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

Area burned in wildfires, Western contiguous US (km²)

Balch et al. (2018)
Fire seasons are longer

Fire seasons have lengthened, particularly in the Rockies

Fire season length:

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</thead>
<tbody>
<tr>
<td>All</td>
<td>138</td>
<td>166</td>
<td>202</td>
<td>222</td>
</tr>
<tr>
<td>Northern Rockies</td>
<td>49</td>
<td>107</td>
<td>114</td>
<td>134</td>
</tr>
<tr>
<td>Southern Rockies</td>
<td>31</td>
<td>52</td>
<td>98</td>
<td>117</td>
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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 and J. T. Abatzoglou

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
2020 punctuates recent trends

Record-setting fire activity:
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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 conditions, 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.
3. Fire and climate have been tightly linked in the Northern Rockies. Climate is a key driver of annual area burned, and this does not mean that humans and vegetation are not important.

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

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

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

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

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

**Impact of anthropogenic climate change on wildfire across western US forests**

John T. Abatzoglou\(^*\) and A. Park Williams\(^b\)

*This does not mean humans and veg. are not important*

**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. Reier\(^{II}\)

**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\(^{1}\)

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

**Medieval warming initiated exceptionally large wildfire outbreaks in the Rocky Mountains**

**Long-term perspective on wildfires in the western USA**

**Decreasing fire season precipitation increased recent western US forest wildfire activity**

Zachary A. Holden\(^*\), Alan Swanson\(^b\), Charles H. Luce\(^c\), W. Matt Jolly\(^d\), Marco Maneta\(^a\), Jared W. Oyler\(^f\), Dyer A. Warren\(^g\), Russell Parsons\(^h\), and David Affleck\(^h\)
Climate is a key driver of annual area burned

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

Higuera and Abatzoglou (2020)
Climate is a key driver of annual area burned

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

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* and A. Park Williams*

*Department of Geography, University of Idaho, Moscow, ID 83844; and 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” 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

Threshold-governed

Not threshold-governed

Ecosystem driver (e.g., climate)

Young et al. (2019), GEB
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