

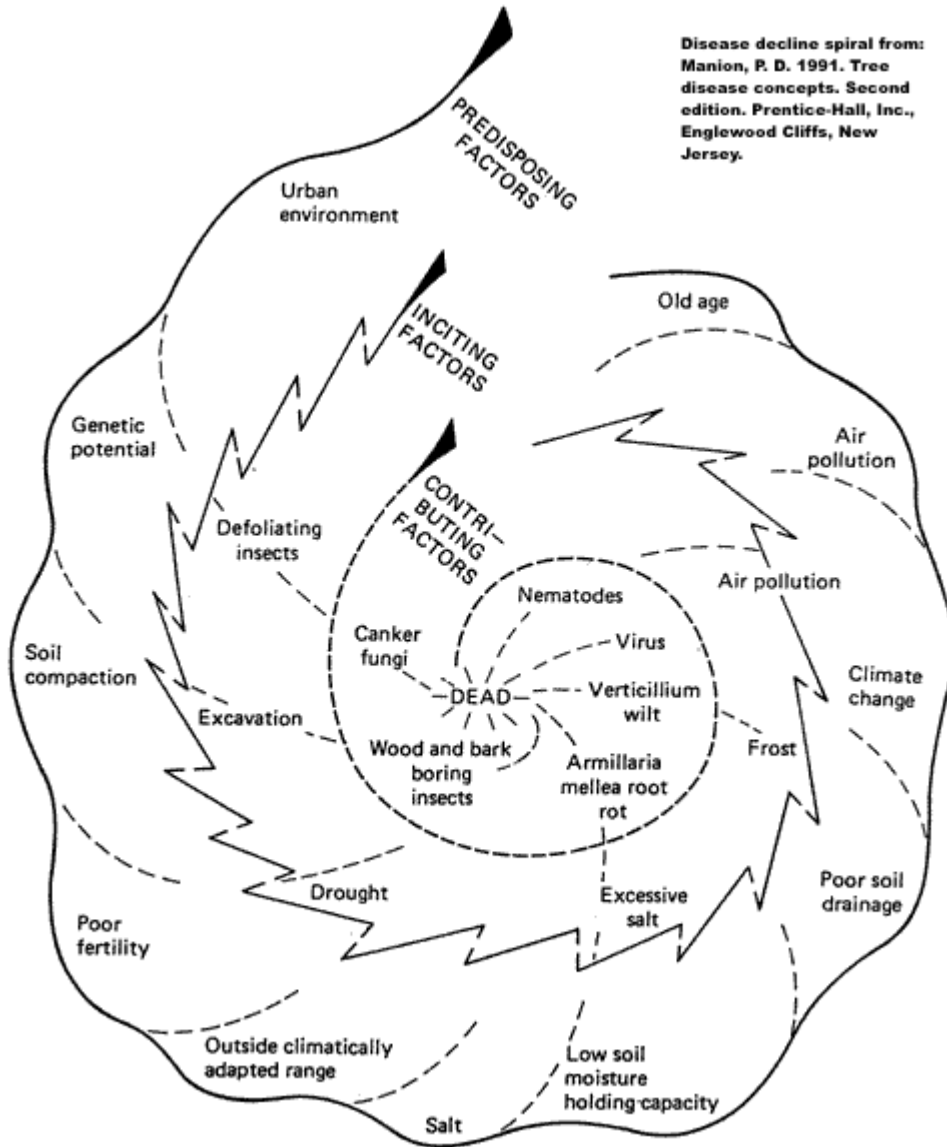


# Douglas-fir decline in SW Oregon: Why here, why now?

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# Framework for understanding regional DF decline



## Predisposing factors

Water-stressed sites that are marginal for DF



## Inciting factors

Drought and increasingly, hot drought



## Contributing factors

- Flatheaded fir borer (FFB)
- Other secondary insects
- Canker diseases
- Hydraulic failure (embolism)

**Mannion's Disease Decline Spiral**

# Predisposing factors

- Douglas-fir encroachment / densification on sites that, with a warming climate, are climatically marginal for the species

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- A photograph of a forest with many thin trees and two prominent, moss-covered trees in the foreground. The forest floor is covered with fallen branches and pine needles. The text is overlaid in the bottom left corner.
- Fire exclusion
  - DF encroachment/densification
  - 43% of cumulative 1975-2019 DF mortality overlaps with historic oak & pine habitat

