Changing wildfires, changing forests: the effects of climate change on fire regimes and vegetation in the PNW



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Fire Ecology

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Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA

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Abstract

Background: Wildfires in the Pacific Northwest (Washington, Oregon, Idaho, and western Montana, USA) have been immense in recent years, capturing the attention of resource managers, fire scientists, and the general public. This paper synthesizes understanding of the potential effects of changing climate and fire regimes on Pacific Northwest forests, including effects on disturbance and stress interactions, forest structure and composition, and post-fire ecological processes. We frame this information in a risk assessment context, and conclude with management implications and

NORTHWEST
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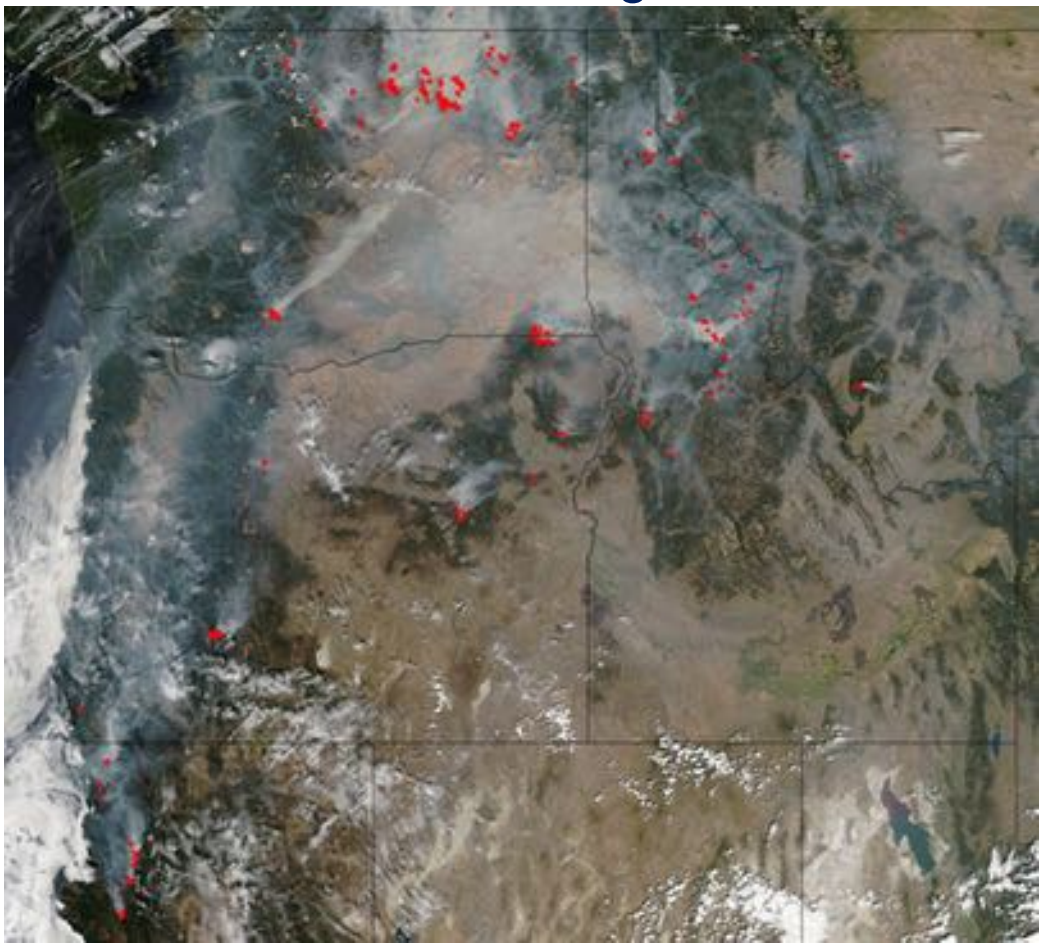
Some recent statistics:

In 2014, a record was set for the largest wildfire in Washington State history, the 256,100-acre Carlton Complex Fire

Some recent statistics:

In 2015, 1.7 million acres were burned in Oregon and Washington, with over 9 million acres burned in the western United States.

