Fire and climate change in the West

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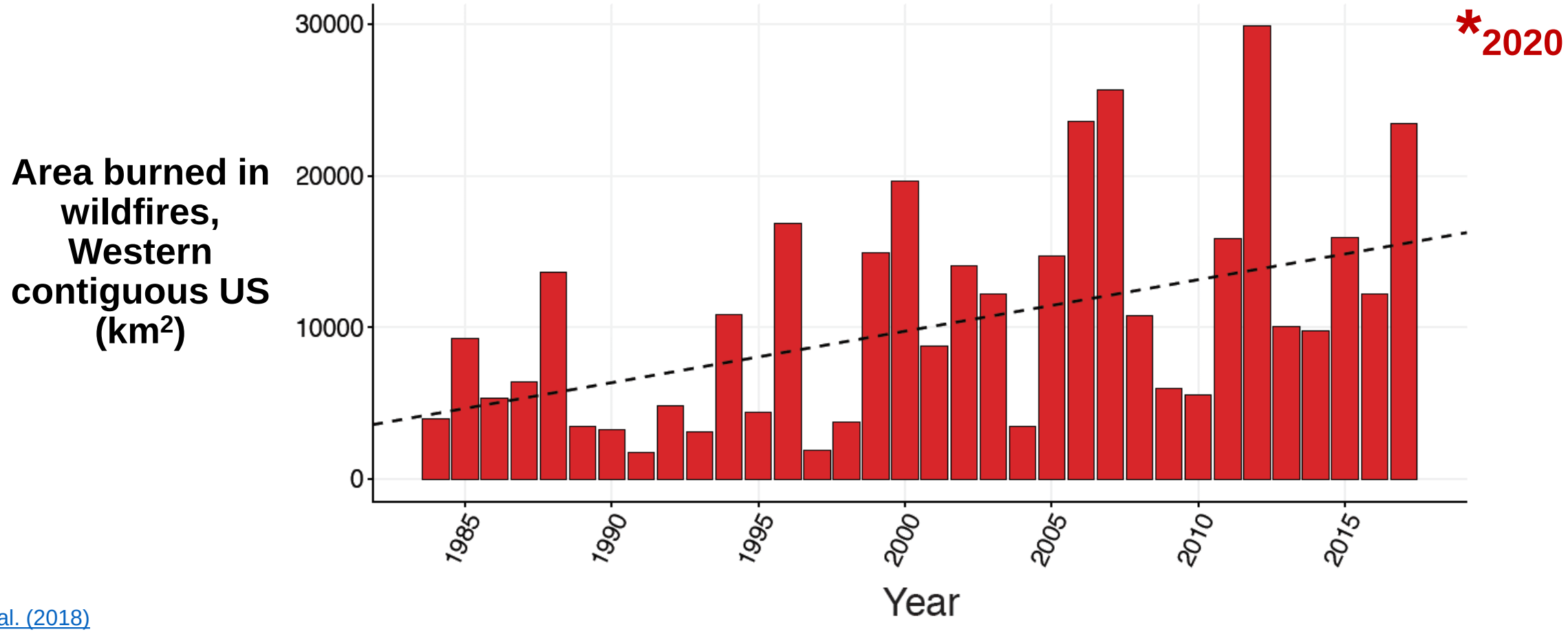
Area burned is increasing

2020 continued the trend of increasing area burned across the West



Balch et al. (2018)

Fire seasons are longer

Fire seasons have lengthened, particularly in the Rockies


PHILOSOPHICAL TRANSACTIONS B

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Research

CrossMark

Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring

Anthony LeRoy Westerling

Sierra Nevada Research Institute, University of California, Merced, 5200 N. Lake Road, Merced, CA 95343, USA

Fire season length:

Region	1973-1982	1983-1992	1993-2002	2003-2012
All	138	166	202	222
Northern Rockies	**49**	**107**	**114**	**134**
Southern Rockies	**31**	**52**	**98**	**117**

Westerling (2016)

