Water, Fire, and Biodiversity in the Sierra Nevada
A Possible Triple Win

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Managed Wildfire in Yosemite

- Policy changes from full fire suppression to fire use in 1972
  - Lightning ignited fires allowed to burn with careful monitoring, also prescribed fires allowed
- Multiple fires have burned in the Illilouette Creek basin
  - What are their burning patterns?
  - How have they impacted vegetation?
  - Have they changed the hydrology of this area?
  - Can we learn from this area and improve forest management?
    - *Stephens et al. 2021 Env Res Comm 3 081004*

Managed Wildfire

50 years of fire use
45,000 ac watershed
Snow dominated area

Yosemite program: 1974 to present

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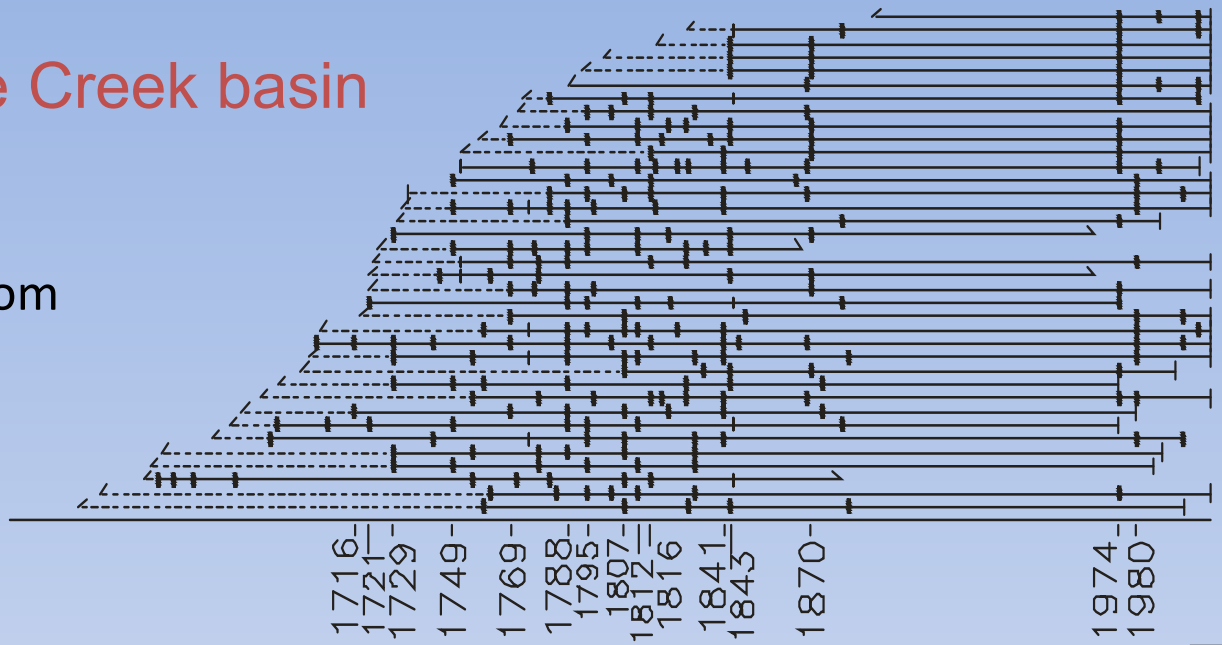
Collins and Stephens 2007, Collins et al. 2009 Ecosystems

