Do Forest Restoration Treatments Mediate Drought-Induced Mortality in True Firs in the Sierra Nevada?

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Inyo, Sequoia, and Sierra National Forests

Sierra Nevada Forests

- Removal of fire as a natural ecological process
  - Loss of forest ecosystem integrity
    - Increased densification & structural homogenization
    - Reduced health, resilience, and diversity

Fire exclusion

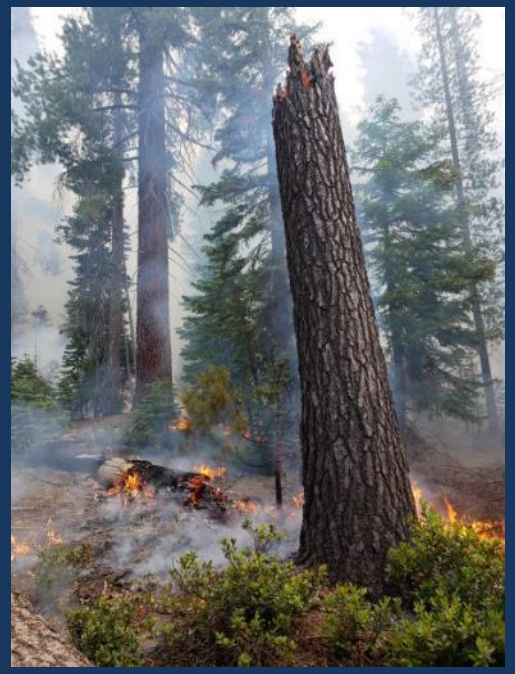
Sierra and Sequoia National Forest Historic Photo Archives

Forest Restoration

- Restoration treatments can reestablish forest ecosystem structure, composition & function
  - Reduce stand densities and biomass
  - Facilitating heterogeneity
  - Improve health and resilience

Essential Questions

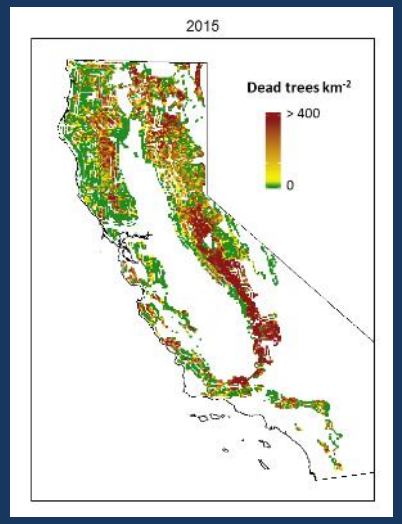
- Do forest restoration treatments mediate drought-induced mortality in true firs?



Drought

Relevant Studies

1. Southern & Central Sierra Nevada
2. Southern Sierra Nevada
   - Teakettle Experimental Forest



Young et al. 2017

Forest structure and climate mediate drought-induced tree mortality in forests of the Sierra Nevada

Christina Restaino[1], Derek Young[1], Marc Meyer[2], Becky Estes[2], Amarina Wuenschel[2], Shana Gross[2], Hugh Safford[1,2]

