



# **Fire, Forests, and Water: Possible Steps Forward**

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# Sierra San Pedro Martir

Mediterranean climate  
Peninsular Mountains

Precipitation averages 60 cm/yr  
Within California floristic province

Mixed conifer forests  
Similar to forests in southern  
California mountains and xeric areas  
of Sierra Nevada

Fire suppression begins in 1970  
No harvesting

Most intact Mediterranean climate  
forest in the world







# SSPM Wildfire July 4, 2003

- Largest fire in 20 years
  - Occurred at end of a severe 4 year drought
- Approximately 20% of trees killed
  - Fire was very patchy
  - Directly linked to heterogeneity of forest structure and fuels
- Fire maintained or increased spatial heterogeneity in seedlings and trees
- Mortality very low even after 4 year drought and wildfire
  - Tens of millions of trees died southern California – no fire
- Every time I work there – gives me optimism







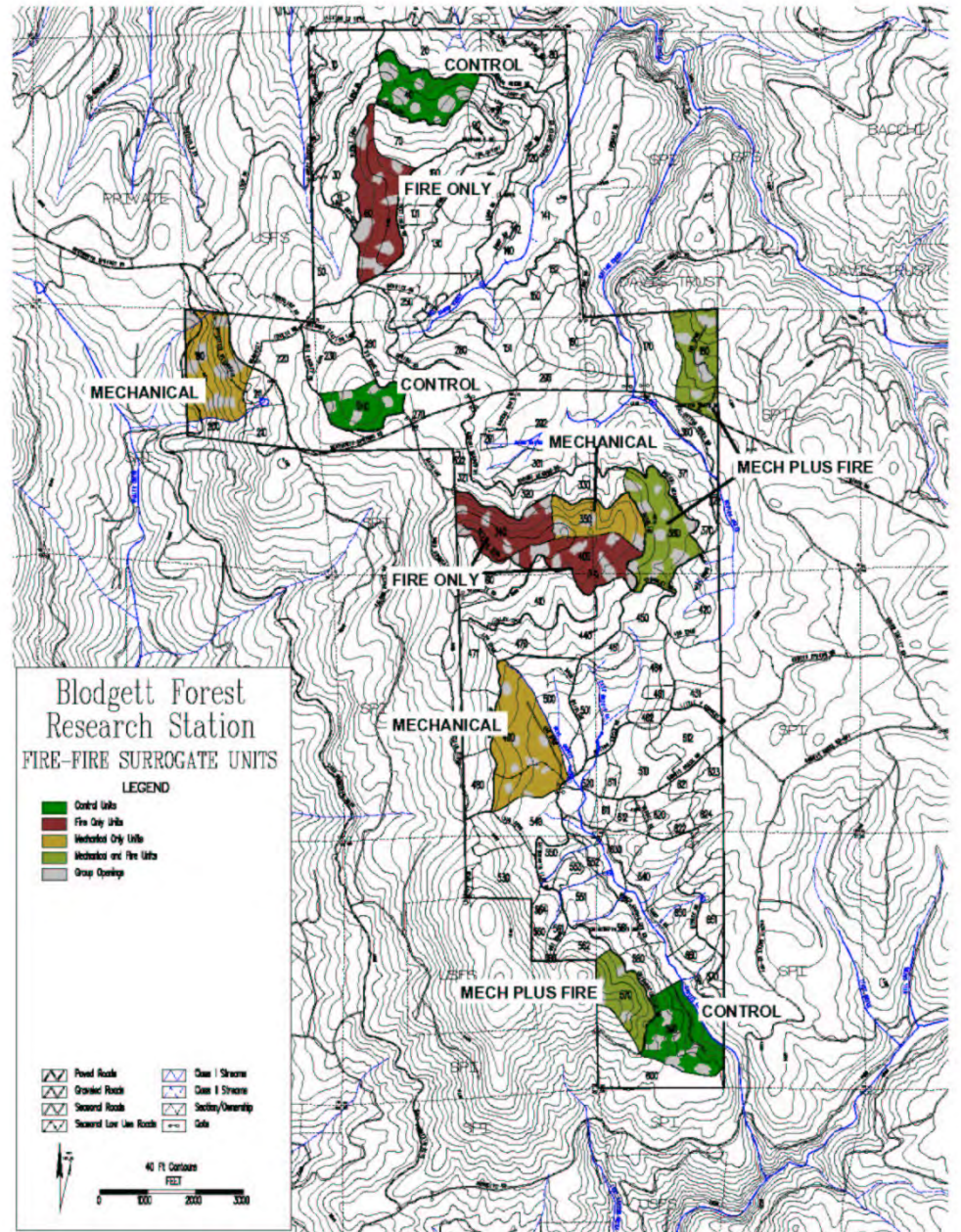
# Wildfire Dynamics

- Current SSPM fire regime dominated by unchanged and low severity fire (0-25% tree mortality)
  - No trend in fire severity over time
- No correlation between the years of greatest fire area and percentage of high severity fire
  - In Sierra Nevada strong correlation
- Fuels in SSPM are more important than weather regarding fire behavior
  - Bottom-up fire regime control continues
- How do we use this information in the western US?
  - Research on prescribed fire and restoration treatments

# Fire and Fire Surrogate Study

- Mixed conifer forest in northern Sierra Nevada
