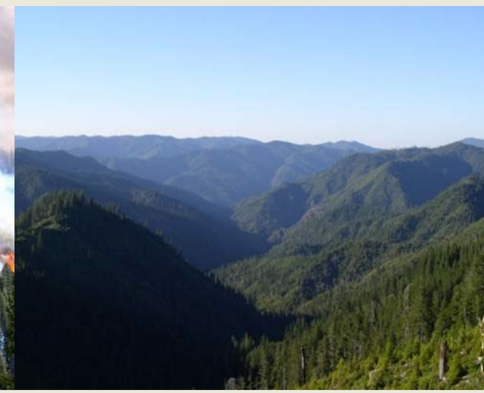
Adapting to Changing Climate and Disturbance Regimes in the Pacific Northwest

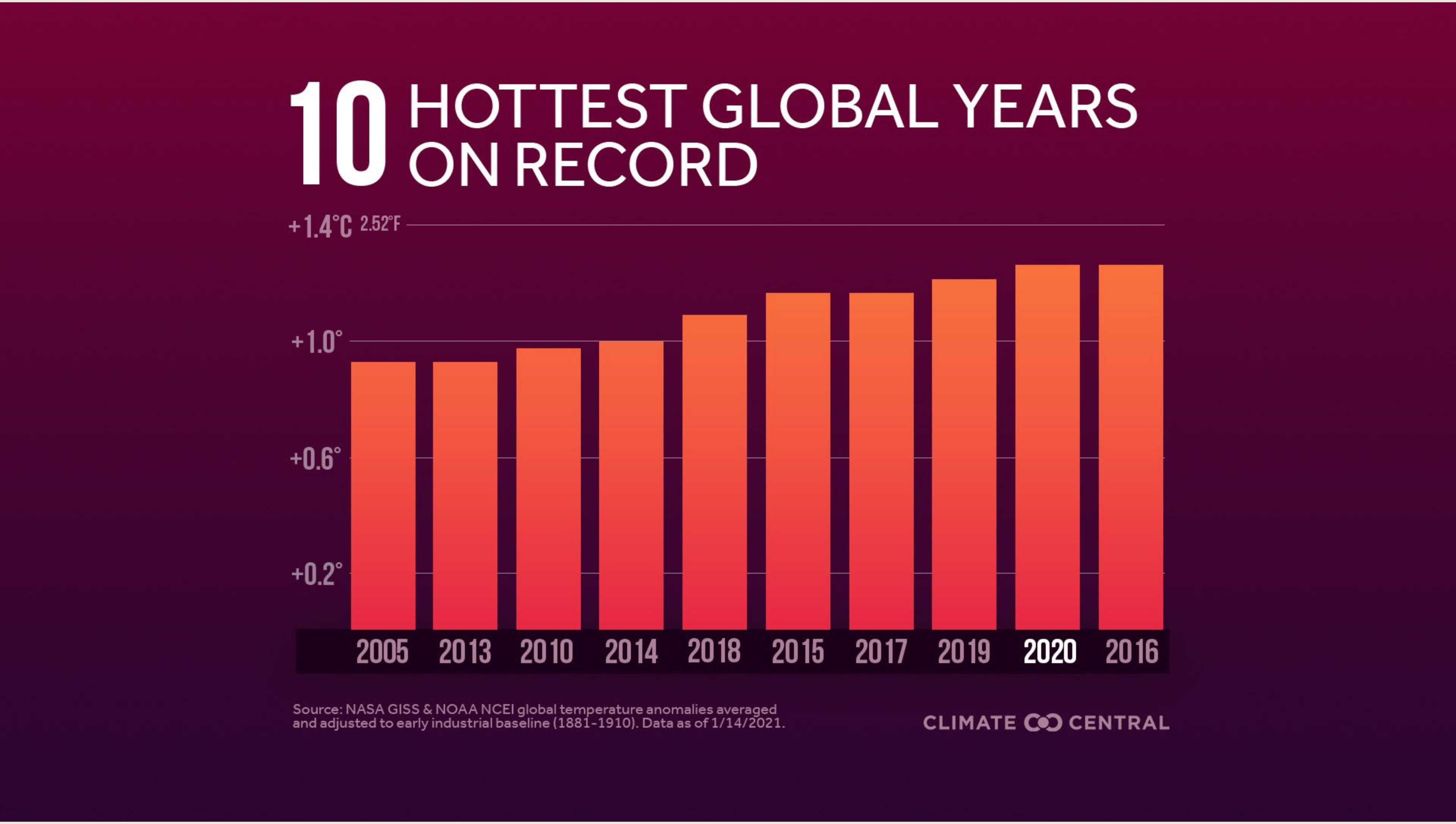




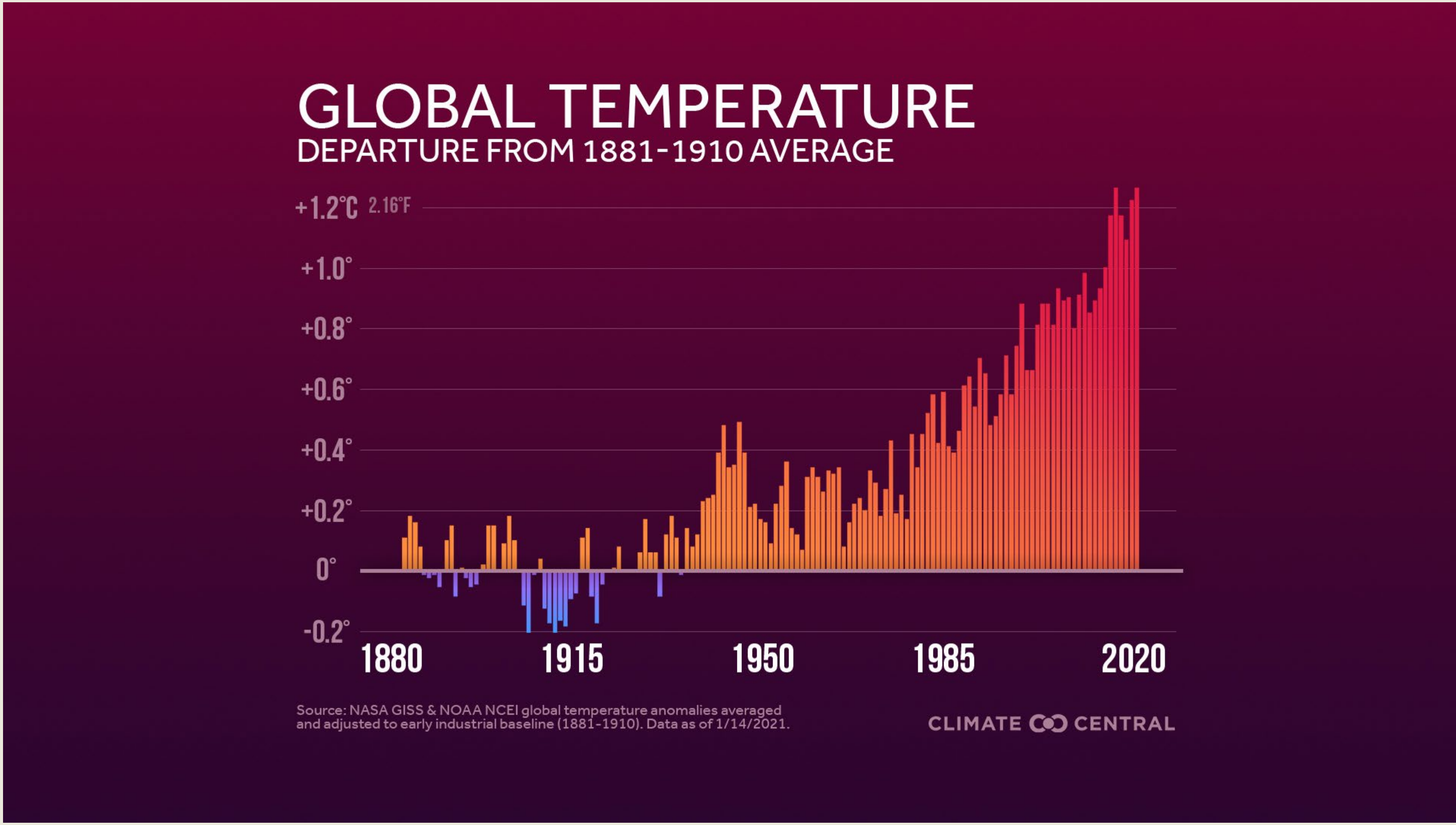

Jessica Halofsky

USDA Forest Service, Northwest Climate Hub and Western Wildland Environmental Threat Assessment Center

Some recent statistics:



Global temperature trend



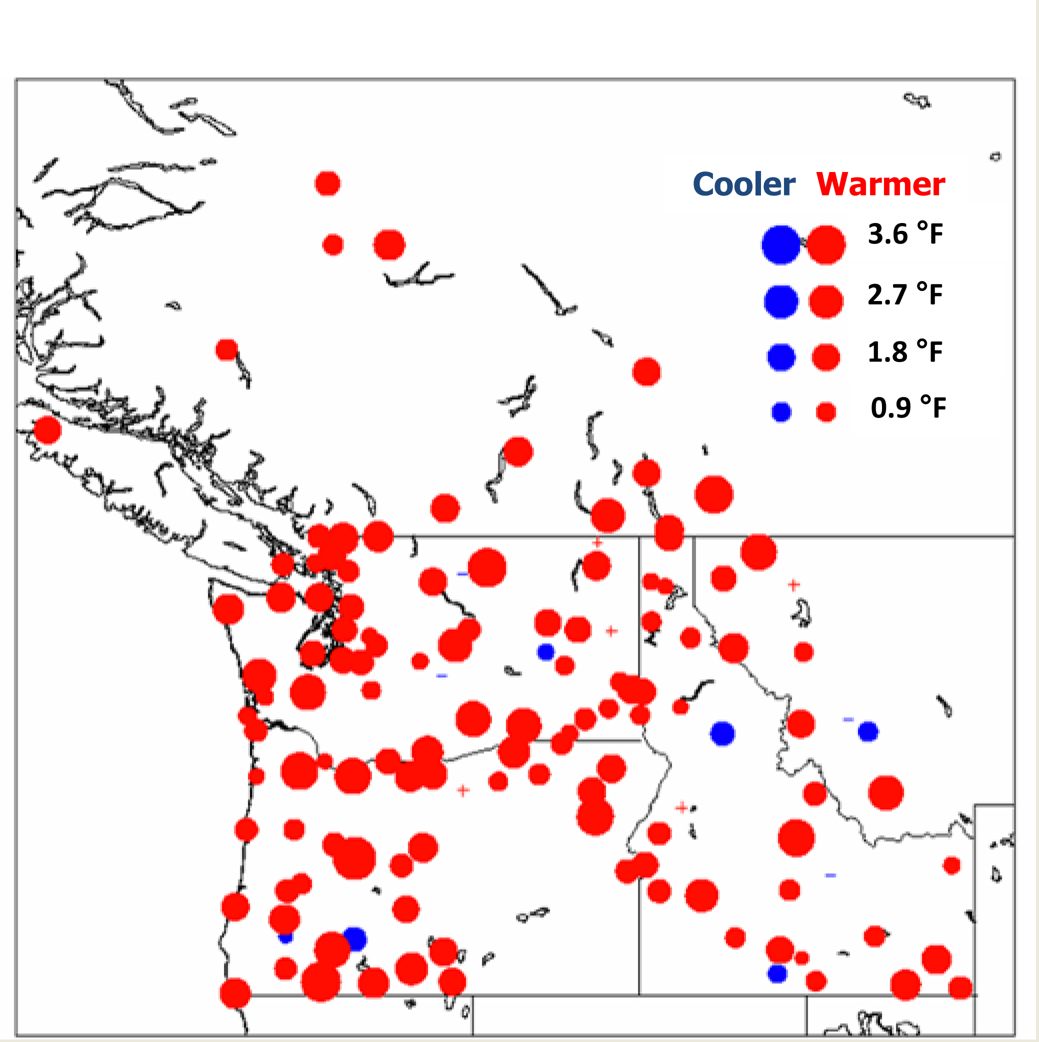
Temperature trends by station

Average annual temperature has increased +1.6°F since 1920.