Douglas-fir mortality is largely found on "marginal" (hot, dry) sites

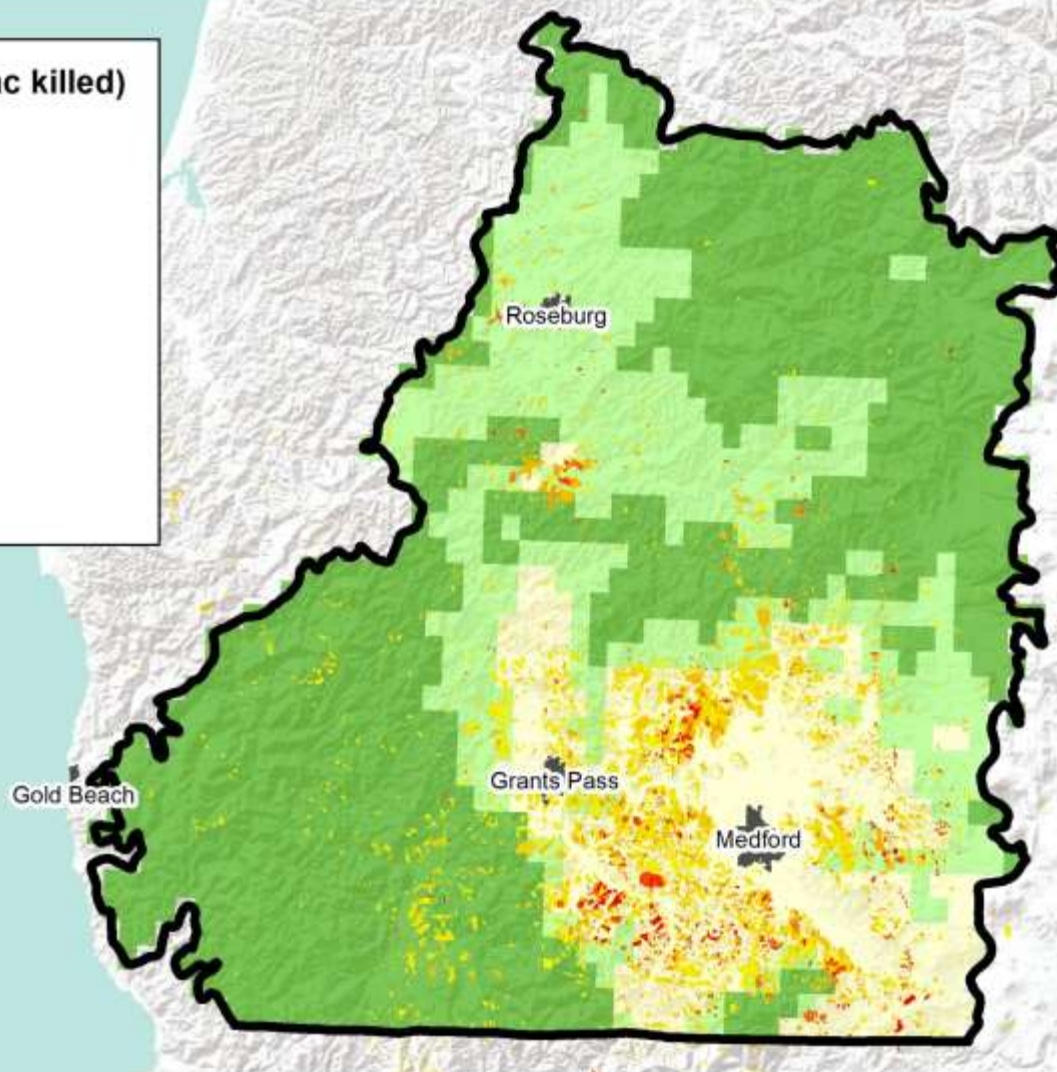
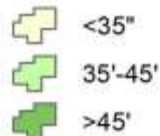
Relative severity of mortality (trees/ac killed)

Value



Precipitation zone

Mean annual precipitation (inches)