More area is burning at high severity

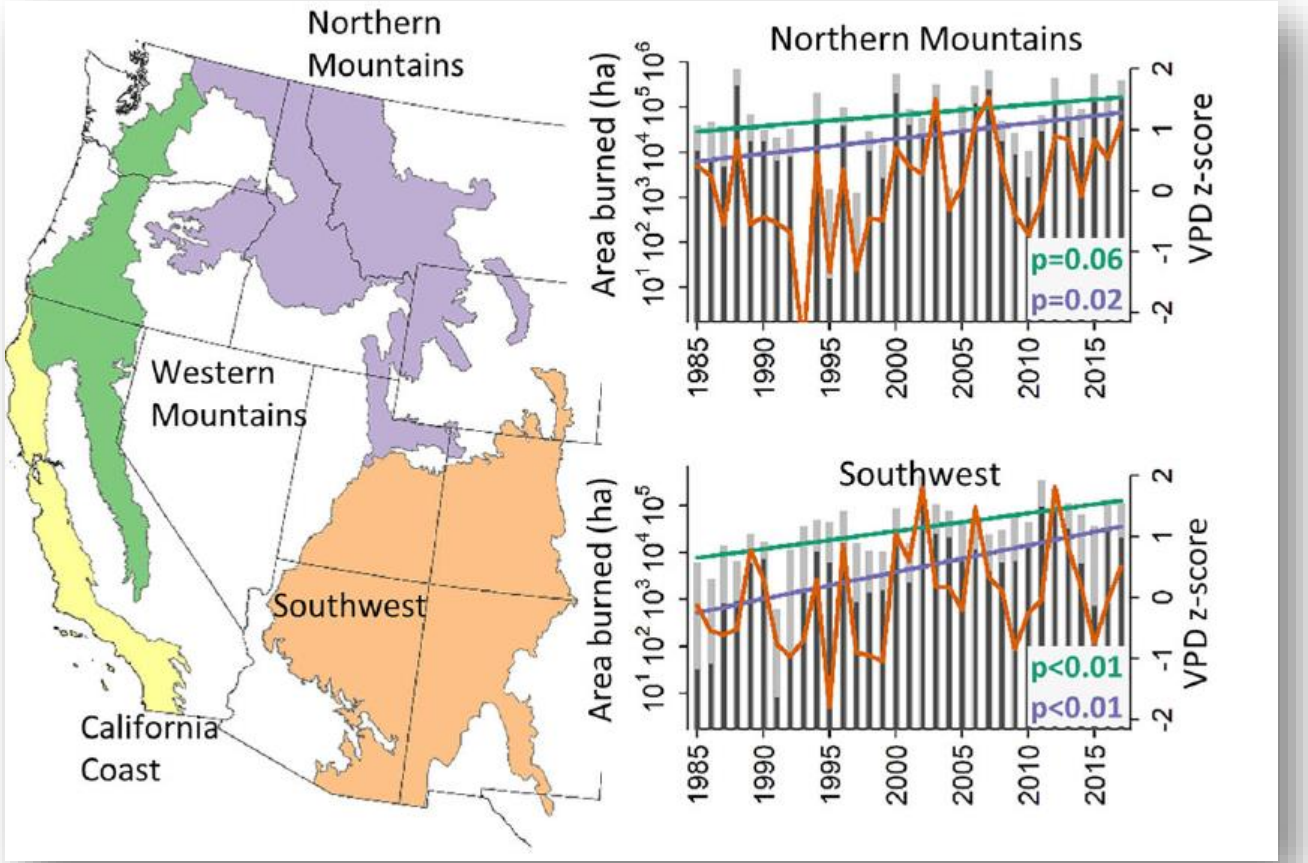
More area burning at high severity

Warmer and Drier Fire Seasons Contribute to Increases in Area Burned at High Severity in Western US Forests From 1985 to 2017

S. A. Parks[1] and J. T. Abatzoglou[2]

Total area burned ↑

High-severity area burned ↑

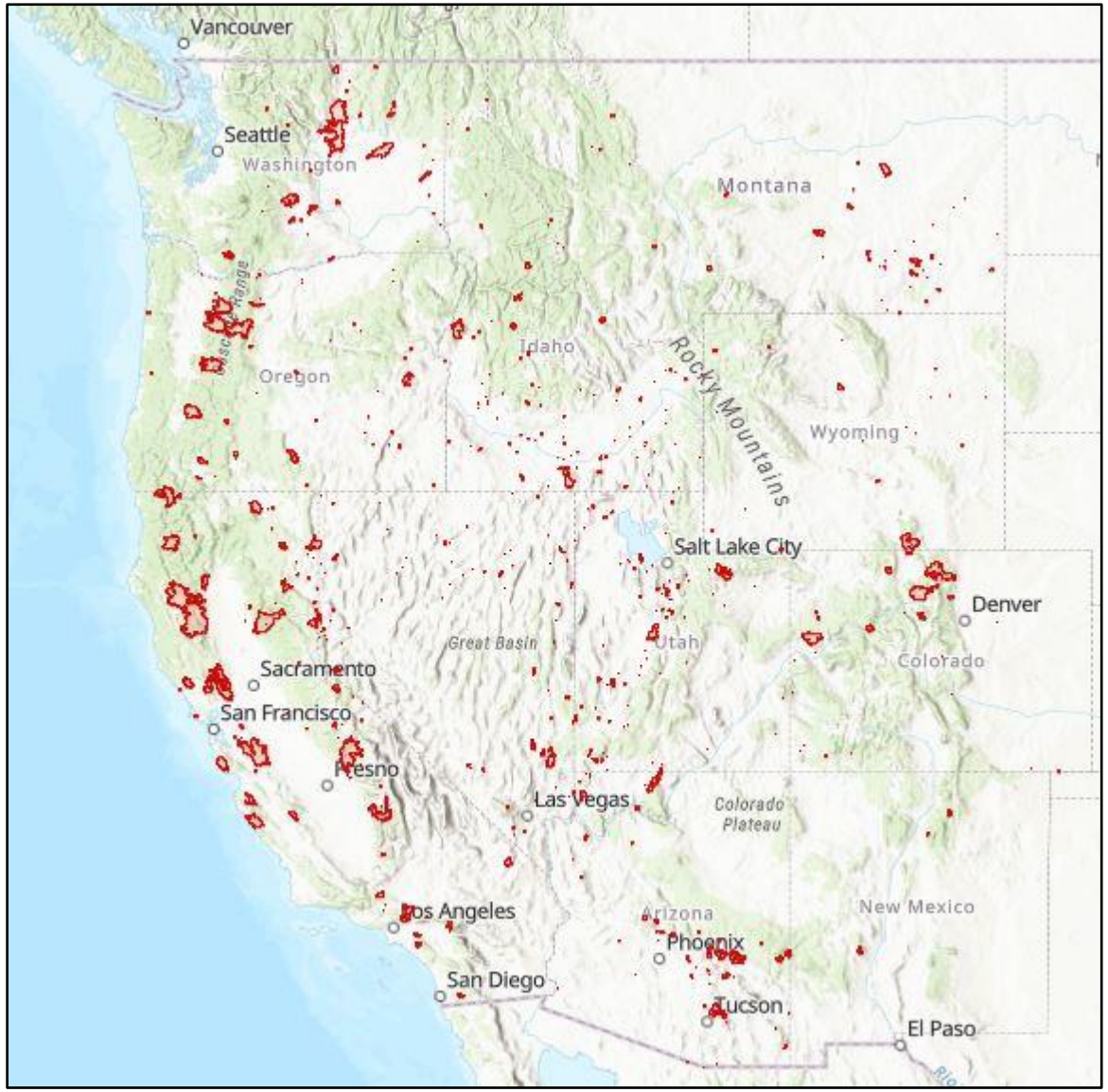


Parks and Abatzoglou (2020)

2020 punctuates recent trends

Record-setting fire activity:

- Over 3 million ha (7.4 million acres)
- Multiple fire-size records broken
- Late-season burning



Area burned in 2020, as of 7 Dec.

