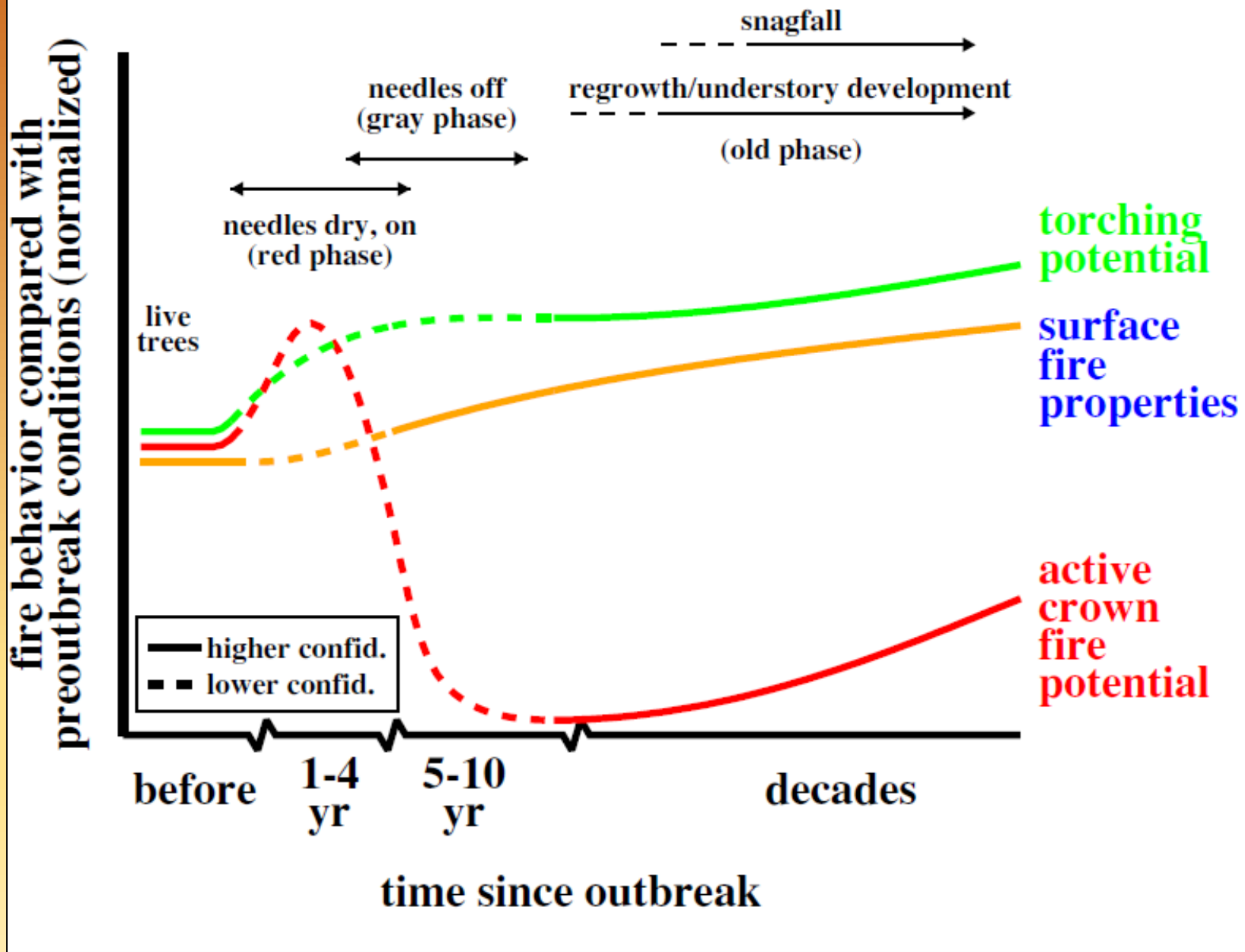
Bark Beetle Influence on fuels over time

- Hicke et al. 2012. Forest Ecology and Management
- Canopy bulk density strongly declines in the short term
- Long term increase in 100- and 1000-hr surface fuels (snagfall)



Bark beetle influence on fire behavior over time

- Hicke et al. 2012. Forest Ecology and Management
- Active crown fire potential is high during red phase.
- Drops significantly in gray phase
- Surface fire and torching may increase long term