- 100 years of fire suppression and past harvesting
- 3 controls
- 3 mechanical only
- 3 mechanical plus fire
- 3 fire only
- All experimental units 20 ha in size

What do treatments look like?





# Fire only – pre-treatment (2002)

**Watch**



C400  
P 103 S  
SEP-24-02  
F  
PRE-BURN



UCB Blodgett Forest  
prescribed fire



4 12:26 AM



# Fire only – 1<sup>st</sup> fire post-treatment (2003)



Same tree



Fire only – post-treatment 6 years (2009)





# Fire only – during 2<sup>nd</sup> Ignition (2009)

Same tree





# Fire only – post- 2<sup>nd</sup> fire (2010)





# Fire only – post-2<sup>nd</sup> fire 8 years (2017)



11/01/2017



# Fire only – during 3rd Ignition (2017)





# Fire only – After 3<sup>rd</sup> prescribed fire (2018)



Also restoration  
thinning and thinning  
followed by fire

10/30/2018



# Restoration/Fuels Treatments

- Forest treatments implemented to reduce fire behavior and effects in frequent fire forests
  - Reduction of ***Surface and Ladder Fuels Critical***
    - Treatments can increase the vigor/resistance/resilience of remaining trees to improve adaptation to climate change (Collins et al. 2015)
  - Fuel Treatments: Most ecosystem components exhibit very subtle effects or no measurable effects at all (soils, small mammals and songbirds, vegetation, bark beetles, carbon sequestration) (Stephens et al. 2012)
    - Longevity of treatments about 20 years
    - Treatments never end – lightning fire maintenance in some areas
- National study has determined that treatments are effective and appropriate ecologically
  - But scale of treatments continues to be relatively low in western US