2020 punctuates recent trends

Record-setting fire activity:

- Over 3 million ha (7.4 million acres)
- Multiple fire-size records broken
- Late-season burning

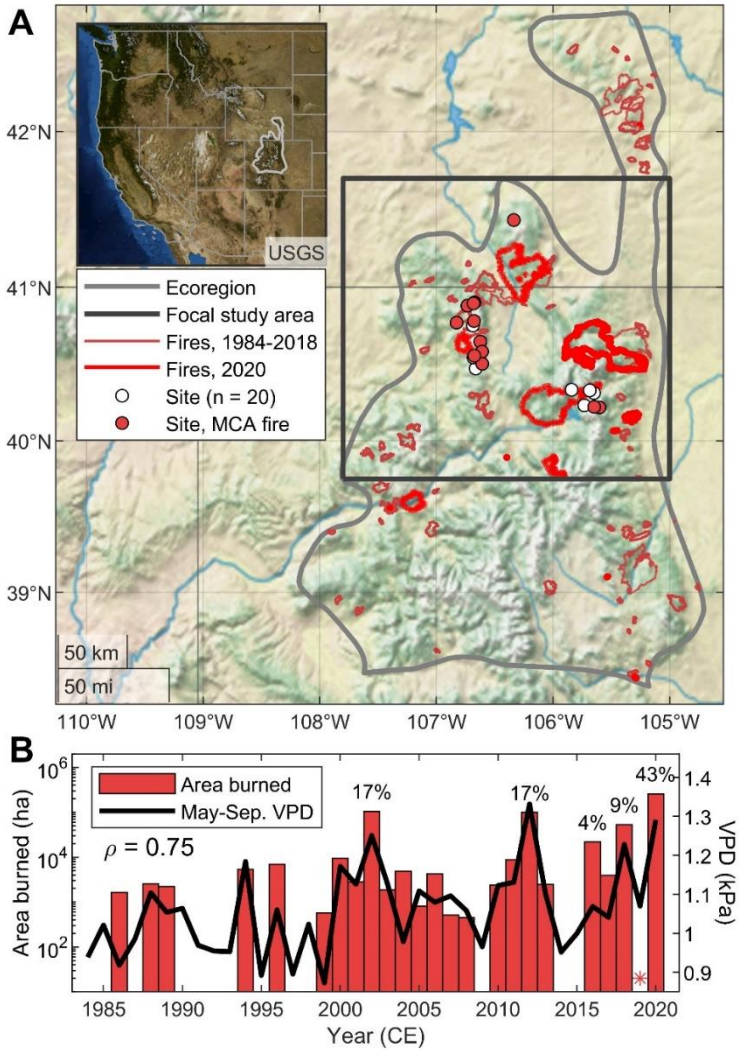
Colorado's East Troublesome Fire, started on Oct. 14, and grew to just under 200,000 acres; 2/3 in just two days, under red-flag conditoins, jumping the Continental Divide at 12,000'.

2020 punctuates recent trends

Record-setting fire activity:

- Over 3 million ha (7.4 million acres)
- Multiple fire-size records broken
- Late-season burning

Colorado subalpine forests now burning more than at any time in past 2000 years



(A) Fire perimeters in the central Rockies of Colorado and Wyoming, and (B) time series of area burned and vapor pressure deficit (VPD), from Higuera, Shuman, and Wolf, submitted.

Key questions

Why is fire activity increasing?

What does this mean for forests?

What can we expect for the future?

What can we do?

Climate is a key driver of annual area burned

Widespread forest fire activity is strongly linked to warm/dry seasonal conditions, across multiple time scales

Climate is a key driver of annual area burned

Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity

MULTI-SEASON CLIMATE SYNCHRONIZED HISTORICAL FIRES IN DRY FORESTS (1650–1900), NORTHERN ROCKIES, USA

Emily K. Heyerdahl,[1,3] Penelope Morgan,[2] and James P. Riser II[1]

Climate and wildfire area burned in western U.S. ecoprovinces, 1916–2003

MULTI-SEASON CLIMATE SYNCHRONIZED FOREST FIRES THROUGHOUT THE 20TH CENTURY, NORTHERN ROCKIES, USA

Penelope Morgan,[1,3] Emily K. Heyerdahl,[2] and Carly E. Gibson[1]

Continued warming could transform Greater Yellowstone fire regimes by mid-21st century

Anthony L. Westerling ... d Michael G.

Large wildfire trends in the western United States, 1984–2011

The Changing Strength and Nature of Fire-Climate Relationships in the Northern Rocky Mountains, U.S.A., 1902-2008

Philip E. Higuera[1]*, John T. Abatzoglou[2], Jeremy S. Littell[3], Penelope Morgan[1]

Medieval warming initiated exceptionally large wildfire outbreaks in the Rocky Mountains

Climate-induced variations in global wildfire danger from 1979 to 2013

W. Matt Jolly[1], Mark A. Cochrane[2], Patrick H. Freeborn[1,2], Zachary A. Holden[3], Timothy J. Brown[4], G...

Long-term perspective on wildfires in the western USA

Jennifer R. Marlon[a,1], Patrick J. Bartlein[b], Daniel G. Gavin[b], Colin J. Long[c], R. Scott Anderson[d], Christy E. Briles[e], Kendrick J. Brown[f], Daniele Colombaroli[g], Douglas J. Hallett[h], Mitchell J. Power[i], Elizabeth A. Scharf[j], and Megan K. Walsh[k]

Impact of anthropogenic climate change on wildfire across western US forests

John T. Abatzoglou[a,1] and A. Park Williams[b]

Decreasing fire season precipitation increased recent western US forest wildfire activity

Zachary A. Holden[a,1], Alan Swanson[b], Charles H. Luce[c], W. Matt Jolly[d], Marco Maneta[e], Jared W. Oyler[f], Dyer A. Warren[b], Russell Parsons[d], and David Affleck[g]

