



Effects of bark beetle and drought induced tree mortality on wildfire severity in the Sierra Nevada

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Study Question:
Does recent tree mortality influence wildfire severity in an historically frequent fire forest?



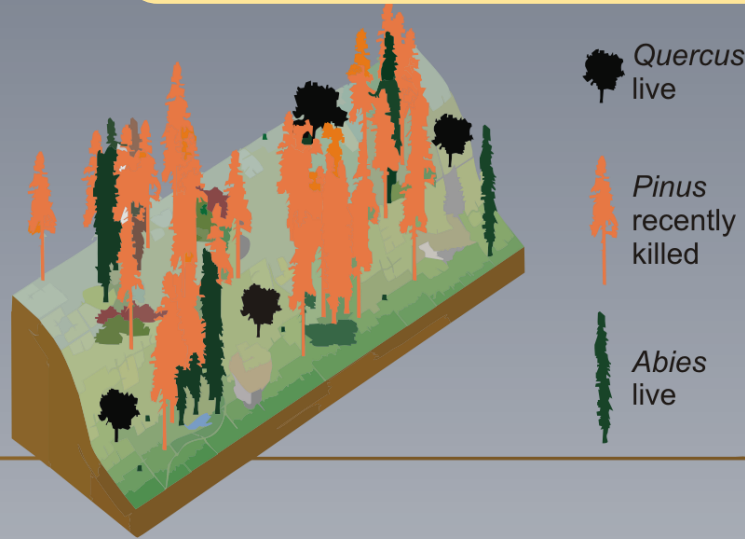
Rough fire, 8/9/2015. National Park Service.



Rough fire, 9/2015. USDA Forest Service.

Vegetation and fuel dynamics following severe pine mortality (theoretical)

1-2 yr

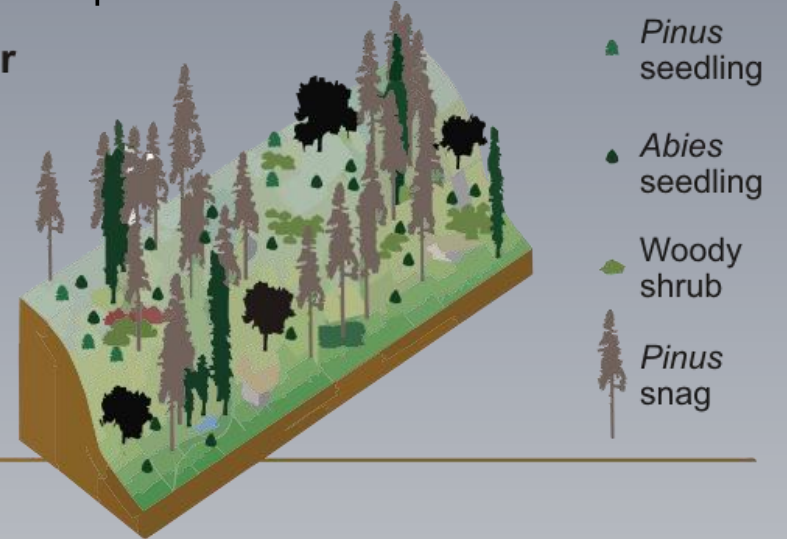


↓ **Canopy fuel moisture**

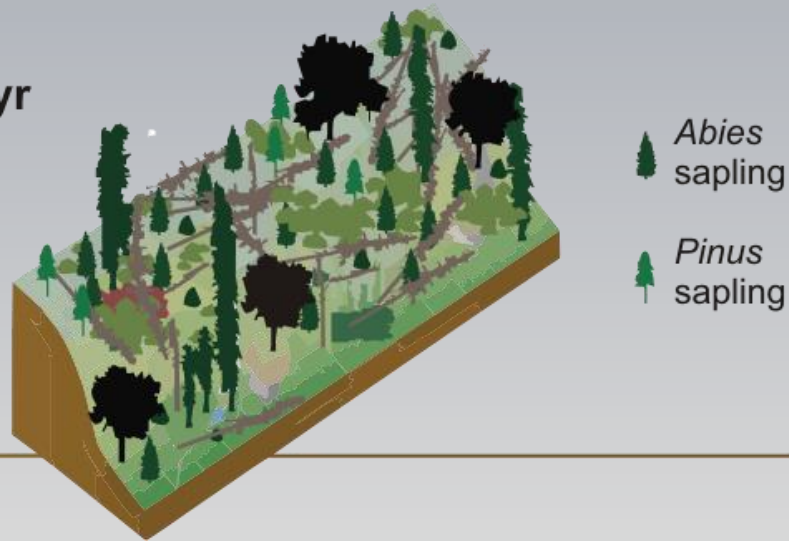
↓ **Canopy fuel load**

↑ **Fine surface fuel load**

3-10 yr



11-20 yr



↓ **Canopy fuel load**

↑ **Coarse & live surface fuel load**

Disturbance Characteristics and Metrics

Pre-fire mortality conditions		Fire conditions		
Outbreak phase (time since outbreak)	Outbreak metric	Fire metric	Fire severity type	Historic fire regime
Red (1-3 yrs)	Area affected	Likelihood	Canopy	High frequency, low/mod severity
Gray (3-10 yrs)	Severity	Severity	Surface	Low/mod frequency, high severity
Old/tree fall (11-20 yrs)		Intensity		

