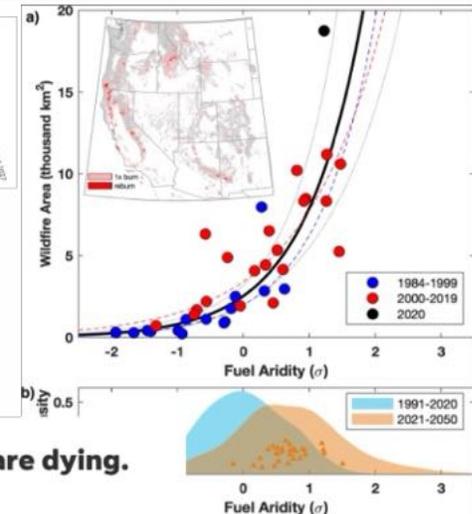
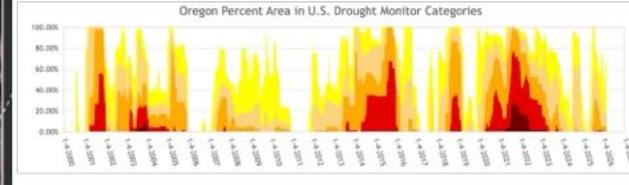


# The Science of Changing Wildfire Risks in Oregon Environments



npr OPB NEWSLETTERS

NEWS CULTURE MUSIC PODCASTS & SHOWS SEARCH

ENVIRONMENT LISTEN & FOLLOW

**A record high number of dead trees are found as Oregon copes with an extreme drought**

DECEMBER 20, 2022 - 5:00 AM ET

Juliana Kim

CLIMATE-CHANGE

**Iconic PNW 'trees of life' are dying. Scientists now know why**

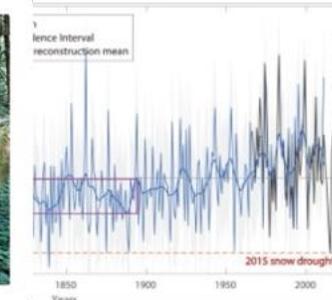
Nathan Gilles Columbia Insight

Published 6:01 a.m. PT Aug. 31, 2022 | Updated 2:43 p.m. PT Sept. 1, 2022

View Comments



**'Firmageddon': Oregon conifers suffer record die-off as climate crisis hits hard**



Abatzoglou et al., 2018; Dye et al. 2023; WK commons

Dr. Andrés Holz  
Professor  
[andres.holz@pdx.edu](mailto:andres.holz@pdx.edu)

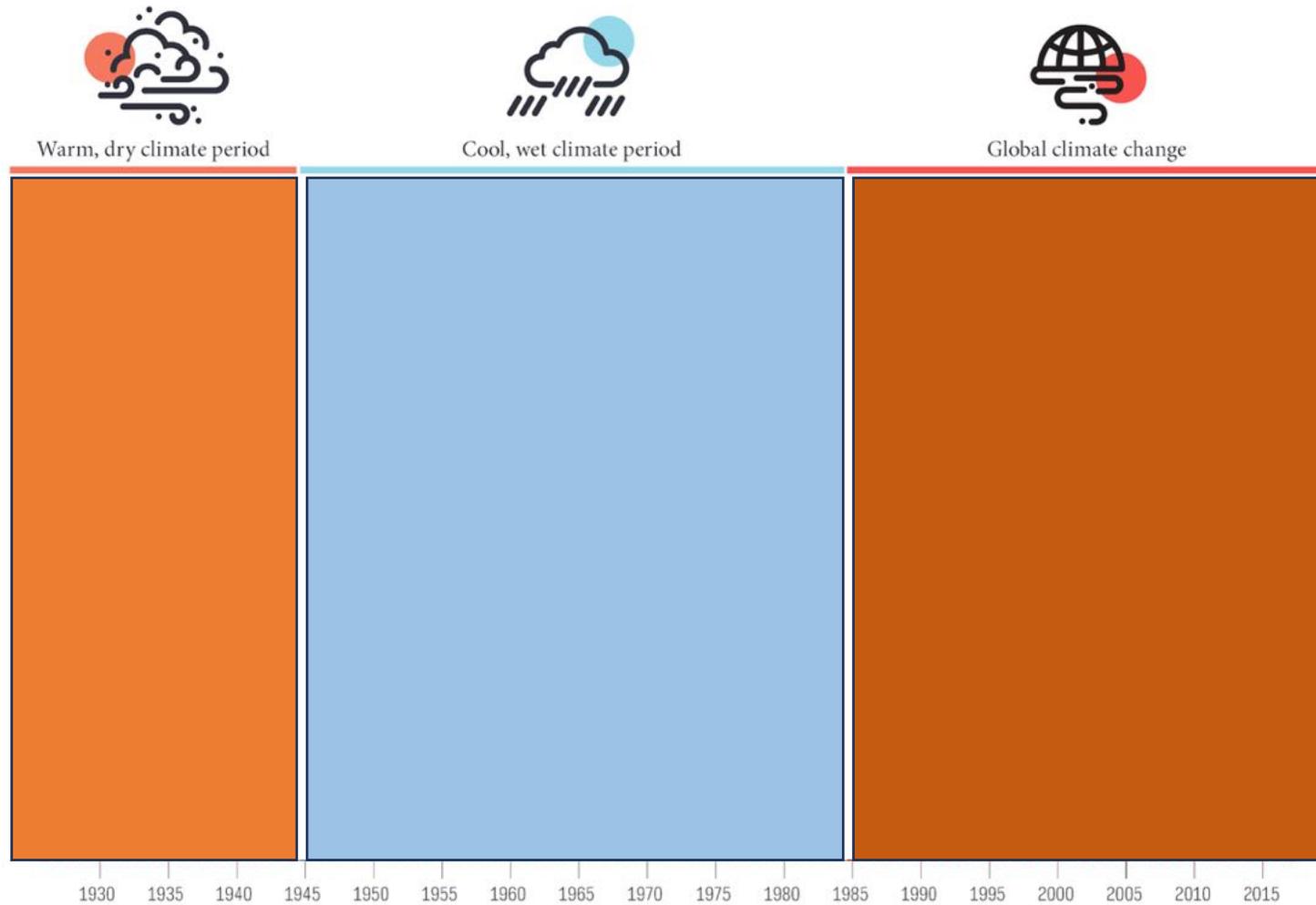
Portland State University  
Oregon's PUC 02/26/2026



# Outline

- Rationale for understanding wildfire science – why matters, why now
- Wildfire 101s: triangle and 4 switches – How Fire Ecology can help
- PNW: One Region with Very Different Fire Regimes - Different problems require different solutions
- Wildfire archetypes and controllers: Not Just Extreme East winds
- Where things stand today: cutting edge science

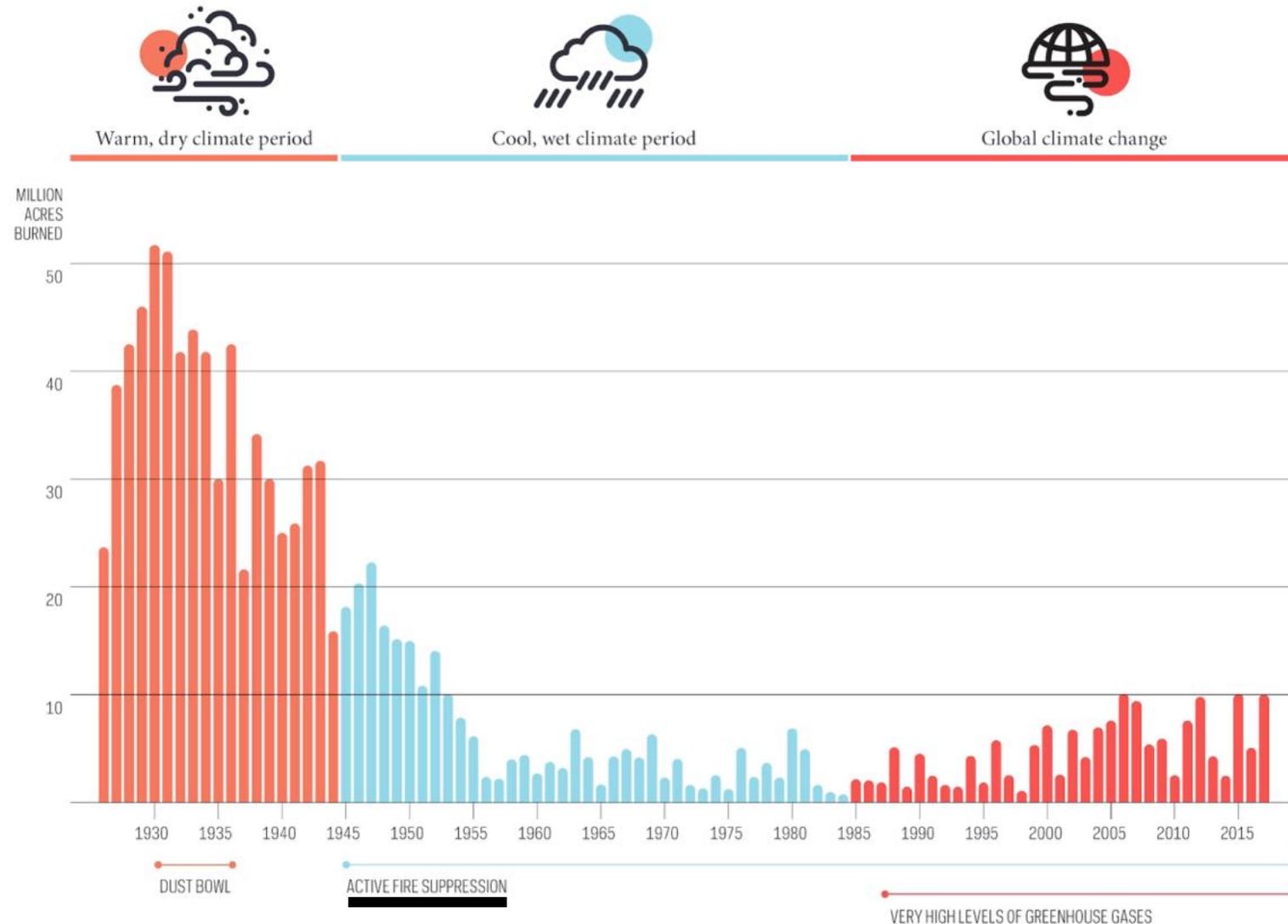
# Climatic Conditions in the PNW (1920s-2010s)



# Climate (Variability & Change) + Human Activity = Wildfire Activity in the US

## TOTAL U.S. WILDFIRE ACRES 1926-2017

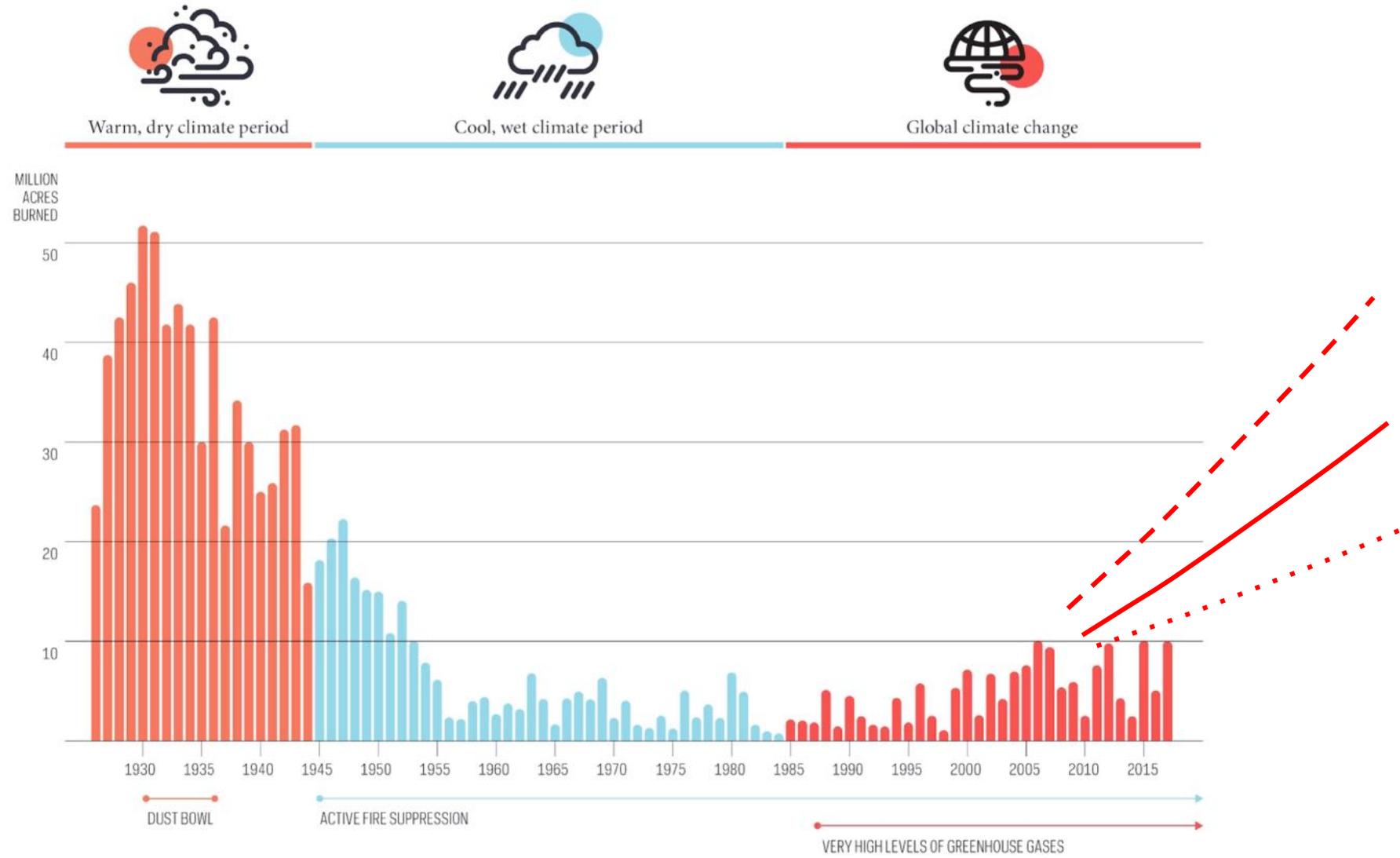
Source: National Interagency Fire Center; nifc.gov



# ...and where from here?

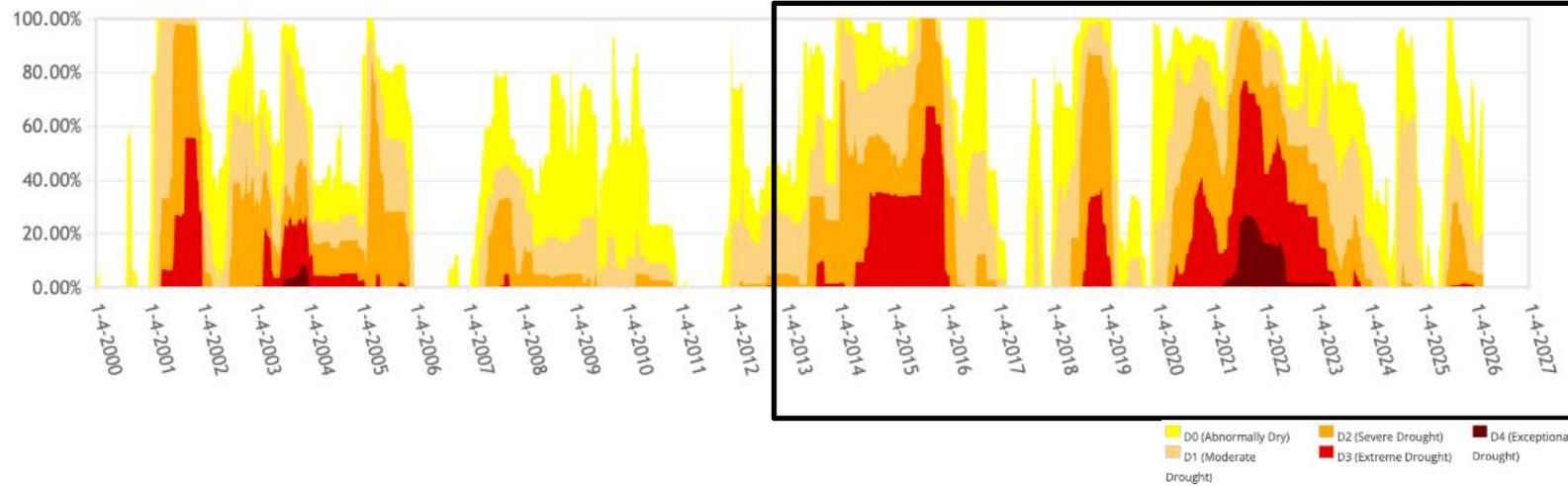
## TOTAL U.S. WILDFIRE ACRES 1926-2017

Source: National Interagency Fire Center; nifc.gov

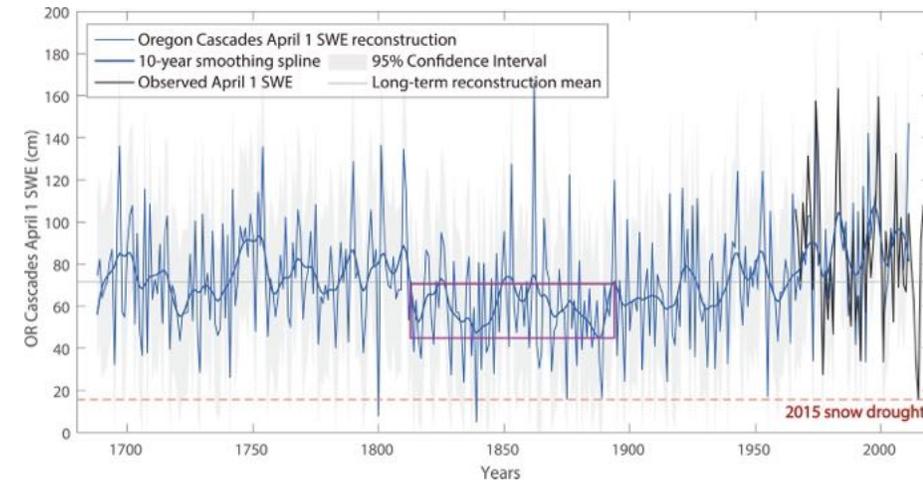


# 2015-Present Trends in the PNW

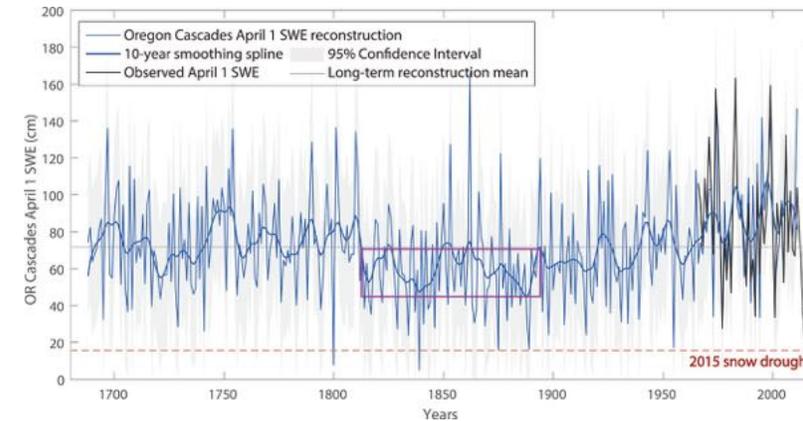
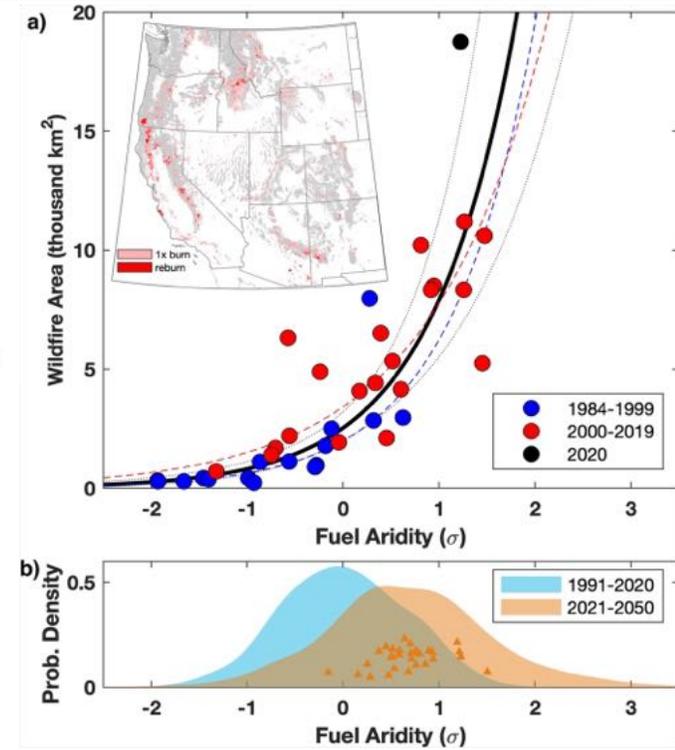
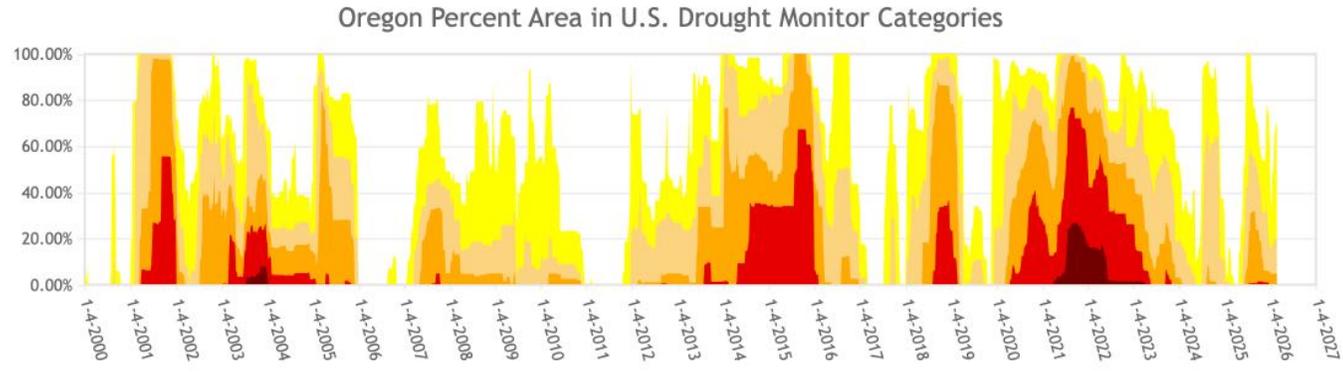
Oregon Percent Area in U.S. Drought Monitor Categories