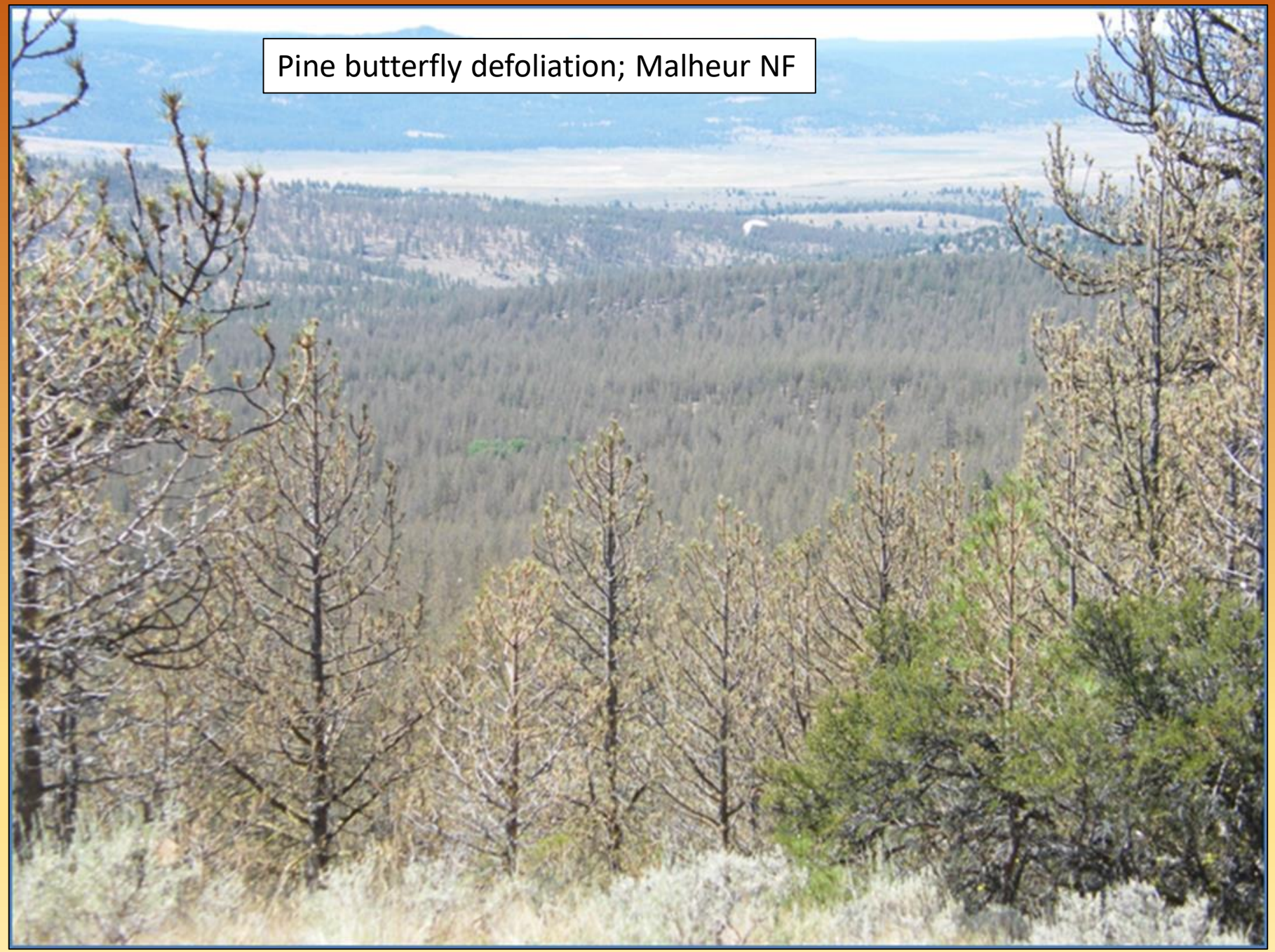
Conclusions

- Reviewed 37 papers
  - Most empirical studies found reduced fire severity after red phase
- Fire behavior and severity depend on:
  - Phase of the outbreak
  - Outbreak severity
  - Fire weather
  - Topography/landscape setting
  - Pre-bark beetle outbreak stand composition, structure and surface fuels

