The Science Behind Forest Restoration in the Sierra Nevada

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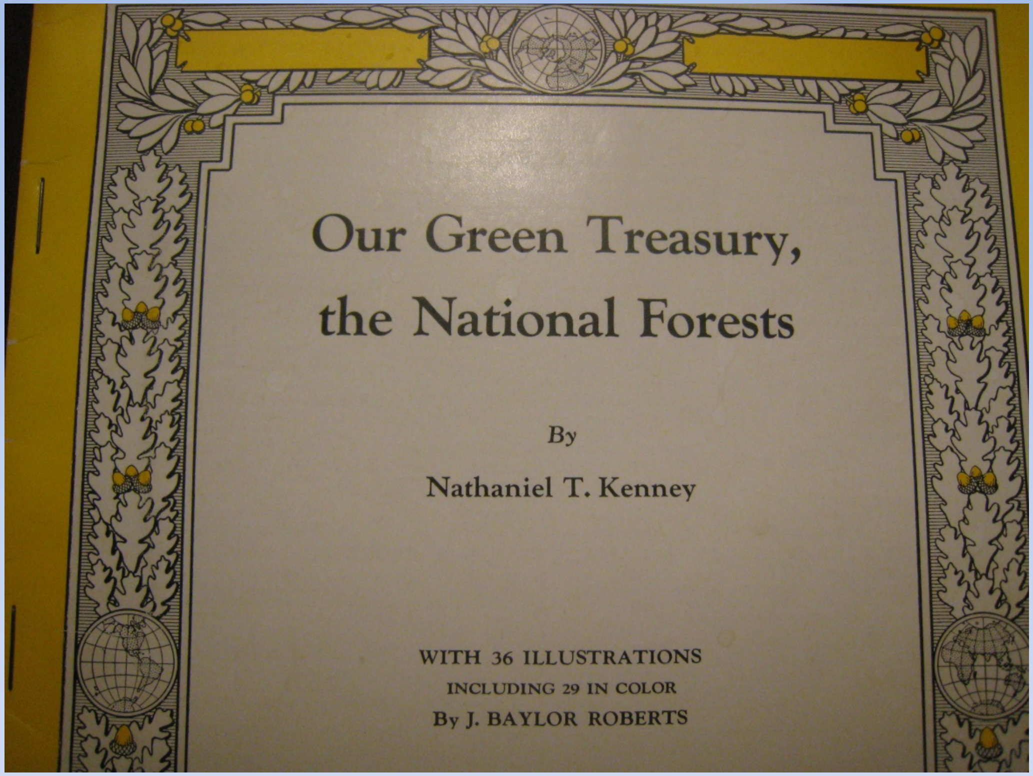
Connection to the Past

National Geographic 1956


Our Green Treasury, the National Forests

By

Nathaniel T. Kenney

WITH 36 ILLUSTRATIONS
INCLUDING 29 IN COLOR
By J. BAYLOR ROBERTS

As one fire expert told me ‘I don’t believe that equipment and development alone will show us how to keep having the relatively few big fires… Researchers must let their imaginations soar for answers that today would seem fantastic’.

Historical Fire Effects

Mixed-conifer and ponderosa pine forests:

Show and Kotok (1924):

> "California pine forests* represent broken, patchy, understocked stands, worn down by the attrition of repeated light fires."

Bear Creek Guard Station - 1915
Plumas National Forest

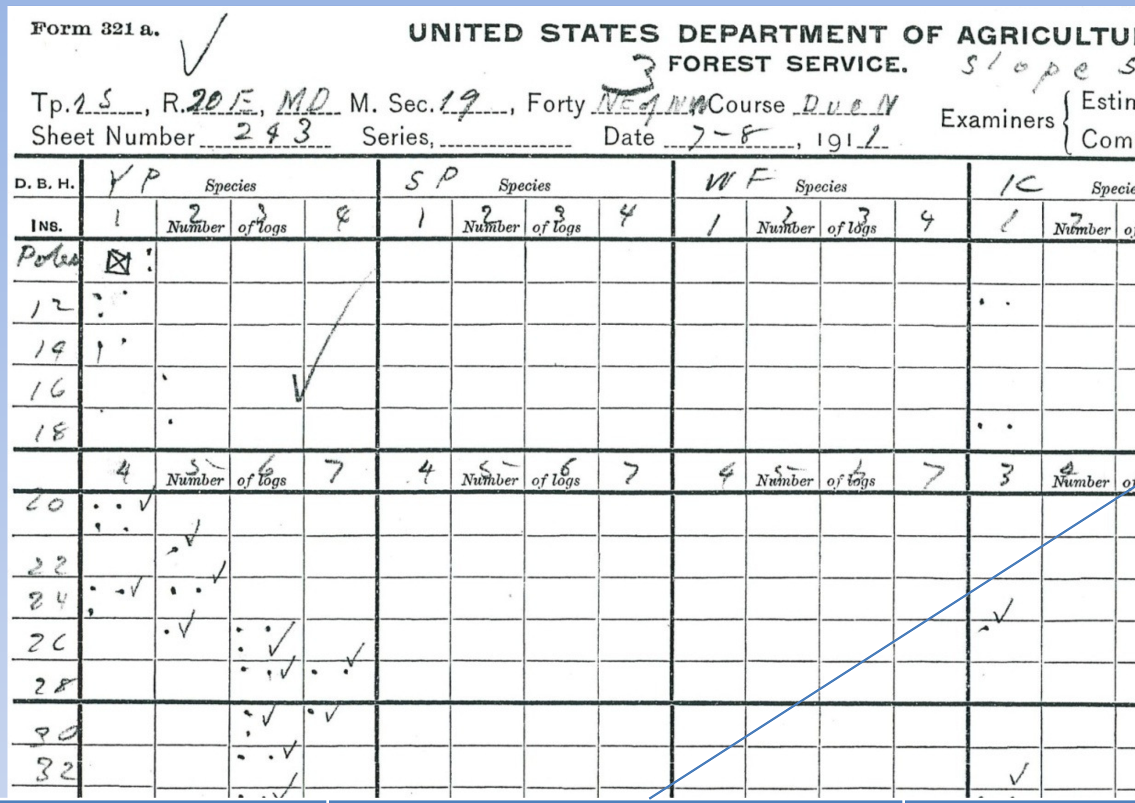
"Extensive crown fires…are almost unknown to the California pine region."