[1]Department of Environmental Science and Policy, UC Davis

[2]Region 5 Ecology Program, USDA Forest Service

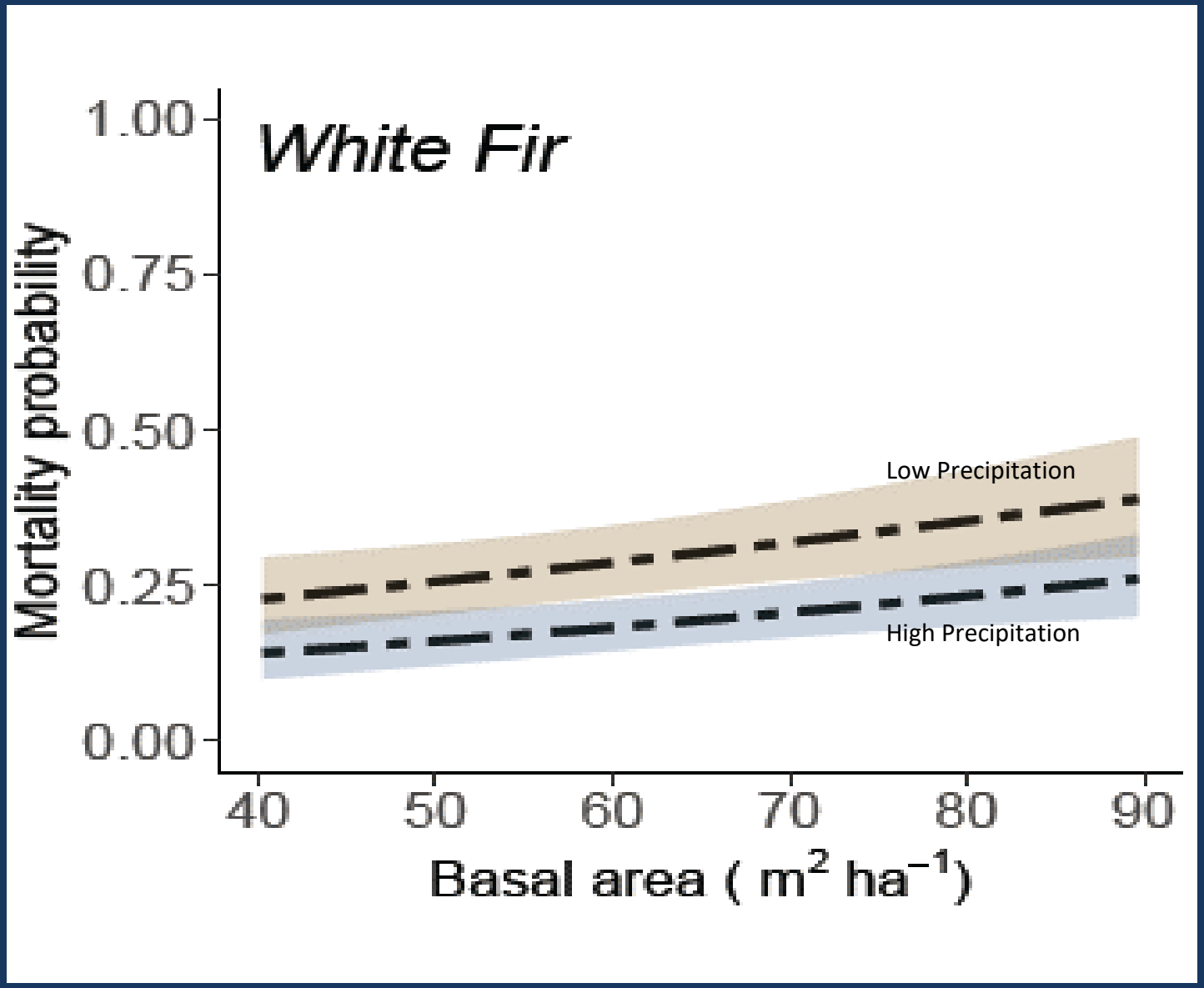
Source: Restaino, C., D. Young, B. Estes, A. Wuenschel, S. Gross, M. Meyer, and H. Safford. 2020. Forest structure and climate mediate drought-induced tree mortality in forests of the Sierra Nevada. *Ecological Applications* e01902.

Study Design

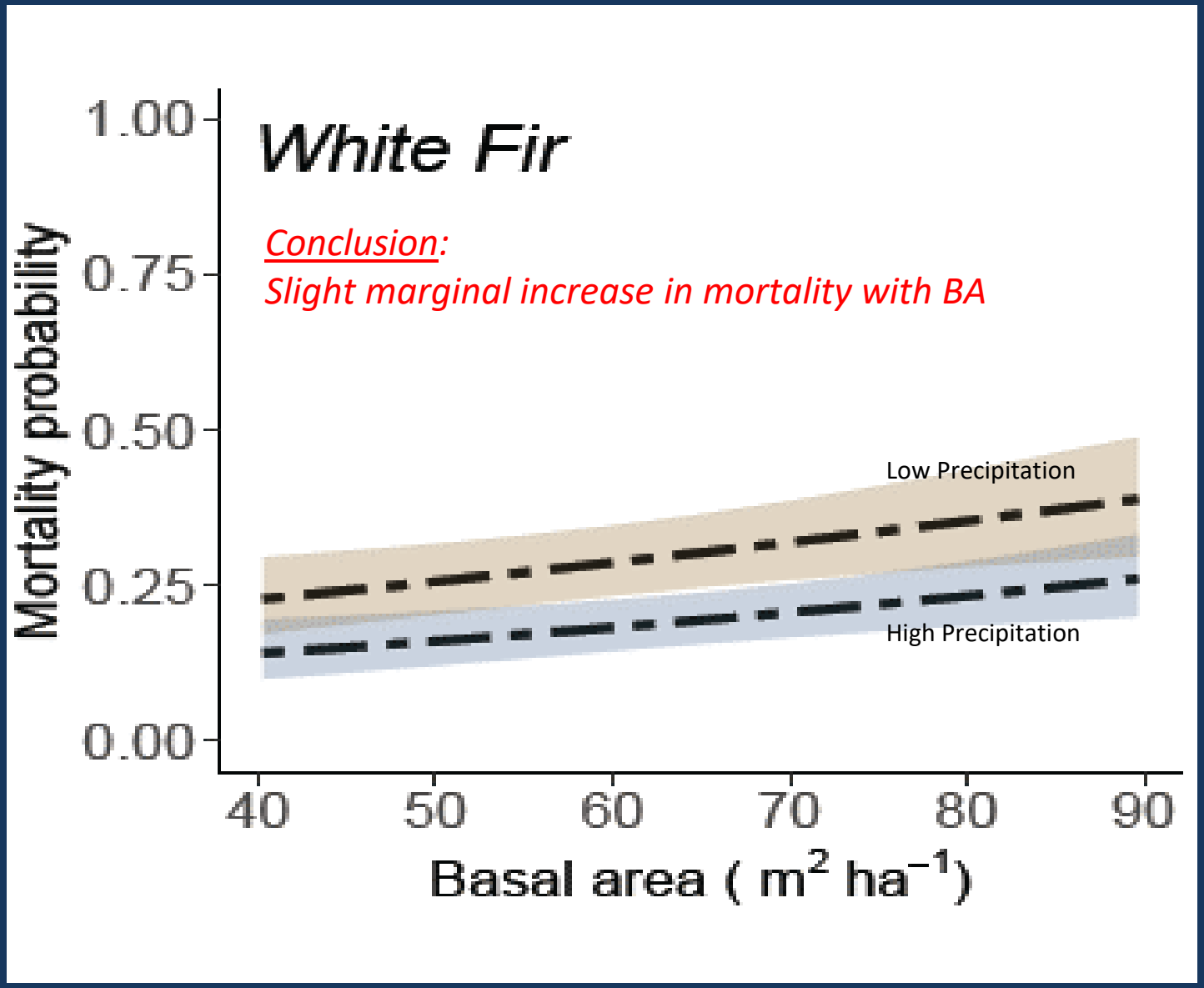
- Paired thinned vs. un-thinned stands*
- Three national forests and Yosemite NP
- Sampled 10 sites, 158 plots total
- Data collected primarily in 2017