This does not mean humans and veg. are not important

Climate is a key driver of annual area burned

Global Change Biology

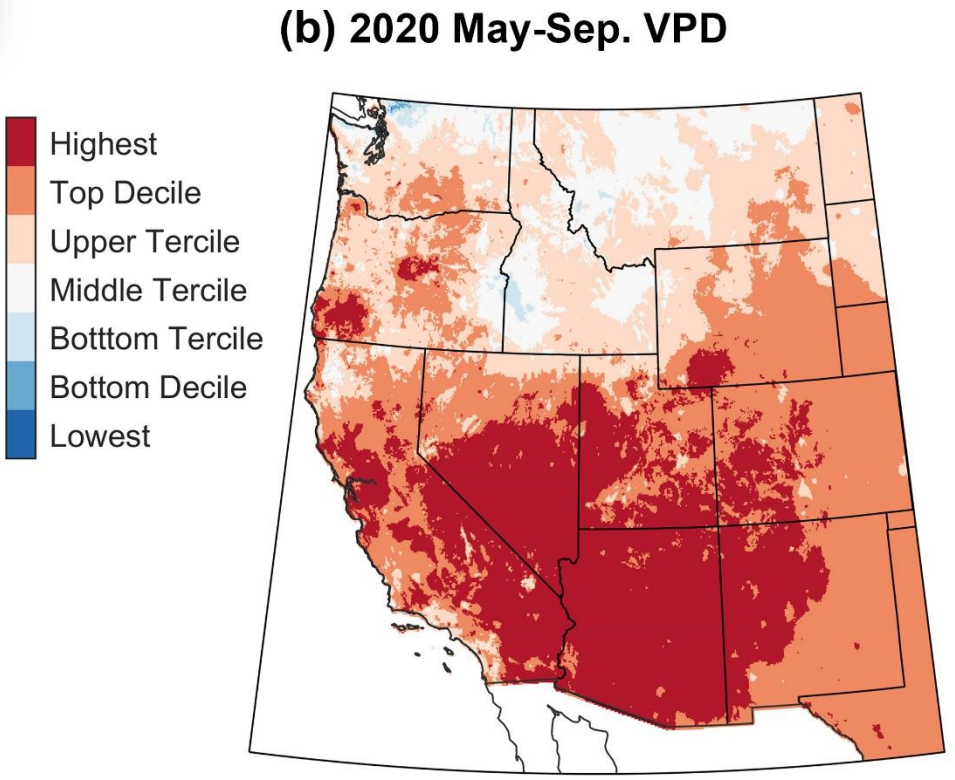
LETTER TO THE EDITOR | Free Access

Record-setting climate enabled the extraordinary 2020 fire season in the western United States

Philip E. Higuera, John T. Abatzoglou

First published: 13 October 2020 | https://doi.org/10.1111/gcb.15388

2020 exemplifies climate-driven trends in increased area burned across the West



https://disasterresponse.maps.arcgis.com/

Higuera and Abatzoglou (2020)

Climate is a key driver of annual area burned

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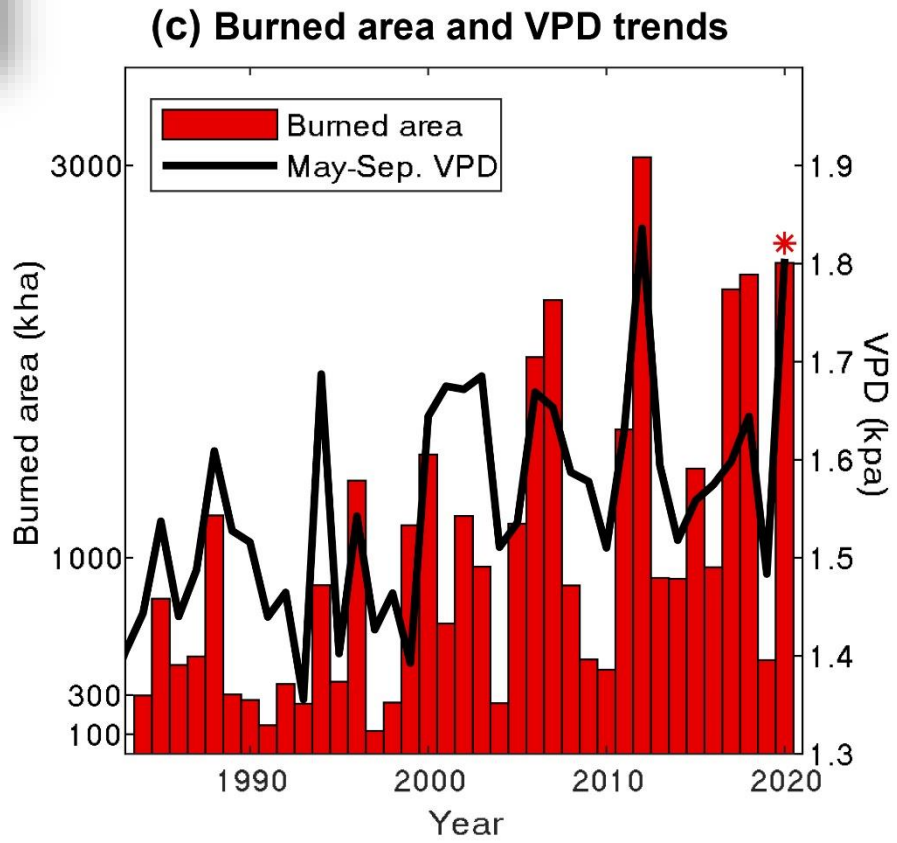
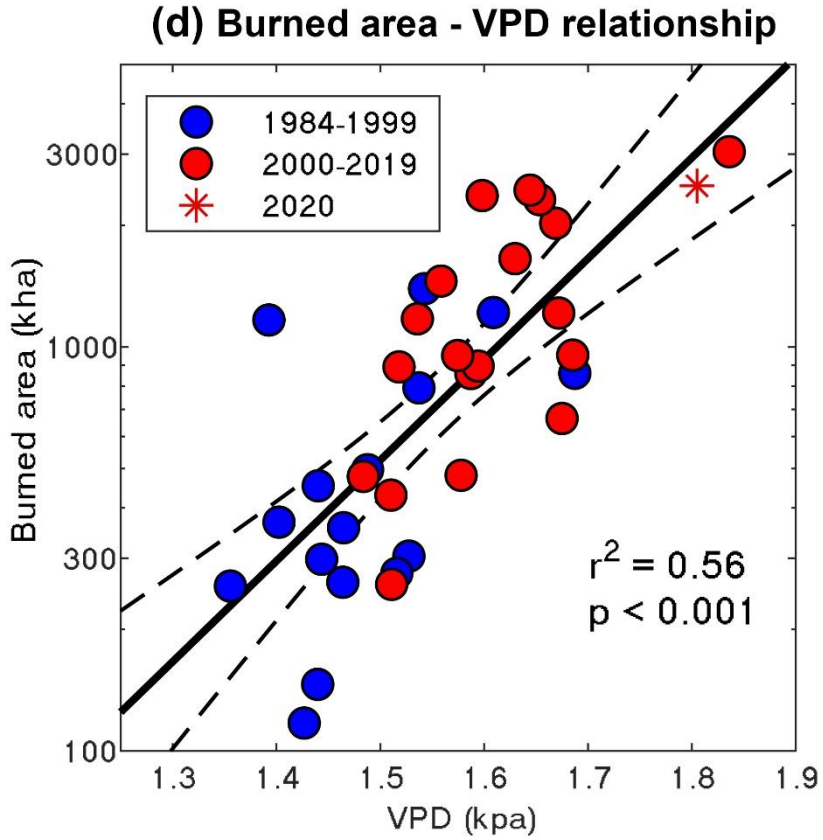