Pacific Northwest, August 30, 2015



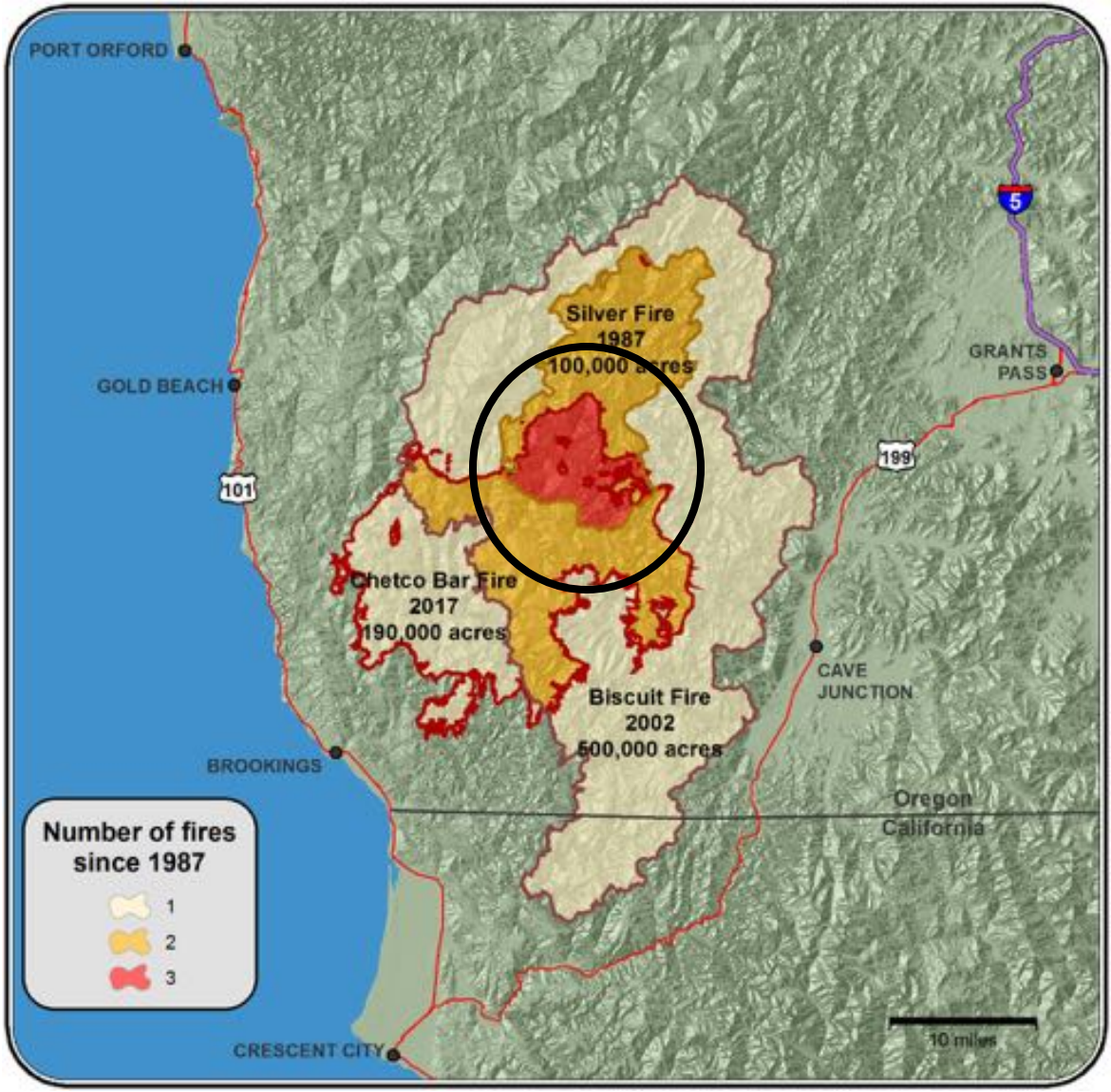
NASA MODIS

Several fires in 2015 occurred in west-side conifer forests, including a rare fire event in coastal temperate rainforest on the Olympic Peninsula.

