Potential Effects of Climate Change on Mixed Severity Fire Regimes of the Western U.S.

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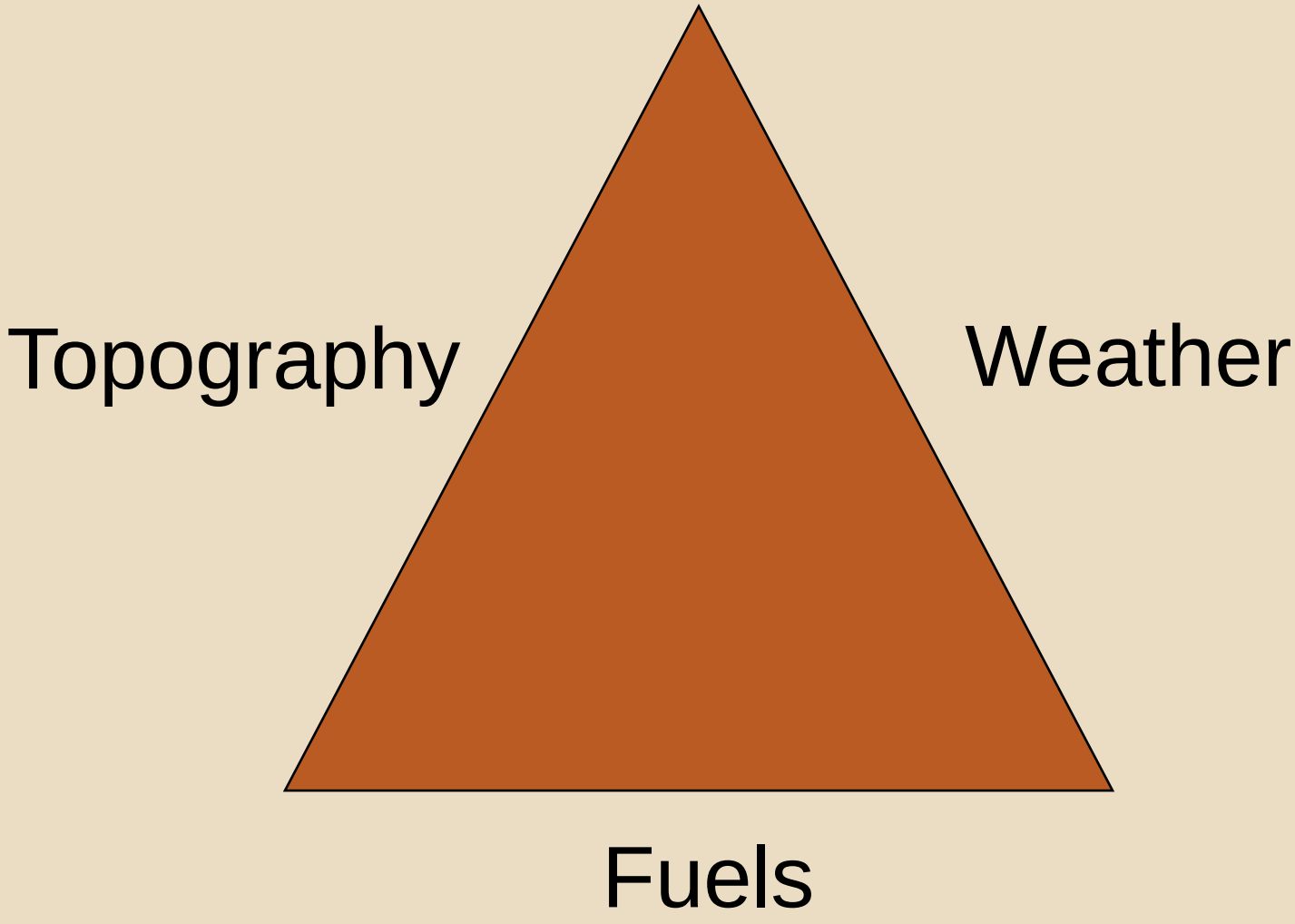
Climate controls ecosystem processes

- The hydrologic cycle
- Plant establishment, growth, and distribution
- Disturbance
  - Drought
  - Fire
  - Flooding
  - Insect outbreaks

Fire Behavior Triangle



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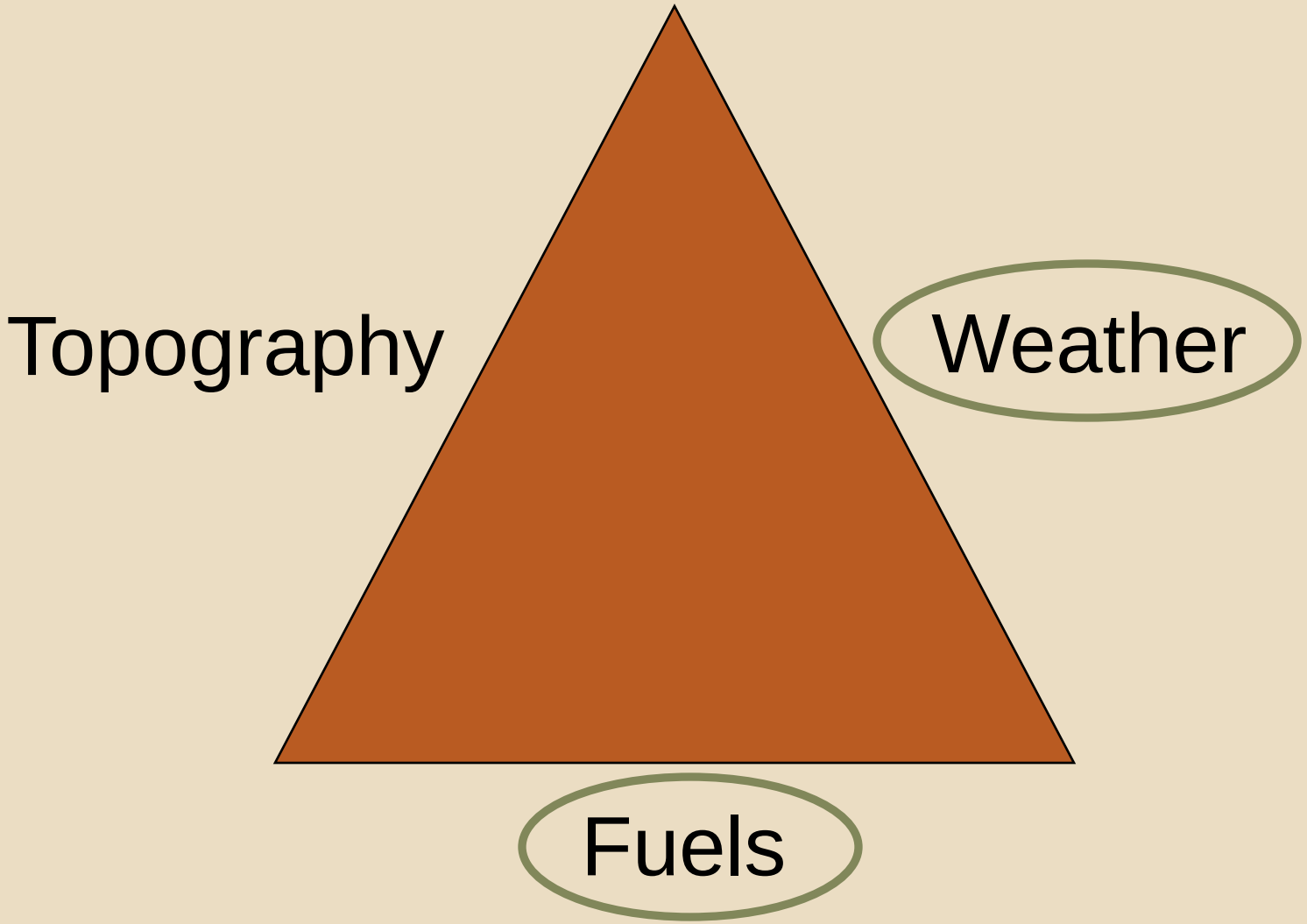
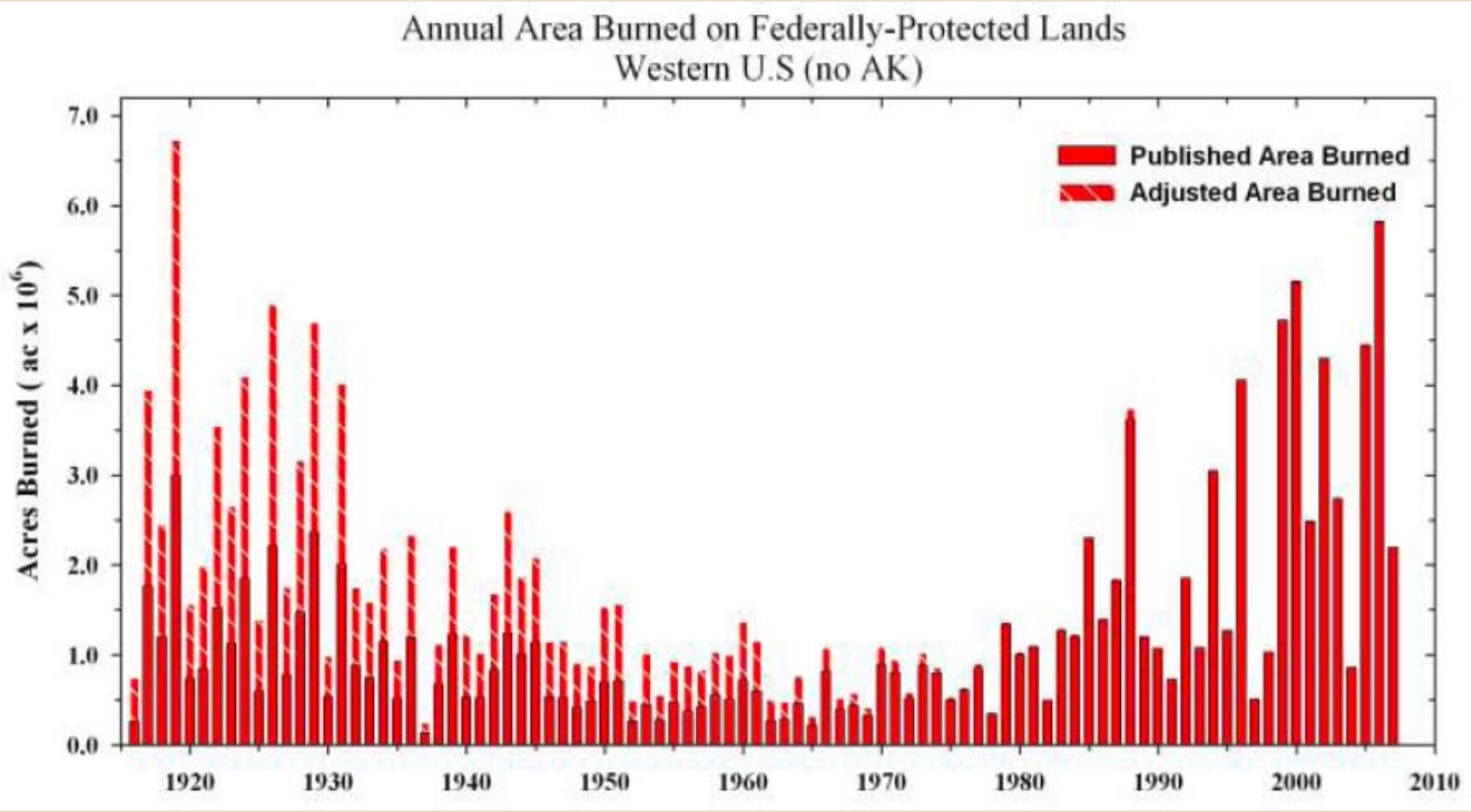