From the U.S. Drought Monitor website: <https://droughtmonitor.unl.edu/Default2.aspx>, 2/28/2020

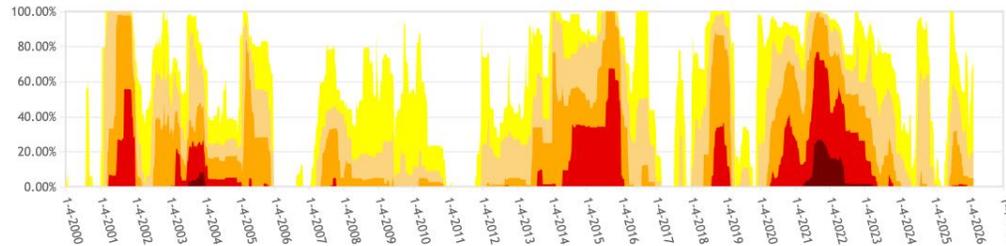


# 2015-Present Trends in the PNW



# 2015-Present Trends in the PNW

Oregon Percent Area in U.S. Drought Monitor Categories



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ENVIRONMENT ENVIRONMENT LISTEN & FOLLOW

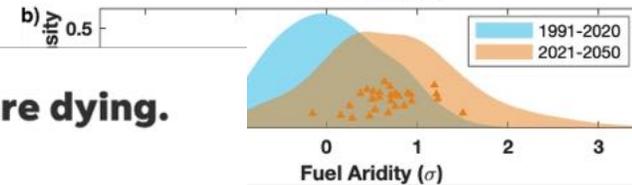
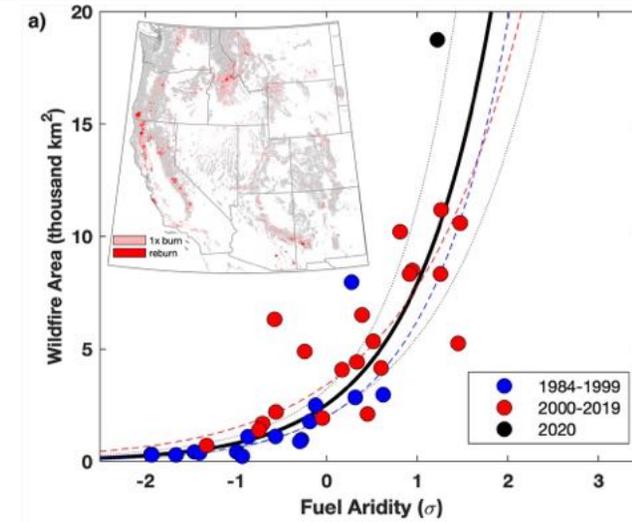
## A record high number of dead trees are found as Oregon copes with an extreme drought

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## CLIMATE-CHANGE

## Iconic PNW 'trees of life' are dying. Scientists now know why

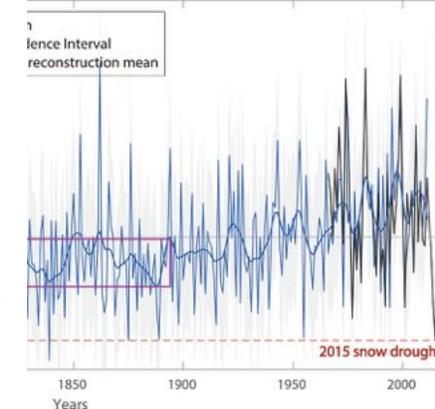
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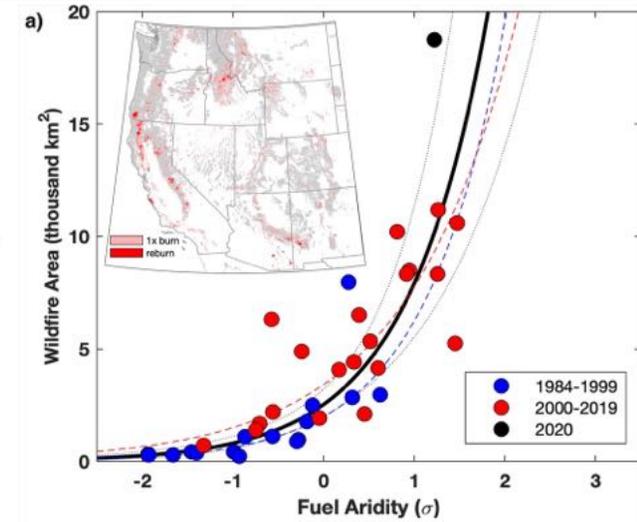
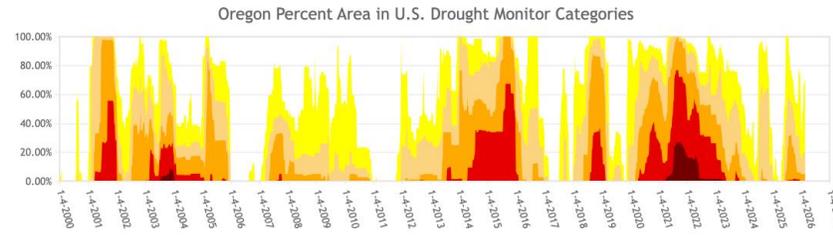
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Healthy western redcedars are still around, but are in decline. Nathan Gilles / Columbia Insight



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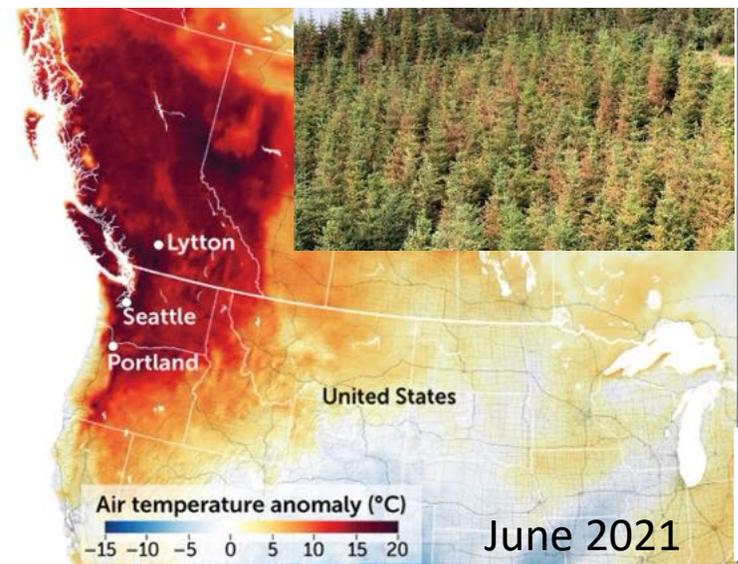
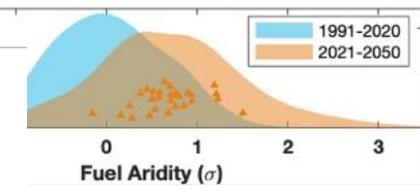


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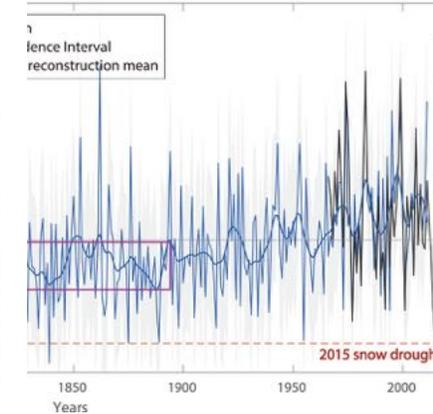
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Healthy western redcedars are still around, but are in decline. Nathan Gilles / Columbia Insight



June 2021



# The 2020 Labor Day Fires



(cooler)

cold air mass  
(high pressure)

East winds

Beachie Creek

Riverside

Lionshead

Holiday Farm

Archie Creek

(wetter)

(drier)

warm air mass  
(low pressure)

(warmer)



September 8th, 2020

# Wildfire and PNW Forests/Ecosystems

Wildfire has **strongly** shaped the biotic landscapes we see today



# Wildfire and PNW Forests/Ecosystems

Wildfire has **strongly** shaped the biotic landscapes we see today



Ecologically important, yet historically viewed negatively by Euro-Americans

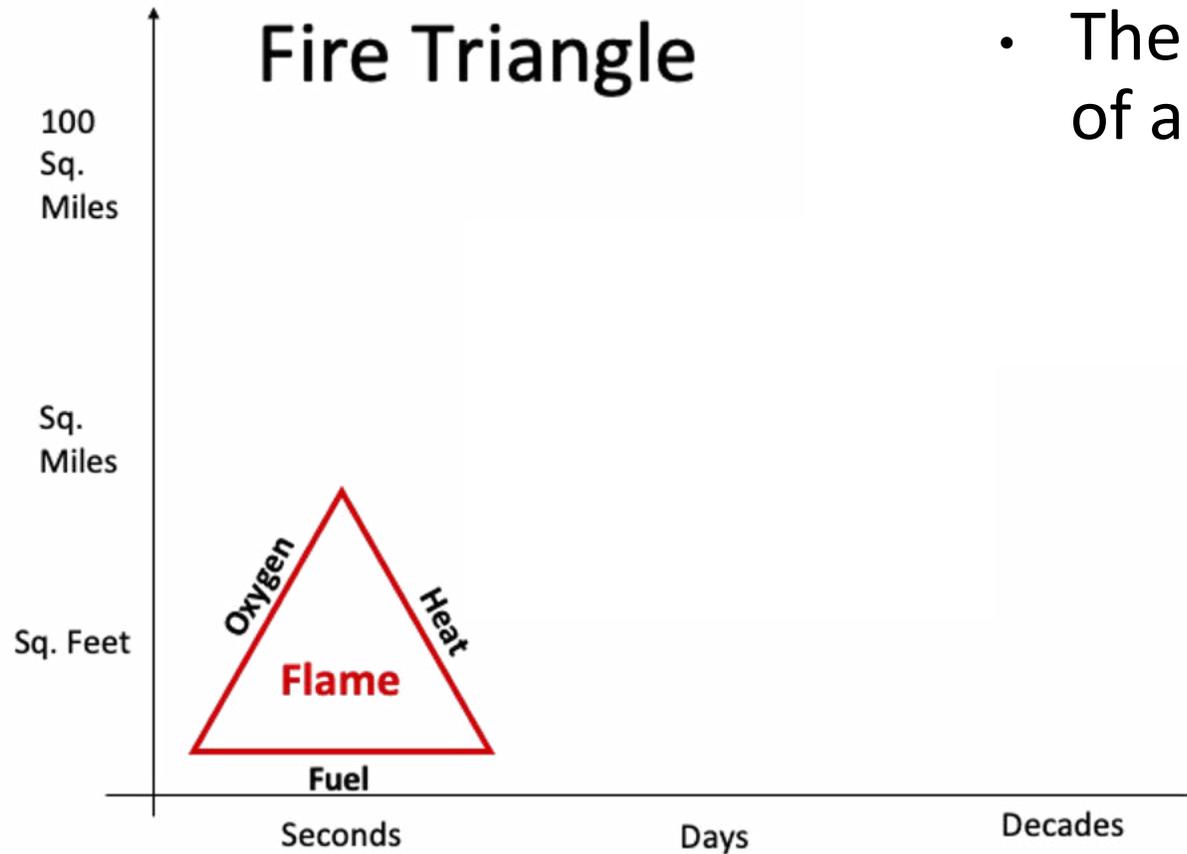
Government and public perception is changing



**Fire Ecology 101:** fire triangles & key drivers that control wildfire across scales

# Fire ecology 101

-Drivers across spatial & temporal scales

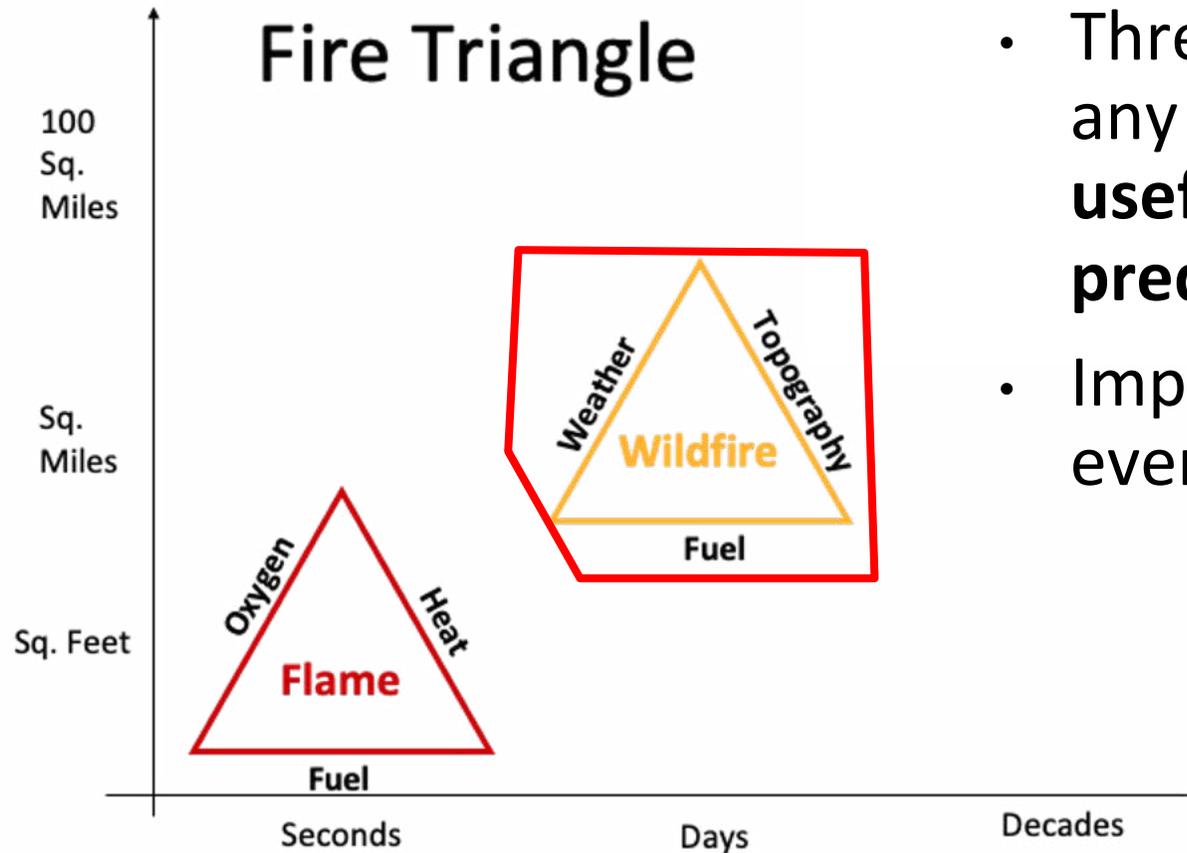


- The three key fine-scale elements of any given flame

Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

-Drivers across spatial & temporal scales

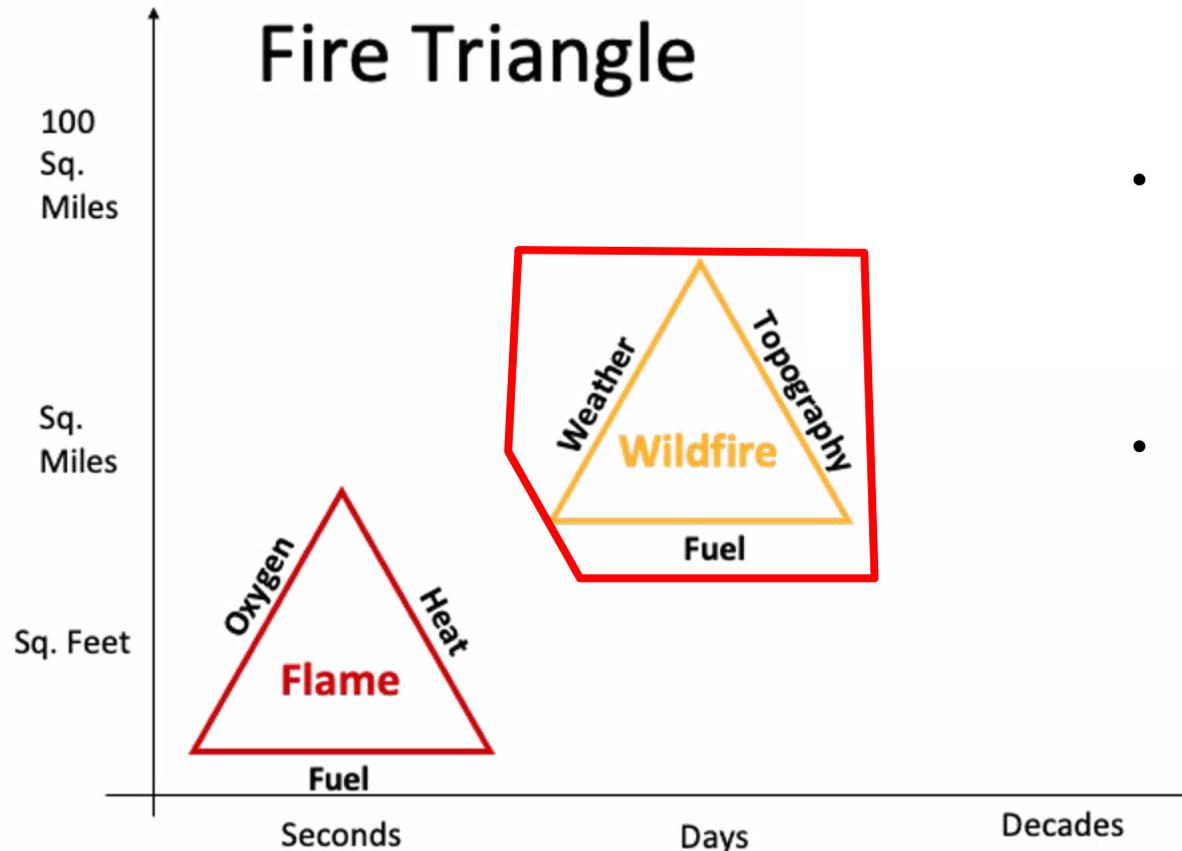


- Three key drivers/controllers of any given wildfire event/behavior – **useful theory for developing predictions/ what to expect**
- Importance vary dramatically by event and vegetation type

Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

-Drivers across spatial & temporal scales

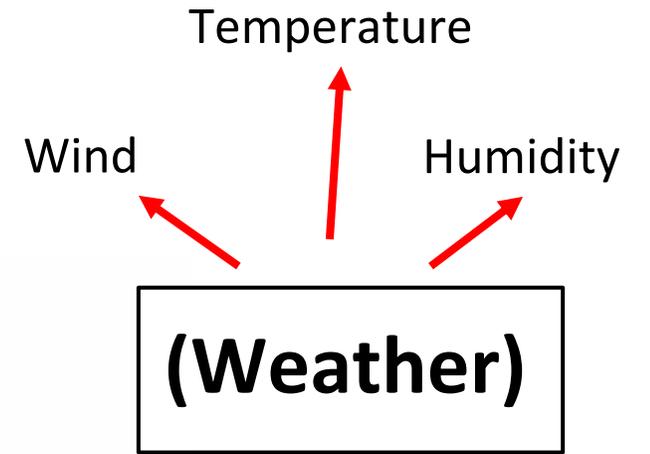
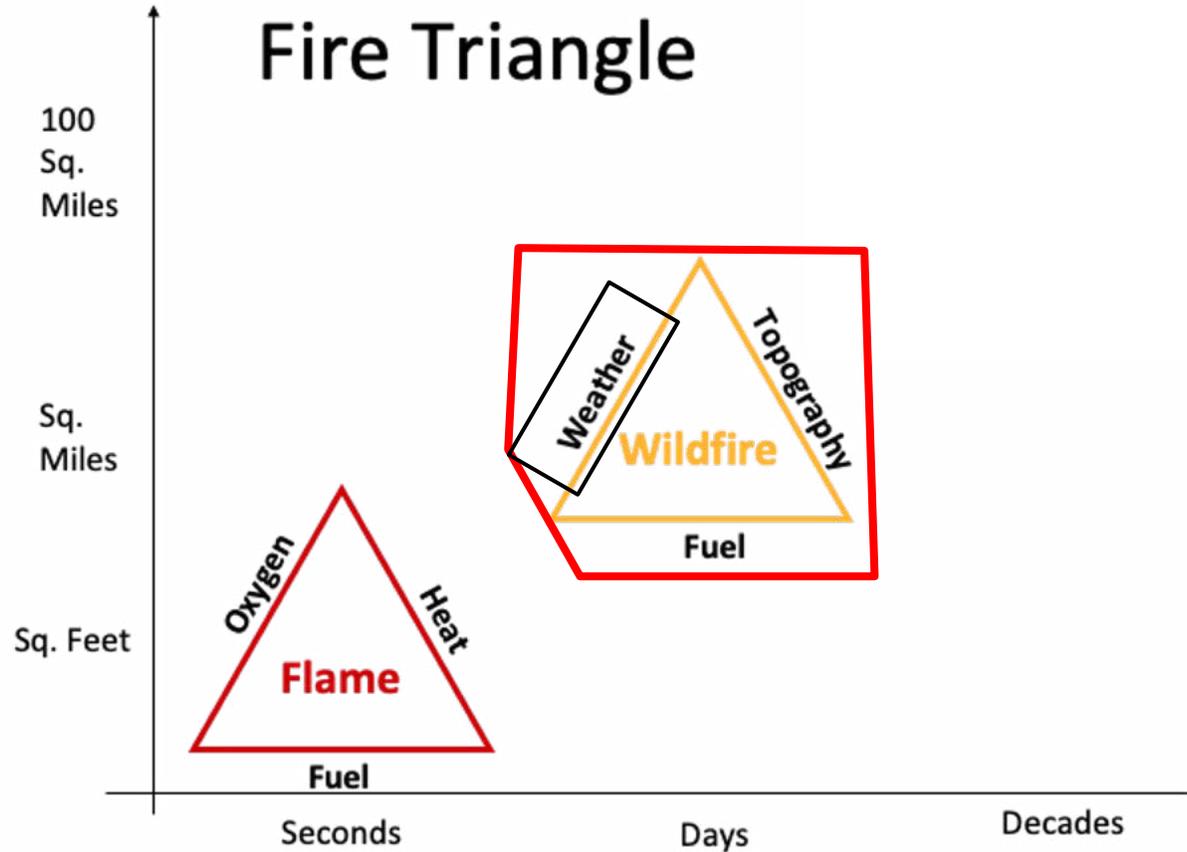


