

Historical context for addressing increasing fire activity in the West

The Social-Ecological Consequences of Future Wildfire in the West

Session 1: The Trajectory of Wildfire in the West, National Academies Workshop

13 June, 2024

Philip E. Higuera

Prof. of Fire Ecology

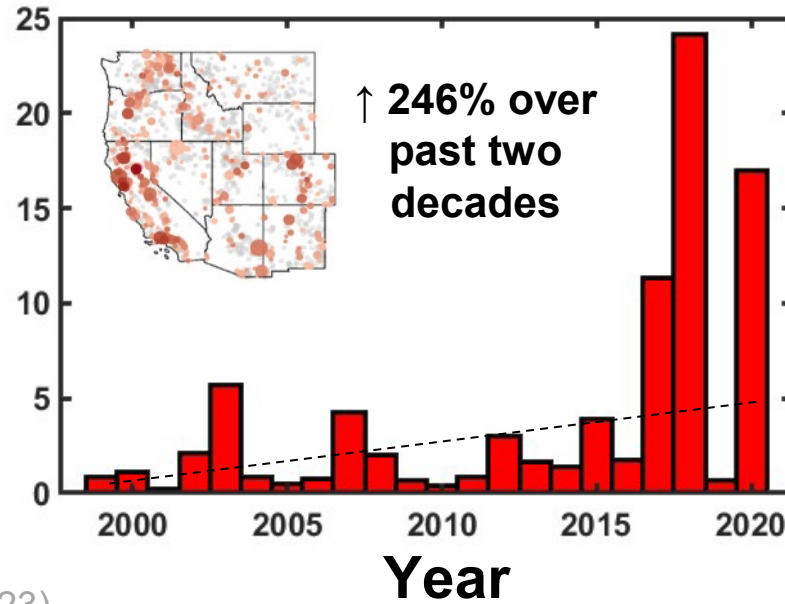
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@PhilipHiguera



Marshall Fire, Dec. 30th, 2021, Boulder Co., CO (Patrick Cullis, NOAA)

**Structures
destroyed
(# x 1000)**



Higuera et al. (2023)

“The United States is experiencing a crisis – a present and future defined by wildfires that are increasingly extreme, vast in scale, and devastating to communities and landscapes.”

- ON FIRE: The Report of the Wildland Fire Mitigation and Management Commission, Sep. 2023

1. History resolve fire regimes,* foundational for understanding and addressing current challenges

*characteristic causes, patterns, and impacts of fire over space & time



Crown-fire in a high-elevation (subalpine) forest in Yellowstone Nat. Park, characterized historically by a high-severity fire regimes (photo: NPS).



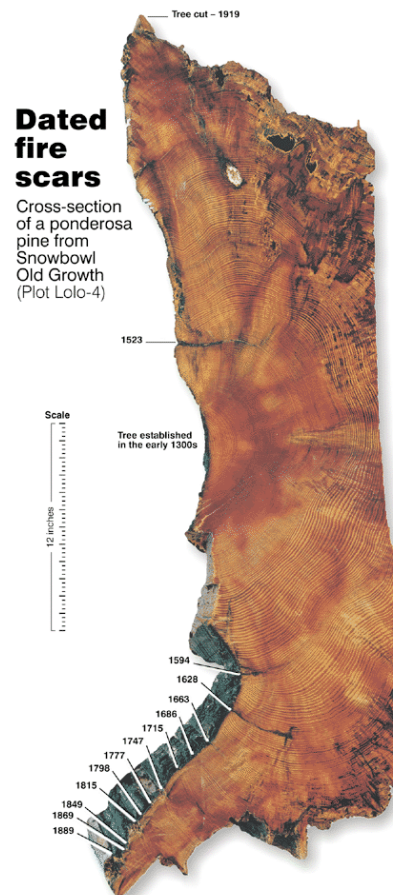
Prescribed surface-fire in a low-elevation (montane) forest in Idaho, characterized historically by a low-severity fire regimes. (P. Higuera).



Home loss from a small, unintentional human-ignited wildfire in Montana. (P. Higuera)

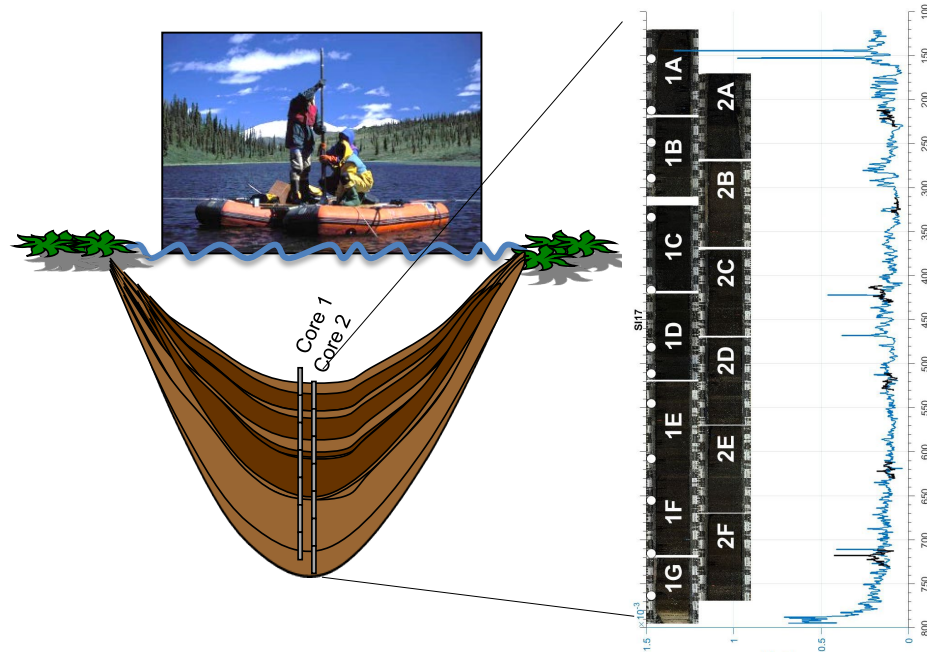
2. Fire history is well resolved across North America from tree rings, lake sediment, +

Tree rings



Emily Heyerdahl, USFS RMRS.