"The virgin forest, subjected to repeated surface fires for centuries has been exposed to… cumulative risk."

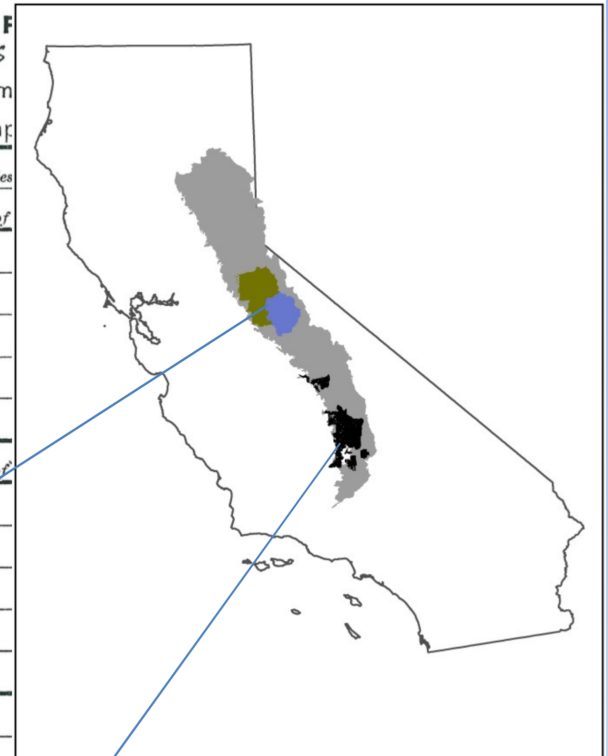
Fire Suppression

- Begins around 1905
- Approximately 80,000 fires/year today
- 98-99 percent of all wildland fires out at less than 5 acres in size
- 95% of area burned today is from 1-2% of the fires that escape initial attack
- Before 1800, fires burned approximately 1.1 million acres of forests annually in California in an average year, 4.5 million acres total (*Stephens et al. 2007 For. Ecol. Man.*)
  - Lightning and Indigenous ignitions
  - Today we burn 10-25% of this area
- How have forests changed in Sierra Nevada?


The 1911 Historical Data
San Bruno Federal Archive



Form 321 a.
UNITED STATES DEPARTMENT OF AGRICULTUR
FOREST SERVICE.
Tp. 1 S, R. 20 E, MD M. Sec. 19, Forty NE 1/4 NW Course Due N
Sheet Number 243 Series, Date 7-8, 1912
Examiners { Estim / Comp
D. B. H. INS. | YP Species | SP Species | WF Species | IC Species
Number of logs
Poles, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32
8—1198



Total count	Stanislaus NF & Yosemite NP	Sequoia (Kern) NF Greenhorn Mts.
Transects	294	378
Trees	20,700	18,052
Survey area (ac)*	41,496	28,405

*no prior timber harvesting, ~3% sample of total area

Stanislaus NF, Sampling 1911 Location
(15-Jul-2013)

Same Field Plot Within Rim Fire

Post-fire (25-Sep-2013)

Field Plot Within Rim Fire

Post-fire (August-2016)