Area burned – Western U.S., 1916 - 2007



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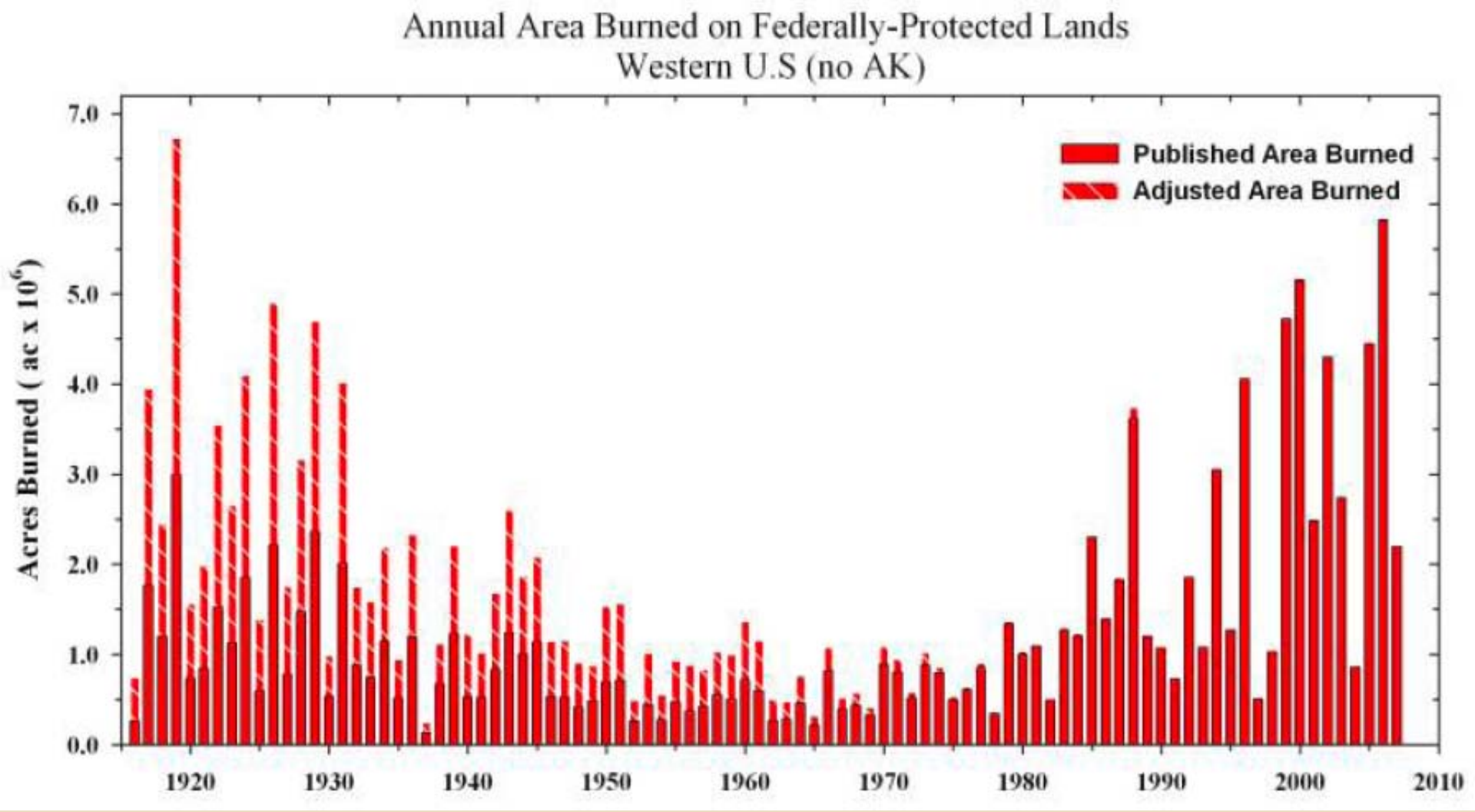

Fire Suppression → Fire Exclusion → Fuel Accumulation

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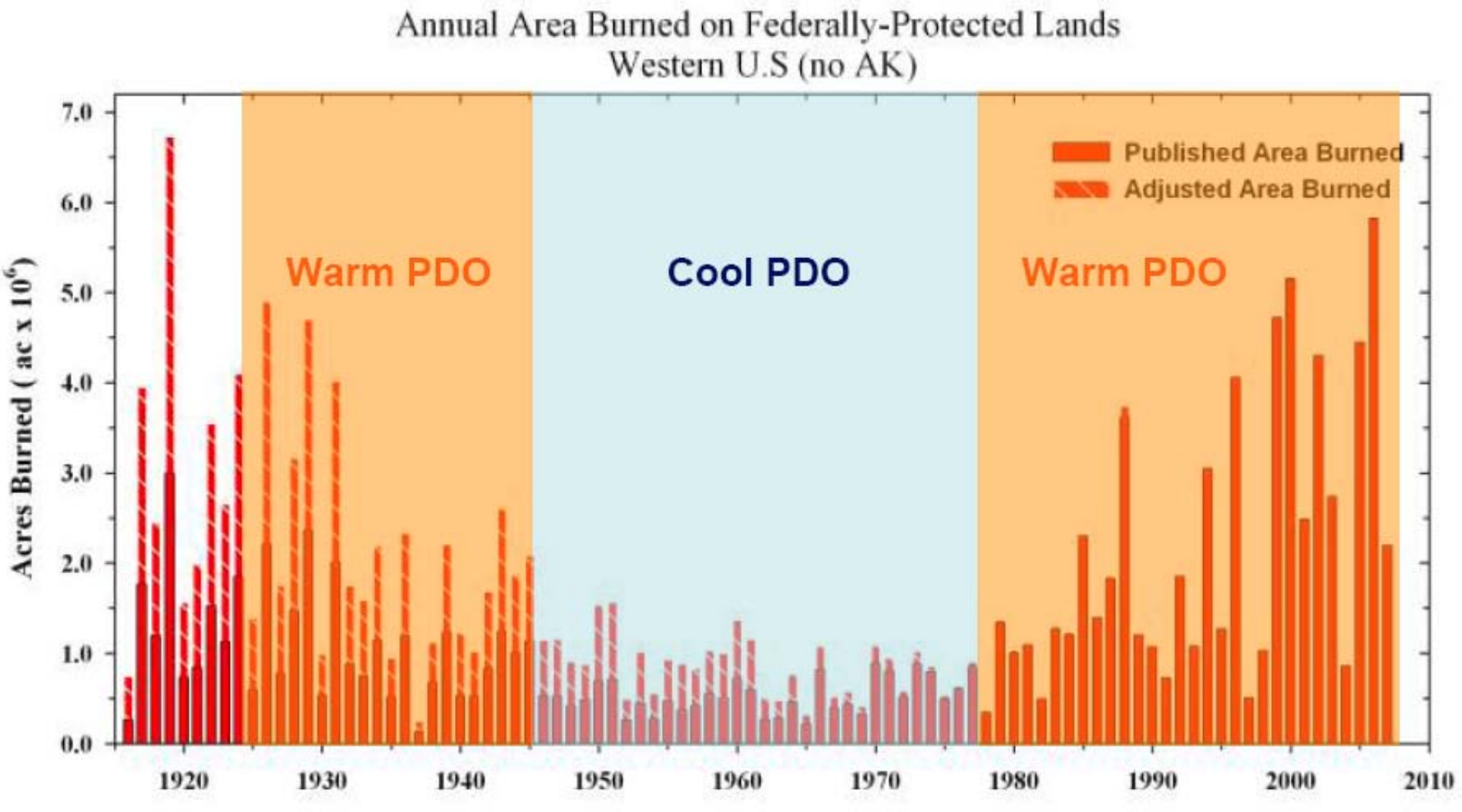

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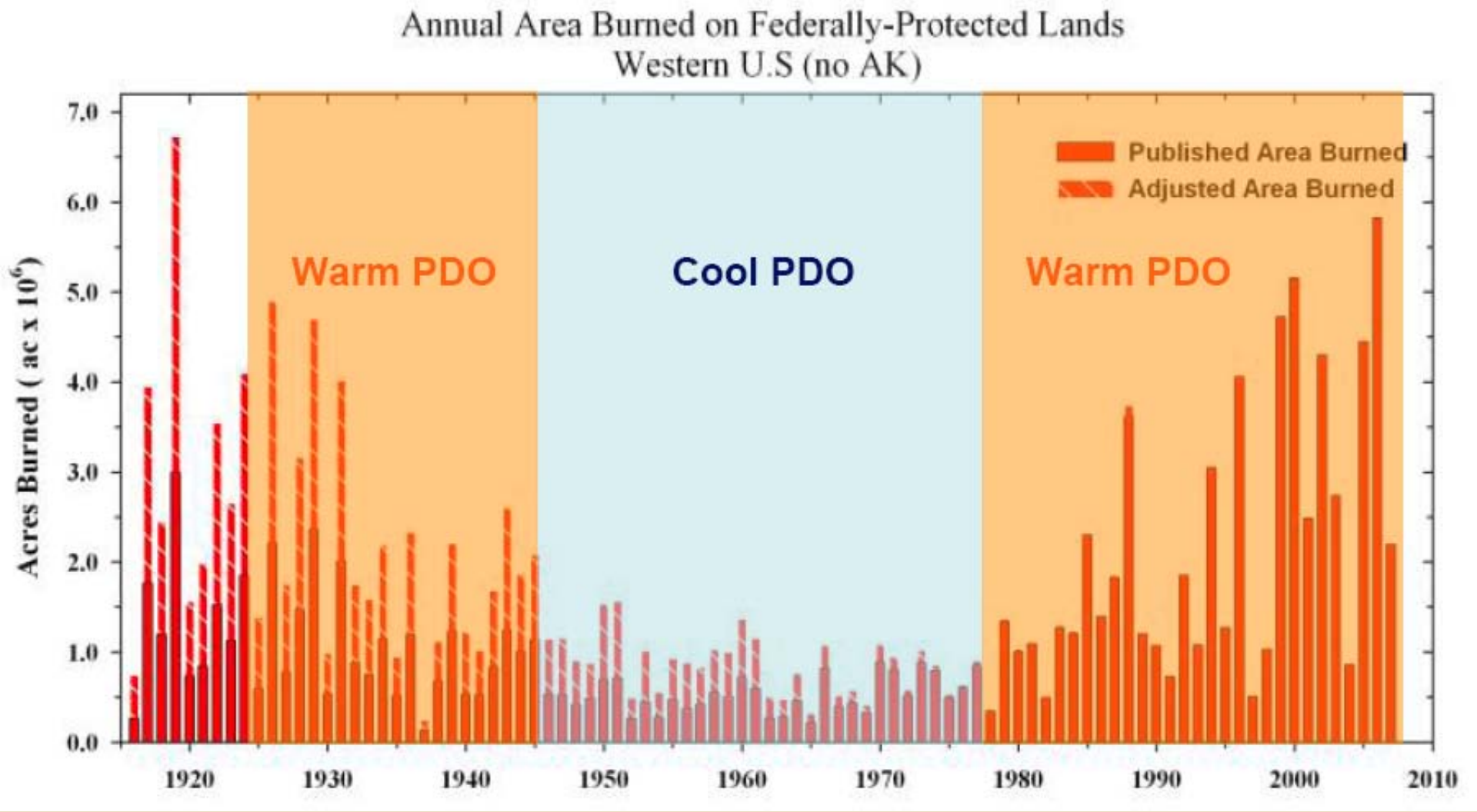