- Expect 'balance' among three drivers/controllers of any given wildfire event/behavior
- If a driver is more important, the others are less relevant

Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

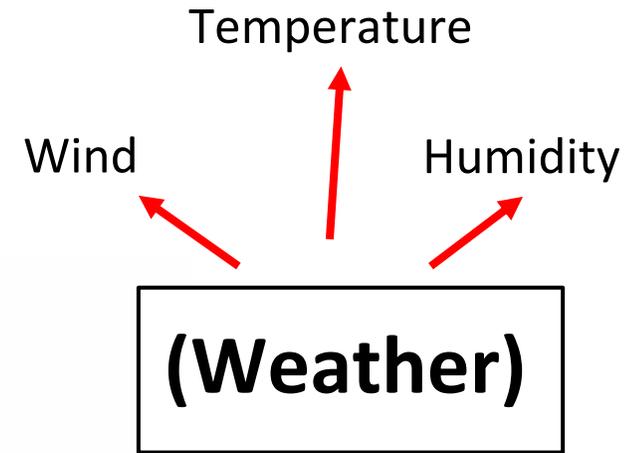
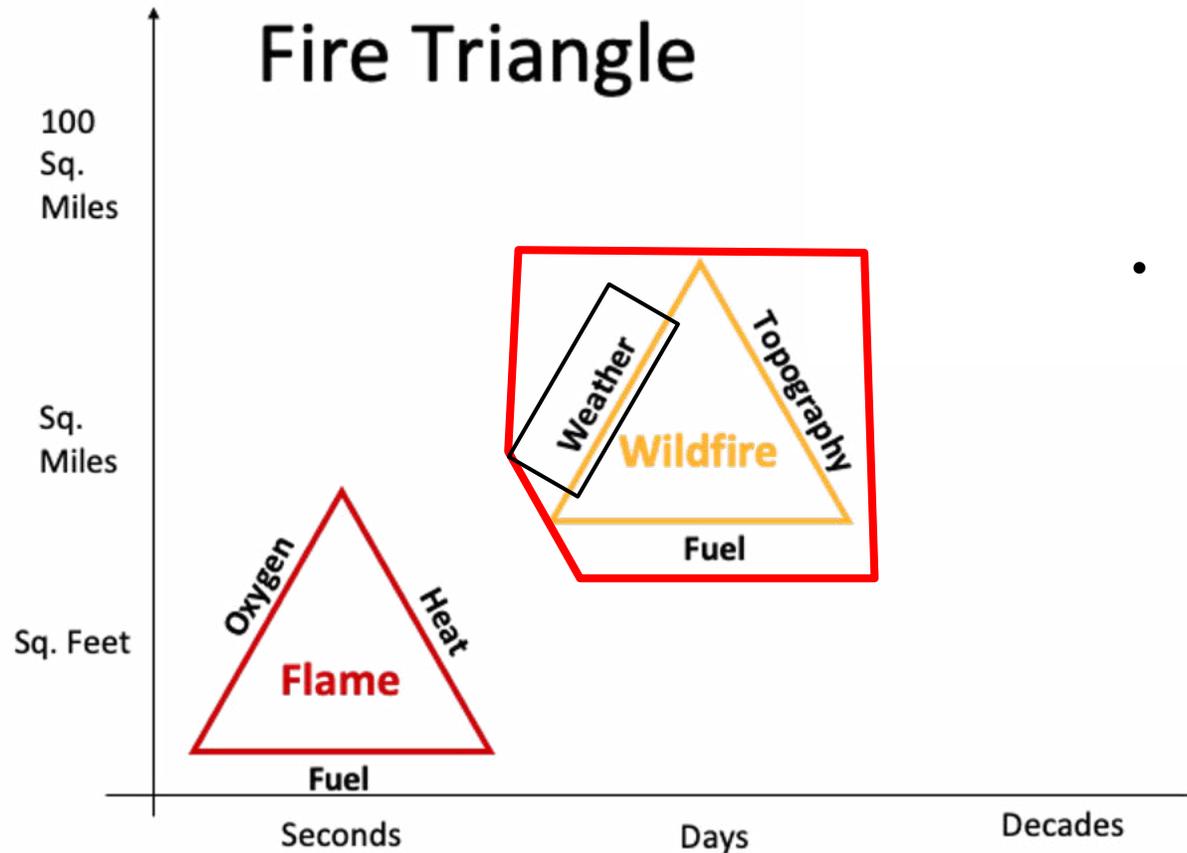
-Drivers across spatial & temporal scales



Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

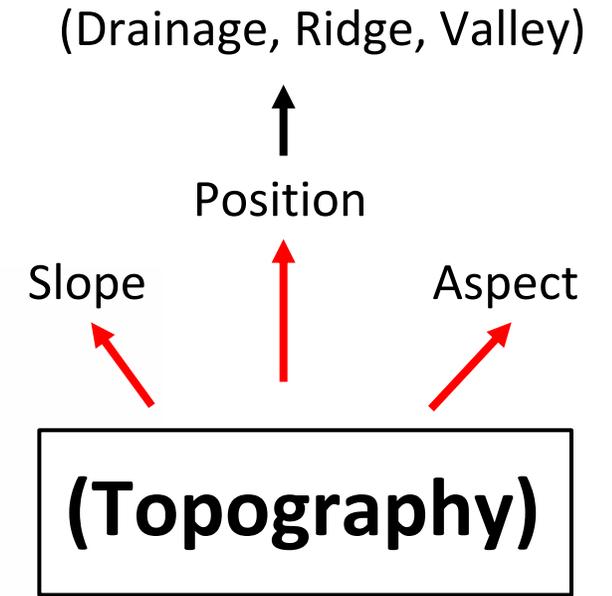
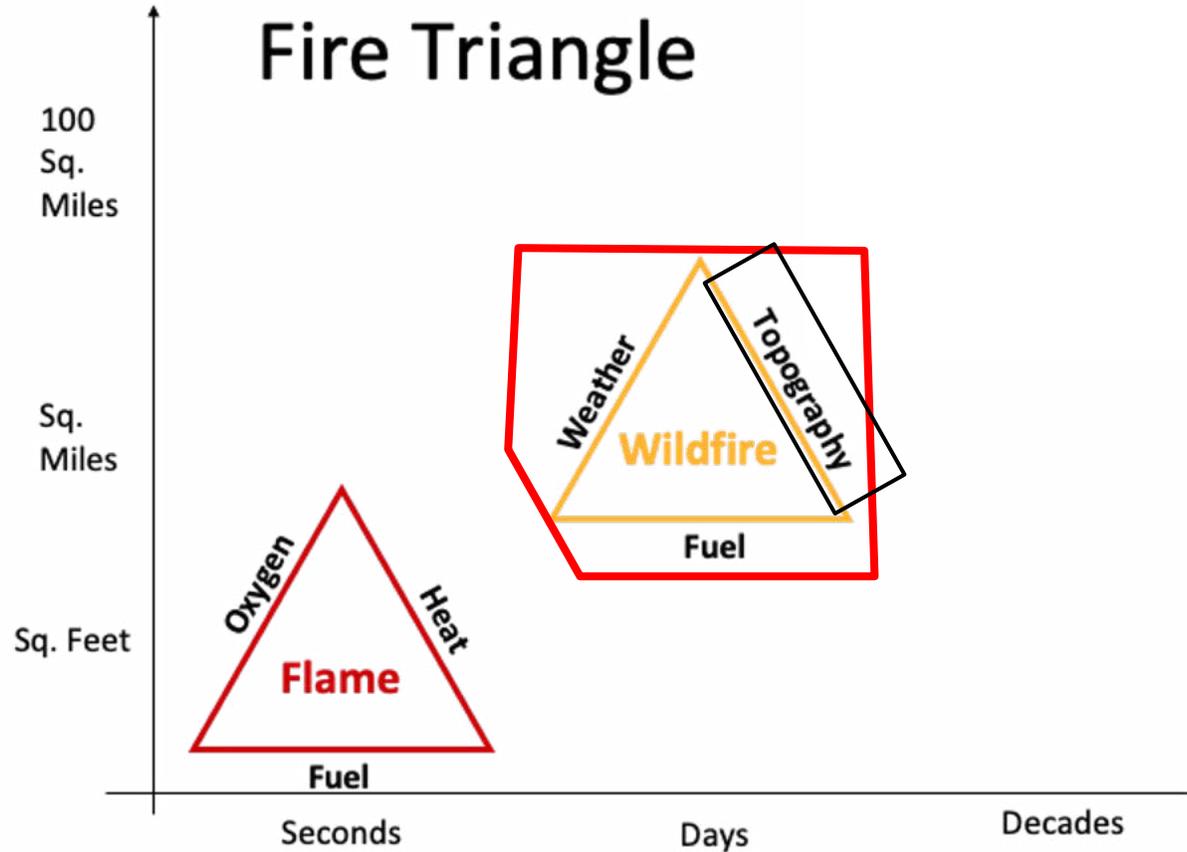
-Drivers across spatial & temporal scales



- Under extreme fire weather, fuels and veg types and topographic conditions should be less relevant

# Fire ecology 101

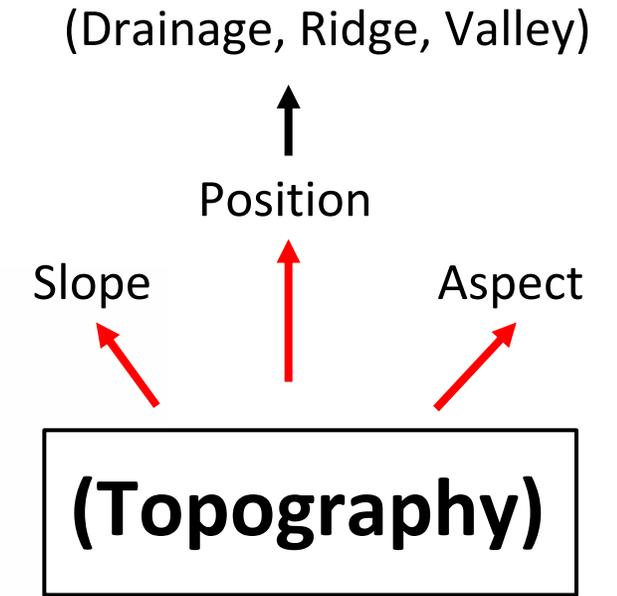
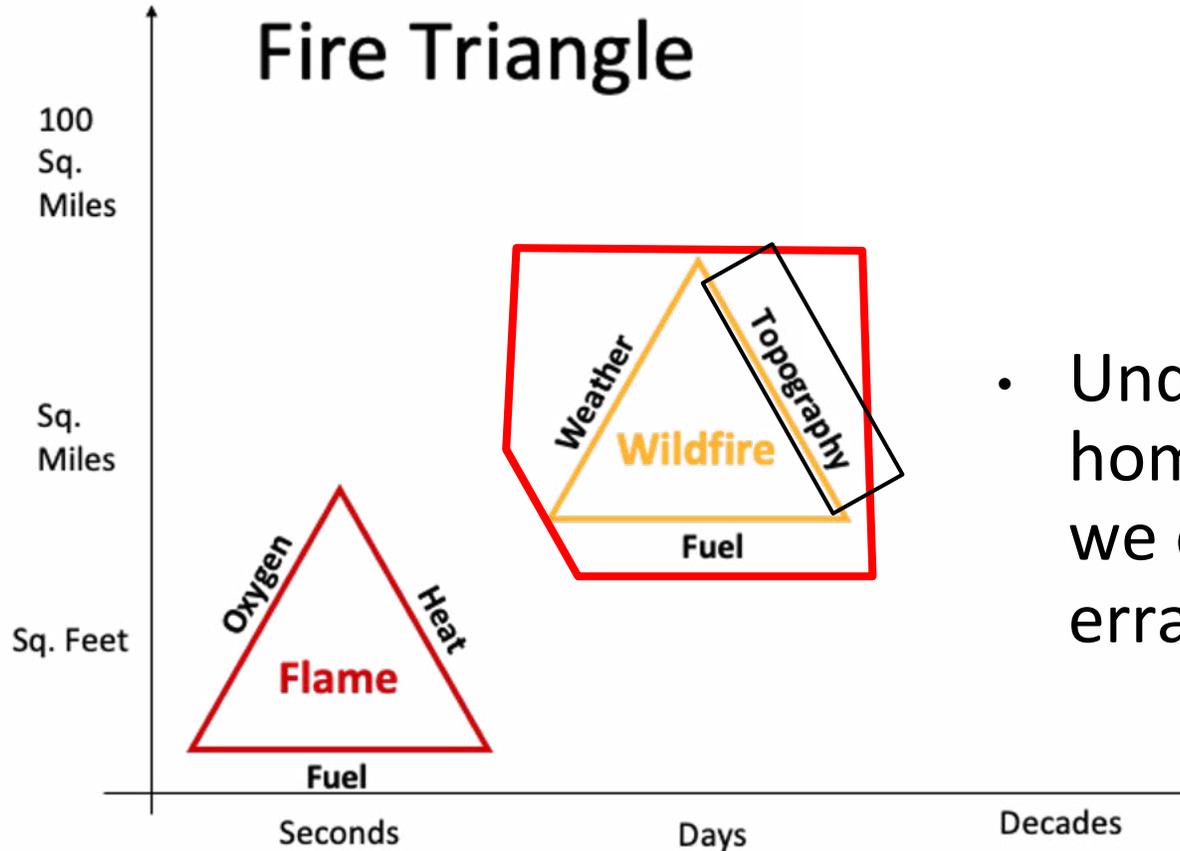
-Drivers across spatial & temporal scales



Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

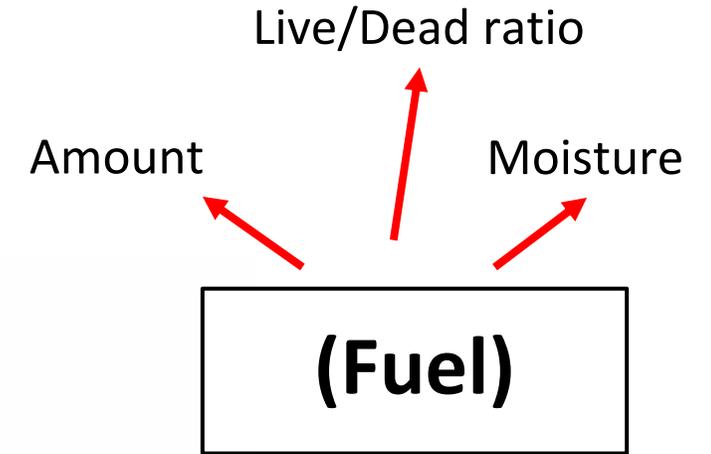
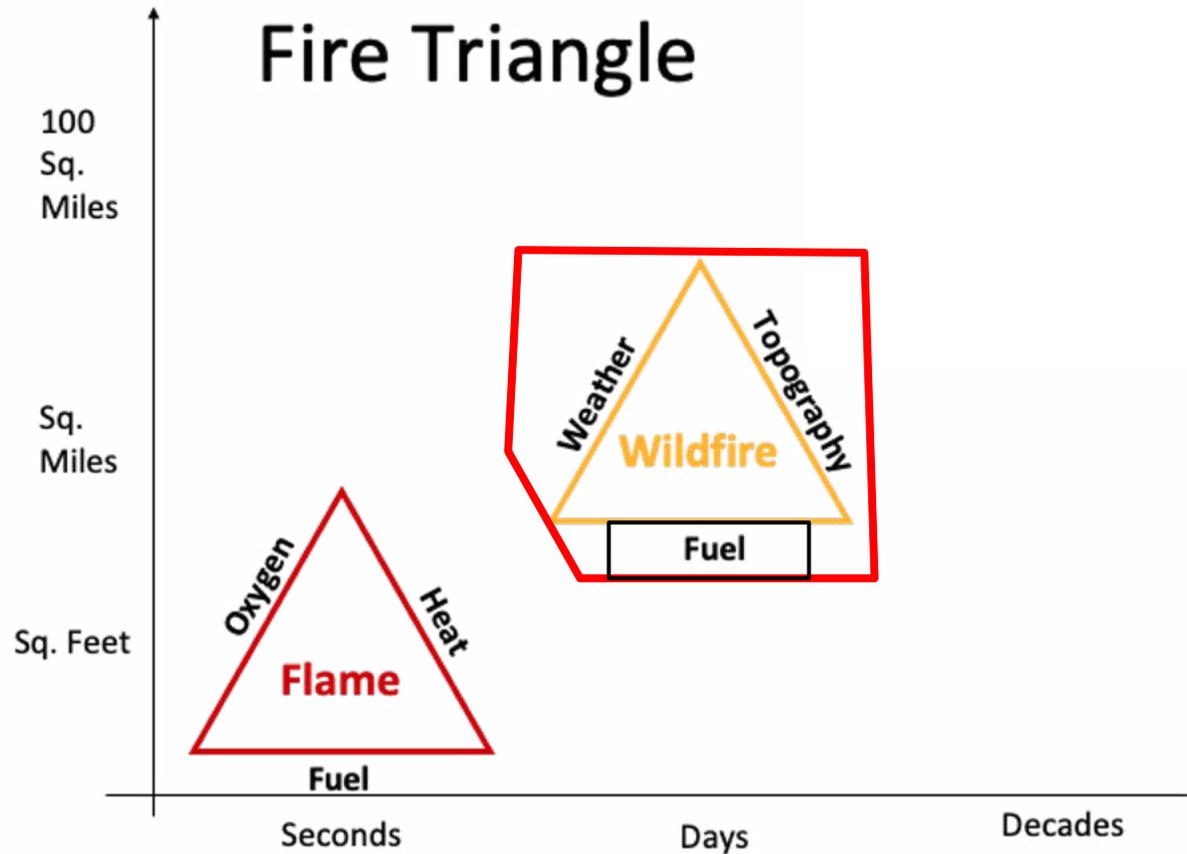
-Drivers across spatial & temporal scales



- Under moderate fire weather and homogeneous fuels and veg types, we expect upslope fire runs and erratic behavior in flat areas

# Fire ecology 101

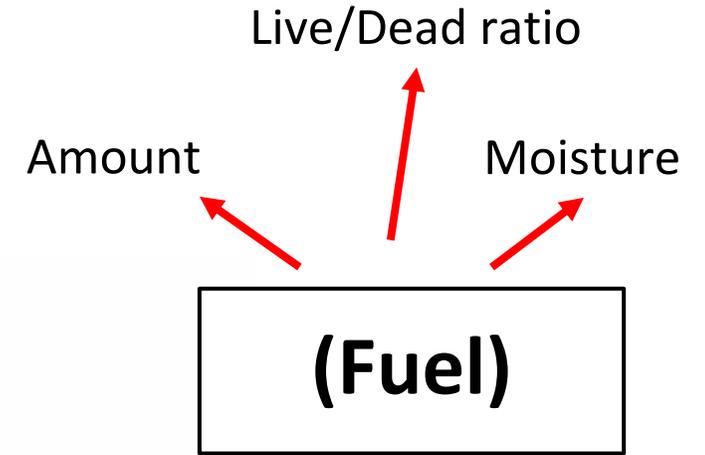
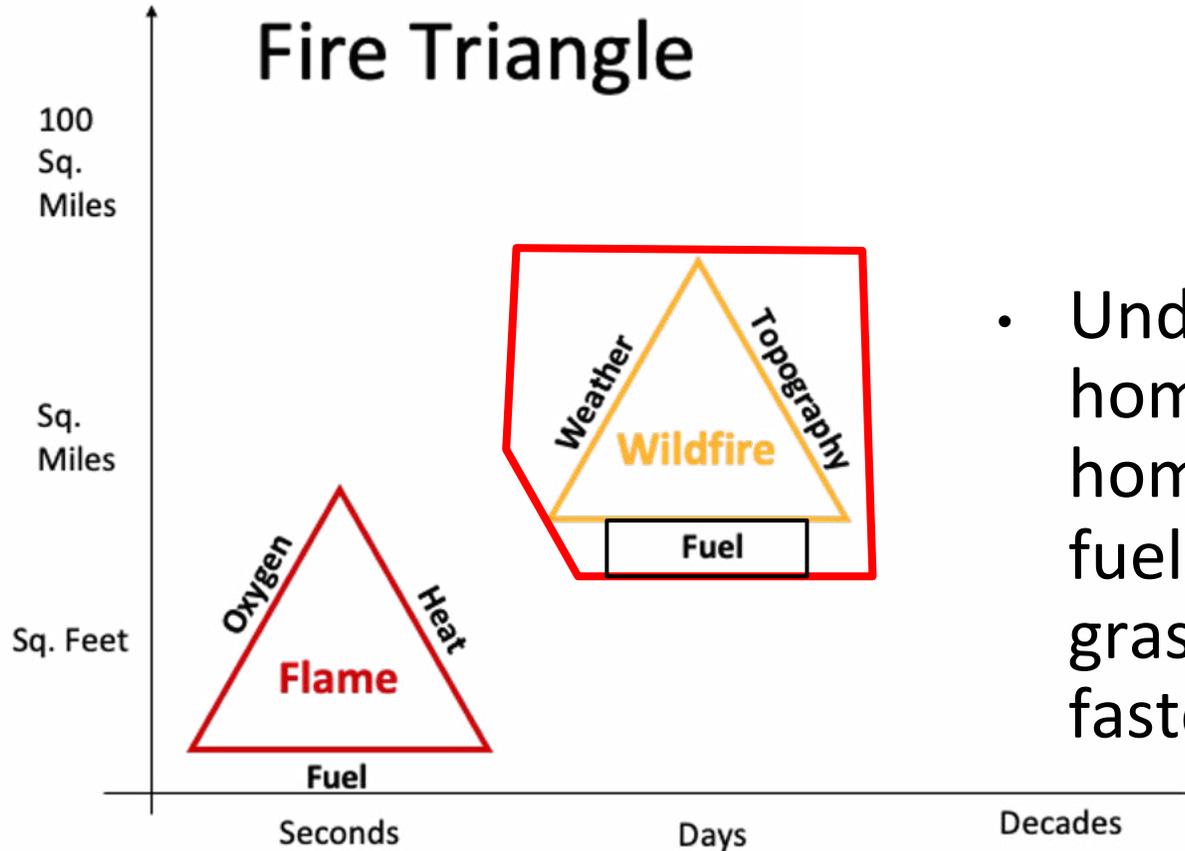
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Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