Field plot within Rim Fire

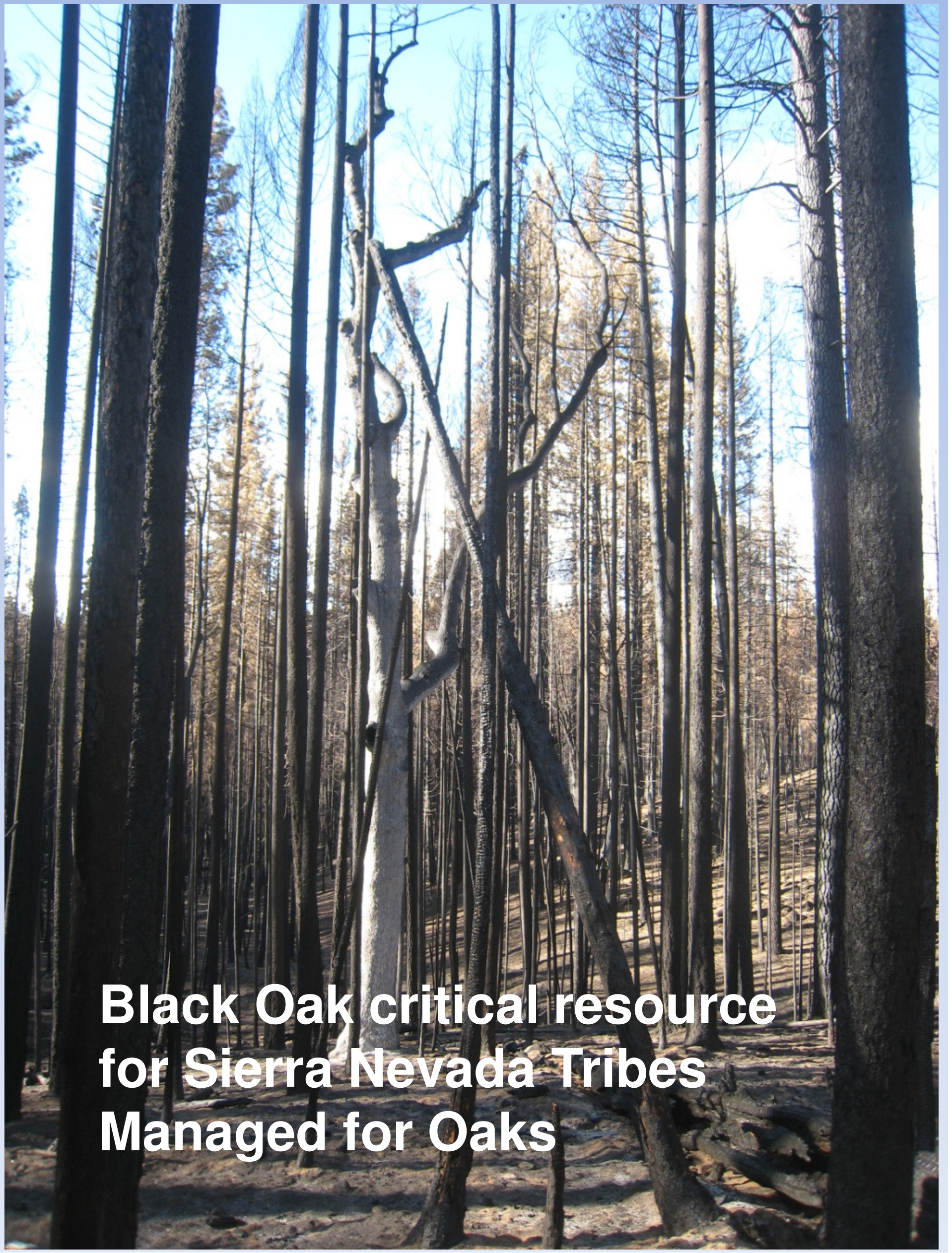
Pre-fire (15-Jul-2013)

Post-fire (25-Sep-2013)

Field plot within Rim Fire

Pre-fire (15-Jul-2013)

Post-fire (25-Sep-2013)



Stanislaus-YOSE Historical vs. current:
re-measurement of 1911 timber surveys

Year	Basal area (ft^2 ac^{-1})	Tree density (ac^{-1})		Pine proportion
		> 6 in.	>36 in.	
1911	87	22	5	0.56
2013	173	101	5	0.45

Forest management implications:

- **Contemporary stand-replacing fire is outside historical range of variability**
  - ➢ **Most pronounced in mixed-conifer and yellow pine types**
  - ➢ **Not only proportions, <u>patch sizes</u> as well**