Gray phase or Snag and snagfall phase, SC Oregon

Defoliators

- Episodic outbreaks
- Reduce foliage amount and canopy bulk density
- May cause mortality and top-kill



Defoliators

- Fire hazard can be reduced
- Fires were less likely after WSB in OR/WA
- Reduced potential for torching and active crown fire
- Surface fuels may increase in longer term however

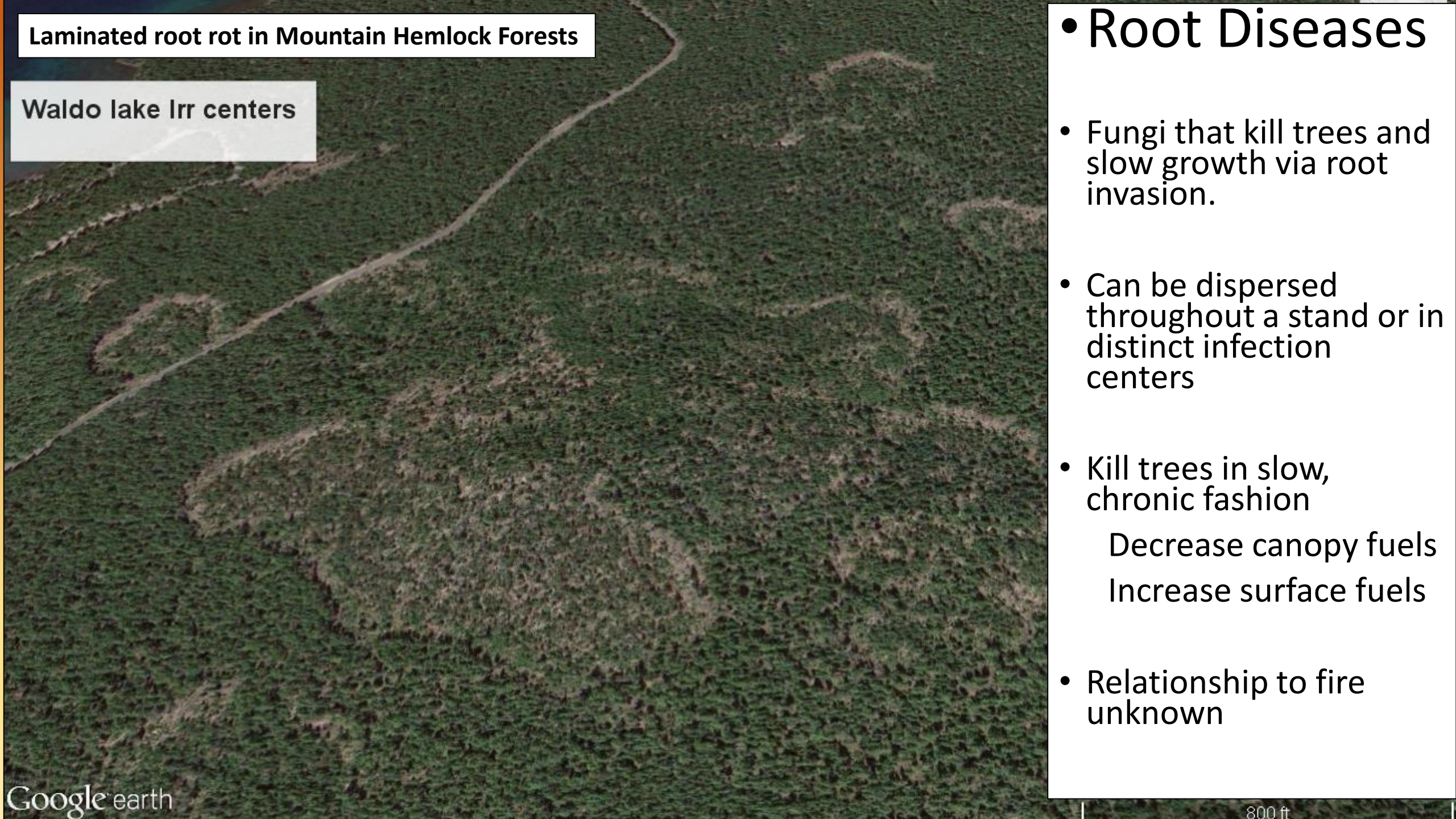
Dead tops and dead trees, post western spruce budworm in Washington