# Fire and Hydrology in Sierra Nevada Watersheds

Sierra Nevada

45 years of fire use  
15,000 ha watershed

Yosemite Wildland fire use  
program: 1972 to present

Crane Flat  
weather station

○ Yosemite NP boundary

○ Illilouette Creek basin

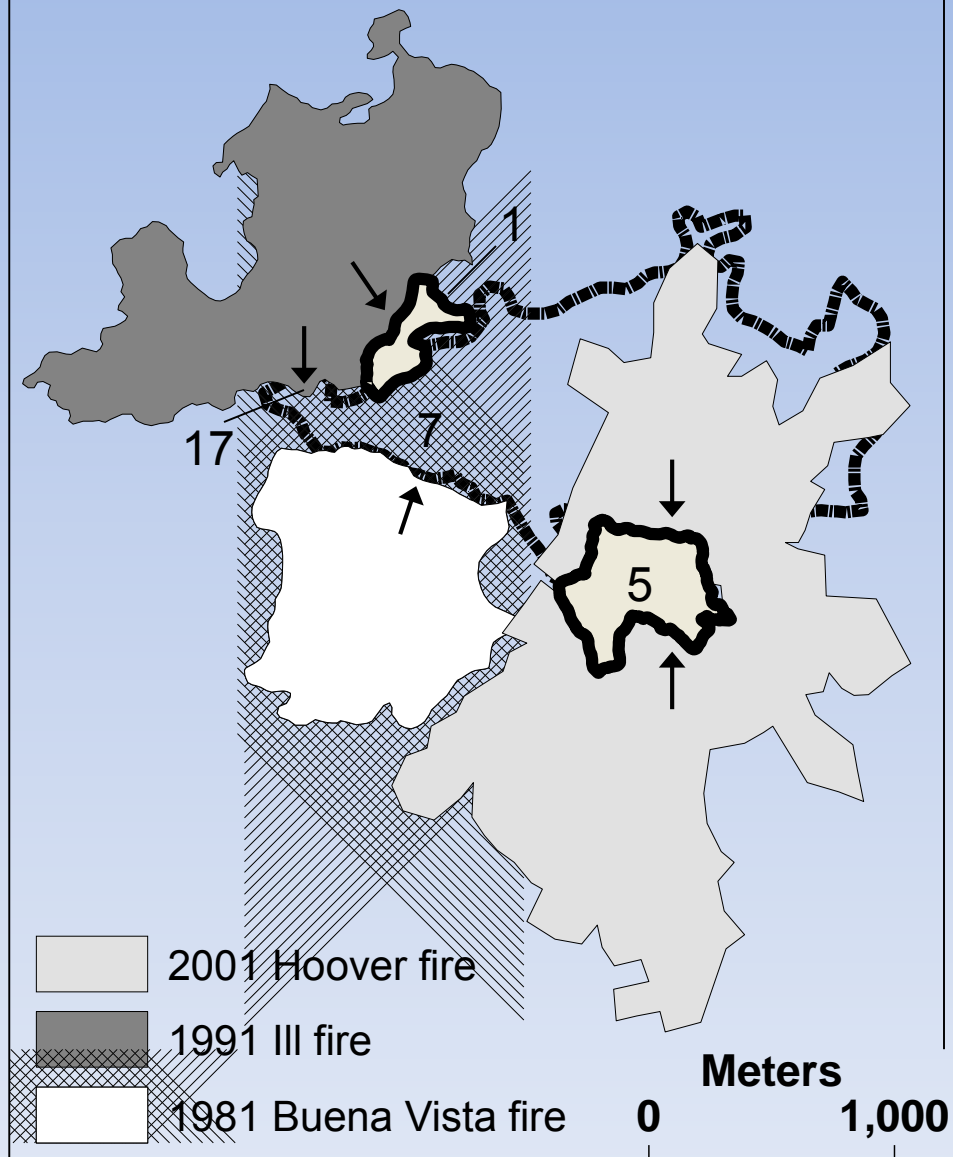
— Roads

0 10 Kilometers

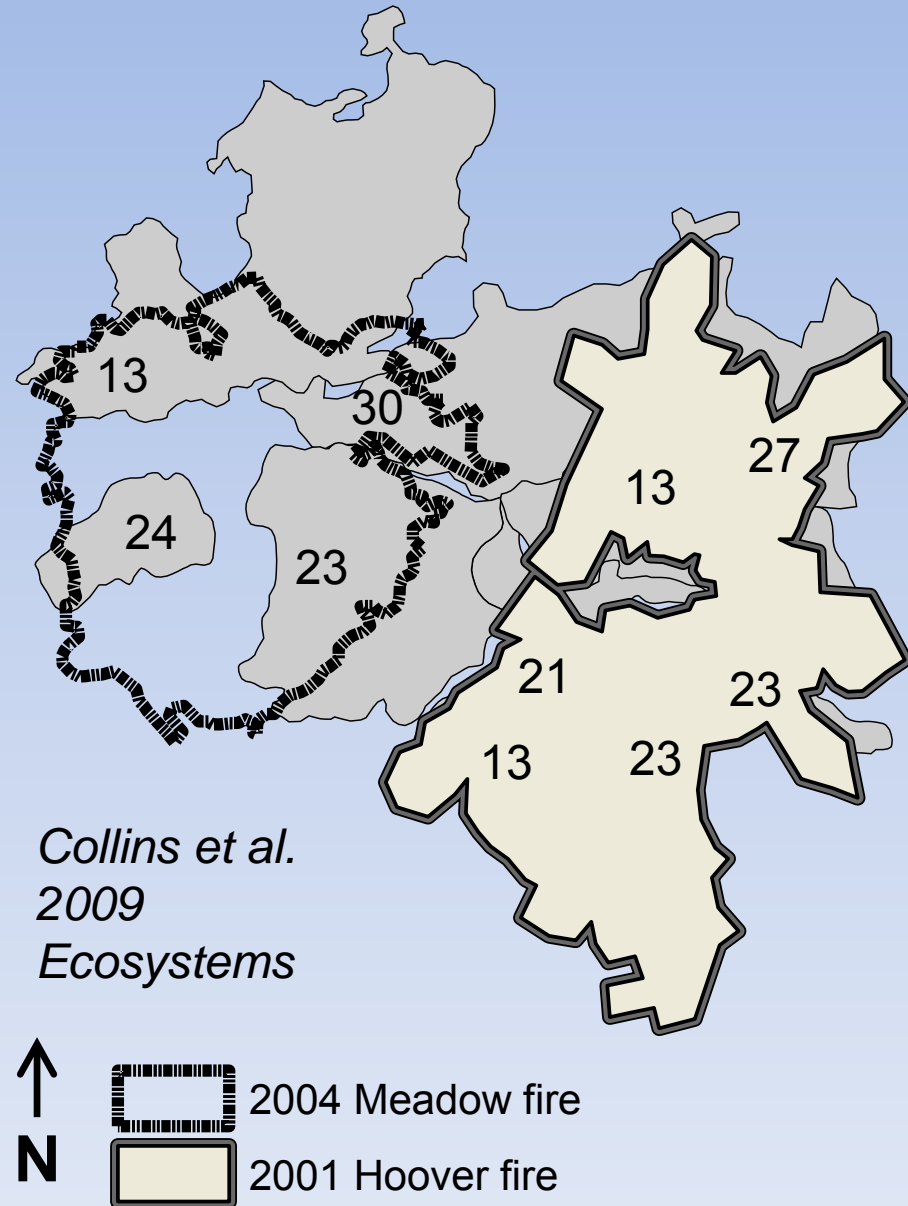




## Limited fires



## Reburn fires

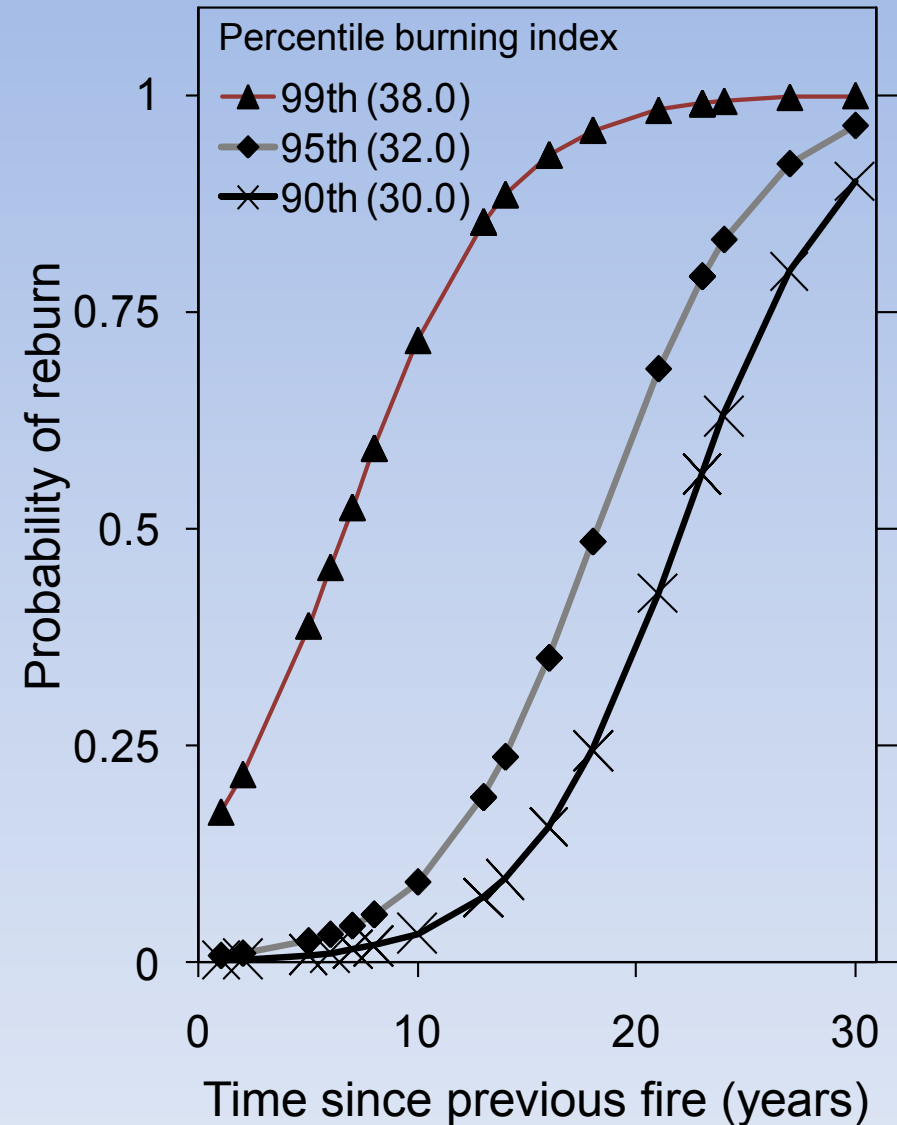