Illilouette Creek basin

Fire scars sampled from trees in the basin



Collins & Stephens 2007. *Front. Ecol. Environ.*

Starr King Fire, 1974
First Managed Fire
Jan van Wagtendonk picture

2001 Hoover Fire Yosemite National Park

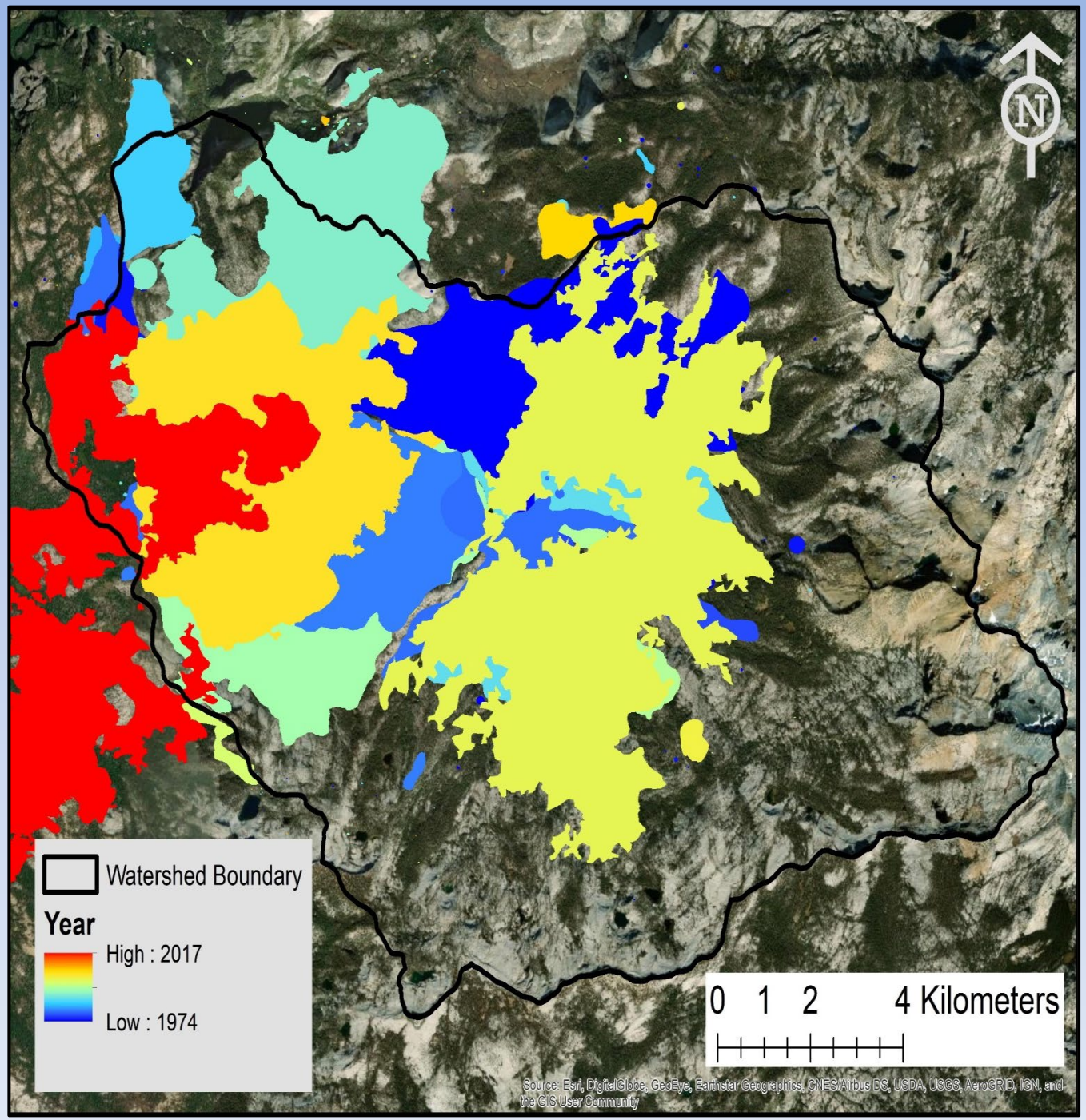
Illilouette Creek basin