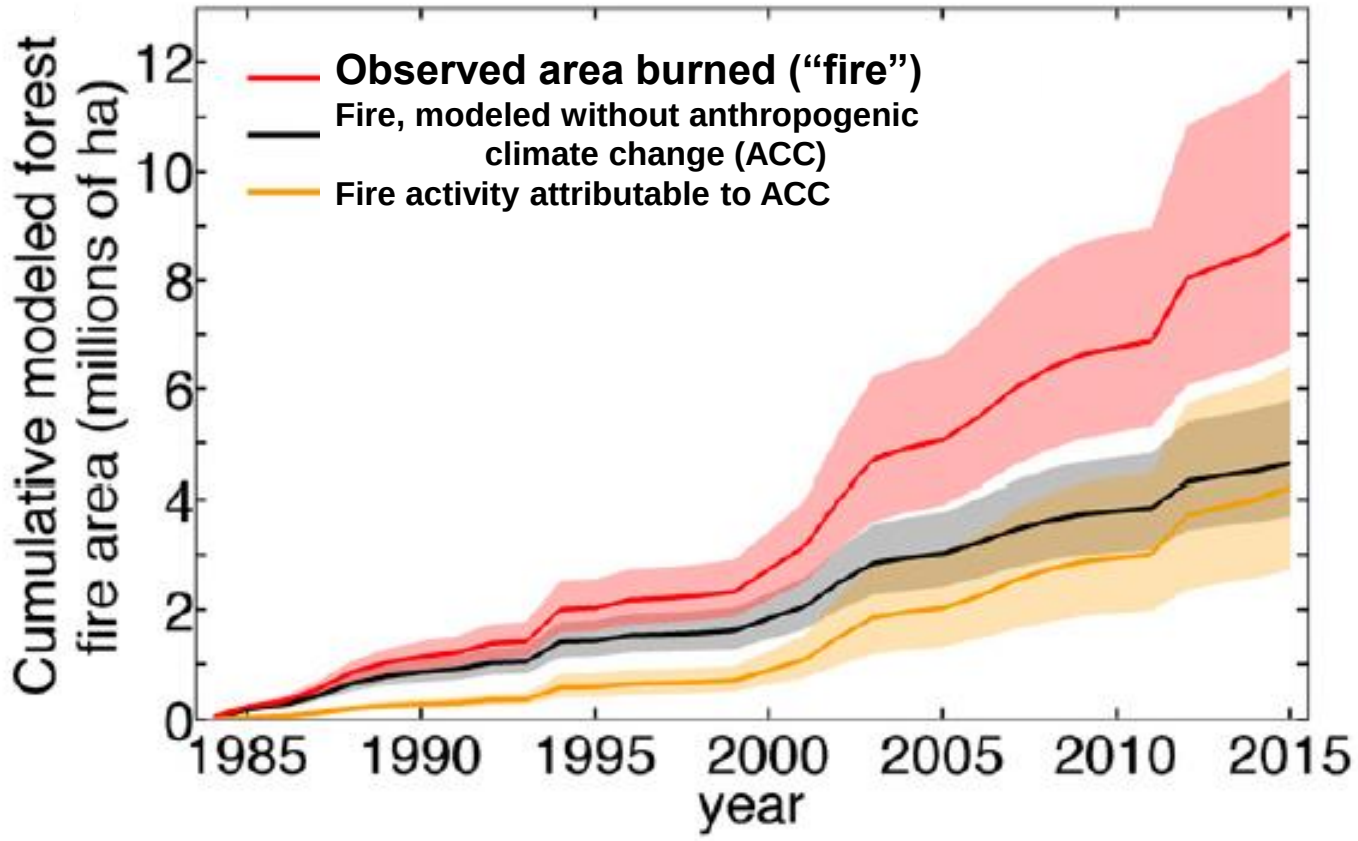
Higuera and Abatzoglou (2020)

Human-caused climate change is increasing fire activity

Impact of anthropogenic climate change on wildfire across western US forests

John T. Abatzoglou[a,1] and A. Park Williams[b]

[a]Department of Geography, University of Idaho, Moscow, ID 83844; and [b]Lamont–Doherty Earth Observatory, Columbia University, Palisades, NY 10964



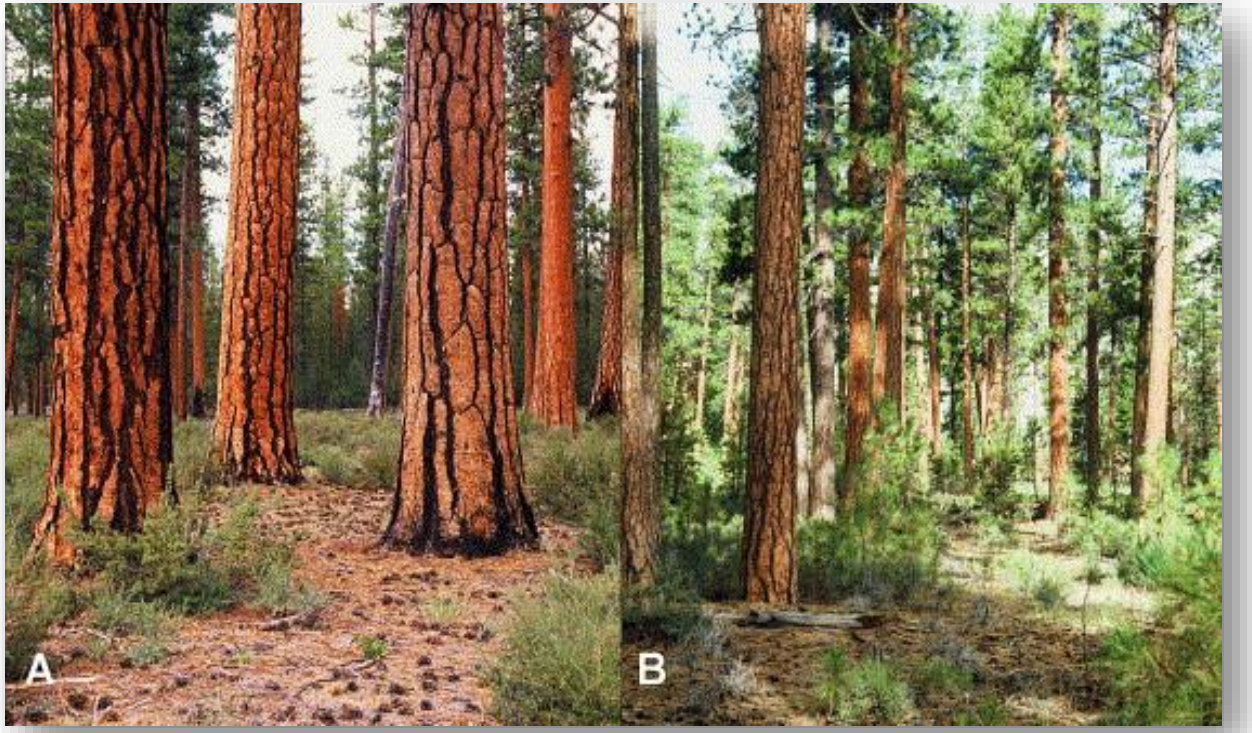
Anthropogenic climate change accounts for ~45% of the total forest area burned from 1984-2015

