



## **Big Picture of Fuels, Downed Material, and Management Challenges from Forest Mortality**

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# Talk Outline

Forest response to drought and bark beetles from a relatively intact forest in a Mediterranean climate

- Sierra San Pedro Martir, Baja California

Drought and bark beetle mortality in the Sierra Nevada

- How does this effect potential fire behavior and effects and forest succession?
  - Analysis from 2015 Rough Fire

Management response to forest change

# Forests in the Sierra San Pedro Martir, Northern Baja, Mexico

Within the California floristic province

- unique to Northern Baja California

Jeffrey pine-mixed conifer forests

- Similar to forests in southern California, eastern Sierra Nevada, drier parts of Sierra Nevada west-side
- Forested area approximately 70,000 ac

Elevation upper plateau 8500 feet

- 3 large plateaus, Peninsular mountains

Fire suppression begins in 1970, little harvesting

**Severe drought in SSPM and southern  
California forests from 1999-2002**





# Surface Fuel Loads

Summary of a set of inventory plots on similar aspect, soils, forest type, after multi-year drought

Less than average fuel load of 6.6 tons/acre on 73% of plots

Greater than 8 tons/acre on 24% of plots

Greater than 16 tons/acre on 8% of plots

Conclusion

- average fuel loads are rare (14% of plots)
- high loads in small areas, low hazard but is already changing

*Stephens 2004, Dunbar-Irwin and Safford 2016*

# Snag Densities in the SSPM

## **After severe 1999-2002 drought**

0 snags on 26% of plots

Less than average density (2 snags/ac) on 65% of plots

Greater than 4 snags/ac in 14% of plots

## Conclusion

- Low forest mortality from beetles/drought
- Average snag densities are rare
- Occur in approximately 12% of plots
  - *Stephens 2004, Stephens and Gill 2005*

# SSPM Wildfire July 4, 2003

- Started in chaparral below forest
  - In SSPM lightning ignited fires suppressed by suppression crews since 1970
    - Very low hazards, suppression efficient like it was in the early 1900's in the USA
- Fire burned approximately 600 acres of forests
  - More shrublands burned
- Largest fire in 20 years
  - Occurred at end of severe drought, 1999-2002

# 2003 Wildfire in SSPM after 4 Year Drought





# Wildfire Impacts

- Approximately 20% of trees killed
  - Jeffrey pine more dominant after fire, trees and seedlings (less white fir, incense-cedar)
- Fire was very patchy
  - directly linked to heterogeneity of forest structure and fuels pre-fire
  - Fire maintained or increased spatial heterogeneity in seedlings, trees
    - produces fire with diverse effects
    - continues high spatial heterogeneity
- Mortality very low even after 4 year drought, bark beetles, and wildfire (*Stephens et al. 2008*)

# SSPM Wildfire Severity

- 17 fires burned forests in SSPM from 1984-2010
  - Total area burned 66,000 ac
    - 4980 ac burned in forests, mostly chaparral
  - 7-15 lightning fires/year in SSPM forests, all suppressed today
    - Fires that make it into forests mostly come from chaparral
- High severity fire characteristics
  - Average patch size 7.2 ac, median 1.6 ac, largest 27 ac (high severity > 90% basal area mortality)
  - Total proportion of Jeffrey pine or mixed conifer forests burned at high severity: **3%**
    - (*Rivera-Huerta et al. 2016*)

# Drought and Bark Beetle Impacts in USA

Almost all research on this topic done in Rocky Mountains or Pacific Northwest forests