Wildfires are colliding

<u>Southwest Oregon</u>

Fires have burned some areas 3 times since 1987

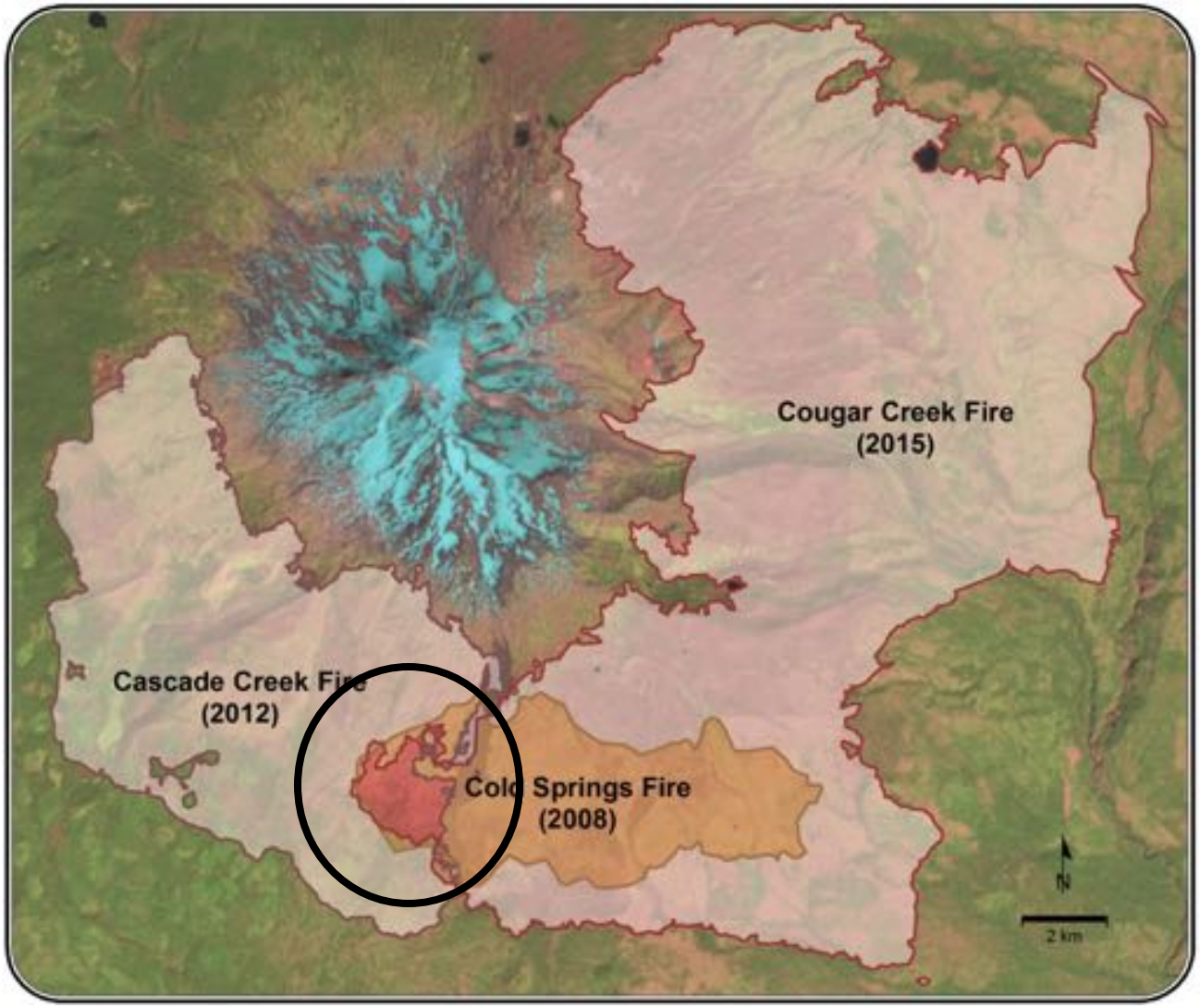


Map by R. Norheim

Wildfires are colliding

<u>Southwest Washington</u>

Fires have burned some areas 3 times since 2008



Map by R. Norheim

Wildfires are colliding

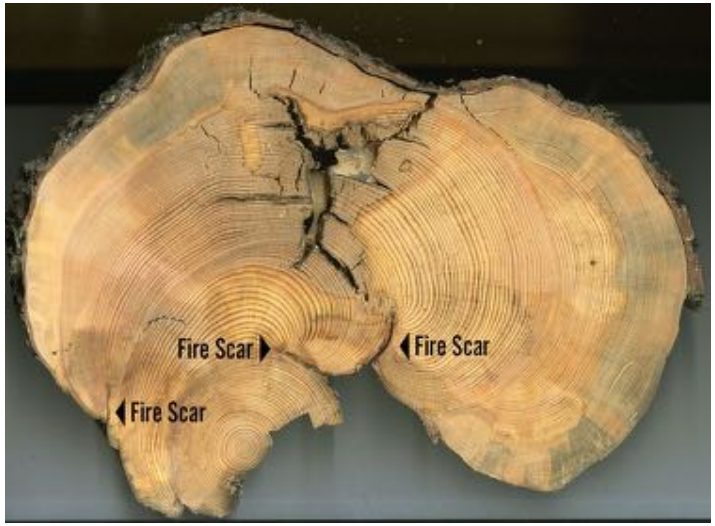
<u>Southwest Washington</u>

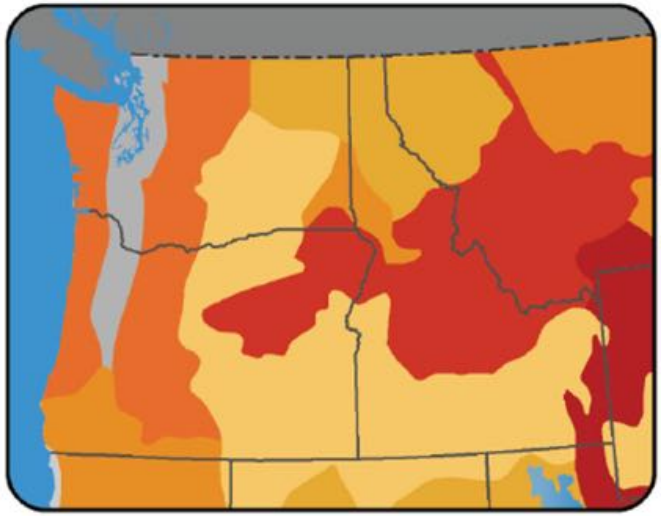
Fires have burned some areas 3 times since 2008

Map by R. Norheim

Information sources for climate change effects on fire:

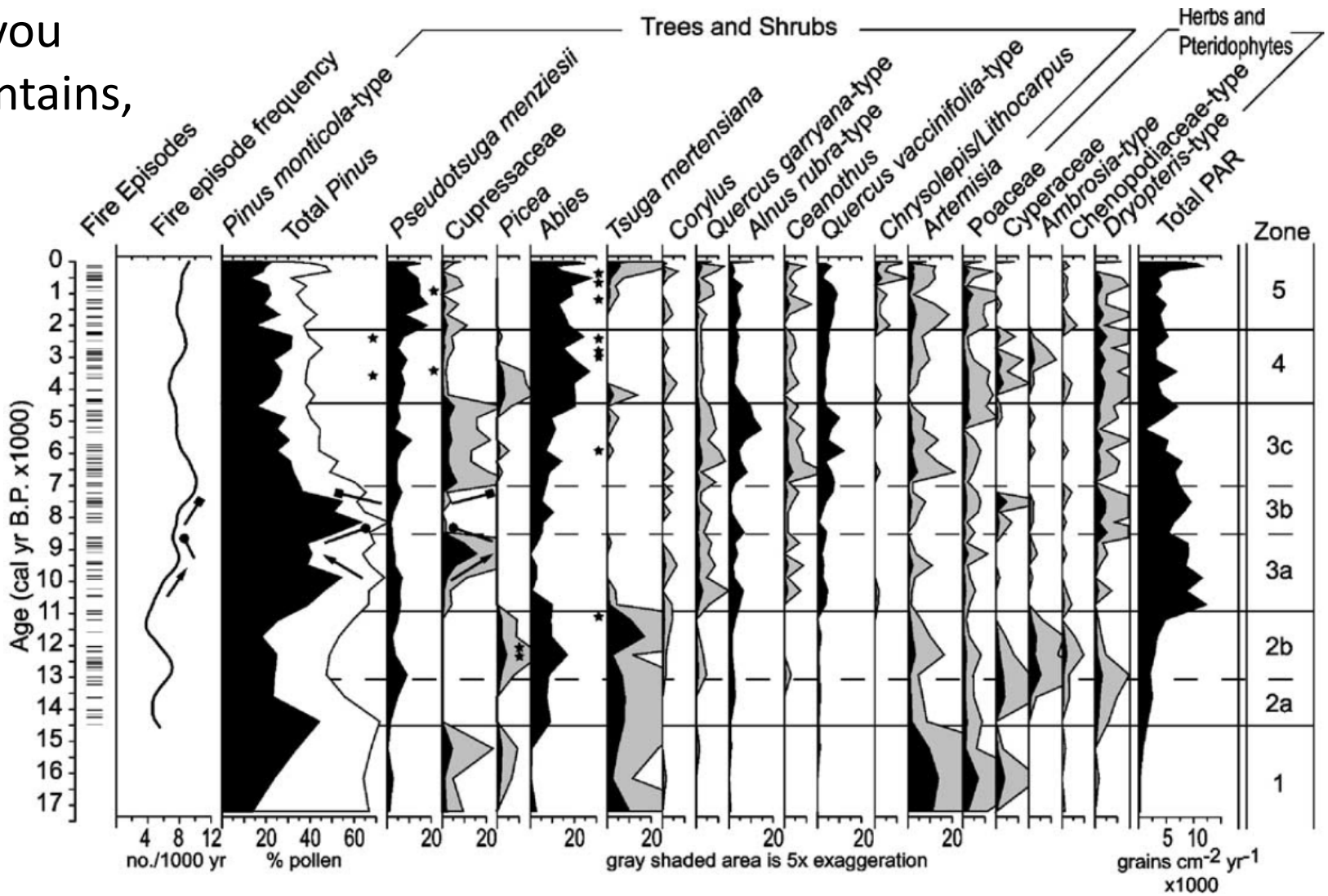
- Paleoecological record
- Tree ring records of fire
- Observed trends with recent warming
- Model projections