Abatzoglou and Williams (2016), PNAS

Land use exacerbates climate-driven trends

Fire suppression removes critical ecosystem services and alters future fire behavior

Fuel accumulation across many low- and mid-elevation ecosystems exacerbates climate-driven trends



Hessburg et al. (2005)

Key questions

Why is fire activity increasing?

What does this mean for forests?

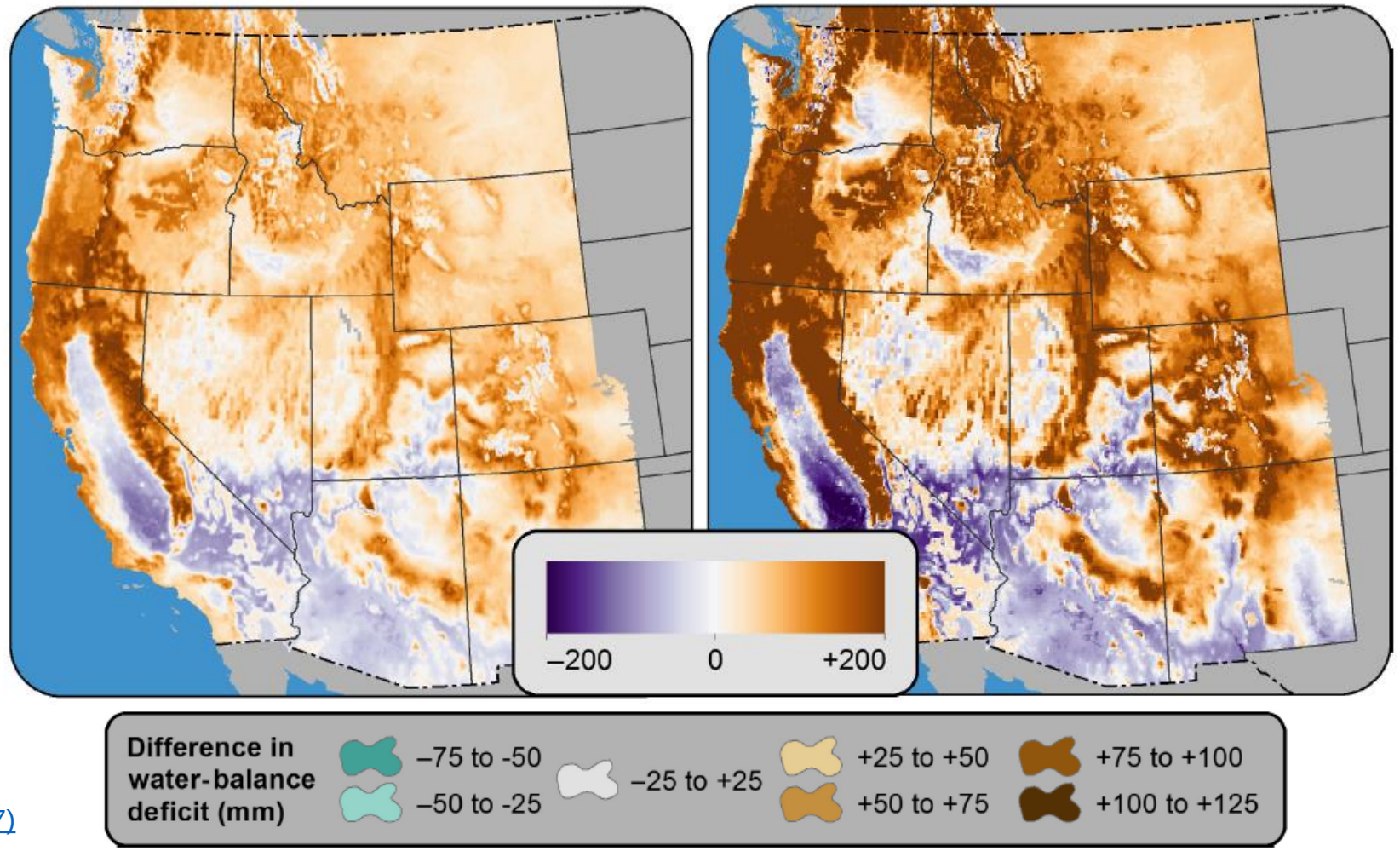
What can we expect for the future?

What can we do?