*Includes either mechanical thinning, prescribed burning (one or more entries), or their combination

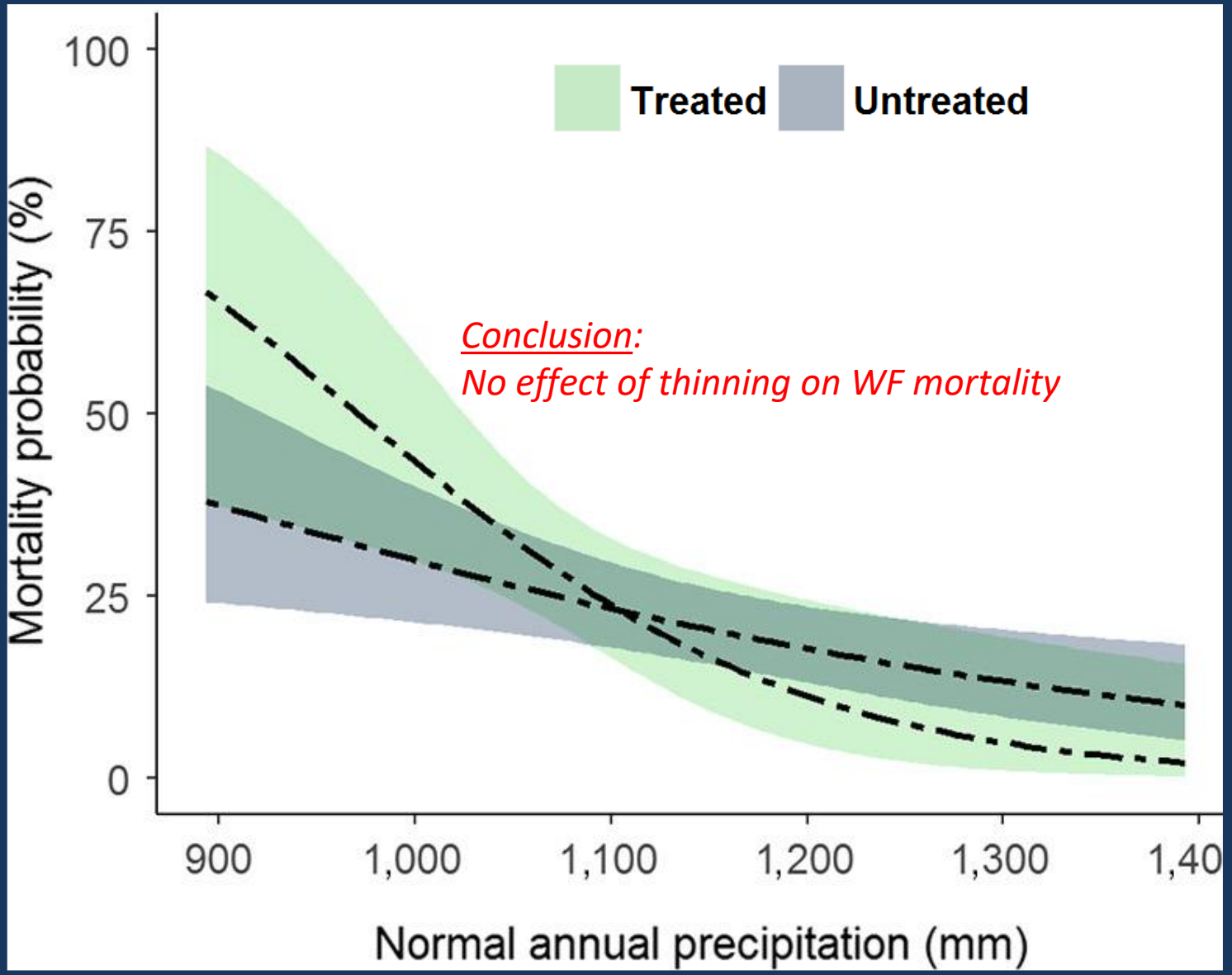
Basal Area Effect



Basal Area Effect



Treatment Effect



Conclusions

- Treatments had no effect on white fir mortality
  - May even increase mortality under extreme moisture stress
- Greater basal area slightly increases mortality in white fir

Fuels reduction treatments have variable effects on conifer resistance to beetle infestation and drought mortality