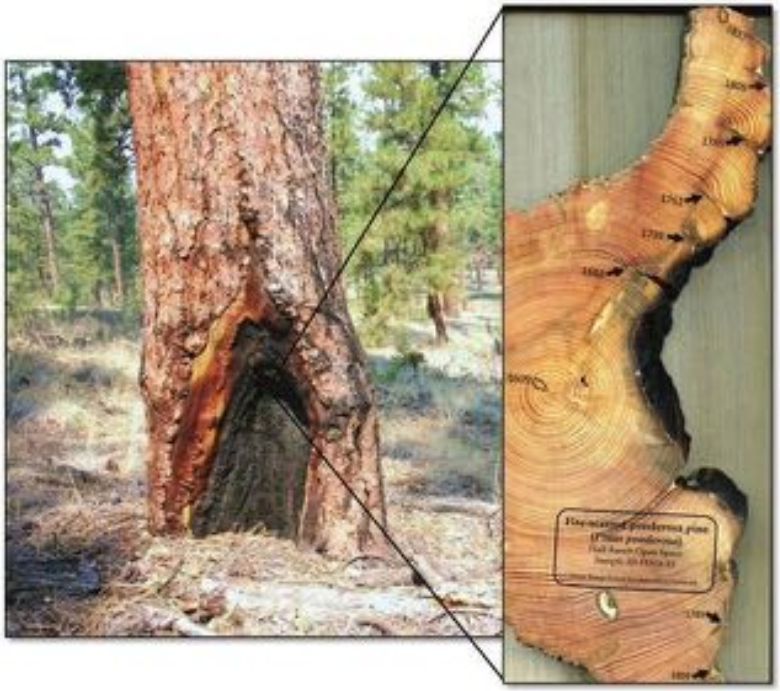
Paleoecological evidence of changing fire frequency with shifts in climate