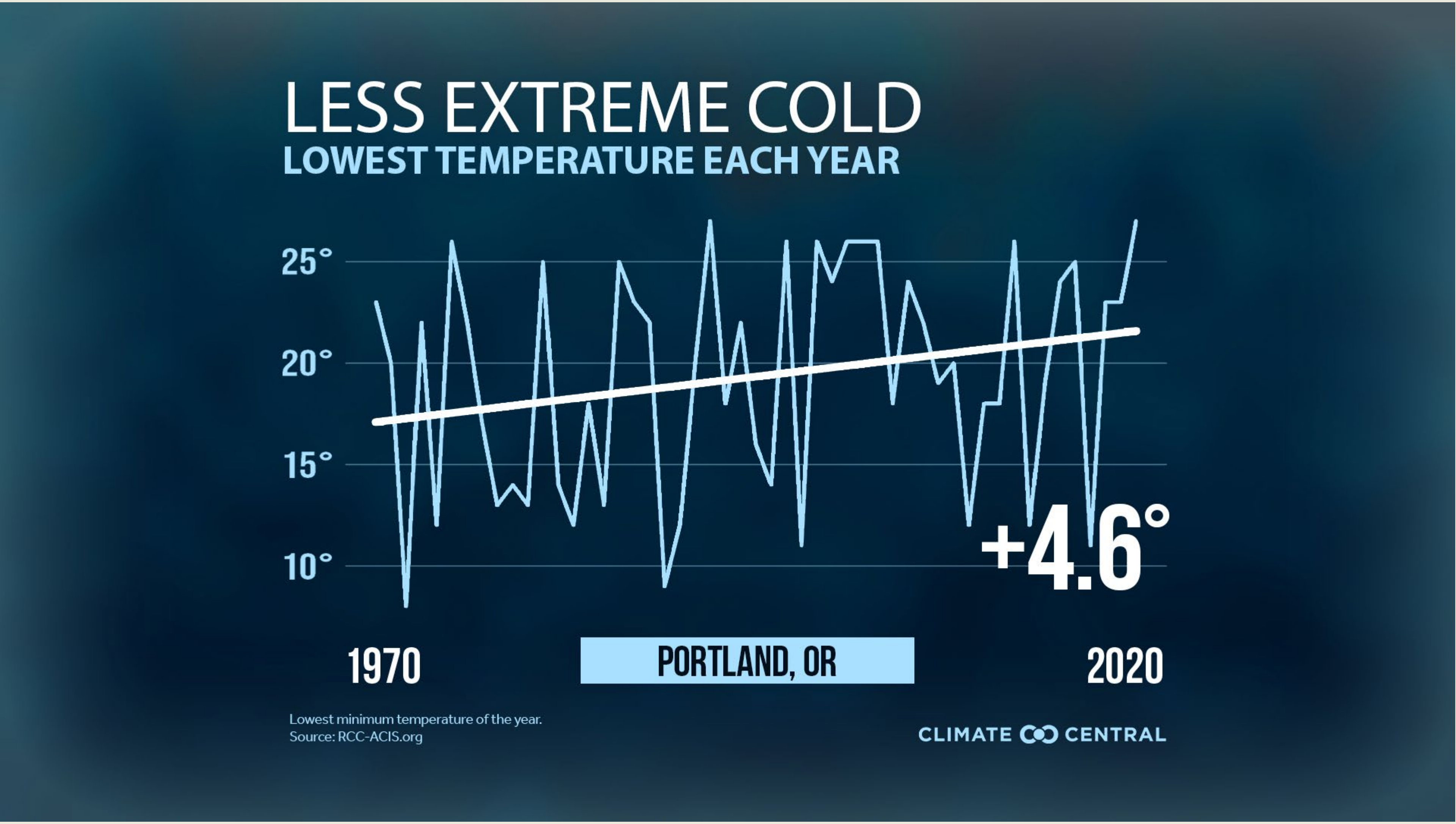
Almost every station shows warming.

Extreme cold conditions have become rarer.

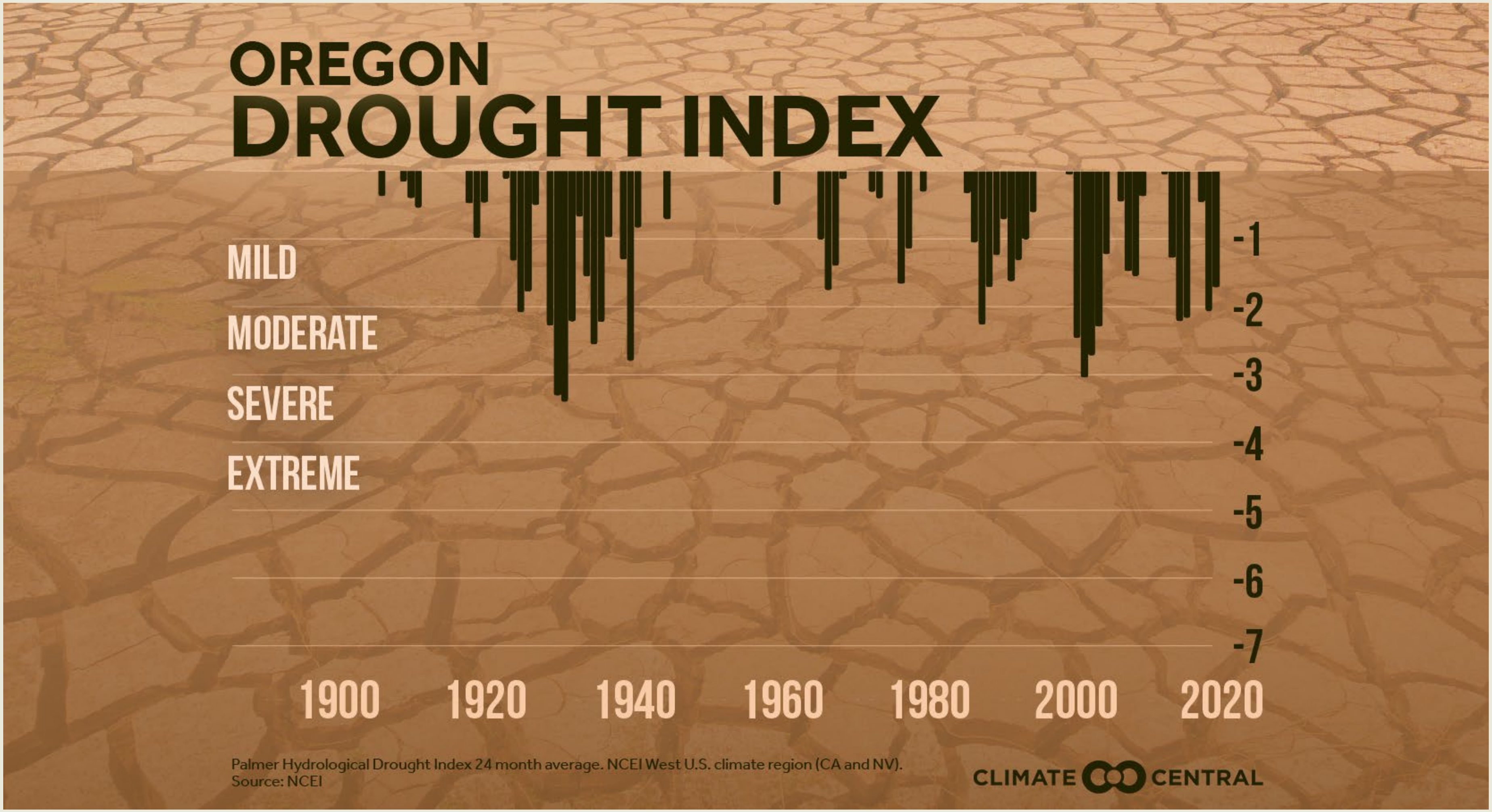
Minimum temperatures rose faster than maximum temperatures.



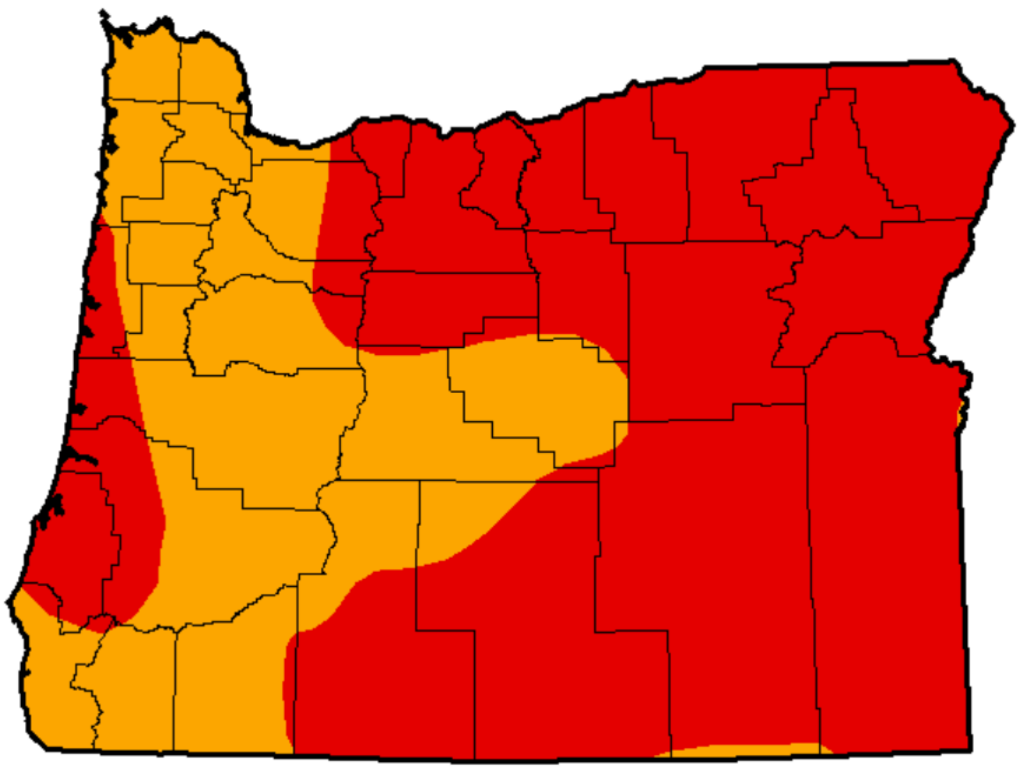
Extreme cold is becoming more rare



Droughts are occurring regularly



U.S. Drought Monitor
Oregon



August 25, 2015
(Released Thursday, Aug. 27, 2015)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	67.29	0.00
Last Week 8/18/2015	0.00	100.00	100.00	100.00	49.89	0.00
3 Months Ago 5/26/2015	0.00	100.00	88.27	68.48	34.09	0.00
Start of Calendar Year 12/30/2014	13.61	86.39	80.70	49.29	34.11	0.00
Start of Water Year 9/30/2014	1.56	98.44	76.61	56.26	35.30	0.00
One Year Ago 8/26/2014	1.69	98.31	75.78	56.02	33.82	0.00

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

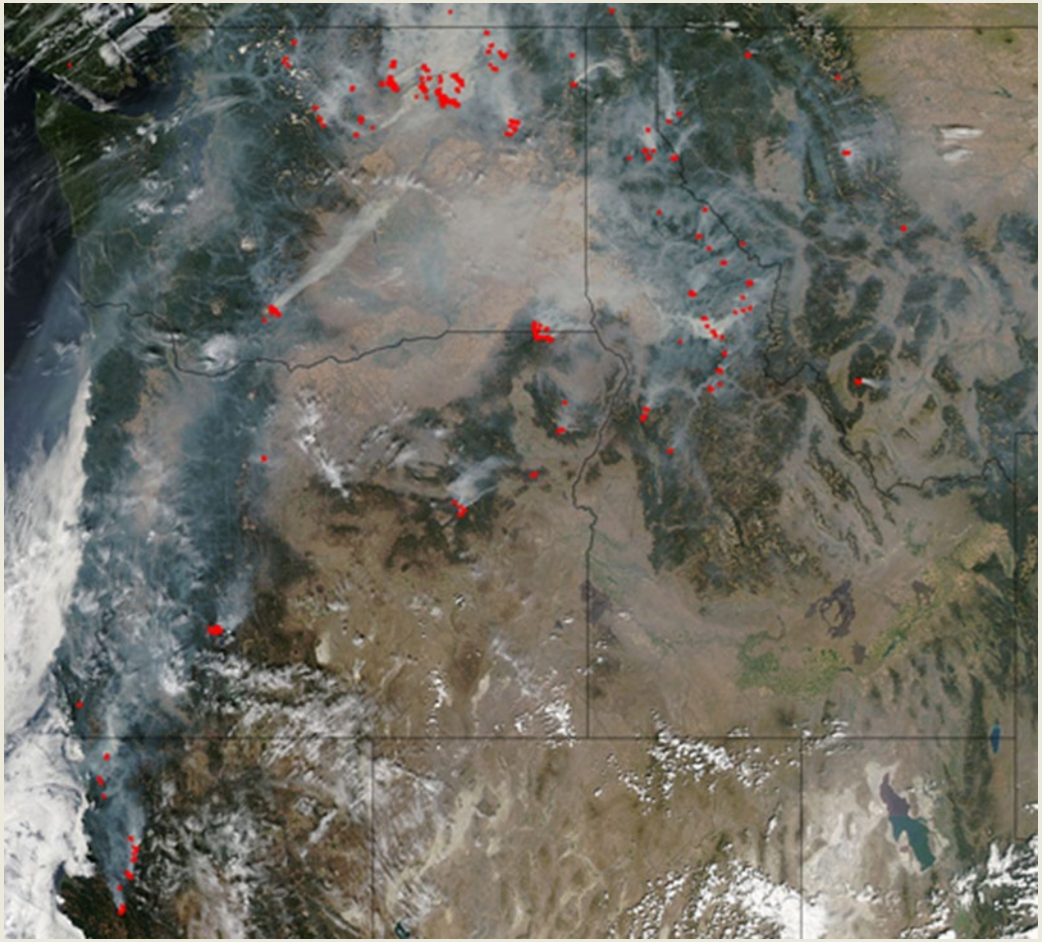
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

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.

Environmental Research Letters

LETTER

The 2015 drought in Washington State: a harbinger of things to come?