Evidence strongly suggests more fire in our future

Water deficit will increase over 21st century

2040s: **2080s:**

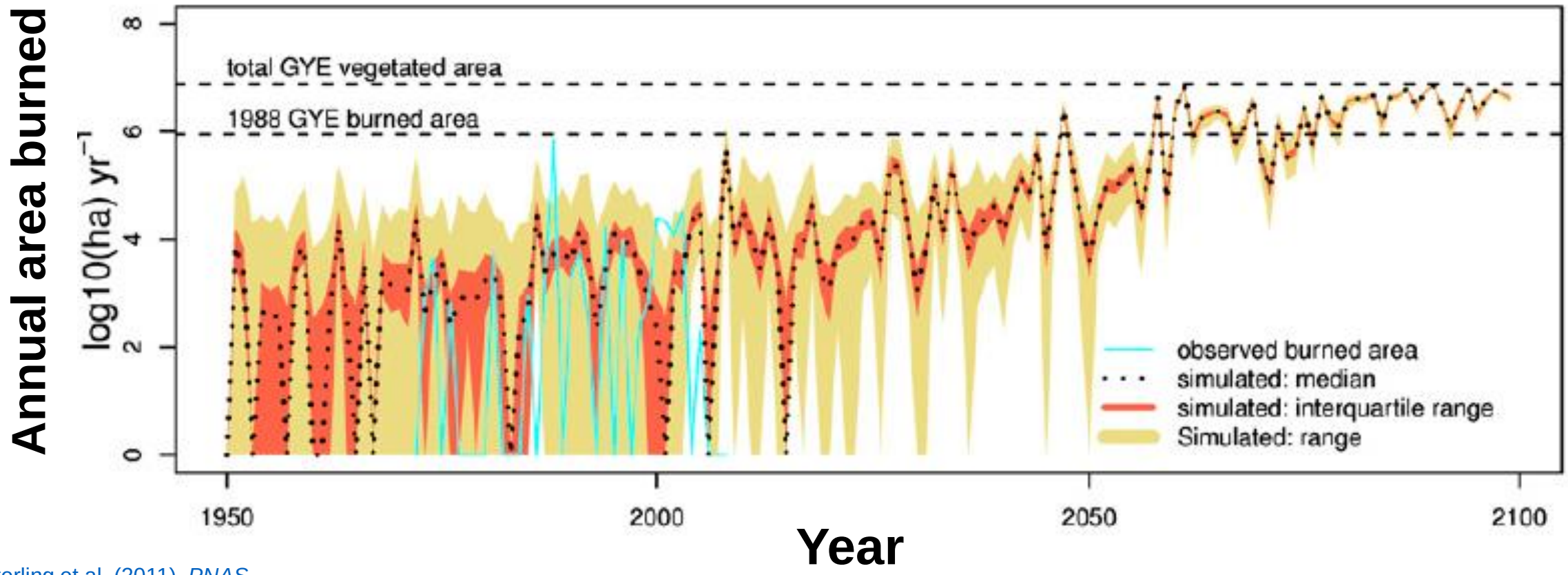


McKenzie and Littell (2017)

Evidence strongly suggests more fire in our future

Greater climate suitability for fire:

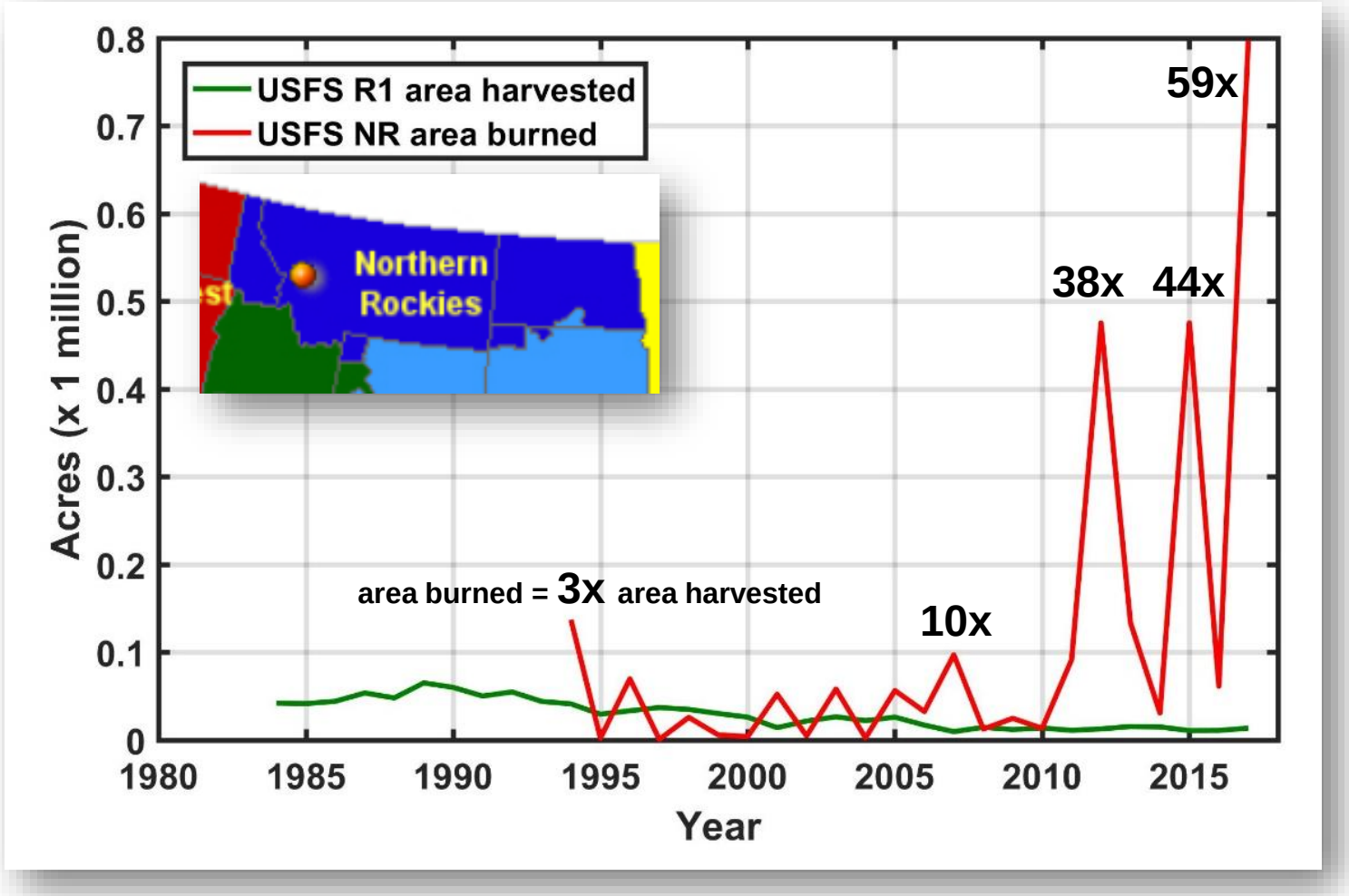
More years like 2020; shorter fire-free periods; higher severity fires



Westerling et al. (2011), *PNAS*

Fire will be the dominant “treatment”