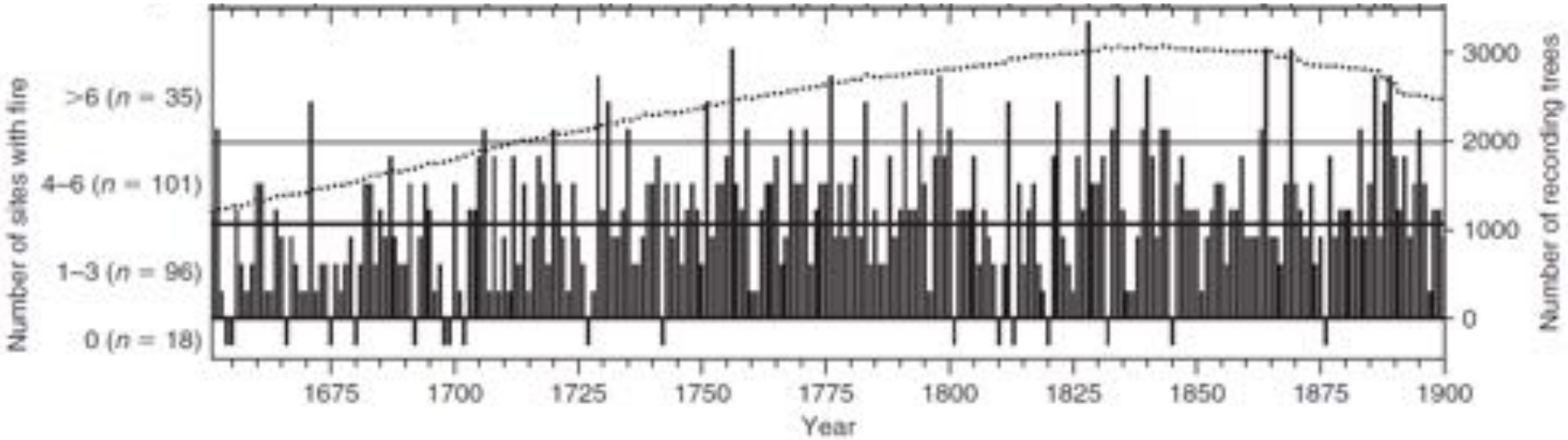
Siskiyou Mountains, OR



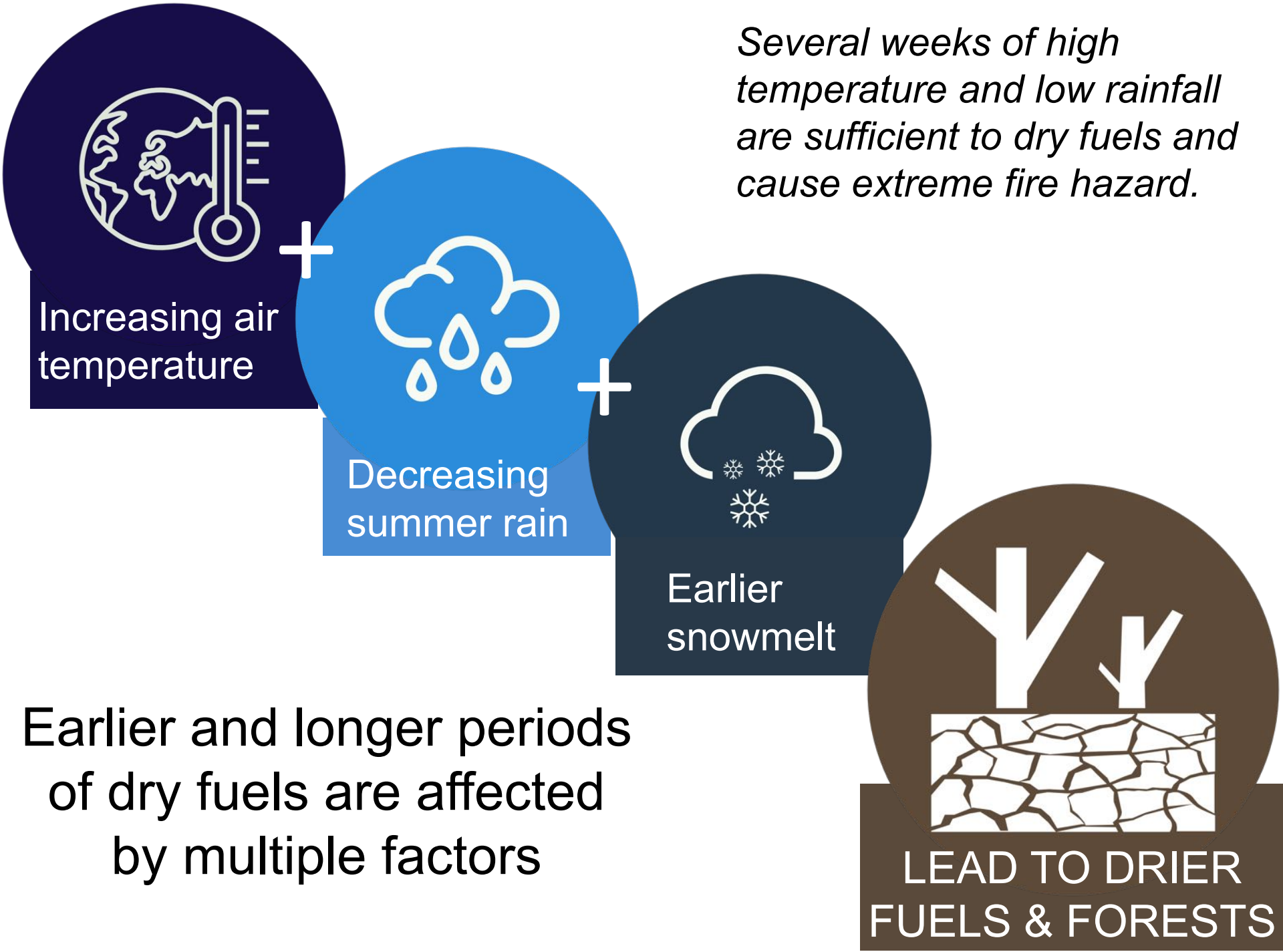
Briles et al. 2005

Tree ring records suggest greater fire frequency with warm and dry summers in the past



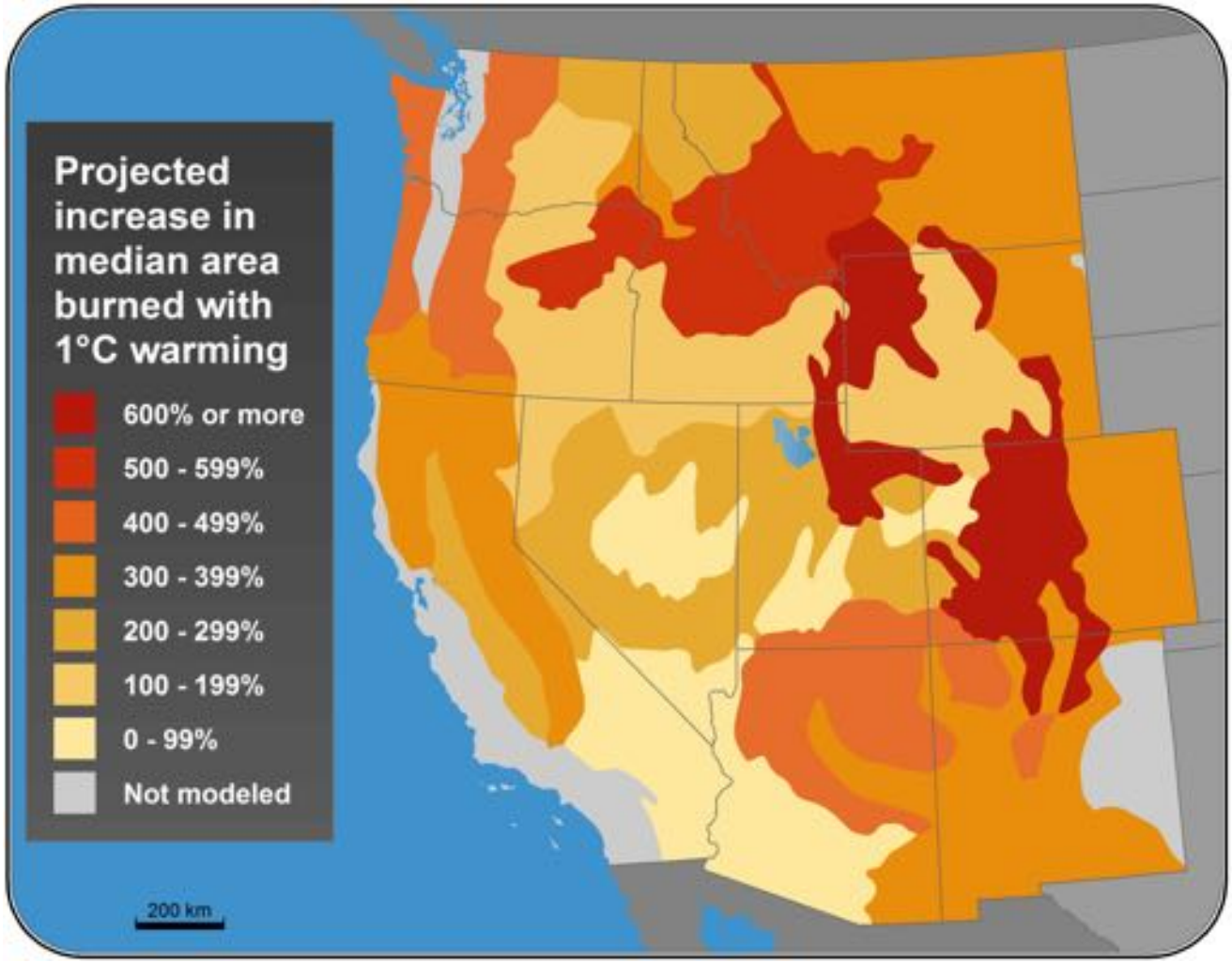


Several weeks of high temperature and low rainfall are sufficient to dry fuels and cause extreme fire hazard.

