Strategies for Reducing Impacts of Drought, Insects and Disease

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https://www.pinterest.com/pin/143481938103820703/

Strategies for Reducing Impacts of Drought, Insects and Disease

- Introduction:
  - Dead trees
  - The rate of mortality
- Hotter Drought
  - VPD and tree mortality
  - California Epic Drought and Tree Death
- Insect and Pathogen Response to Drought and Climate Change
- Managing Stands
- Landscapes

Predicted Climate Changes: Depends on Geographic Region

Douglas-fir mortality in Willamette Valley associated with drought

Common Changes Predicted for the Short-Term…~50 years

- Hotter Drought
- Hotter, Drier, Longer Growing Season
- Warmer Winter
  - Wetter winter?
  - Low snowpacks
- Shift in Late-Spring and Summer Precipitation?
- Extreme Events!

But…Does a healthy forest have dead trees?

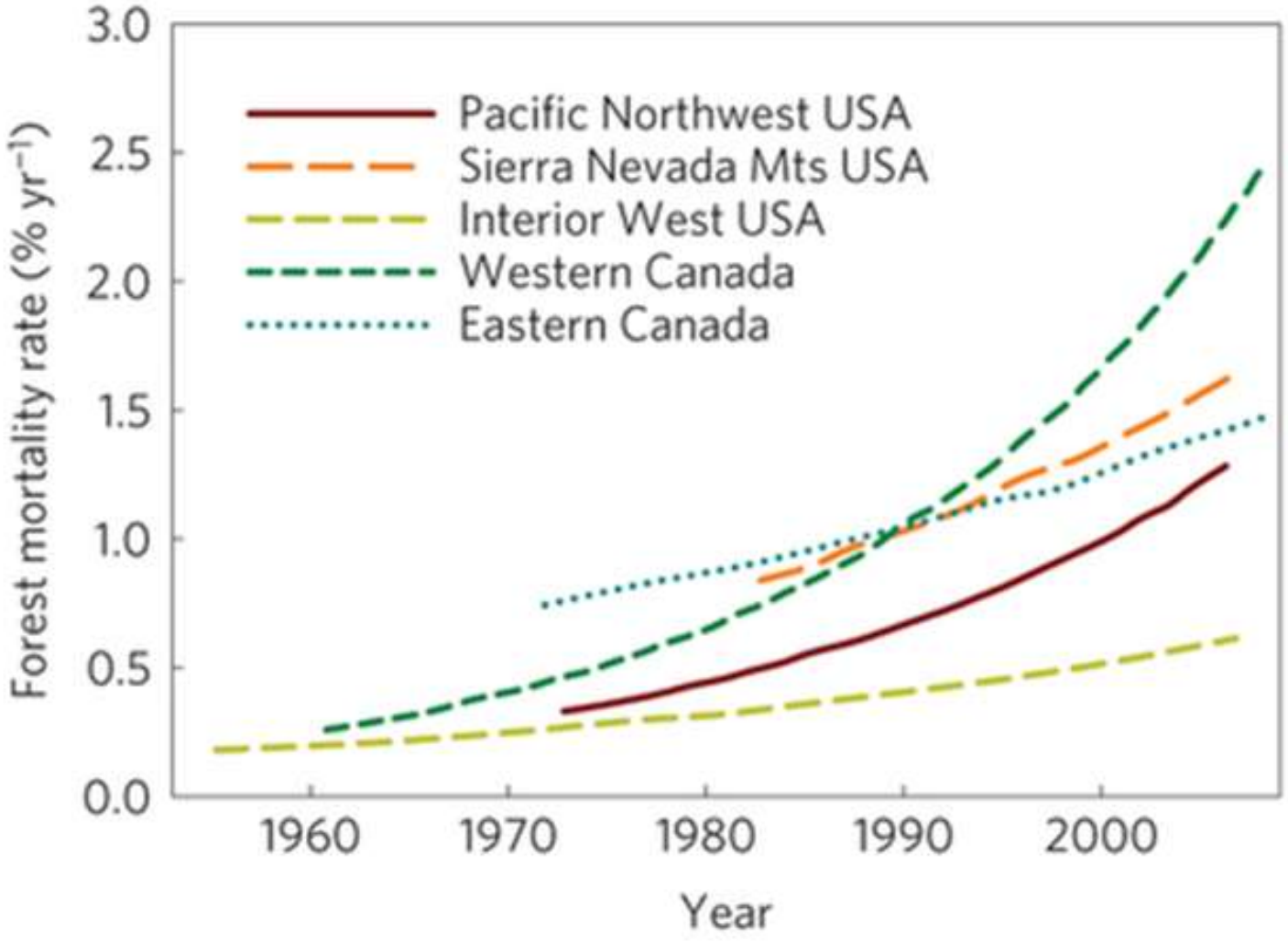
- Mortality is important for stand development and sustainability
- Dead trees are important for habitat, biodiversity, and forest resilience
- The rate of mortality is key to forest health (%/year) and economic losses

The Rate of Mortality

From McDowell et al. 2015. Nature Climate Change.

"Multi-scale predictions of massive conifer mortality due to chronic temperature rise."

- The rate of tree mortality is probably a better indicator of ecosystem and economic impacts.
- Rate is %tree dying/yr
- We prefer to stay under about 2%



Risks to Forests From Climate Change

- Tree Mortality
- Reduced Productivity
- Local Tree Species Extinctions
- Loss of Biodiversity
- Loss of Ecosystem Function

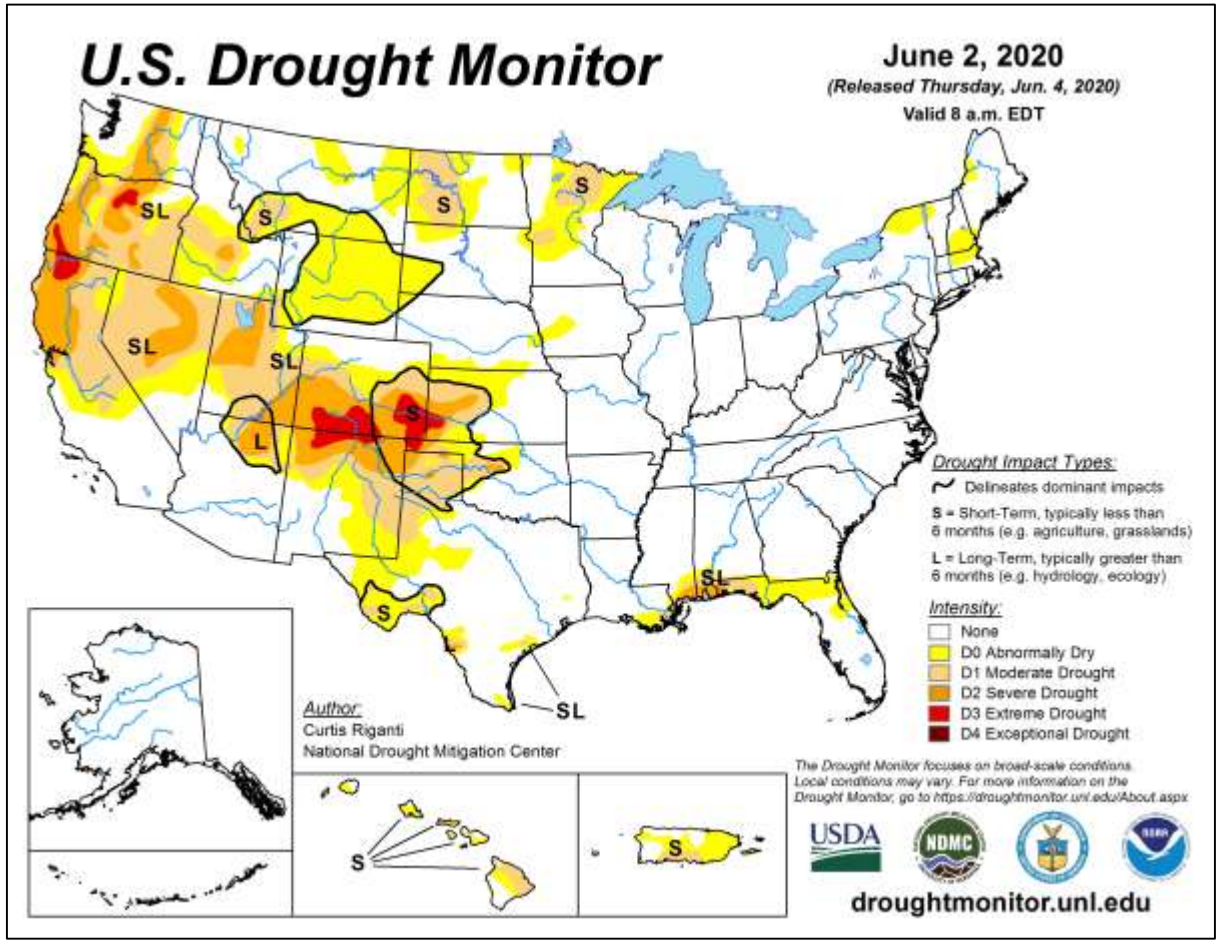
Dendroctonus ponderosae caused mortality in *Pinus contorta*, Oregon, USA

Polling Question 1.

- Have you had any tree mortality in your woods, or in your local area in the last few years?
  - Not sure
  - A little
  - A lot

Drought is thought to be increasing in many ways: The U.S. Drought Monitor

- U.S. Drought Monitor is the best integrating system available.
- 5 Factor Metric!
- Palmer Drought Severity Index
- CPC Soil Moisture Model
- USGS Weekly Streamflow
- Standardized Precipitation Index
- Objective Drought Indicator Blends



https://droughtmonitor.unl.edu/CurrentMap.aspx

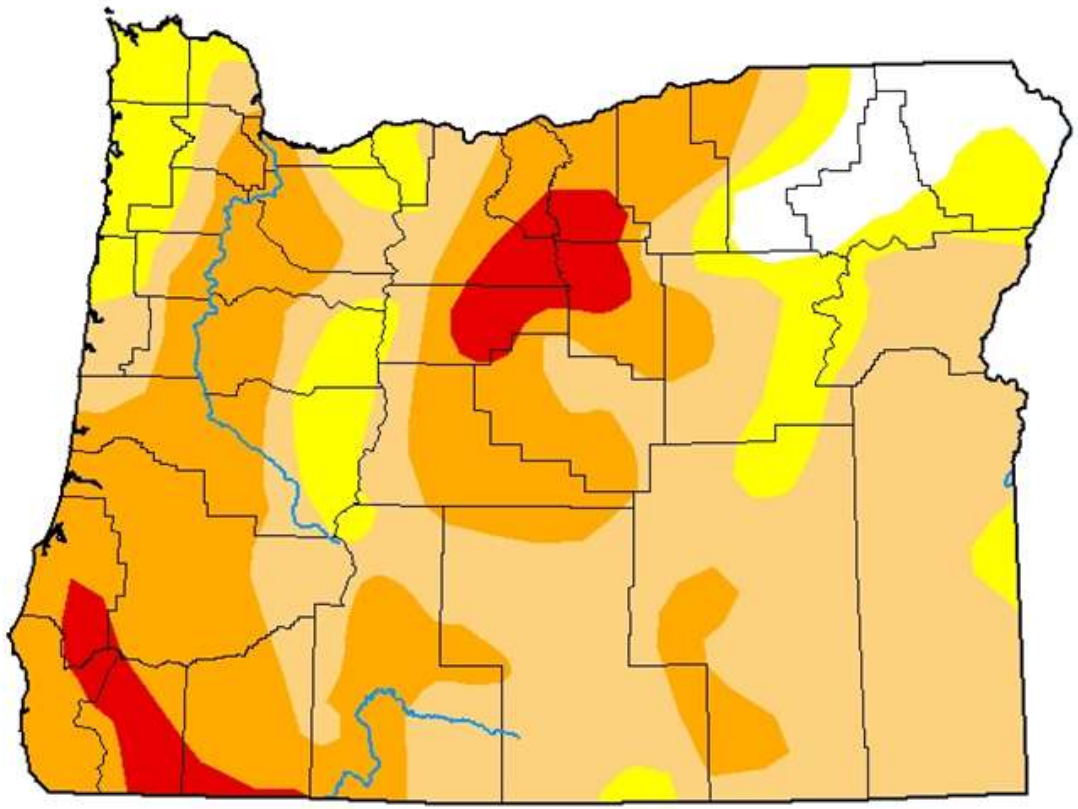
U.S. Drought Monitor

Oregon

June 2, 2020

(Released Thursday, Jun. 4, 2020)

Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

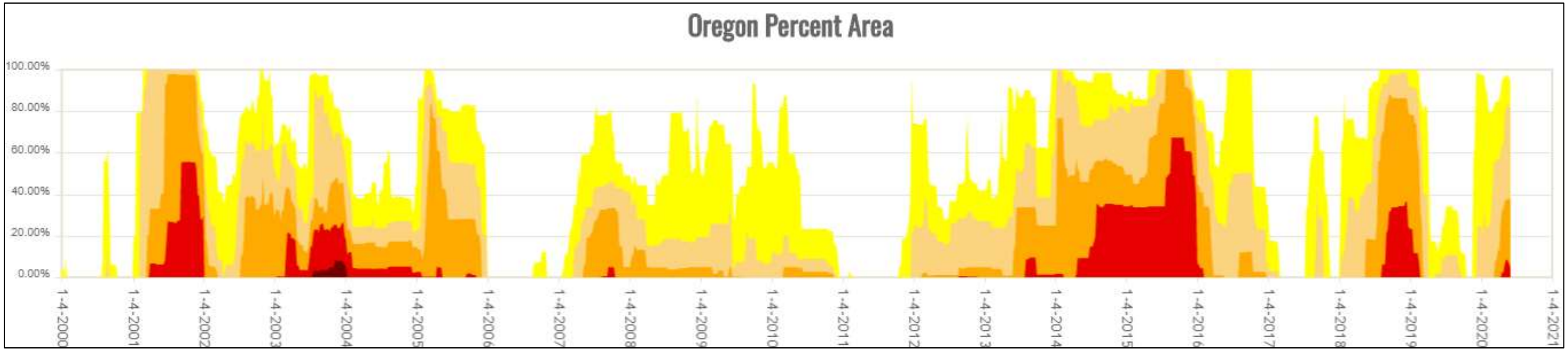
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Curtis Riganti
National Drought Mitigation Center

droughtmonitor.unl.edu

20 Year Record of Drought Severity in Oregon

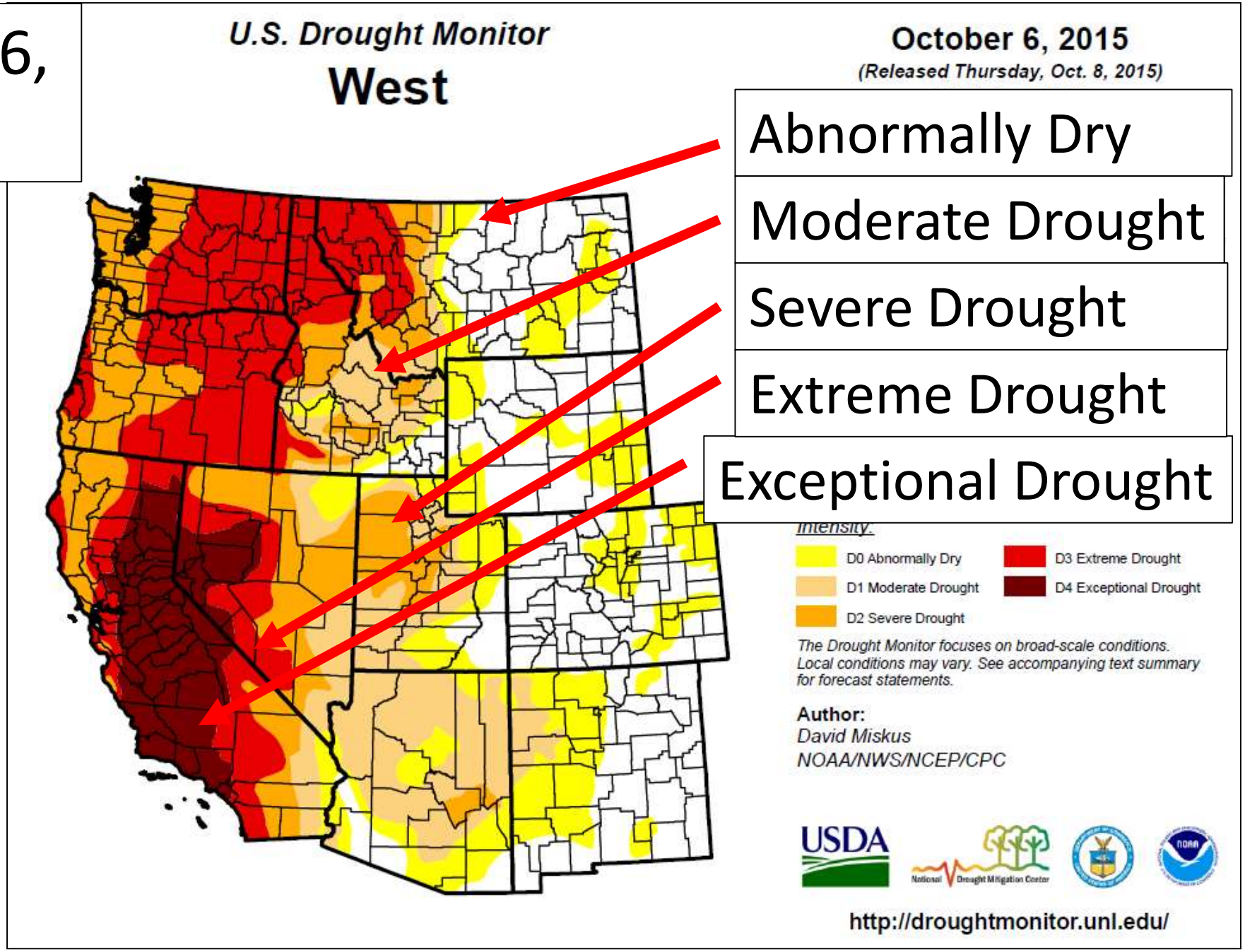


Jan 1, 2000

Jan 1, 2010

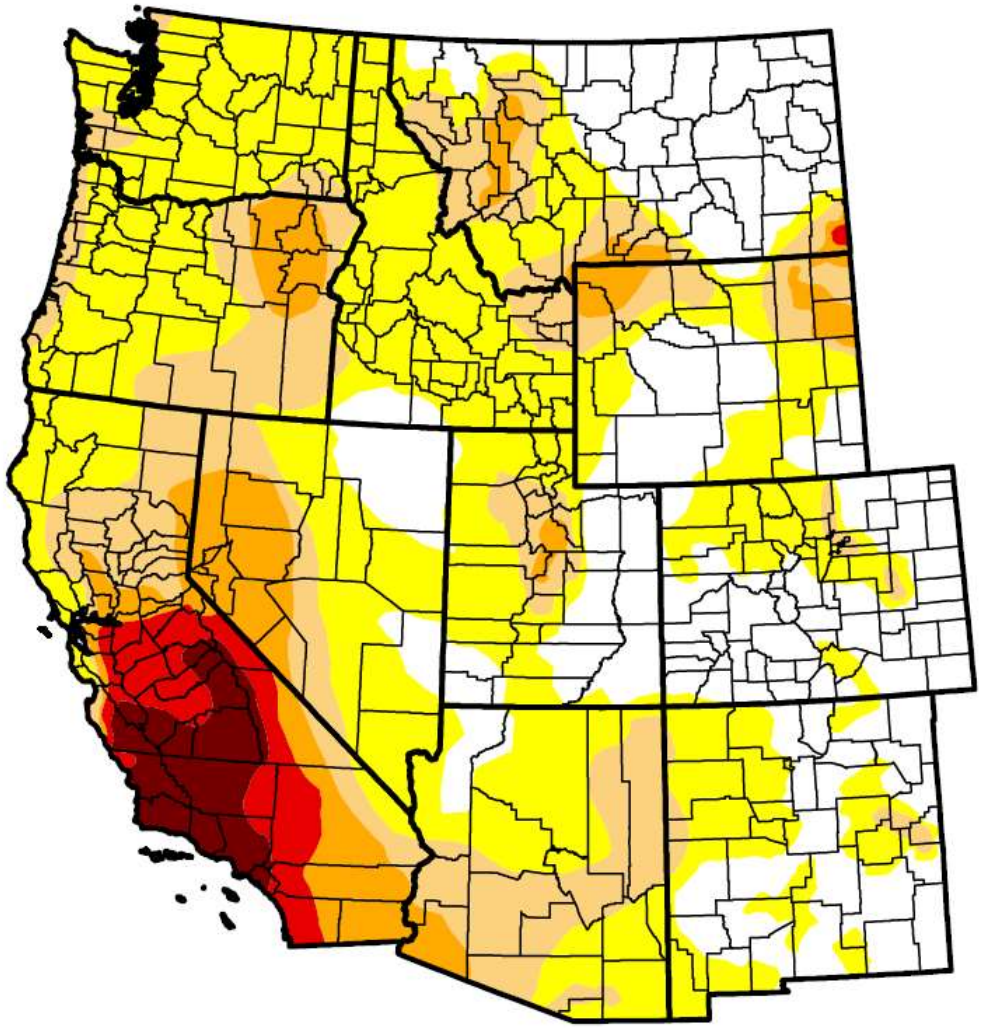
Jan 1, 2020

October 6, 2015



September 27, 2016

U.S. Drought Monitor
West



September 27, 2016
(Released Thursday, Sep. 29, 2016)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	27.78	72.22	30.95	13.45	5.77	2.81
Last Week *9/20/2016*	23.39	76.61	32.27	13.67	5.77	2.81
3 Months Ago *6/28/2016*	35.80	64.20	27.65	11.08	5.80	2.81
Start of Calendar Year *12/29/2015*	33.17	66.83	45.07	29.30	15.92	6.85
Start of Water Year *9/29/2015*	22.77	77.23	57.81	42.42	26.50	7.62
One Year Ago *9/29/2015*	22.77	77.23	57.81	42.42	26.50	7.62

Intensity:

- D0 Abnormally Dry
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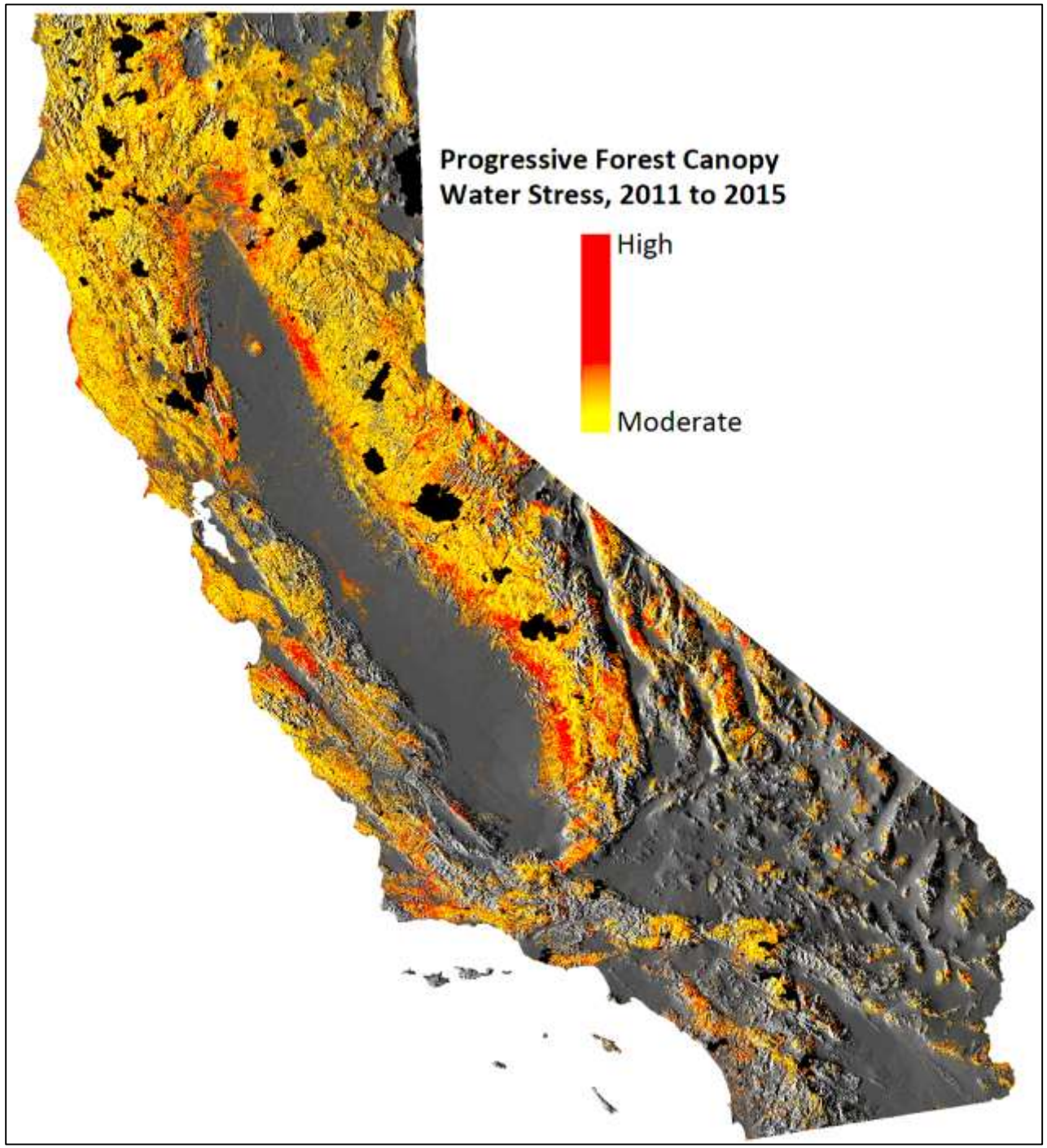
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Chris Fenimore
NCEI/NESDIS/NOAA