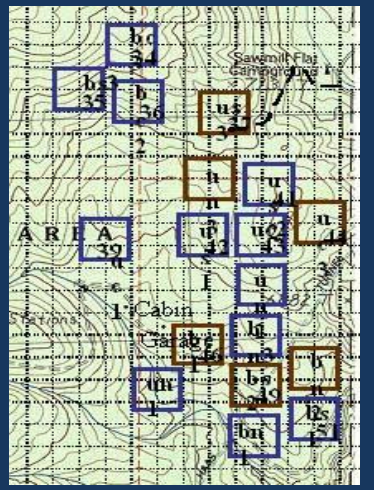
Steel, Z.L.[1], M.J. Goodwin[2], M.D. Meyer[3], G.A. Fricker[4], H.S.J. Zald[5], M.D. Hurteau[2], and M.P. North[7]

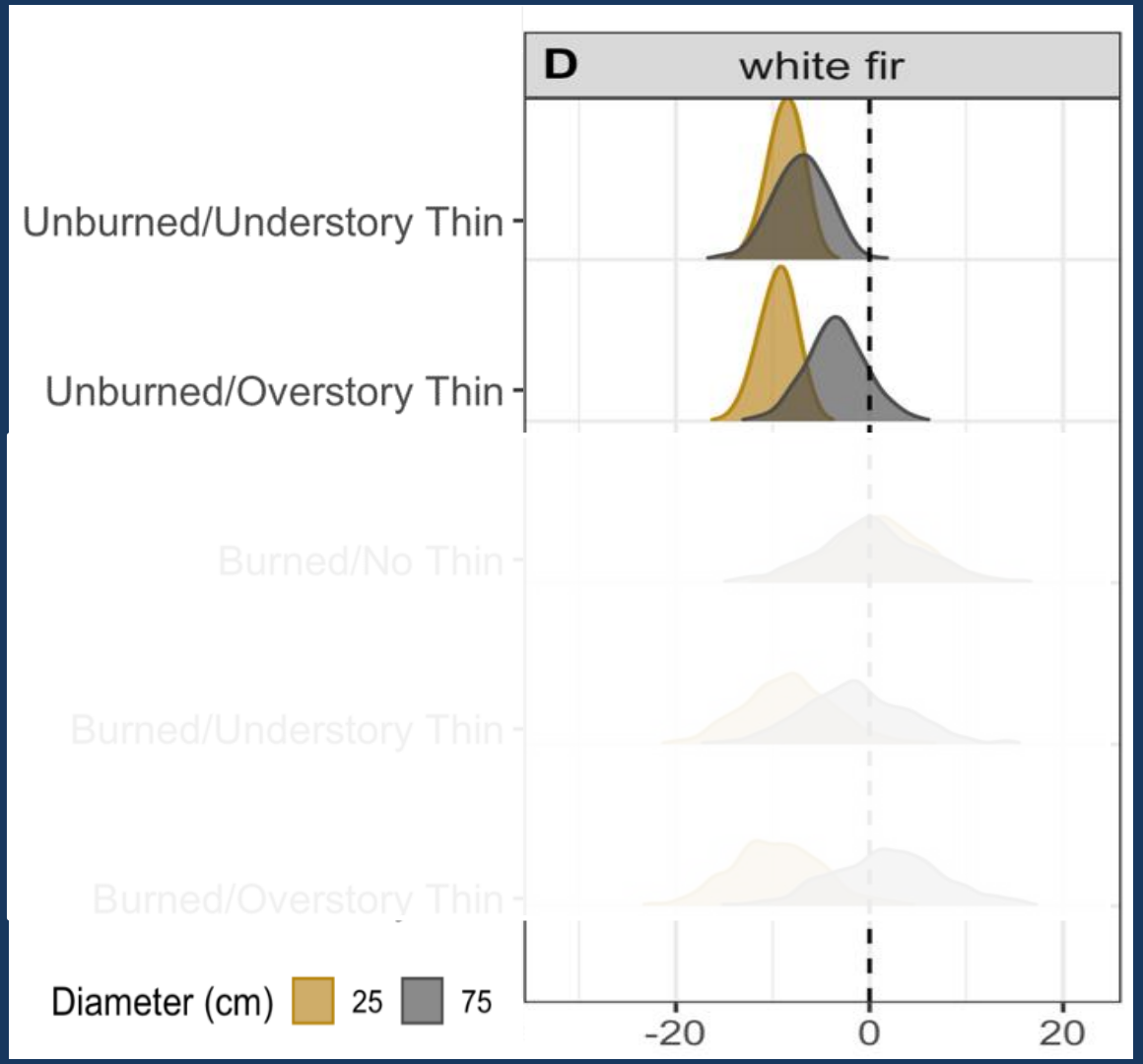
[1]UC Berkeley, [2]University of New Mexico, [3]USFS Region 5 Ecology Program, [4]Cal Poly San Luis Obispo, [5]USFS Pacific Northwest Research Station, [6]USFS Pacific Southwest Research Station and UC Davis

