Conifer mortality and fuel loading changes due to bark beetles and drought in Central and Southern California

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Extreme Drought

Bark Beetles

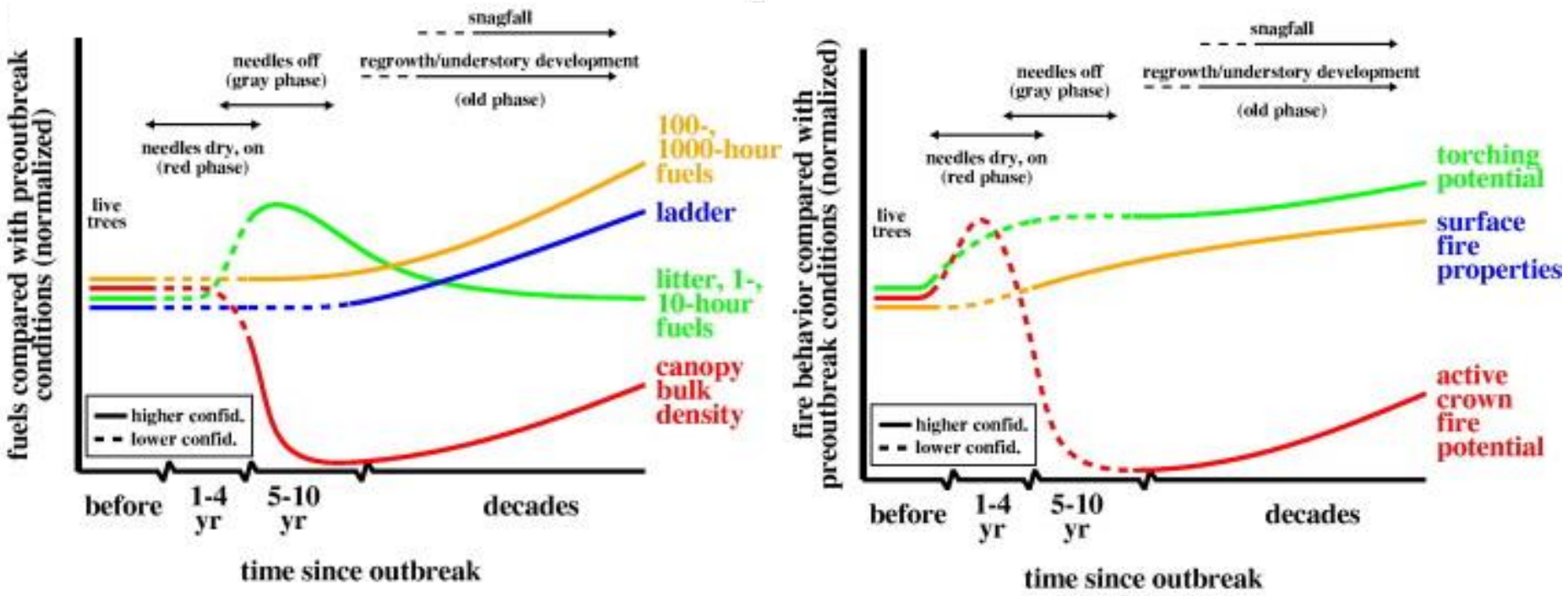
Tree mortality impacts:

- Fuels
- Forest succession
- Fire behavior
- Fire effects
- Public and firefighter safety

Study Objectives

1. Record changes in vegetation and fuels over time
2. Relate vegetation and fuel changes to potential fire behavior
3. Compare growth patterns between living and dead trees

Fire Behavior Modeling



Hicke et al. 2012 Forest Ecology and Management

Locations:

Los Padres National Forest – pinyon pine

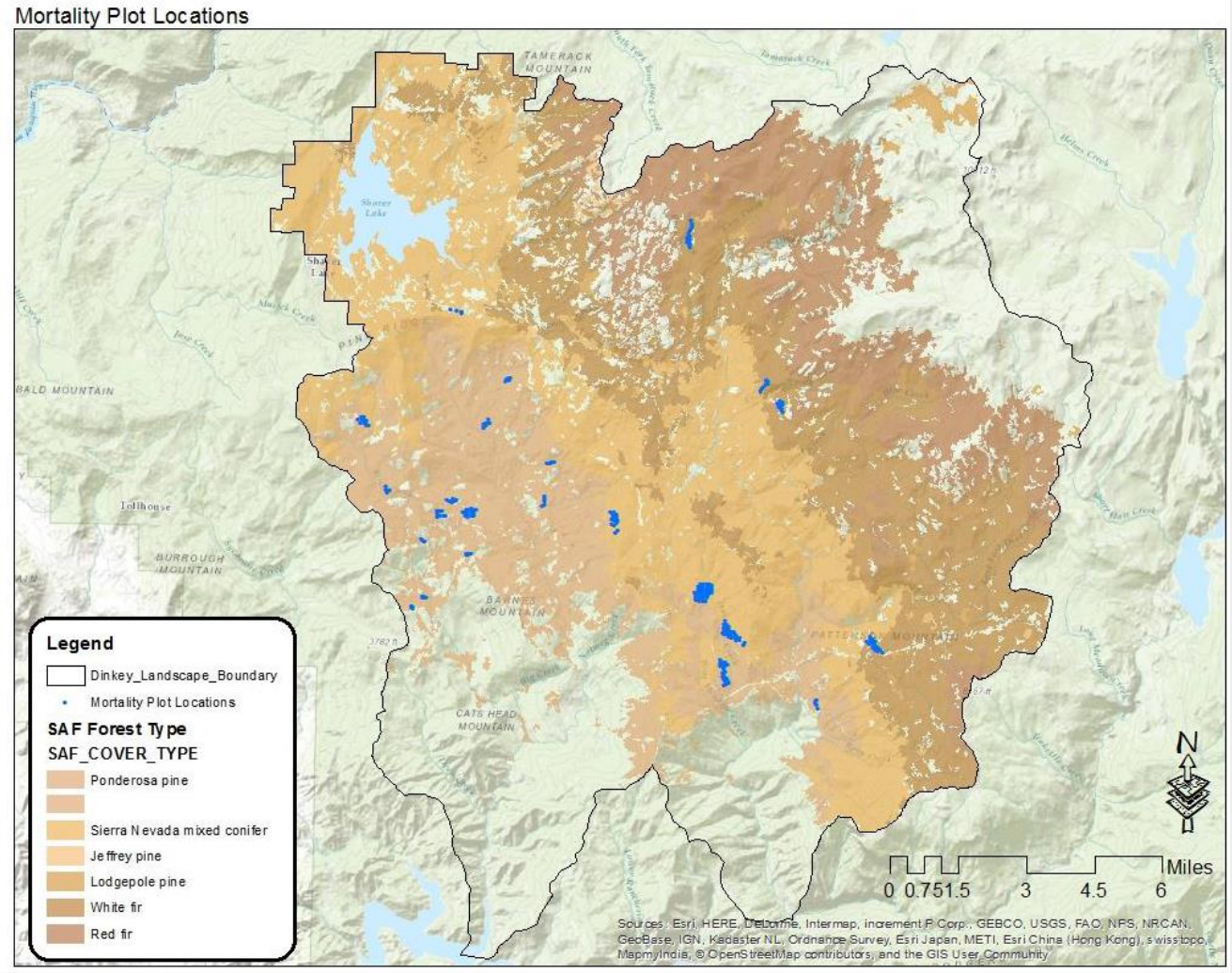
Sierra National Forest – pine and mixed conifer

Plots were in areas of recent mortality (most needles remained) and stratified by:

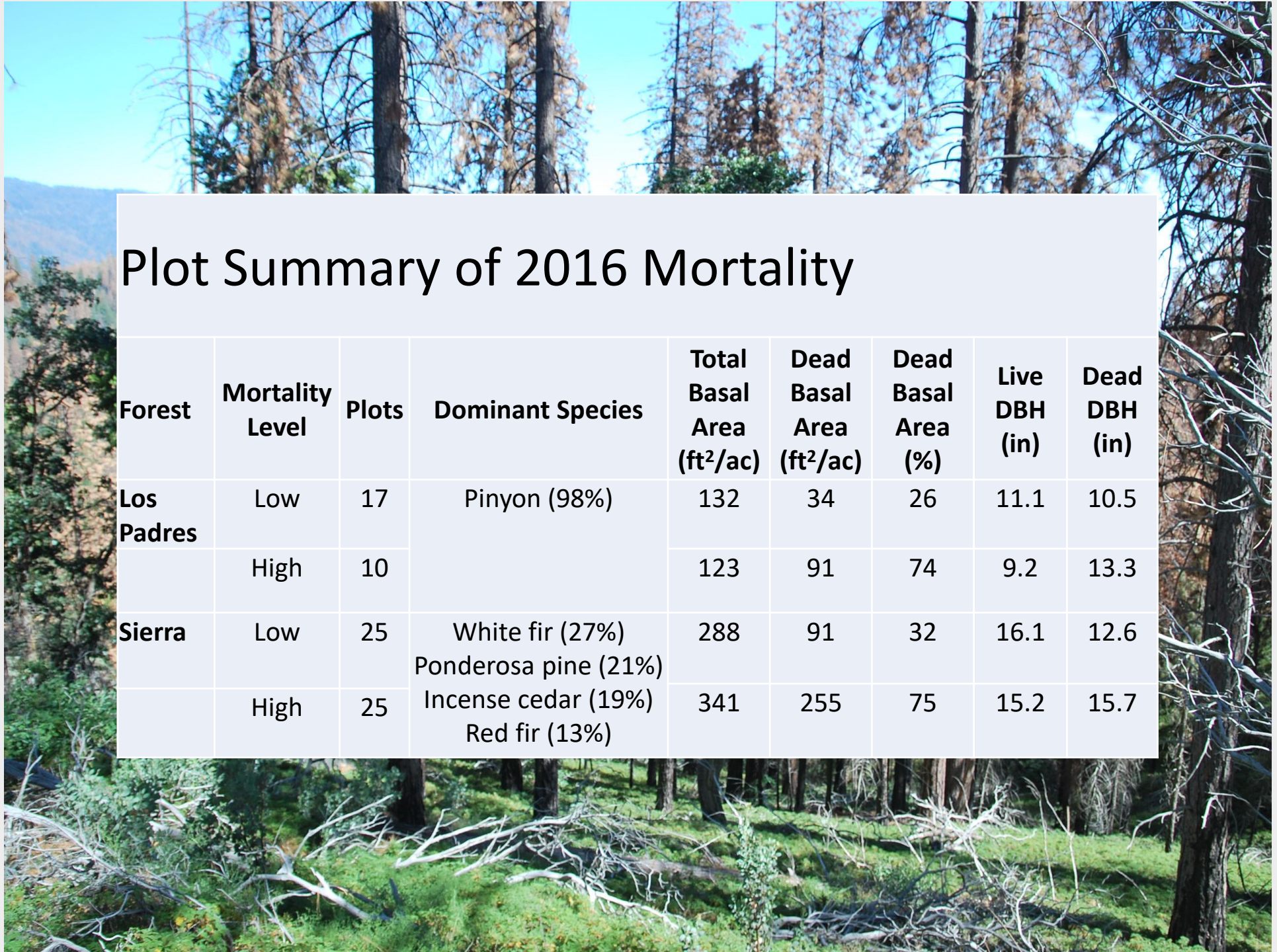
Low mortality ≤ 5%

High mortality >40%

Sierra NF – Dinkey Forest Collaborative Plot Network



Credit: Ramiro Rojas



Plot Summary of 2016 Mortality

Forest	Mortality Level	Plots	Dominant Species	Total Basal Area (ft^2/ac)	Dead Basal Area (ft^2/ac)	Dead Basal Area (%)	Live DBH (in)	Dead DBH (in)
Los Padres	Low	17	Pinyon (98%)	132	34	26	11.1	10.5
	High	10		123	91	74	9.2	13.3
Sierra	Low	25	White fir (27%) Ponderosa pine (21%) Incense cedar (19%) Red fir (13%)	288	91	32	16.1	12.6
	High	25		341	255	75	15.2	15.7

Mortality by species

Species	Dead in 2016 %	Dead in 2017 %
White fir	37	44
Red fir	11	17
Incense cedar	25	35
Sugar pine	90	93
Ponderosa pine	77	89
CA Black Oak	47	48
Pinyon pine	27	30

Needle Retention

Species	No. Recently Dead Trees	Needle Retention 2016 (%)	Needle Retention 2017 (%)	Rate of Annual Needle Loss
Pinyon pine	85	35	9	78%
White fir	59	63	21	68%
Sugar pine	36	74	26	67%
Ponderosa pine	140	80	36	56%