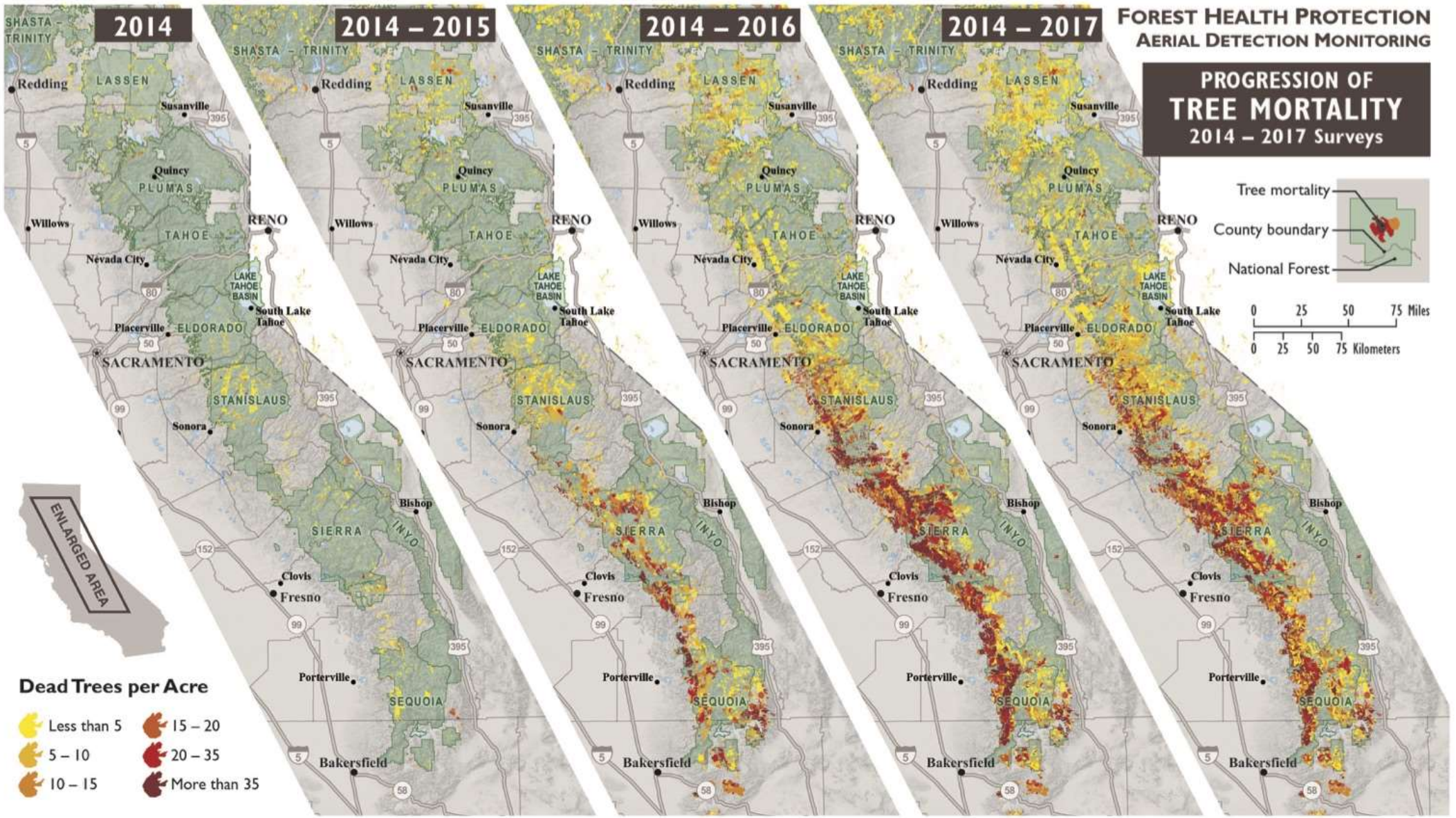
USDA · National Drought Mitigation Center · NOAA

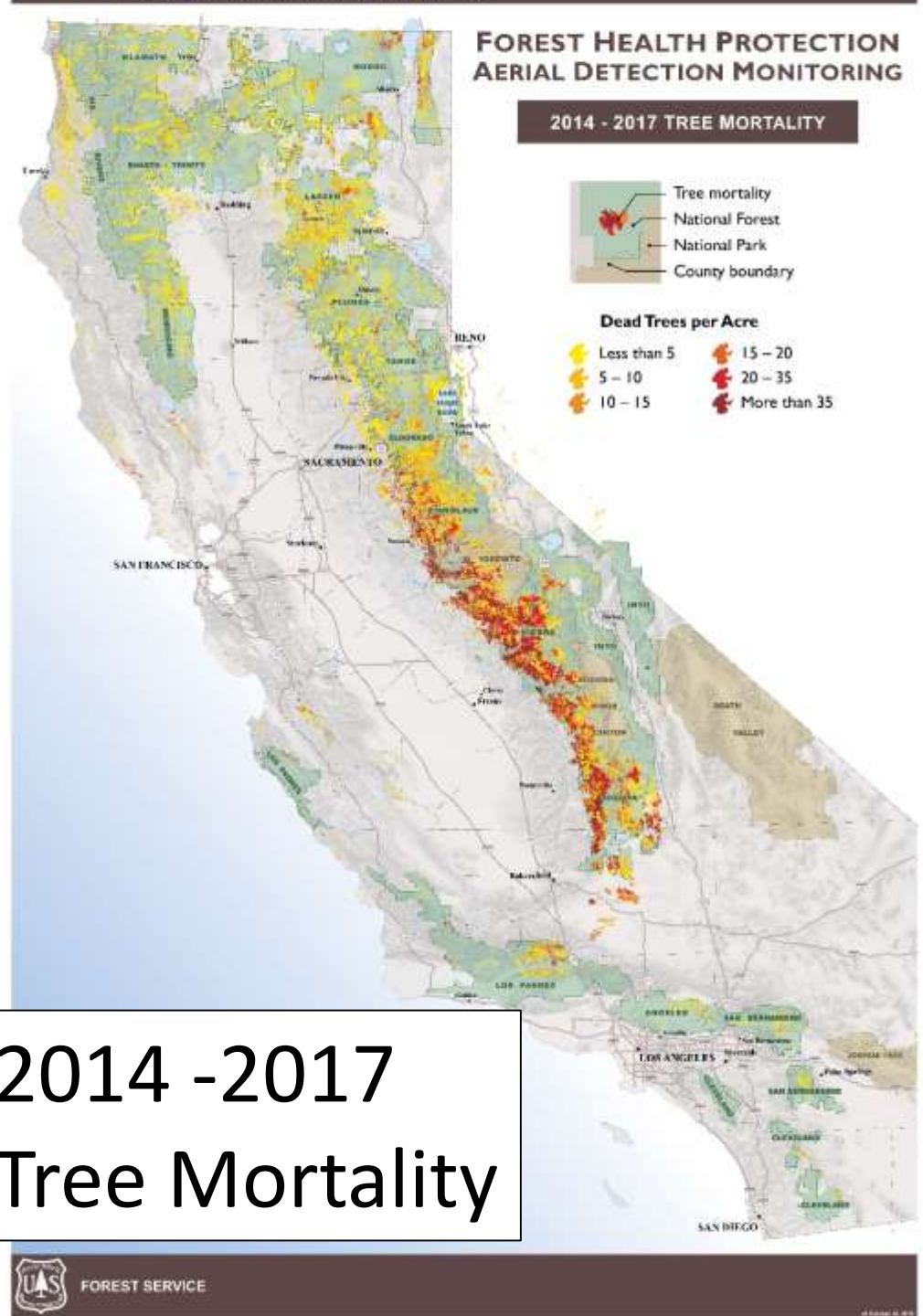
http://droughtmonitor.unl.edu/



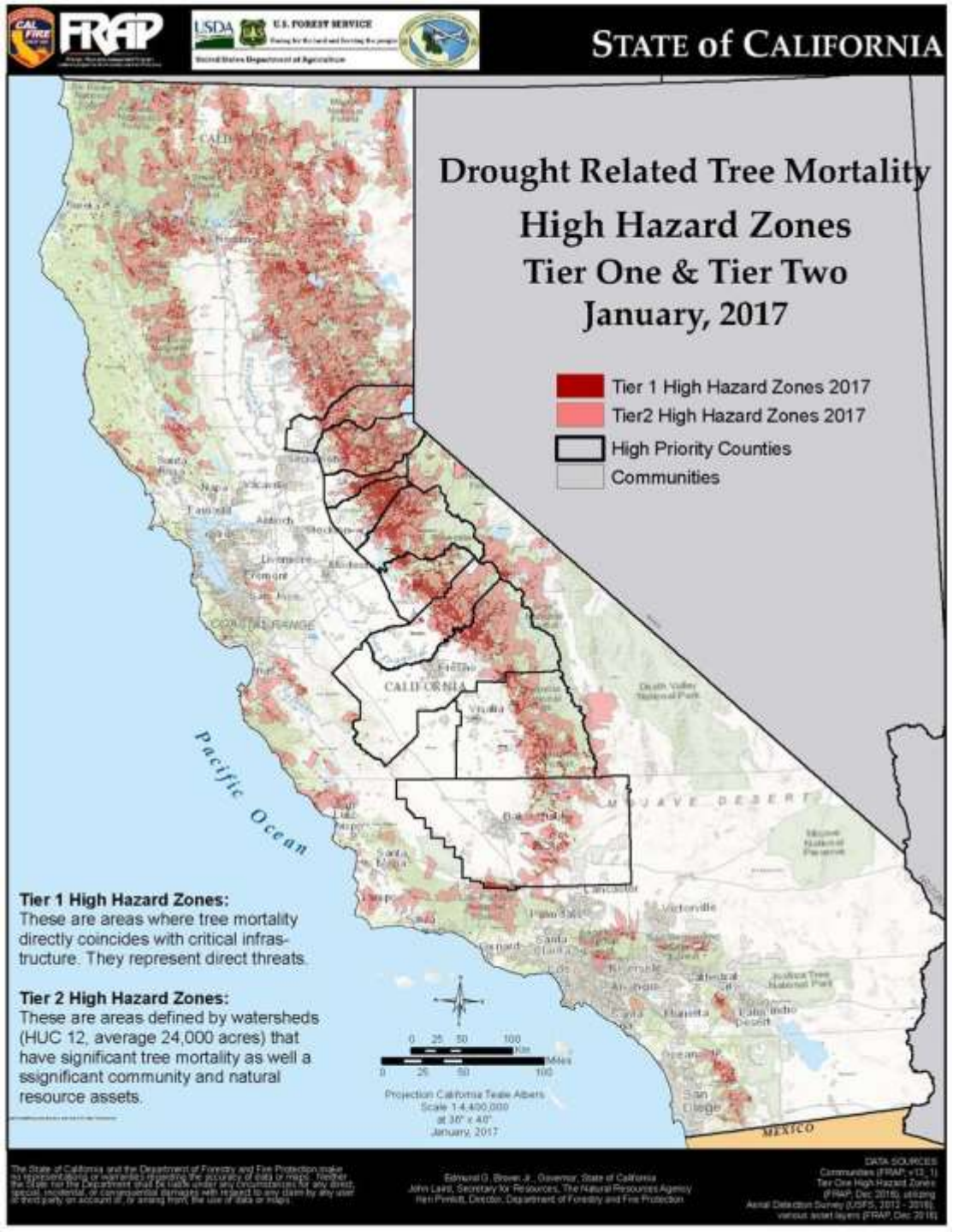
- California, USA
- Progessive Forest Canopy Water Stress 2011-2015
- Indicates potential tree stress.
- Greg Asner, Stanford Univ. Carnegie Airborne Observatory