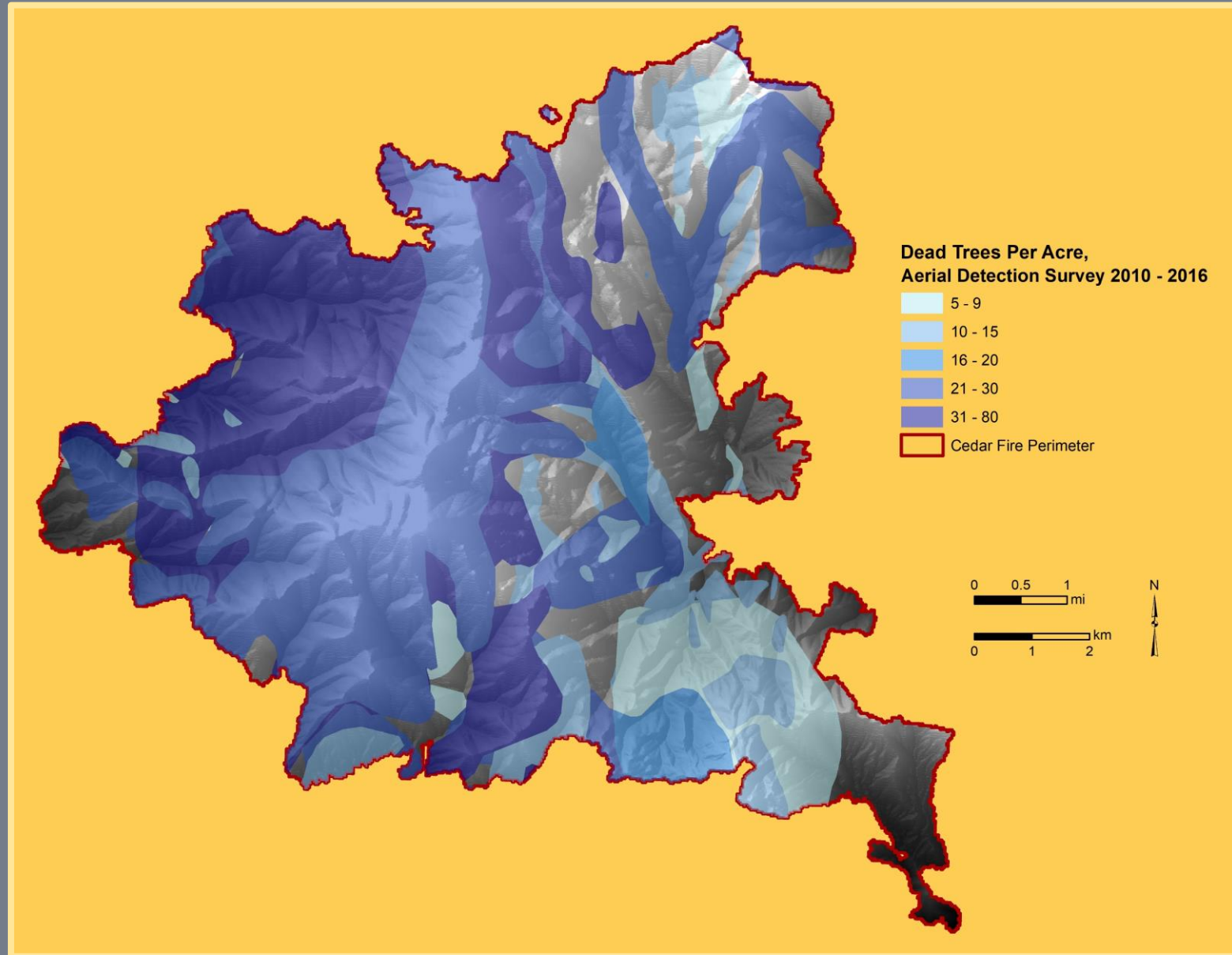
Study area



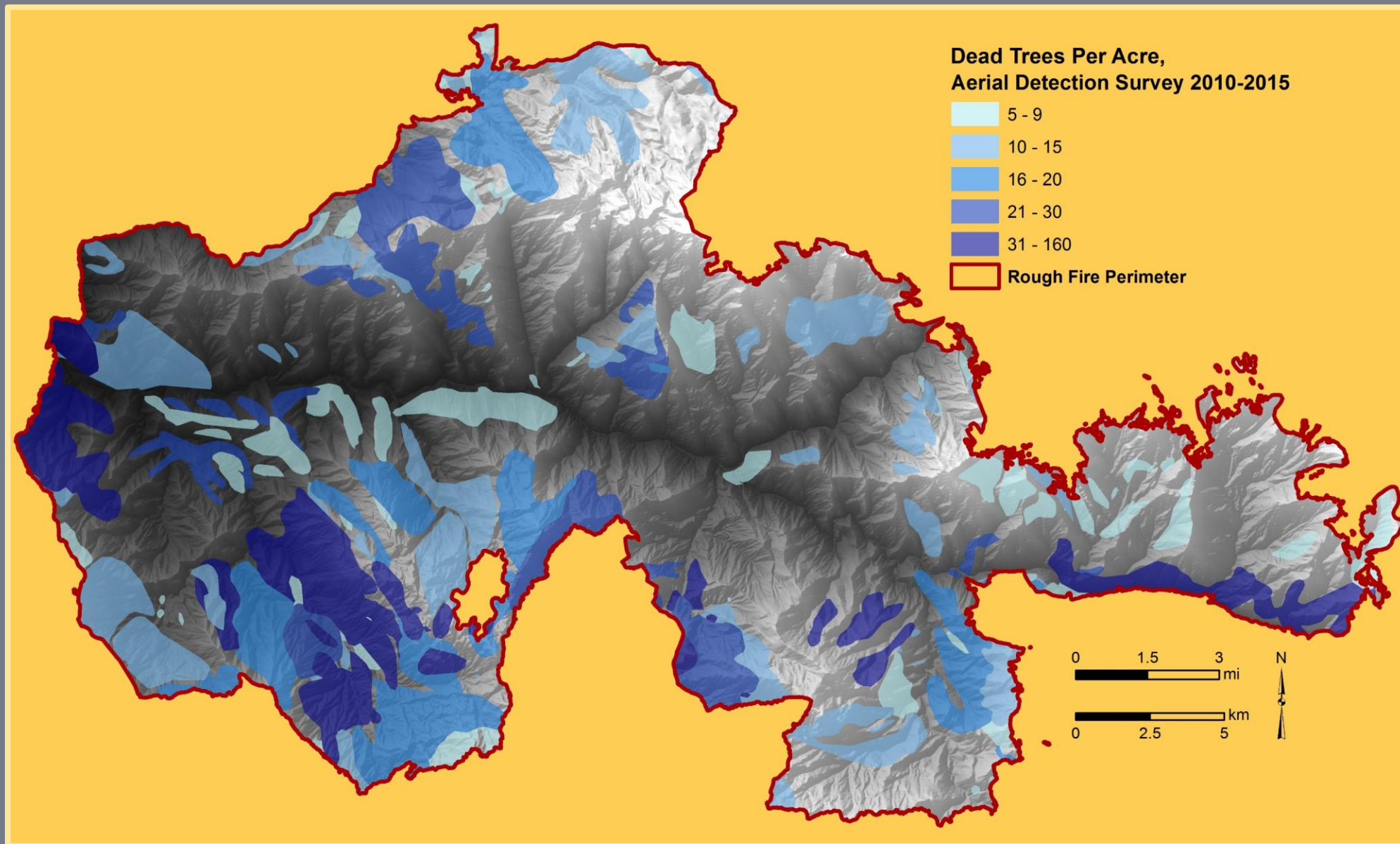
2015 Rough Fire
~60,000 ha (~150,000 ac)

2016 Cedar Fire
~12,000 ha (~30,000 ac)

Study area: 2016 Cedar Fire



Study area: 2015 Rough Fire





Rough fire approaching the Kings River, USDA Forest Service 2015.