Lake sediments



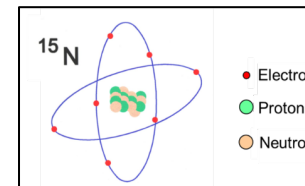
charcoal:



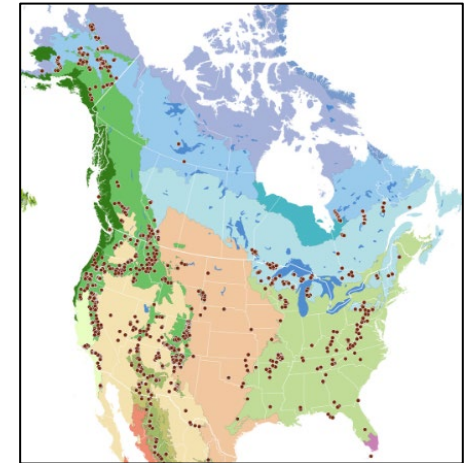
pollen:



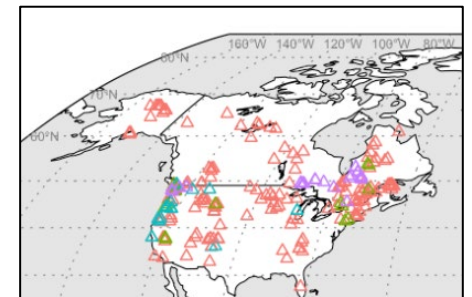
elemental composition:



Networks of sites



N American Fire-scar Tree-ring Network,
Margolis et al. (2022), [Ecosphere](#)



International Paleofire Network,
ipn.paleofire.org

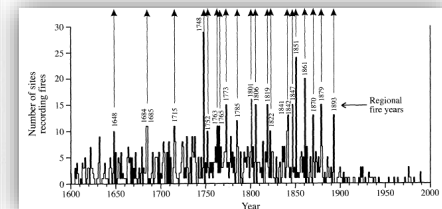
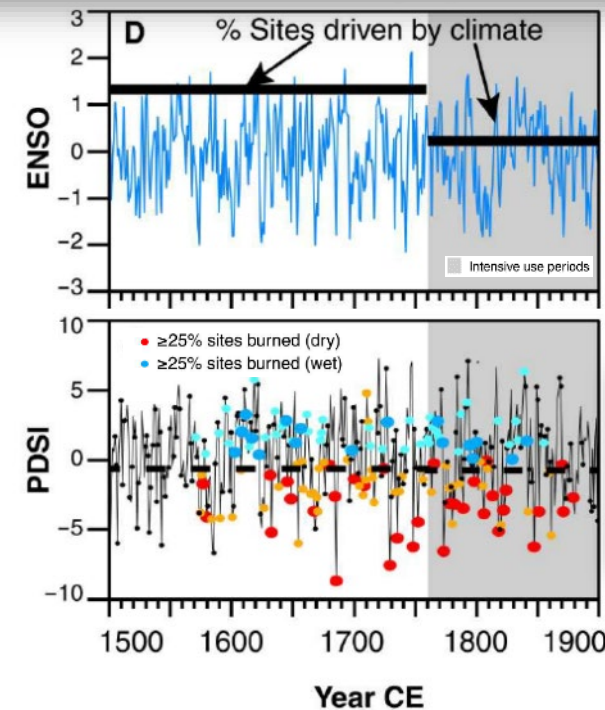
2. History highlights mechanisms of change, and impacts;

- Sensitivity to climate, veg., humans



Indigenous fire management and cross-scale fire-climate relationships in the Southwest United States from 1500 to 1900 CE

Christopher I. Roos^{1*}, Christopher H. Guiterman^{2,3*}, Ellis Q. Margolis⁴, Thomas W. Swetnam⁵, Nicholas C. Laluk⁶, Kerry F. Thompson⁷, Chris Toya⁸, Calvin A. Farris⁹, Peter Z. Fulé¹⁰, Jose M. Iniguez¹¹, J. Mark Kaib¹², Christopher D. O'Connor¹³, Lionel Whitehair¹⁰



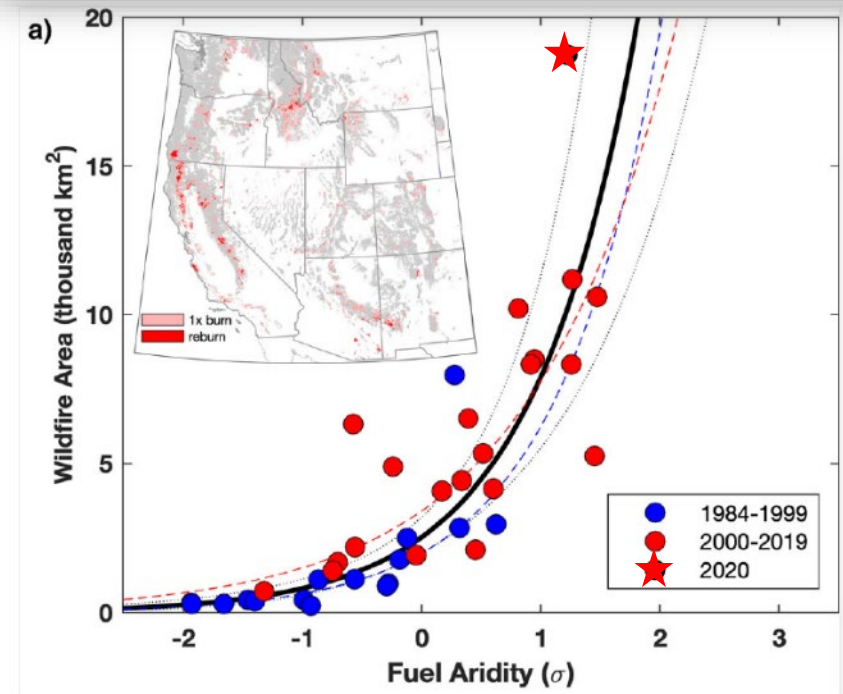
Swetnam et al. (1999)

2. History no longer a possible analog or target for the future

- Sensitivity to climate, veg., humans

Impact of anthropogenic climate change on wildfire across western US forests

John T. Abatzoglou  and A. Park Williams [Authors Info & Affiliations](#)