Source: Steel et al. In press. Fuels reduction treatments have variable effects on conifer resistance to beetle infestation and drought mortality. *Ecosphere*.

Teakettle Experimental Design

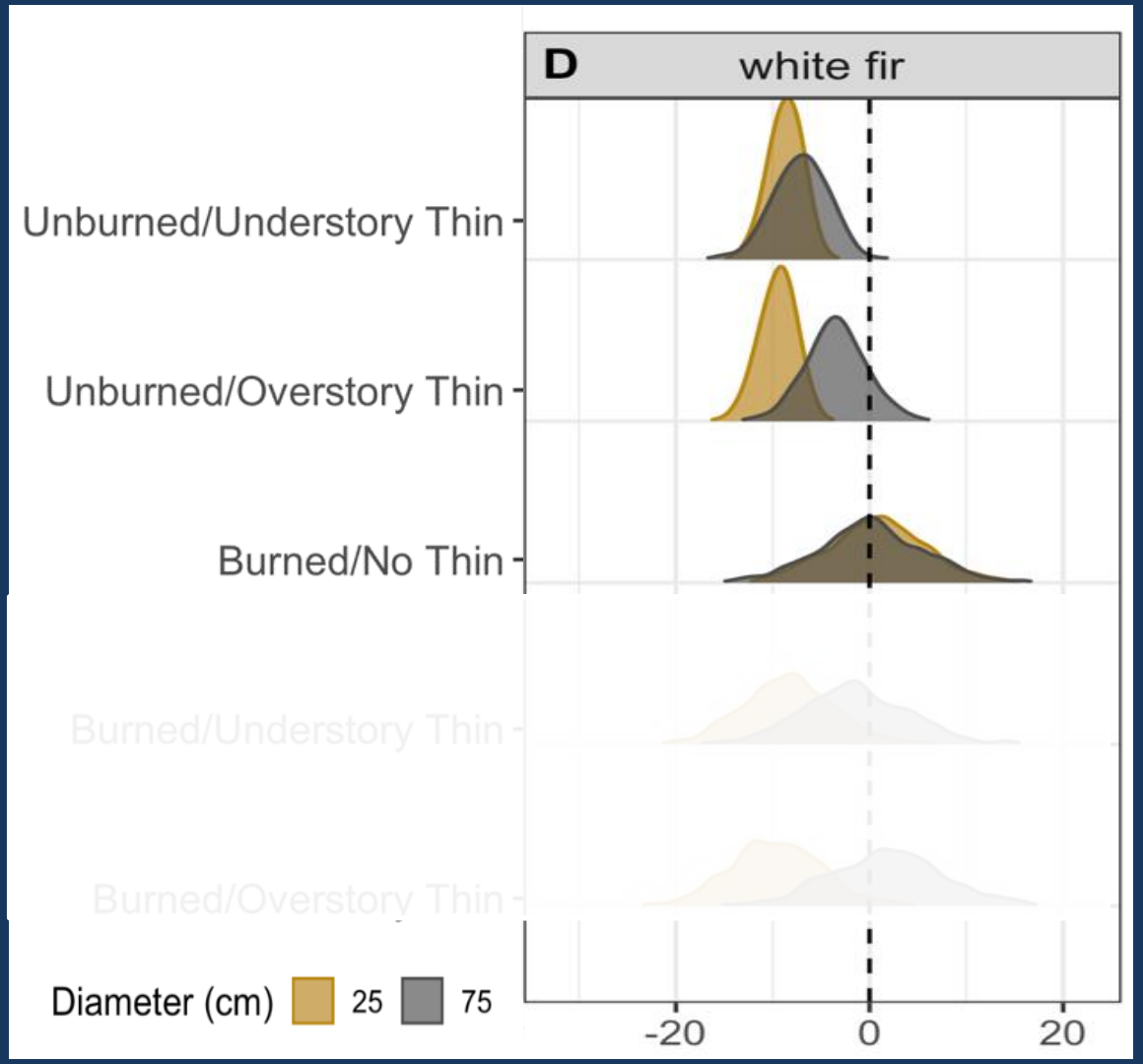
- Six treatments experimentally fully crossed
  - Heavy thin, light thin, no thin (2000)
  - Rx burn /no burn (2001)
- 18 4-ha old growth mixed conifer plots
- Stand inventory & insect activity in 2016-2017