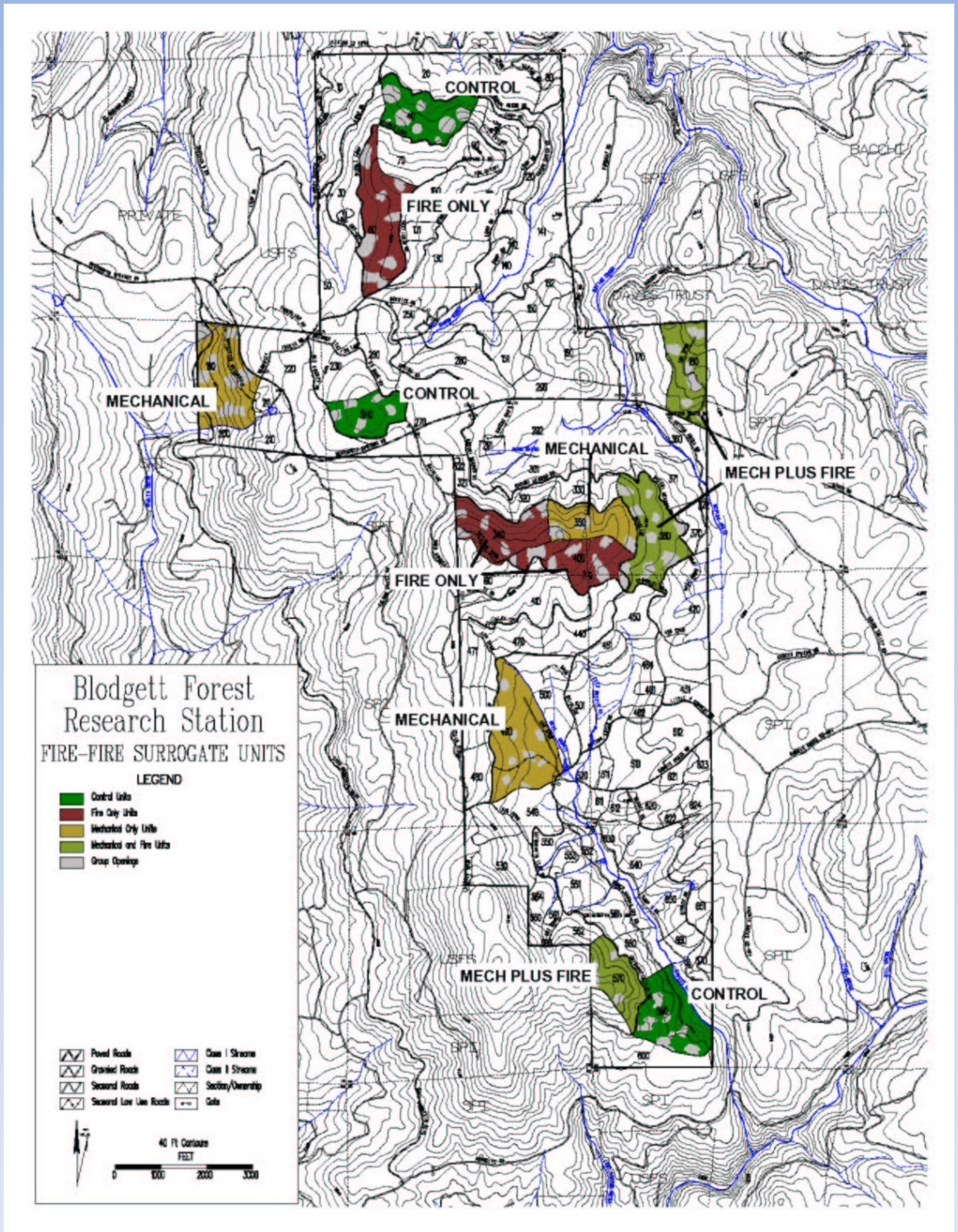
- **Coordinated landscape treatments can mitigate uncharacteristic fire behavior (and effects)**
  - ➢ **<u>Strategic</u> treatments across 15-20% of landscape seems optimal**
  - ➢ **Cannot continue to use treatments to STOP fire**
  - ➢ **Manage landscapes to incorporate fire**
  - ➢ **<u>Ecological Effects of Treatments</u>**

Forest Restoration Fire Surrogate Study UC Blodgett Forest

12 Treatment Units

- 3 Control
- 3 Mechanical only
  - Thin and mastication
- 3 Mechanical plus fire
  - Same as mech + fire
- 3 Prescribed fire only
- All units 40-70 ac in size
- Pre-treatment all units had very high fire hazards

What do treatments look like?



Mechanical Only – Pre-Treatment (2001)

Rotary Masticator in Central Sierra

Crown thin, commercial thin from below, mastication

Mechanical Only – Post-1st Treatment (2003)

Mechanical Only – Post-1st Treatment (2010)

Mechanical Only – Post-1st Treatment (2015)

Mechanical Only – Post-2nd Treatment (2019)

Mechanical + Fire – Pre-Treatment (2001)

Mechanical + Fire – Post-Thin and Mast (2002)

Mechanical + Fire – Post-1st Treatment (2003)