Invasive Non-native Insects

- Invasive insects have the potential to strongly influence fuels and species composition
- Balsam woolly adelgid, spruce aphid, and larch casebearer are currently in the west on conifers.
- No studies on fire effects

Spruce aphid damage in Arizona. Photo Jim Slagle

Mortality from balsam woolly adelgid

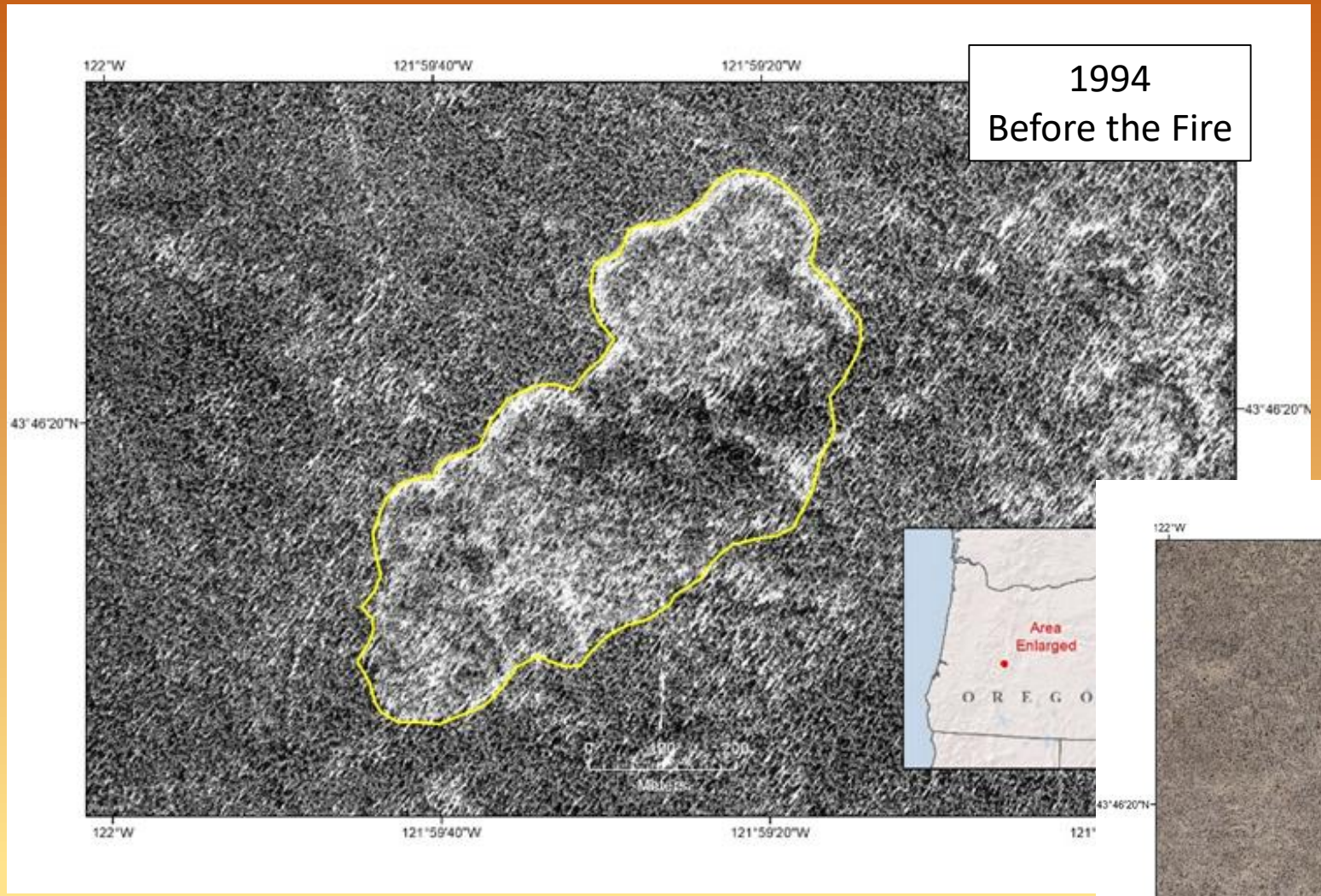


• Root Diseases

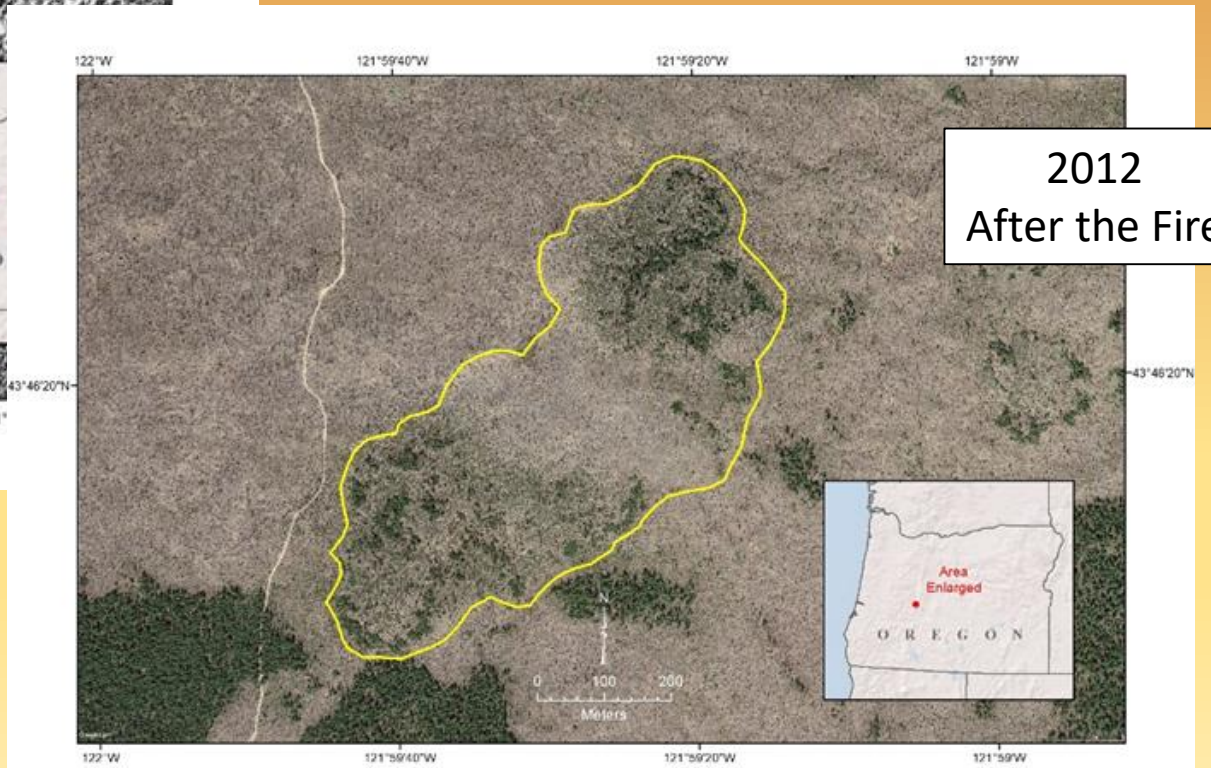
- Fungi that kill trees and slow growth via root invasion.
- Can be dispersed throughout a stand or in distinct infection centers
- Kill trees in slow, chronic fashion
  - Decrease canopy fuels
  - Increase surface fuels
- Relationship to fire unknown


Root Disease Center
Intact Forest

Fire 1996



1994
Before the Fire



2012
After the Fire

Dwarf Mistletoe

Large dwarf mistletoe broom in Douglas-fir

- Dwarf mistletoe tends to occur in distinct infection centers
- Fire strongly influences landscape pattern of dwarf mistletoe
- Crown structure is profoundly influenced by severe levels of infection
  - Branches deformed; witches' brooms
- Reduced tree density and size
- Reduced canopy bulk density
- Canopy base height is lower

Dwarf Mistletoe

- Decreased crown fire potential
- Increased ladder fuels and torching
- Surface fuels effects not consistent
- Severity of individual tree infections and size of infection center likely important