Fire Suppression → Fire Exclusion → Fuel Accumulation

Lots of Fire → Much Less Fire → Lots of Fire

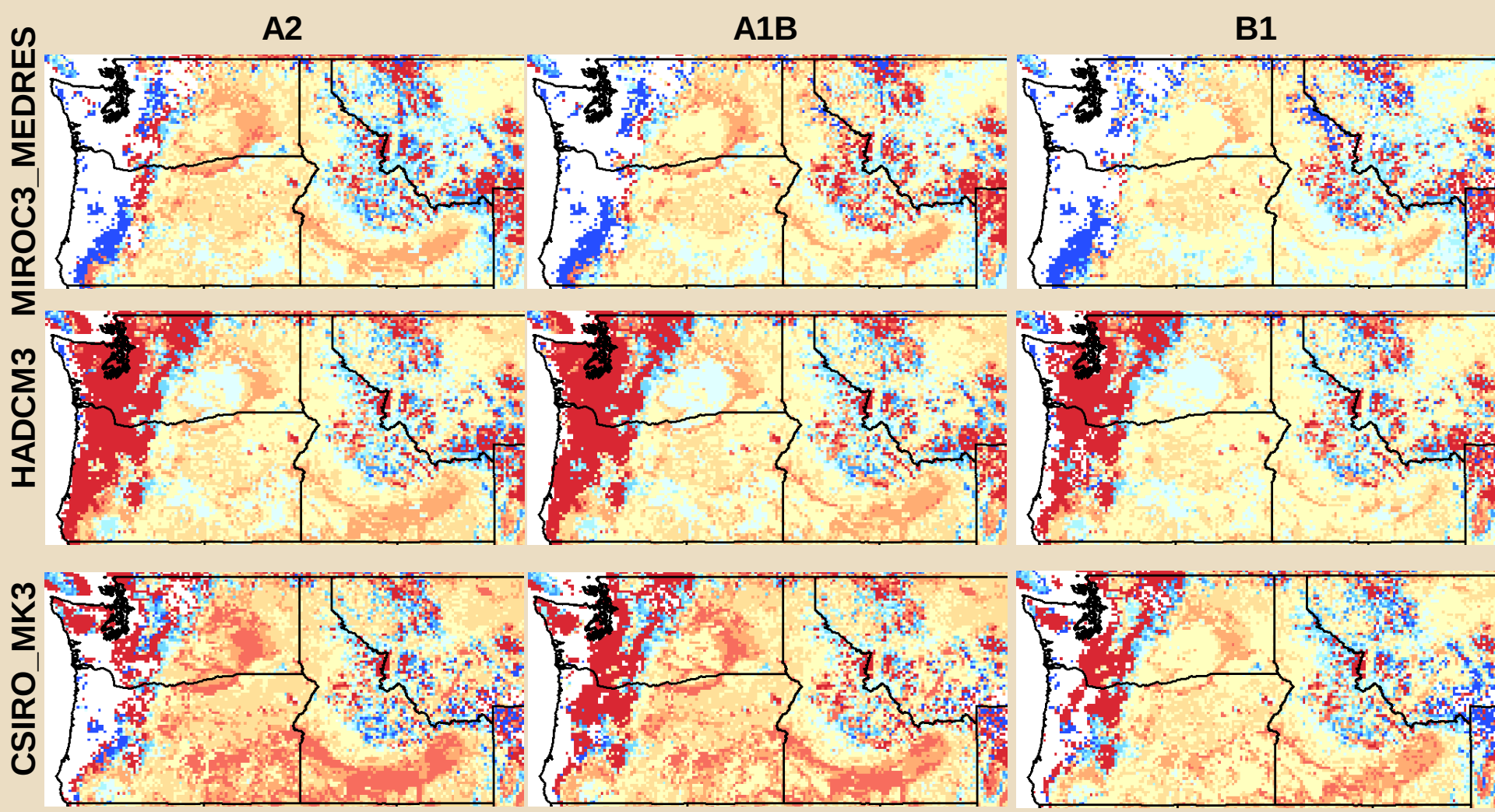
Climate Change and Fire

- Warmer and drier spring conditions =
  - early snowmelt
  - lower summer soil and fuel moisture
  - longer fire seasons
  - increased fire frequency and extent
- Fire intensity and severity may also increase

How much will area burned increase with climate change?

Analysis of wildfire data since 1916 for the 11 contiguous Western states shows that *for a 4 F increase* that *annual area burned will be 2-3 times higher*.