Fire will be the dominant “treatment” on federally managed forests

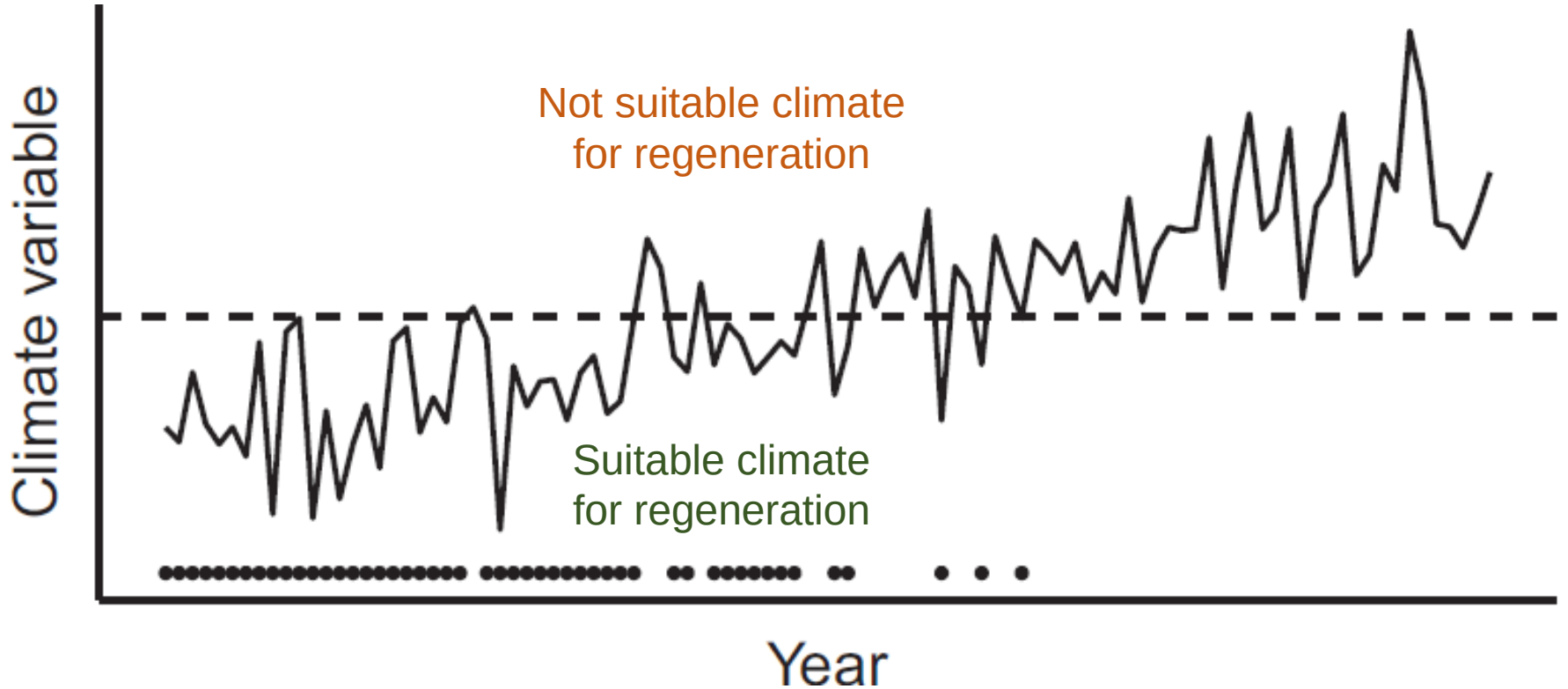


https://www.fs.fed.us/forestmanagement/products/cut-sold/
https://gacc.nifc.gov/nrcc/predictive/intelligence/ytd_historical/ytd_historical.htm

Climate and fire will change landscapes

Lower climate suitability for tree regeneration:

No or slower regeneration; lower density forests; changing spp. composition



Davis et al. (2019), *PNAS*

Changes will appear surprising and rapid

Non-linear relationships will lead to rapid changes and high variability across space and time

DOI: 10.1111/geb.12872

RESEARCH PAPER

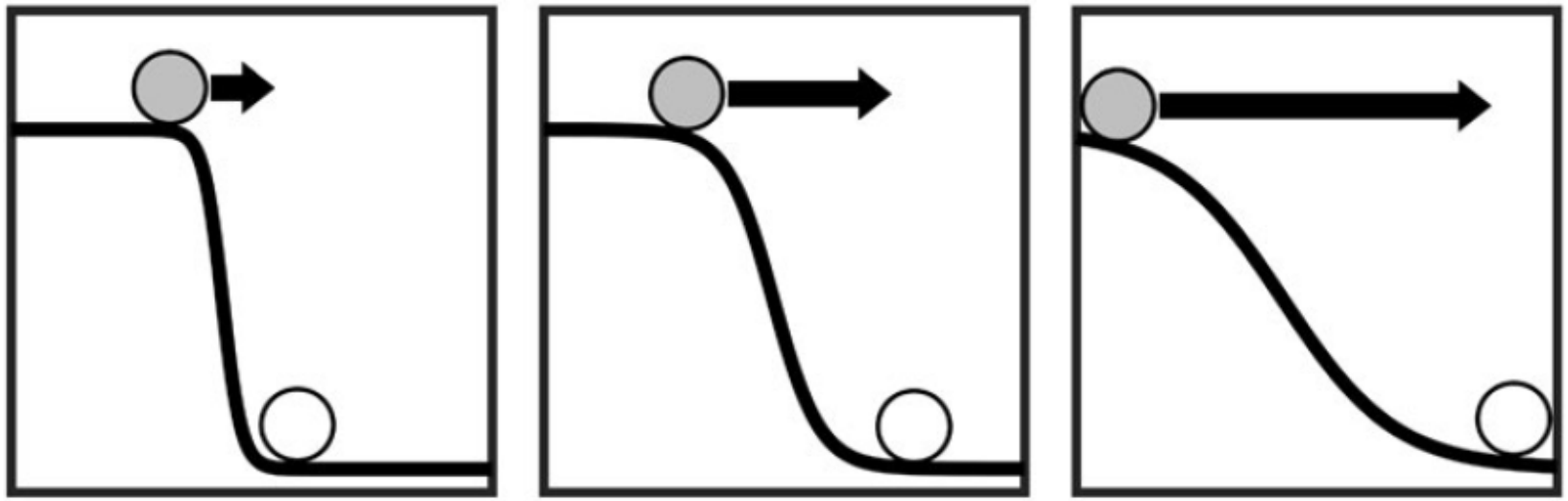
WILEY Global Ecology and Biogeography

Consequences of climatic thresholds for projecting fire activity and ecological change

Adam M. Young[1,2] | Philip E. Higuera[2] | John T. Abatzoglou[3] | Paul A. Duffy[4] | Feng Sheng Hu[5,6]

Threshold-governed

Not threshold-governed



Young et al. (2019), *GEB*

Summary

- **Climate and climate change enable widespread fire activity**
- **Expect more fire in our future: shorter intervals between fires & regional fire years**
- **Increasing aridity will alter post-fire vegetation change, with thresholds and non-linear relationships leading to surprises**