Dwarf mistletoe brooming in lodgepole pine

Invasive non-native Phytophthoras

Phytophthora ramorum, sudden oak death in California

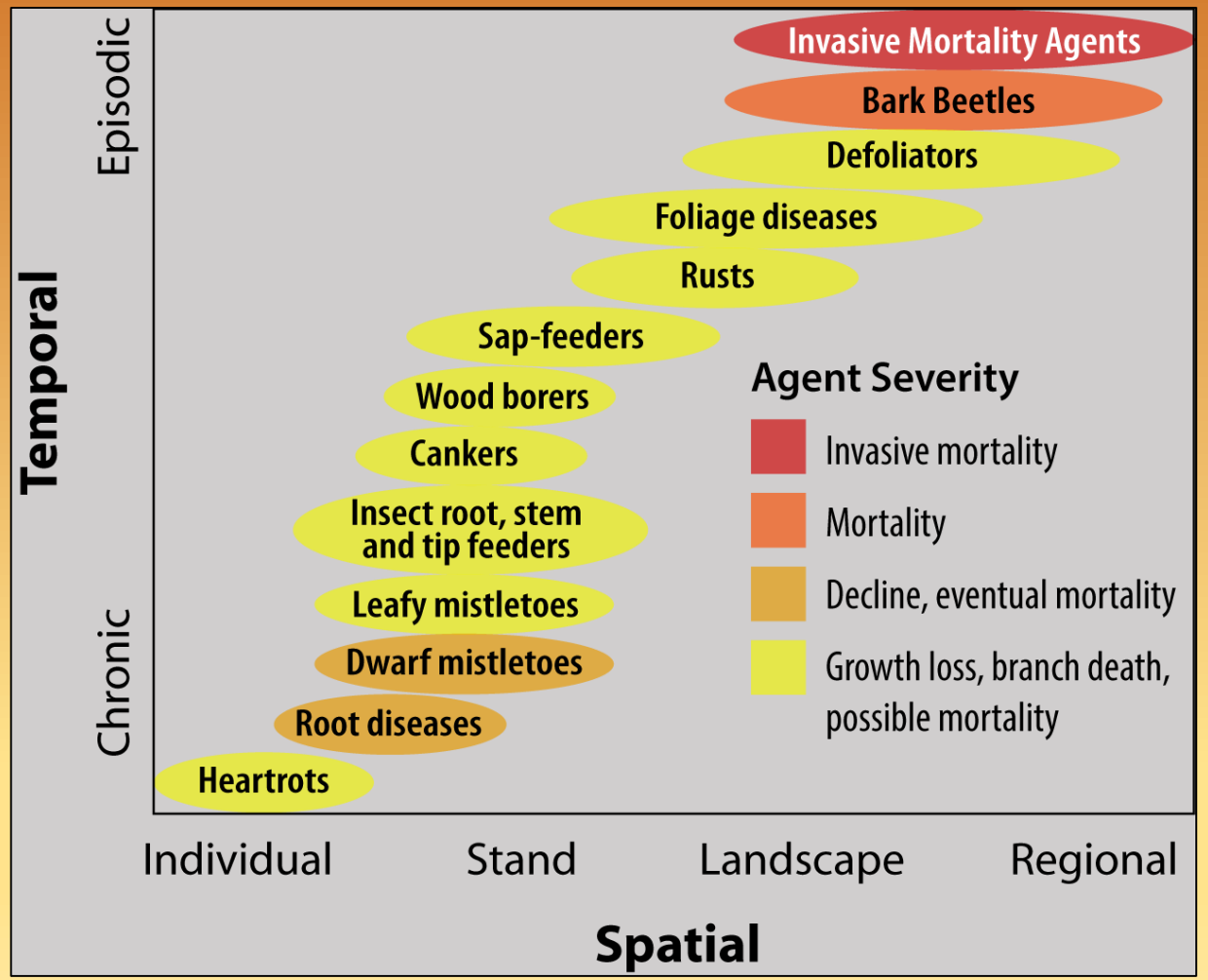
Phytophthora lateralis, Port Orford Cedar Root Disease in Oregon