Progression of Tree Mortality

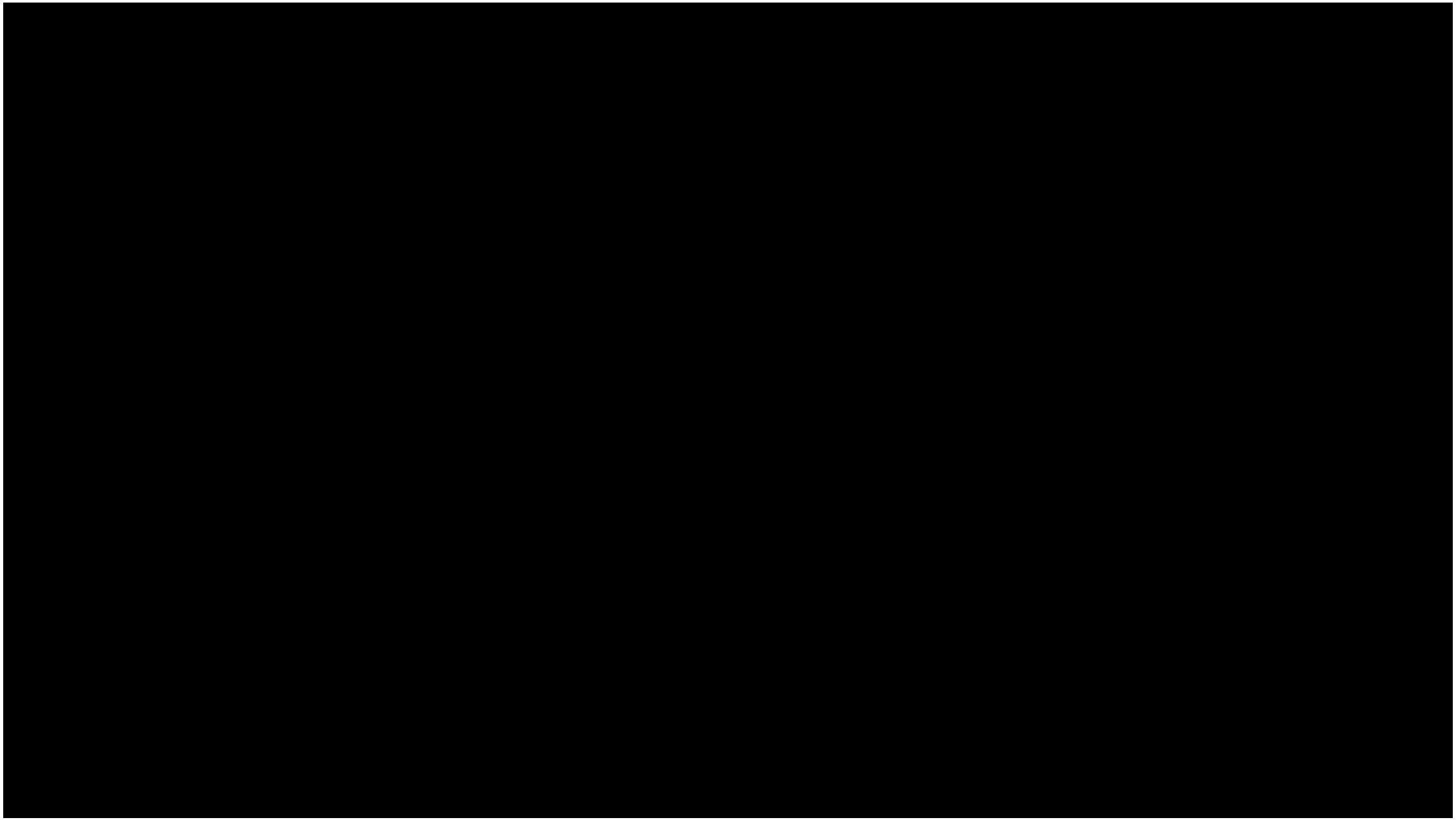




2014 -2017
Tree Mortality



Pinus ponderosa mortality, California (USFS photo)



Hotter Drought in California: 120,000,000+ trees died

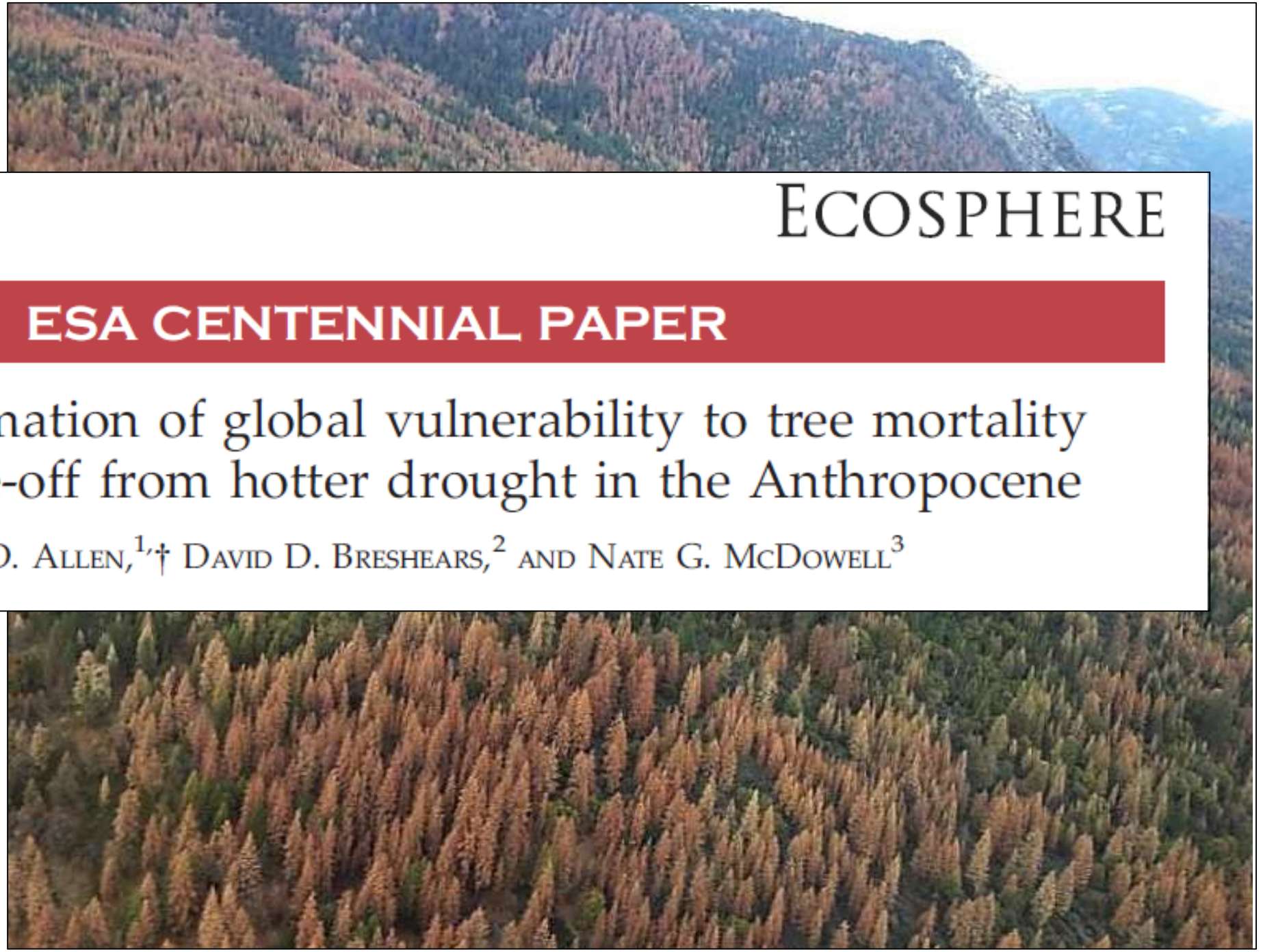
- Unusual Event
  - 100,000 yr event
- Large scale mortality.
- *Pinus ponderosa*
- *Abies* species.
- Bark Beetles:
  - Western Pine Beetle
  - Fir Engraver

P. ponderosa mortality in S. California 2016

Polling Question 2.

- Can the California style drought happen in Oregon?
  - Yes
  - No

Hotter Drought



esa

ECOSPHERE

ESA CENTENNIAL PAPER

On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene

CRAIG D. ALLEN,[1,]† DAVID D. BRESHEARS,[2] AND NATE G. MCDOWELL[3]

- California, USA Mortality Event

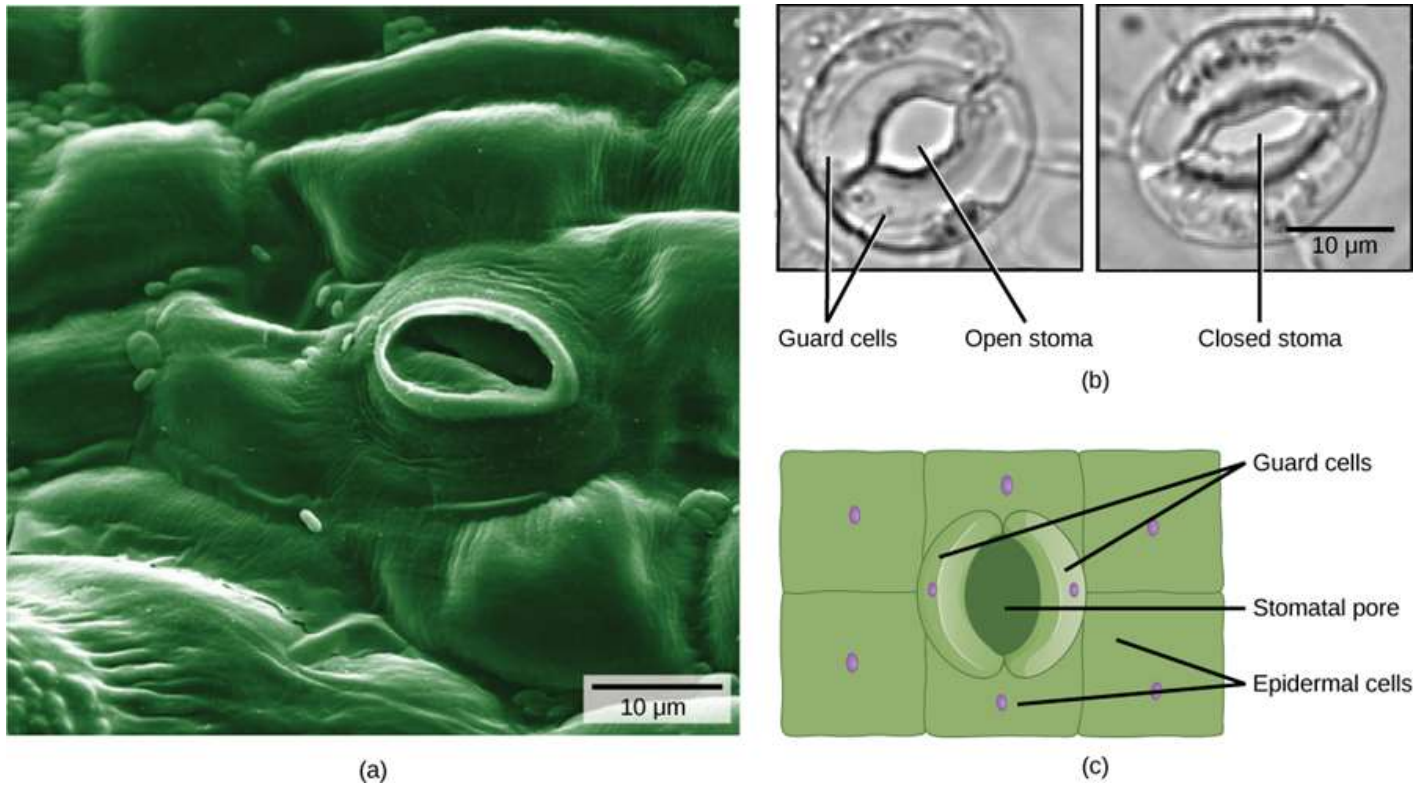
Pinus ponderosa mortality in California, USA
California Tree Mortality Task Force