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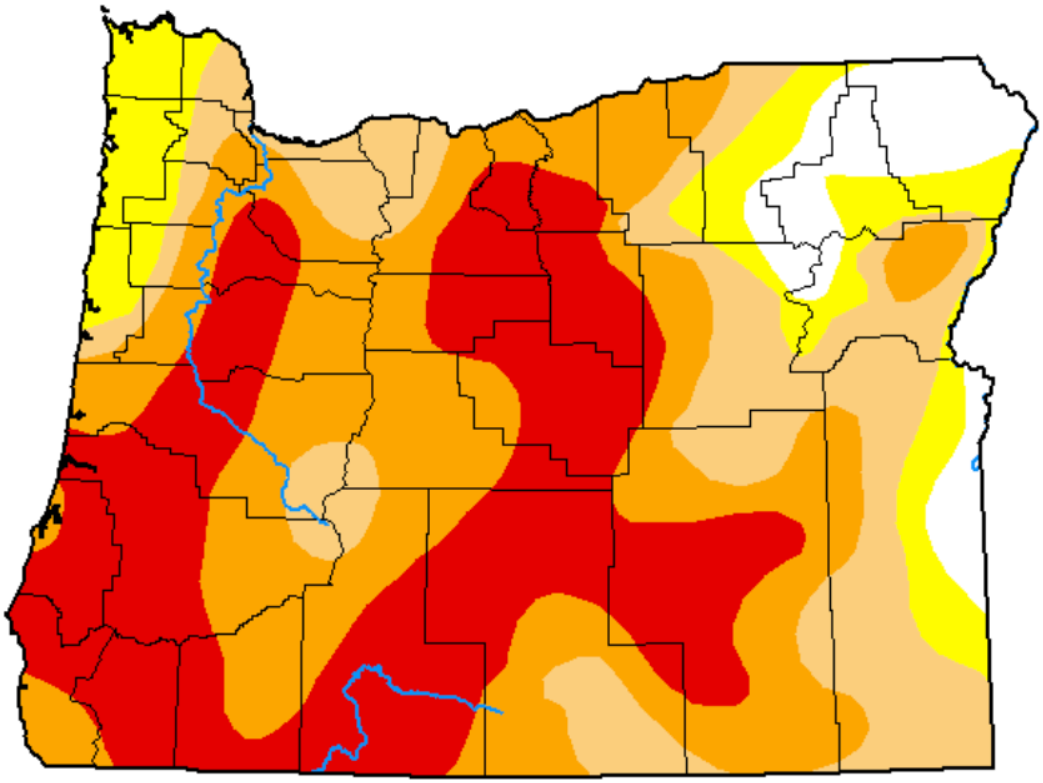
Keywords: drought, climate change, fire risk, hydrology

Supplementary material for this article is available online

Abstract

Washington State experienced widespread drought in 2015 and the largest burned area in the observational record, attributable in part to exceptionally low winter snow accumulation and high summer temperatures. We examine 2015 drought severity in the Cascade and Olympic mountains relative to the historical climatology (1950–present) and future climate projections (mid-21st century)

U.S. Drought Monitor
Oregon



September 15, 2020
(Released Thursday, Sep. 17, 2020)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.33	93.67	83.70	64.18	31.84	0.00
Last Week *09-08-2020*	6.38	93.62	81.80	59.05	24.90	0.00
3 Months Ago *06-16-2020*	5.49	94.51	78.38	44.30	4.79	0.00
Start of Calendar Year *12-31-2019*	2.40	97.60	24.46	0.00	0.00	0.00
Start of Water Year *10-01-2019*	88.54	11.46	0.00	0.00	0.00	0.00
One Year Ago *09-17-2019*	84.85	15.15	4.19	0.00	0.00	0.00

Intensity:

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

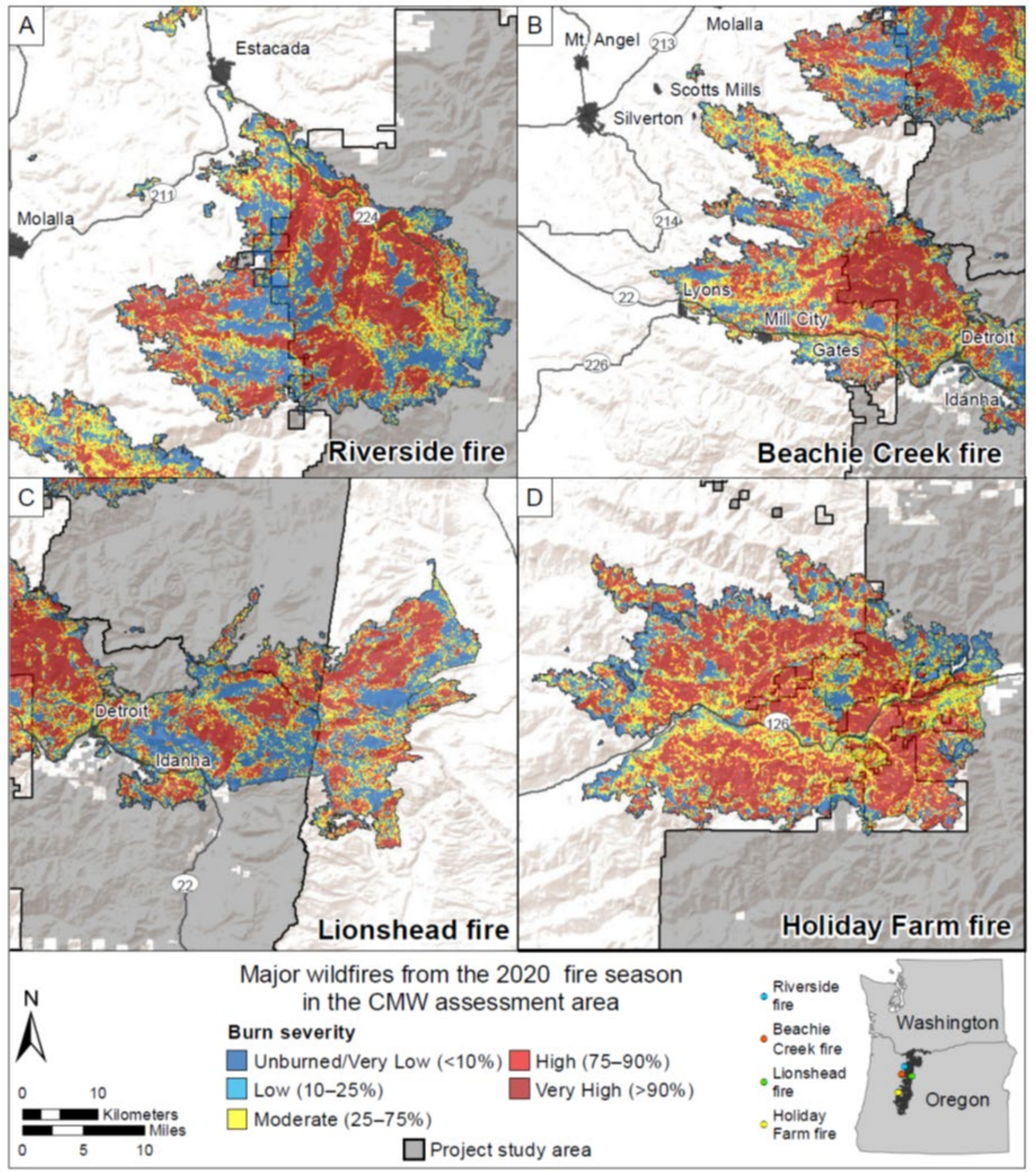
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Brad Rippey
U.S. Department of Agriculture

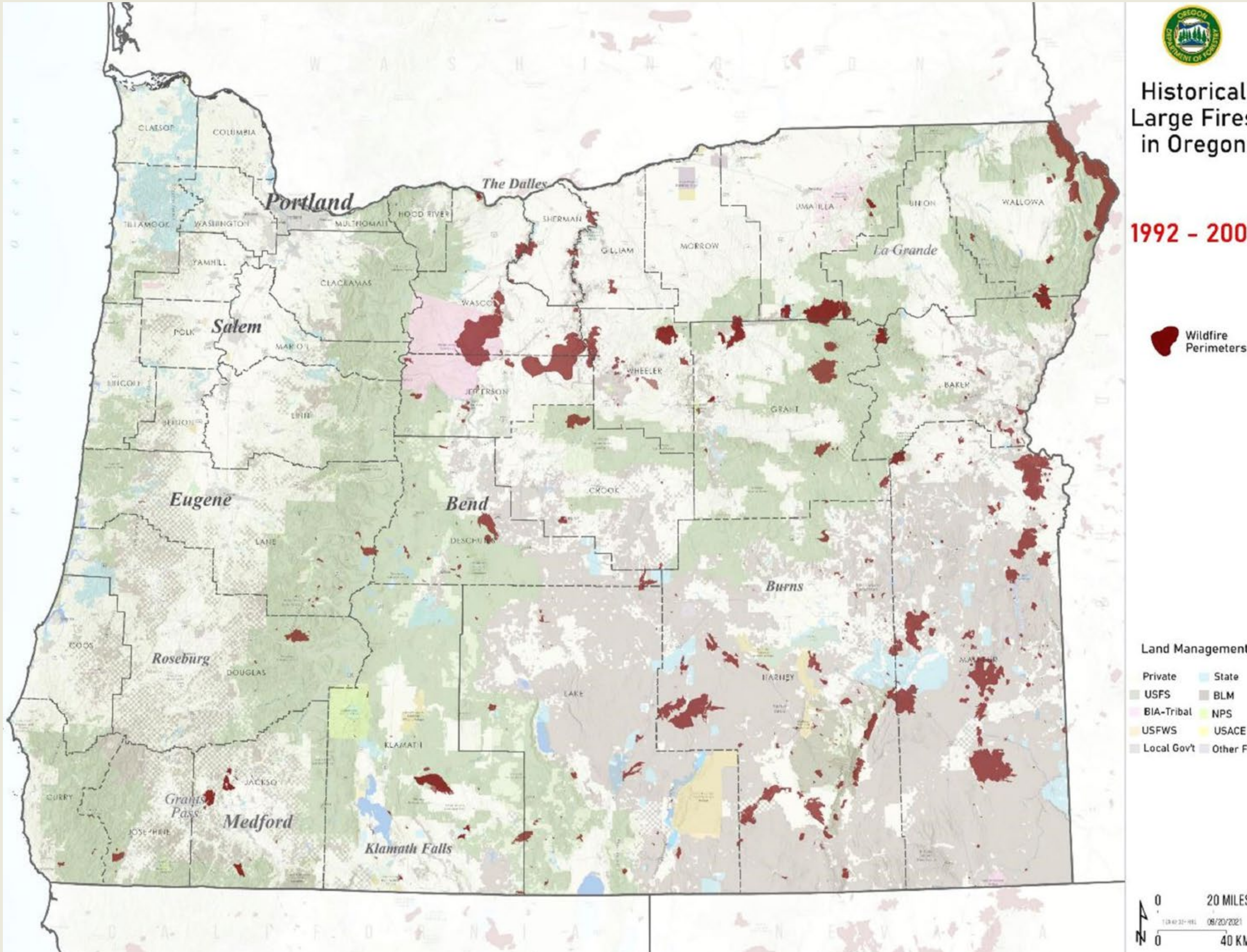
2020 Fires in Oregon

- Strong east winds were a key driver of fire spread.
- Fires were similar to east wind-driven events in the past.
- Event was consistent with what we might expect to occur more frequently with climate change