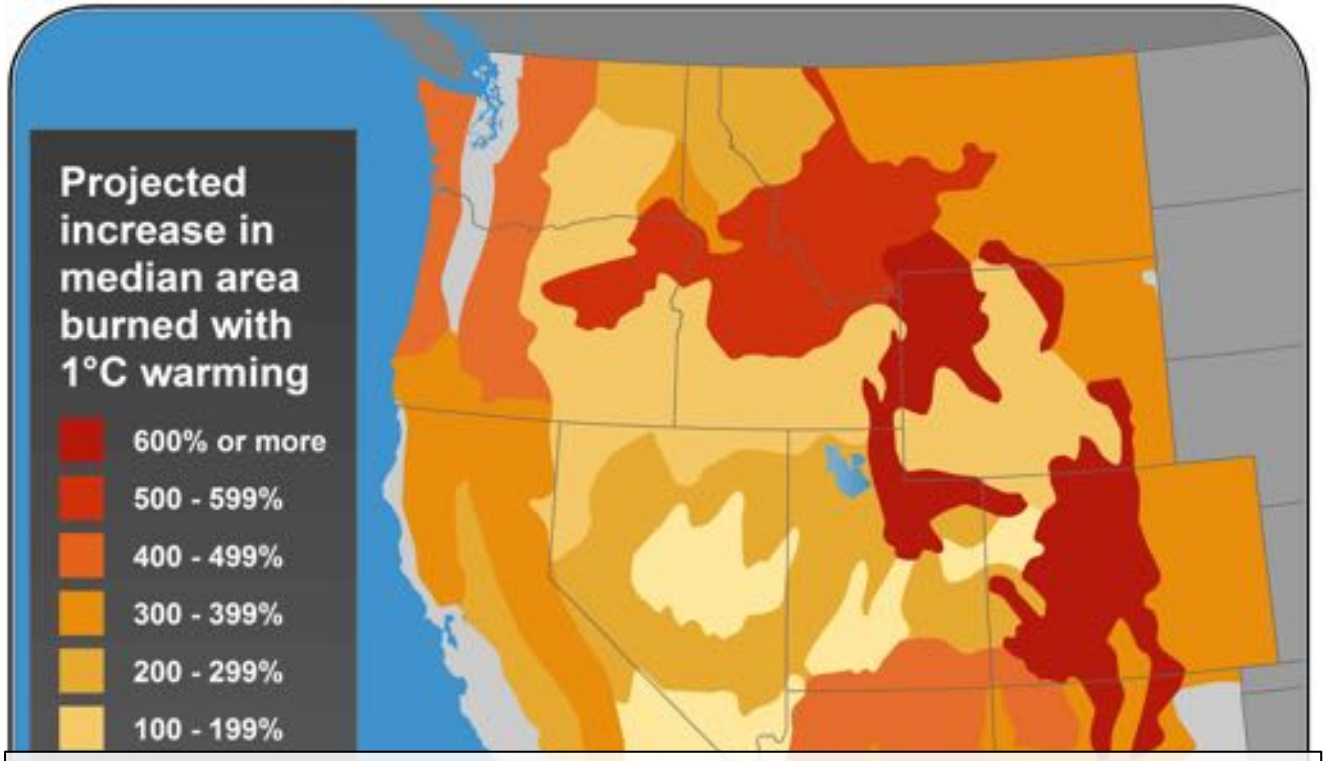


Earlier and longer periods of dry fuels are affected by multiple factors

Wildfire area burned, 2050

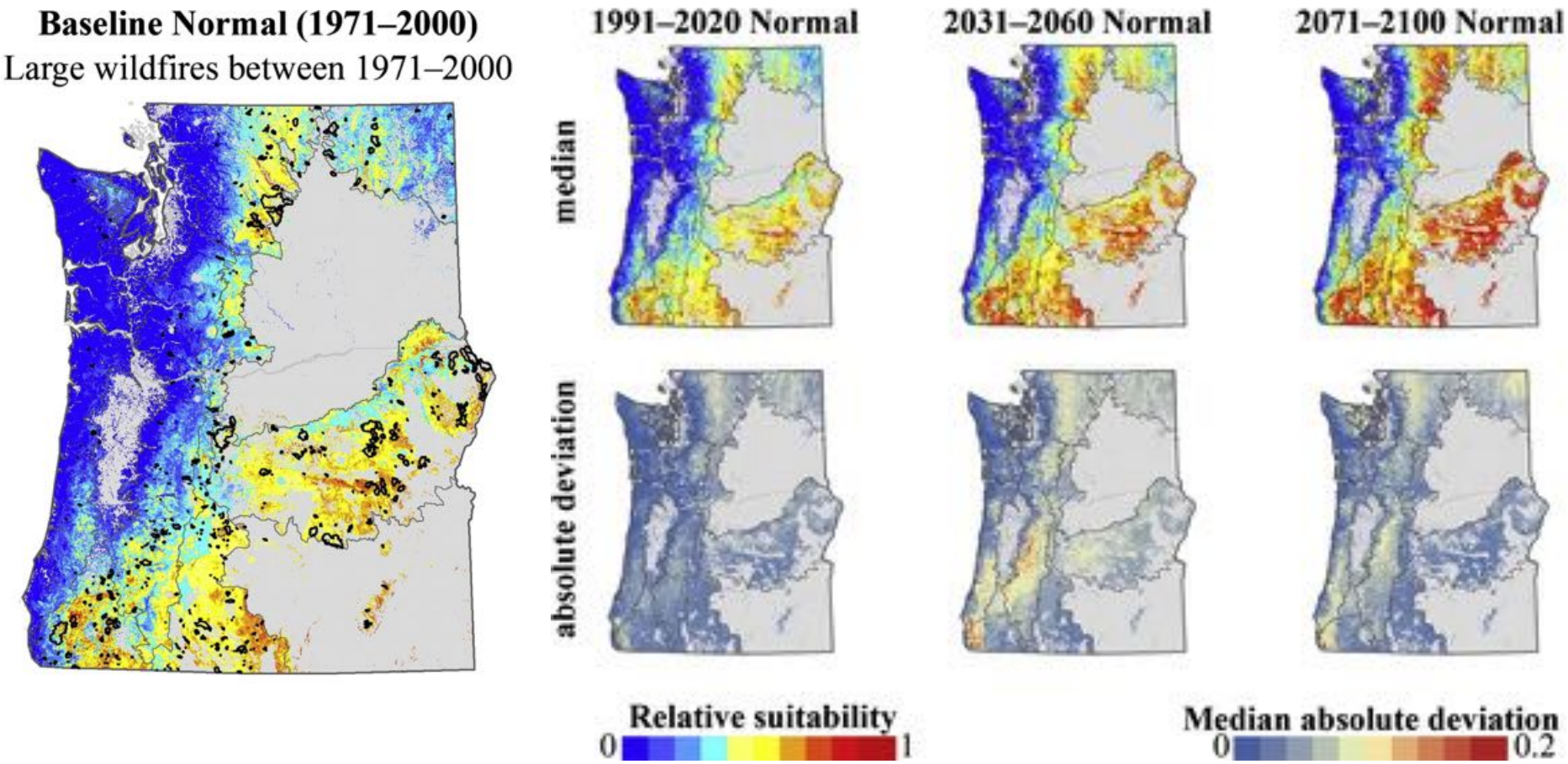


Wildfire area burned, 2050



In the Northwest, for a 1 ^{o}C increase, annual area burned will be at least 2-3 times higher.

Projections for suitability of large forest wildfires



Davis et al. 2017

Large west-side fires of the past

- **Year ~1700 fire episode:**
  - → **>1 million acres on Olympic Peninsula,**
  - → **3 to 10 million acres in western WA**