Hotter Drought
VPD and tree mortality

- Vapor Pressure Deficit-VPD
- Vapor pressure is the amount of water in the air
- VPD is the difference between the maximum amount of water the air can hold and the amount actually in the air

VPD

- VPD can be thought of as the drying power of the air.
- The higher the VPD, the greater the power of drying (water evaporating)
- Plant stress especially relates the VPD because it increases the water loss by the plant/tree
- Trees have to close air pores to prevent drying, and therefore can't get carbon dioxide to photosynthesize



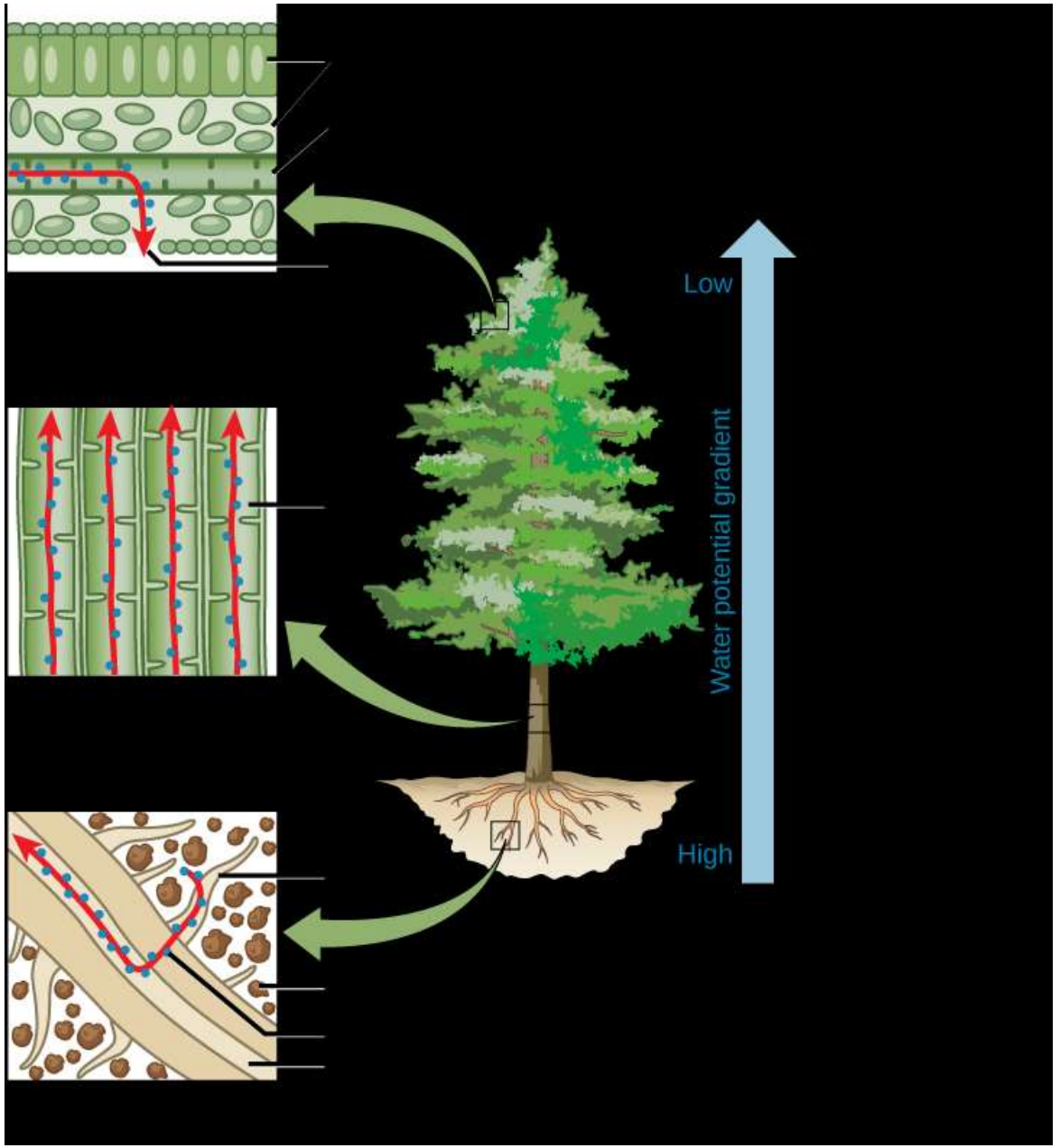
Stomates of a plant (air pores)

https://tophat.com/marketplace/science-&-math/biology/textbooks/oer-openstax-biology-openstax-content/79/4133/

Part II

VPD and Tree Death

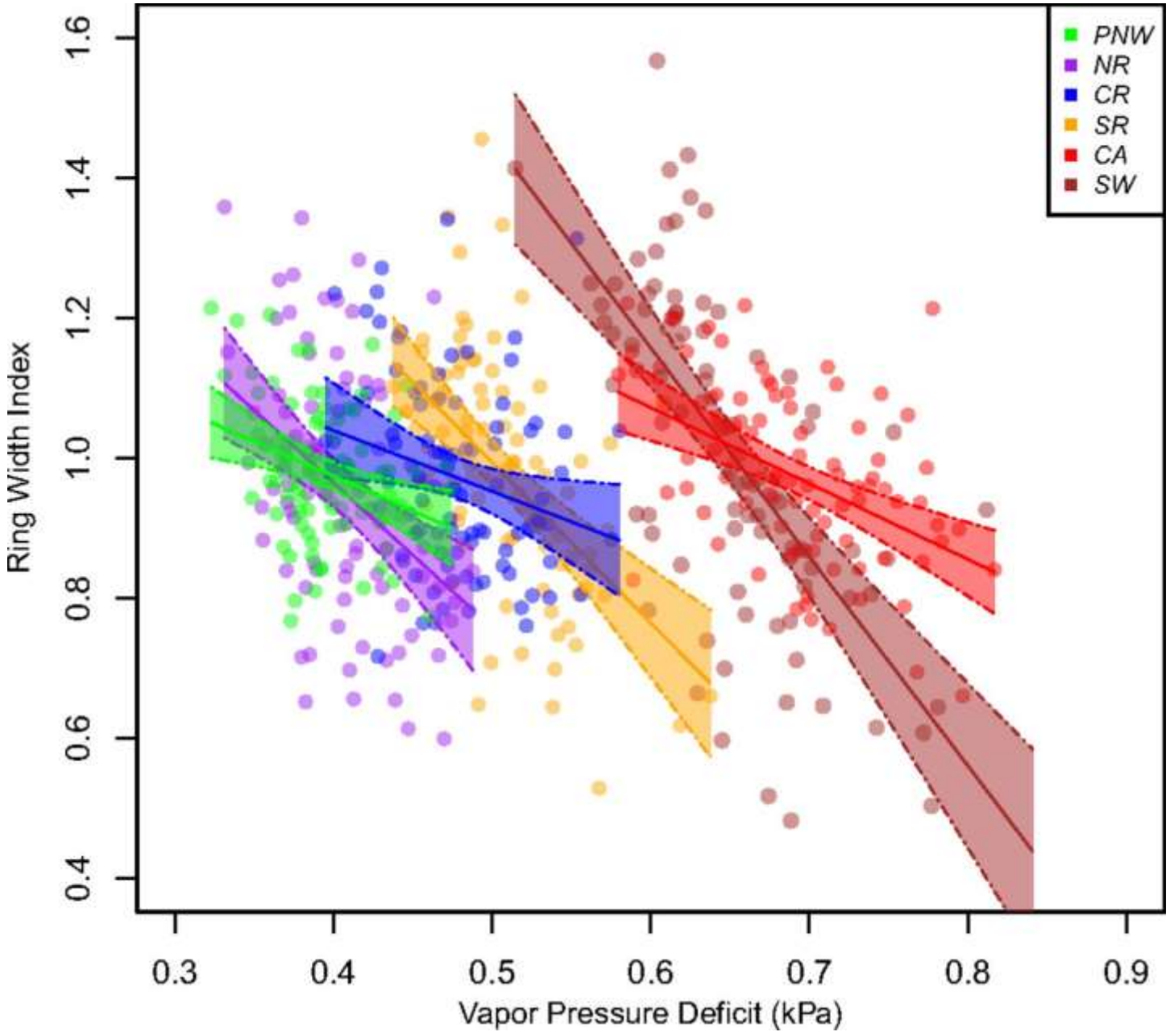
- The higher the temperature, the more water the air can hold.
- Higher VPD is associated with higher temperature
- Climate change is increasing temperature
- Tree may not be able to move water fast enough to keep up with loss
  - Catastrophic embolism



https://tophat.com/marketplace/science-&-math/biology/textbooks/oer-openstax-biology-openstax-content/79/4133/

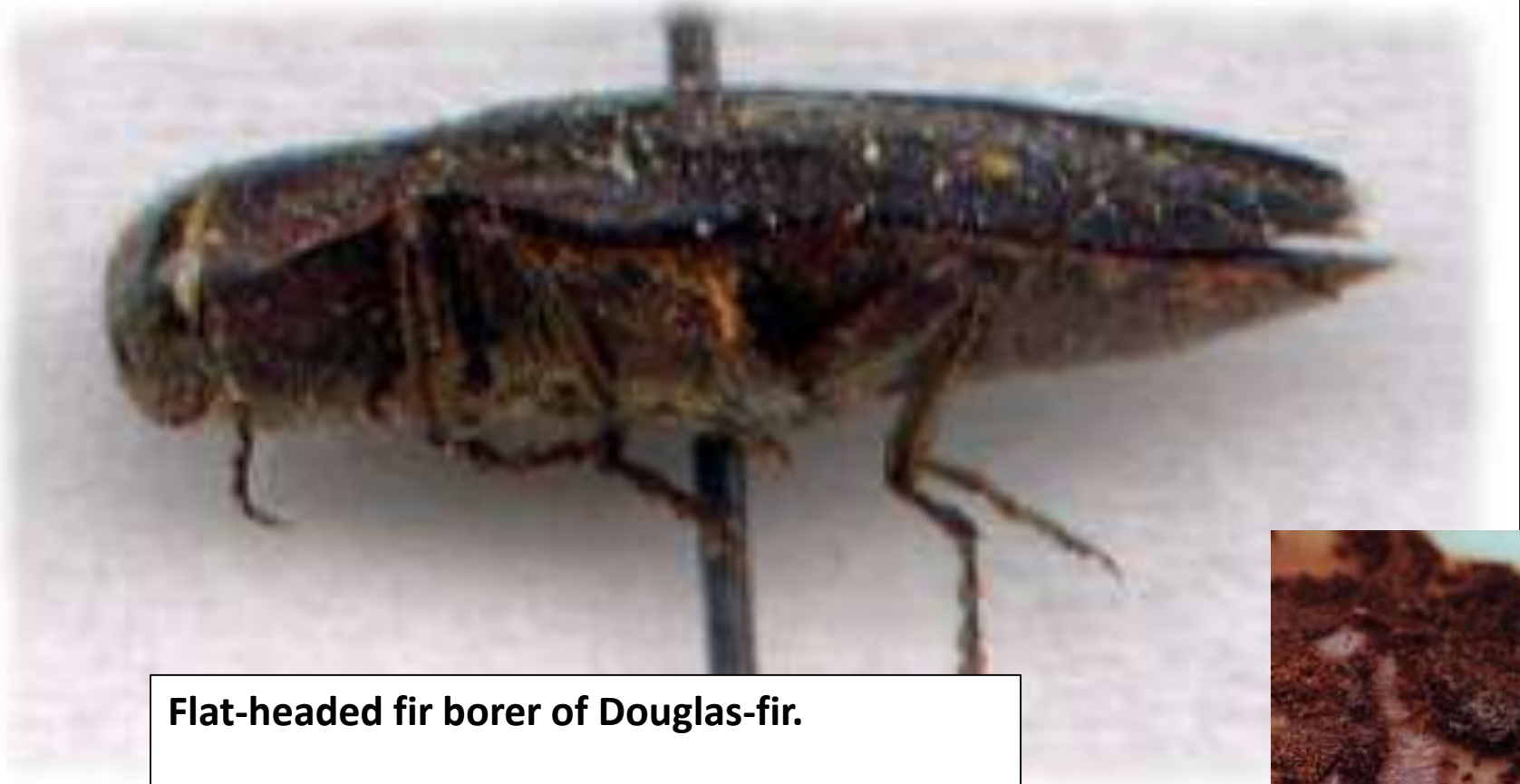
VPD and Douglas-fir

- Study by Restaino et al. 2016. PNAS
- Increased water deficit decreases Douglas fir growth throughout the western US forests.
- Hotter drought increases VPD!