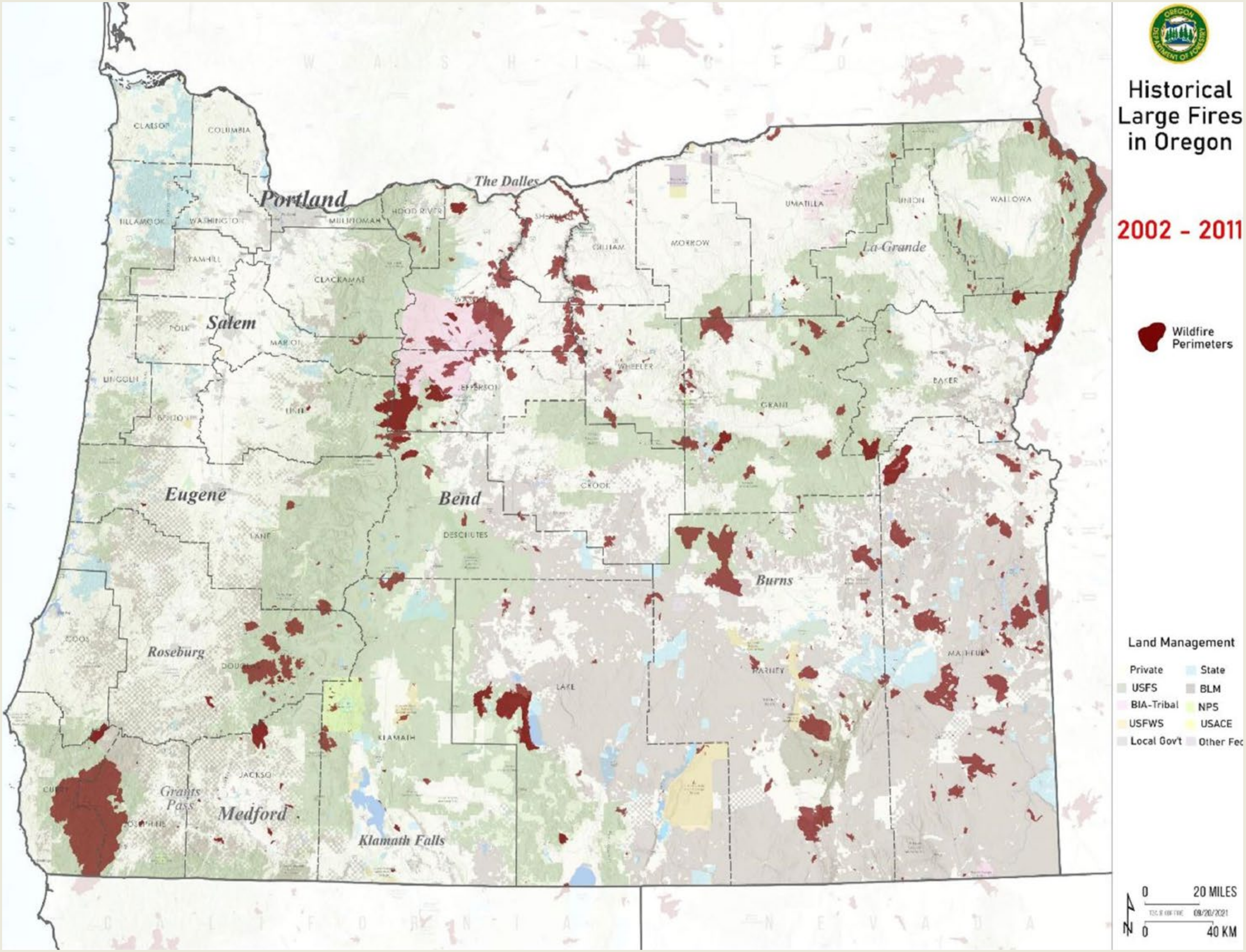


Wildfire area burned in Oregon

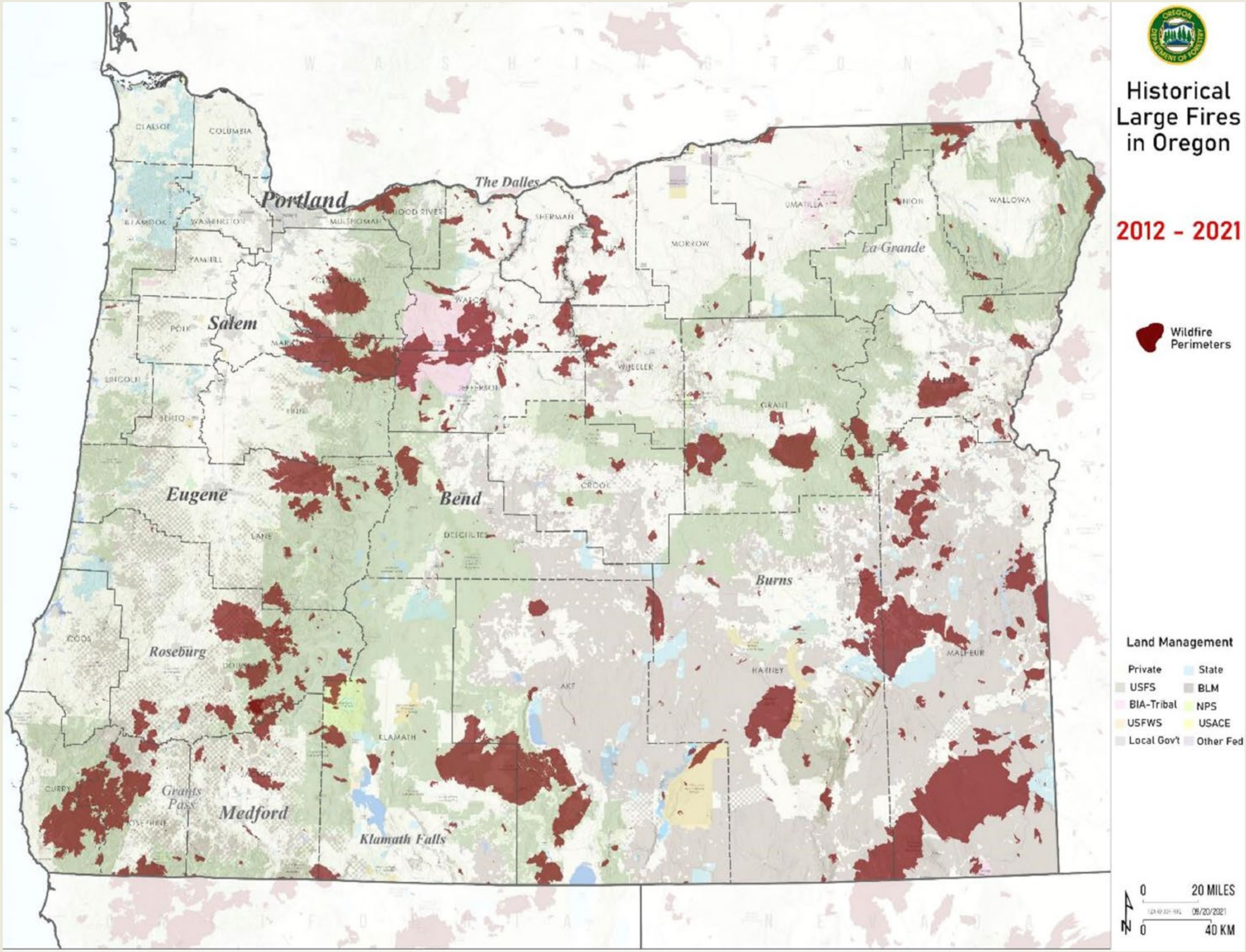
- 1992 – 2001: 169,000 acres
- 2002 – 2011: 327,000 acres
- 2012 – 2021: 662,000 acres



Map by Oregon Dept. of Forestry



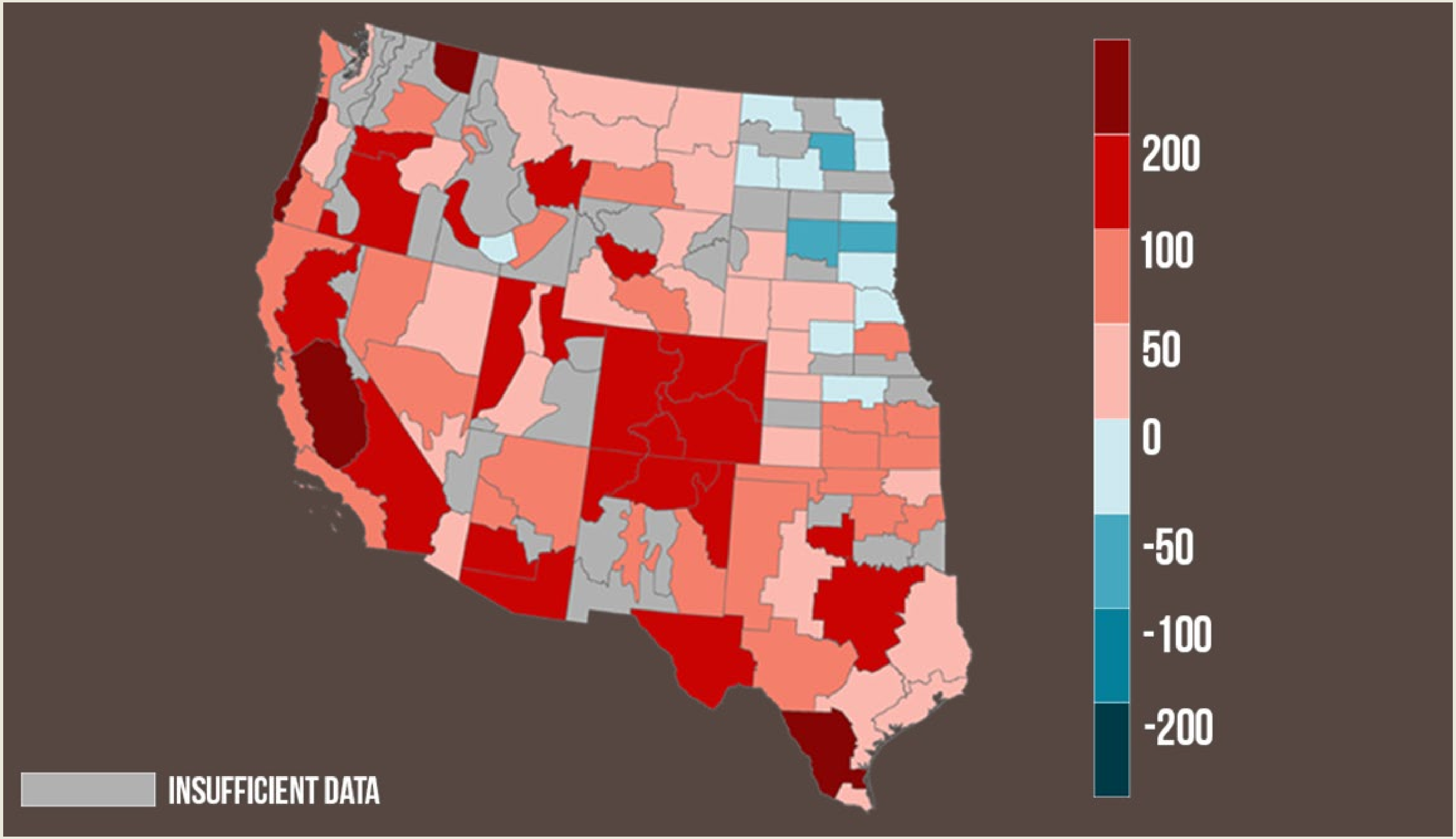
Map by Oregon Dept. of Forestry



Map by Oregon Dept. of Forestry

Change in fire weather days

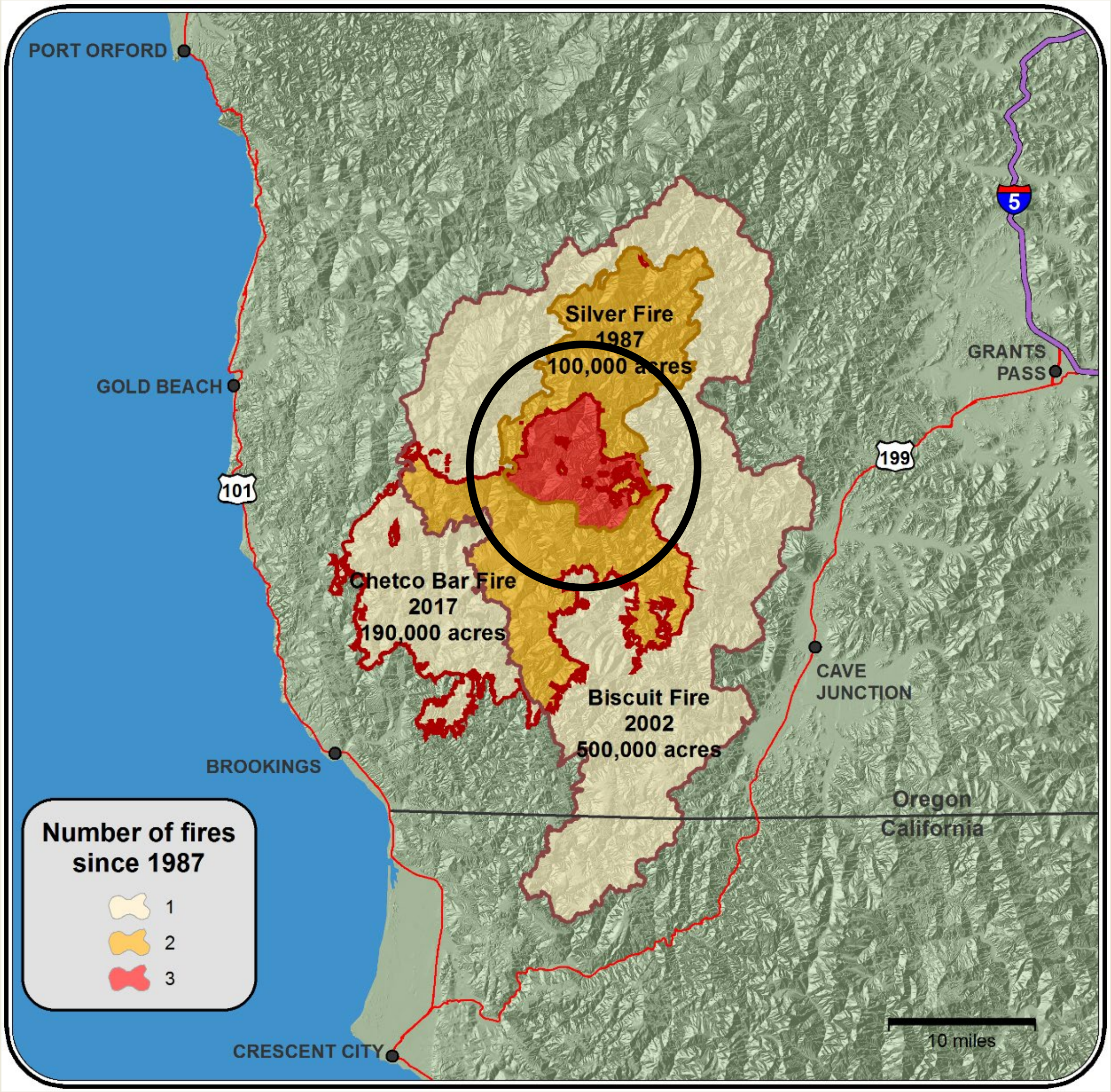
(% change from 1973 to 2020)