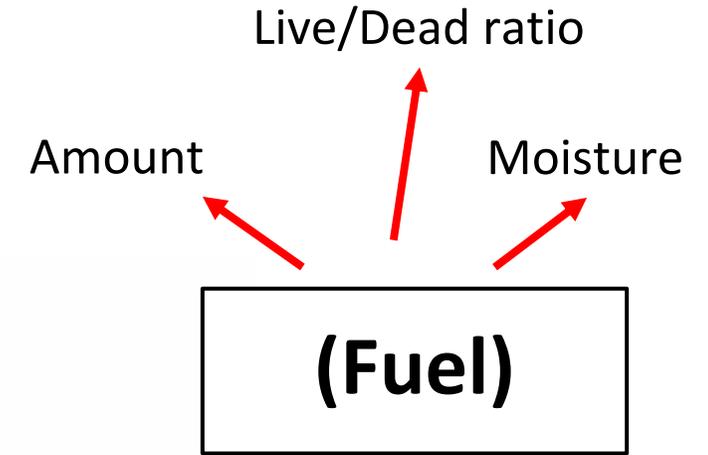
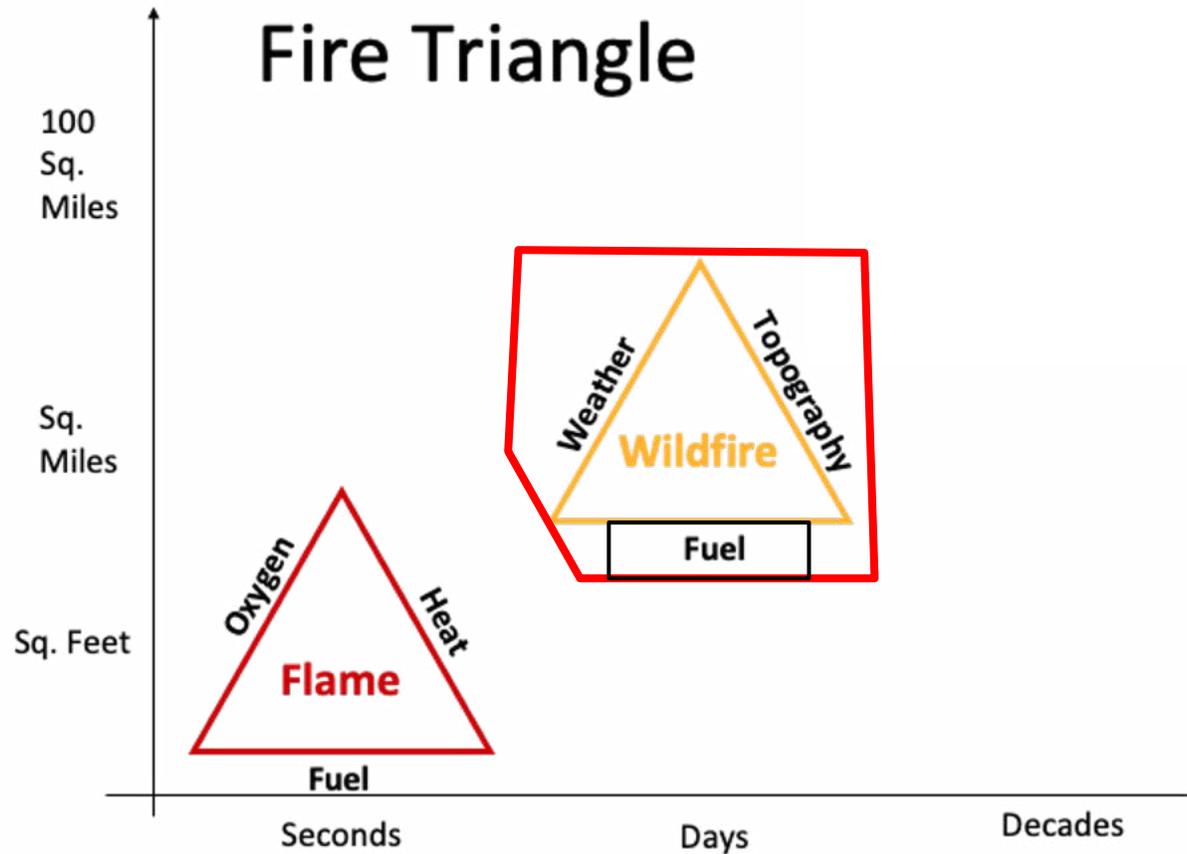
-Drivers across spatial & temporal scales



- Under moderate fire weather and homogeneous topography, homogeneous, flammable, and fine fuels (plantations, shrublands, grasslands) should burn hotter and faster

# Fire ecology 101

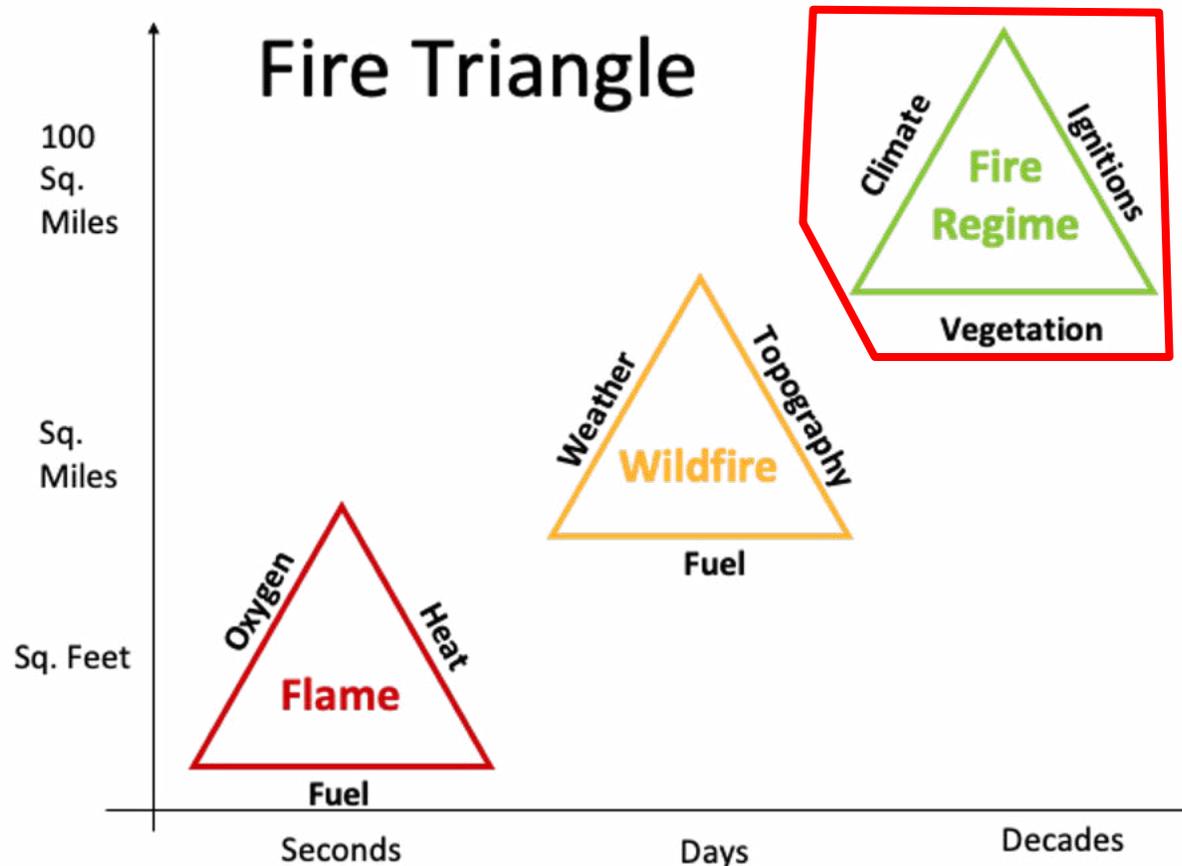
-Drivers across spatial & temporal scales



Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

-Drivers across spatial & temporal scales

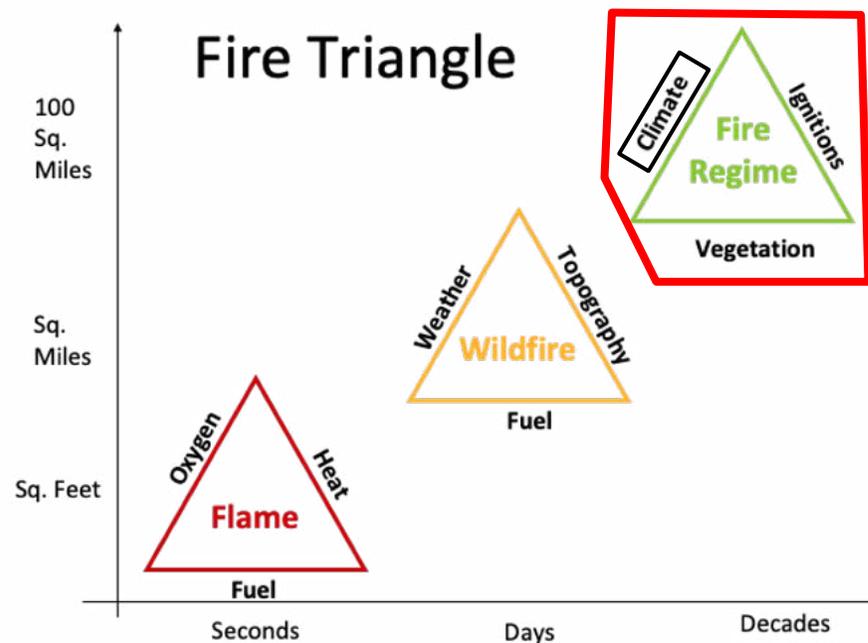


- Longterm attributes of multiple wildfire events for a given landscape (size, frequency, severity, seasonality)
- Vary along Aridity
- Flipside? What's left behind (legacies) affect postfire vegetation

Adapted from Moritz et al. 2005, PNAS

# Fire ecology 101

-Drivers across spatial & temporal scales



Adapted from Moritz et al. 2005, PNAS

**(Climate)**



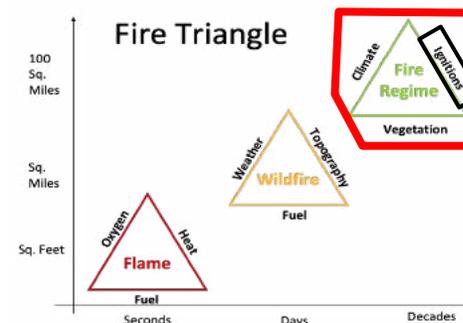
**(Fuels)**



1. **Vegetation Structure (Density)**
2. **Vegetation Moisture (Aridity)**
3. **Vegetation Traits (Flammability)**

# Fire ecology 101

-Drivers across spatial & temporal scales



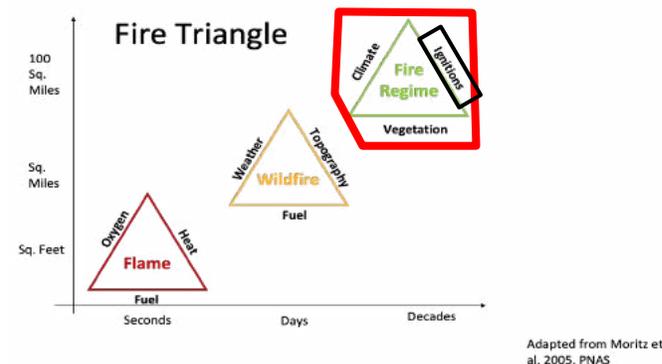
human  
activities

(Ignitions)

1. **WUI development (Density & Spatial Dynamics)**
2. **Management (Rx Fires, Suppression [Bad Fire] & Monitoring [Good Fire] of Fires, etc.)**
3. **Education and Prevention (e.g. Fire Bans)**

# Fire ecology 101

-Drivers across spatial & temporal scales



**human activities**

**(Ignitions)**

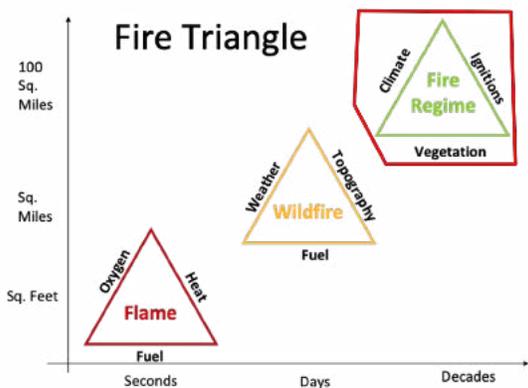
**synoptics**

1. **WUI development (Density & Spatial Dynamics)**
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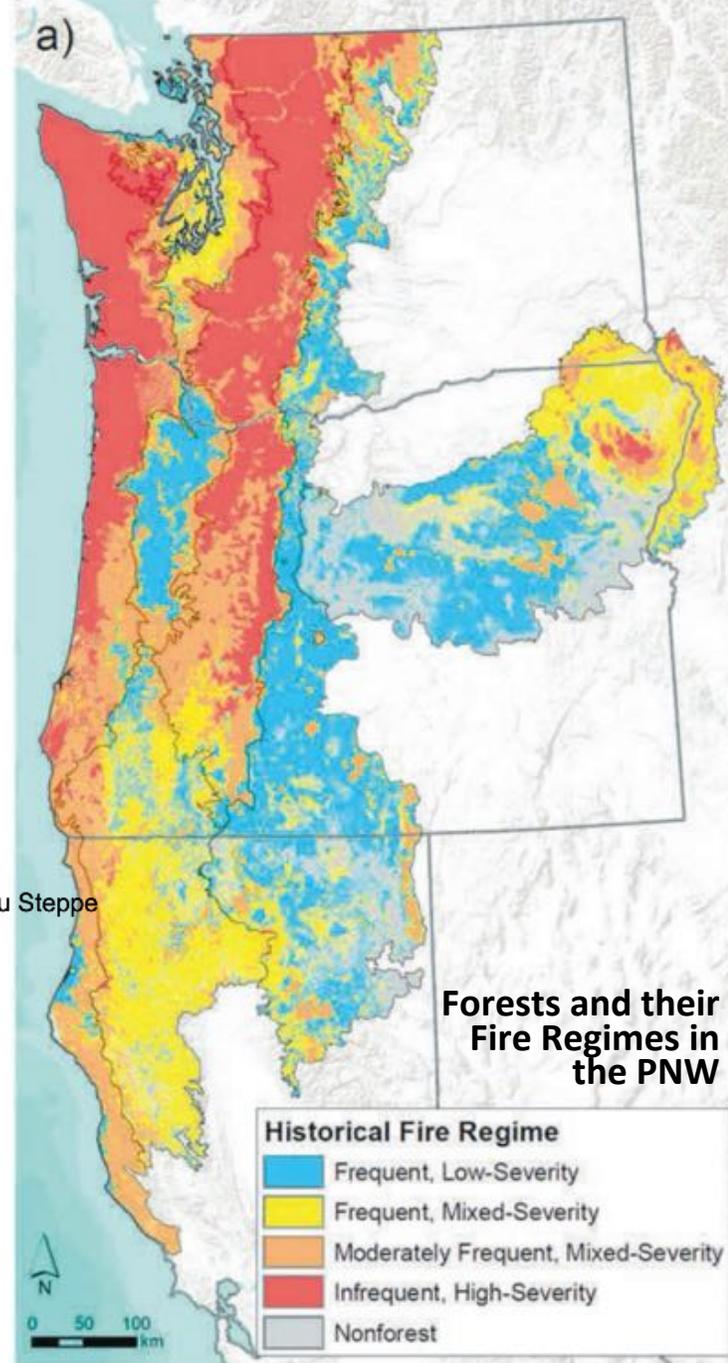
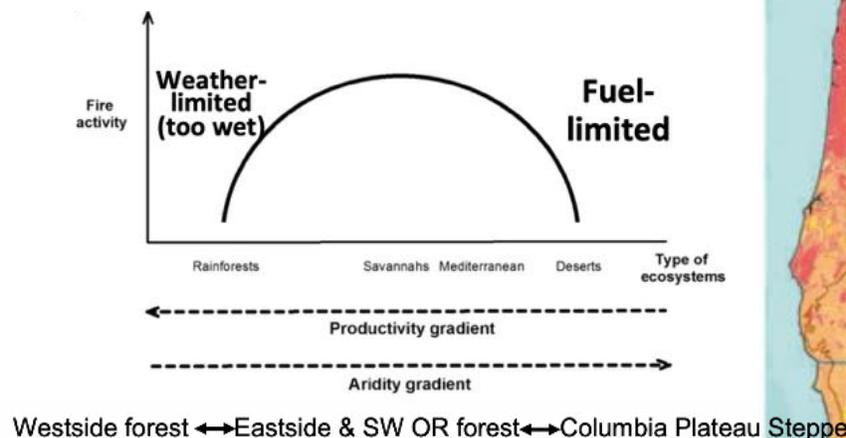
1. **Convective storm (Density)**
2. **Pressure systems (late Fall/early Winter to late Summer)**
3. **Pyrocumulonimbus (self-propagating *monsters*)**

# Fire ecology 101

-Drivers across spatial & temporal scales



Adapted from Moritz et al. 2005, PNAS



Source: Reilly et al., 2021

**Fire Ecology 201: PNW** - Multiple Fire Regimes & Different  
Human Impacts – Multiple Challenges

# Wildfire Regimes

## The Cyclic Nature of Wildfire Patterns

(At the landscape scale...)

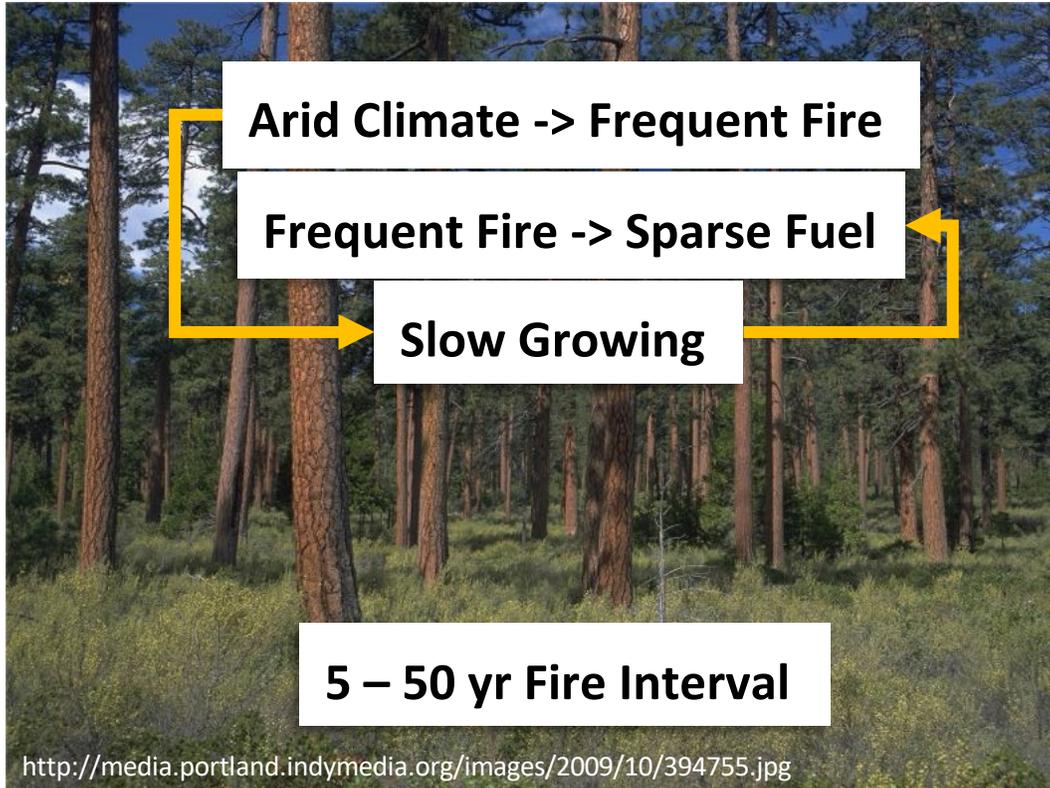
Across the western US: Two major Wildfire Archetypes

Arid Climate



## *Fuel-Limited* Wildfire Regime

(i.e. wildfire is limited by amount of fuel)



Arid Climate -> Frequent Fire

Frequent Fire -> Sparse Fuel

Slow Growing

5 – 50 yr Fire Interval

<http://media.portland.indymedia.org/images/2009/10/394755.jpg>

Low-elevation Central-Eastern Cascades  
Pre Euro-American settlement Willamette Valley

# Wildfire Regimes

## The Cyclic Nature of Wildfire Patterns

(At the landscape scale...)