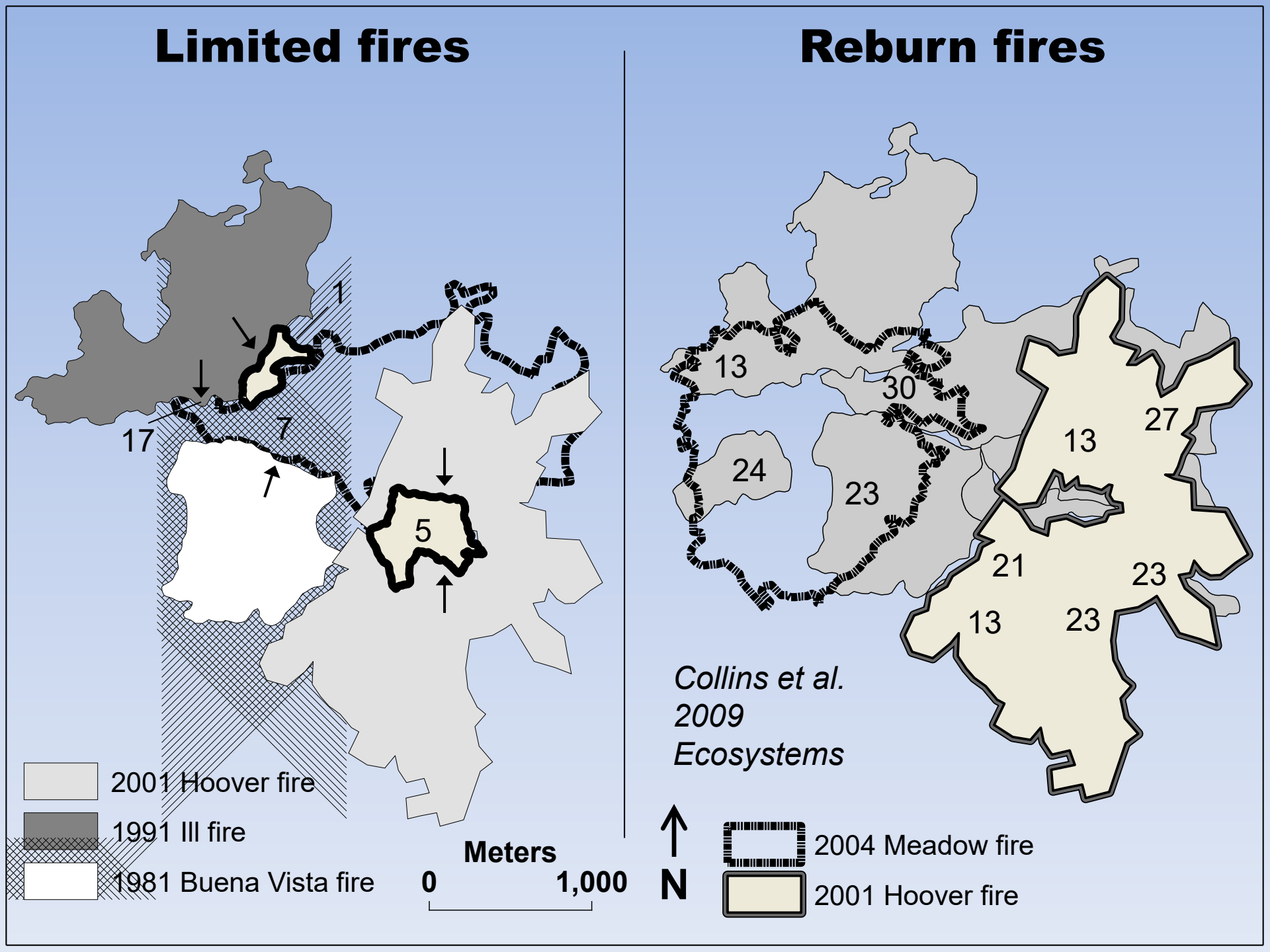
Fires excluded for about 100 years, ending in 1974

Pre-suppression (1700-1875) mean fire return interval: **6.3 years**

1974-2006 mean fire return interval: **6.8 years**

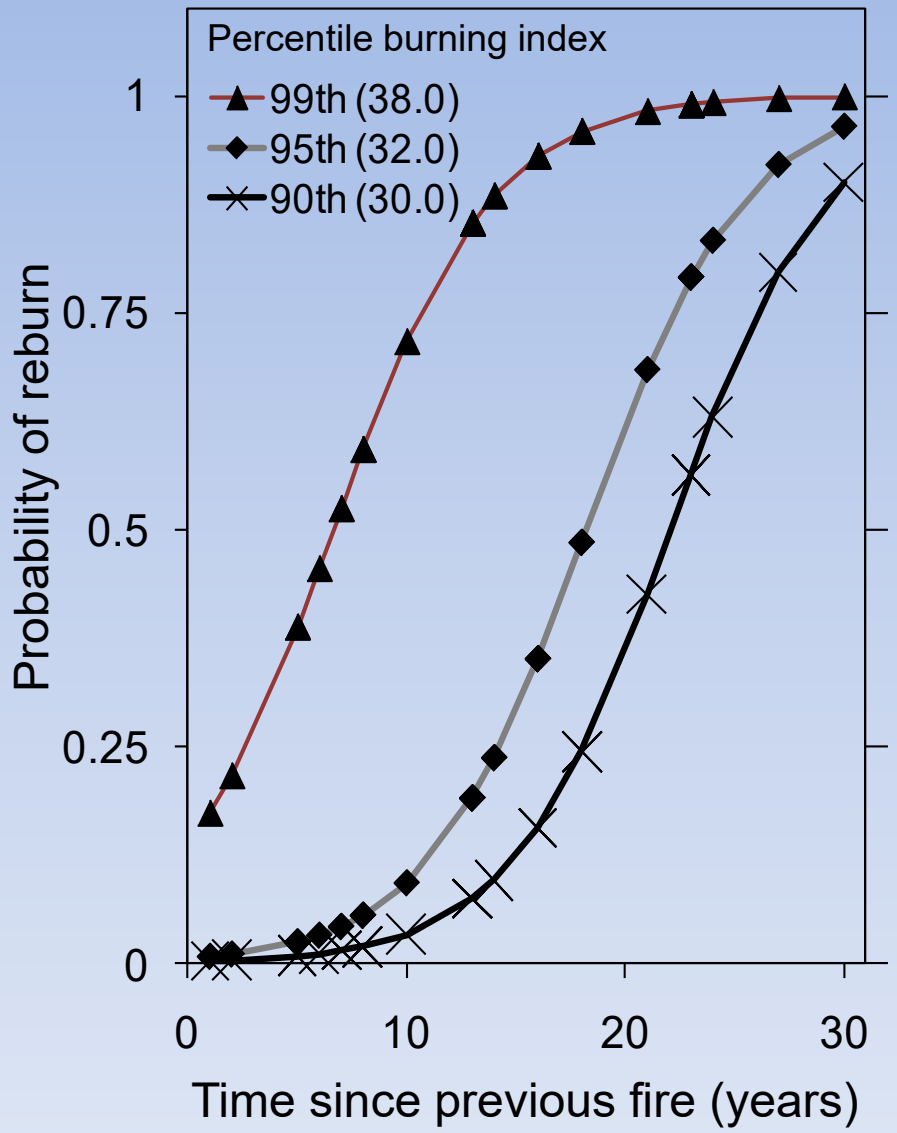
(Collins and Stephens 2007 Fire Ecol.)