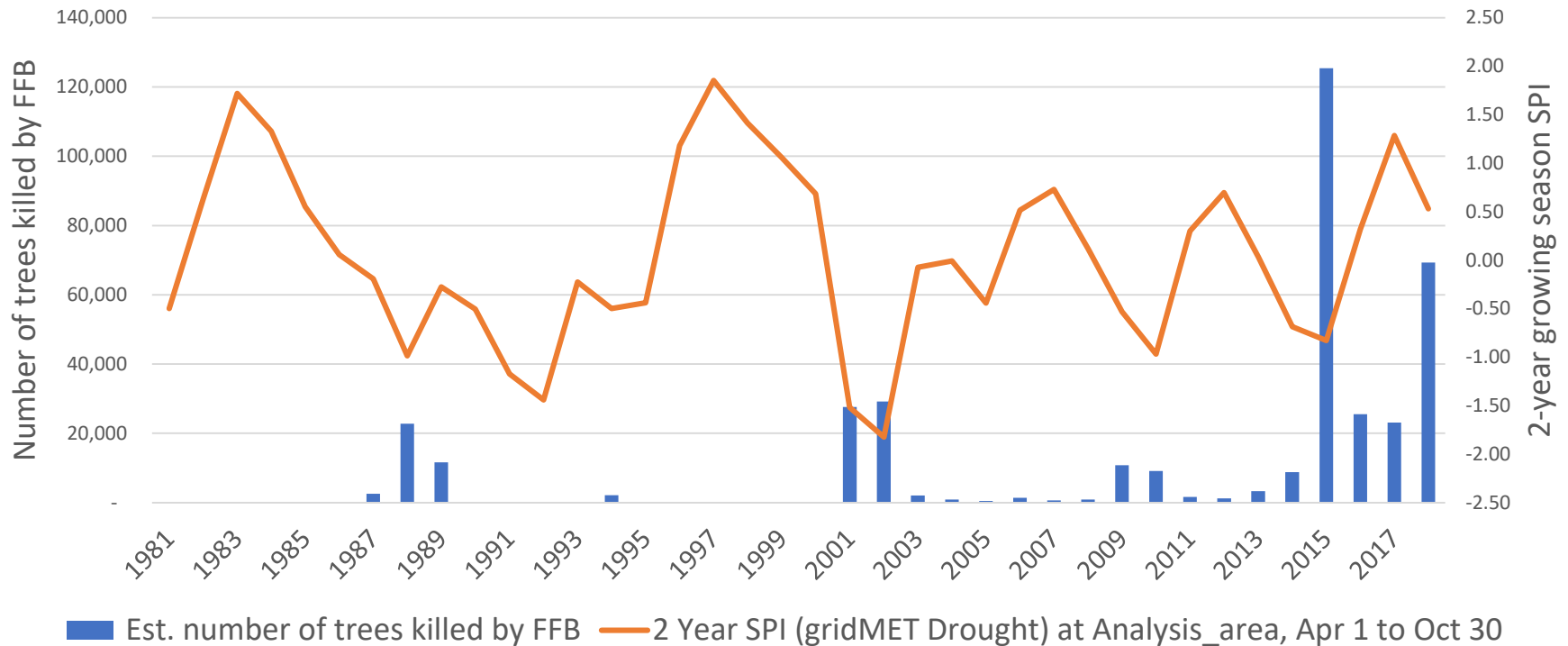
Data: ODF/USFS Aerial Detection Survey, PRISM