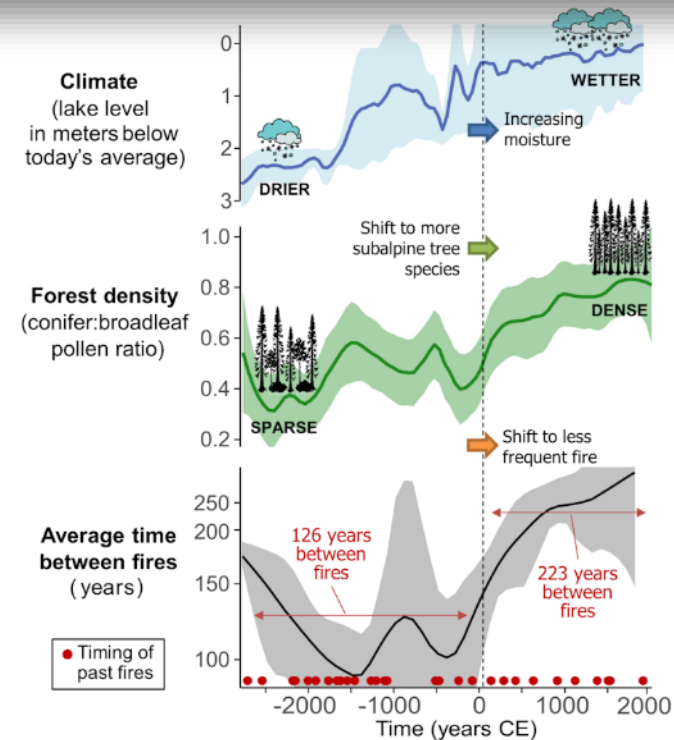
Abatzoglou et al. (2016, 2021), [PNAS](#), [Nature Communication Earth & Environment](#)

2. Understanding the past reveals mechanisms of change and context for today; not necessarily analog or target

- Sensitivity to climate, veg., humans
- Ecosystem impacts, resilience

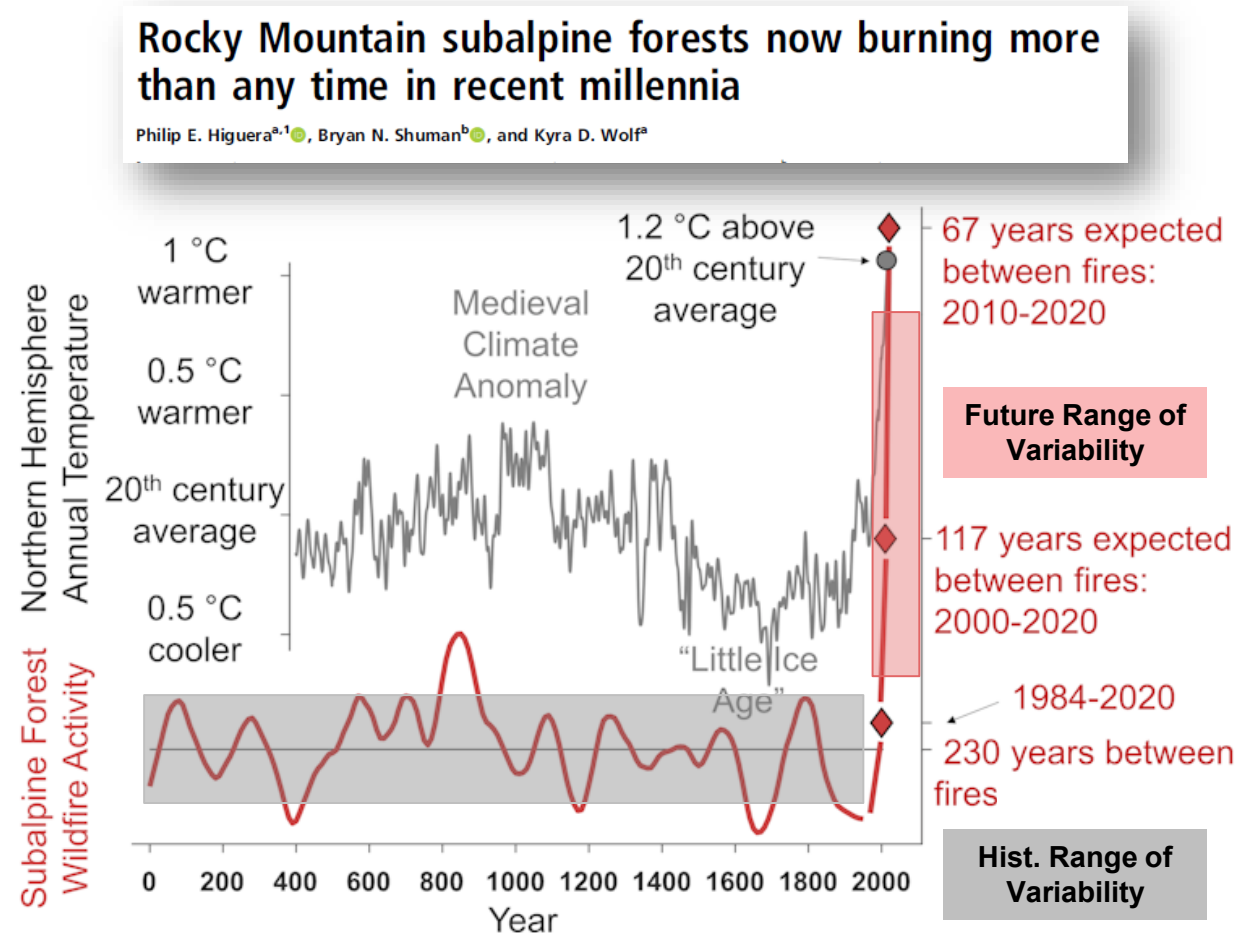
Fire-regime variability and ecosystem resilience over four millennia in a Rocky Mountain subalpine watershed

Kyra D. Clark-Wolf¹ | Philip E. Higuera¹ | Kendra K. McLauchlan² | Bryan N. Shuman³ | Meredith C. Parish⁴



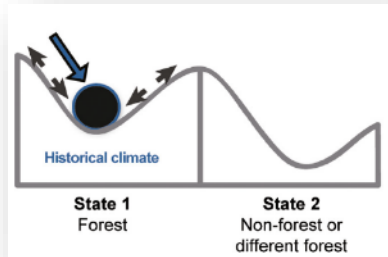
2. Understanding the past reveals mechanisms of change and context for today; not necessarily analog or target