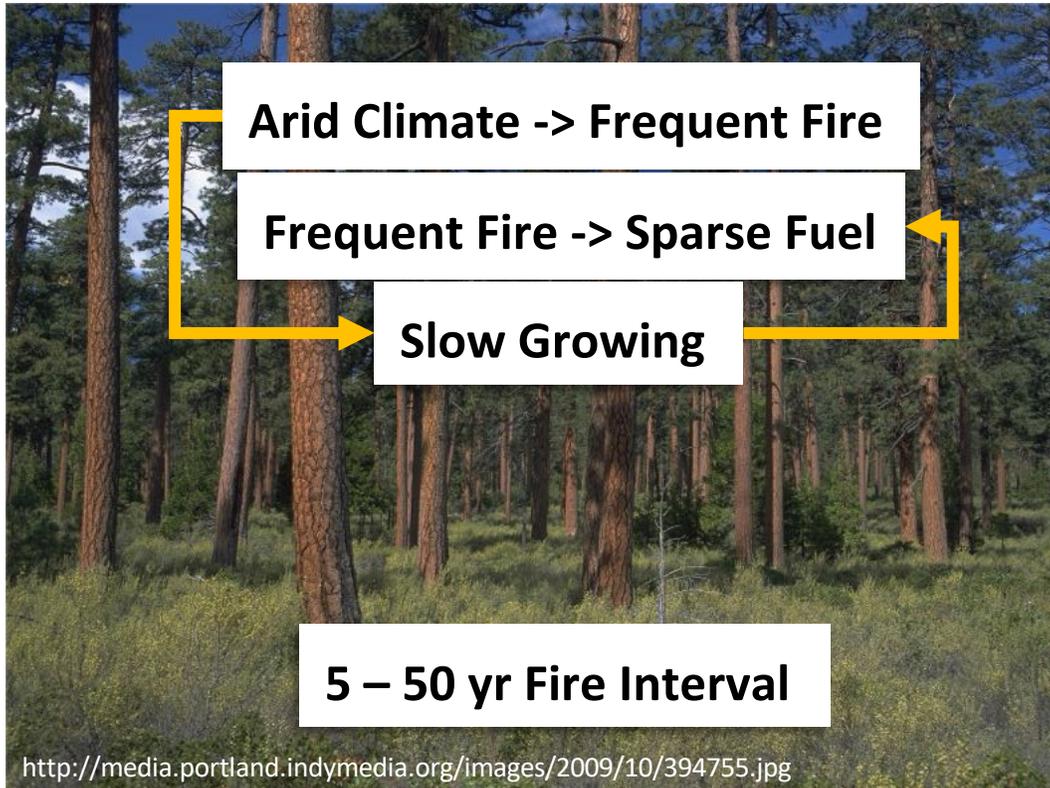
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Arid Climate

Mesic Climate

### *Fuel-Limited* Wildfire Regime

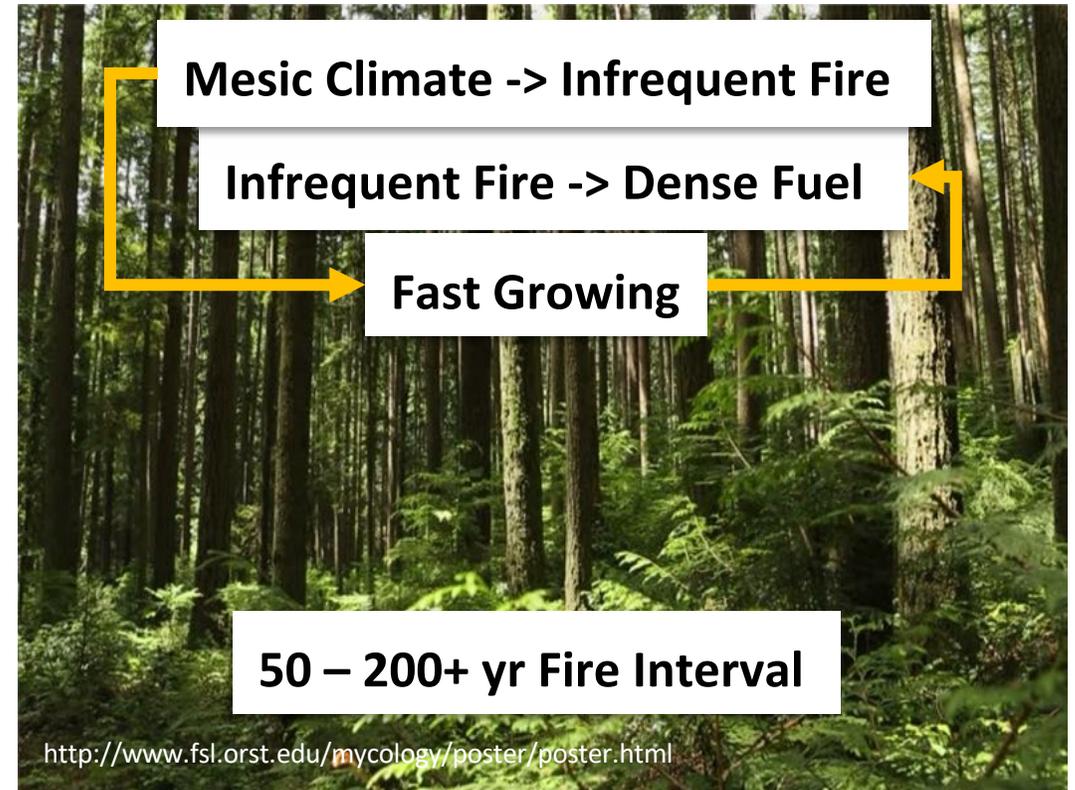
(i.e. wildfire is limited by amount of fuel)



Low-Mid elevation Central-Eastern Cascades,  
Willamette Valley, Columbia Plateau

### *Climate-Limited* Wildfire Regime

(i.e. wildfire is limited by fuel moisture)



Western and High Cascades, Coastal Range, High Rockies

# Historic Wildfire Regimes – Burn Severity Patterns across Two Major Archetypes

## Dry Conifer Forest



Frequent Fire, Fuel-Limited Regime, Tree Scale



## Mesic Conifer Forest



Infrequent Fire, Climate-Limited Regime, Patch Scale

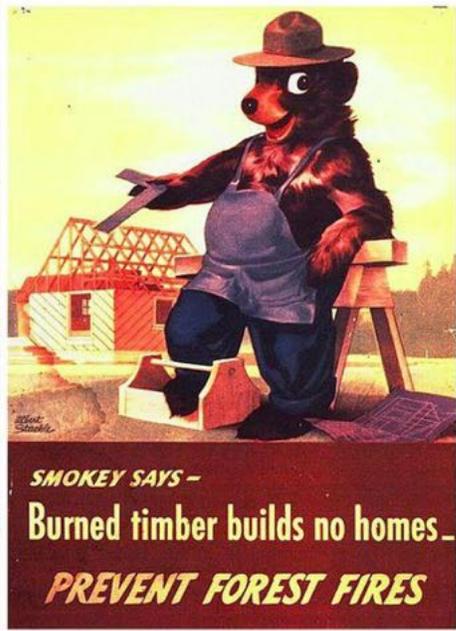
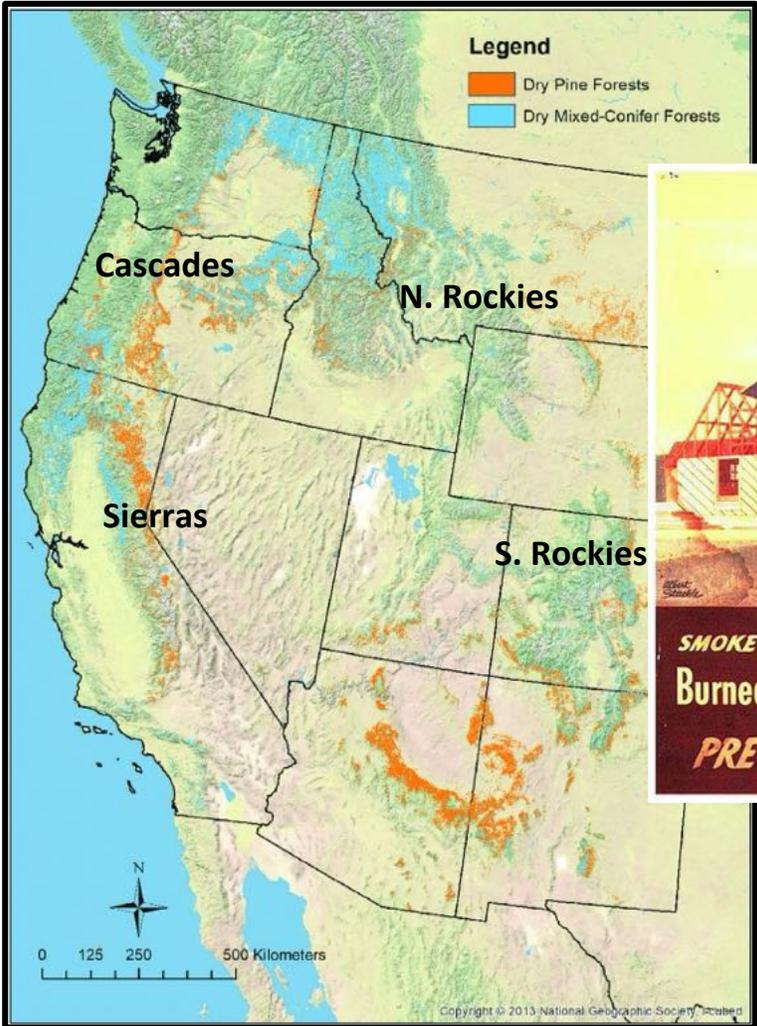


Photo Credits: Bottom left, bottom right; US Forest Service

# Humans and Fire

## Impacts of Euro-American Management Practices (Logging, Grazing, **Fire-Suppression**, Forest Plantations)

Many dry to mixed forests are now unnaturally dense, highly connected, lower diversity of species adapted to wildfire



# Current Wildfire Regimes – Burn Severity Patterns

Dry Conifer Forest



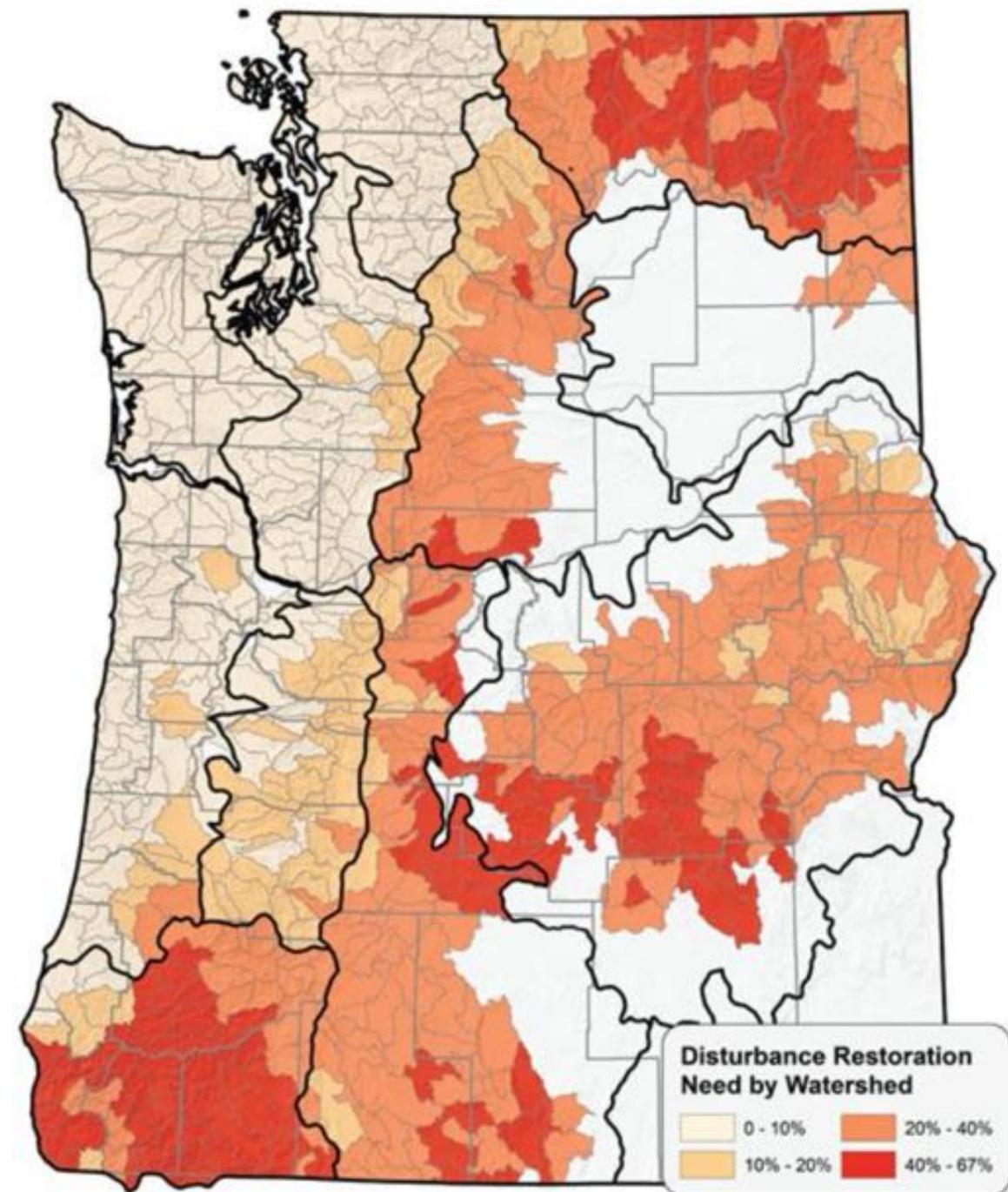
Logging, Grazing, **Fire-Suppression,**

Frequent Fire, Fuel-Limited Regime, Tree Scale

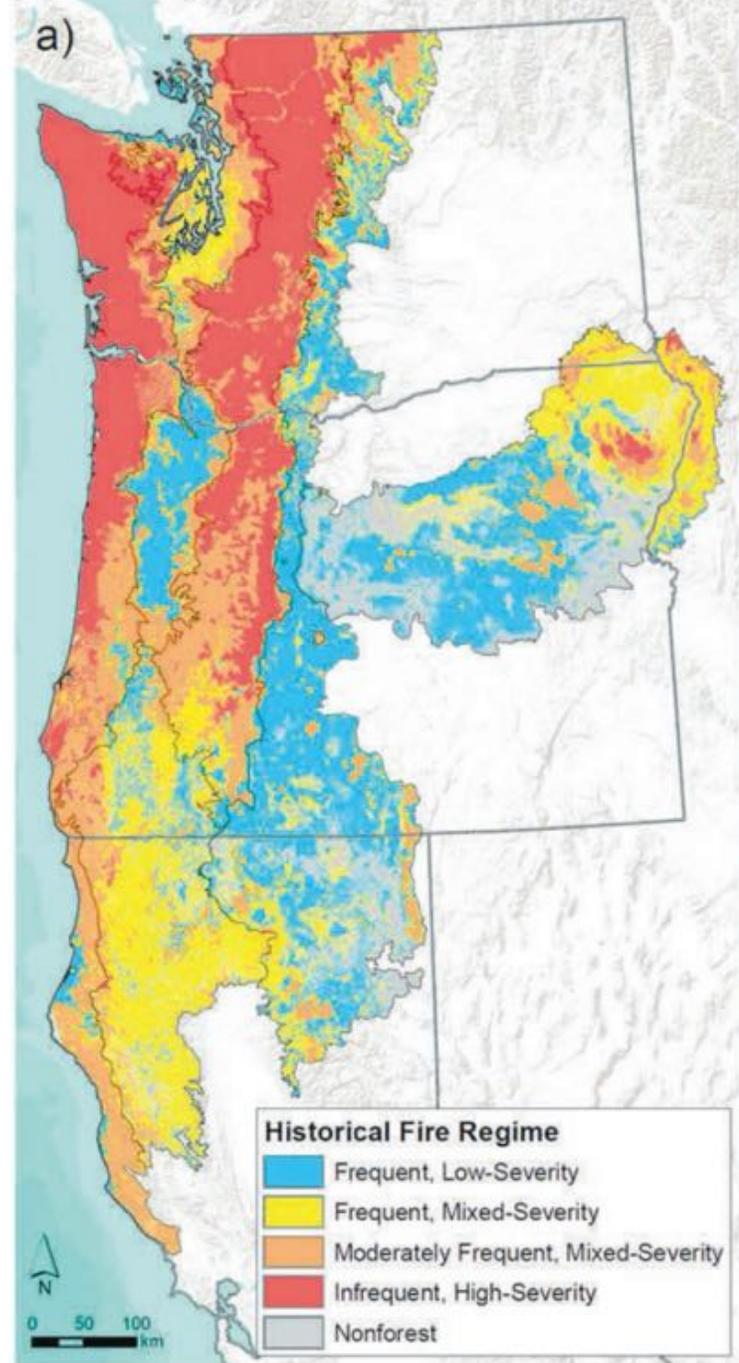


Infrequent Fire, Climate-Limited Regime, Patch Scale





Source: De Meo et al., 2018



Source: Reilly et al., 2021

# The Story of Wildfire in Mesic Conifer Forests

(Western Oregon and Washington)

- ❖ Compared with dry-to-moist forests, fire regime minimally impacted by management (i.e., suppression)
- ❖ Historically too wet to burn most of the time
- ❖ Very large and severe fires are common but have occurred infrequently (100-500+ yrs)
- ❖ These fires occurred when extremely dry fuels, strong winds, and ignition(s) synchronized
- ❖ However, we know less about smaller/more frequent events

***Climate-Limited* Wildfire Regime**  
(i.e., wildfire is limited by fuel moisture)



**50 – 200+ yr Fire Interval**

# Current Wildfire Regimes – Burn Severity Patterns



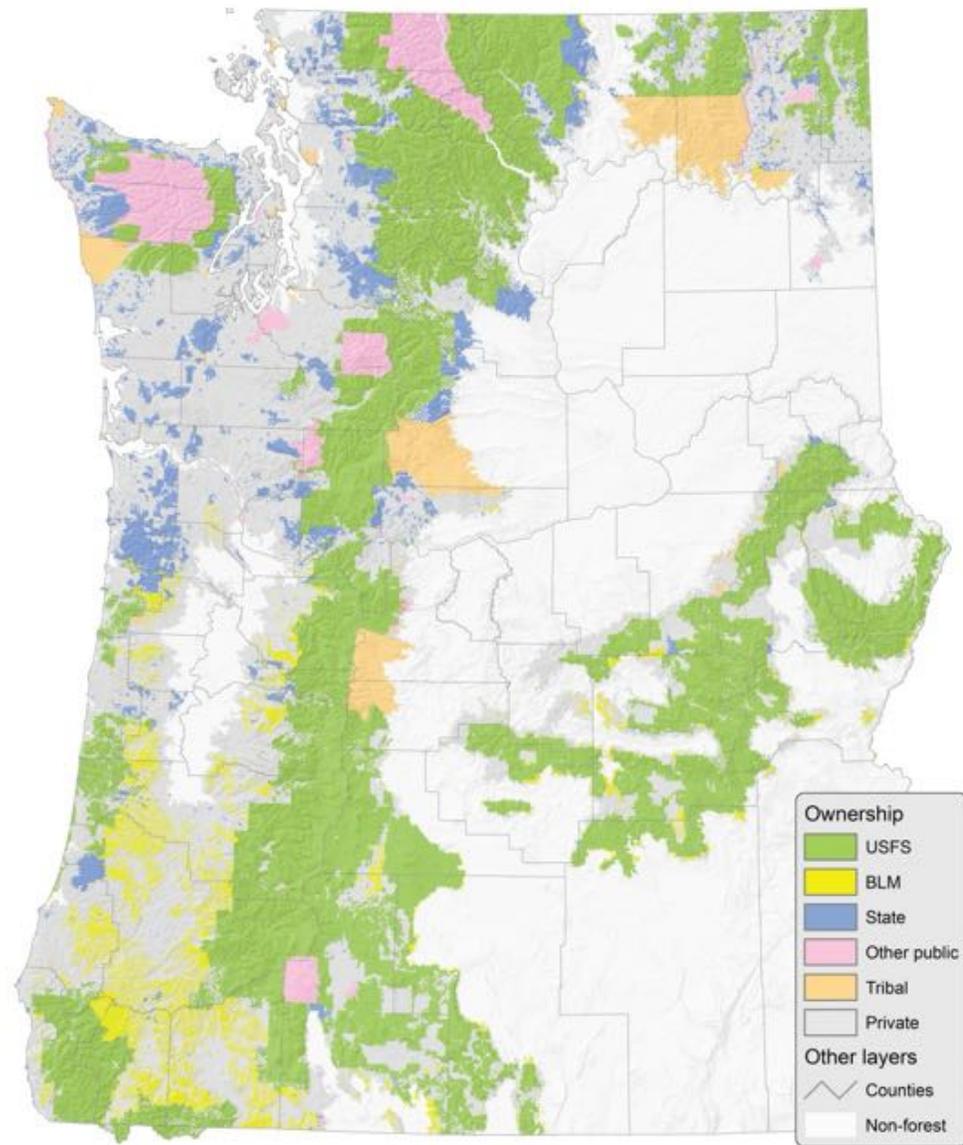
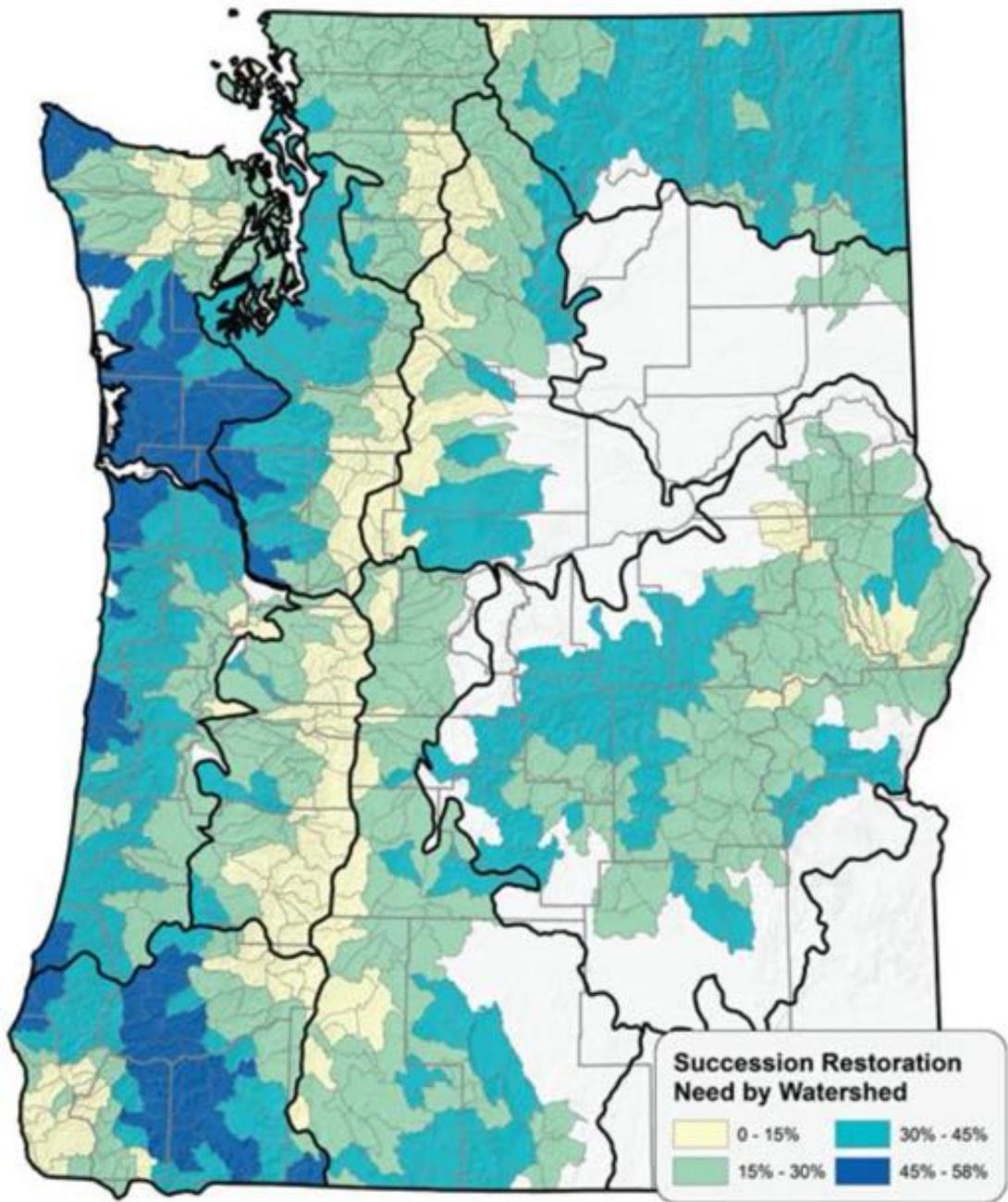
Logging and industrial landscape-scale plantations.