McKenzie et al. 2004

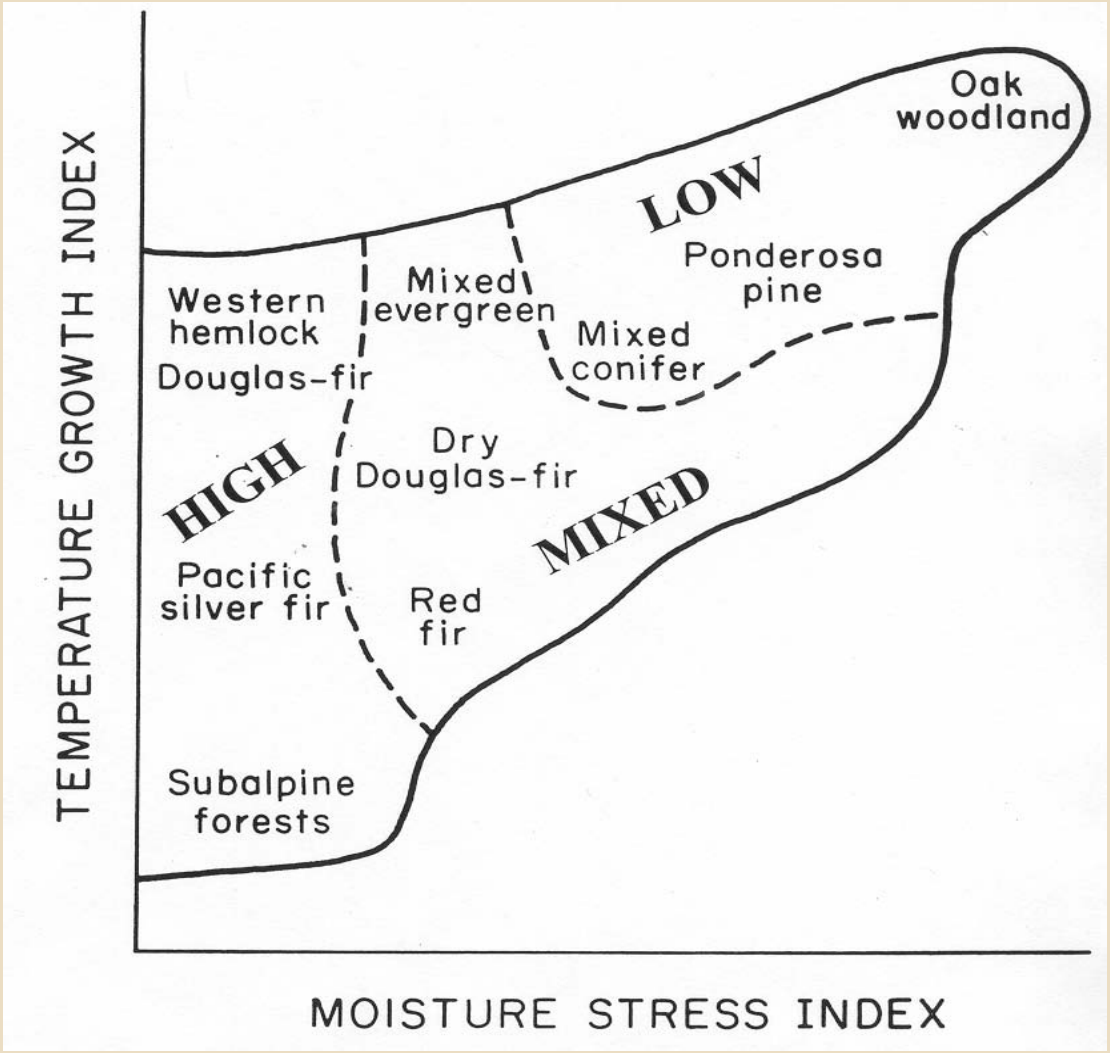


Percent change in biomass consumed by fire 2051-2100 vs. 1951-2000

R. Neilson et al., USFS and OSU MAPSS Team, Corvallis, OR

Fire Regimes Vary by Environment

Warm

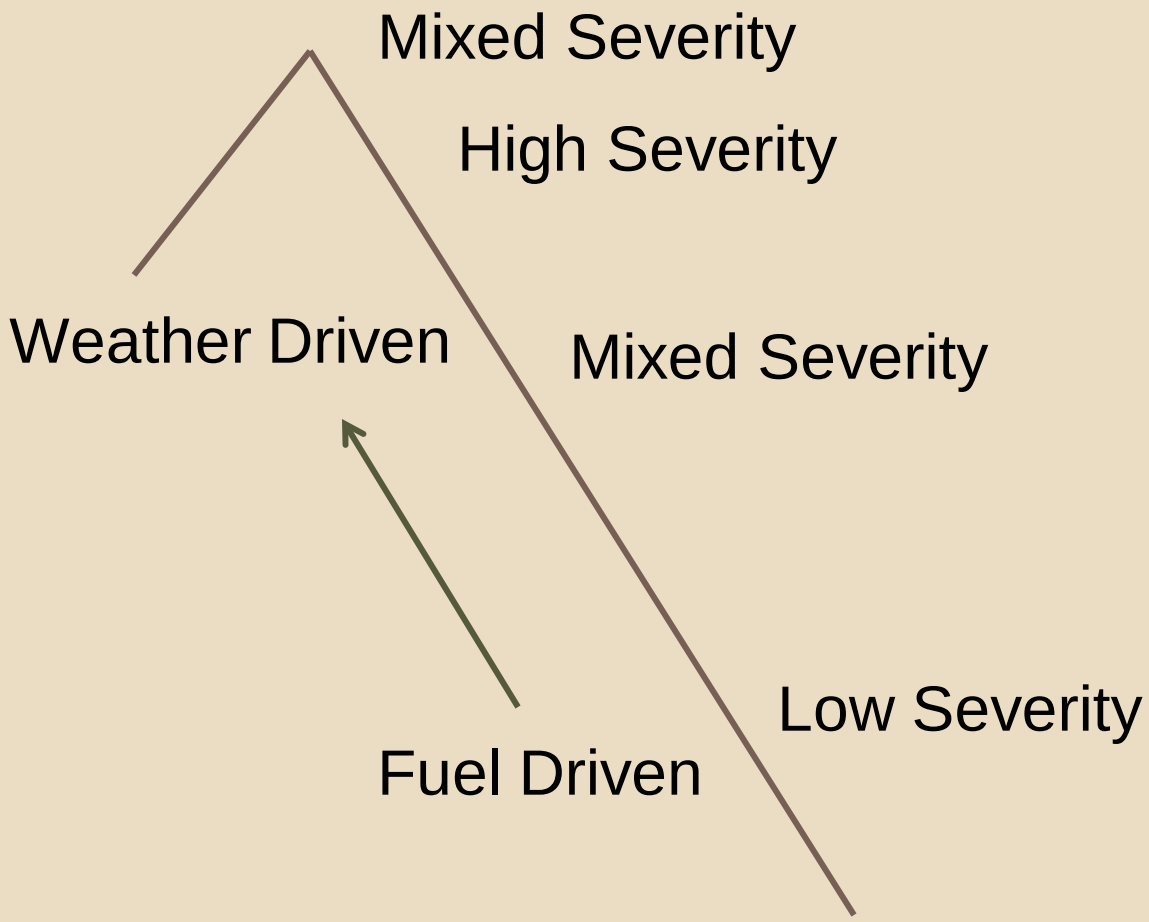


Cold

Wet → Dry

Agee 1993

Gradients of Fire Regime Controls



Adapted from J.K. Agee

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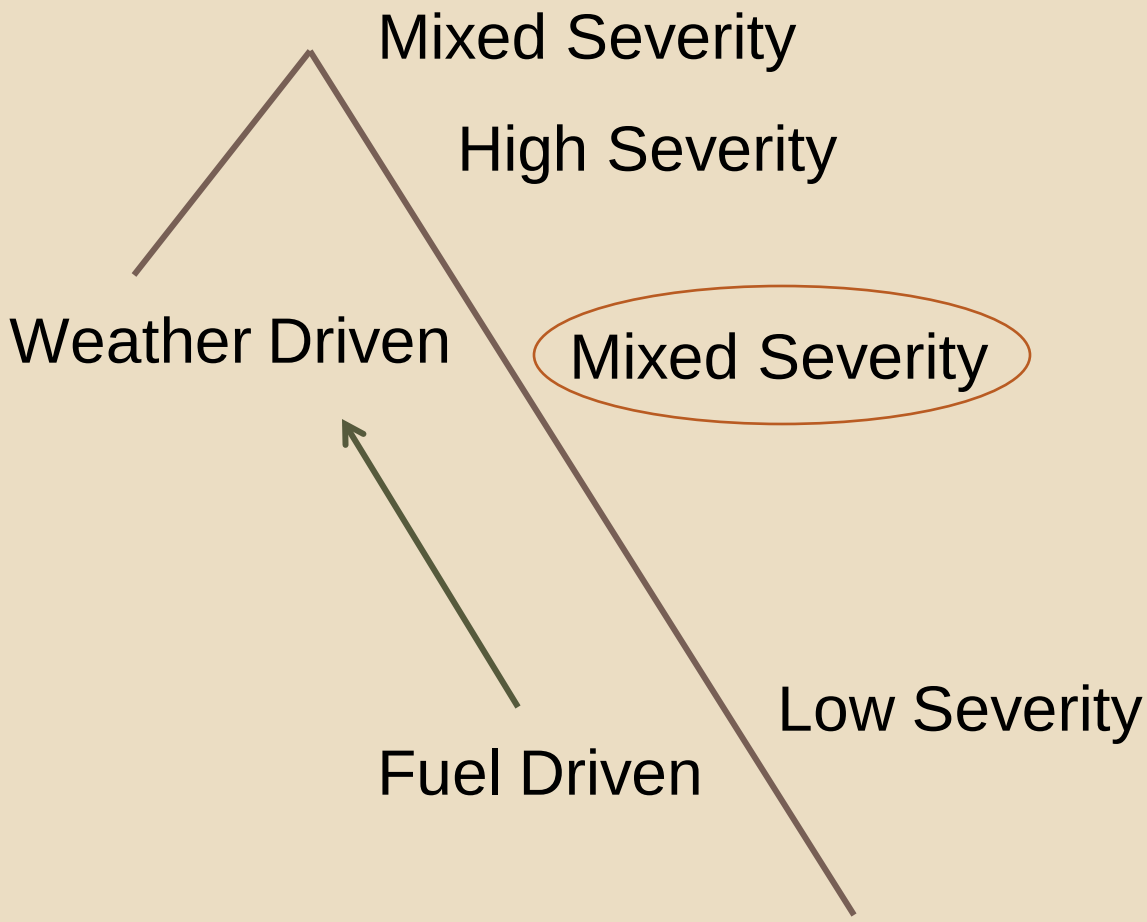

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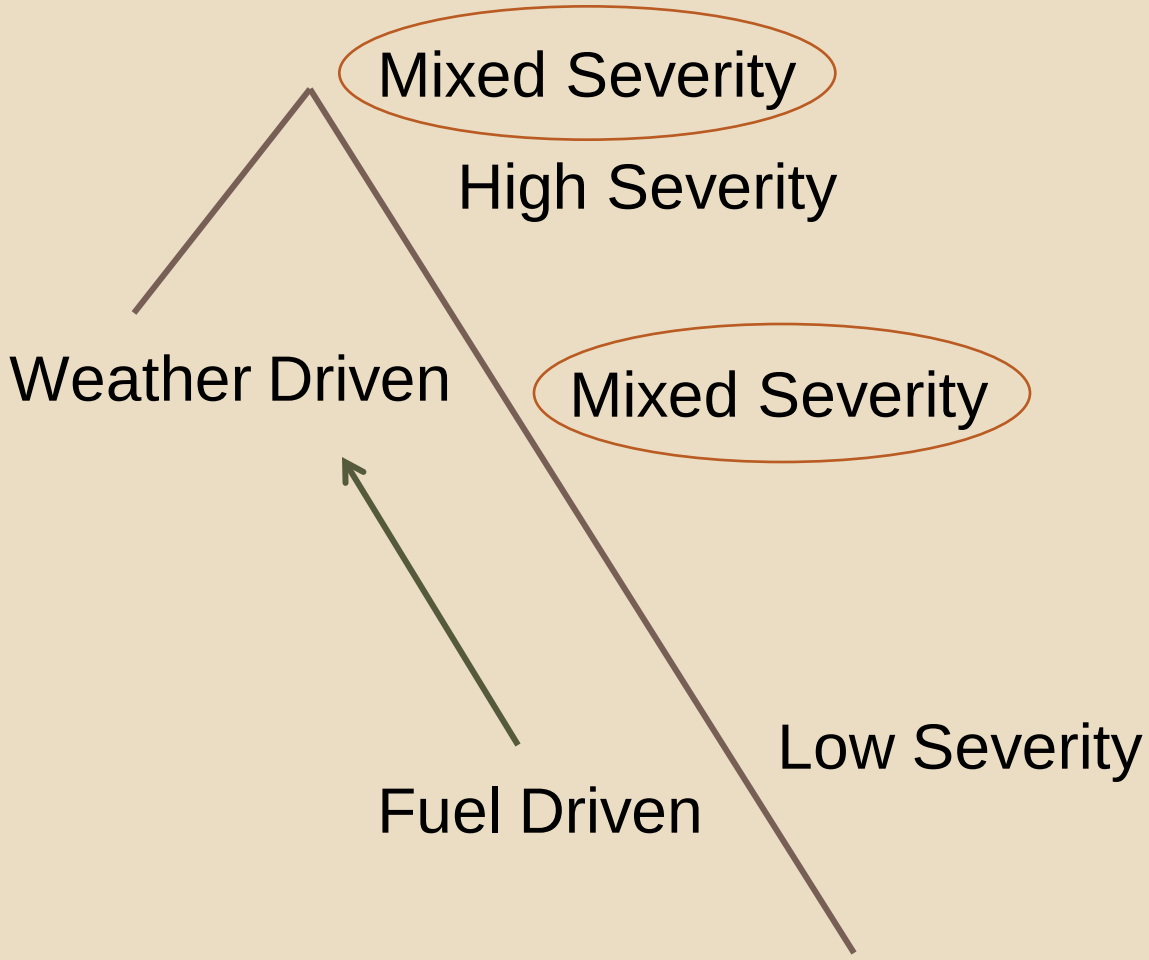

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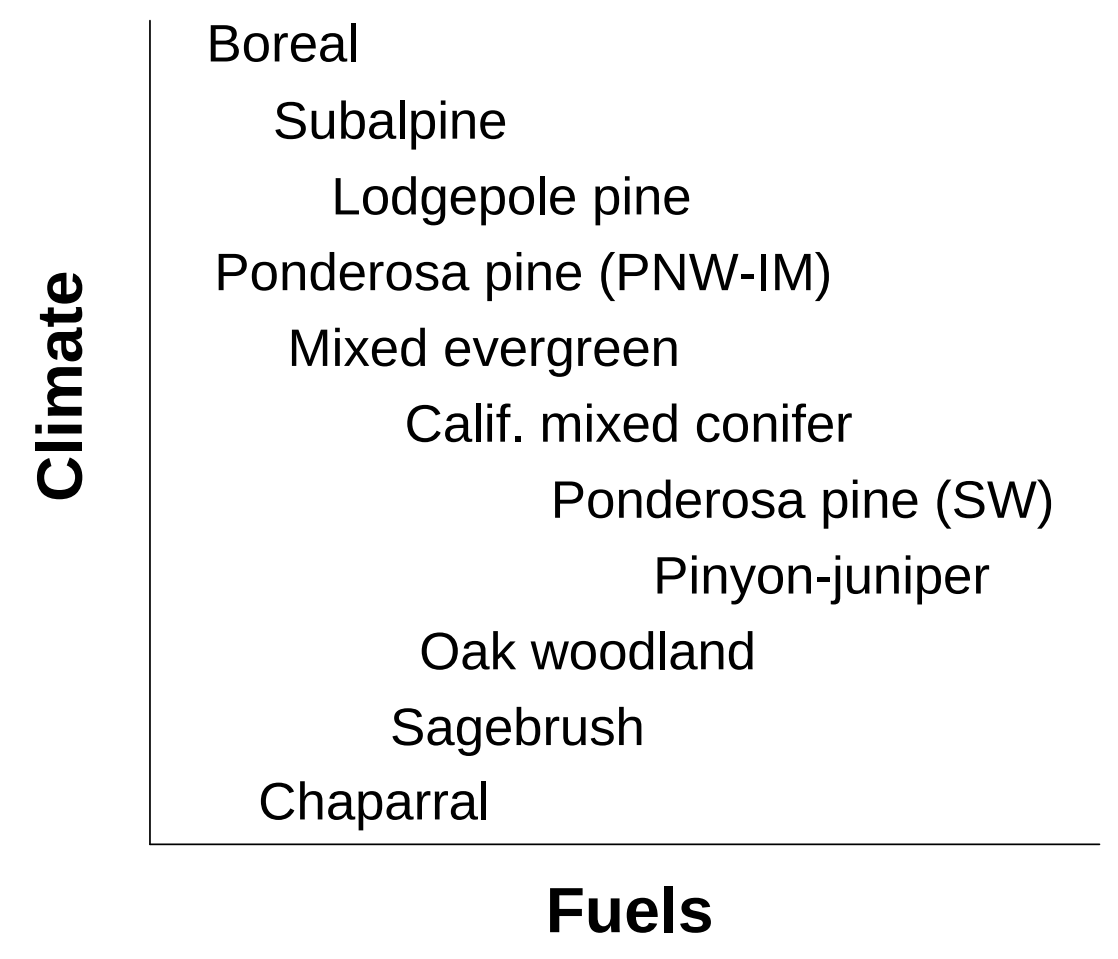
Relative influence of climate and fuels on fire regimes in common western US ecosystems



PNW-IM = Pacific Northwest and intermountain region of the West
SW = American Southwest