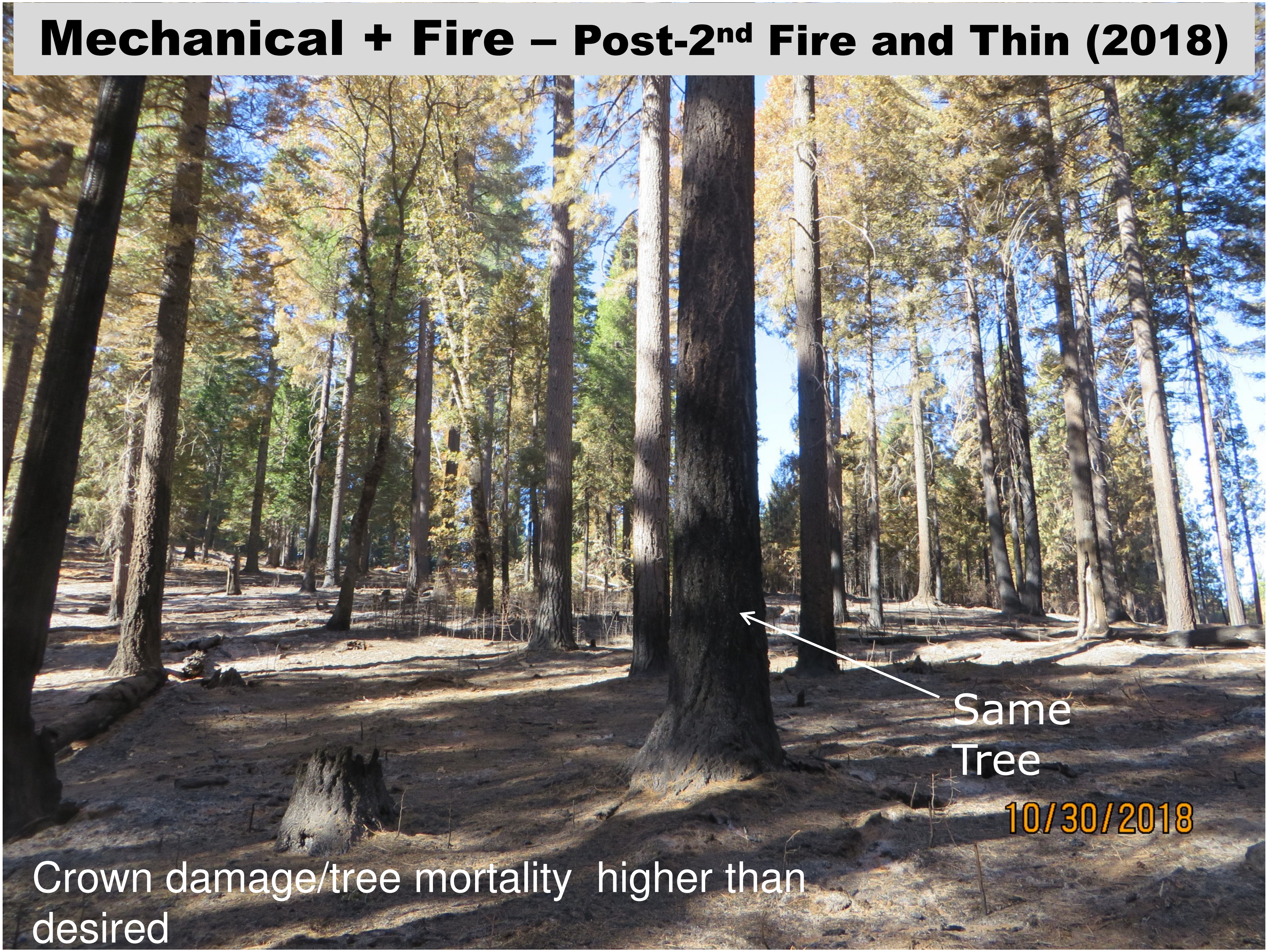
Mechanical + Fire – Post-1st Treatment (2010)

Mechanical + Fire – Post-1st Treatment (2015)

Mechanical + Fire – 2nd Mast and Thin (2018)

Mechanical + Fire – 2nd Fire in Fall 2018

Mechanical + Fire – Post-2nd Fire and Thin (2018)



Crown damage/tree mortality higher than desired

Fire Only – Pre-Treatment (2002)


UCB Blodgett Forest
prescribed fire
4 12:26 AM

Fire Only – Post-1st Prescribed Fire (2003)

Fire Only – Post-1st Prescribed Fire (2009)

Fire Only – During 2nd Ignition (2009)

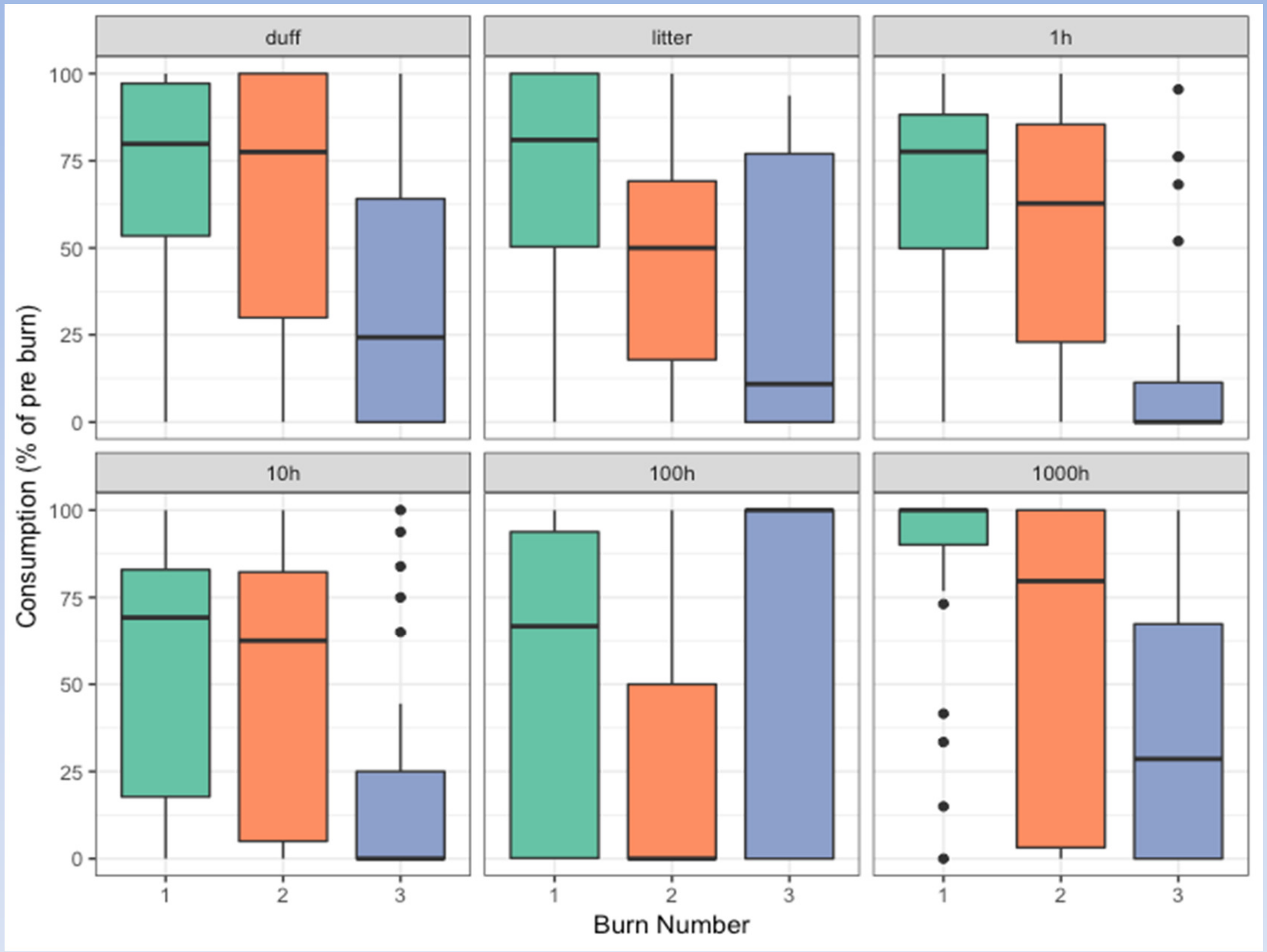
Fire Only – Post- 2nd Prescribed Fire (2010)