- Sensitivity to climate, veg., humans
- Ecosystem impacts, resilience
- Historical range of variability (HRV)
- Rates of change



Higuera, Shuman, and Wolf (2021), [PNAS](#), [The Conversation](#)

2. Understanding the past reveals mechanisms of change and context for today; not necessarily analog or target



Wildfire activity in northern Rocky Mountain subalpine forests still within millennial-scale range of variability

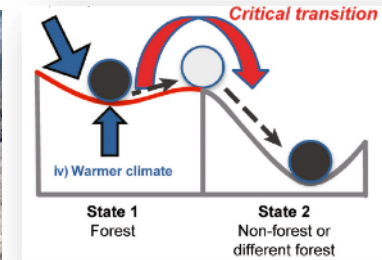
Kyra Clark-Wolf^{4,5,1} , Philip E Higuera¹ , Bryan N Shuman²  and Kendra K McLauchlan³ 
Published 5 September 2023 • © 2023 The Author(s). Published by IOP Publishing Ltd

Mesic mixed-conifer forests are resilient to both historical high-severity fire and contemporary reburns in the US Northern Rocky Mountains

Melissa R. Jaffe^{a,*}, Mark R. Kreider^a, David L.R. Affleck^a, Philip E. Higuera^b, Carl A. Seielstad^c, Sean A. Parks^d, Andrew J. Larson^e

Conifer seedling demography reveals mechanisms of initial forest resilience to wildfires in the northern Rocky Mountains

Kyra Clark-Wolf^{*}, Philip E. Higuera, Kimberley T. Davis



Rocky Mountain subalpine forests now burning more than any time in recent millennia

Philip E. Higuera^{a,1} , Bryan N. Shuman^b , and Kyra D. Wolf^a

Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration

Kimberley T. Davis^{a,1}, Solomon Z. Dobrowski^b, Philip E. Higuera^a, Zachary A. Holden^c, Thomas T. Veblen^d, Monica T. Rother^{d,e}, Sean A. Parks^f, Anna Sala^g, and Marco P. Maneta^h

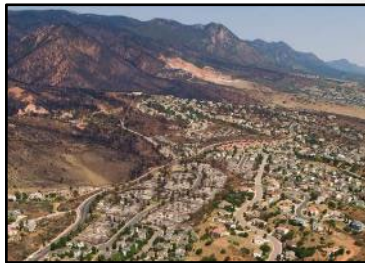
Evidence for declining forest resilience to wildfires under climate change

Camille S. Stevens-Rumman , Kerry B. Kemp, Philip E. Higuera, Brian J. Harvey, Monica T. Rother, Daniel C. Donato, Penelope Morgan, Thomas T. Veblen

3. Fire regimes should be considered as social-ecological phenomena

Shifting social-ecological fire regimes explain increasing structure loss from Western wildfires

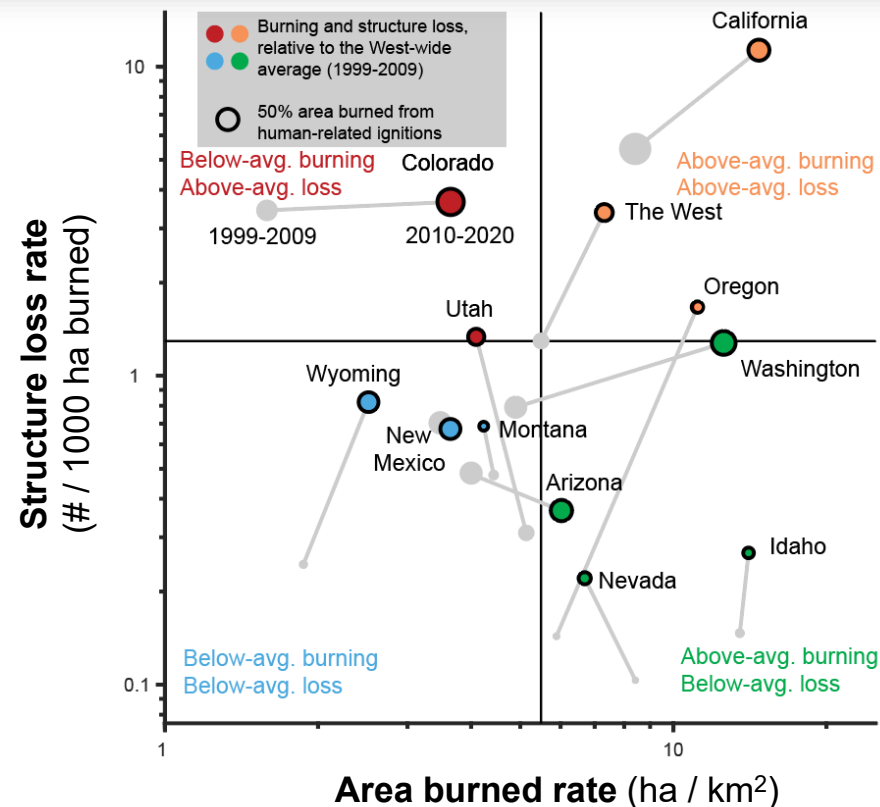
Philip E. Higuera^{ID^{a,*}}, Maxwell C. Cook^{b,c}, Jennifer K. Balch^{b,c}, E. Natasha Stavros^{ID^b}, Adam L. Mahood^{ID^{b,d}} and Lise A. St. Denis^b



2012 Waldo Canyon Fire, CO.
(Kari Greer, "On Fire" report)



2000 Sula Complex Fire, MT.
(John McColgan)



2017 Santa Rosa Fire, CA
(Justin Sullivan/Getty Images)

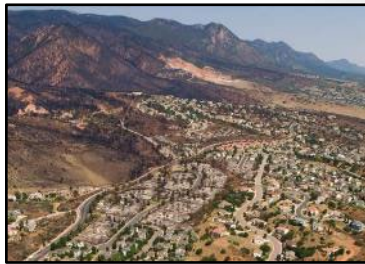


2013 wildfires in the Frank Church Wilderness, ID. (NASA)

3. Fire regimes are changing at different rates, from different causes, across the West

Shifting social-ecological fire regimes explain increasing structure loss from Western wildfires