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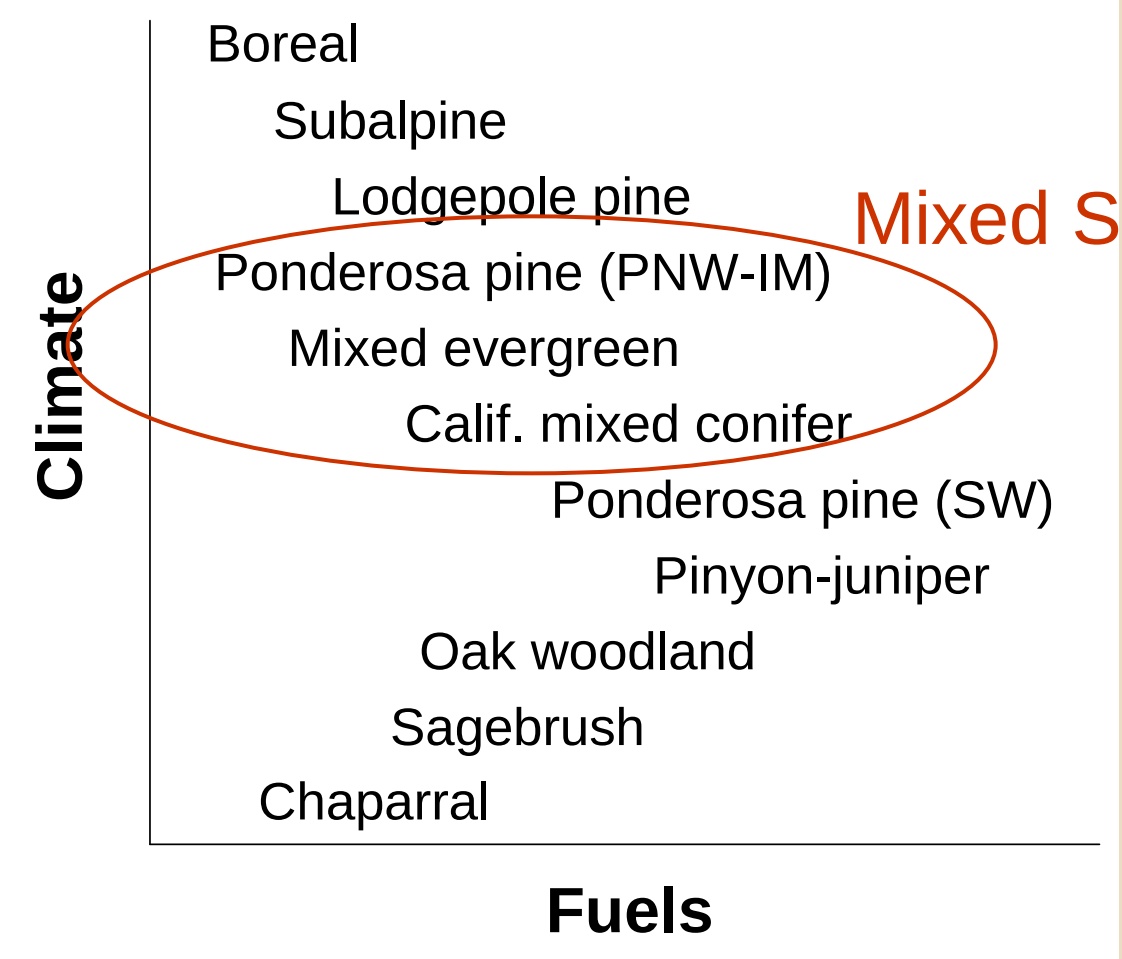

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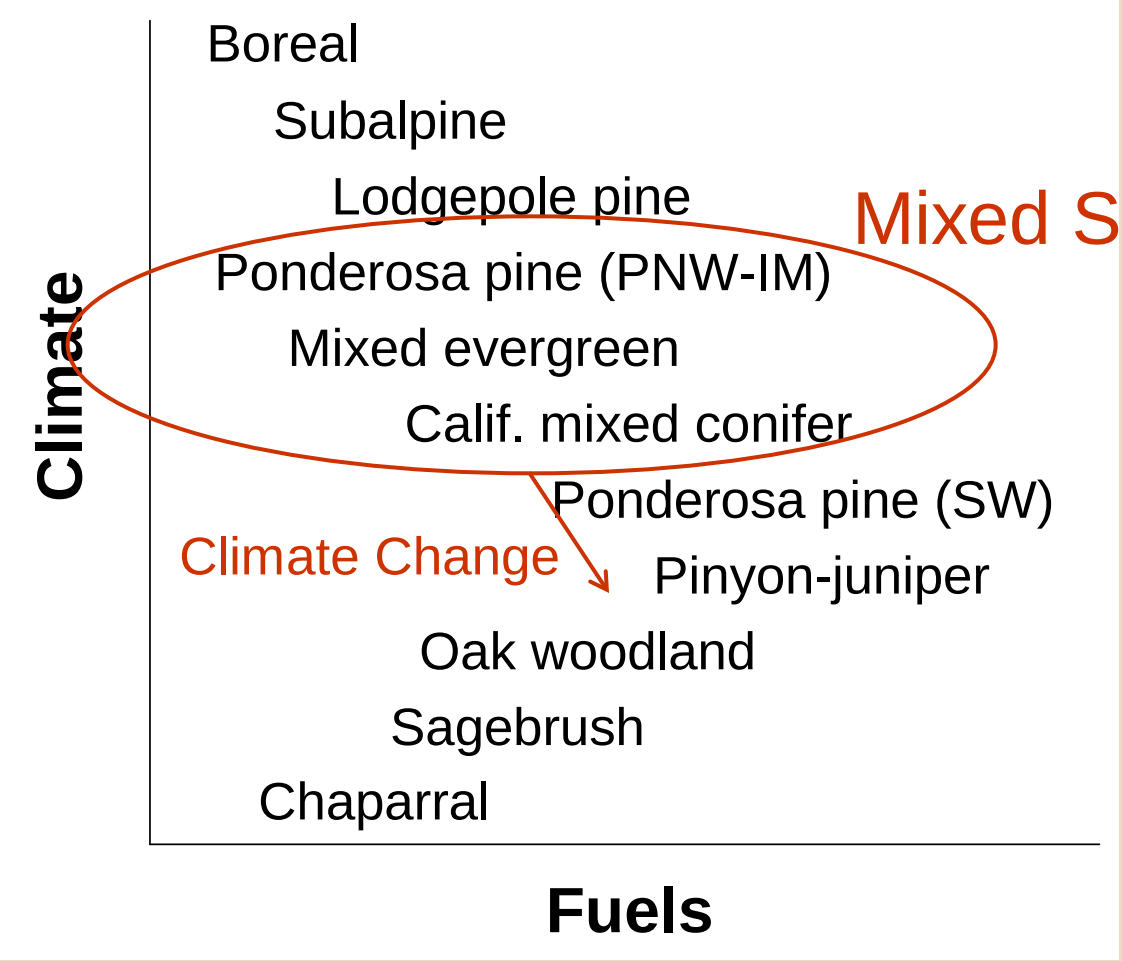

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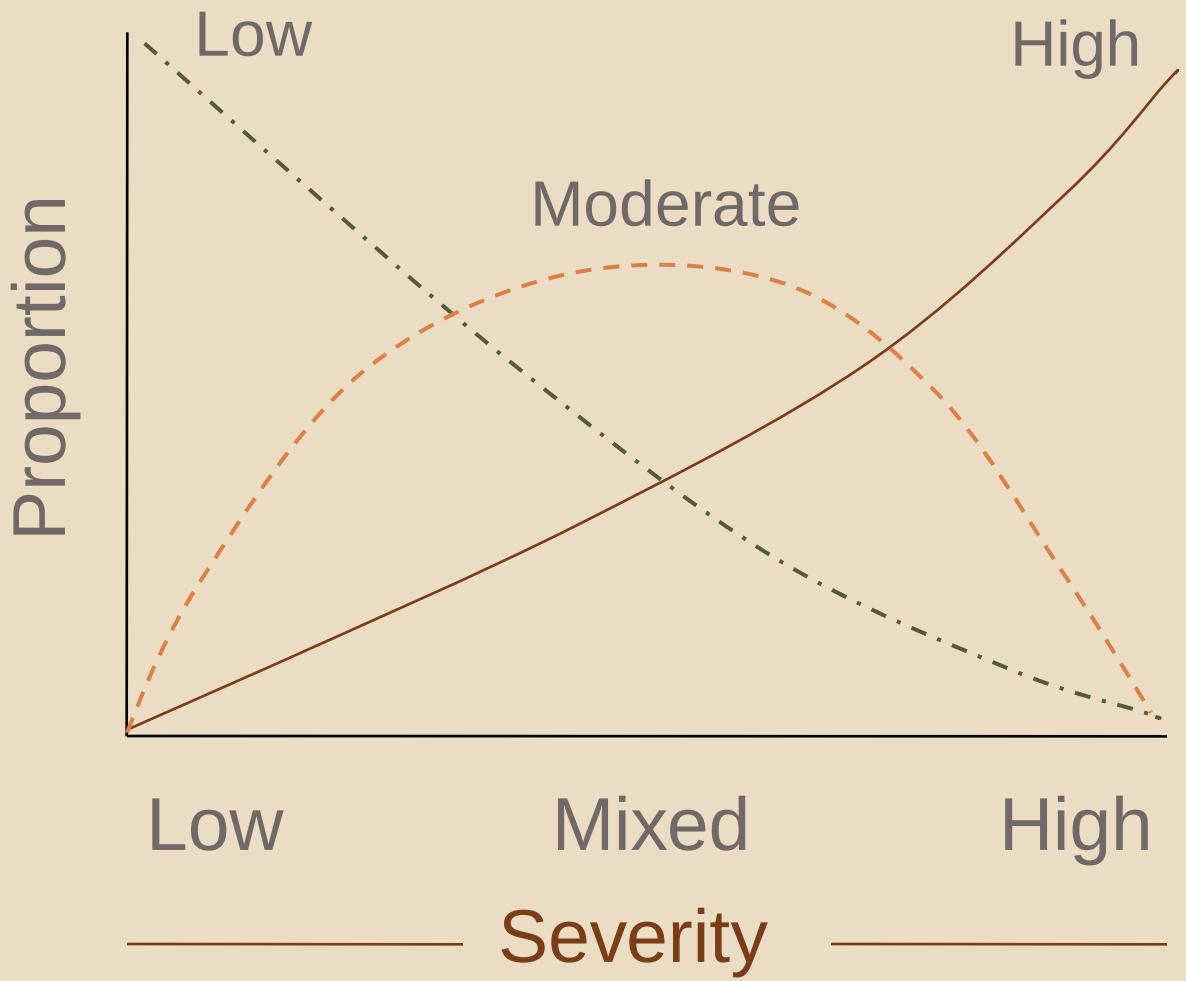
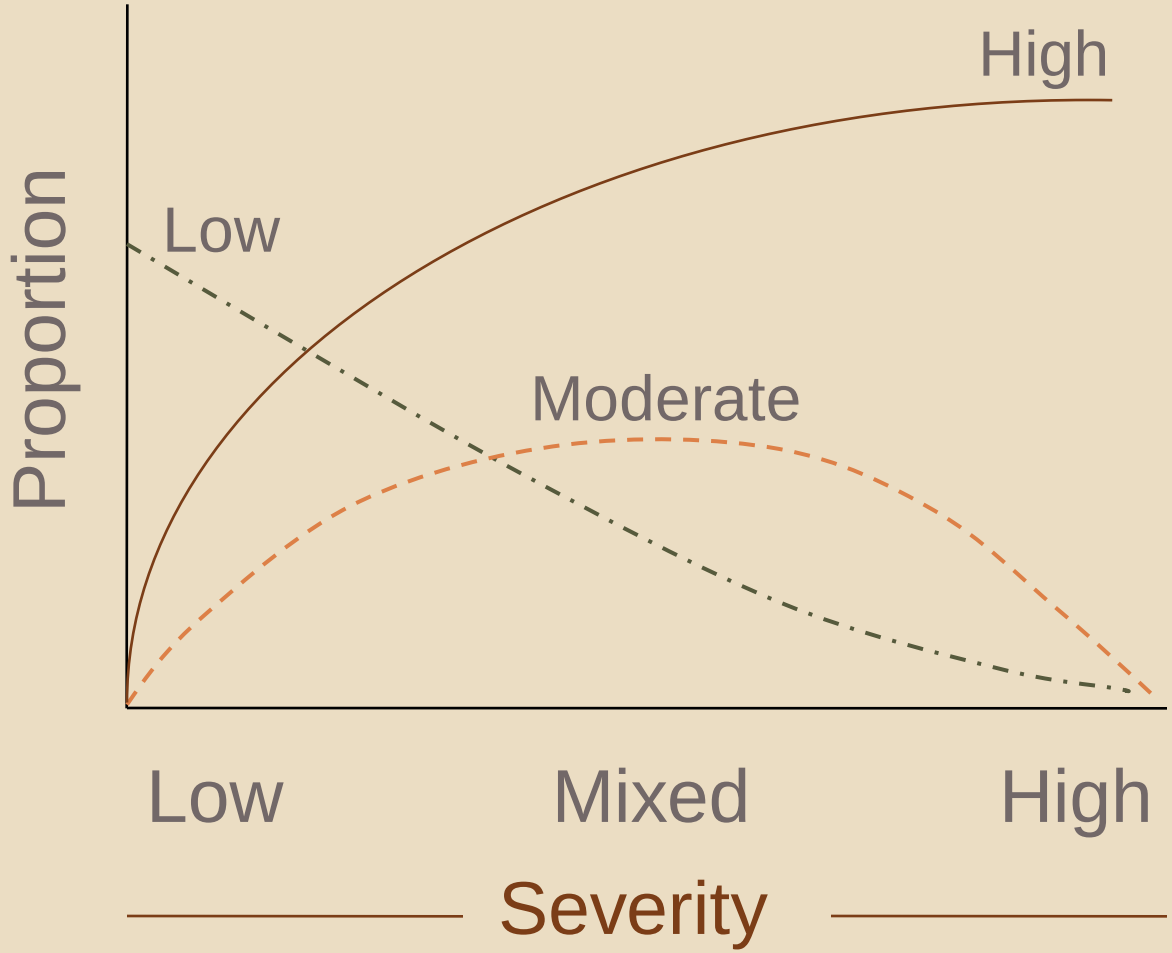
Variation in Fire Severity within a General Fire Regime