*Collins et al.*  
2009  
*Ecosystems*

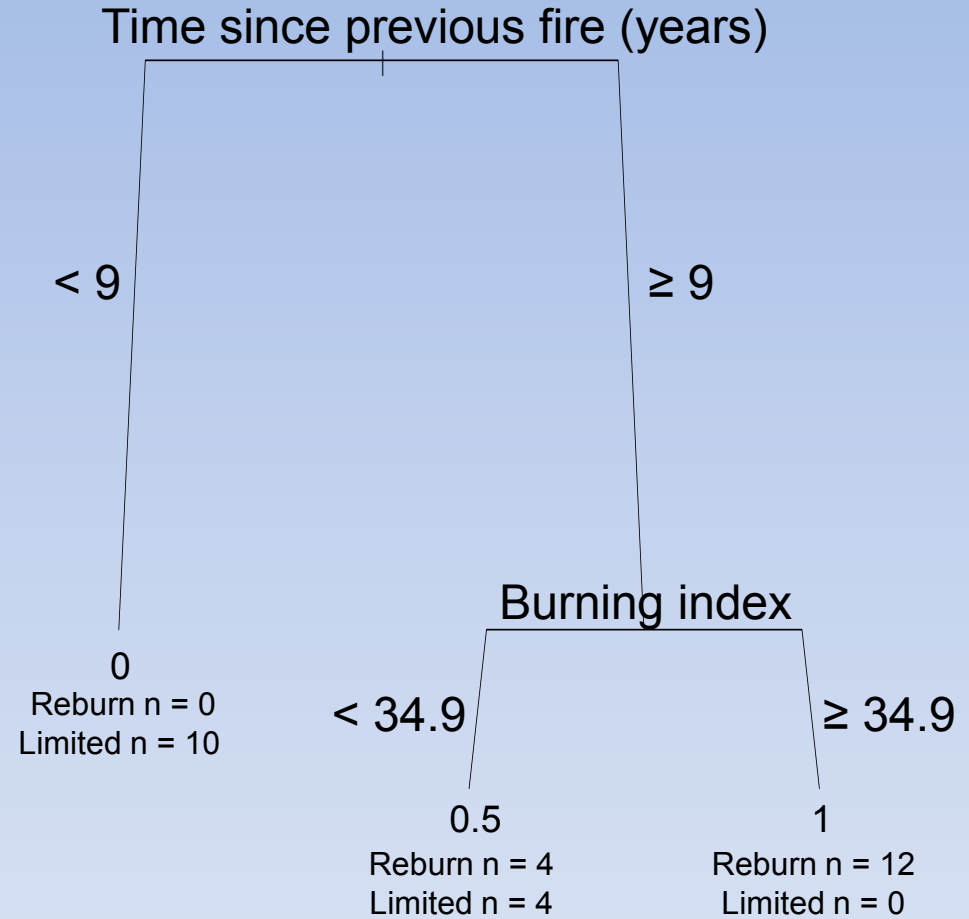


# Interactions between adjacent fires

## Logistic regression



## Categorical tree



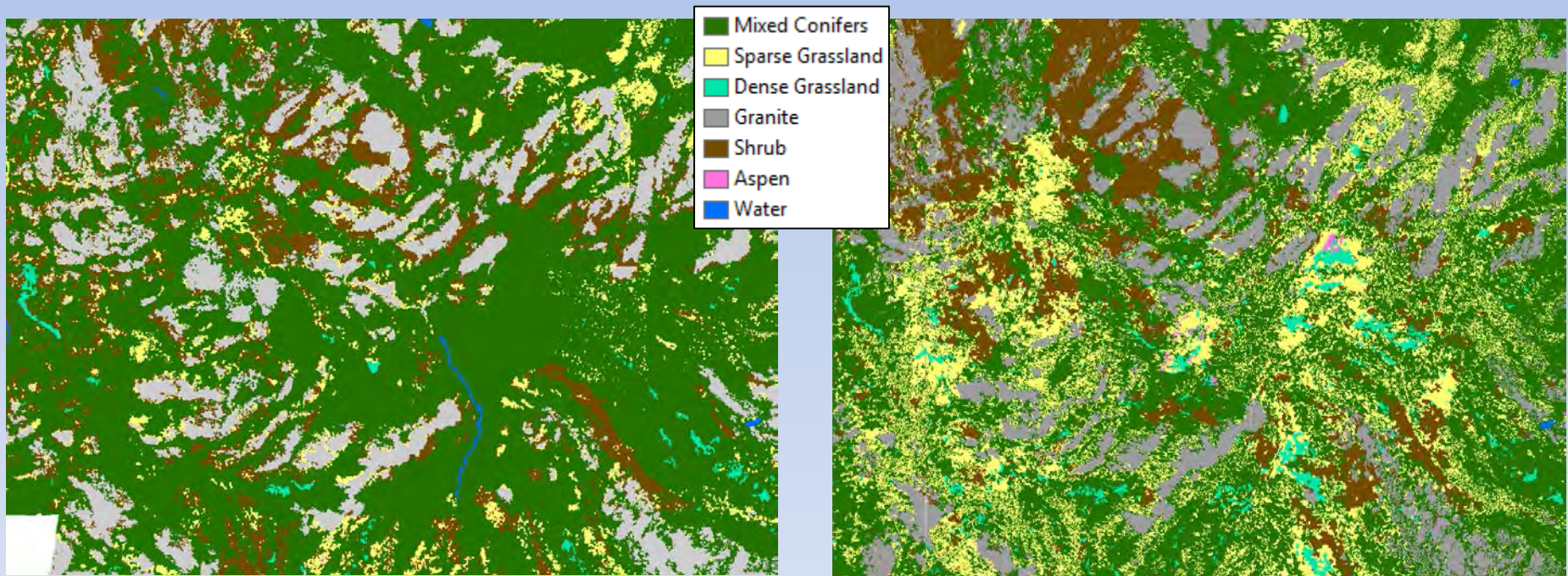


# Vegetation Change in Yosemite

## Fires Reduced Forest Area by 22%

1970 (1974 1<sup>st</sup> fire)

2012



Wet meadows increased by 200%  
Dry meadows increased by 200%  
Shrublands increased by 30%