0 15 30 60 Miles

# Inciting factor: Drought

Standardized Precipitation Index (SPI) & DF mortality from FFB



Assumes trees killed in year prior to year of detection in aerial survey

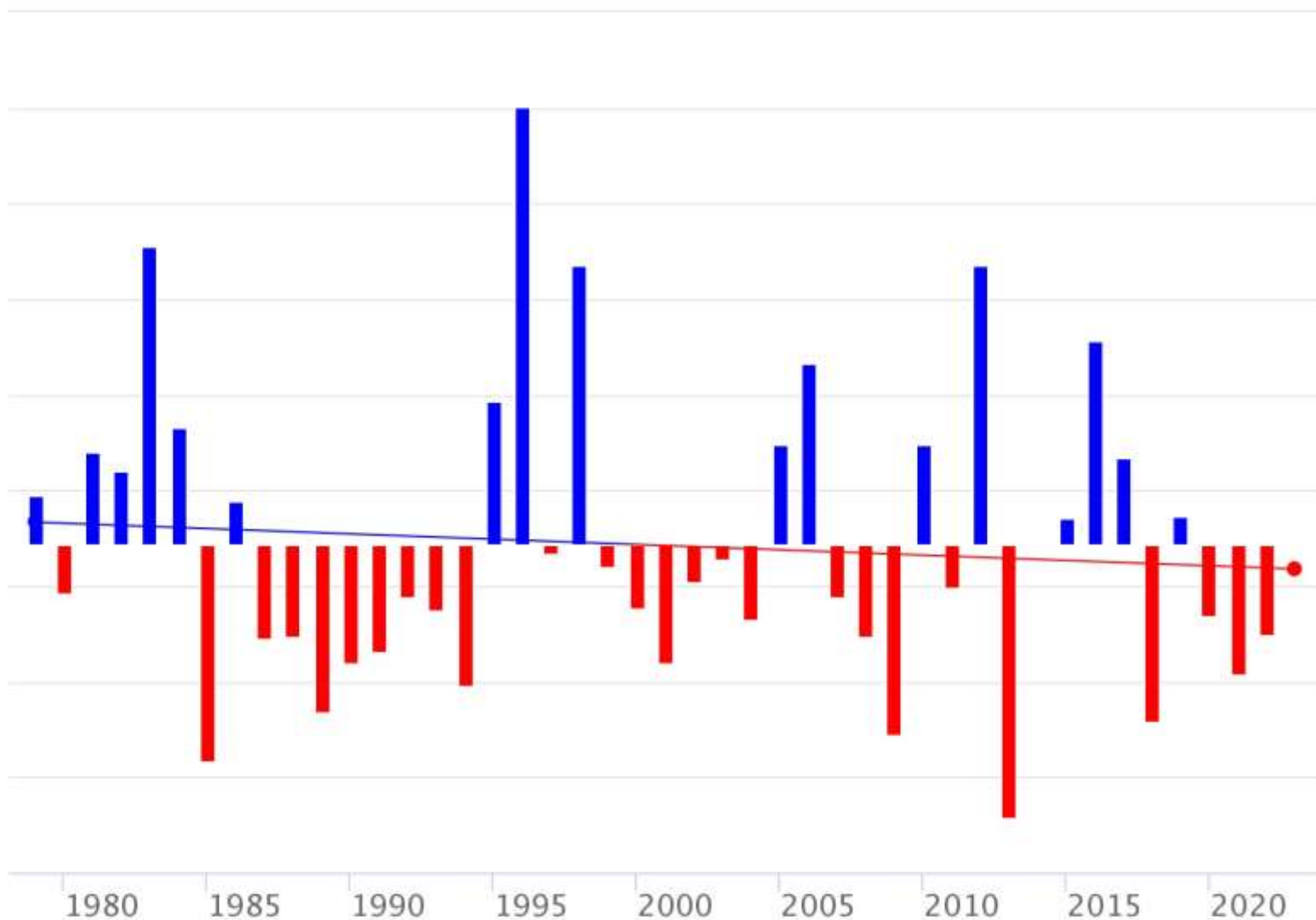
Data: DF mortality data from Aerial Detection Survey. Climate data from Climate Engine, <https://clim-engine.appspot.com/climateEngine>