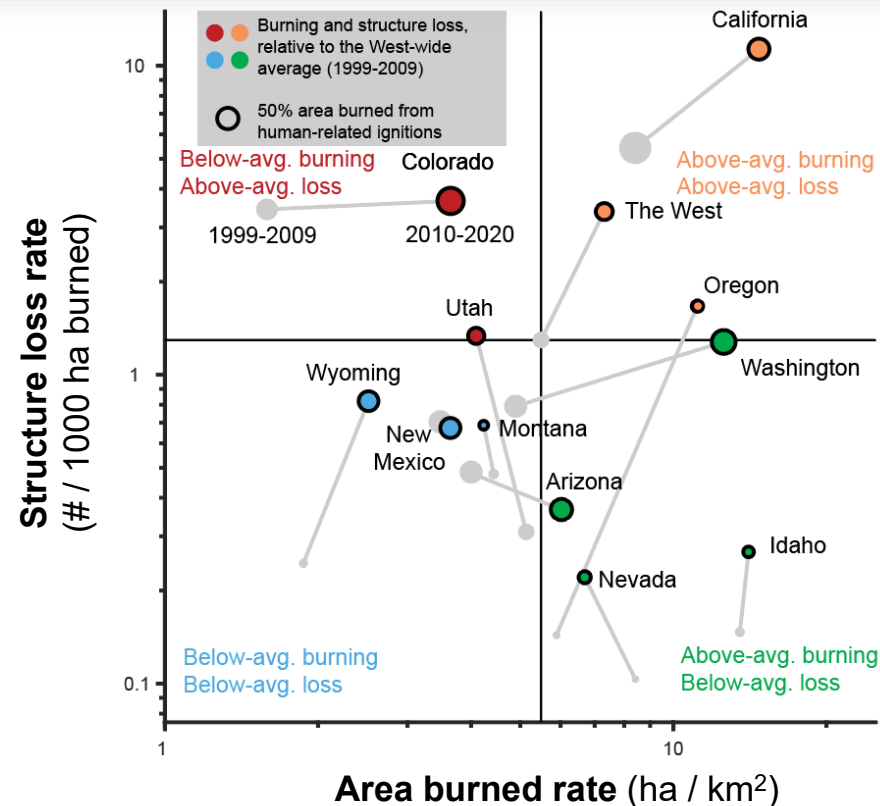
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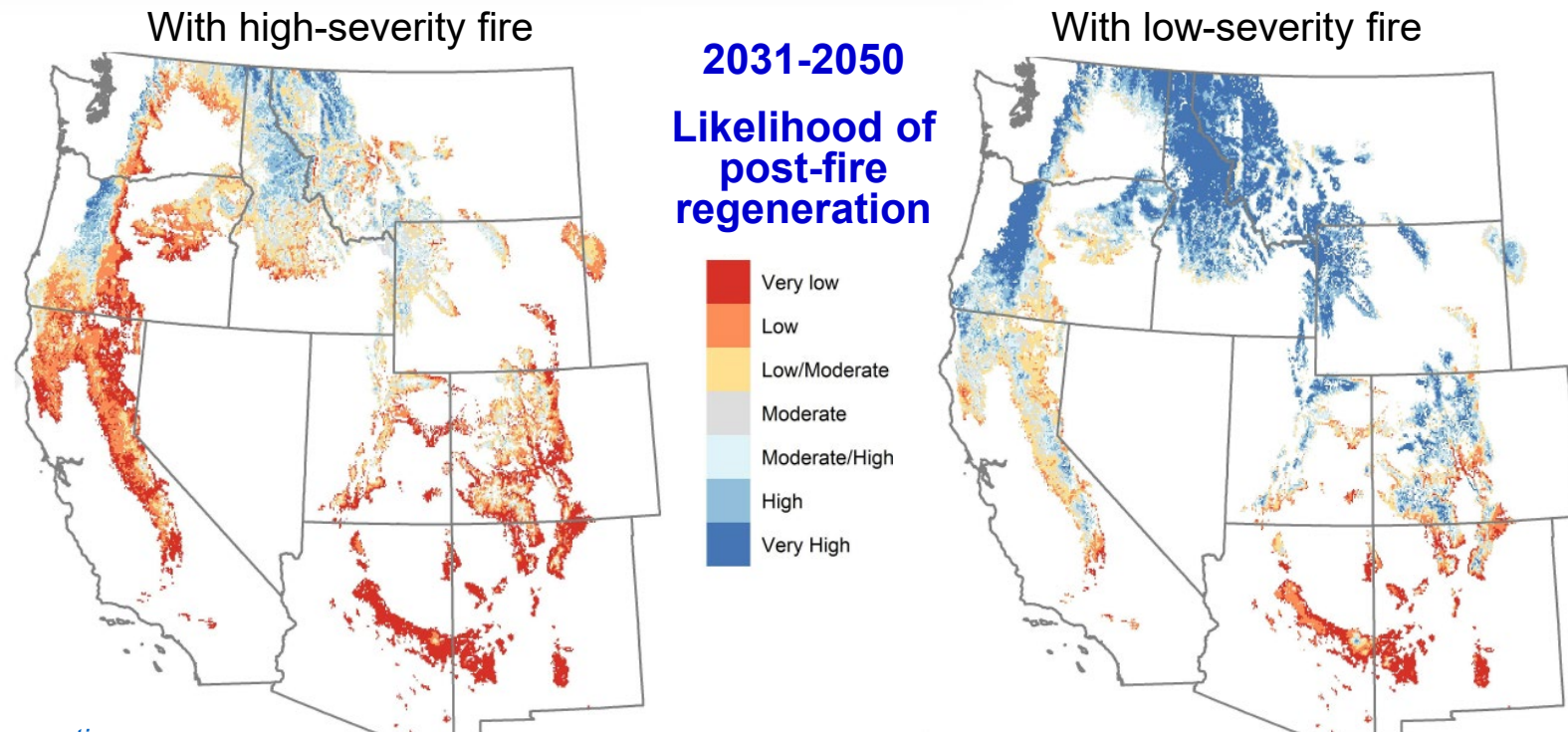


2017 Santa Rosa Fire, CA.
(Justin Sullivan/Getty Images)



2013 wildfires in the Frank Church Wilderness, ID. (NASA)

3. Human can steward change



4. Our relationship with fire is largely reactive, but working to accept, safely live with more fire



“Wildfire is no longer - if it ever was - an issue simply of land management. ... Solutions must...encompass all of society in scope and scale...to change our relationship with fire....”