Fire Only – Post-2nd Fire 8 years (2017)

Fire Only – During 3rd Ignition (2017)

Fire Only – After 3rd Prescribed Fire (2018)

Fuel Consumption After 3rd Prescribed Fire



Green 1st fire   Red 2nd fire   Blue 3rd fire

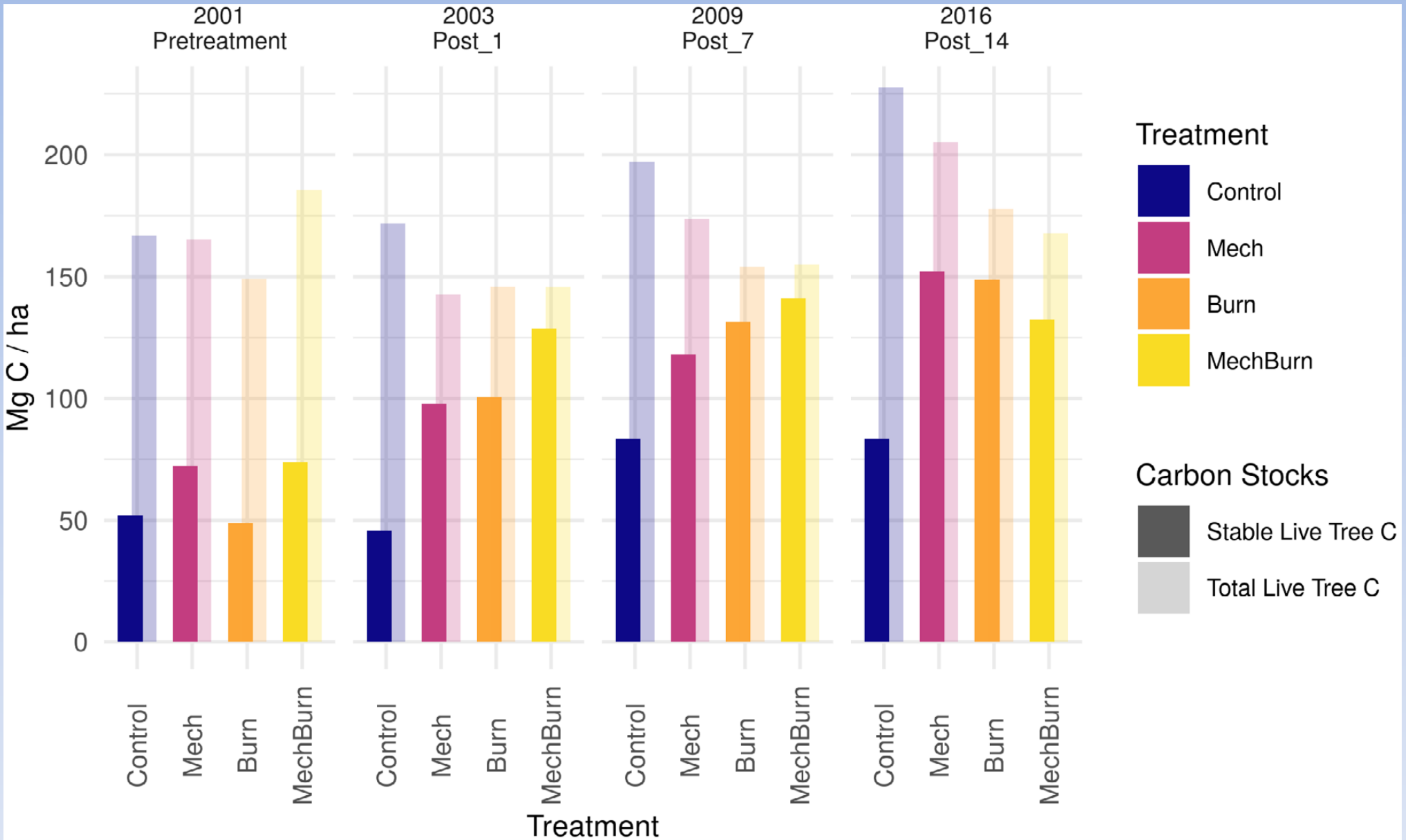
More variability in fuel consumption in 3rd fire