# January–December Precipitation

Canyonville Oregon, Avg (1979–2022): 32.1 inches

60 inches

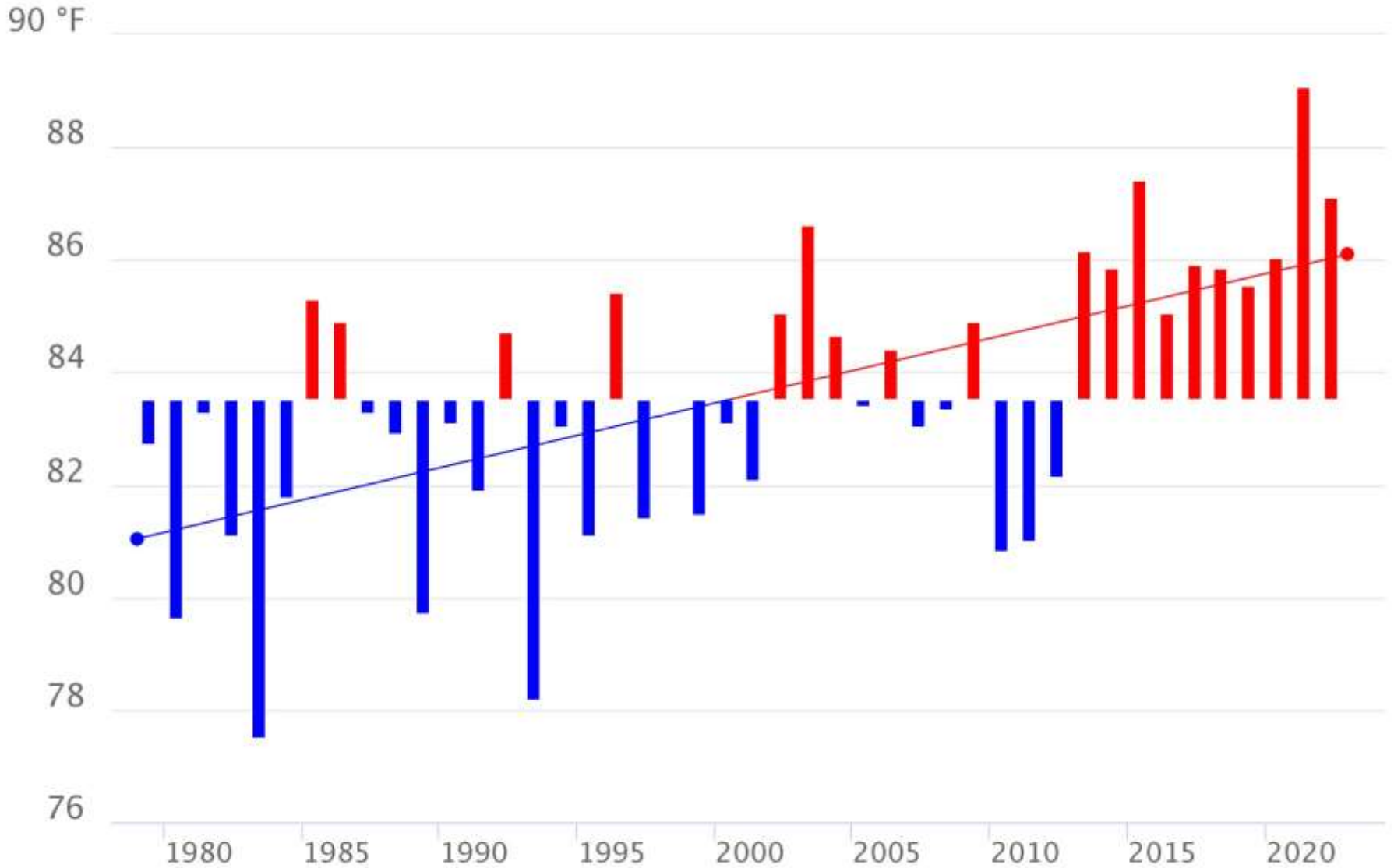
55  
50  
45  
40  
35  
30  
25  
20  
15



● Trend Line (-0.6 inches/decade,  $r = -0.09$ ,  $p = 0.5$ )