Wildfires are colliding

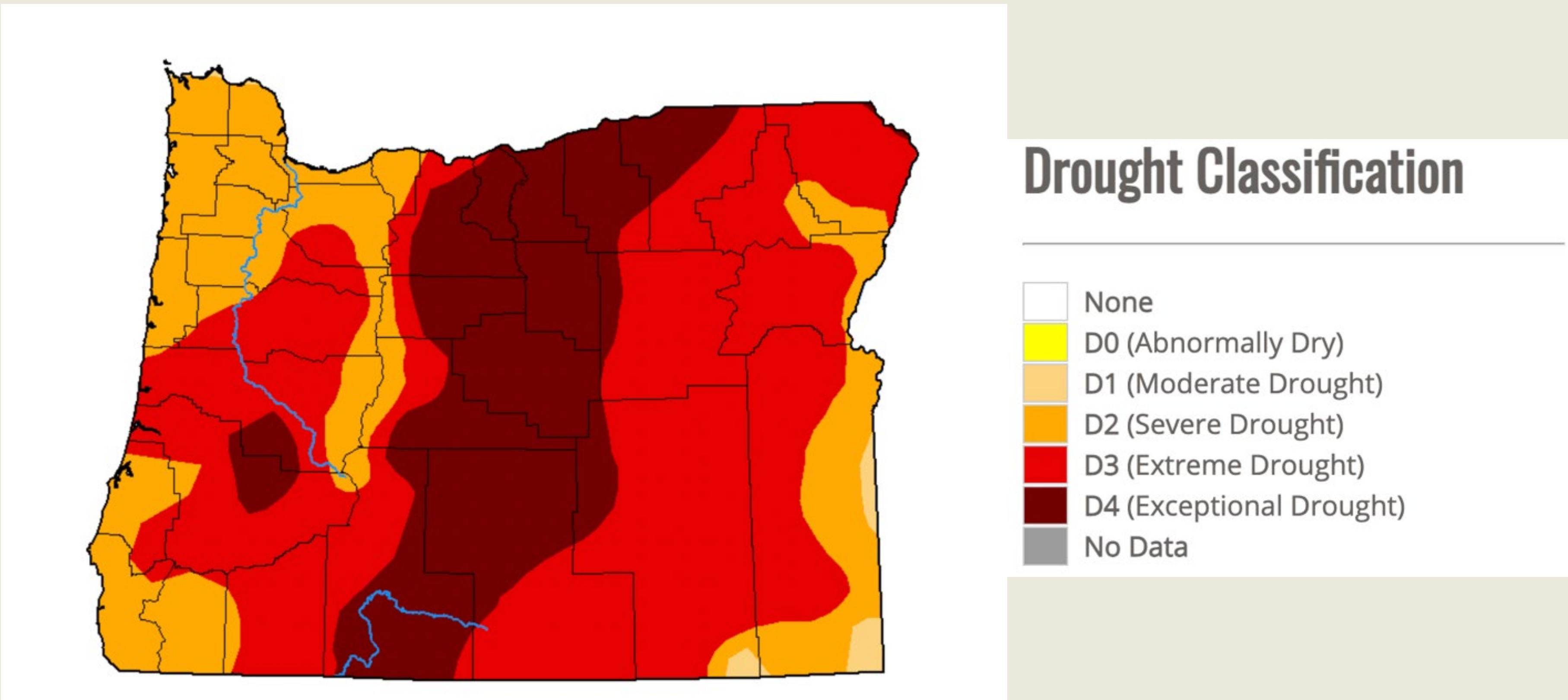
<u>Southwest Oregon</u>

Fires have burned some areas 3 times since 1987

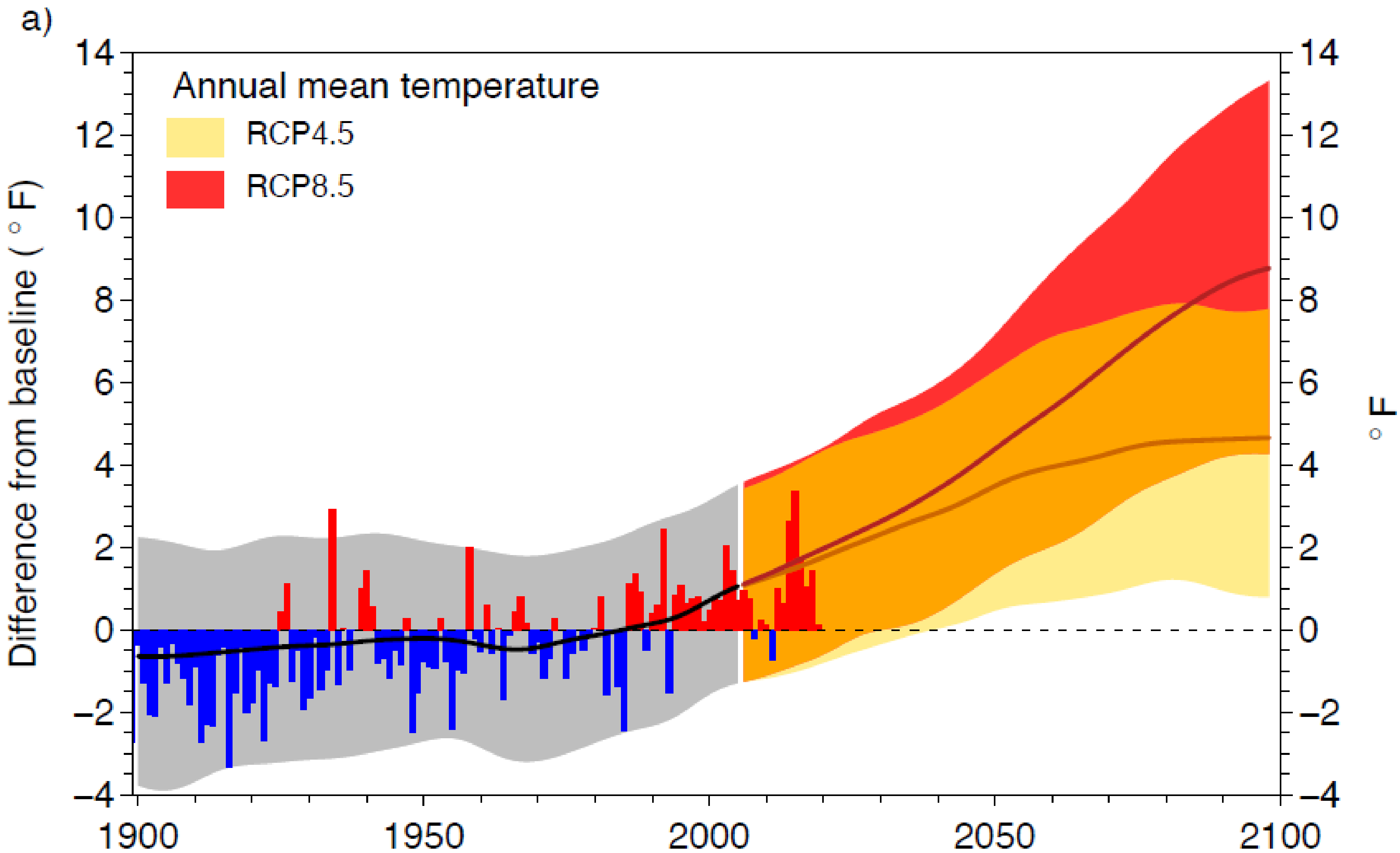


Map by R. Norheim

Oregon drought status
August 31, 2021

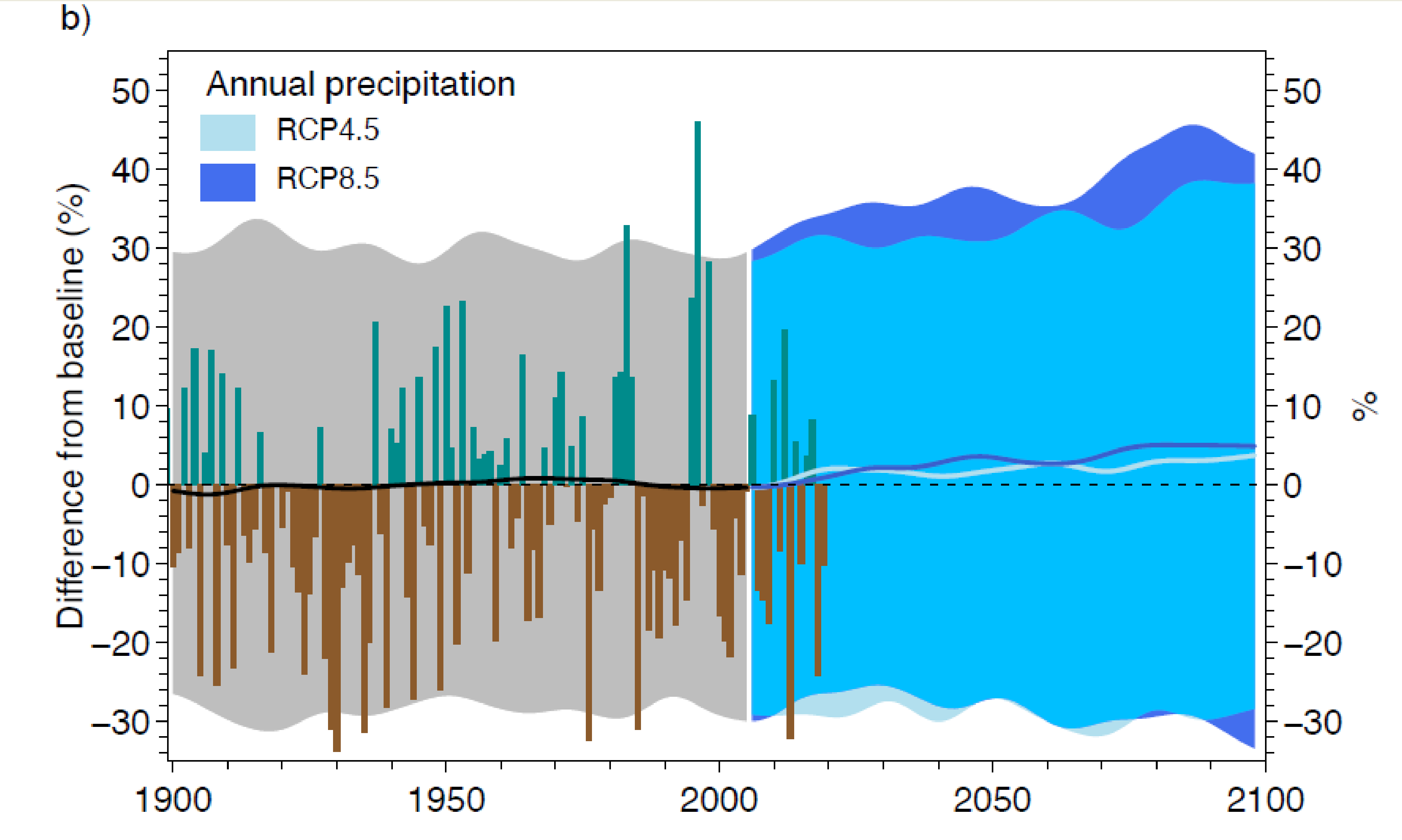


Projected temperature in Oregon

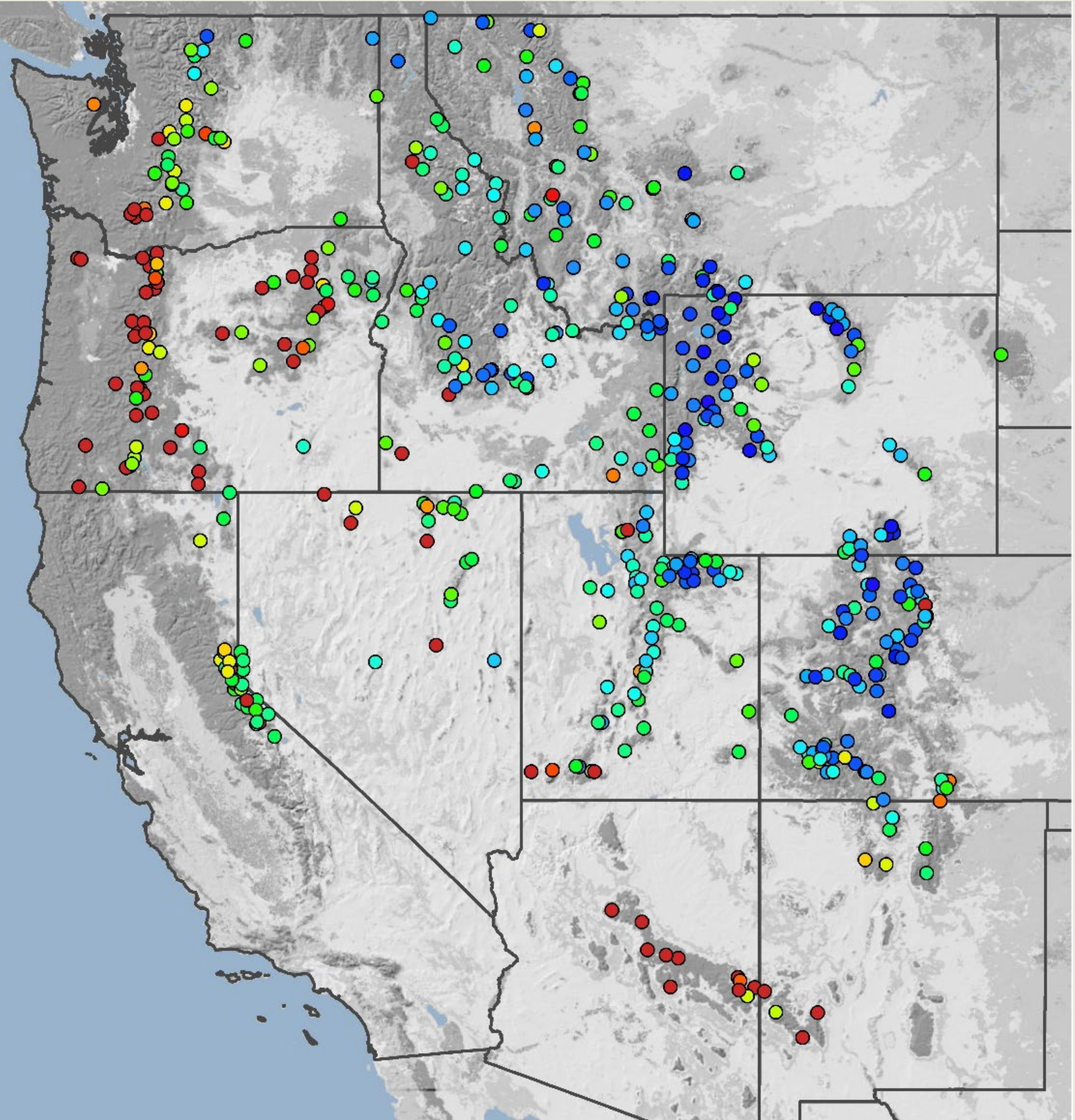


Fifth OR Climate Assessment, 2021

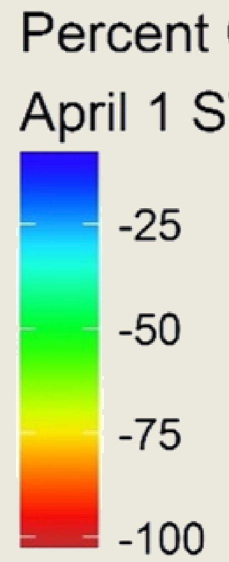
Projected precipitation in Oregon



Fifth OR Climate Assessment, 2021