An Example of biota and hotter drought interaction (hypothetical)

Flatheaded fir borer: *Melanophila drummondi*



Flat-headed fir borer of Douglas-fir.

Kills trees that are weakened by drought, over stocking etc.

Low elevation DF in SW Oregon.

Flatheaded fir borer in Douglas-fir, (*Phaenops drummondi*, Coleoptera: Buprestidae)

“Classic” flatheaded fir borer mortality pattern of Douglas-fir. Edges and among oaks. Photo: Bill Schaupp

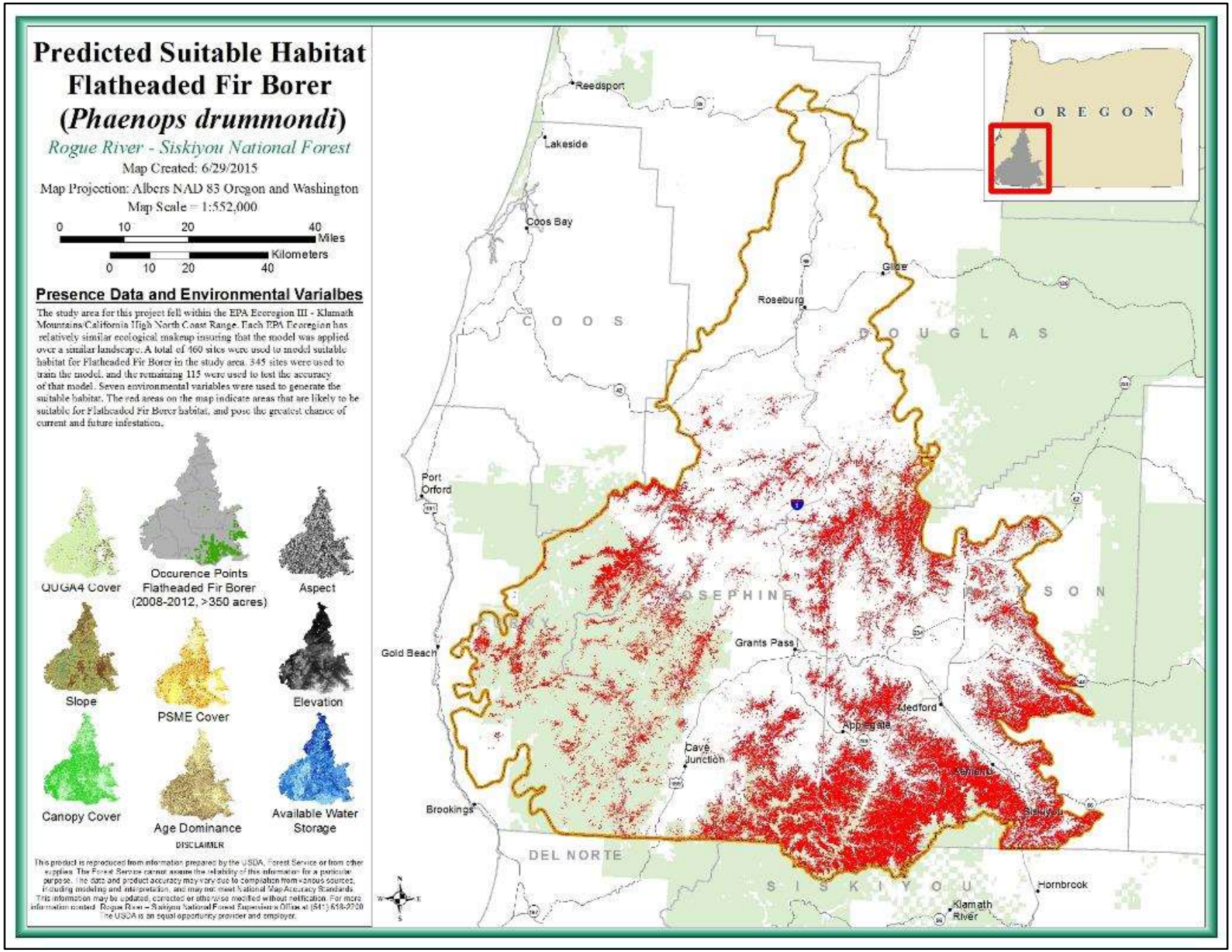
B. Schaupp, USFS

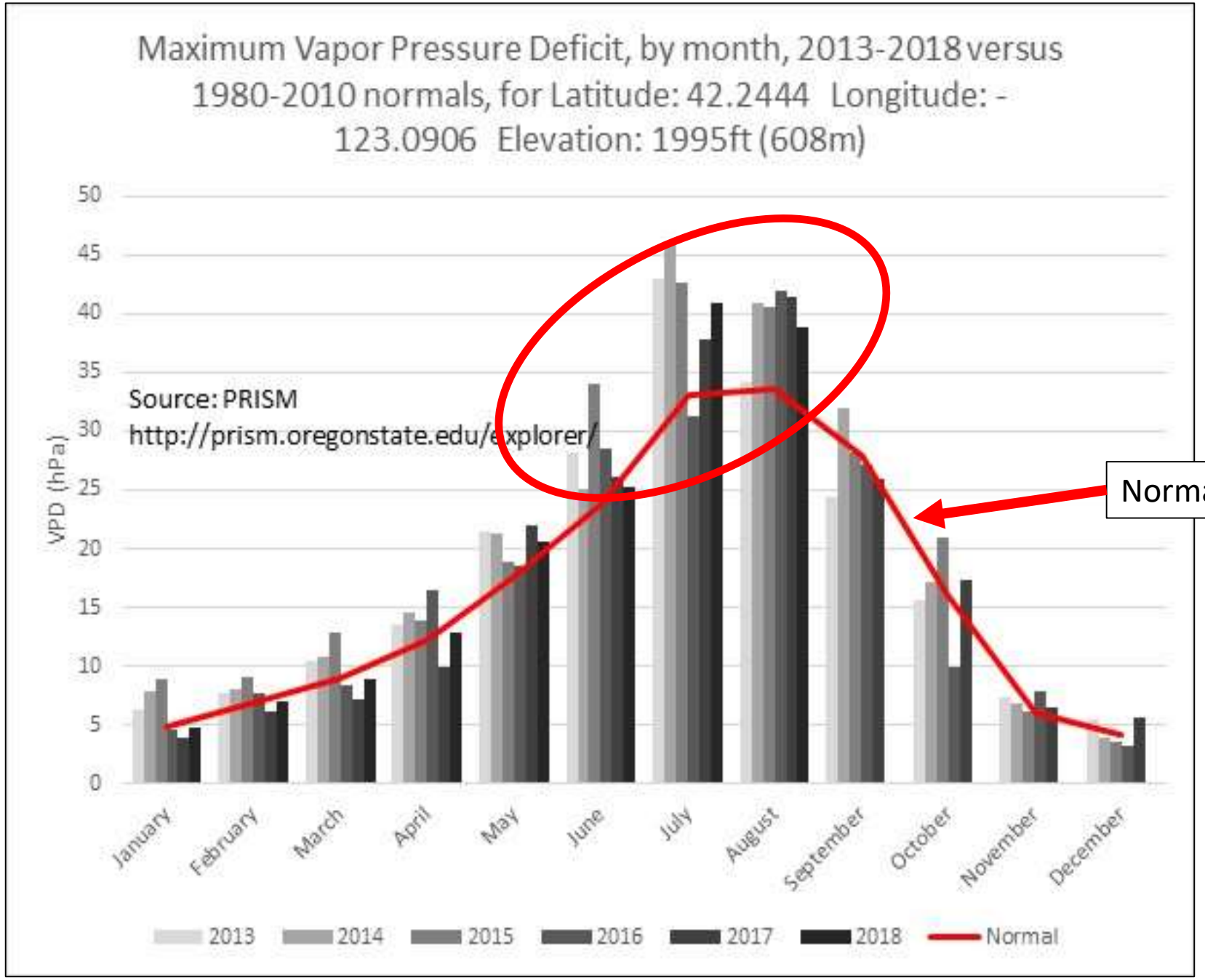
Risk Map for Flatheaded Fir Borer in Southern Oregon (Klamath Mts.)

Max Bennett, OSU FNR Ext.

Associated with:
Ann. Precip < 40 inches
Elevation 1,500-3,500ft

NOT:
Aspect
Heat Load index
Slope position
Slope
Density Canopy Cover
Age





Vapor Pressure Deficit

- Late spring
- Summer
- Explain Mortality?
- From Max Bennett, OSU Forestry Extension
- South Oregon

Polling Question 3

- **What do you believe are the most important causes of the tree mortality you've observed? Pick two.**

- Wrong species for the site
- Lack of management
- Drought
- Extreme high or low temperature or other weather extremes
- High VPD (hotter drought)
- Lack of salvage of dead and dying trees
- Stand damage (soil compaction, etc.)
- Tree diseases
- Bark beetles
- Other insect pests
- Overstocking, overly dense forests
- Other

Douglas-fir mortality caused by black stain root disease

Insect and Pathogen Response to Drought and Climate Change

- **Pathogens are controlled by moisture and temperature**
- Some respond to stress and low vigor
  - Armillaria root disease
  - Black stain root disease
  - Cankers
  - Diplodia tip blight
- Others prefer summer moisture or healthy trees
  - Foliage diseases
  - Mistletoe
  - Laminated root rot
  - White pine blister rust

Black stain root disease is vectored by weevils and a root bark beetle known to focus on low vigor trees

Pre-existing condition of the tree is important to drought and pest/pathogen response