Fir mortality pattern

5-10% decline with thin

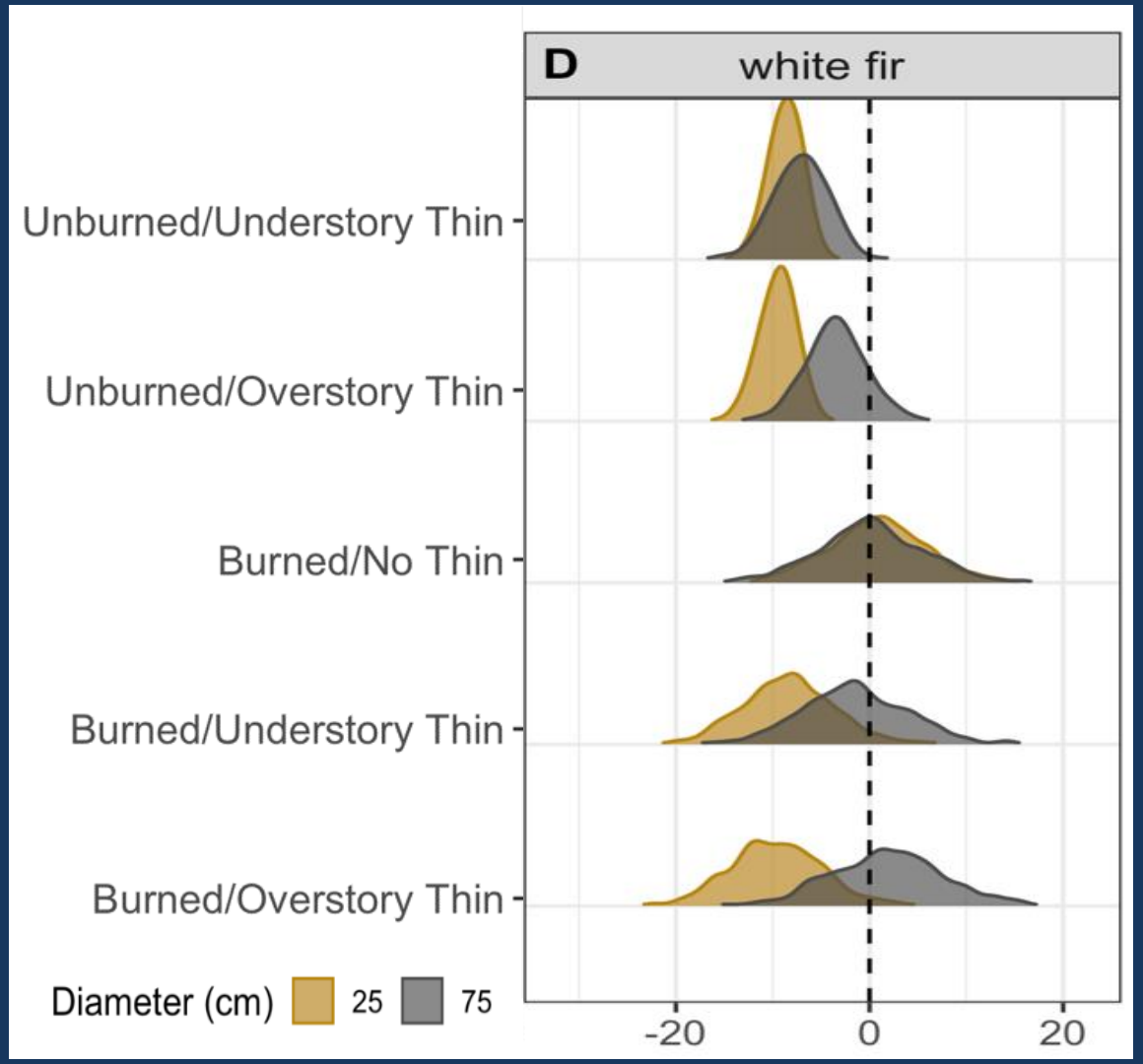


Mortality Probability Change
(control – treatment)