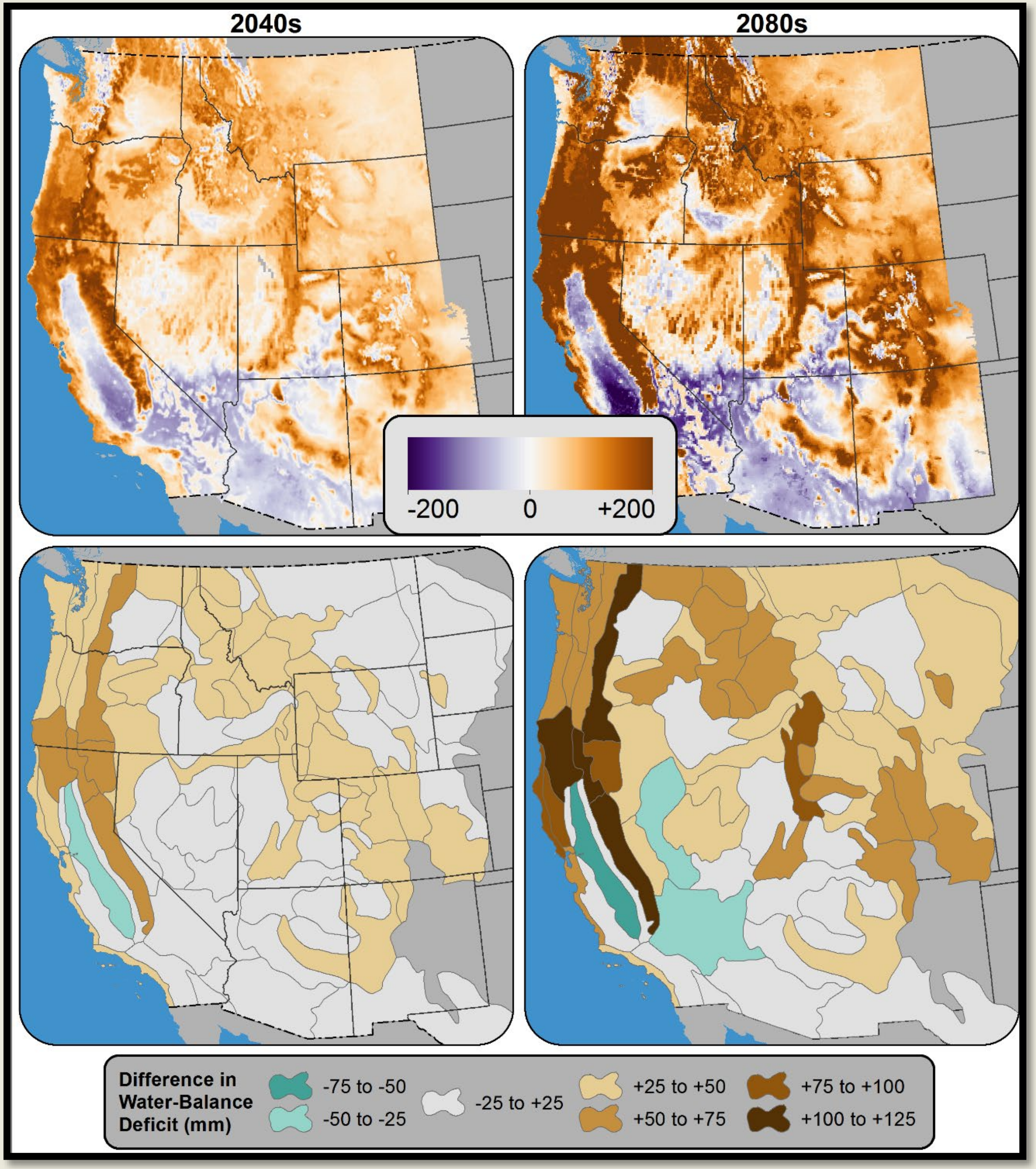


Snowpack Sensitivity



3°C temperature increase

Data from C. Luce



Projections for changes in summer water-balance deficit

McKenzie & Littell, 2017
Map by Robert Norheim

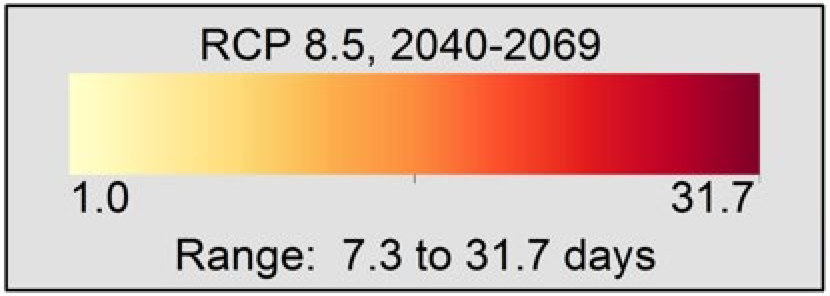
Several weeks of high temperature and low rainfall are sufficient to dry fuels and cause extreme fire hazard.

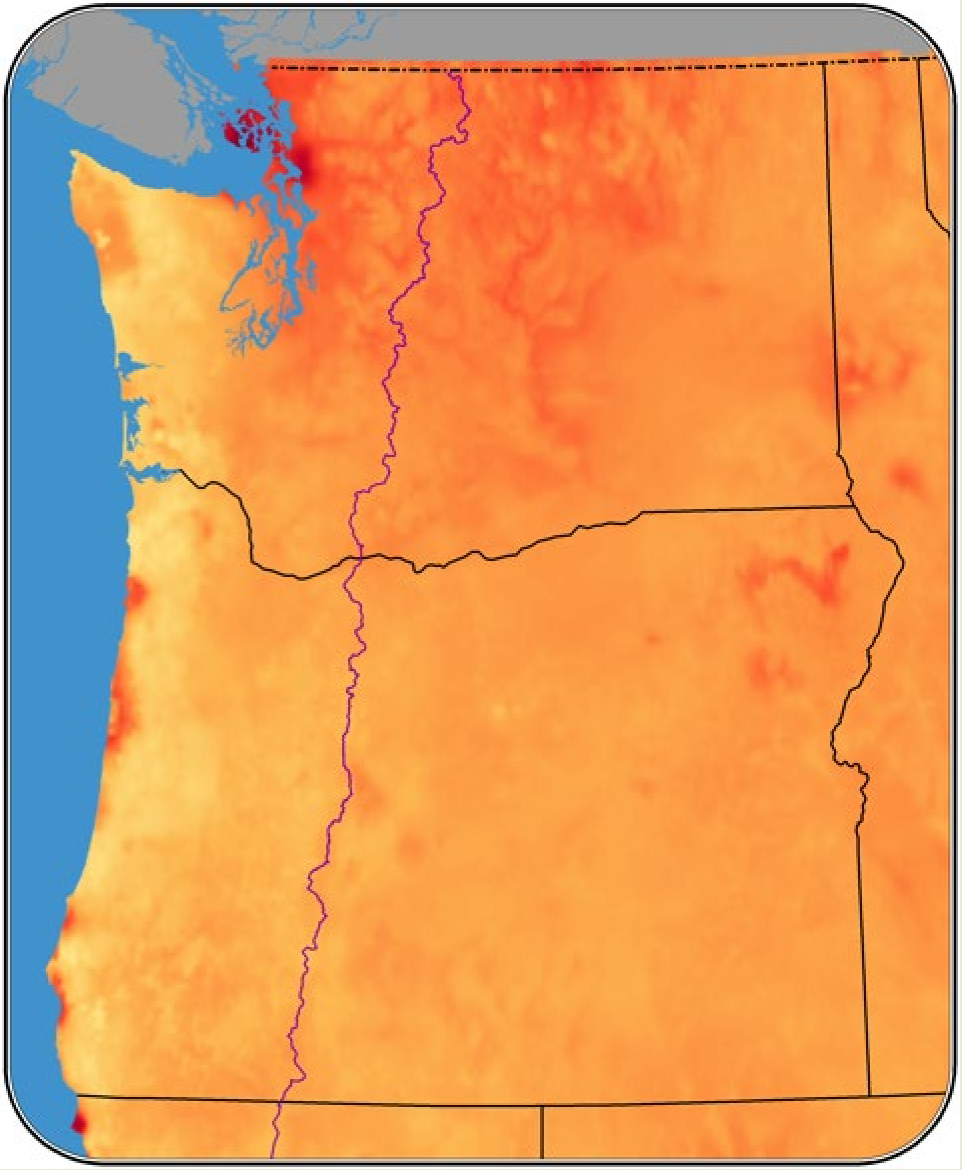
Earlier and longer periods of dry fuels are affected by multiple factors