Sudden oak death, fuels and fire well-studied

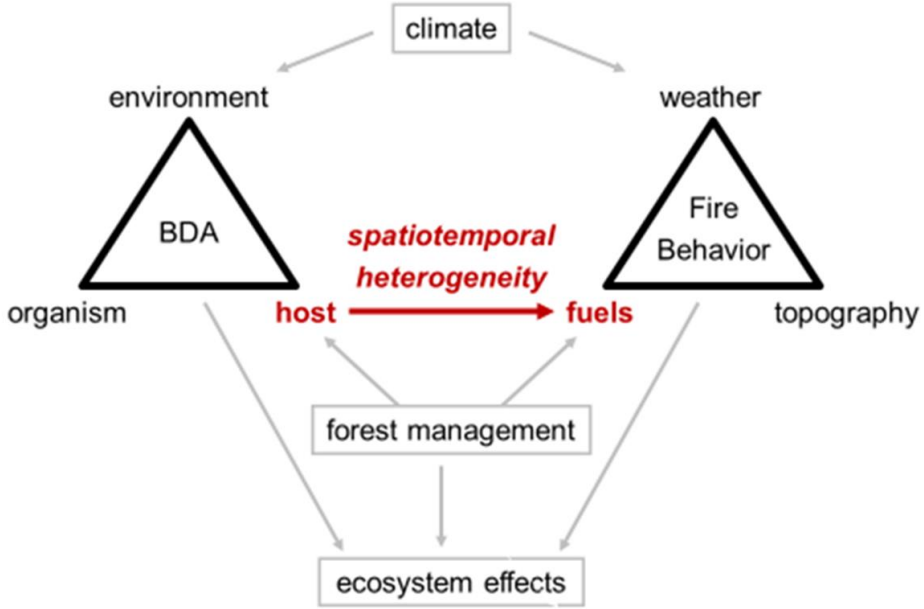
- Pulse of dead fuels after invasion
- Disease spread strongly influenced by seasonal weather patterns also
- Rates of spread, flame lengths, fire line intensities and surface fire intensities may all increase
- Stage of invasion important, impacts on fire begin to abate after time