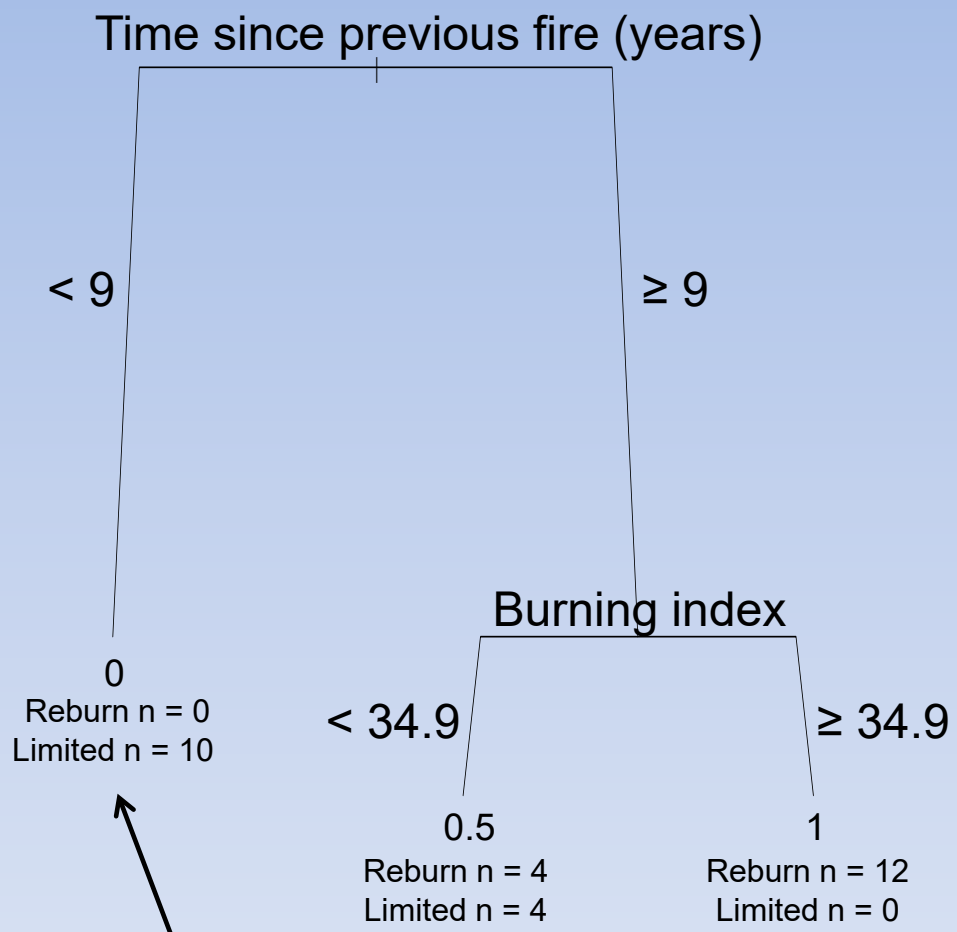

Limited fires
Reburn fires
1
17
7
5
13
30
24
23
27
13
21
23
13
23
Collins et al.
2009
Ecosystems
2001 Hoover fire
1991 Ill fire
1981 Buena Vista fire
Meters
0
1,000
N
2004 Meadow fire
2001 Hoover fire

Interactions between adjacent fires

Logistic regression



Categorical tree



Critical Result

Collins et al., 2009 *Ecosystems*

Landscape-scale variability in vegetation and fire from historical data/accounts

- Historically open, patchy stands with large trees not everywhere
- Evidence of small proportions of stand-replacing fire (5-15%)