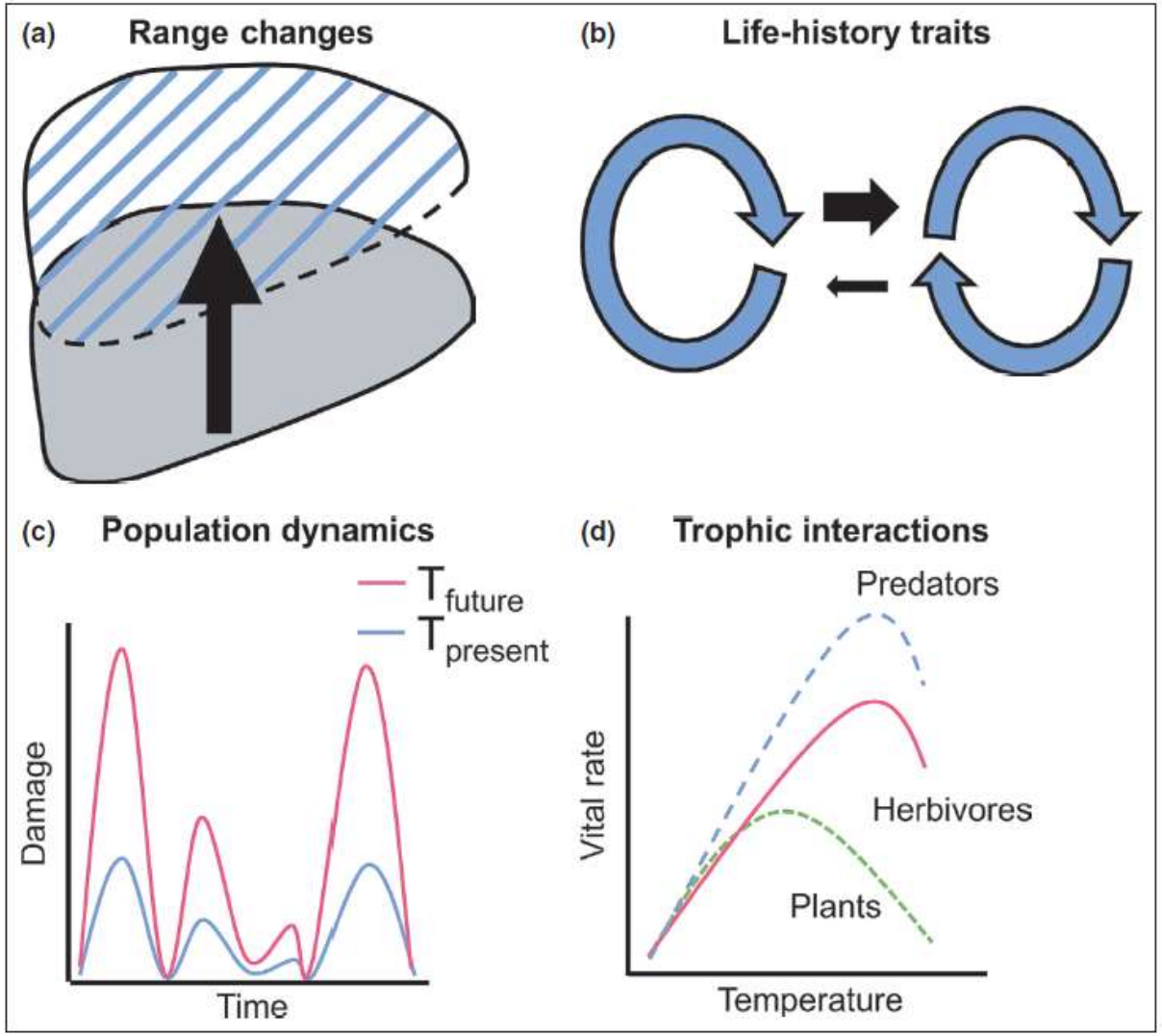
- Pathogens already present on a tree
  - Root disease
  - Dwarf mistletoe
- Vigor/carbohydrate status… was the tree defoliated
- Recent events?

Climate Change and Forest Insect Pests

- Recent paper in Frontiers in Ecology and the Environment
- **Lehmann et al. Complex responses of global insect pests to climate warming. Frontiers in Ecology and Environ. 2020.**

- Four ways climate change impacts insect pests:

- Geographic Range Changes
- Insect Population Dynamics
- Life History Traits
- Trophic Interactions (predators, parasitoids, host plants)



Polling Question 4

- **Which of the following statements is generally true?**

- Dead trees harbor insects that pose a threat to surrounding trees, so they should be removed
- Dead trees are important for habitat and biodiversity
- Tree mortality is important for stand development
- Both B and C

Management for drought, insects, and pathogens: at the stand level.

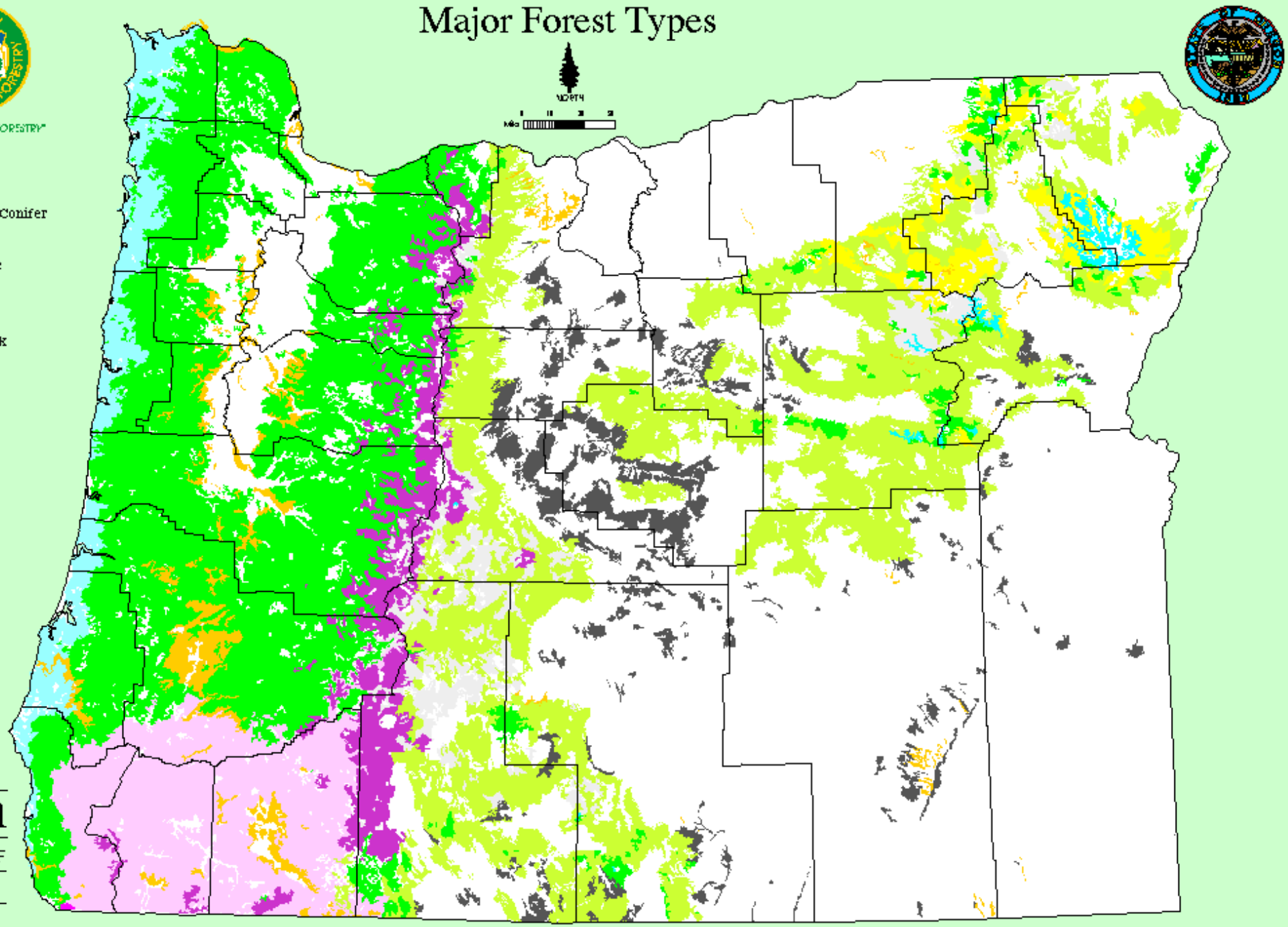
- It depends!
- Location of the stand
- Age, structure, composition
- History
- Planting the right tree in the right place

Western spruce budworm defoliation, associated with fire suppression, reduction of large pine, larch and Douglas-fir, and an increase in un-even aged grand fir and Douglas-fir which create multistoried stands

Major Forest Types

"STEWARDSHIP IN FORESTRY"

- Douglas-fir
- Ponderosa Pine
- Siskiyou Mixed Conifer
- Lodgepole Pine
- Hemlock-Spruce
- Western Larch
- True fir-Spruce
- True fir-Hemlock
- Redwood
- Juniper
- Hardwoods