Adapted from Agee 1993

Initially, with more frequent extreme burning conditions?



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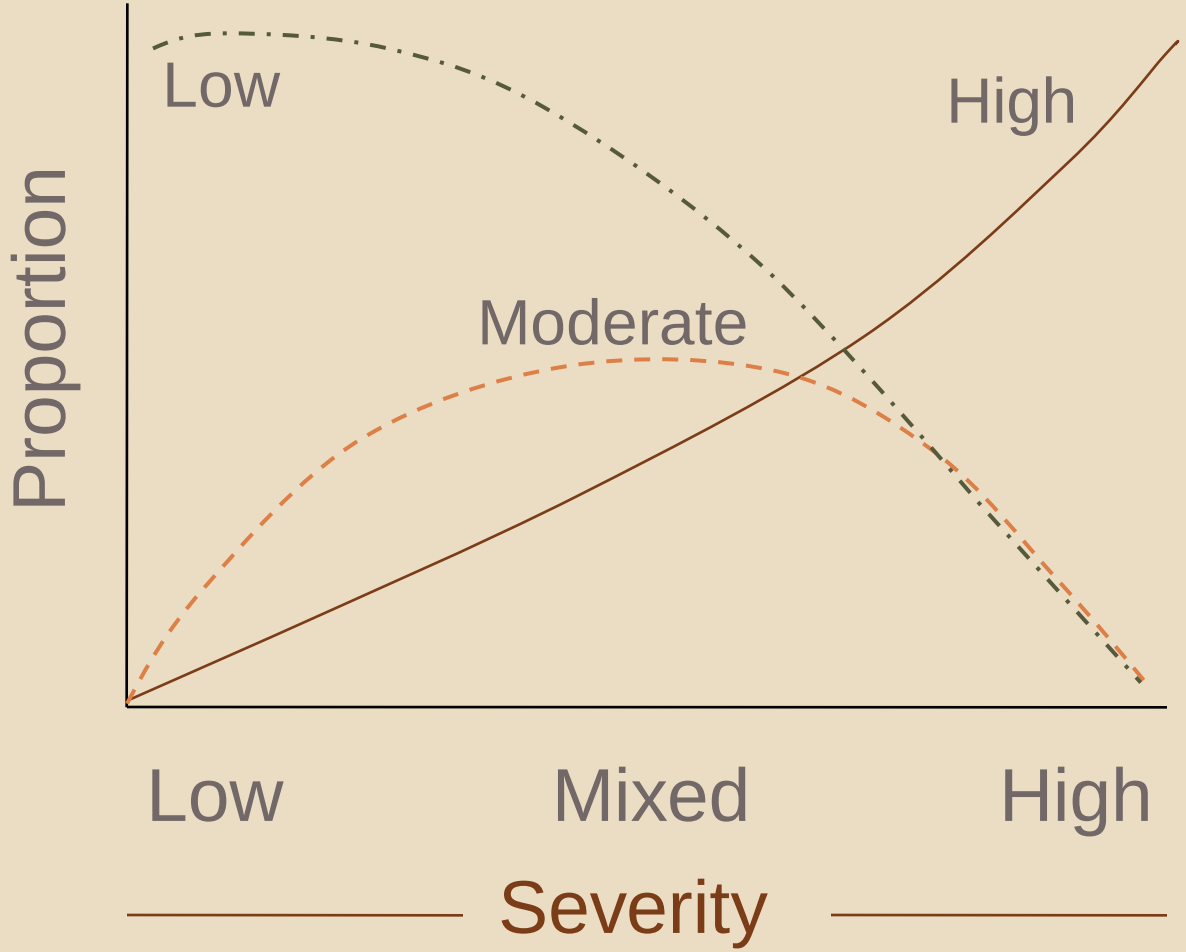
With eventual drought- and fire-induced reductions in fuel in drier forest types?



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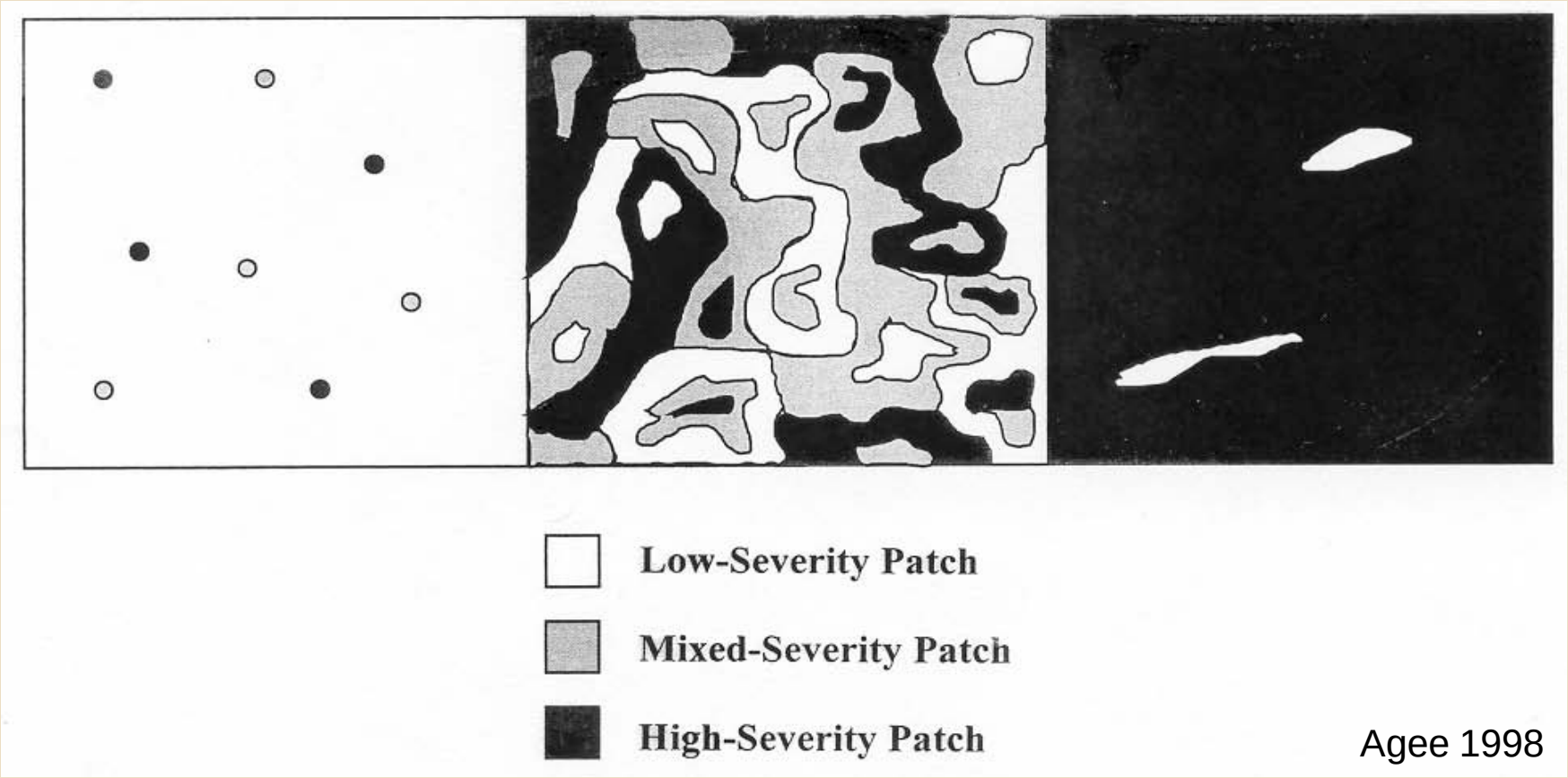
Fire Regimes and Landscape Patterns