(Henderson et al. 1989)

- **1902 Yacolt complex**
  - → **>1 million acres**

(National Interagency Fire Center)

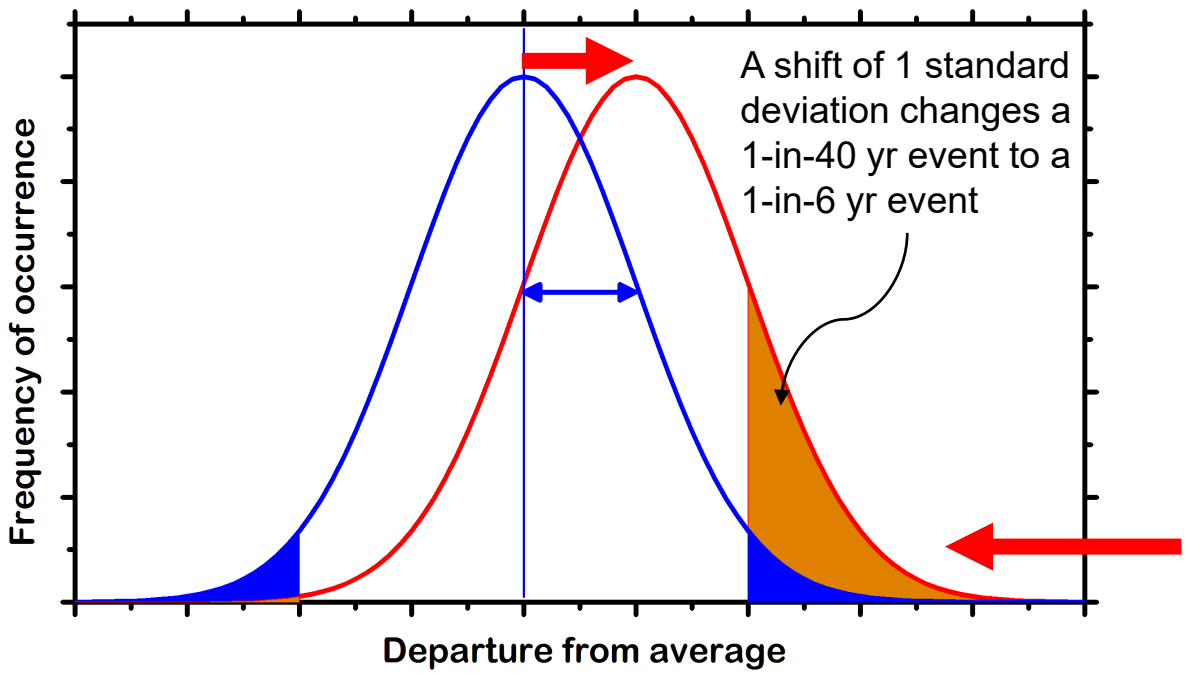
- **1933 Tillamook burn**
  - → **350,000 acres**

(Kemp 1960)

Slide by J. Halofsky and D. Donato

Extremes matter

Frequency, extent, and severity of wildfire may be affected by climate change, altering the mean and <u>variability</u> of wildfire properties.



A shift in *distribution* has a larger relative effect at the *extremes* than near the mean.

It's all about the tail!