More “very high” fire danger days

Mid 21st century

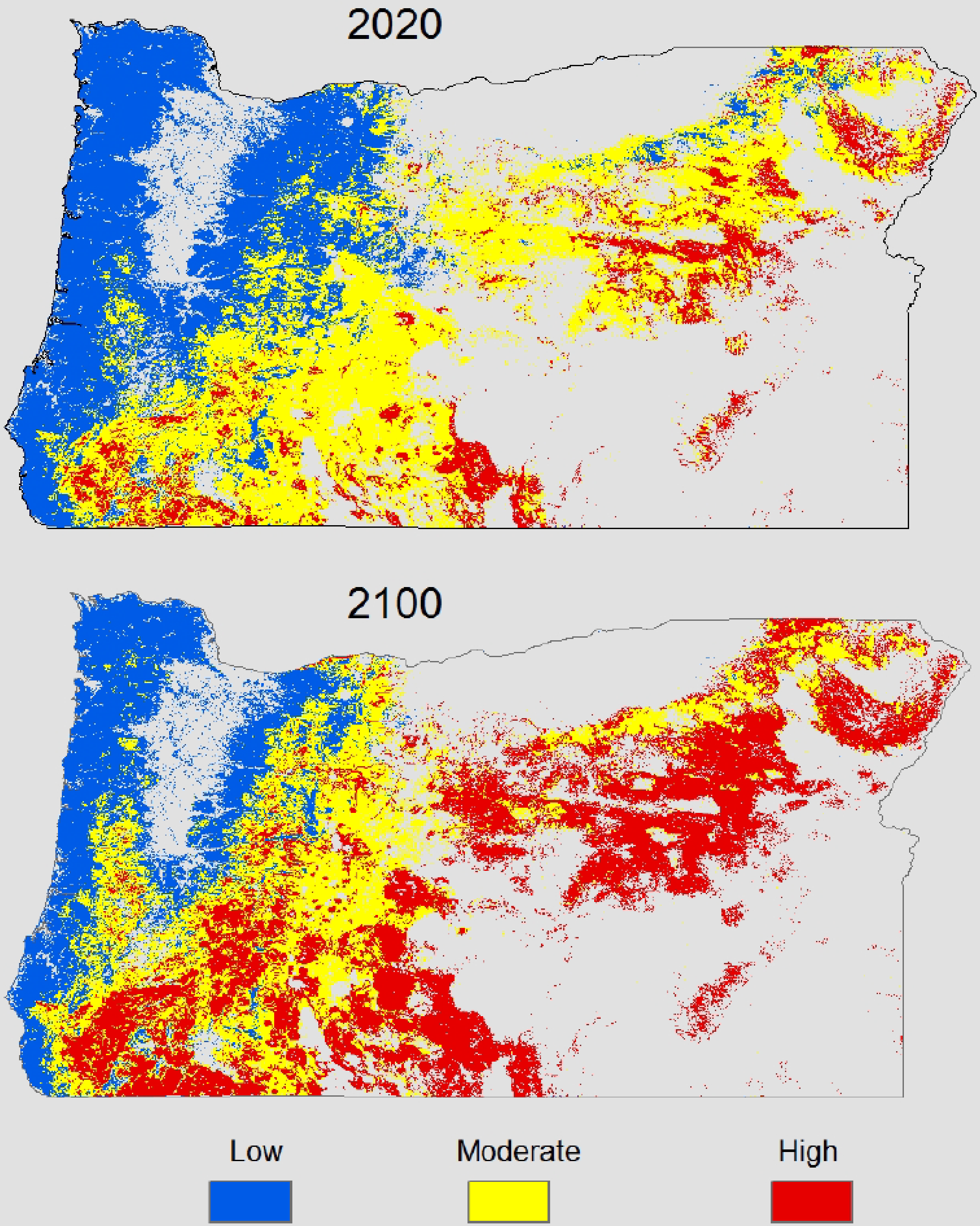
Increase in Very High Fire Danger Days





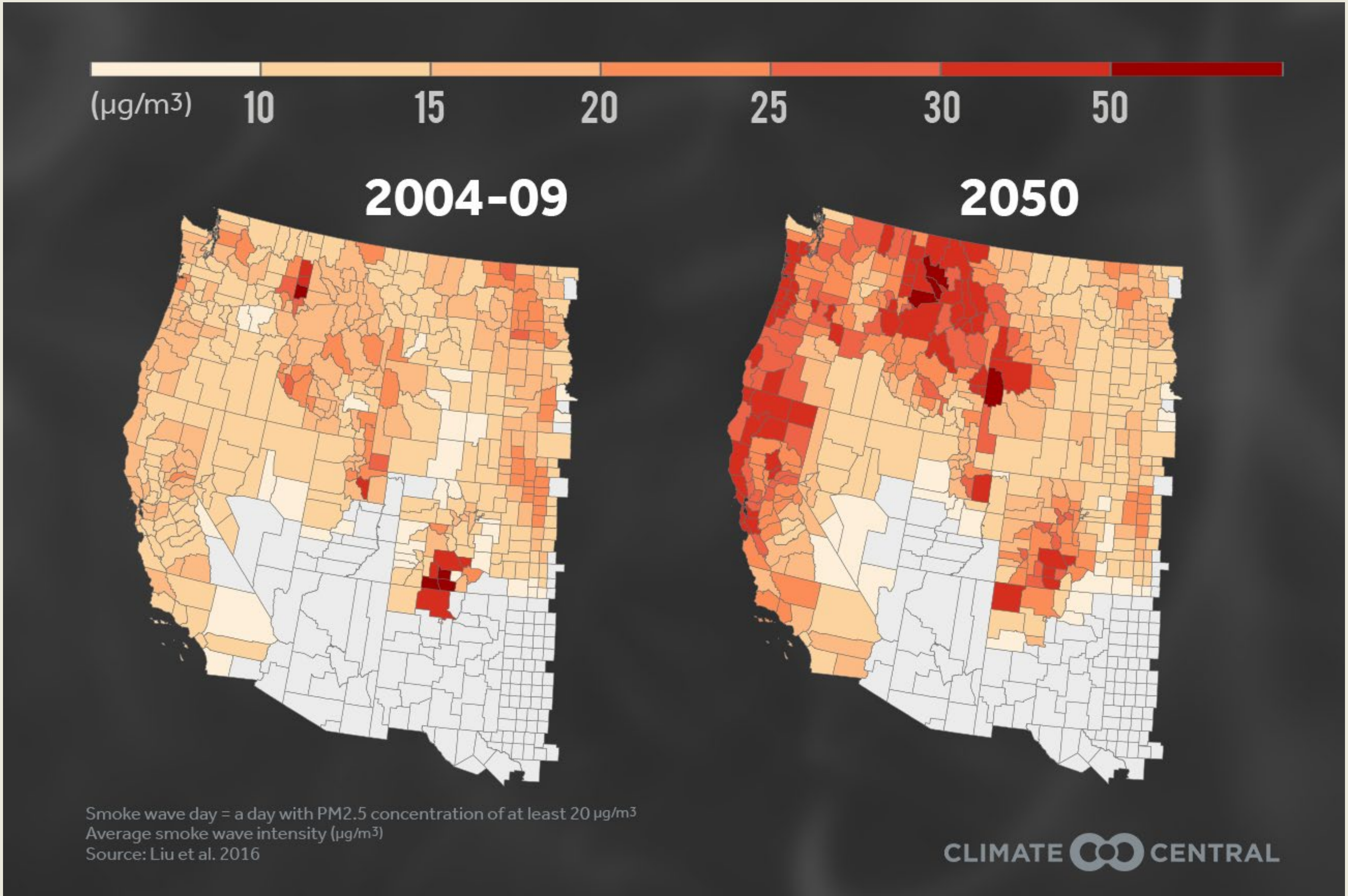
Source: Northwest Climate Toolbox

Suitability of large forest fires



Adapted from
Davis et al. 2017

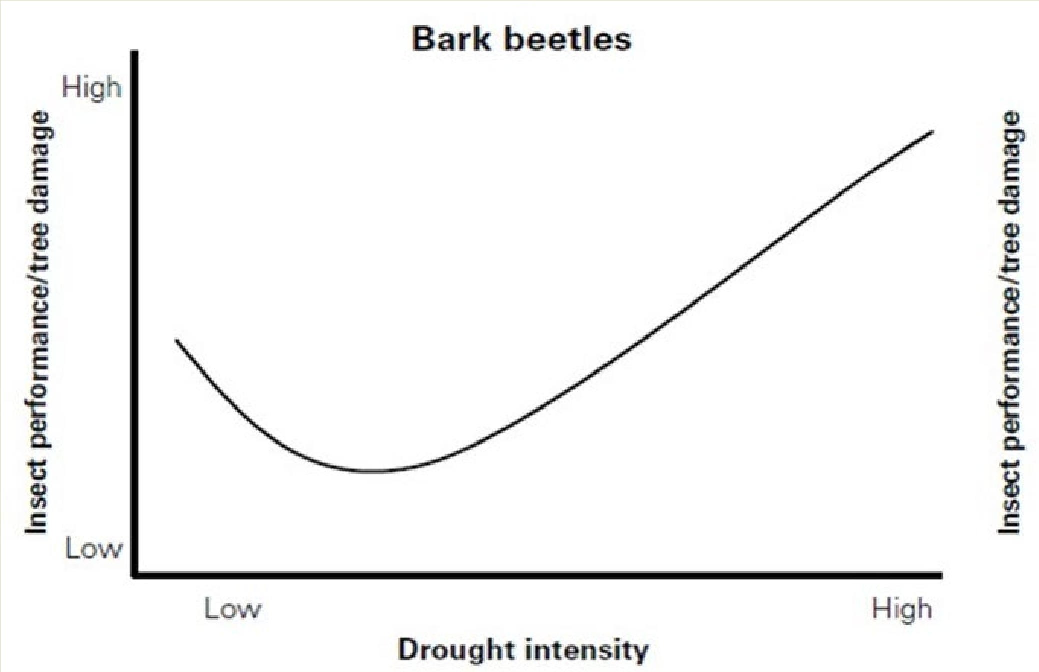
Projected smoke wave intensity



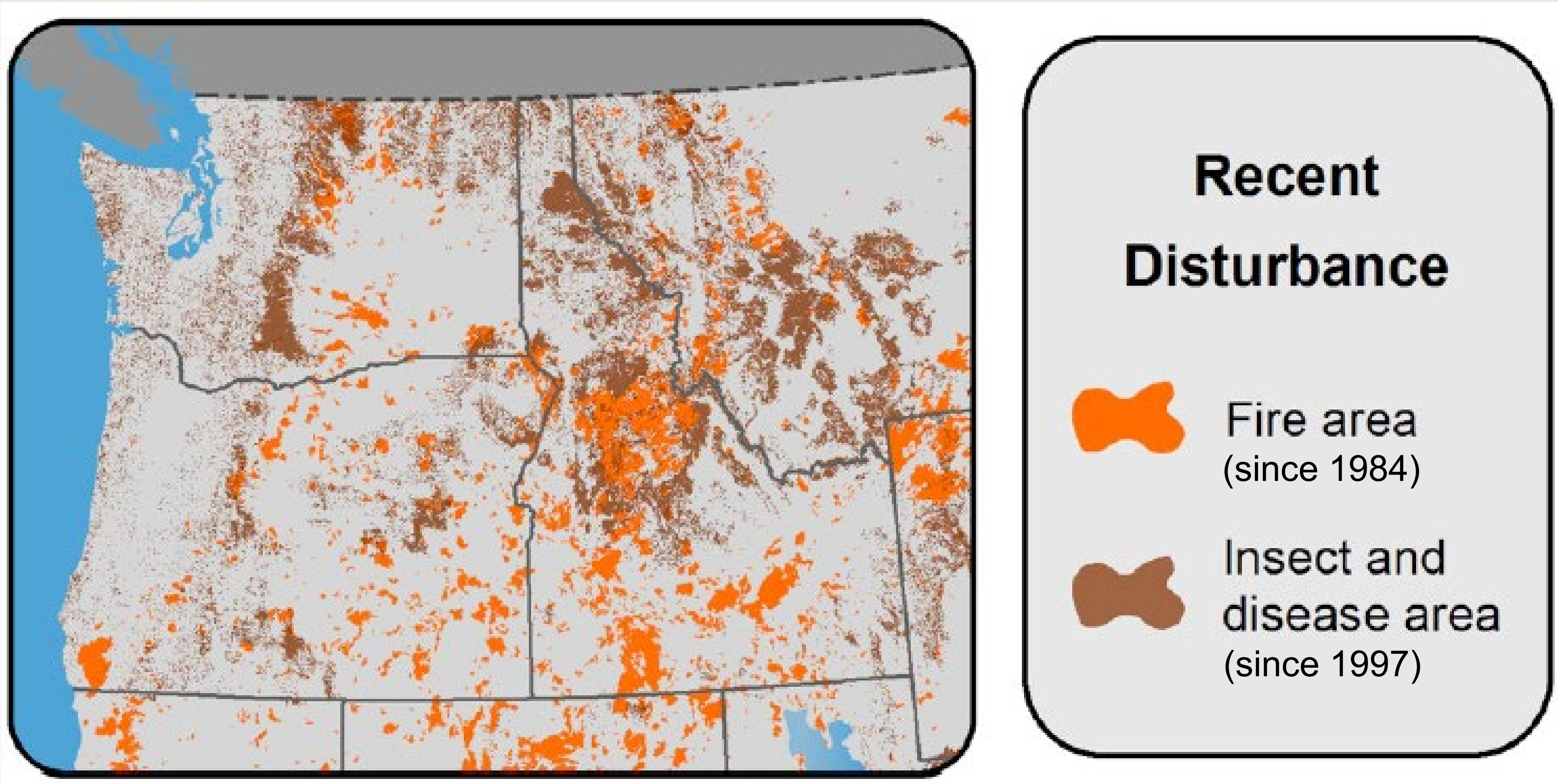
Rapid forest change: Insects

During the past 30 years, **bark beetle-caused tree mortality** in the western U.S. has exceeded that of wildfire.

By 2016, more than 102 million drought-stressed trees were killed by western pine beetle in the central and southern Sierra Nevada.



Interacting disturbances?



Dalton et al. (2013)