## Mesic Conifer Forest



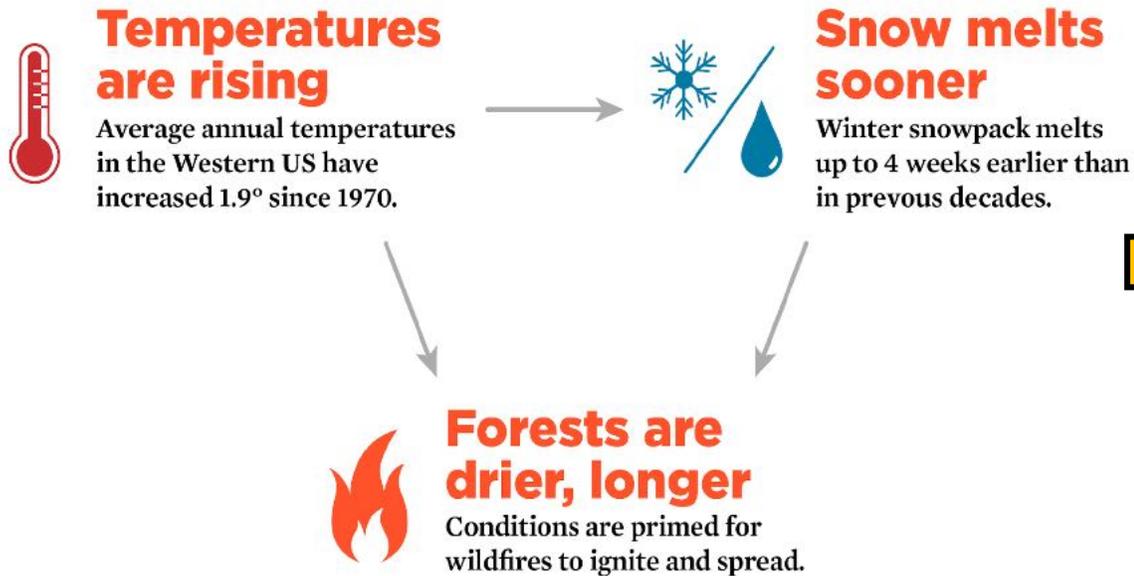
~~Infrequent Fire, Climate-Limited Regime, Patch Scale~~





Source: De Meo et al., 2018

# Climate Change is Increasing Fire Activity in Mesic Conifer Forests

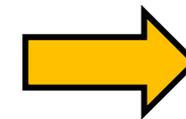


<https://www.ucusa.org/resources/infographic-wildfires-and-climate-change>

Remember that historically, fuel moisture were the main fire limitations in these forests..



1/12

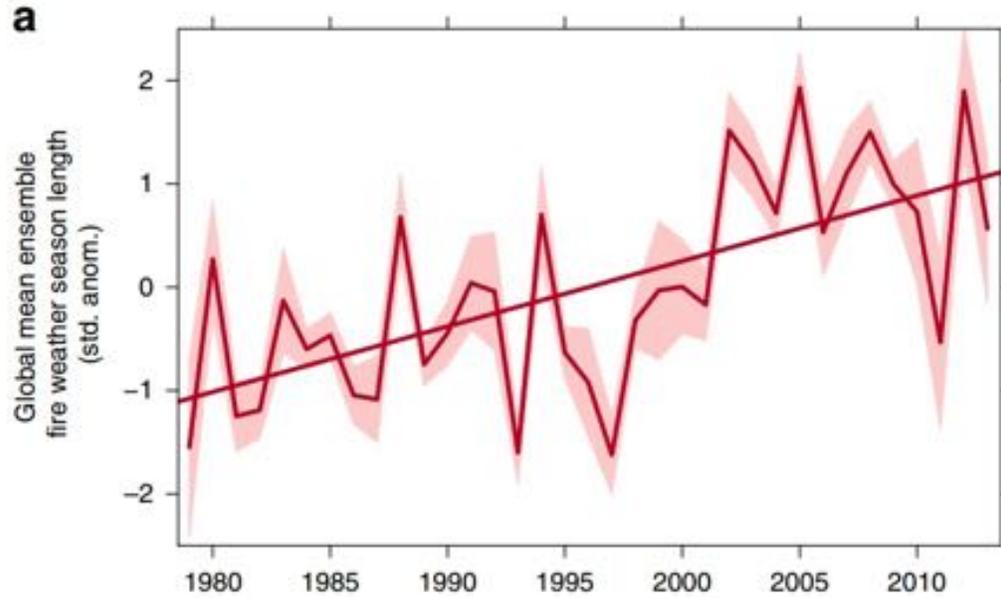


Increased  
Probability

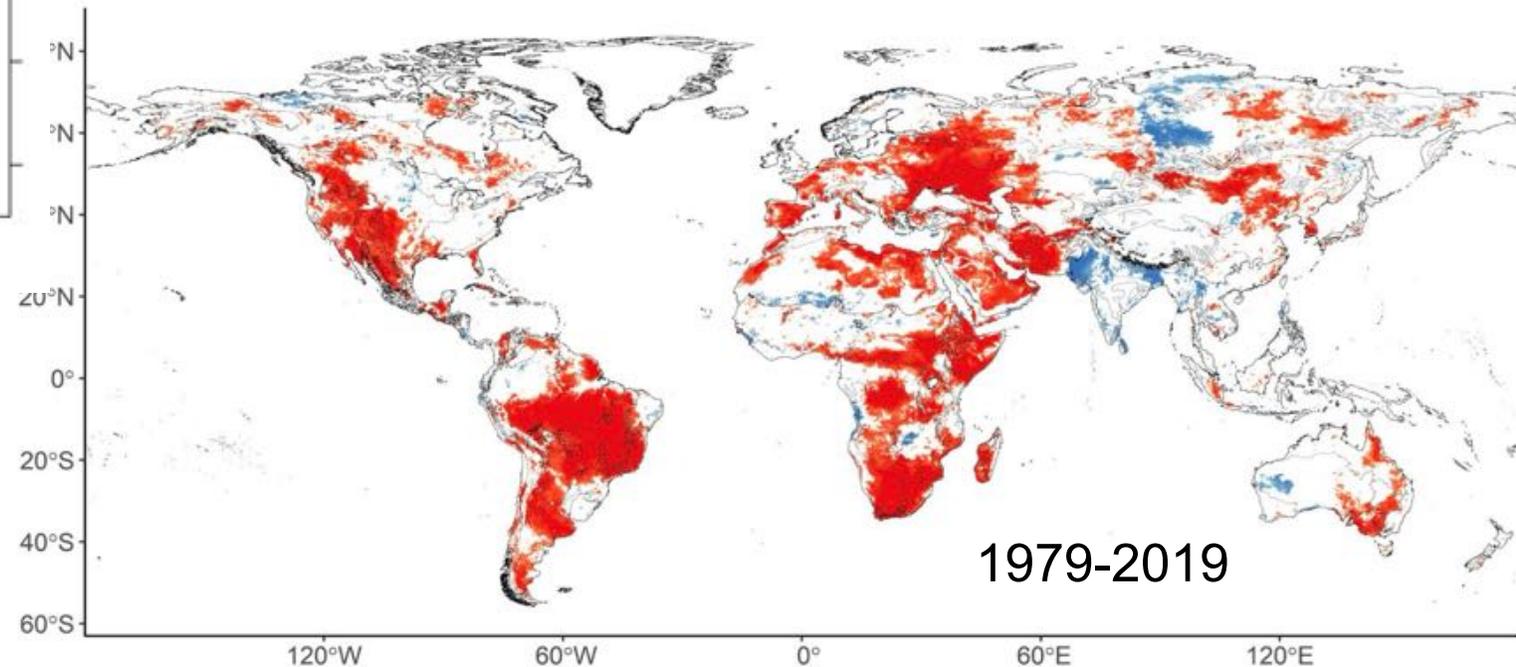


1/6

# Fire Season Length and Aridity Dryness: A Global Trend



## Mean Fire Season

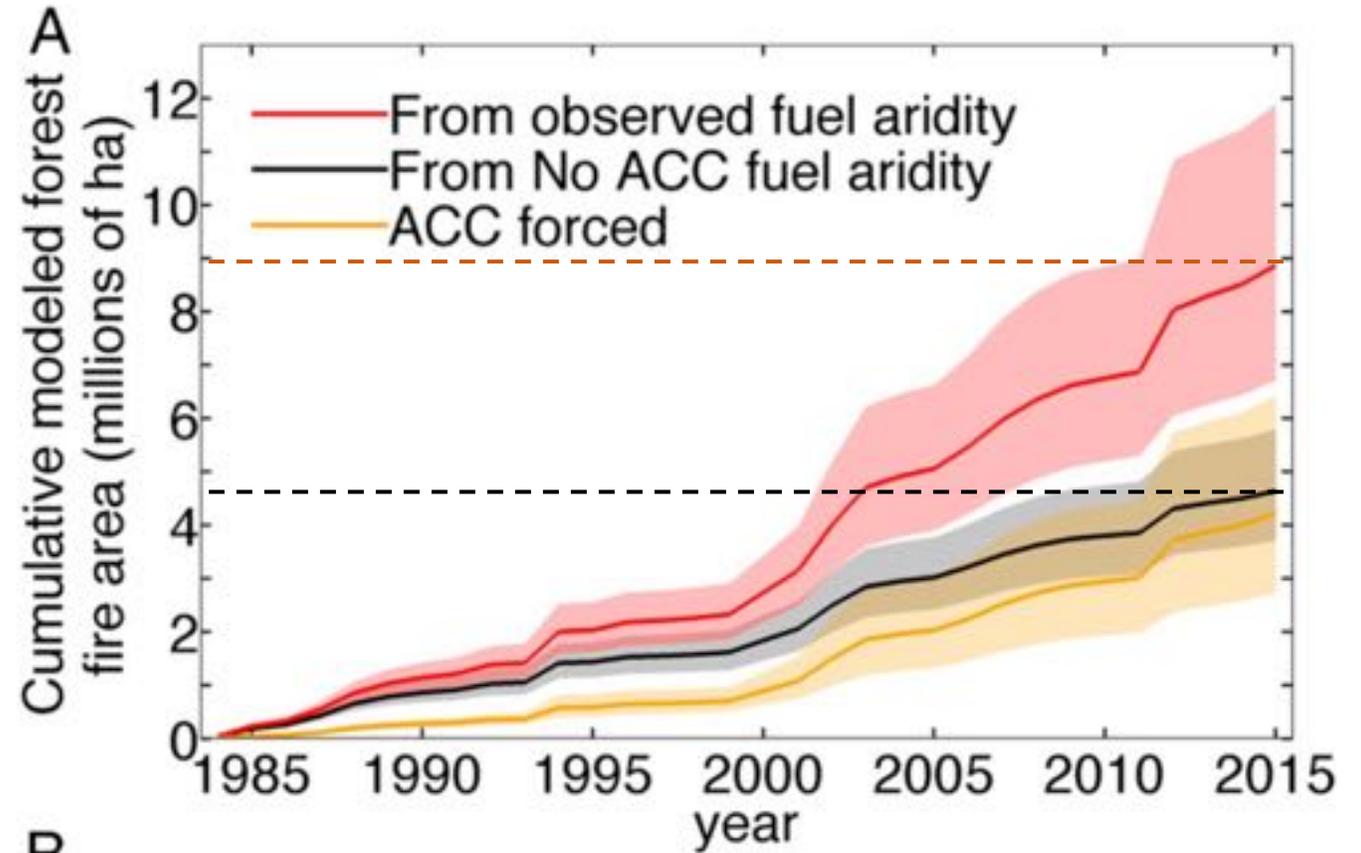


Atmospheric aridity ('thirstiness'): one key factor behind surge in frequency and severity of wildfires



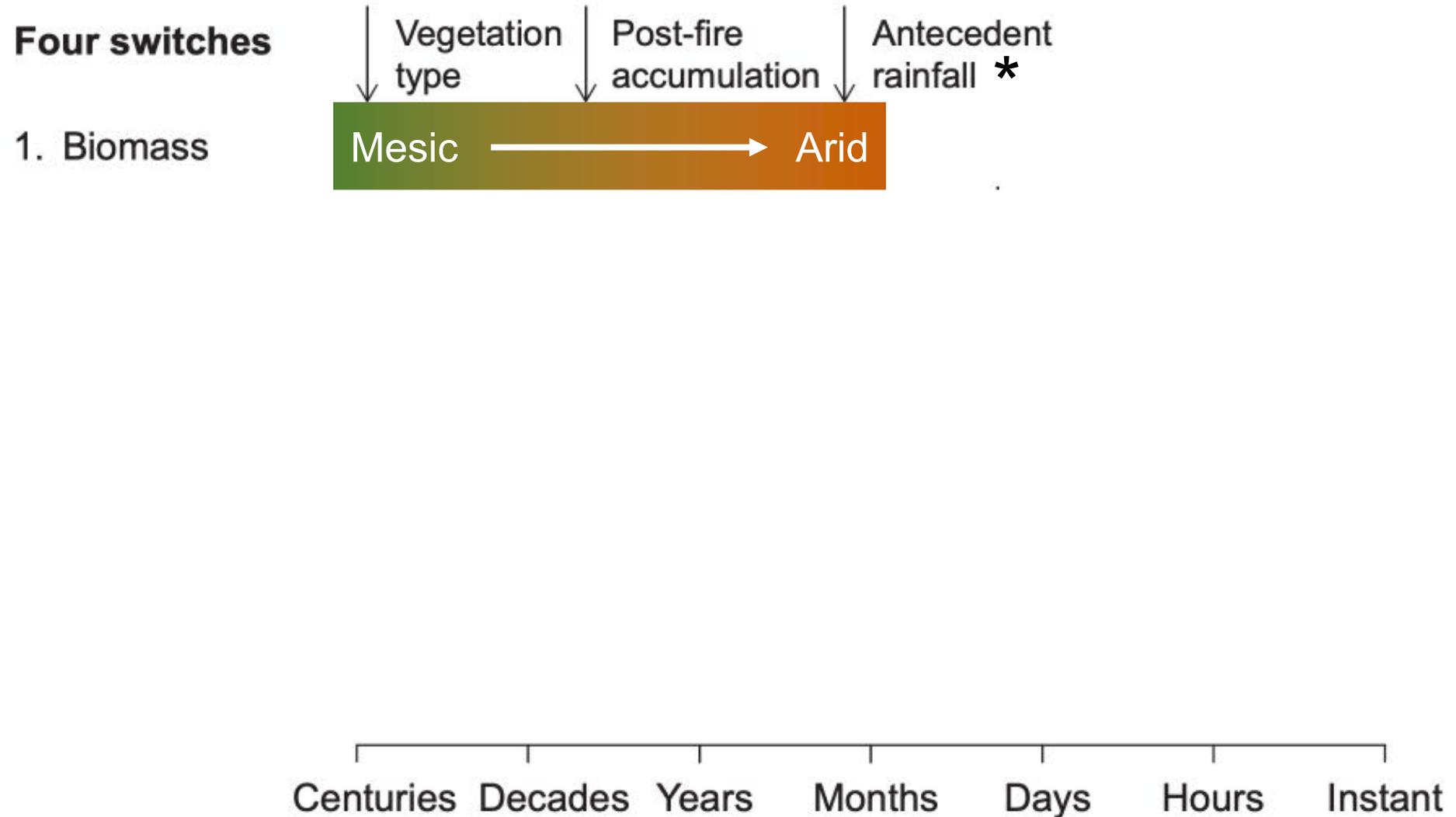
# Across the Western US due to Anthropogenic climate change

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

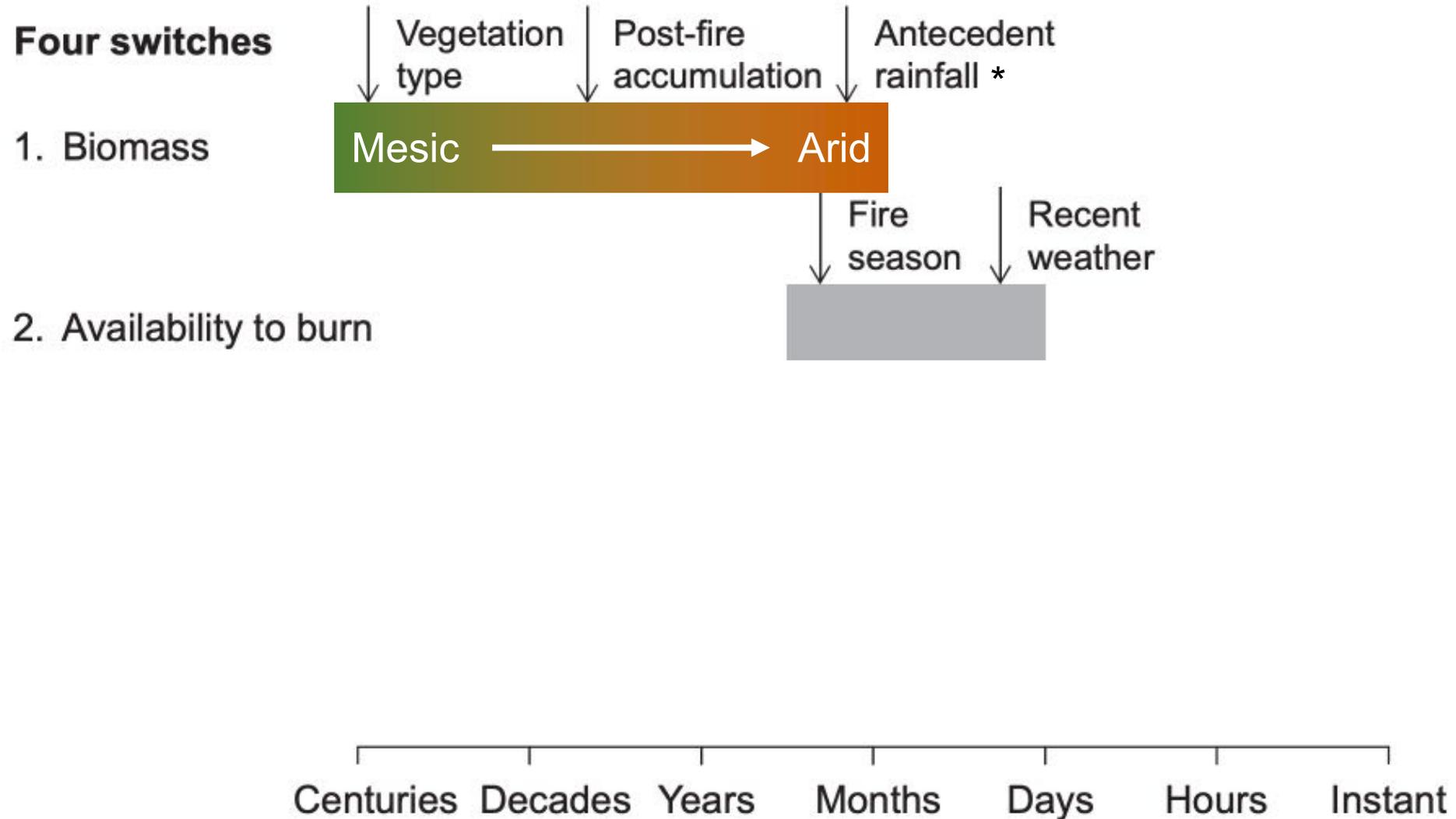


Abatzoglou and Williams, PNAS, 2016

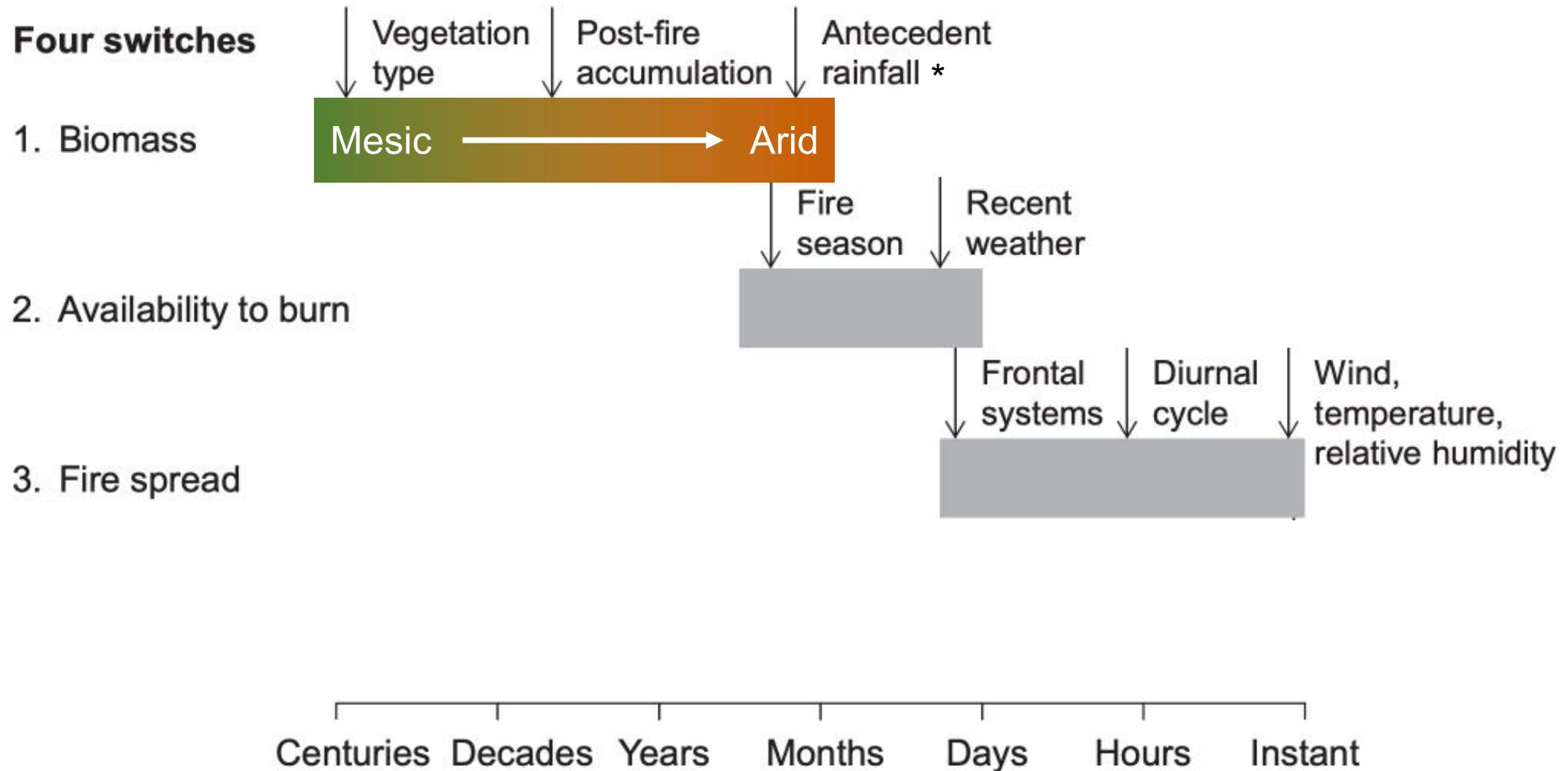
# Fire ecology 201: From Biomass buildup to Ignitions - Bradstock 2010's Four Switches of Fire Activity