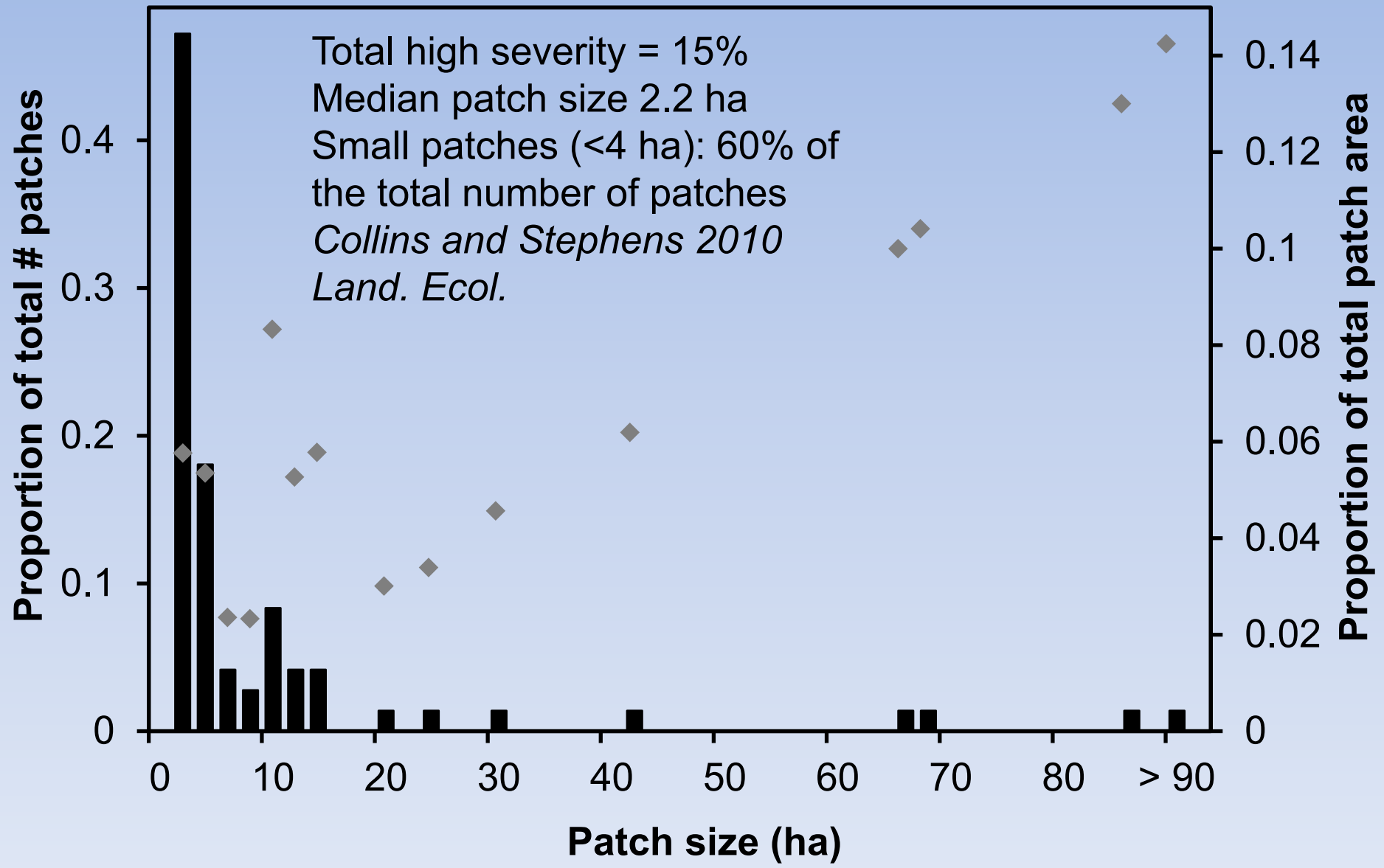
Show and Kotok (1924):

"…no large fires occur without a certain amount of heat-killing"

"This loss, it should be noted, represents the complete or nearly complete wiping out of ***small patches*** of the stand rather than a uniformly distributed loss over the entire area"

High Severity Patch with Forest Recovery

Stand-replacing patches: Hoover (2001) and Meadow (2004) fire (Illilouette Creek basin)