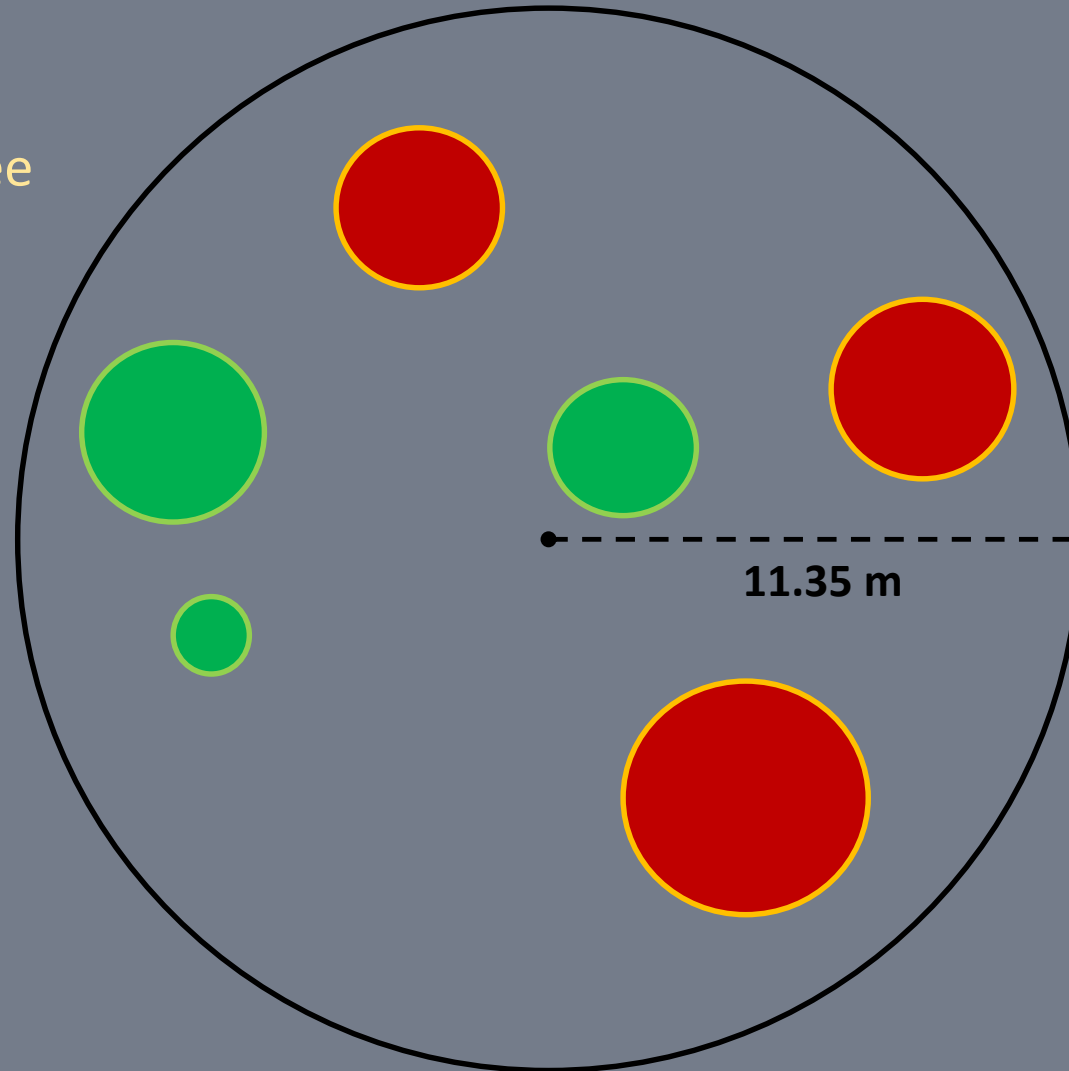
Does recent tree mortality influence wildfire severity in an historically frequent fire forest?

If yes, does the relationship vary under different weather or stand structural conditions?