Surface fuel bed after SOD invasion of coast live oak in California

Predominant effect of BDAs on Fuels



Influence of BDAs on fuels and fire behavior



The spatial and temporal influence on fuels creates heterogeneity

Central Questions

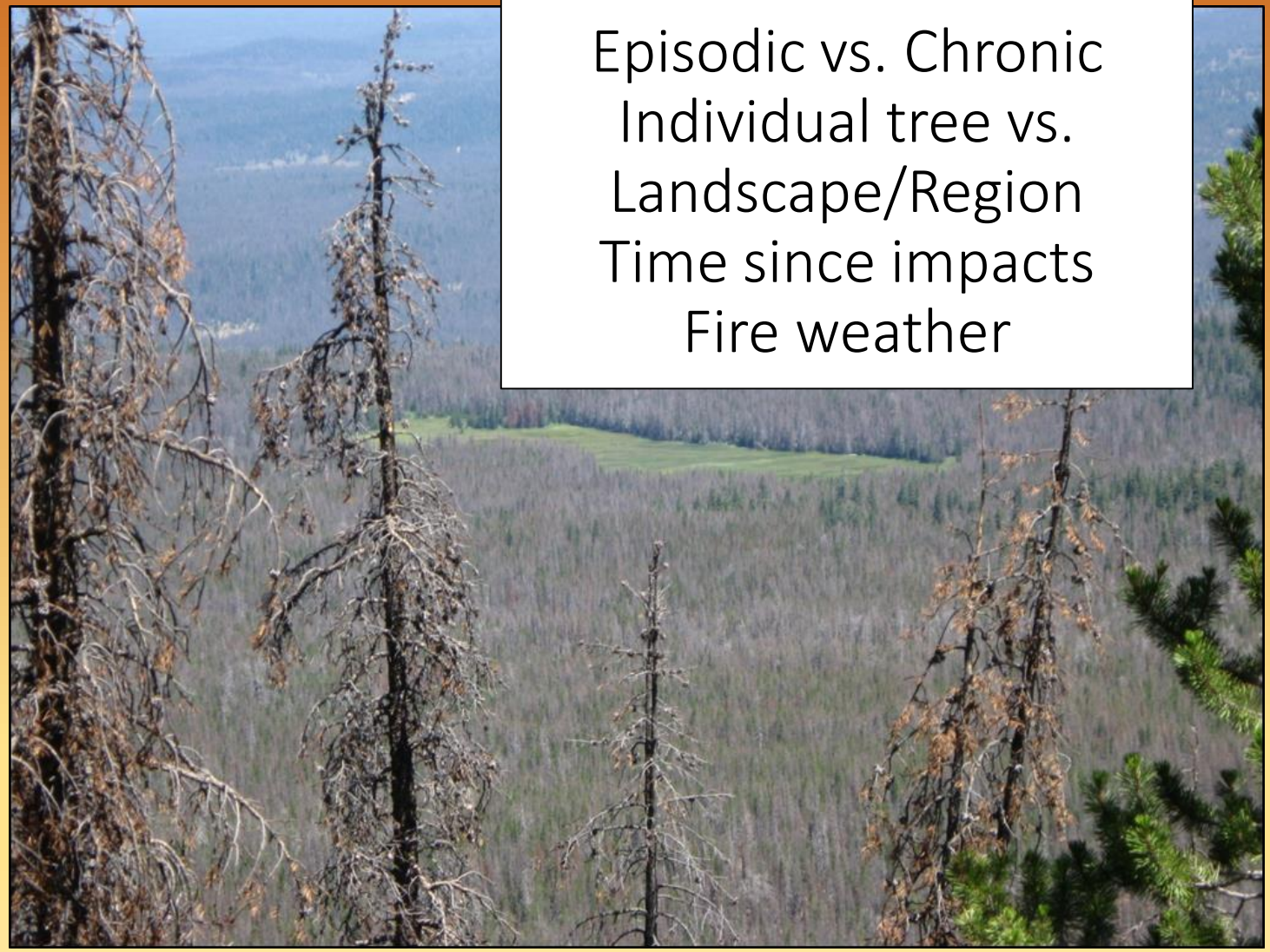
- How do forest BDAs influence fuels and fire in the western US?
- Create heterogeneity
  - Increases diversity of fire effects.
- Increase surface fuels
- Decrease canopy fuels

Central Questions

- **Do BDAs increase fire risk?**
- No evidence fire is more likely in bark beetle and defoliator outbreak areas
- Fire risk is increased in some cases, decreased in others
- Extreme fire weather overwhelms the influence of forest structure on fire behavior

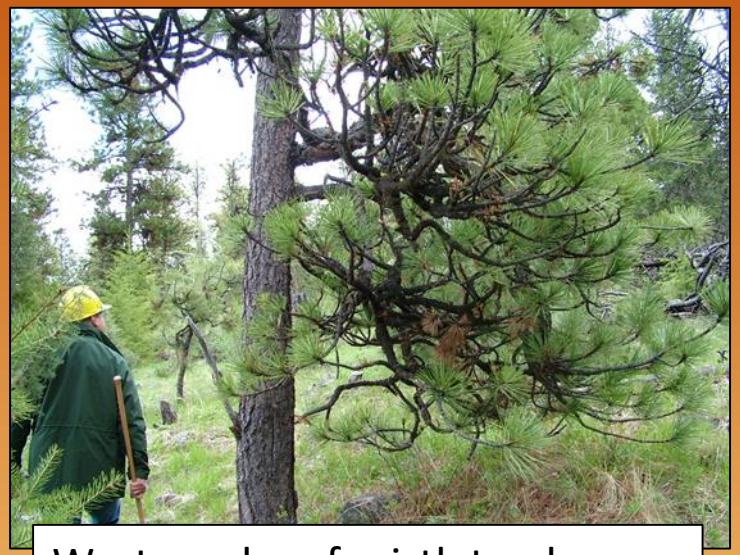
It Depends!!

Episodic vs. Chronic
Individual tree vs. Landscape/Region
Time since impacts
Fire weather



Mt. pine beetle in SC Oregon

Questions?



Western dwarf mistletoe broom

Black stain root disease center

Douglas-fir tussock moth defoliation
Photo Glenn Kohler, WA DNR

Fir broom rust

Larch needle cast

BIOTA CREATED FUELS STRUCTURES