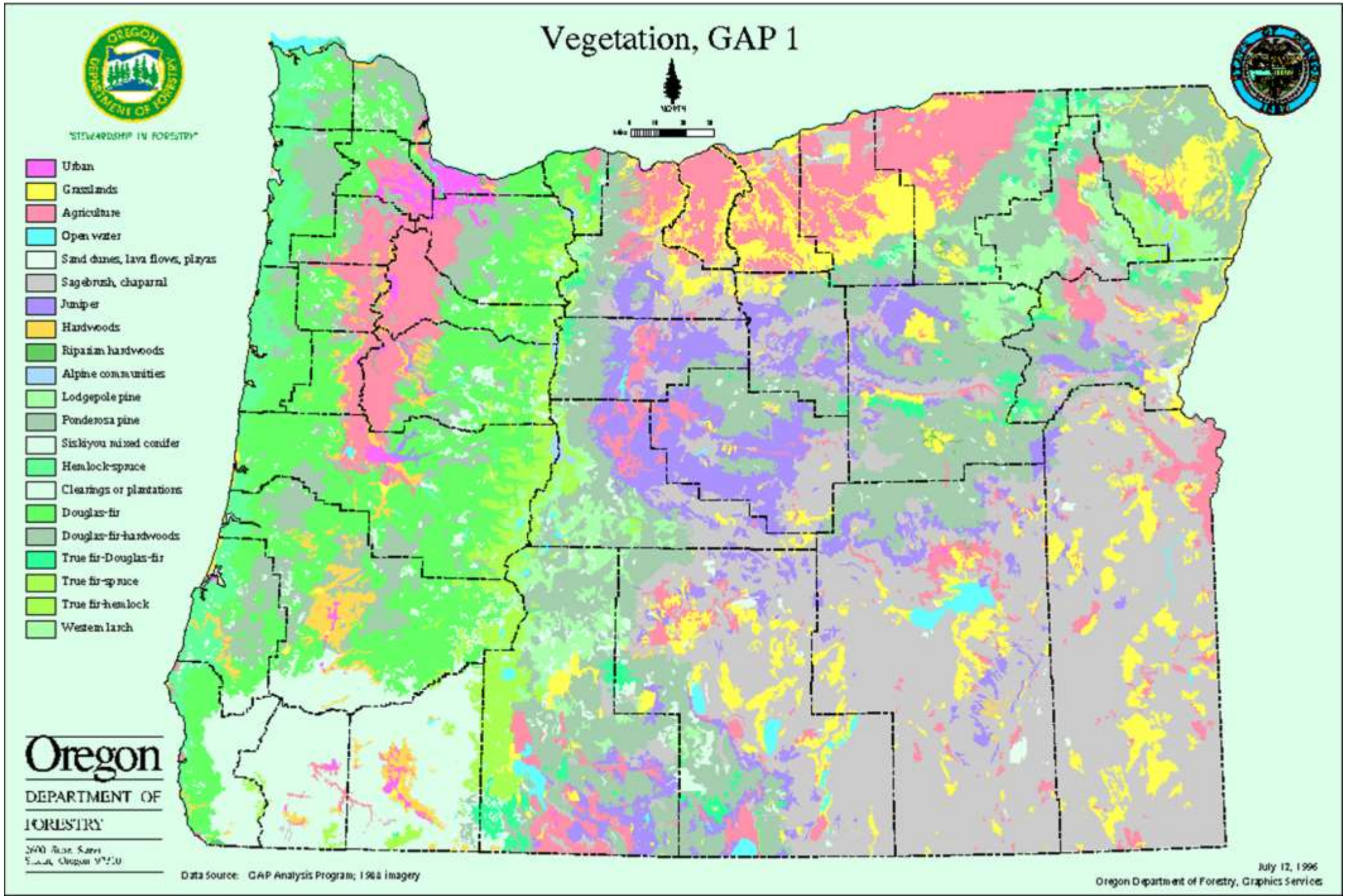


Oregon
DEPARTMENT OF
FORESTRY
2600 State Street
Salem, Oregon 97310

Data Source: Oregon Gap Analysis program

May 11, 1996
Oregon Department of Forestry, Graphics Services

Vegetation, GAP 1



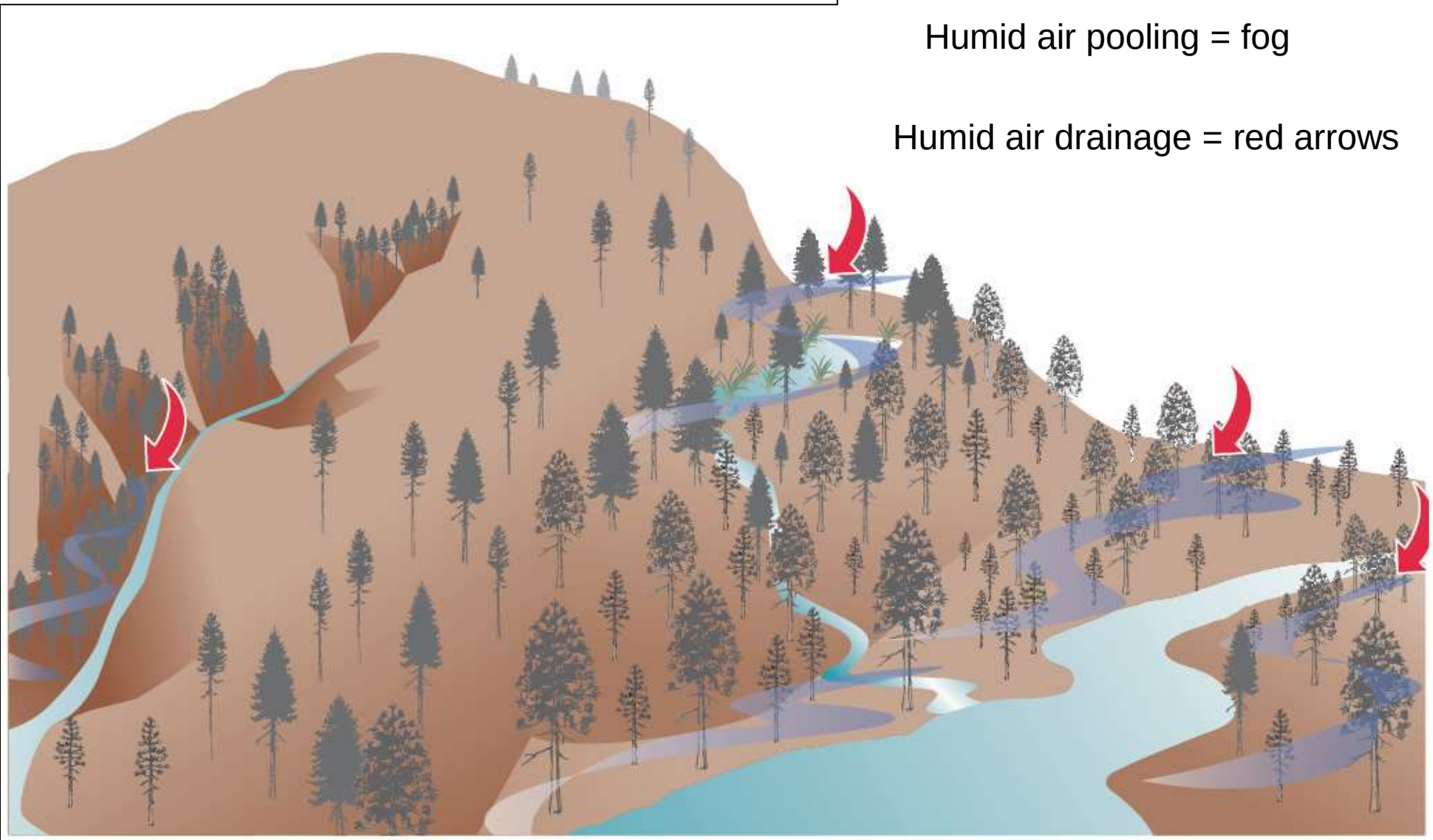
Oregon
DEPARTMENT OF
FORESTRY

Data Source: GAP Analysis Program; 1988 imagery

July 12, 1996
Oregon Department of Forestry, Graphics Services

Landscape setting and location of your stand(s)

- Cold and humid air flow
- Pooling and settling
- Flats, benches, wetlands
- Select the right tree for the site



Hypothetical higher hazard zones for foliage diseases and rust fungi are areas of humid air flow and humid air pooling, yet these sites might be most buffered from heat events

Managing for drought impacts

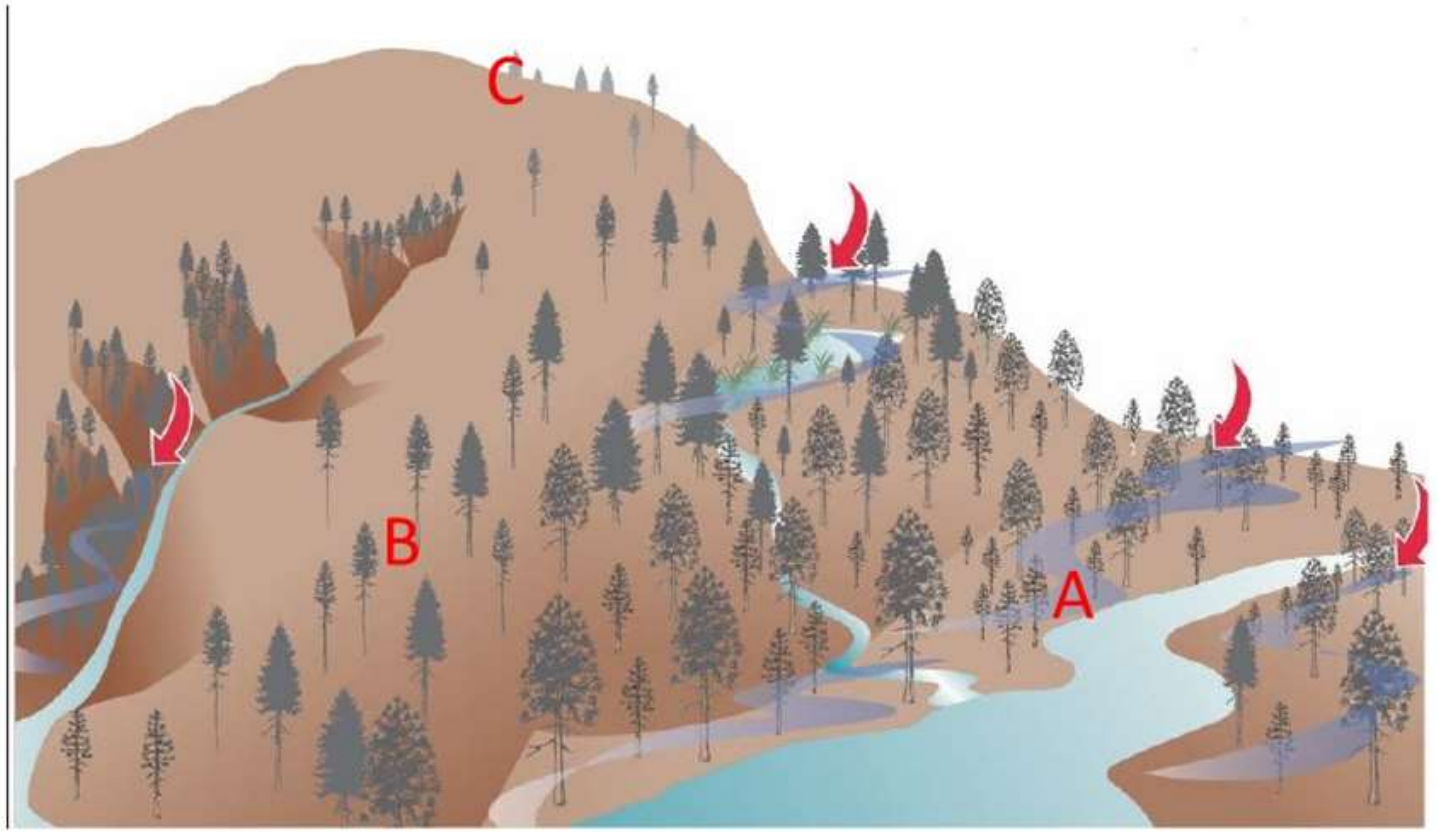
- Right tree in the right place
- Density and competition management
- Shift to drought tolerant species
- Reduce exposure of individual tree crowns/soil (hotter drought)

Silviculture

- Establishment of plantation
- Intermediate treatments
- Rotation age
- Uneven age management vs. even aged management
- Non-timber emphasis

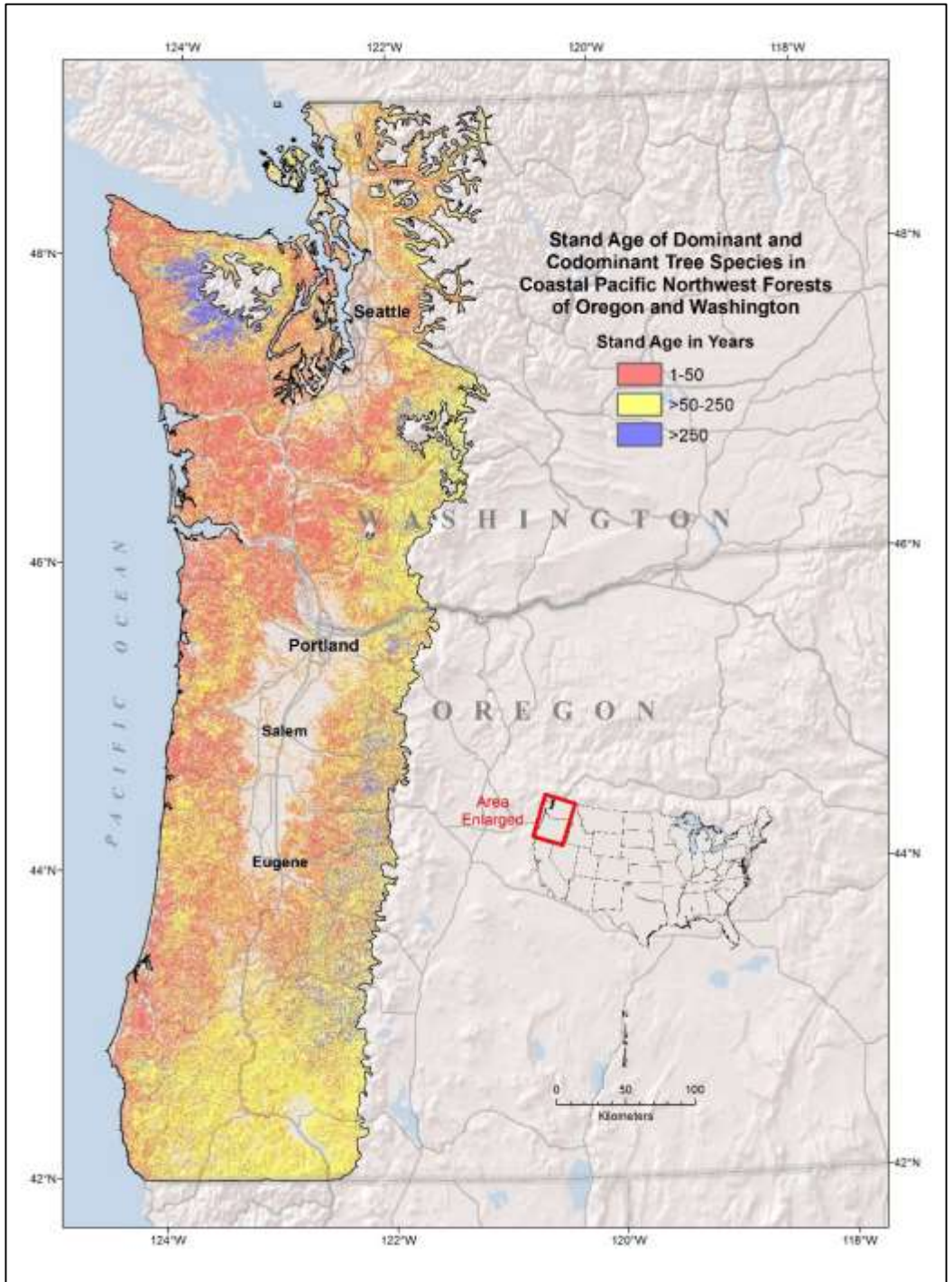
Polling Questions 5

- Which location (A, B, or C) has the highest likelihood of foliage diseases due to flow and pooling of moist air?
- Which location (A, B, or C) is likely to be the LEAST buffered from drought effects?



Landscapes
Age-class Distribution of West-side Forests in the PNW

- 1–50 years (red): 41%
- 50–250 years (yellow): 53%
- > 250 years (blue): 7%
- Forest insects and pathogens predominant certain age classes



Short rotation, intensive management is can shift pests to young forest plantation dominant pests

Conclusions

- Drought impacts will vary with landscape setting and changing climate
- Specific insect and pathogens will vary with geographic location and tree species…. interacting with weather
- Dominance of one age class and species can exacerbate a particular issue.

Bark beetle attacked grand fir

Polling Question 6

- **Strategies to mitigate drought impacts include**

- Right tree in the right place
- Density and competition management
- Inland: shift to drought tolerant species
- Reduce exposure of individual tree crowns/soil (hotter drought)
- All of the above