# June–August Max. Temperature

Canyonville Oregon, Avg (1979–2022): 83.5 °F

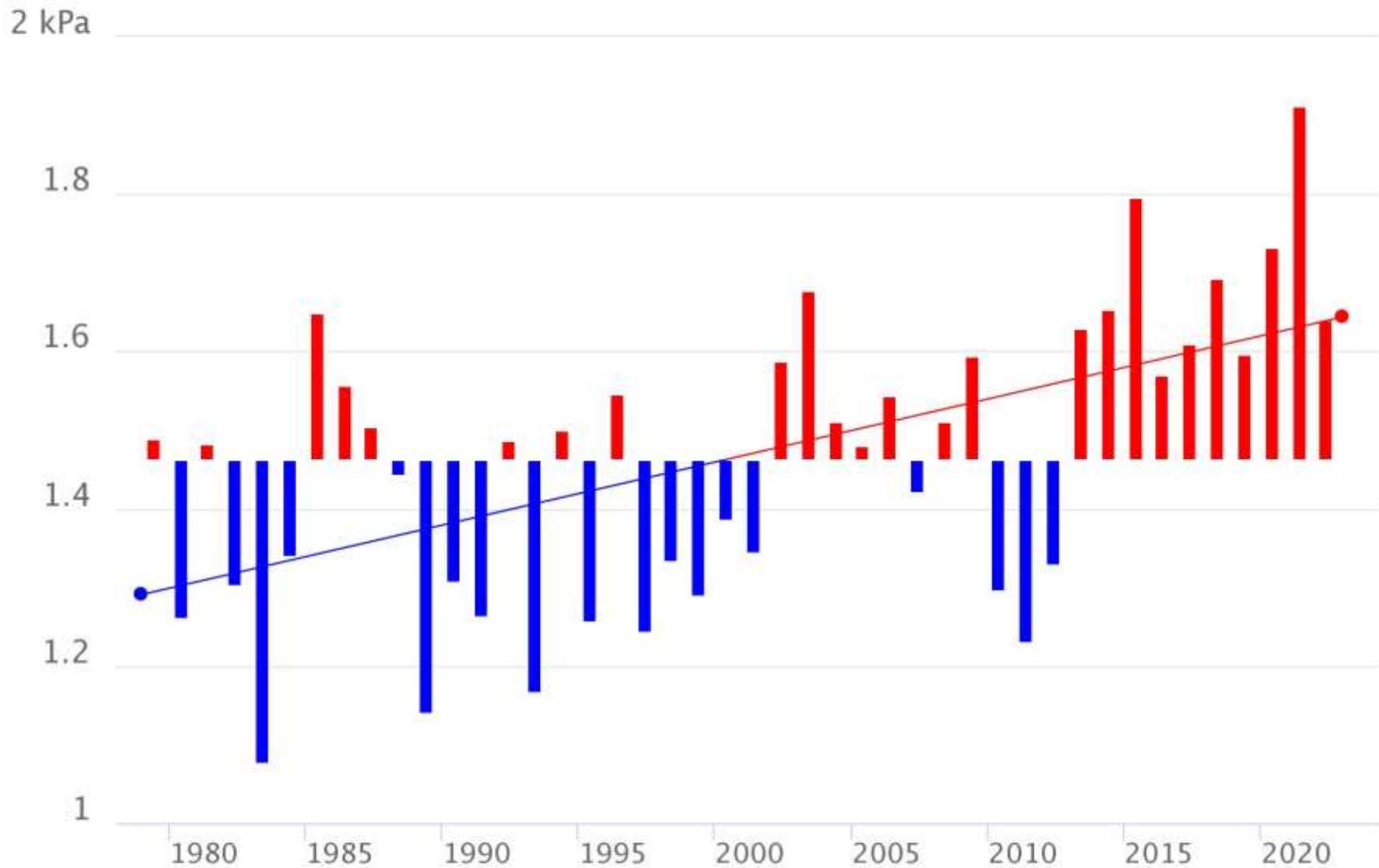


• Trend Line (+1.1 °F/decade,  $r = 0.60$ ,  $p = 0.001$ )