Fir mortality pattern

5-10% decline with thin

Burn has no effect



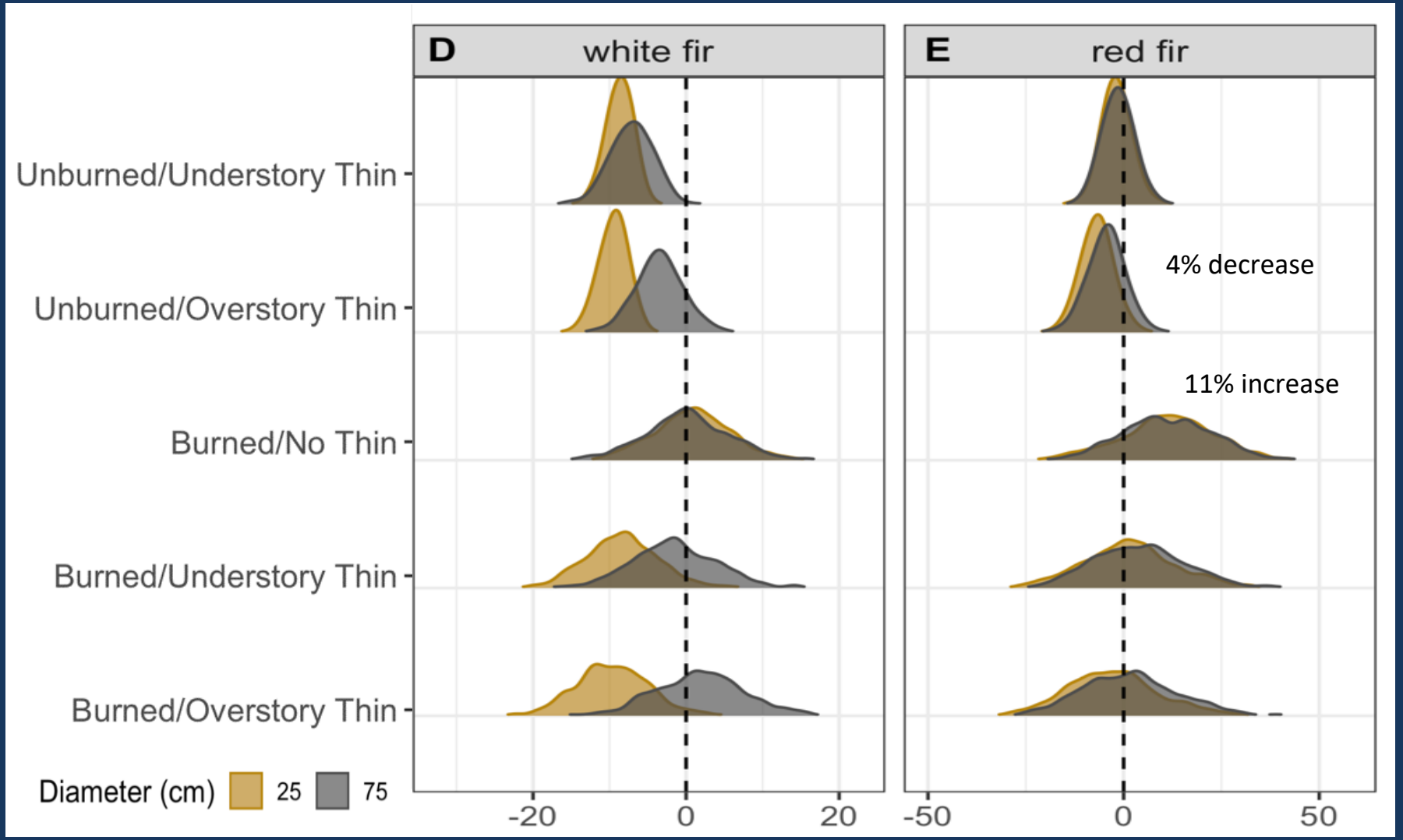
Fir mortality pattern

5-10% decline with thin

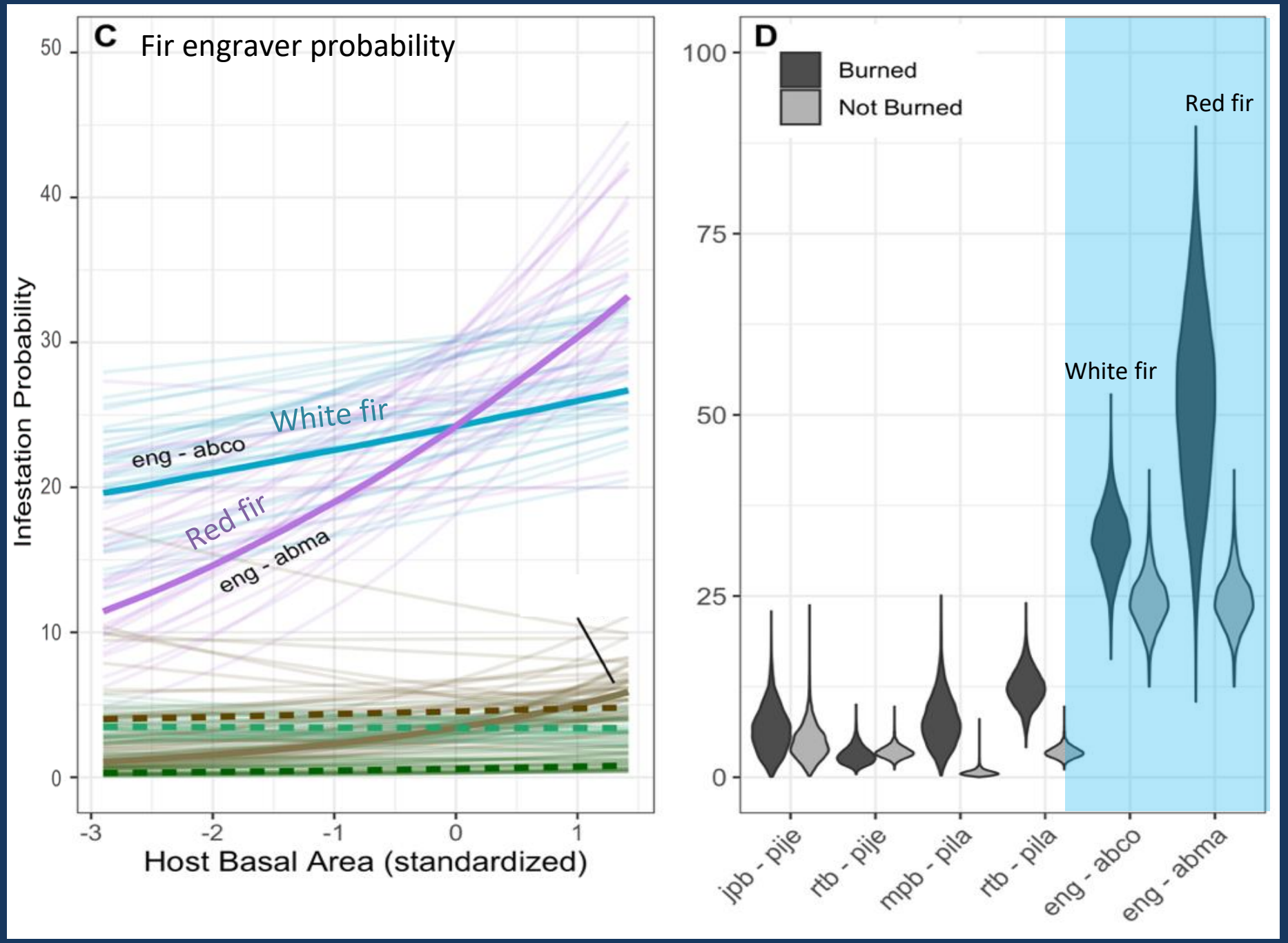
Burn has no effect

~10% decline with thin & burn in small firs only

Conclusion: Positive effect of thinning on white fir



Conclusion: Some positive effect of overstory thin, negative effect of burn on red fir


C
Fir engraver probability
Infestation Probability
50
40
30
20
10
0
eng - abco
White fir
Red fir
eng - abma
-3
-2
-1
0
1
Host Basal Area (standardized)
D
100
75
50
25
0
Burned
Not Burned
Red fir
White fir
jpb - pije
rtb - pije
mpb - pila
rtb - pila
eng - abco
eng - abma

Conclusions

- Thinning decreases mortality in white & red fir
- Rx burning increases mortality in red fir
  - No effect on white fir
- Fir engraver infestation increased by:
  - Rx burning - esp. red fir
  - Greater host basal area - esp. red fir

Do restoration treatments benefit the health of true firs in drought?

- Study 1: No effect to slight benefit*
- Study 2: Mixed results*
  - Thinning reduces mortality
  - Negative or neutral effect of Rx burning
- Study 3: No effect or slight benefit†

*Stand-scale treatments

†Landscape-scale treatments described In Meyer et al. 2019 *IJWF* 28: 386–396

Do restoration treatments benefit the health of true firs in drought?

- Study 1: No effect to slight benefit
- Study 2: Mixed results
  - Thinning reduces mortality
  - Neutral or negative effect of Rx burning
- Study 3: No effect or slight benefit
- However, treatments do increase adaptive capacity of mixed conifer and fir forests
  - Reduced fuel loads, increased heterogeneity, and diverse regeneration

Acknowledgements

- USDA Forest Service Forest Health Protection Program
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- USDA Forest Service Pacific Southwest Region
- California Department of Forestry and Fire Protection