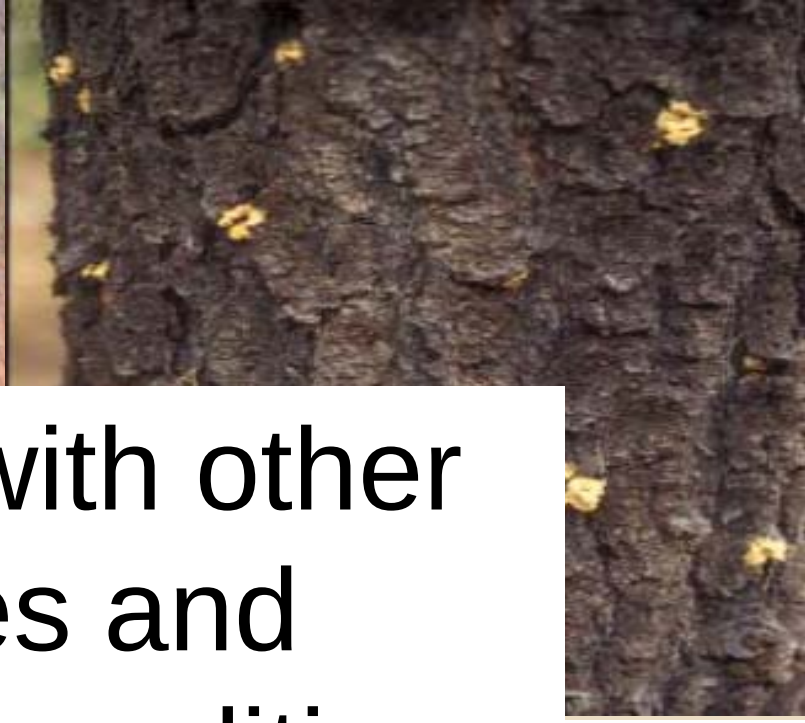
Low-Severity Fire Regime

Mixed-Severity Fire Regime

High-Severity Fire Regime



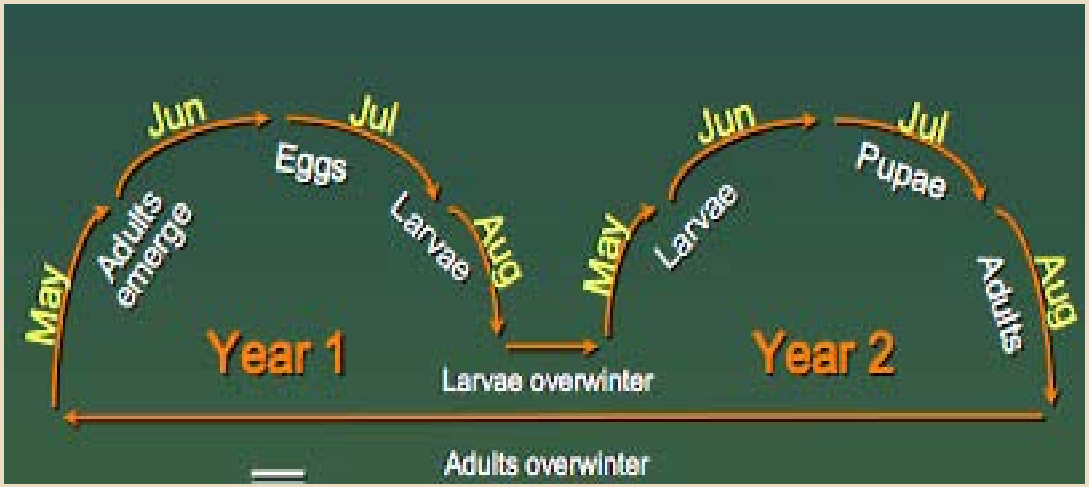
Agee 1998

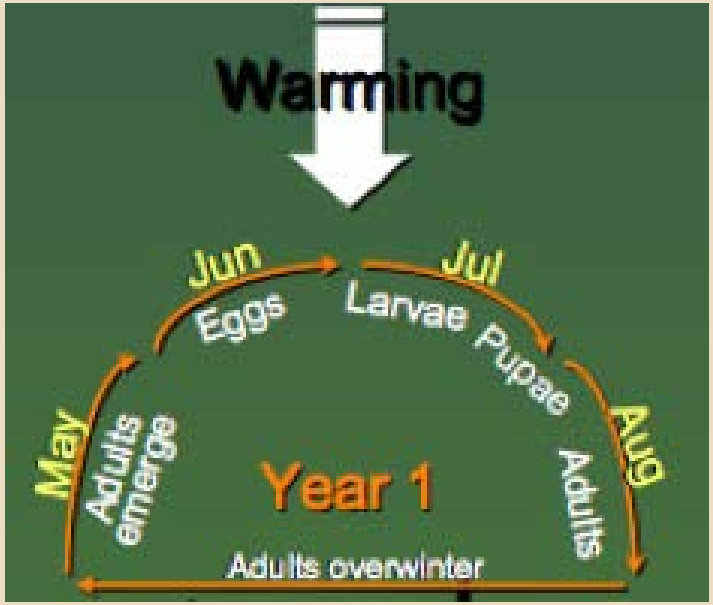


Fire interacts with other disturbances and vegetation/fuel conditions

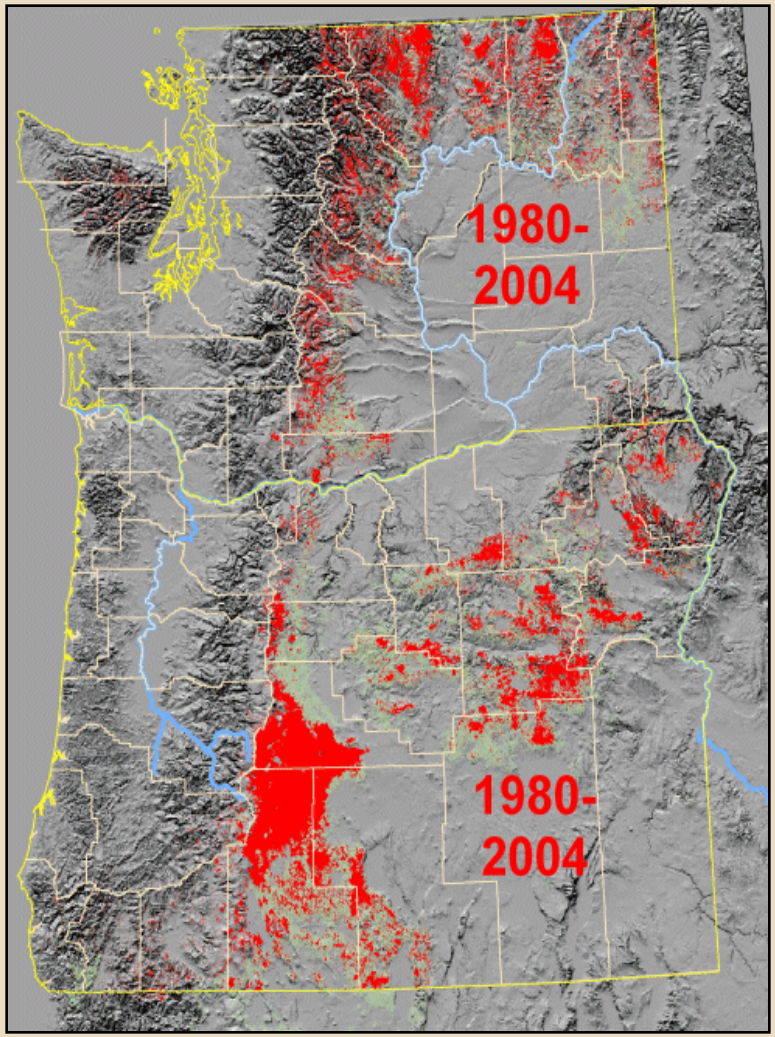
Effects of temperature increase on mountain pine beetle

- Population synchronized by temperature (onset of spring)
- Rate of generation turnover increases with temperature increase
- Mountains were a barrier until recently; limitation is now forest extent and continuity





Mountain pine beetle mortality



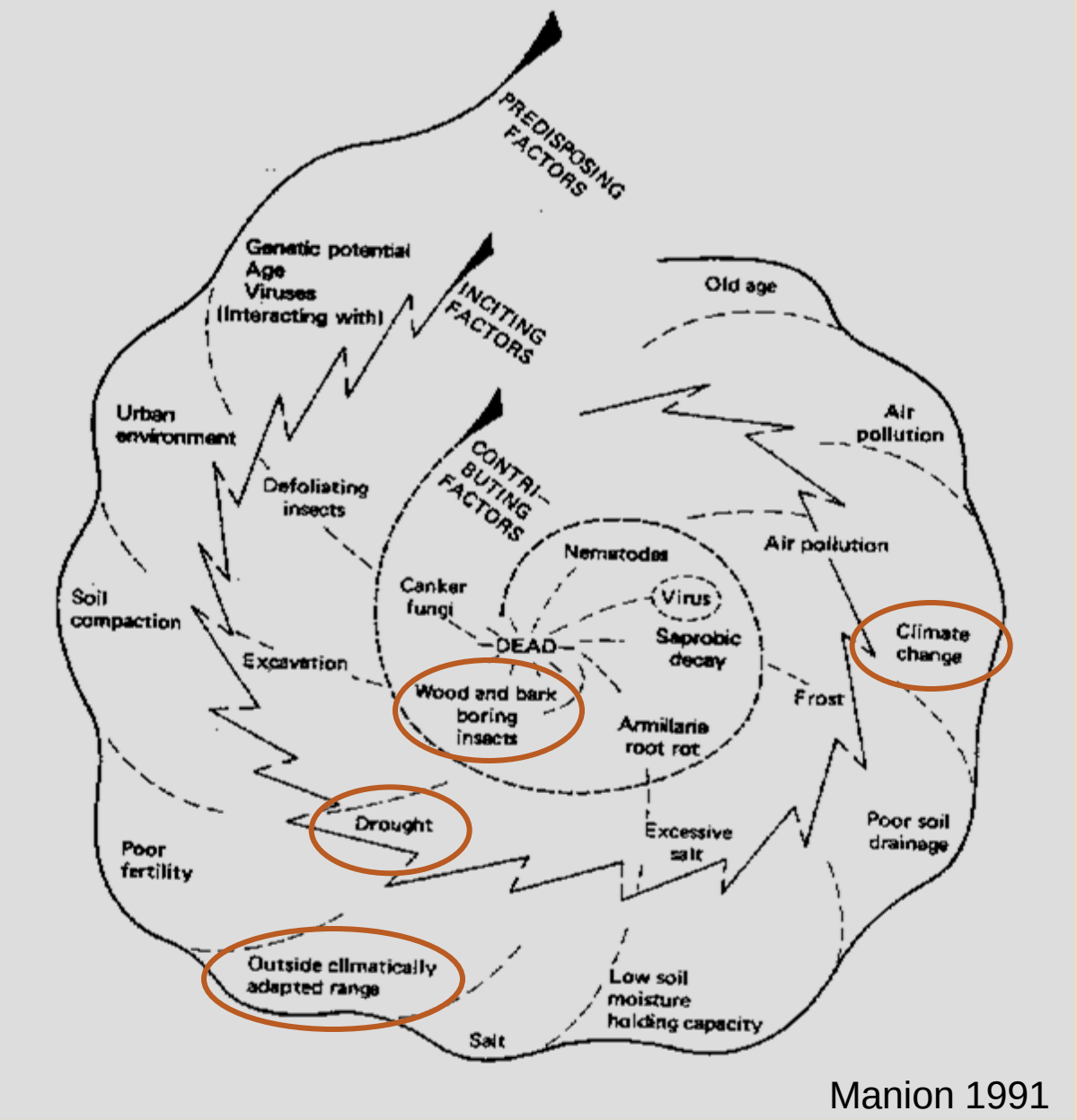
Climate warming effects

- Host life cycle and rate of reproduction
- Host vulnerability (drought, tree vigor)
- Insect life cycle and rate of reproduction
- Insect outbreak frequency and duration
- Insect range expansion