“In fire-adapted ecosystems, it is critical to dramatically increase both the frequency and scope of beneficial fire to mitigate wildfire impacts to both landscapes and communities.”

Rec. 13 “Establish a prescribed fire target based on natural fire regimes as determined locally”

“On Fire:...” (2023)



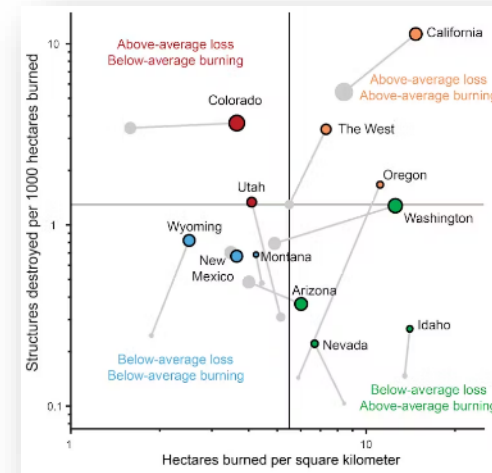
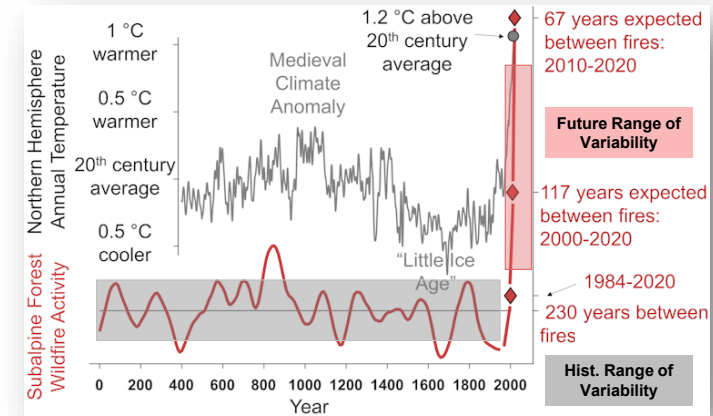
Calkin et al. (2023), [PNAS](#)

“Predominant strategies continue to apply limited, risk-averse reactions that emphasize community protection at the expense of both resilient landscapes and safe, effective wildfire response.”

“Inasmuch as people and communities are implicated in the wildfire problem, so too, are they part of the solution. Federal land-management agencies cannot resolve this crisis alone...”

“We must recognize that our communities [and management systems and approaches] were developed in a climate and environment that no longer exists.”

1. Fire regimes, HRV foundational for context, addressing current challenges
2. Understanding the past reveals mechanisms of change and context for today; not necessarily analogs or targets
3. Fire regimes should be considered as social-ecological phenomena
4. Relationships with fire still largely reactive, but working to accept and plan for living safely with more fire



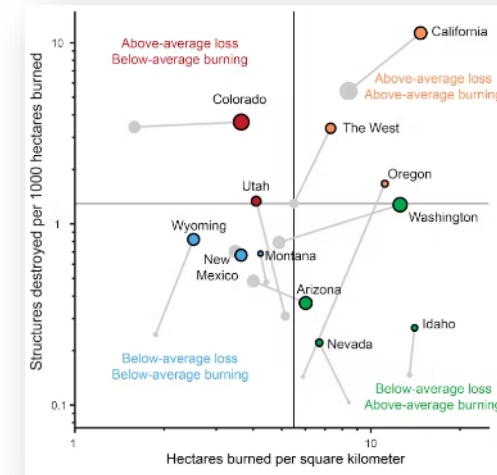
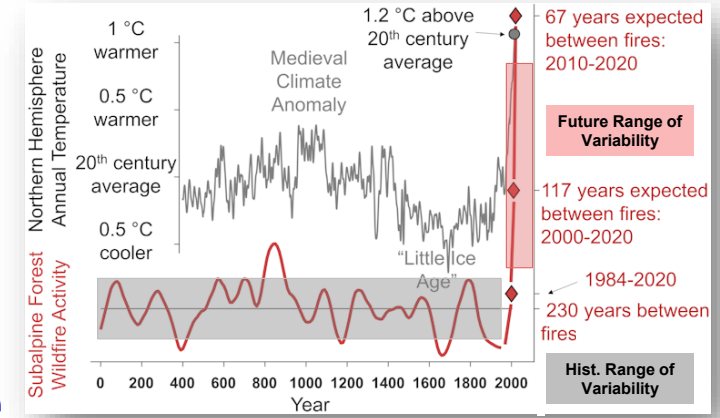
ALTERNATIVE ENDING SLIDE NEXT

1. Recognize the diversity of “fire” and frame current challenges, solutions in context of social-ecological fire regimes

2. Acknowledge and apply lessons from the past, while not simply considering the past as a potential analog or target

3. Understand the varying positive and negative human impacts of “fire”

4. Continue focusing for safely living with more fire, across



END

Historical information to pay attention to

1. Fire is a longstanding social-ecological phenomenon

Natural Phenomenon $\longleftrightarrow$ Human Disaster



Fireweed blooms 10 years after a wildfire in the Selway-Bitterroot Wilderness, Montana. (P. Higuera)



Prescribed fire in montane forests, Idaho. (P. Higuera)

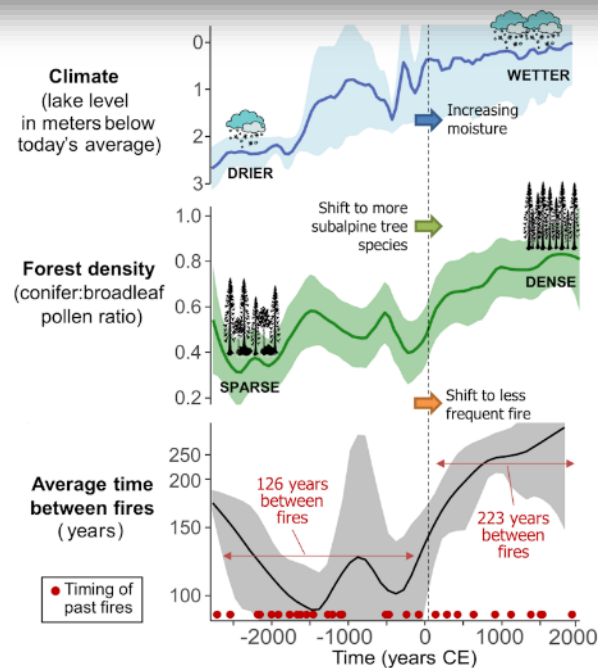


Structures destroyed in the 2021 Boulder 2700 Fire, near Polson, Montana. (P. Higuera)