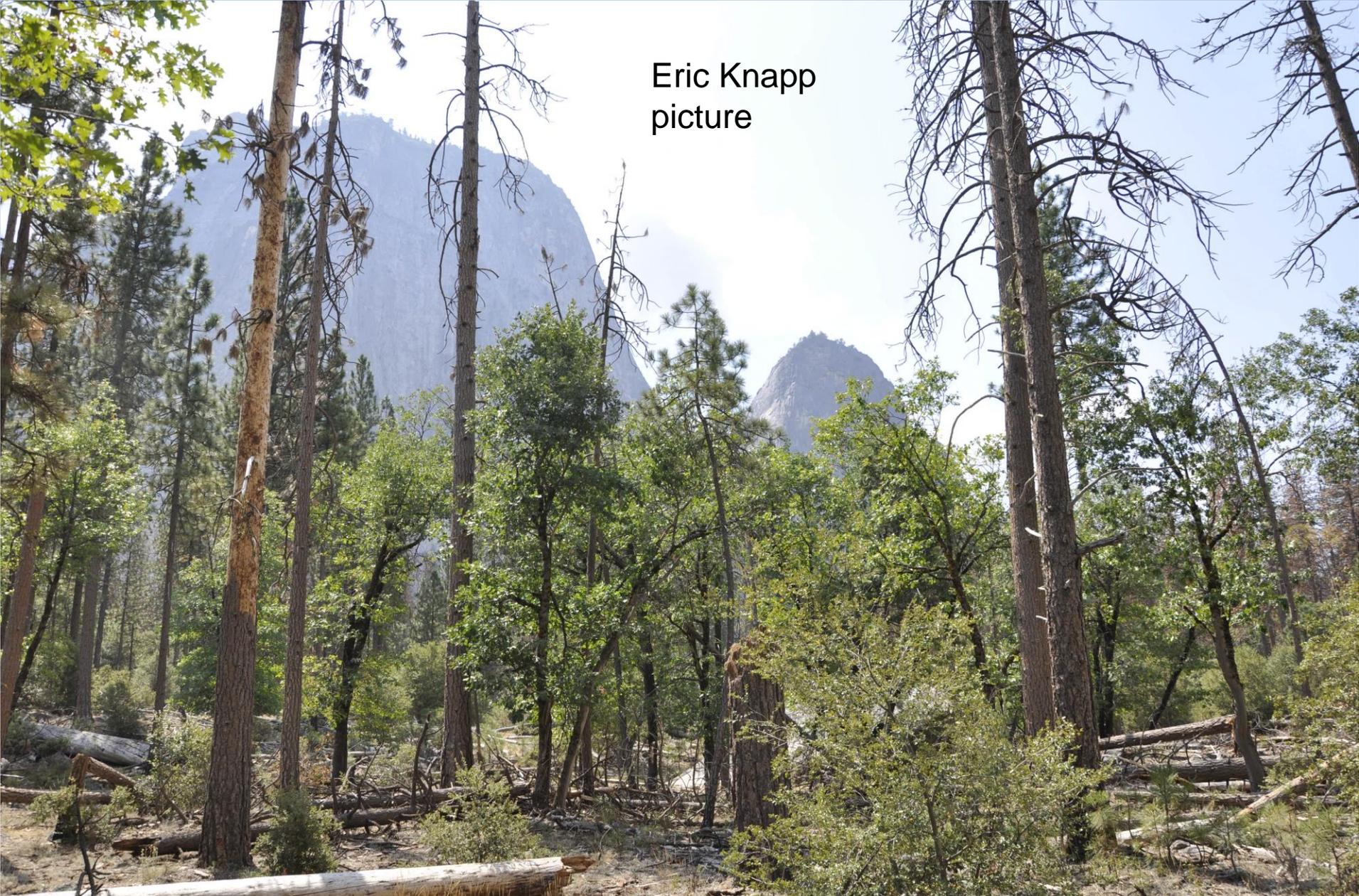
- High or mixed severity fire regimes
  - Research has not found similar results
  - Some limited impacts of mortality on fire, others demonstrate more effects

Frequent fire forests fundamentally different

- Forests adapted to high severity fire have not increased in density
- Mixed severity fire regimes have experienced increased tree density