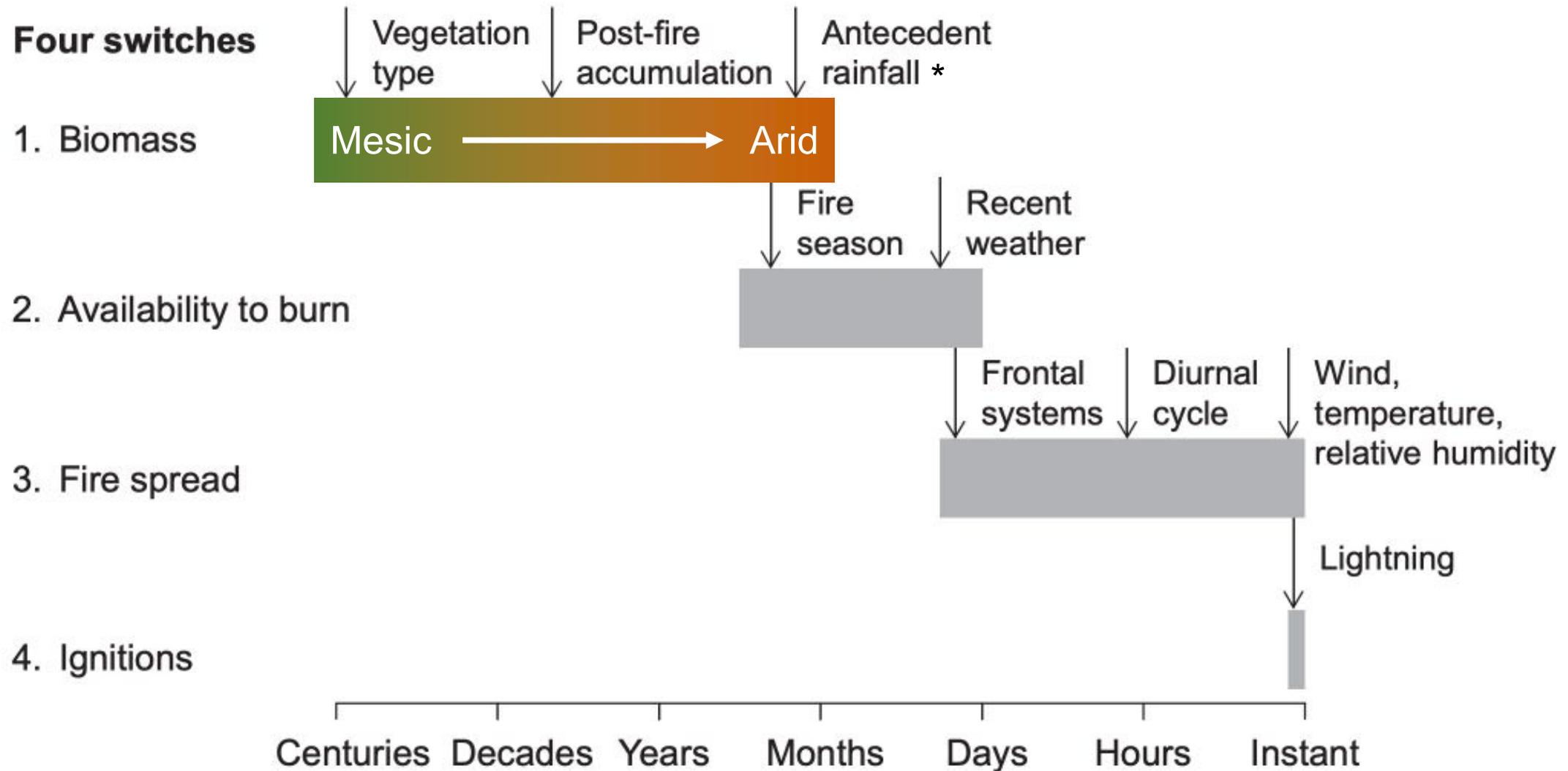
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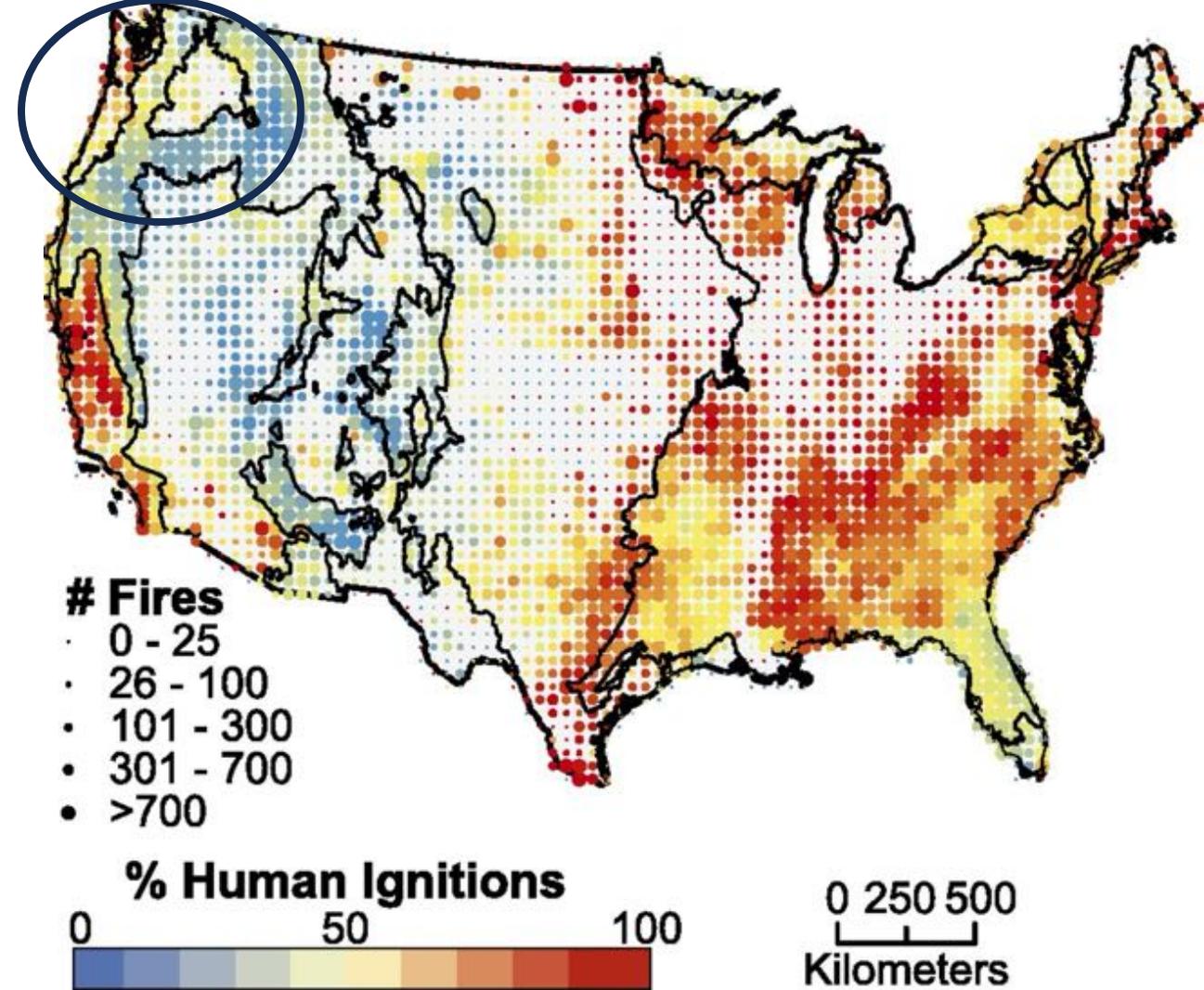


# Fire ecology 201: From Biomass buildup to Ignitions - Bradstock 2010's Four Switches of Fire Activity



# The (spatial) Geography of Ignitions

- PNW
  - Westside: Mostly humans
  - Eastside: Mostly lightning

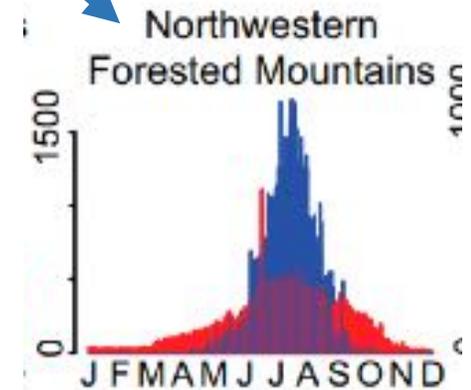
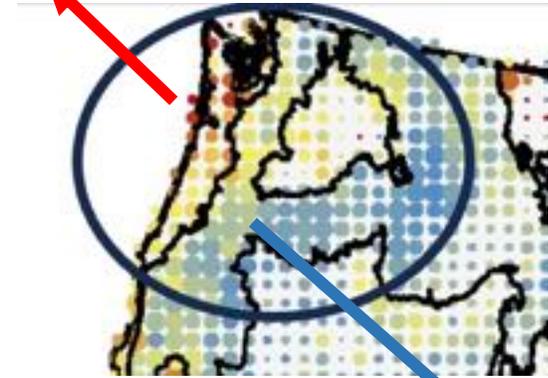
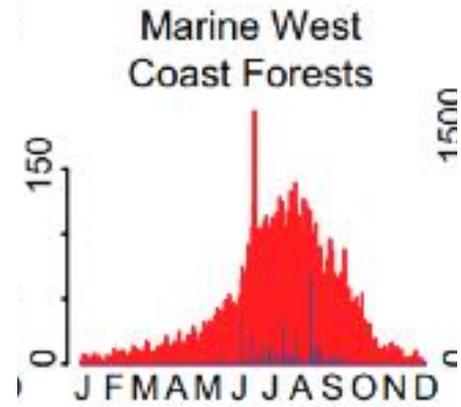
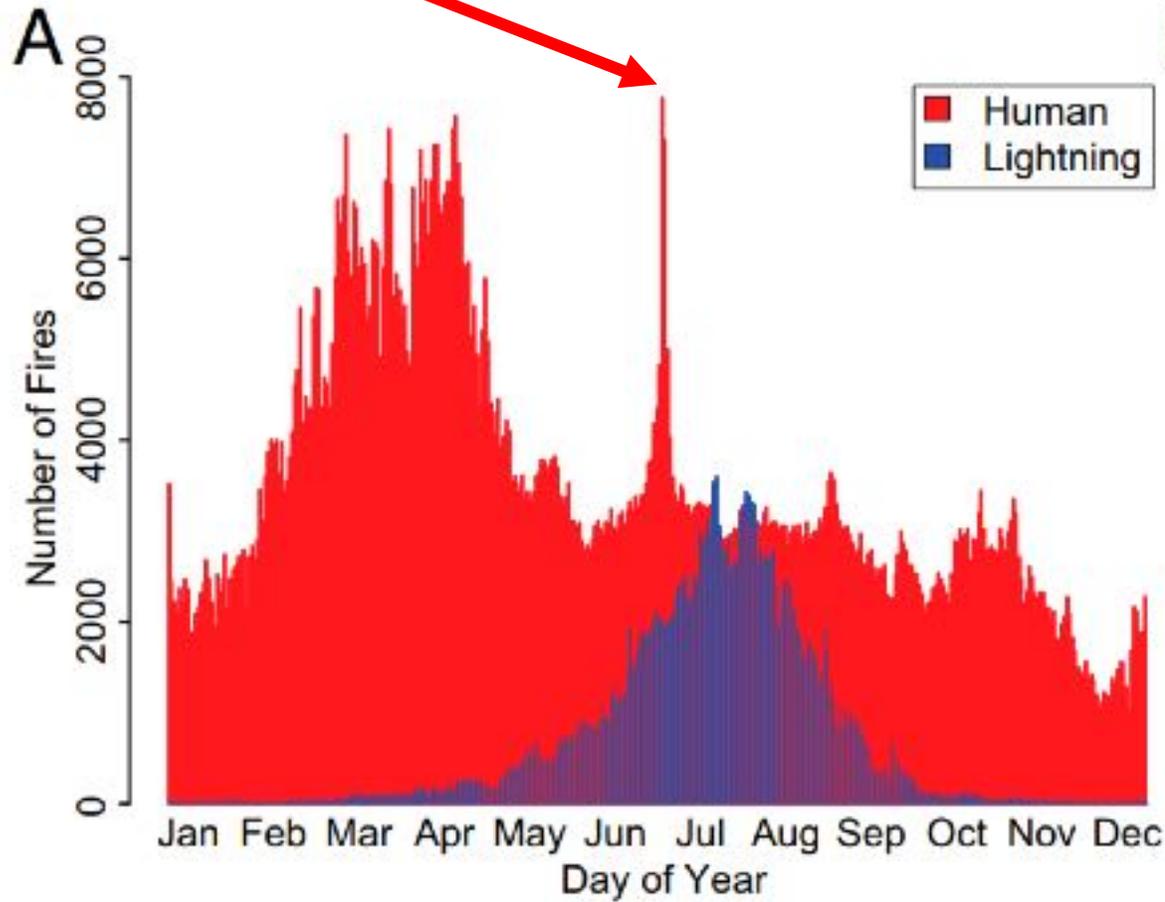


## The (temporal) Geography of Ignitions

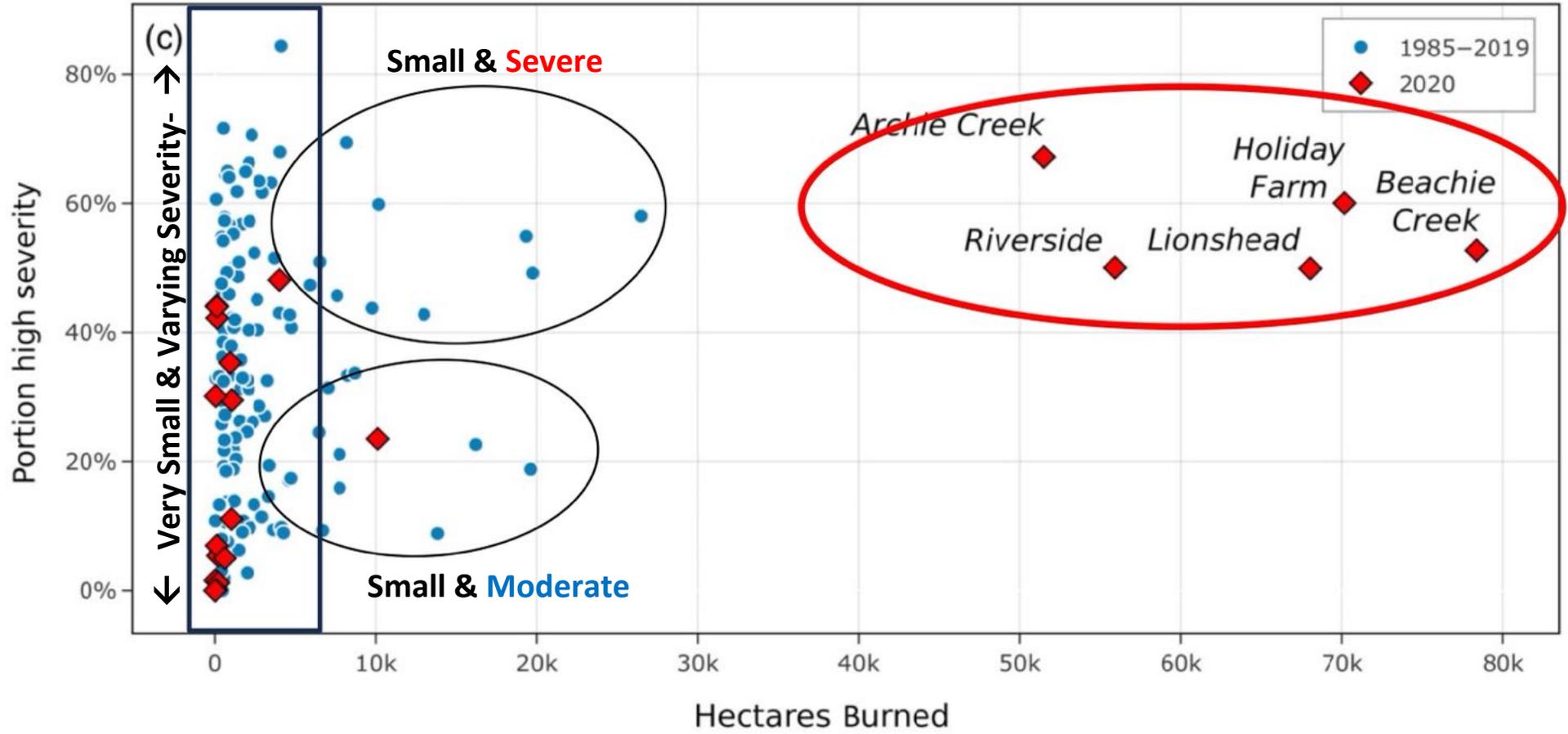
- When do most wildfire occur in the US?

# The (temporal) Geography of Ignitions

- When do most wildfire occur in the US?