High Severity Fire Patch

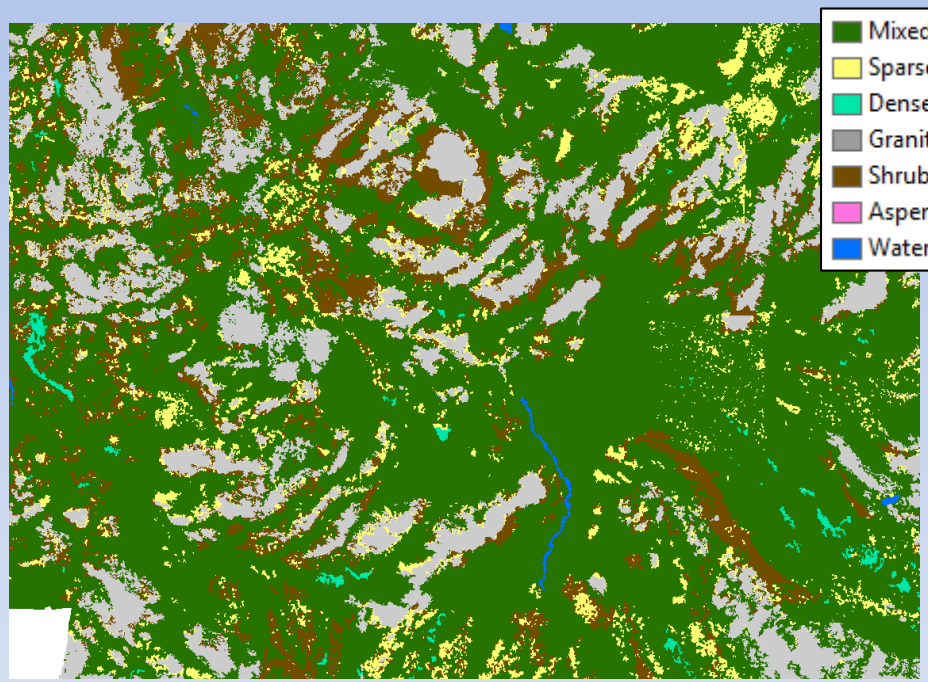
(*Ponisio et al. 2016 Glob. Change Bio.*)

Higher diversity of post-fire vegetation and pollinators

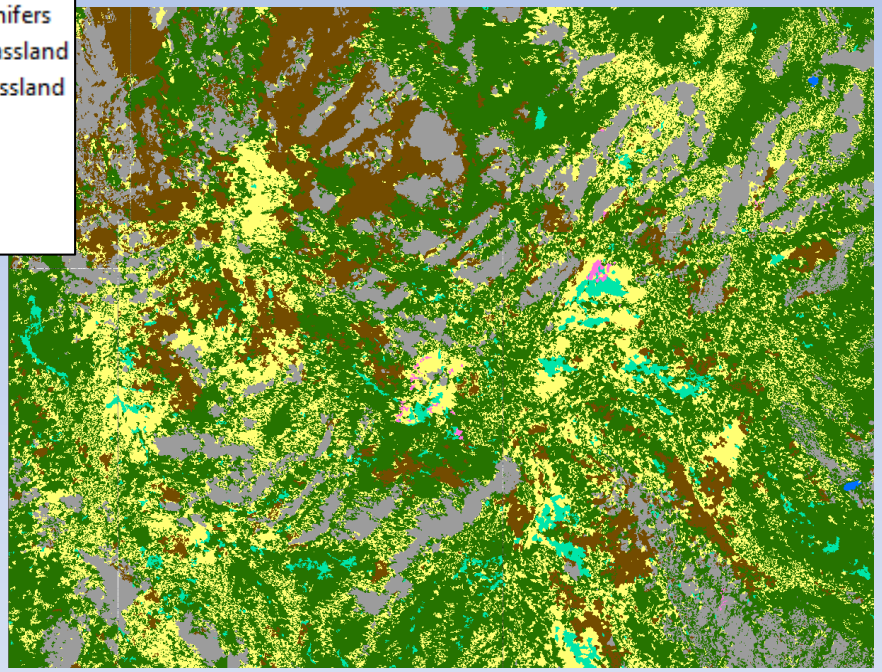
Pyrodiversity buffers pollinator communities against drought-induced floral resource scarcity

Vegetation Change From Photos
Fires Reduced Forest Area by 22%

1970 (1974 1st fire)