Mortality and fire severity metrics

- Live tree
- Red phase dead tree
- Tree killed by fire

Trees not to scale

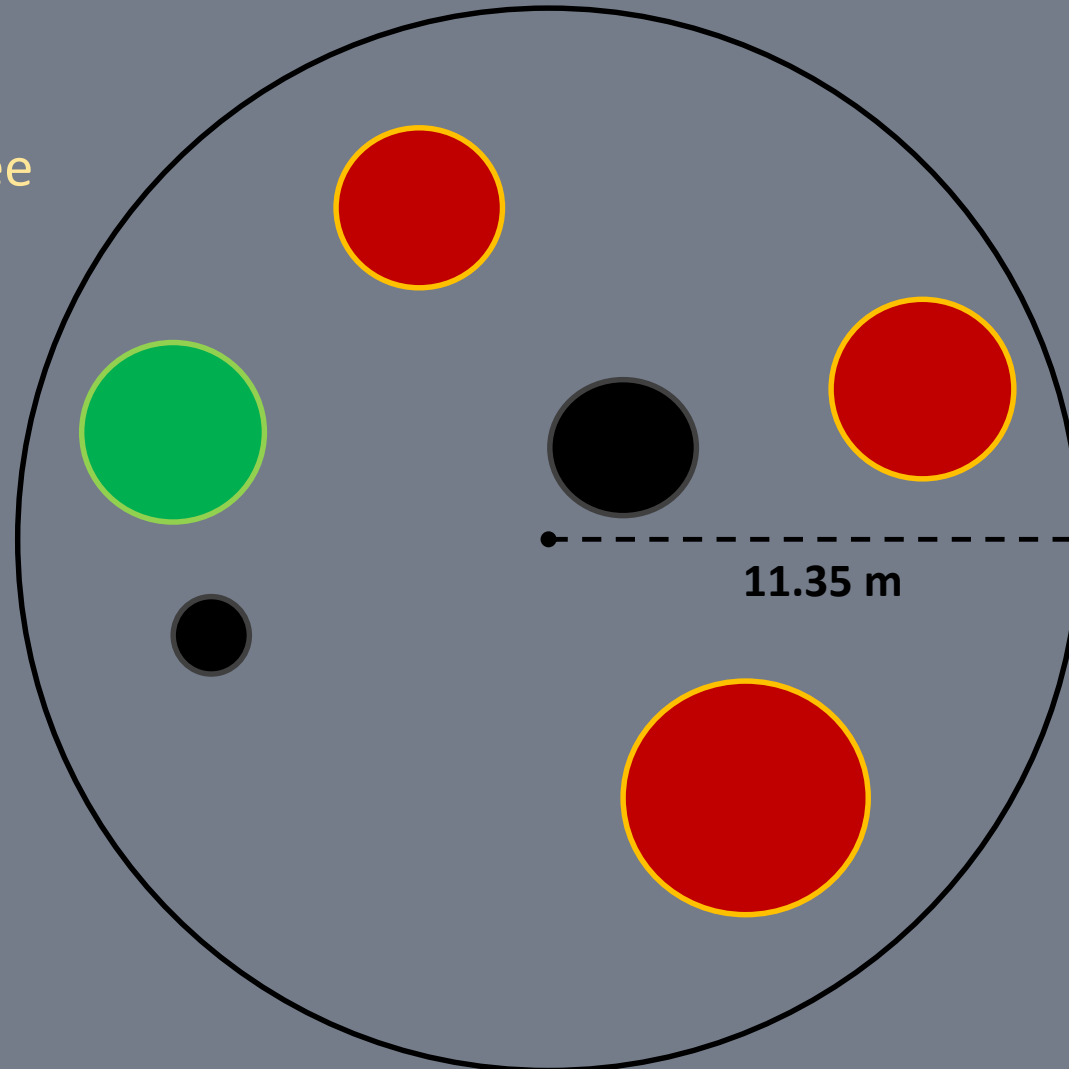


Predictor = mortality
conditions *immediately*
pre-fire

Mortality and fire severity metrics

- Live tree
- Red phase dead tree
- Tree killed by fire

Trees not to scale



Response = mortality conditions *immediately post-fire*