Fuel Consumption with Multiple Prescribed Fires

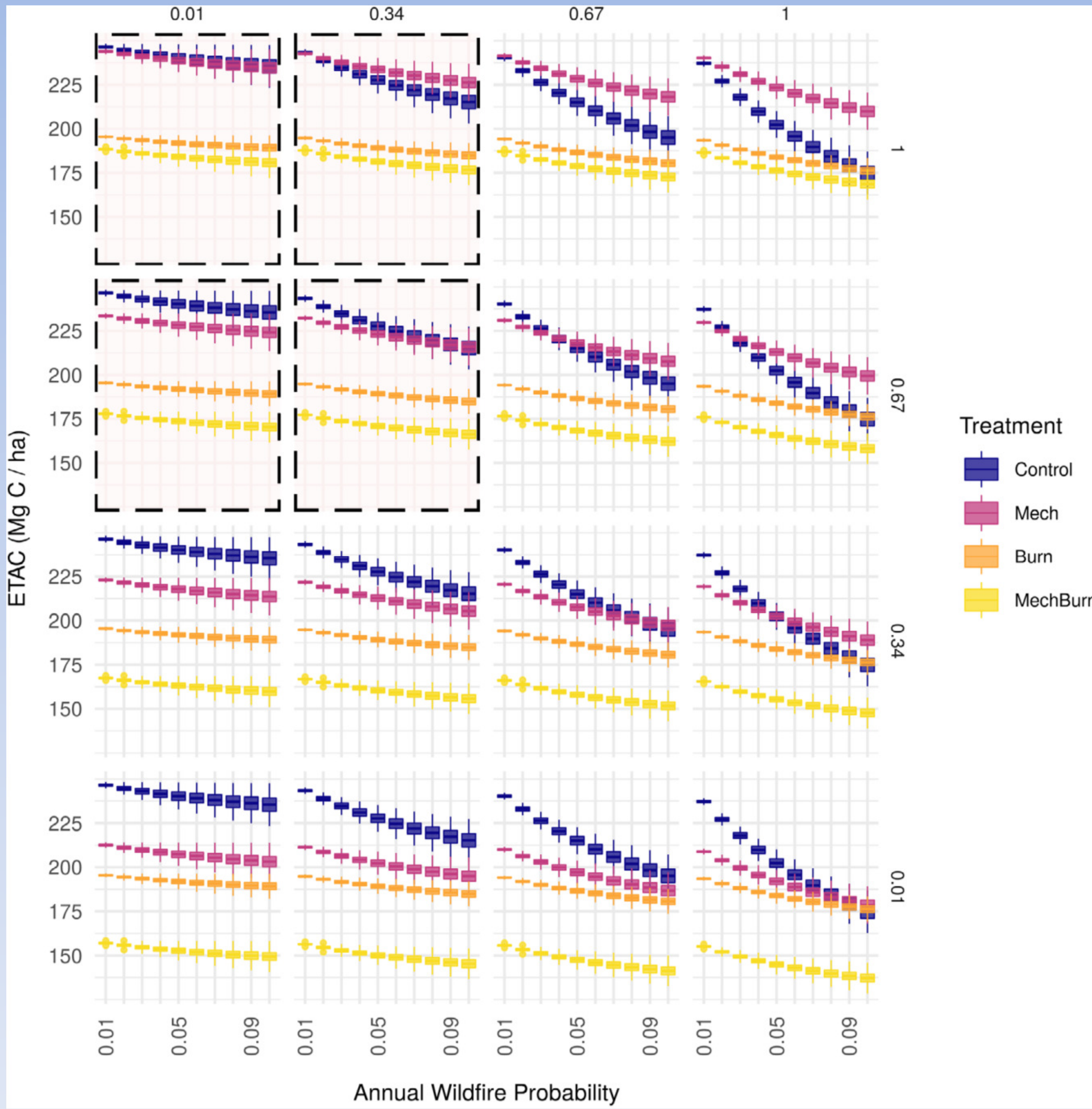
- Overall fuel consumption across the three burns averaged 45% of pre-burn levels
- Consumption rates were highest for the first burn at 65%
- Decreasing by 15-20% with each successive burn
- Fuel consumption was highly variable by fuel type, stand, and tree species composition.
- This variability may be advantageous for managers seeking to foster structural diversity and resilience in forest stands

Fuels Treatments Impacts on Carbon

Foster et al. 2020



Total Aboveground Carbon by Treatment and Annual Wildfire Probability (dashed lines today)



Restoration and Fuels Treatments

- All forest treatments successful in reducing fire hazards and fire effects in frequent fire forests
  - Reduction of ***Surface and Ladder Fuels Critical*** (Agee and Skinner 2005)
    - Treatments can increase the vigor/resistance/resilience of remaining trees to improve adaptation to climate change (Collins et al. 2015)
  - All fuel treatments: Most ecosystem components exhibit very subtle effects or no measurable effects at all (soils, small mammals and birds, vegetation, bark beetles) (Stephens et al. 2012)
    - Longevity of treatments 15 - 20 years (Stephens et al. 2012)
    - Treatments never end – lightning fire maintenance in some areas
  - Forest carbon more stable with fire treatments but mechanical and controls also important
    - fire probabilities increasing, control fire severity likely underestimated
    - Scale of treatments continues to be relatively low in CA - <u>Problem</u>