2012

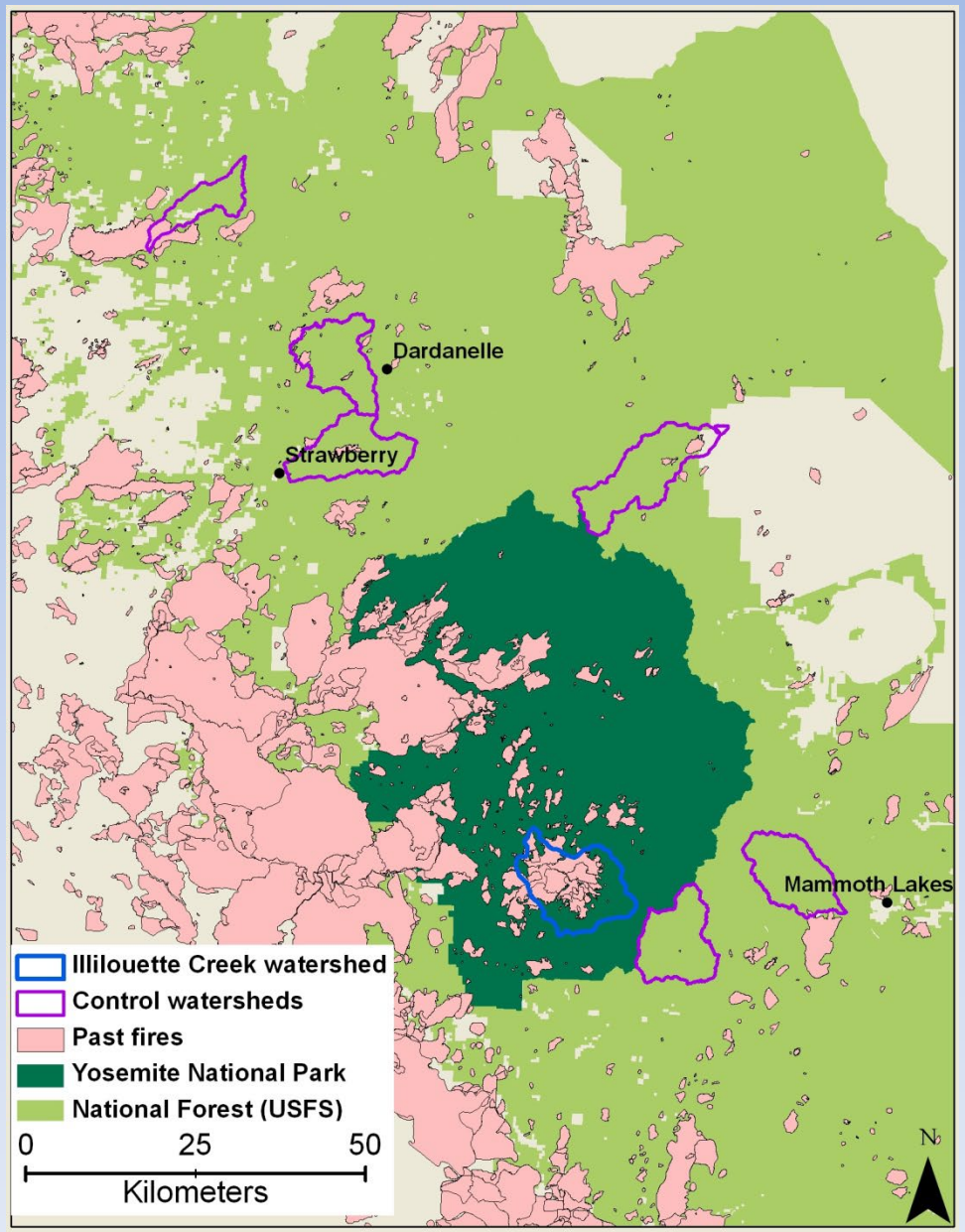


Wet meadows increased by 200%
Dry meadows increased by 200%
Shrublands increased by 30%
Boisramé et al. 2017 For. Ecol. Man.
Stephens et al. 2021 Envir Res Comm