Field methods



Fir engraver (*Scolytus ventralis*) and gallery on white fir (*Abies concolor*). A. Brackett 2017.

- One-year post-fire field assessment of fire severity
- Determination of the cause and timing of tree mortality

Field methods



Dead at the time of fire:

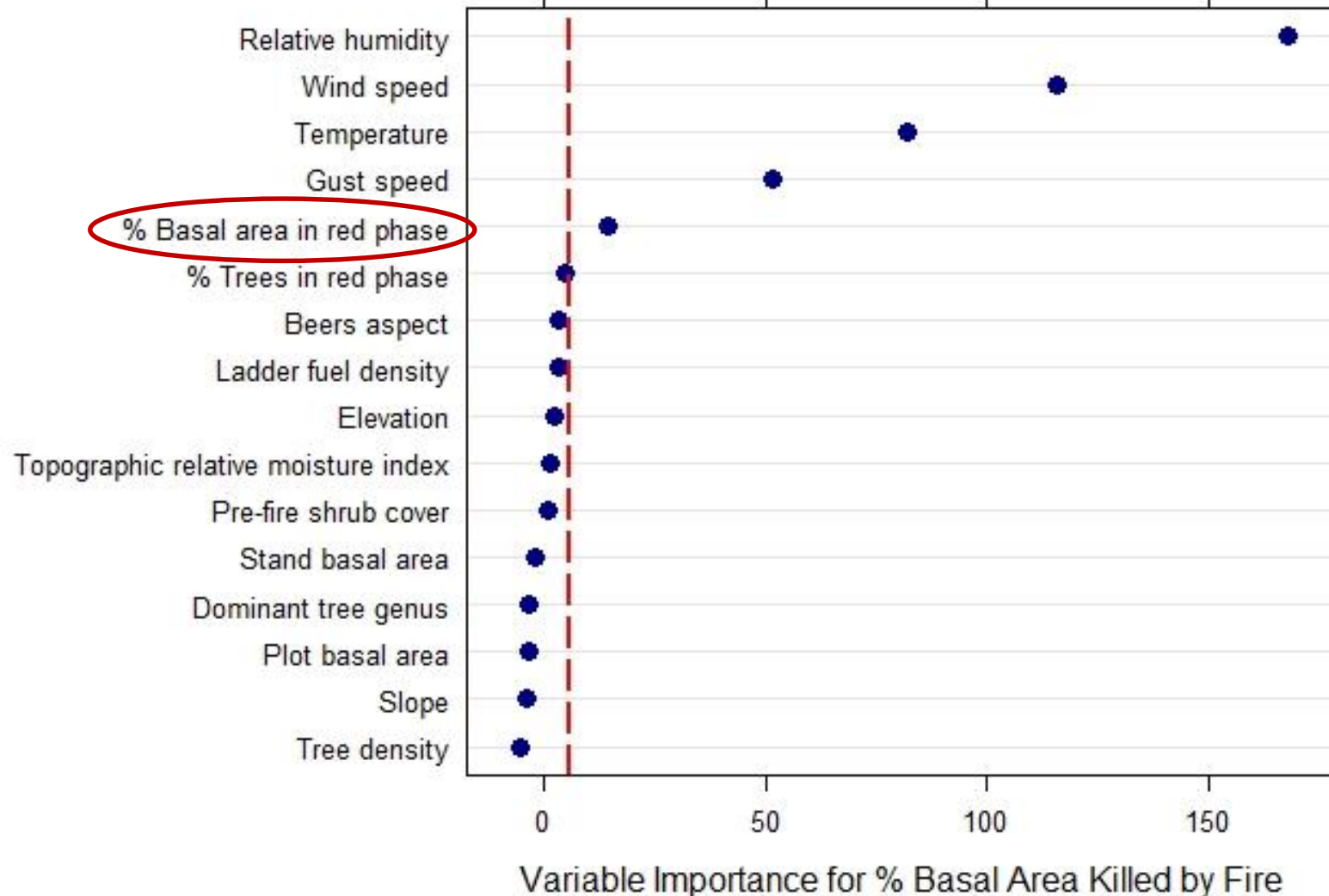
1. Old phase
2. Gray phase
3. Red phase

Live at the time of fire:

4. Killed by fire
5. Killed by insects post-fire
6. Green attack
7. No attack

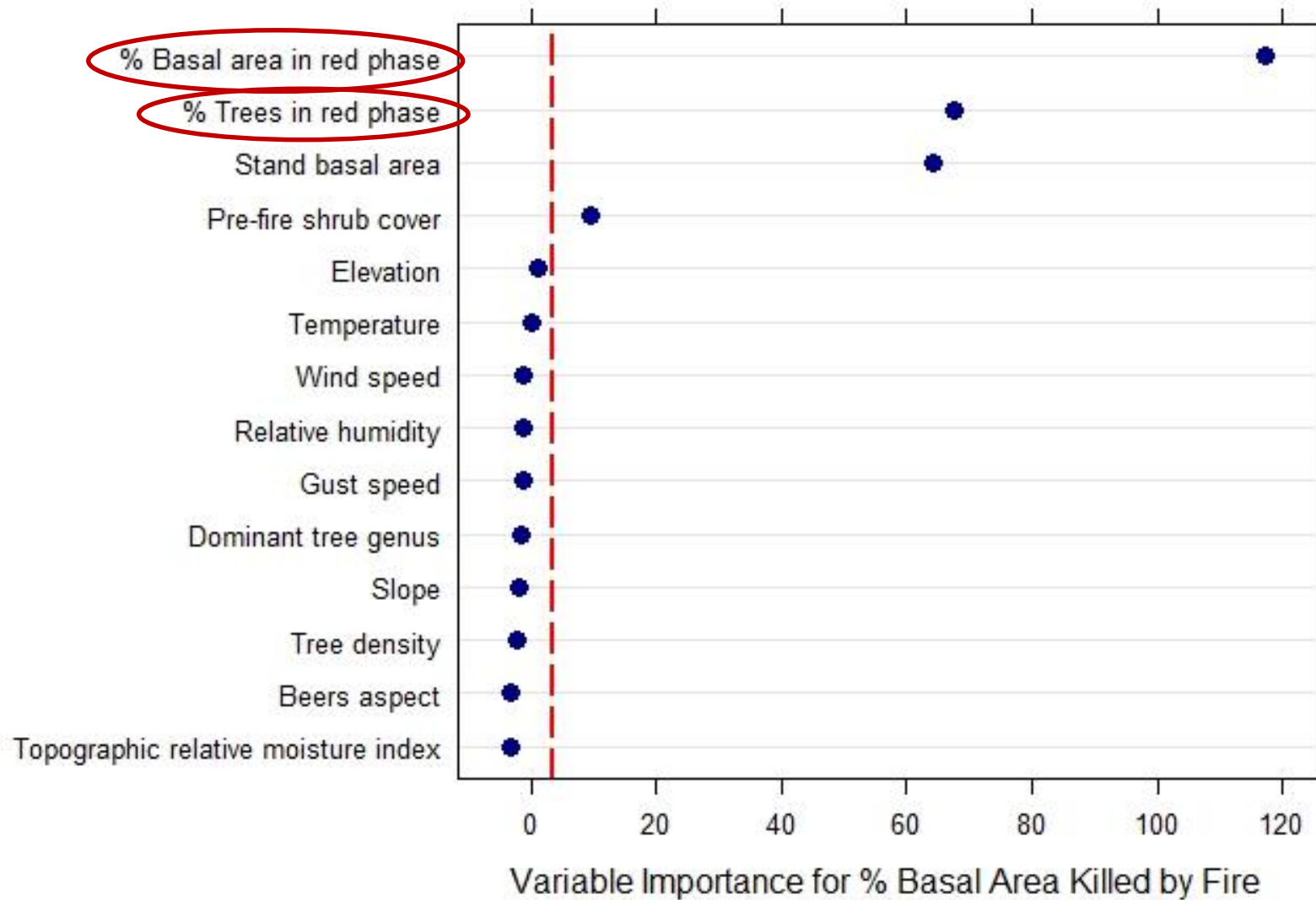
Mountain pine beetle (*Dendroctonus ponderosae*) and wood borer (*Melanophila* sp.) galleries on sugar pine (*Pinus lambertiana*) killed by beetles prior to wildfire. A. Brackett 2017.

Results: Influential Variables on Cedar Fire Severity



Influential variables as identified by random forests analysis. Variables to the right of the red line are considered influential to the percent of plot basal area killed by fire.