# June–August Vapor Pressure Deficit (kPa)

Canyonville Oregon, Avg (1979–2022): 1.5 kPa

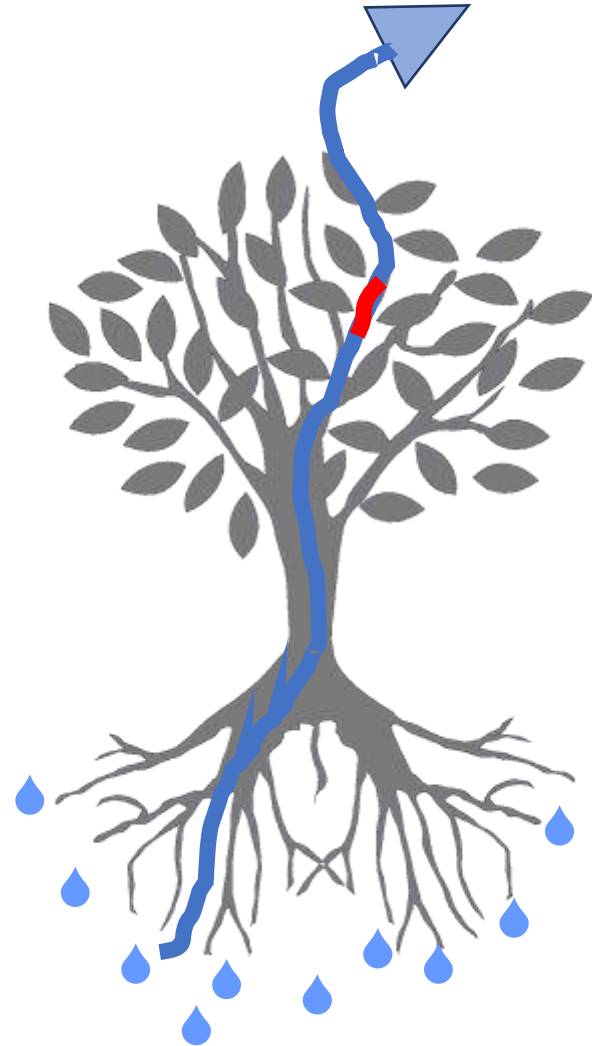


• Trend Line (+0.1 kPa/decade,  $r = 0.56$ ,  $p = 0.001$ )

# *Hotter drought*

- Increased vapor pressure deficit
- Stomatal closure >>>>
- Less food for growth, repair, and defense >>>>
- Fewer defensive compounds
- Higher respiration rates
- High temperatures may damage tissue/growth cessation
- Hydraulic failure

Increased atmospheric demand

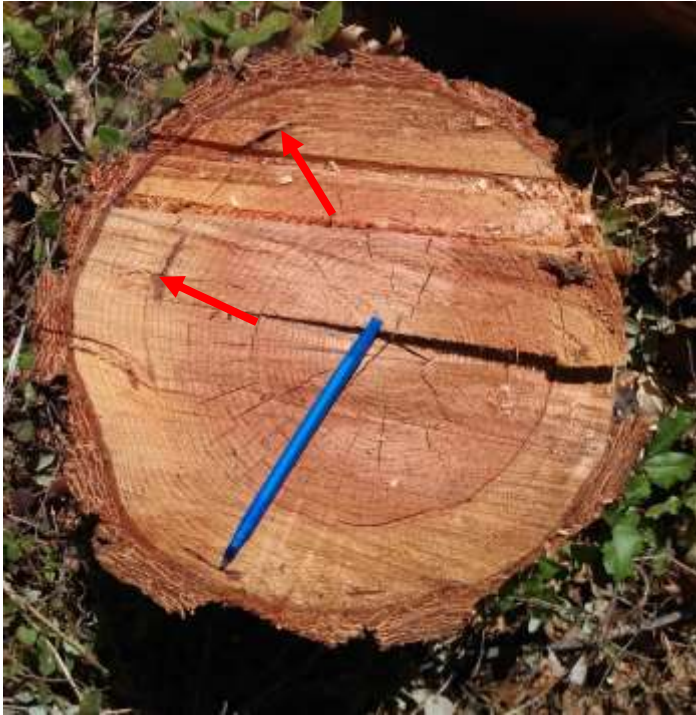


Reduced soil water storage

# Contributing factors

- Flatheaded fir borer (FFB)
- Other insects and diseases
- Hydraulic damage/failure due to development of embolisms

# Field investigation of mortality agents



Pitch pockets –probably resulting from previous unsuccessful FFB attacks

- Felled 18 declining/dying DF trees (6"-27" DBH) across 3 locations w/ ongoing mortality
- Systematically examined each tree for signs & symptoms of insects and pathogens
- Found:
  - Flatheaded fir borer galleries/ larvae on ~50% of trees
  - Many other insects, cankers
  - No root disease or DF beetle
  - Sampled branches of 6 trees for loss of conductivity; avg. % loss of conductivity 37% (range 0-85% for 18 branches)
  - Multiple agents over multiple years
  - Decline complex?

# Spatial patterns

- Aspect
- Edge
- Soils (white oak)
- Even-aged, 80-120+

Southwesterly aspect  
Hot, dry  
Too dry for Douglas-fir  
Oaks & chaparral

Westerly aspect  
Marginally moist for DF  
DF mortality on stand edge

Northwesterly aspect  
Relatively cool  
& moist, deeper soils  
Little DF mortality (so far)

Photo: Ellen Goheen