Big Change *in Basins vegetation*

Much more than current restoration treatments

Fire and Water



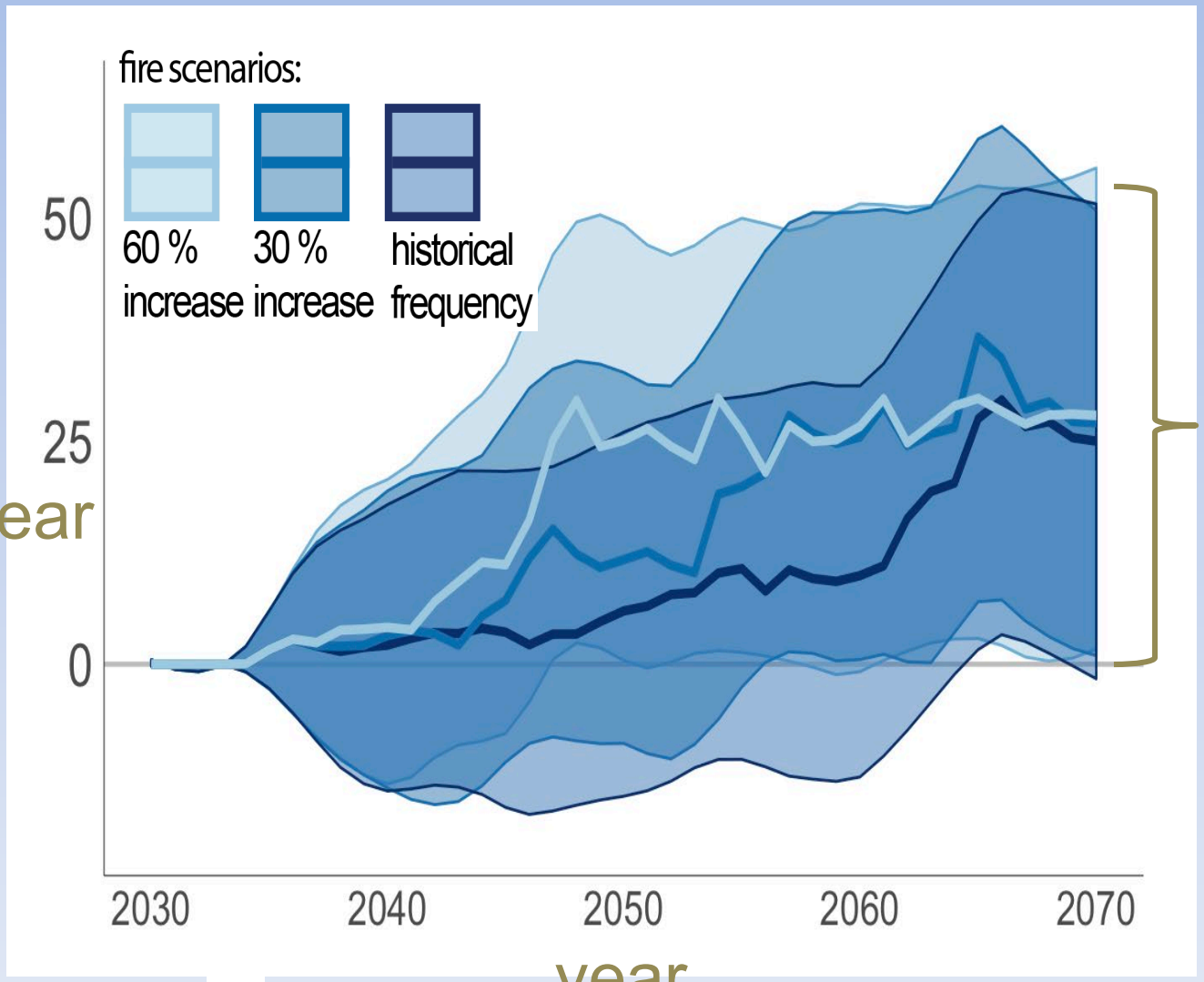
<u>In Yosemite amount of stream water leaving watershed has increased or stable since 1974</u>. Other control watersheds significantly decreased *Boisramé et al.* (2016 Ecosystems, 2019 Water Resources Res)

Soil water storage up, less tree mortality in 2012-2015 drought (*Boisramé et al. 2018,* Advances Water Resources)

Fire severity stable over decades *(Stephens et al. 2021 Envir Res Comm)*

Flood risk unchanged

Future Climate Modeling 2030-2070 + Different Fire Frequencies



Streamflow increase due to fire even with climate change

Rakhmatulina et al. 2021 J. Hydrology

Changing Streamflow Characteristics

Since fire suppression ended…

- Runoff ratio increased or stable
- Duration of spring snowmelt longer
- Soil water increased, less tree mortality in drought
- Stream discharge up modestly, deep storage up

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

<u>Triple Win Possible</u>

Stephens et al. 2021

Conclusion

- California frequent fire forests have big problems
  - Climate change is certainly a factor but fuels and forest structure most critical
    - We have effective options
      - Wildfire, prescribed fire, Indigenous burning, restoration thinning
- California has focused on this issue more since 2016
  - Cal Fire grants for fuels management > $2.6 billion since 2019
  - MOU signed by California Governor and US Forest Service Chief – 1,000,000 acres/yr by 2025
  - California Assembly and Senate focused on problem
  - Federal government > $1.5 billion but need policy reform
    - *Clark et al. 2024 Fire Ecol.*
  - Need workforce, not just fire suppression
    - Current fire suppression workforce could be modified

Conclusion

- Increased streamflow from wildfires in the Illilouette Creek basin should persist in a warming climate
  - Increased streamflow by 19–29 mm/year under 2030–2070 climates (*Rakhmatulina et al. 2021 J. Hydrology)*
  - Rain dominated forest in Yosemite, started similar study this year to work in lower elevation forest

- **Next 1-2 decades absolutely critical in California frequent fire forests**
  - Federal, state, and water agencies work together to increase watershed resilience and outputs
    - Regulatory reform would help (*Clark et al. 2024 Fire Ecol.*)
    - Still hopeful but we need to move decisively
      - Running out of time

Acknowledgements

Jan van Wagtendonk, Sally Thompson, Gabrielle Boisramé, Brandon Collins, Lauren Ponisio, Ekaterina Rakhmatulina, Zachary Steel, Jens Stevens, Kate Wilkin, Tadashi Moody, Danny Fry

Funding from US Joint Fire Sciences Program,
UC ANR Competitive Grants, Cal Fire Research Grant

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