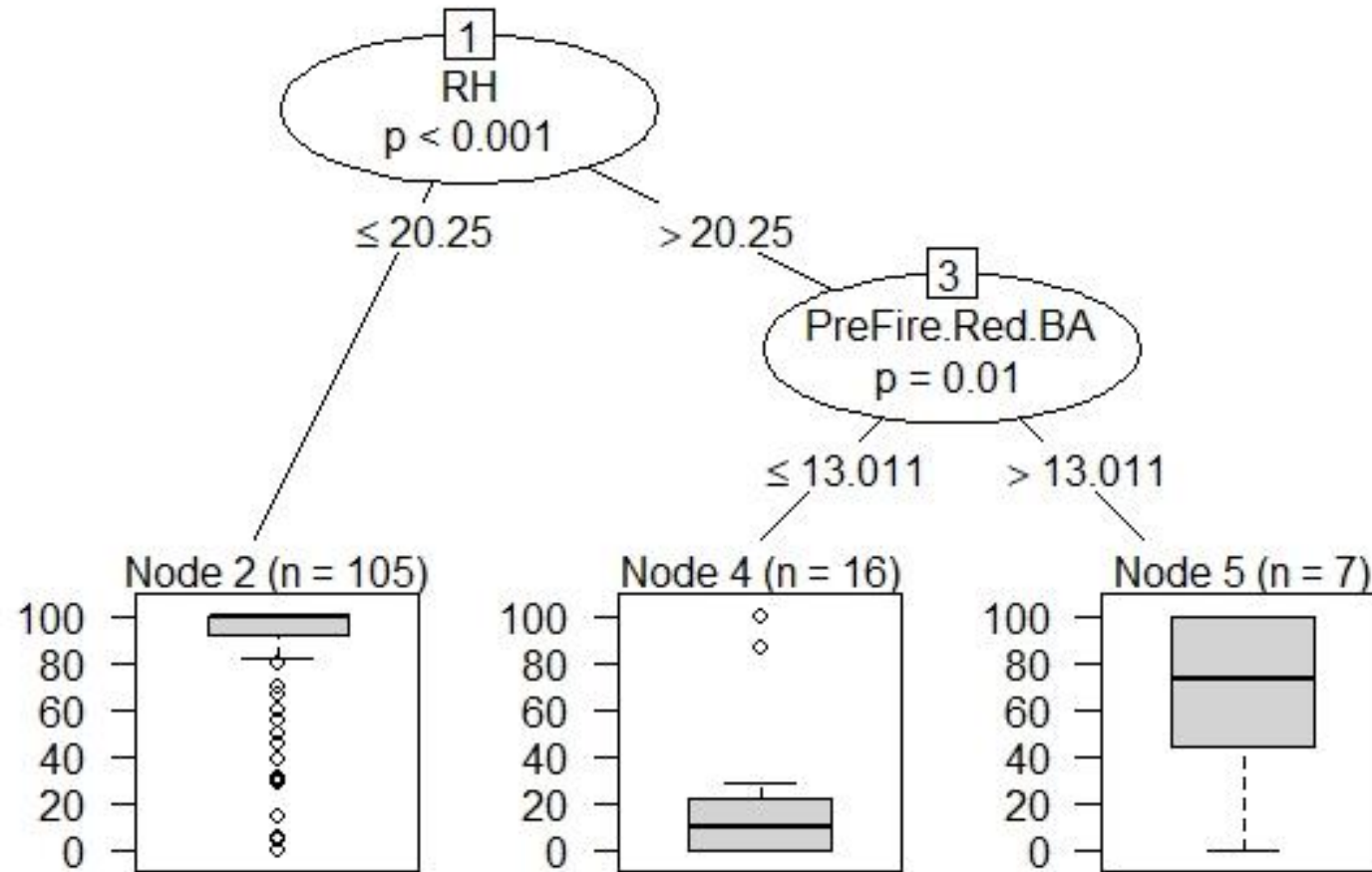
Results: Influential Variables on Rough Fire Severity



Influential variables as identified by random forests analysis. Variables to the right of the red line are considered influential to the percent of plot basal area killed by fire.