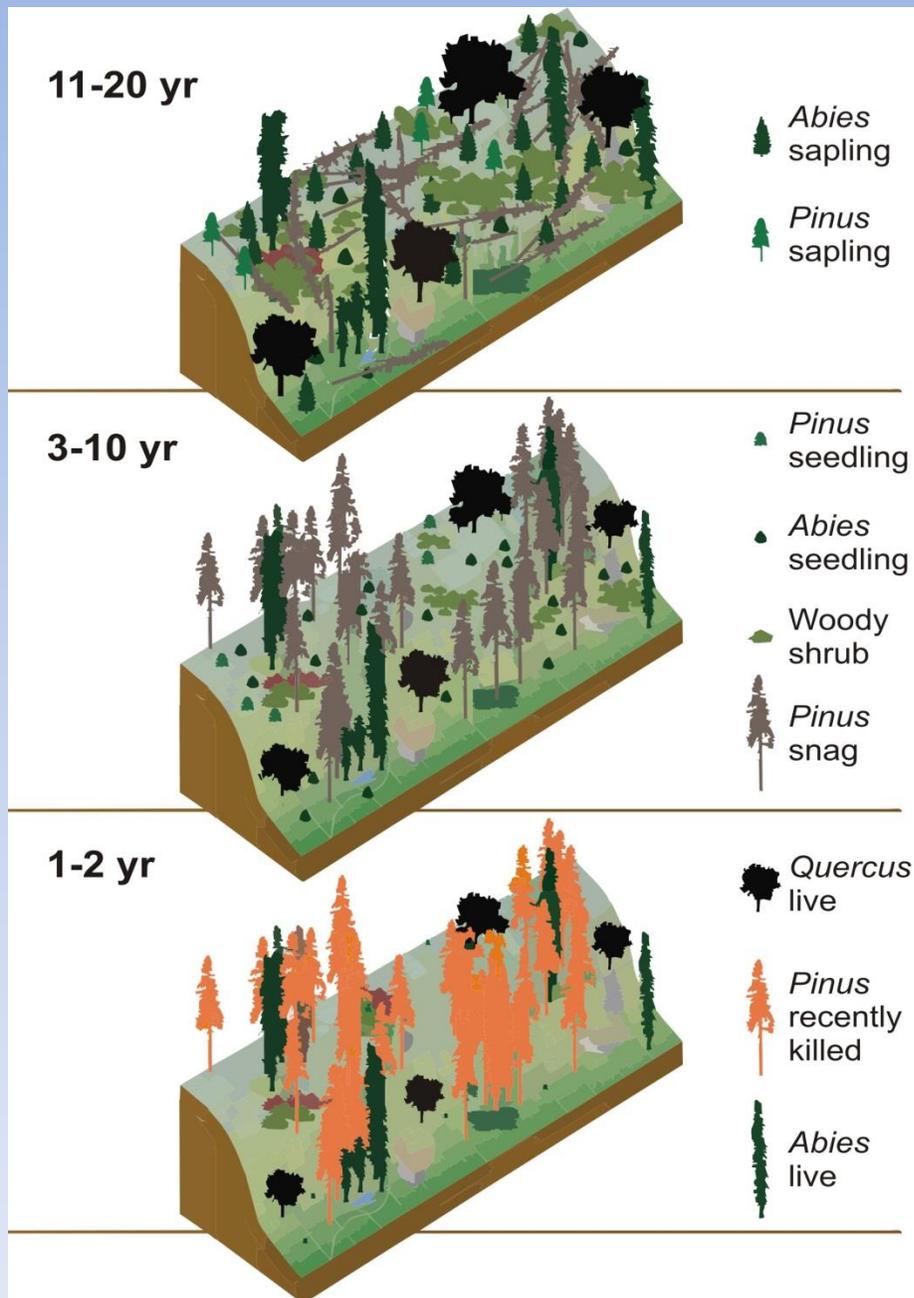
Mixed conifer, ponderosa and Jeffrey pine forests have all experienced recent tree mortality in CA

# Western Pine Beetle Yosemite Large Logs Falling, Heavy Dry Fuels



Eric Knapp  
picture

Theoretical depiction of  
vegetation and fuel dynamics  
following severe mortality



11-20 yr continued decreases in canopy fuels and considerable increases in large surface fuel (top)

3-10 yr, loss of canopy fuels as dead foliage and branches fall, corresponding increase in dead and live surface fuels as tree seedlings and shrubs grow (center)

Initially (1-2 yr) primary change would be the reduced moisture content of canopy fuels – spotting (bottom)

*Stephens et al. (in review)*

# Wildfire in Areas of High Tree Mortality

Collected forest structure, fire severity, and pre- and post-fire tree mortality on 50 mixed conifer plots in the 2015 Rough Fire in the southern Sierra

Used random forest to identify influential topographic, weather, vegetation, and pre-fire tree mortality variables on fire severity

Percentage of live tree basal area killed by fire was most associated with % basal area in the red phase pre-fire, followed by stand basal area, % of trees in red phase pre-fire, and pre-fire shrub cover

As snags fall, increase fuel loads dramatically

*Stephens et al. (in review)*

# Impacts of Severe Mortality

Initially tree mortality increases fine dead fuels

- Can increase spotting potential and embers
- CA. mortality not a ‘natural’ event, SSPM vs. California

Mass fires possible in 10-15 years as large dead wood falls

- Cannot model these types of fires, very hazardous
- Response: burn when needles fall, then again 10-15 years, mechanical treatments too in roaded areas

Forest succession after large scale mortality

- Loss of large, old trees critical
- Homogeneous forest development, big problem
  - Add treatments to increase heterogeneity

Forest mortality a symptom of unsustainable forests

- Modify current frequent fire forests to reduce vulnerability
- Emphasis on Green Forests vs always chasing the dead
  - Have 1-3 decades to move on this: It is possible

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