3. Fire history reveals fundamental mechanisms of change - climate, vegetation, human activity – and context for today

Fire-regime variability and ecosystem resilience over four millennia in a Rocky Mountain subalpine watershed

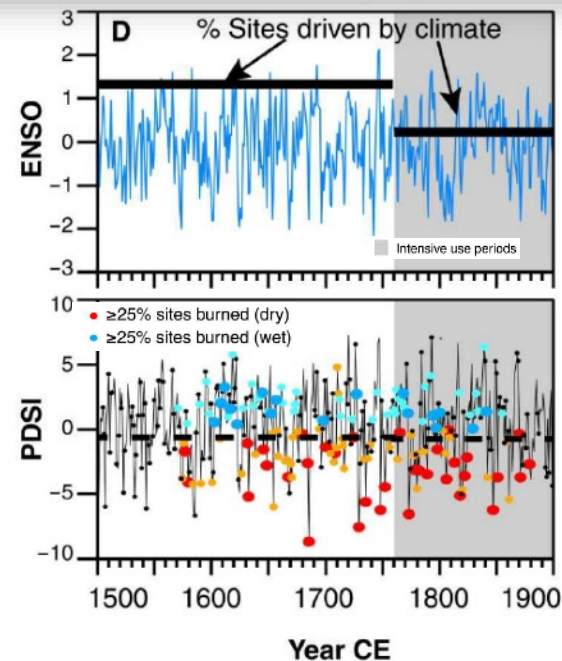
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Clark-Wolf, et al. (2023), [Journal of Ecology](#)

Indigenous fire management and cross-scale fire-climate relationships in the Southwest United States from 1500 to 1900 CE

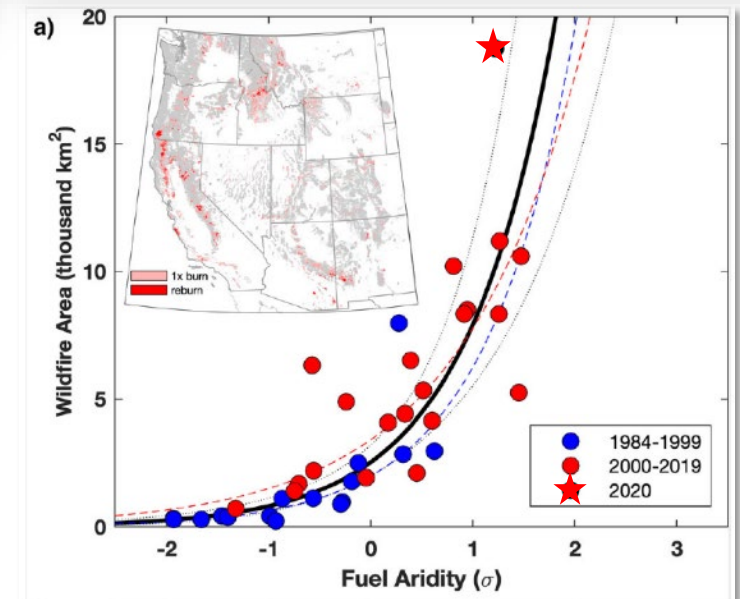
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Roos et al. (2022), [Science Advances](#)

Impact of anthropogenic climate change on wildfire across western US forests

John T. Abatzoglou¹ and A. Park Williams² [Authors Info & Affiliations](#)



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4. History reveals remarkable resilience to fire, over millennia...

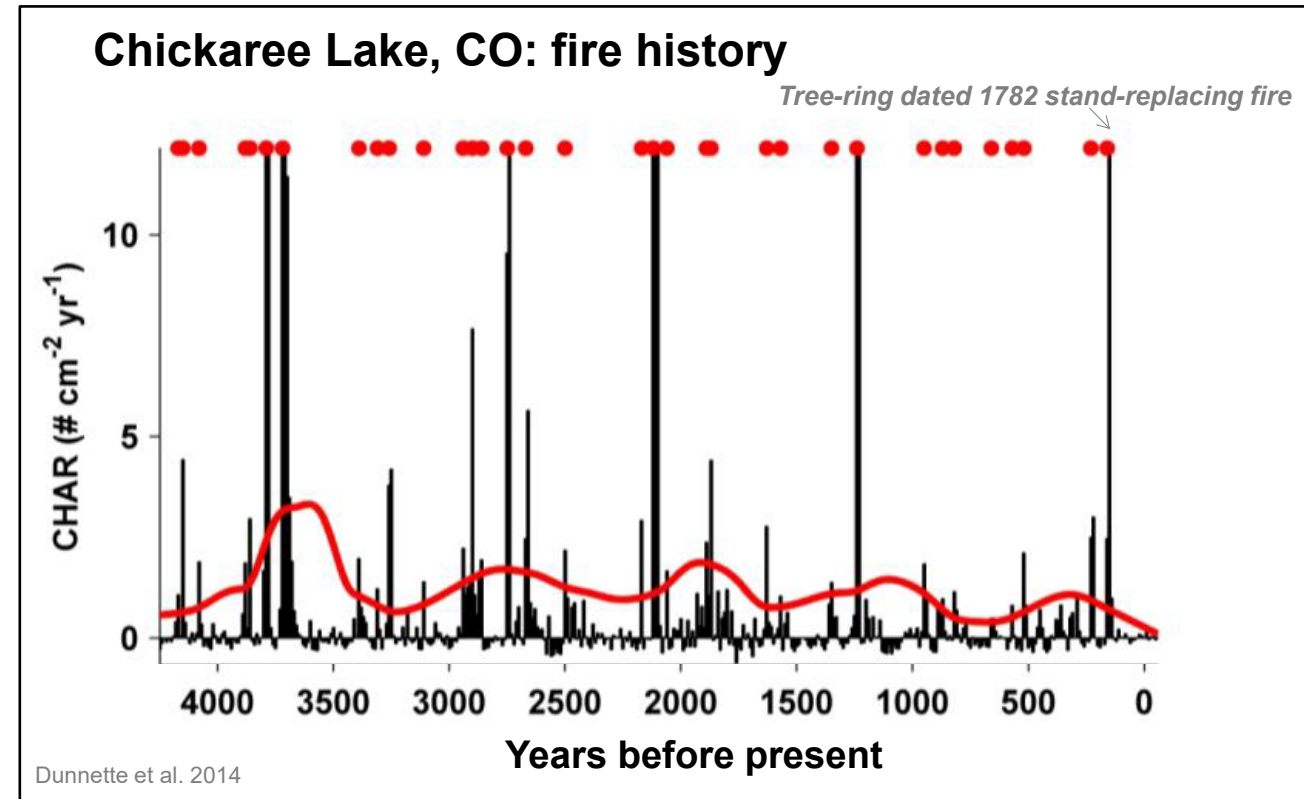
Resilience: “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, and feedbacks”