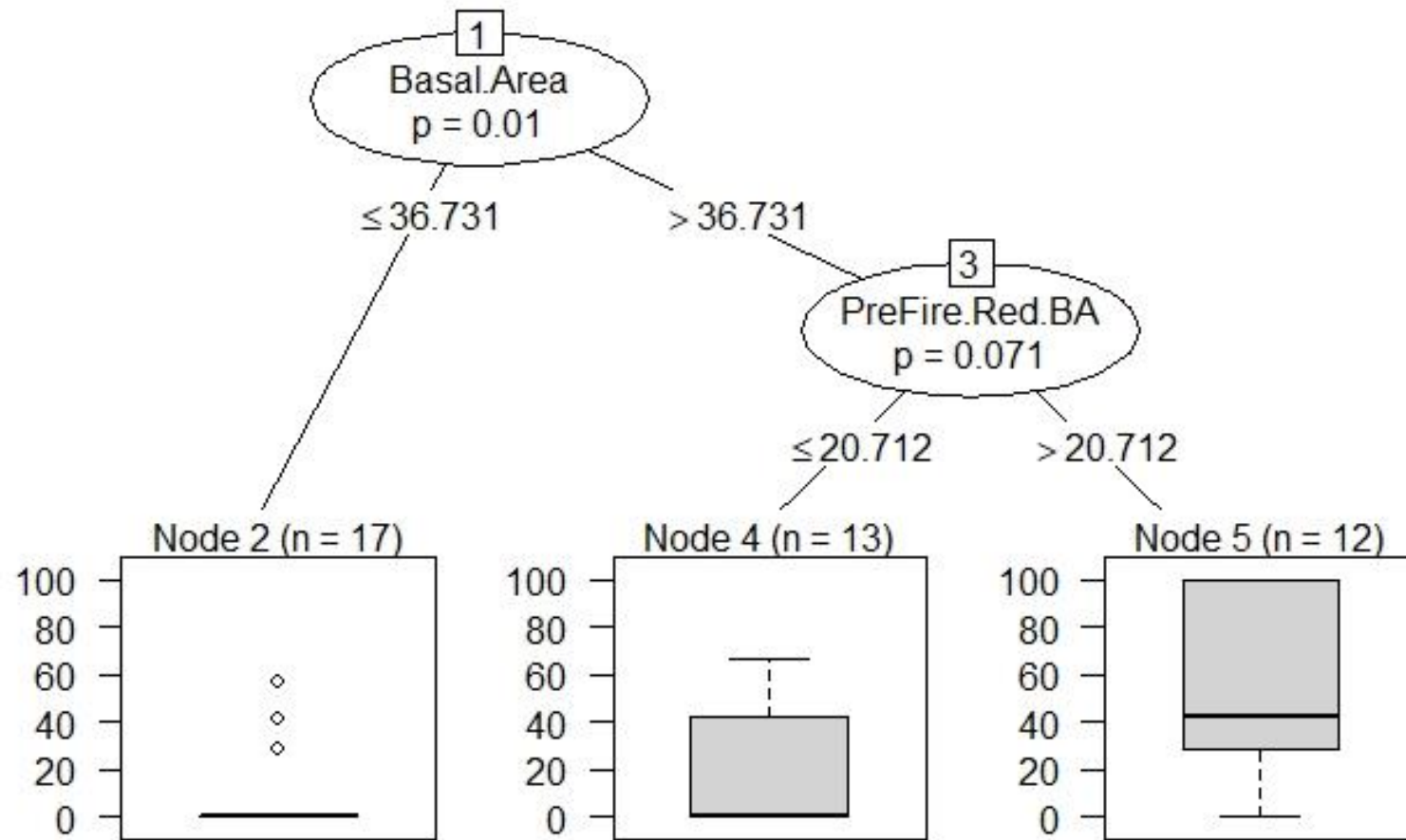
Pre-Fire Mortality Matters During More Severe Weather, Cedar Fire

Conditional Inference Tree for % Basal Area Killed by Fire



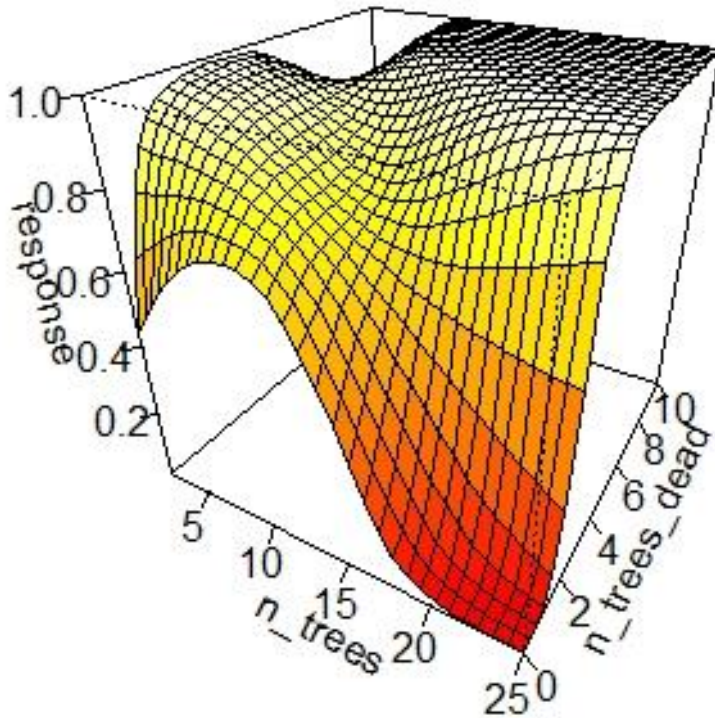
Pre-Fire Mortality Matters at Higher Basal Area, Rough Fire

Conditional Inference Tree for % Basal Area Killed by Fire



Pre-Fire Mortality is More Influential than Stand Density

Density and Pre-fire Mortality Interaction



Generalized Additive Model

Full Model = Best Model (R^2 adj. = 0.595):

Total density (live + dead)

Pre-fire dead tree density*

Stand basal area*

Topographic relative moisture index*

Relative humidity on burn date*

Total density x pre-fire dead density*

Stand basal area x pre-fire dead density*

*significant at $p \leq 0.001$

Acknowledgements



Data collection on the 2016 Cedar fire, June 2017.

Thanks to Beverly Bulaon and crew members Amanda Brackett, Amanda Cooke, Katherine Kangas, Tessa Putz.



Data collection on the 2015 Rough fire, June 2016.

Thank You

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