# Wildfire Archetypes in Westside Oregon Forests



◆ 35 yrs of westside fire size and severity show at least 3-4 fire archetypes

# The 2020 Labor Day Fires



*(cooler)*

*cold air mass  
(high pressure)*

*East winds*

Beachie Creek

Riverside

Lionshead

Holiday Farm

Archie Creek

*(wetter)*

*(drier)*

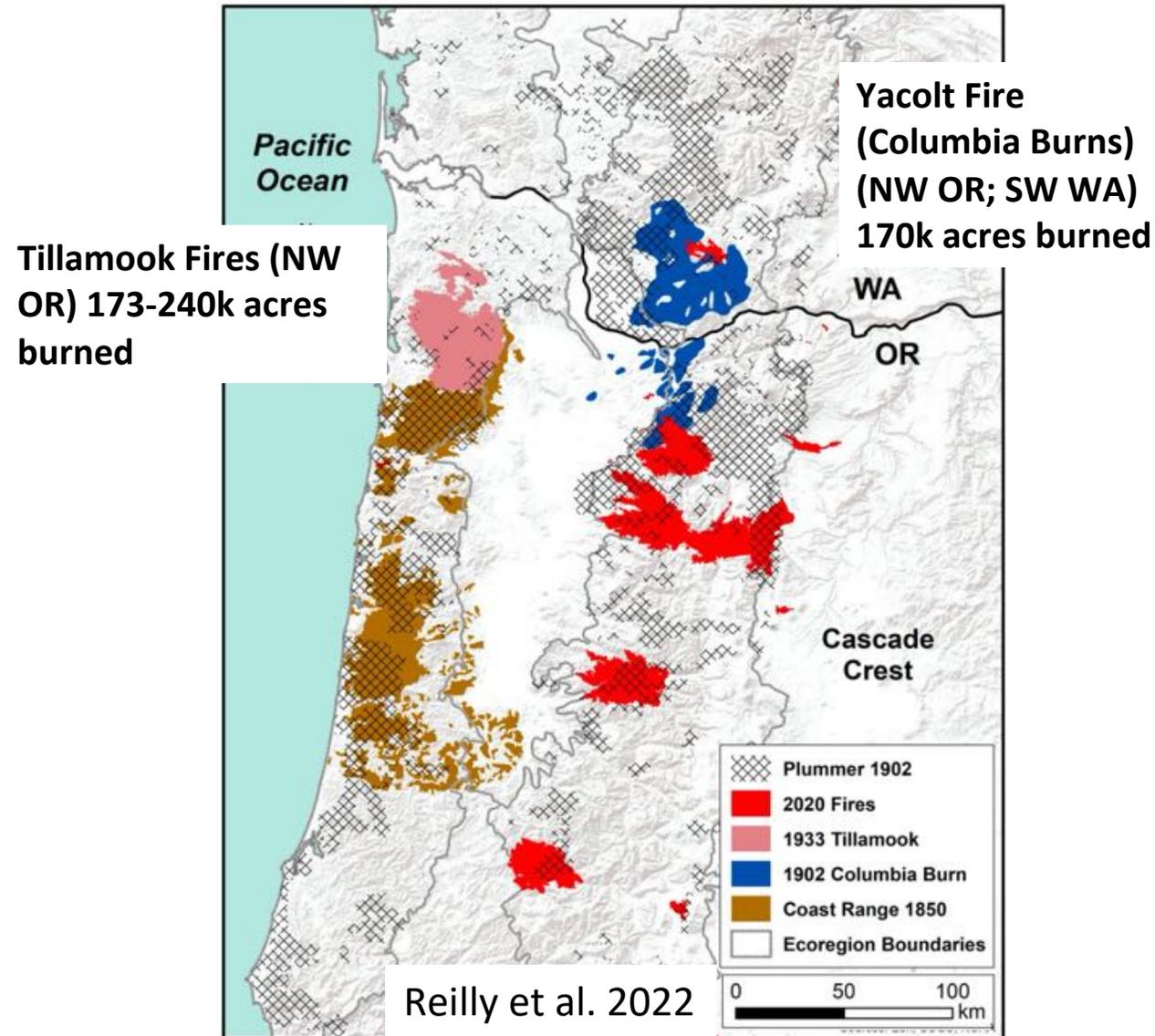
*warm air mass  
(low pressure)*

*(warmer)*

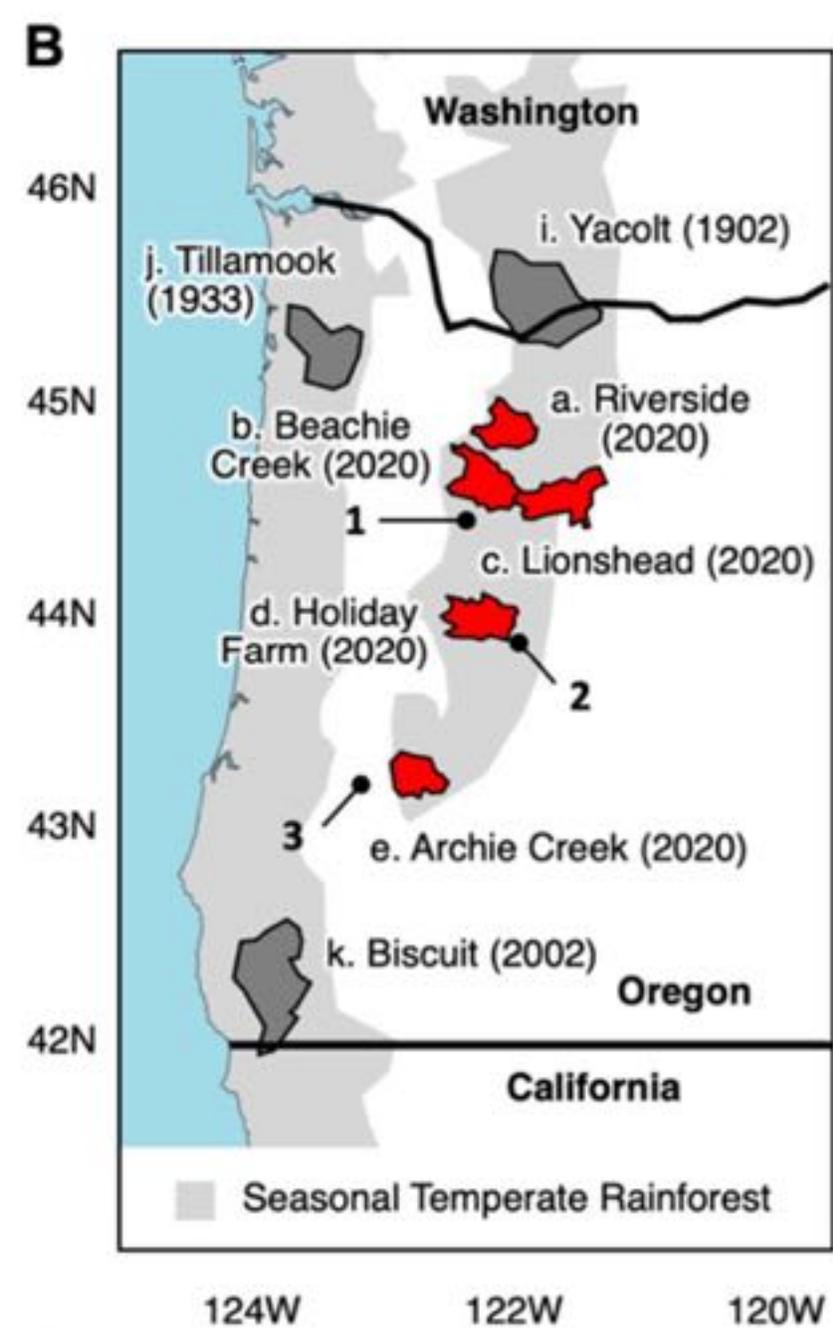


September 8th, 2020

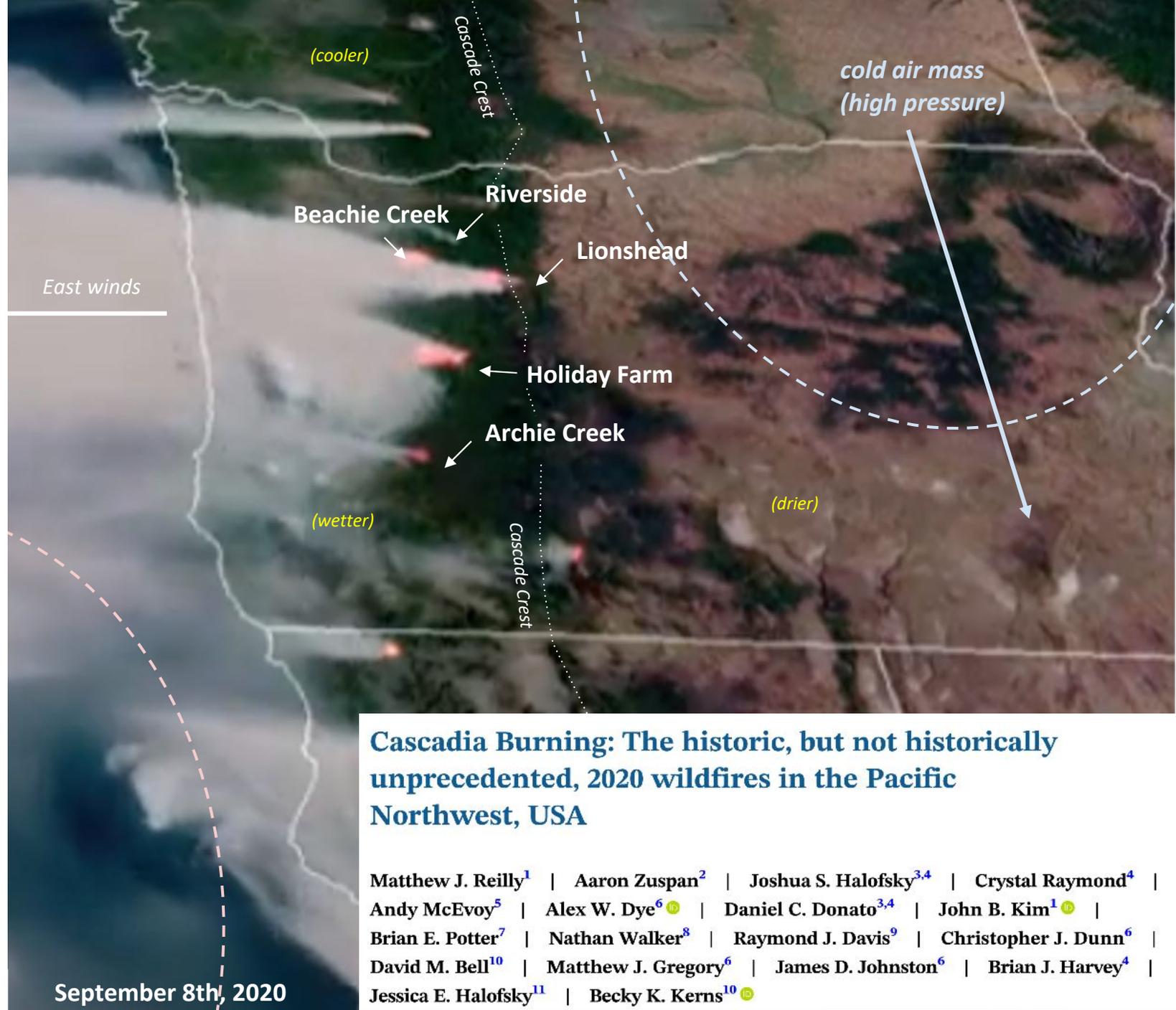
# Megafires in Western Oregon: Anomalous or Routine?

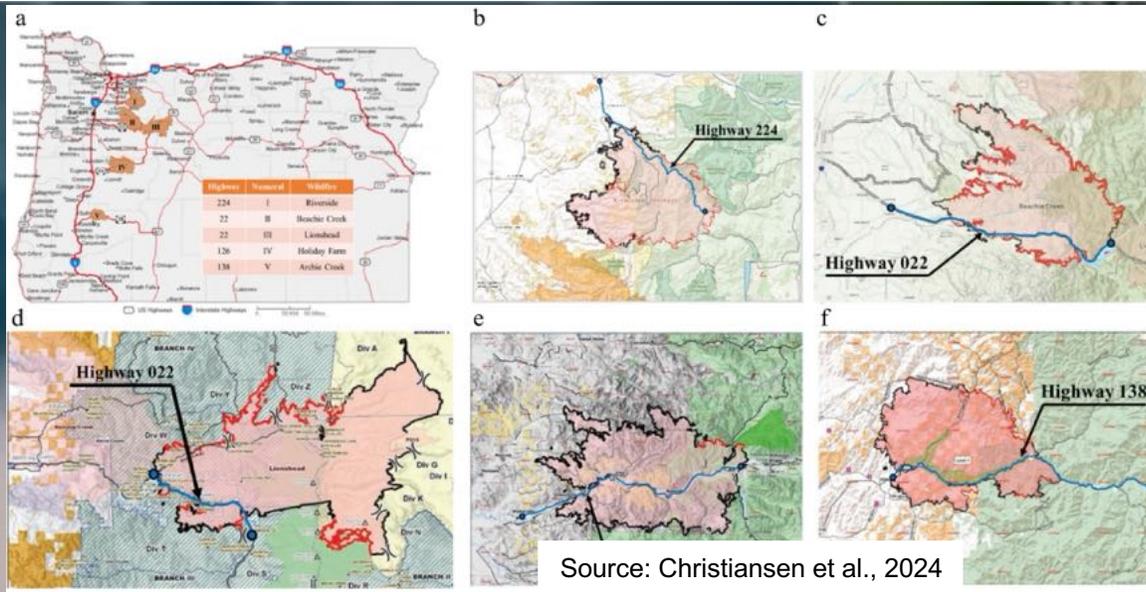


- ❖ Current evidence and theory point to infrequent megafires occurring pre- and post- Euro-American settlement in W. OR/WA.
- ❖ Several megafires occurred during the 20<sup>th</sup> century; e.g., the 1902 Yacolt and 1933-1945 Tillamook fires.
- ❖ Anecdotal evidence says fires occurred under extreme easterly winds, late-summer drought conditions, and human ignitions.

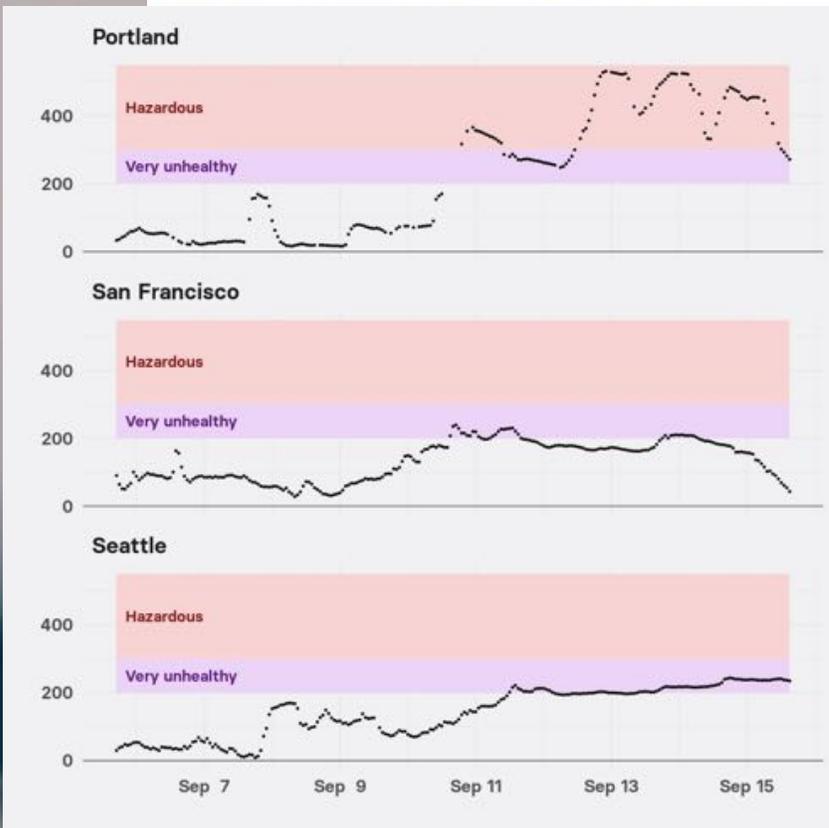


Source: Evers et al., 2022





Source: Christiansen et al., 2024



June 2024 | Volume 135, Number 5

# Journal AWWA

an official publication of the American Water Works Association

## Response to Oregon's 2020 Fires

p. 12

ALSO IN THIS ISSUE

- Treating Arsenic in Drinking Water
- Assessing Drinking Water Systems
- Lessons From 30 Years of Water Crises

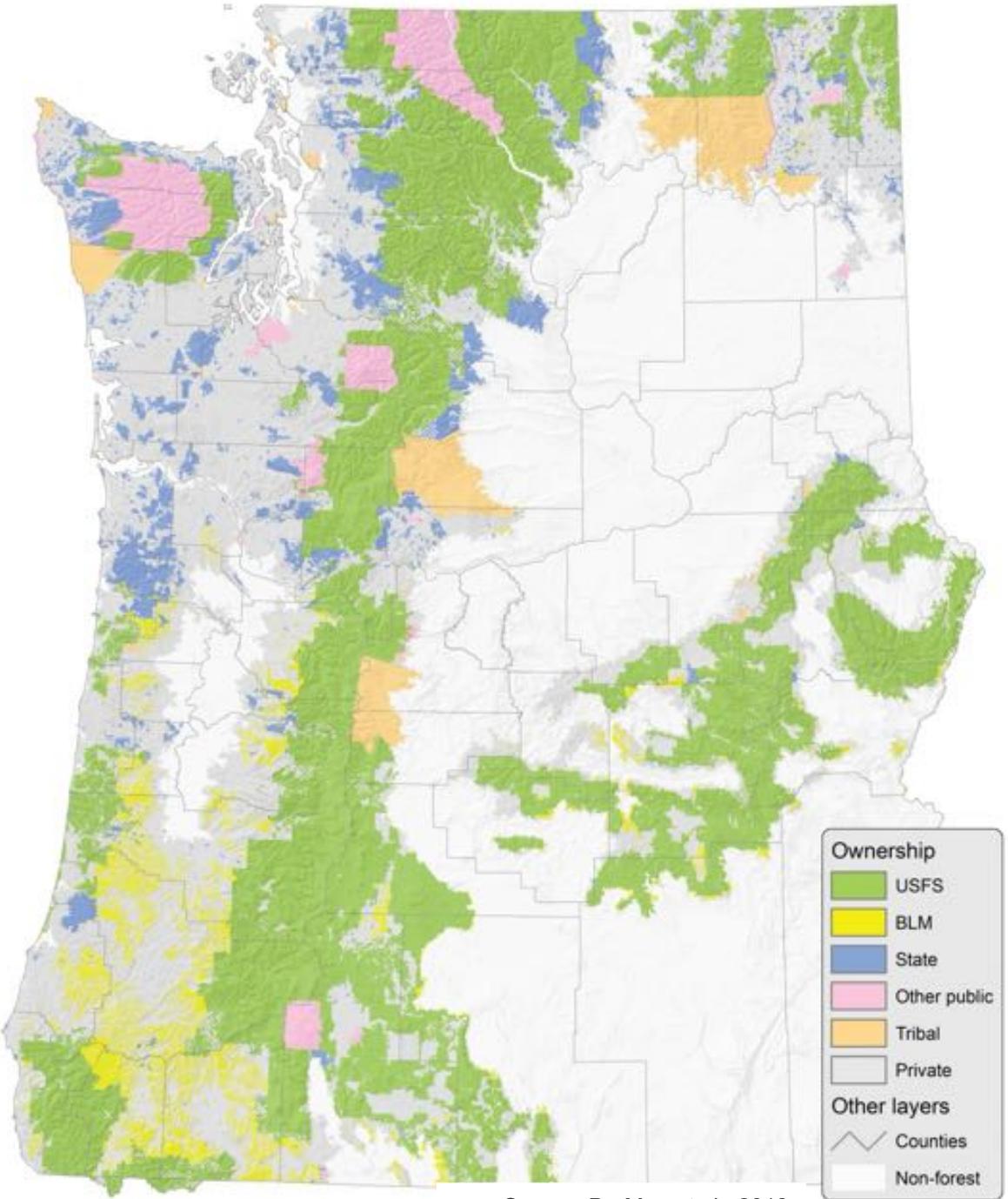
AMERICAN WATER WORKS ASSOCIATION | WILEY

### True Costs of Labor Day Fires Will be Linked to Source Water Supply

Initial estimates from OWUC that ~23 small utilities affected by OR wildfires in 2020  
Includes source water supply for Salem and Eugene

Kevin D. Bladen

September 8th, 2020



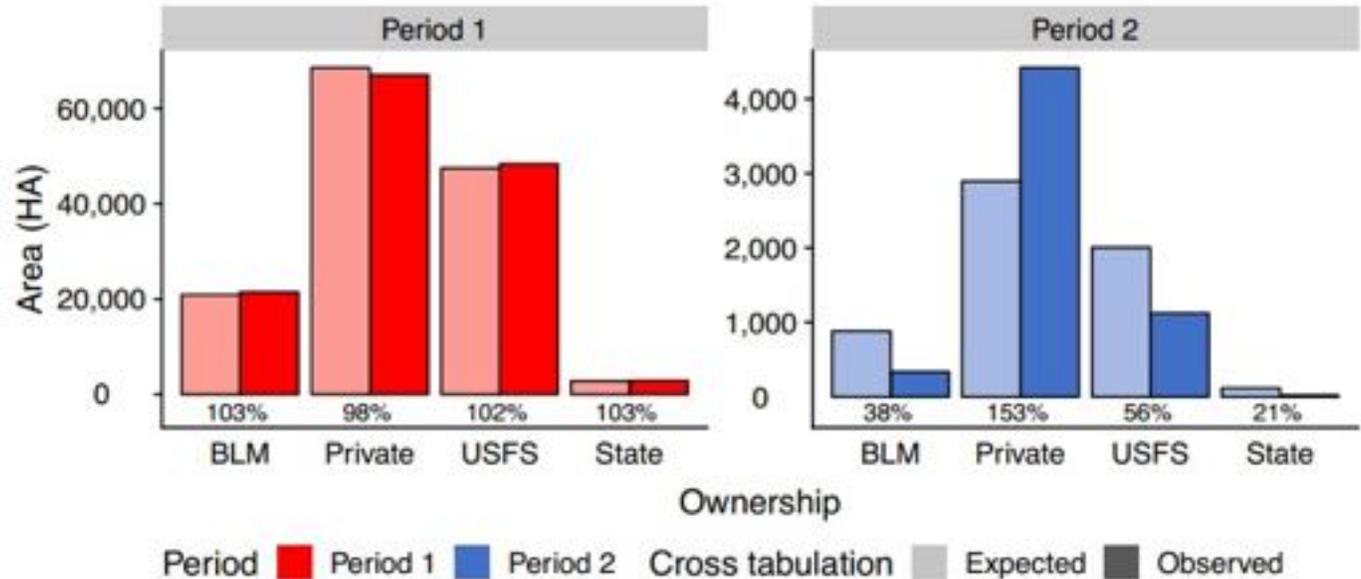
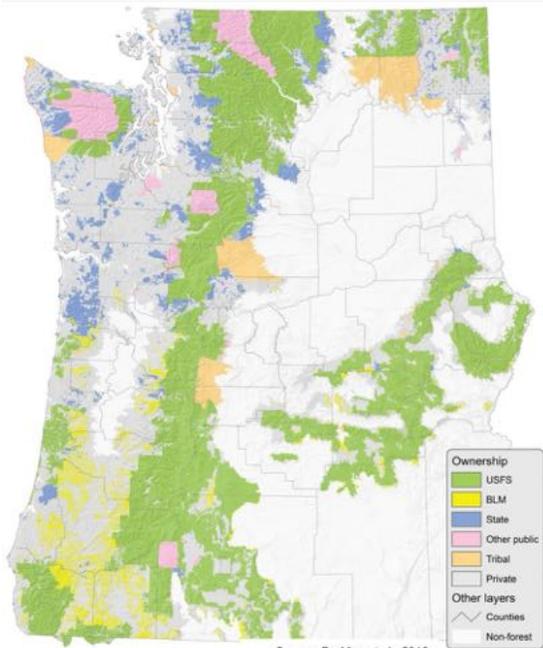
- ❖ Extensive logging removed most old-growth forest in the 1970s and 1980s
- ❖ Substantial increase in private-owned forest plantations (1970 – early 1990s)

Source: De Meo et al., 2018

# What Factors Drove High\* Burn Severity During Labor Day 2020 Fires?

(\* >75% Tree Mortality from Fire Effects)

❖ Young and short forests, concentrated in private timber plantations, were more likely to burn severely during and especially after the windstorm subsided



**Figure 4.** Area of high severity fire (hectares) for BLM (BL), USFS (FS), and private (PR) as observed (darker color) versus as expected (lighter color) based on the individual proportions for weather period and land ownerships. Observed and expected values deviate markedly across all ownership in period 2 (reported as a percent under each set of bars), with much less high-severity fire for BLM, USFS, and state, and much more in private lands.

Source: Evers et al., 2022

# Where things stand today: cutting edge science of Reburns (Short-Interval Fires)

Dry Conifer Forest



Mesic Conifer Forest



## Negative feedback

- ❖ Once burned, slow-growing fuel buildup for longer time (due to aridity)
- ❖ Results in 'free/low-fire island' avoiding future fires for up to 13-36 yrs

## Positive feedback

- ❖ Once burned, quickly builds up finer fuel that dries faster (productive sites!)
- ❖ Results in 'highly flammable island' attracting future fires for up to 20-40 yrs

# Summary

- Fire Ecology can help by ‘unpacking’ mechanisms behind wildfire
- PNW: One Region with Very Different Fire Regimes – No Silver Bullet
- Wildfire architypes and controllers: Not Just Extreme East winds
- Reburns: Build strategies around these

Thanks!  
Questions?

[andres.holz@pdx.edu](mailto:andres.holz@pdx.edu)