*Boisramé et al. 2017 For. Ecol. Man.*

*Large change in forest structure*



# High Severity Patch with Forest Recovery

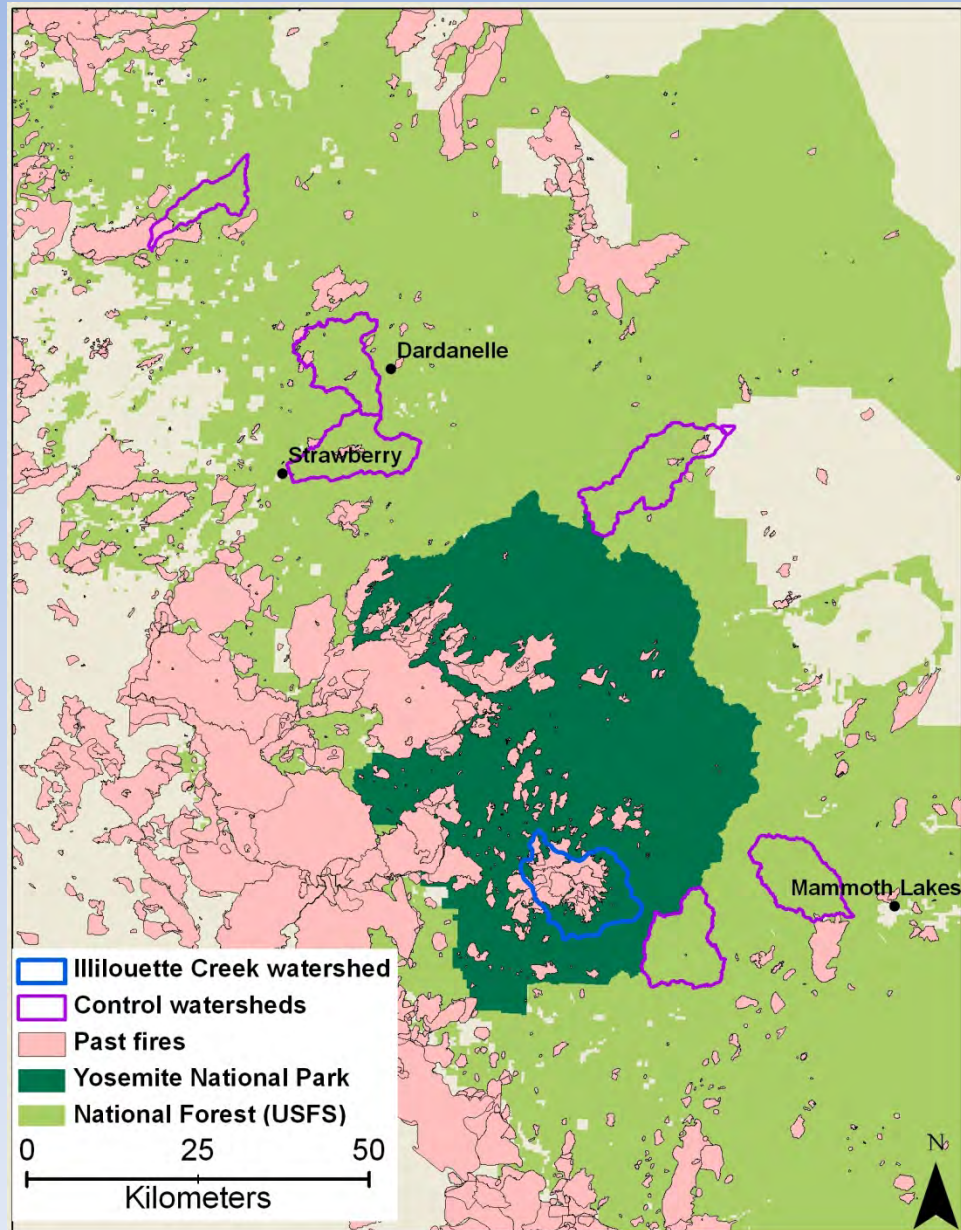








# Compare to Other Watersheds



Amount of stream water leaving watershed has increased or remained stable since 1974 (runoff coefficient)

Other control watersheds significantly decreased  
*Biosrame et al.*  
(2016) Ecosystems

Forest mortality from drought and insects < 10% of adjacent areas without fire use



# Changing Streamflow Characteristics

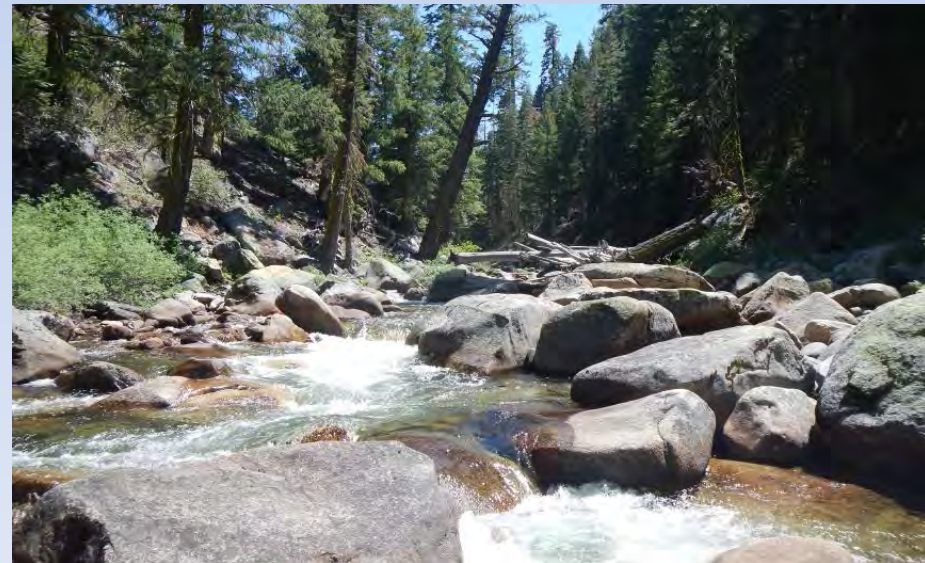
Since fire suppression ended...

- Runoff ratio increased or stable
- Duration of spring snowmelt longer
- Flood frequency not significantly changed
- Stream discharge up 3-6%, deep storage up

Use of lightning ignited wildfires in Yosemite has provided several benefits to forests and water

Continued research in fire and hydrology critical

Possible win-win





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