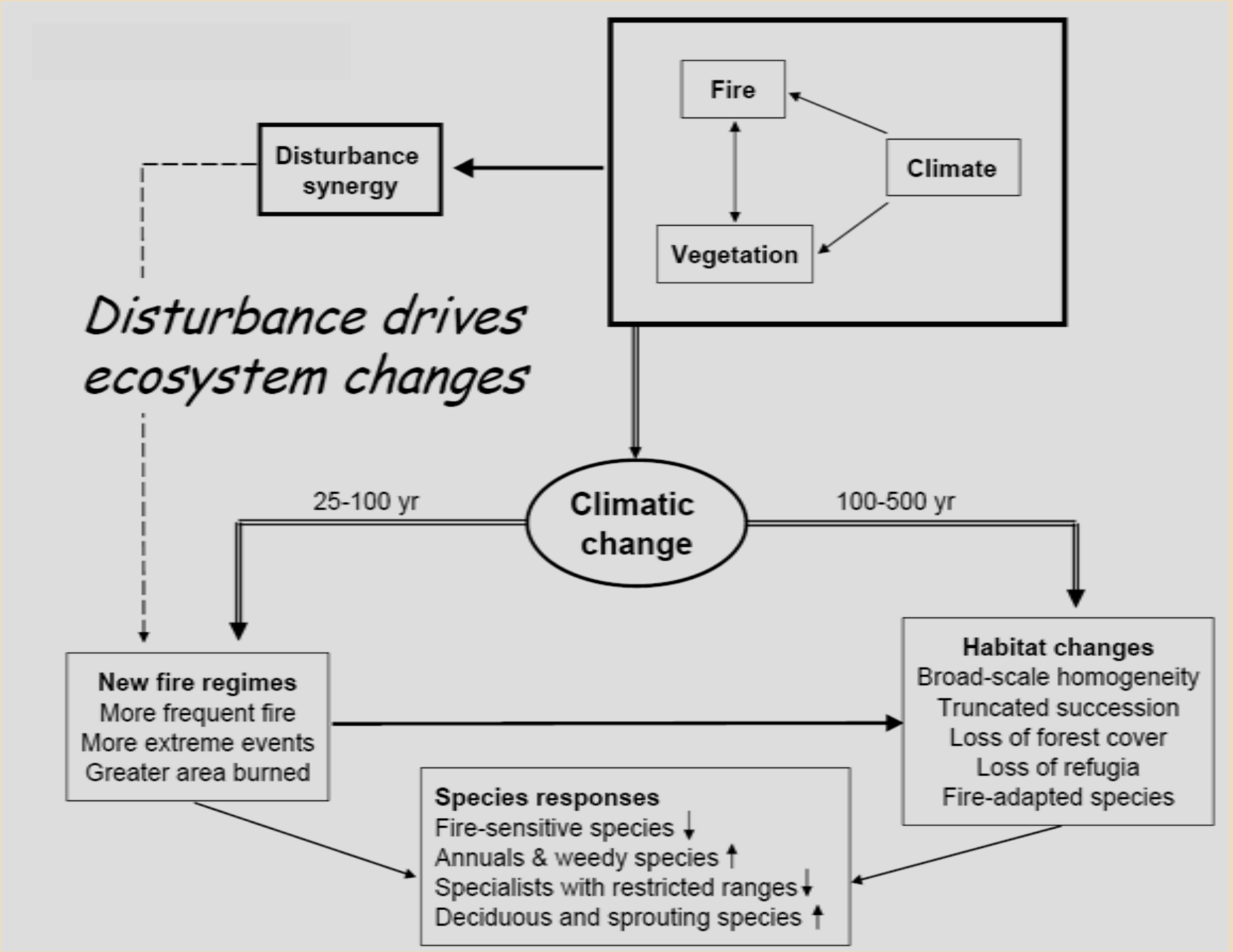
Disturbance interactions

- Direct climate mortality
- Increasing fire frequency

The Disease Spiral



Manion 1991



McKenzie et al. 2009

Lodgepole pine

Extended warm period → bark beetles → tree mortality → fuels accumulate → potential for large fires

Mixed conifer (Sierra Nevada, southern California)

Ozone pollution

Fire exclusion → high stand densities

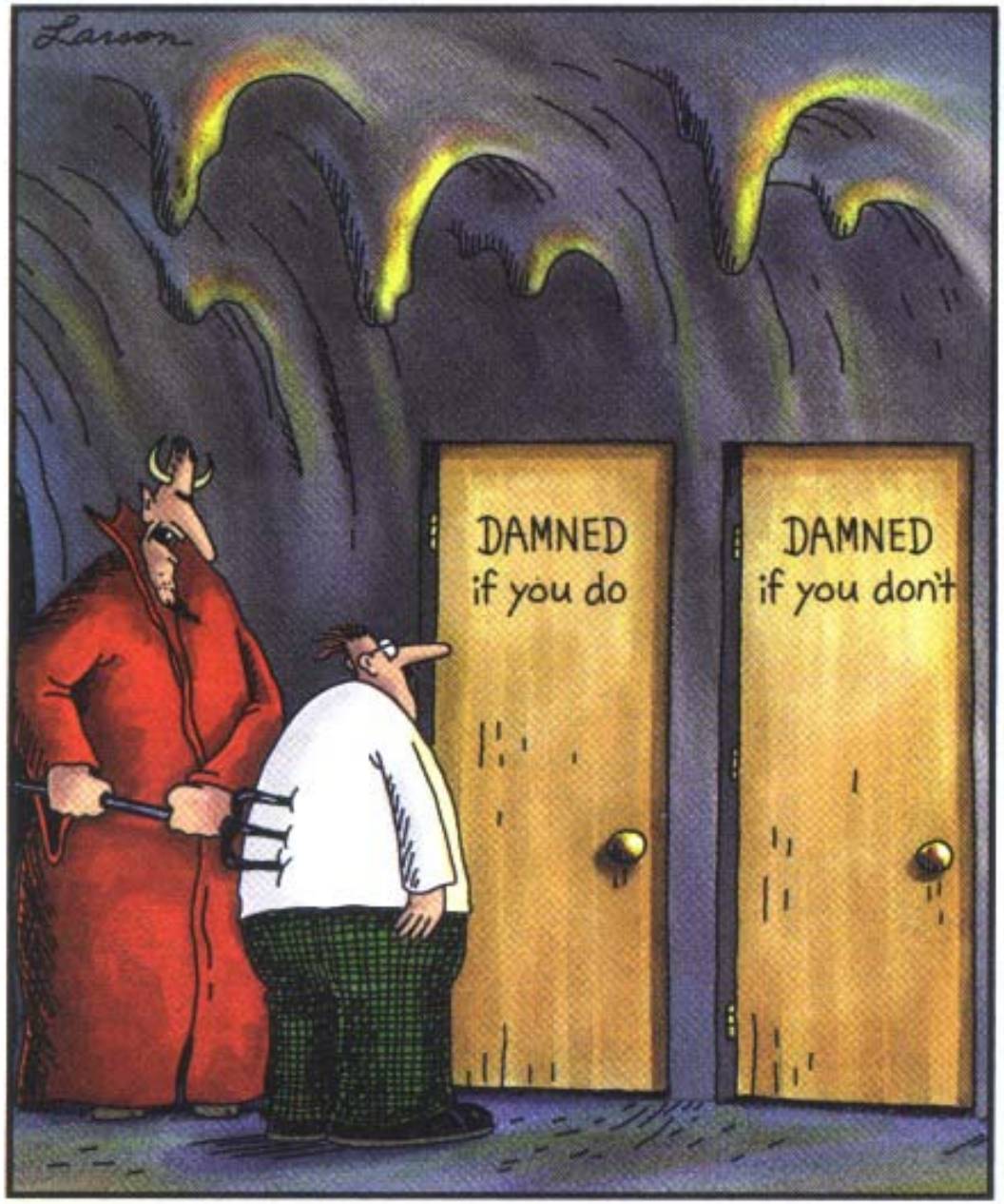
Extended warm period → insects

Ponderosa pine, Jeffrey pine, white fir die

Fuels accumulate → severe fires

Exotic plants increase where fires do occur

Adaptation strategies for natural resource management?



"C'mon, c'mon—it's either one or the other."

We cannot affect area burned, but we *can* modify fire effects through fuel treatments.

Signal Thin DFPZ Timber Sale (HFQLG)
1,189 ac.

Eastside Pine prior to harvesting (2002) Strata - E2G (approx. 300+ Trees Per Ac.)

Eastside Pine after harvesting (2002) Strata - E3N (approx. 90-110 Trees Per Ac.)

- Removed 28.5 green tons/ac., which was 40% sawlogs and 60% chips and biomass
- Generated $74,183.00 or $124.67/ac. in revenues for the portion of the sale which is harvested
- The objectives were to develope a DFPZ and improve stand health and vigor.
- CASPO Prescription

Adaptation strategy #1

Increase landscape diversity

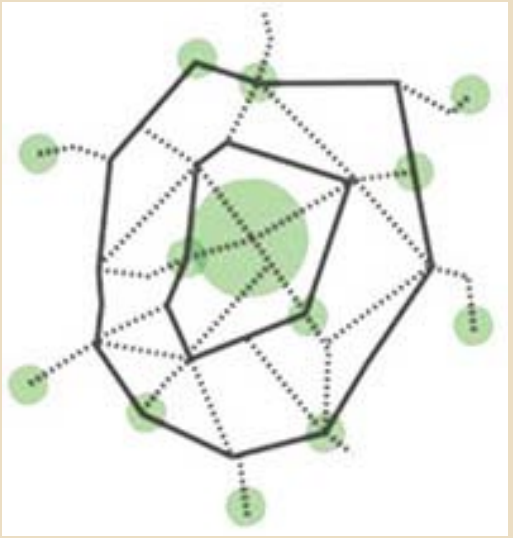
Increase resilience at large spatial scales

--Treatments and spatial configurations that minimize loss of large number of structural and functional groups

Increase size of management units

-- Much larger treatments and age/structural classes

Increase connectivity



Adaptation strategy #2

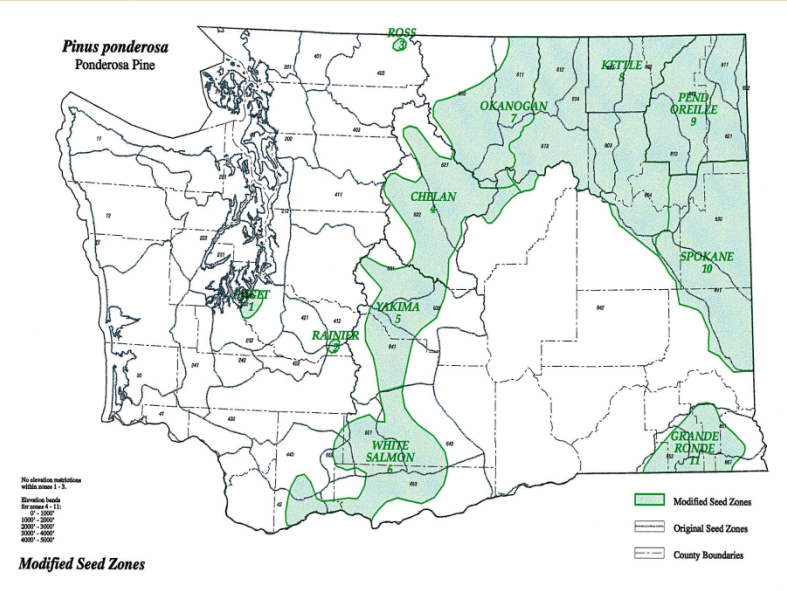
Maintain biological diversity

Modify genetic guidelines

Experiment with mixed species, mixed genotypes

Assist colonization, establish neo-native species

Identify species, populations, and communities that are sensitive to increased disturbance



Adaptation strategy #3

Plan for post-disturbance management

Treat fire and other ecological disturbance as normal, periodic occurrences

Incorporate fire management options directly in general planning process

Adaptation strategy #4

Implement early detection / rapid response

Eliminate or control exotic species

Monitor post-disturbance conditions, reduce fire-enhancing species (e.g., cheatgrass)

Adaptation strategy #5

Anticipate big surprises

Expect mega droughts, larger fires, system collapses, species extirpations, etc.

Incorporate these phenomena in planning

Thank you