– Walker et al. 2004

Historical range of variability (HRV):

“ecological conditions and the spatial and temporal variation in these conditions,...within a period of time and geographical area.”

– Landers et al. 1999



4. History reveals remarkable resilience to fire, over millennia...

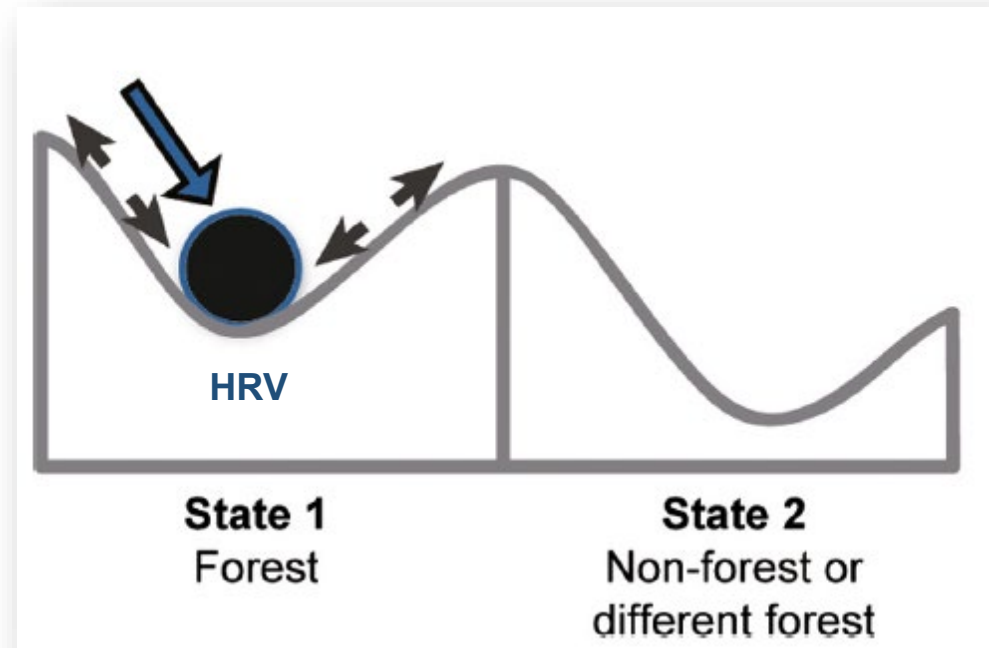
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Johnstone et al. (2016)

4. History reveals remarkable resilience to fire, over millennia...but climate change is moving systems beyond the HRV, compromising resilience.

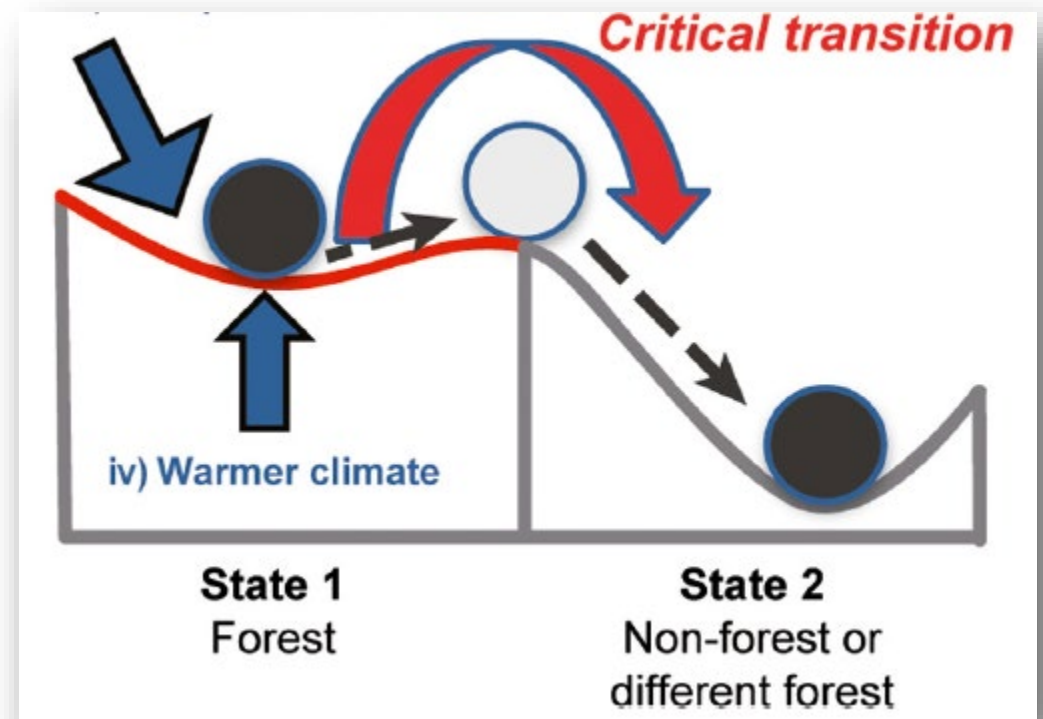
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