Summary

California mixed conifer forests have changed

- Tree density increased 2.75 times since 1900, canopy cover 1.5x higher, large tree deficit (Safford and Stevens 2017)
- Forest change has decreases resiliency
- Climate change makes worse – <u>not biggest issue</u>

Need increased restoration treatments and wildfire for ecological benefit

<u>Answer to *Nathaniel Kenney* from 1956</u> (imaginations soar – fire back and mechanical restoration treatments, more work with Tribes for innovation)

California has increased resources for fuels management

Need to invest in *fire extension program* state-wide, *Western US Prescribed Fire Training Center, increase pace and scale of treatments* <u>(Feinstein Bill released)</u>

<u>**Next 1-2 decades absolutely critical**</u>

<u>**We are running out of time – Still hopeful**</u>

Acknowledgements

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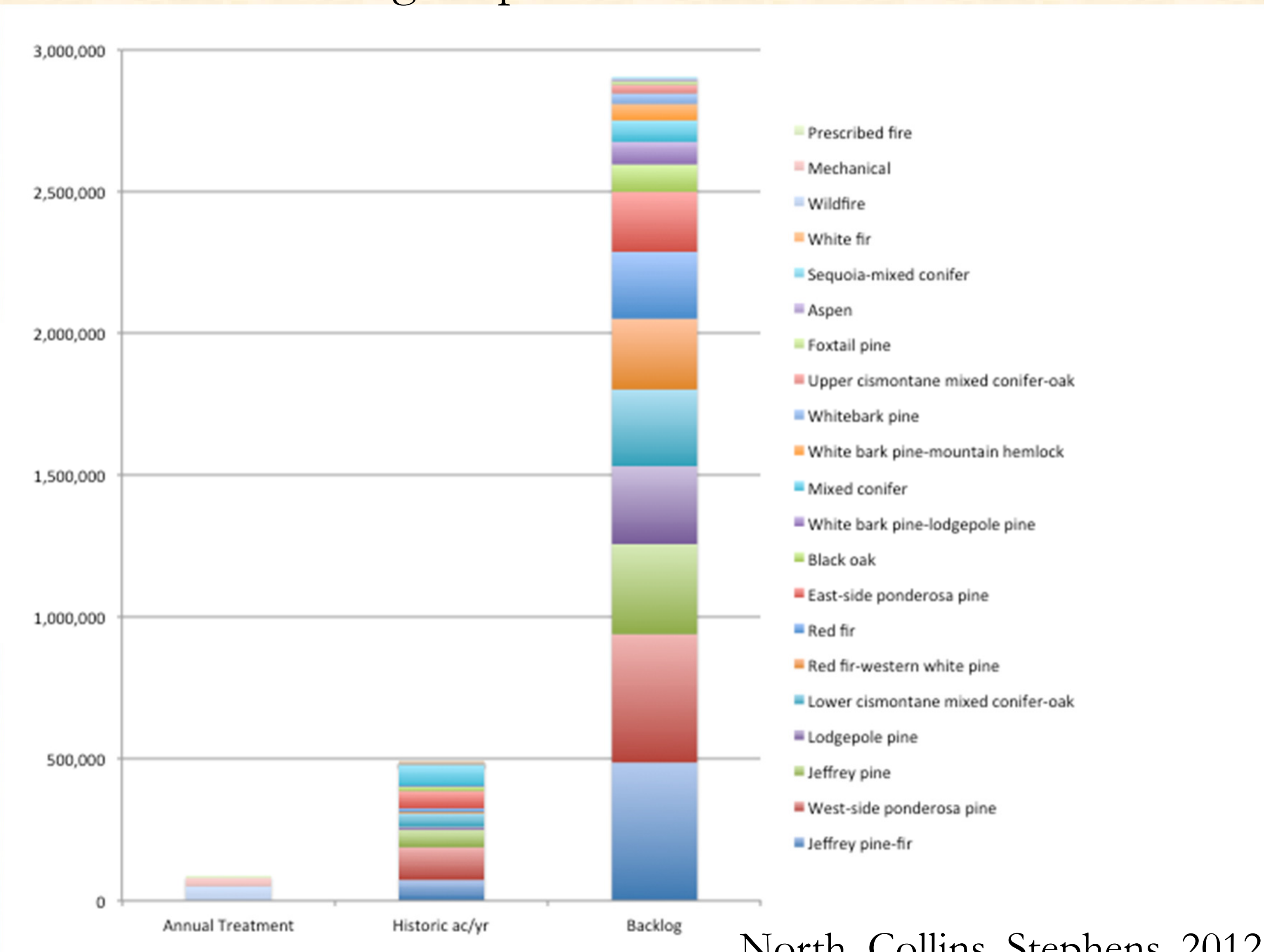
Papers available at:
www.cnr.berkeley.edu/stephens-lab/

Email: sstephens@berkeley.edu

Permanent Backlog:

2.9 million acres (60% of USFS acreage) will always remain fuel loaded

2/3's of this acreage is pine-dominated and mixed-conifer forest types



North, Collins, Stephens. 2012, J. Forestry