Disturbances will interact

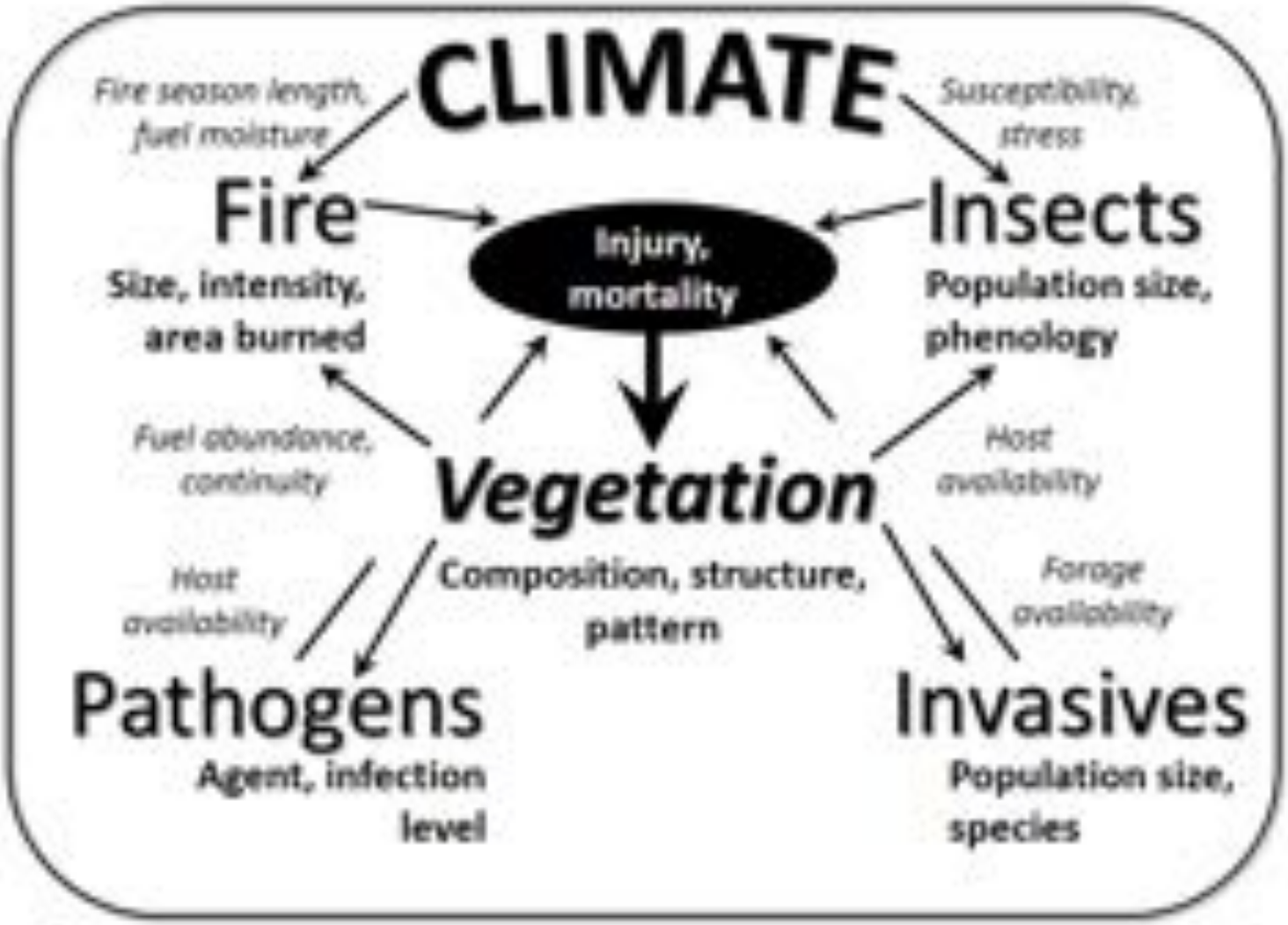


Figure by R. Loehman

What does this mean for forests in the Pacific Northwest and beyond?

High severity “reburns” may occur before forests recover from the most recent high-severity fire

Large fires are creating larger and more homogeneous patches of stand-replacing fire

Post-fire regeneration is very sensitive to climate

Drought, bark beetle outbreaks, and fires will likely interact

Forests will change in species composition and structure, and in some places will transition to non-forest.

Products: Fact Sheet

Changing Fire, Changing Forests:
The Effects of Climate Change on Wildfire Patterns and Forests in the Pacific Northwest

Forests are an iconic feature of Northwest landscapes. From dense forests of towering conifers in the west to ponderosa pine forests in the east, these ecosystems provide water, wildlife habitat, timber, recreation and other benefits. But climate change is already altering Northwest forests and the resources they provide.

Climate change is bringing warmer and drier conditions that are leading to larger wildfires, droughts and insect outbreaks that stress our forests. When these disturbances interact, they are likely to affect tree regeneration (tree seedling establishment after disturbance), impacting the future structure and composition of our forested ecosystems.

Our forests *are* changing, but there are actions we can take now to help our forests become more resilient to future stresses and continue to provide services for society. Adapting forest management strategies can help forest ecosystems transition to changing climate conditions while continuing to provide benefits to lands, waters, wildlife and people. Starting the process of adaptation now, before a long-term increase in wildfire occurs, will help safeguard forests now and in the future.

Forest disturbances are changing

Wildfires in the Pacific Northwest have been immense in recent years. As the climate changes, warmer and drier conditions are likely to result in even more frequent and extensive fires than those in recent history. Warmer and drier conditions will also likely increase the frequency, intensity and severity of other forest disturbances such as drought and insect outbreaks. Interactions between these disturbances are likely to be the main drivers of forest ecosystem change in a warming climate.

Drought, fire and insect outbreaks are drivers of change

As temperatures in the Pacific Northwest become warmer year-round, there will be less water available in the summer to reduce the effects of drought. Historically, melting snowpack has delivered a steady supply of water throughout summer months. But as temperatures increase, more winter precipitation will fall as rain instead of snow, leading to less annual winter snowpack and less water availability throughout the summer. Decreased water availability in the summer stresses forests and can even be lethal, particularly for young tree seedlings establishing after past disturbance.

Drought also affects the frequency and intensity of wildfire and insect outbreaks. Drier forests and a longer fire season in the summer will create larger areas of dry fuel (flammable dead and live vegetation), which is more likely to ignite and sustain fire over longer periods. Reburns, or recurring fires in an area over a relatively short period of time, are also likely to occur more frequently with increasing temperatures and drought. Reburns, particularly severe reburns that occur at short intervals, can have significant effects on forest regeneration and the types of species that regrow.

Insect outbreaks have already expanded across the Pacific Northwest, driven by higher temperatures and unhealthy forests. Second-growth forests may be particularly vulnerable to drought, fire and insect outbreaks in the future because of their high density of trees.

In 2014, the Carlton Complex Fire set a record for the largest wildfire in Washington State history, burning 256,100 acres. Large wildfires have a significant effect on landscape pattern and forest structure and will become more common under climate change. Photo: Morris Johnson.

Regeneration of species such as Douglas-fir will likely be affected by warming temperatures, increasing drought severity and increasing fire frequency in the future. Photo: U.S. Forest Service, CC By 2.0

Products: Story Map

Thank you

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