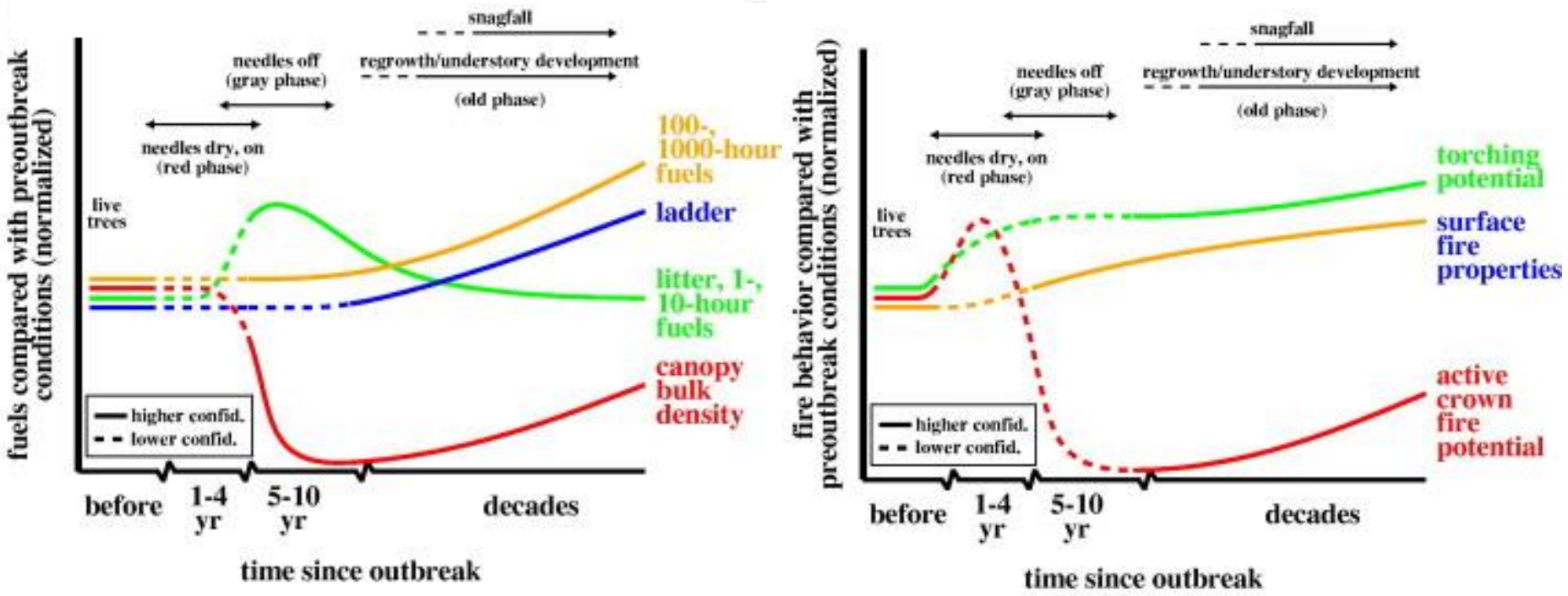
Fuels

Forest	Fine Woody Debris (<3”) tons/ac	Coarse Woody Debris (>3”) tons/ac
Los Padres	1.8	3.1
Sierra	3.9	49

Measure 1000 hr logs 1/10 ac plot

Photoload Method for 1, 10, and 100 hr
Litter and duff depth on transect

Fire Behavior Modeling



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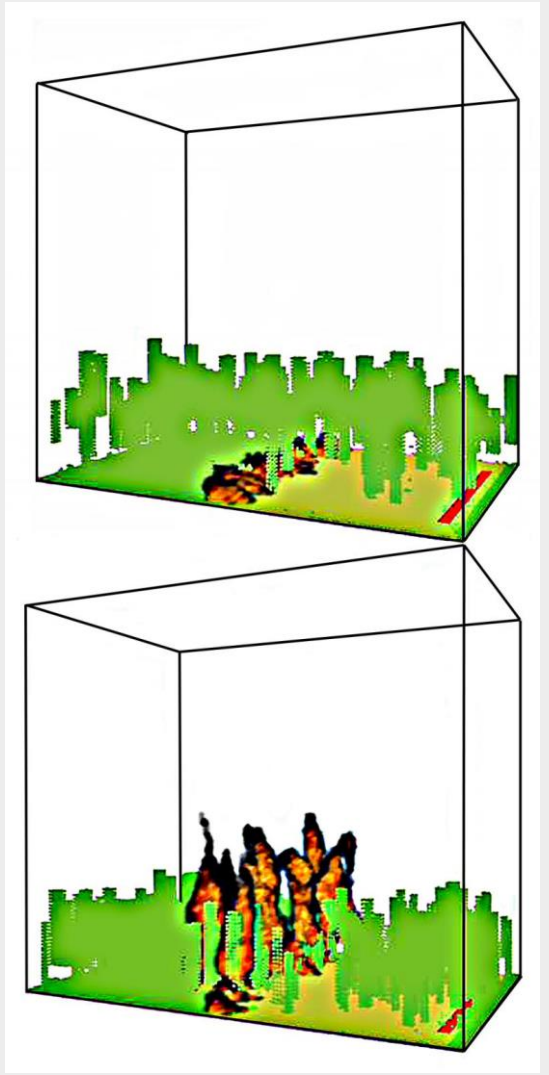
Potential Fire Behavior

Forest	Mortality Level	Torching Index (mph)	Crowning Index (mph)
Los Padres	Low	28	24
	High	13	59
Sierra	Low	23	32
	High	27	39

Fire Behavior Modeling

- Current operational fire behavior models can’t “see” fine scale patterns or red needles
- Makes it very challenging to predict fire behavior in beetle-impacted forests
- Compare predicted fire behavior of current, operational models (BehavePlus) with physics-based models (FIRETEC, WFDS) using STANDFIRE



Example 3D fire simulations for a forest stand, before (bottom) and after treatment (top), carried out with STANDFIRE. Credit: Russ Parsons

Growth Patterns and Susceptibility to Drought

Dead

Alive

Questions?

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