Disturbances will interact

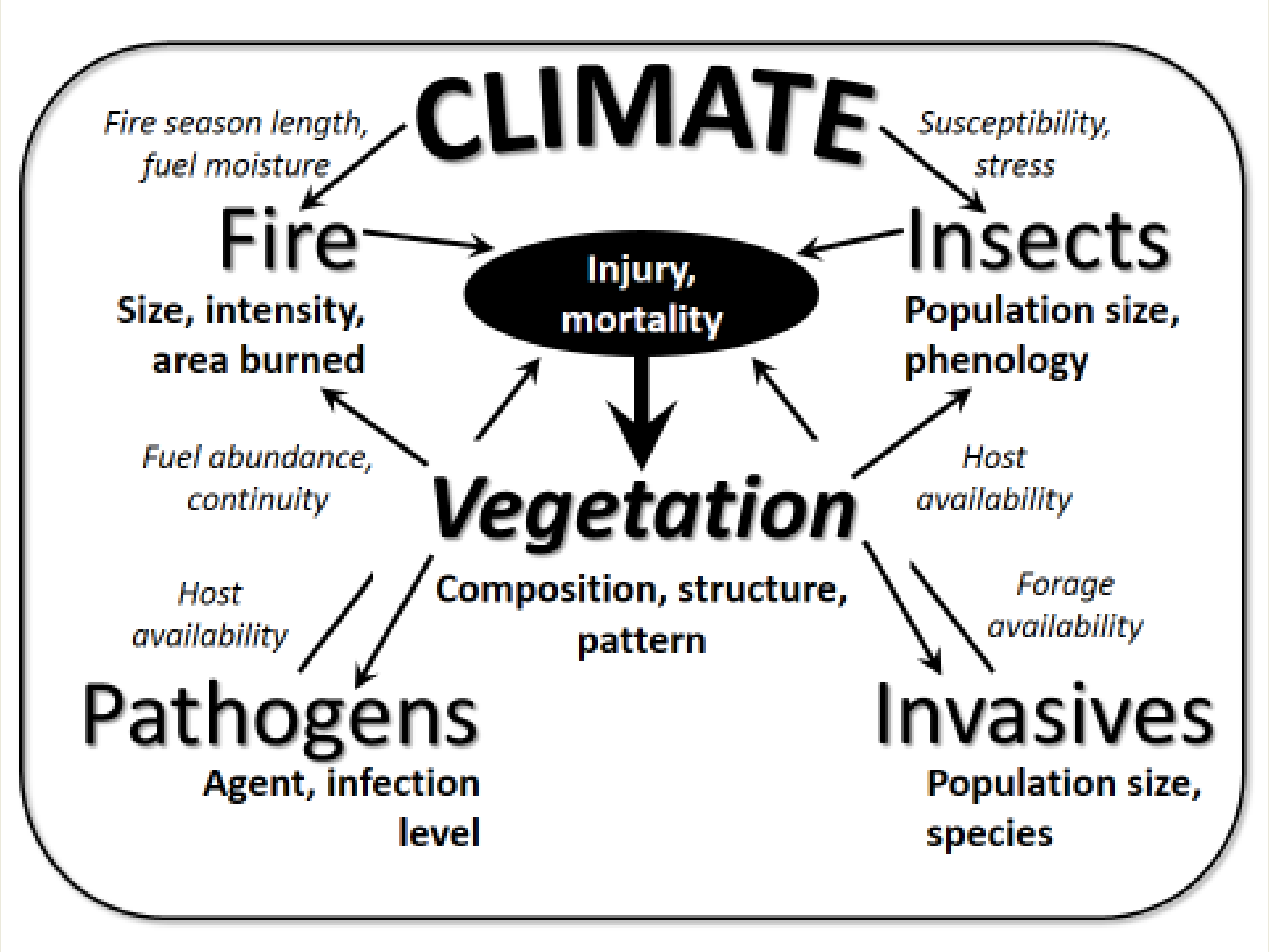


Figure by R. Loehman

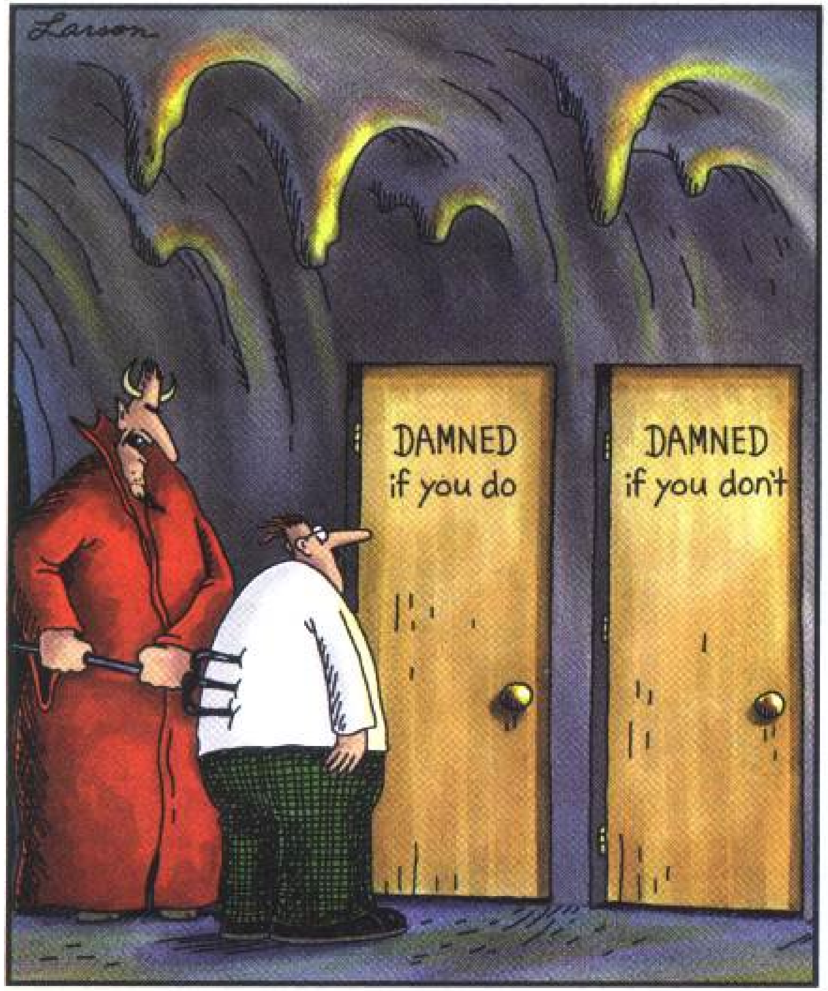

How do we manage for resilient forests in a warmer climate?

Adaptation – working definition

An effort to lower the potentially negative consequences of climate change

AND transition ecosystems and natural resources to a warmer climate.

= building <u>resilience</u>?



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

Adaptation partnership goals

- Increase climate change awareness
- Assess vulnerability of natural resources
- Develop adaptation strategies and tactics


General approach

Establish a science-management partnership

↓

Conduct a vulnerability assessment

↓

Identify adaptation strategies & tactics

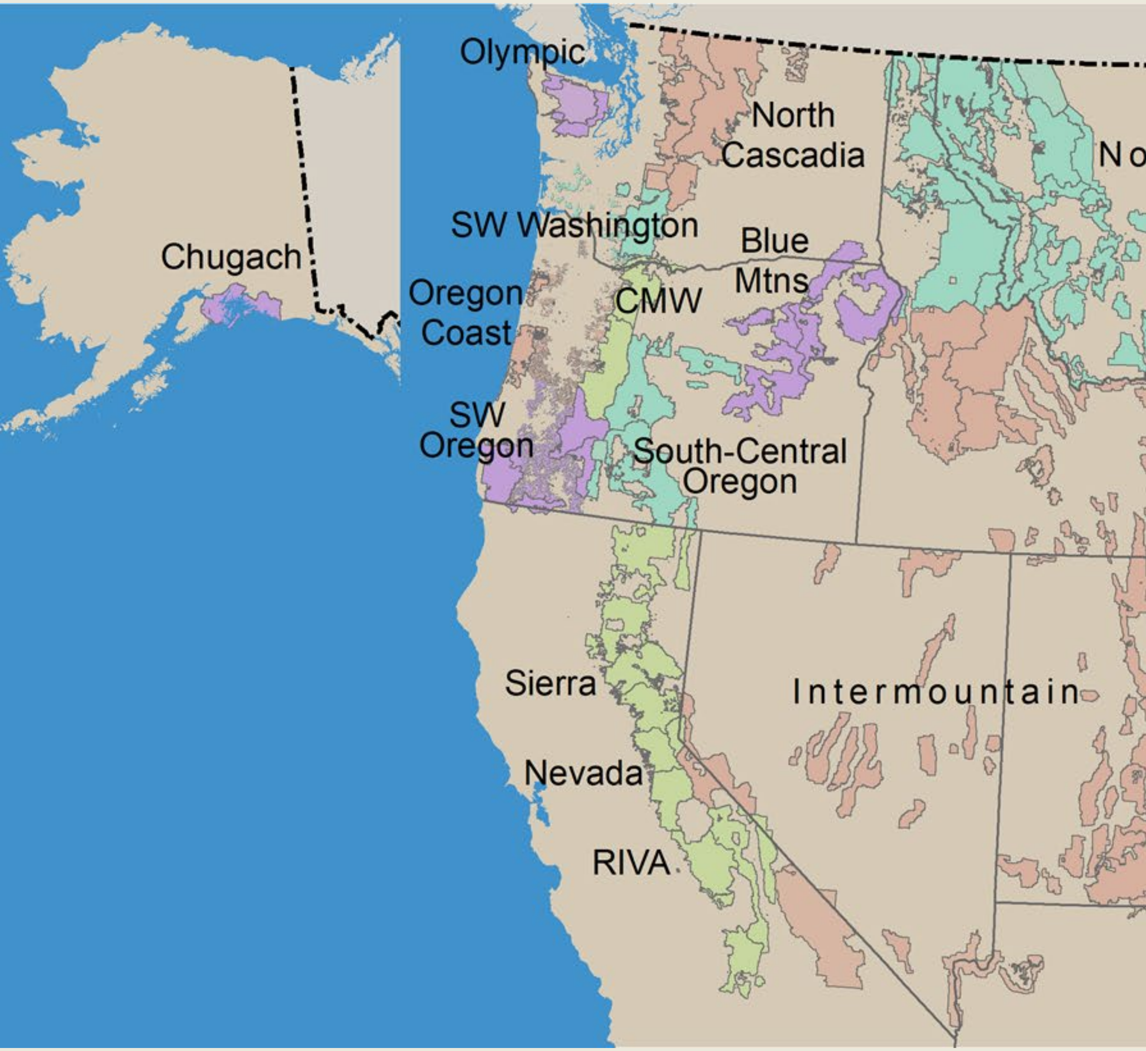
↓

Develop & publish a peer-reviewed report

Core topics addressed in vulnerability assessments

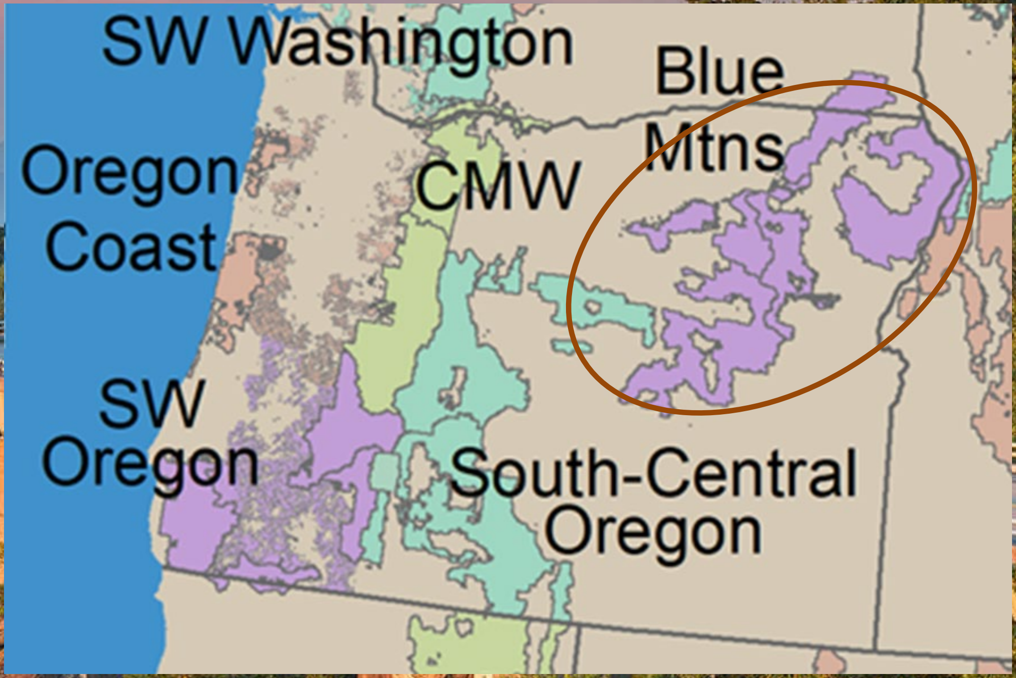
- Climate
- Water resources and infrastructure
- Fisheries
- Vegetation and disturbance
- Wildlife
- Recreation
- Ecosystem services

Adaptation Partnership Locations



57 National Forests
33 National Park Service units
>100 million hectares
120 research scientists
1,400 resource managers

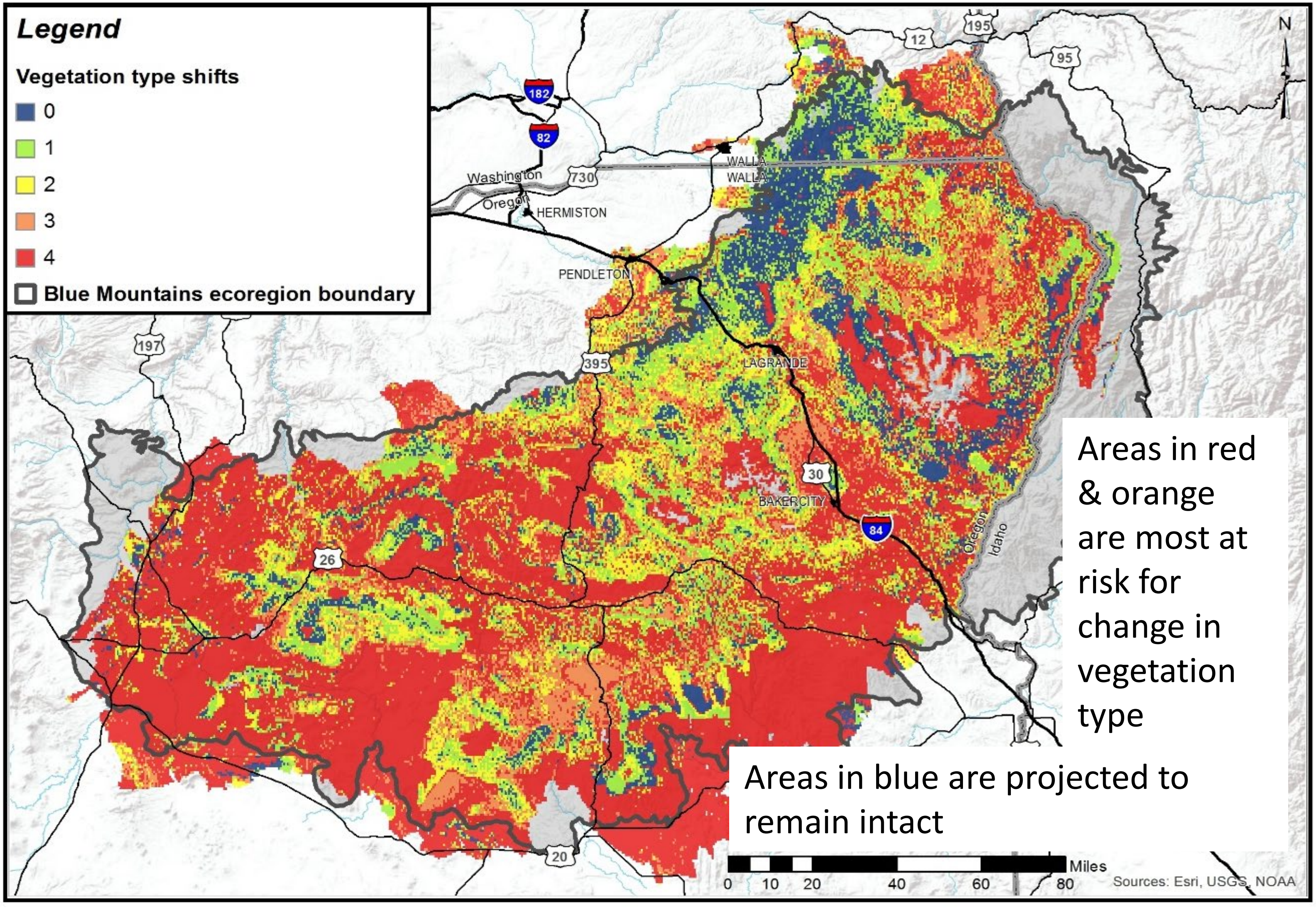
Oregon Road Trip



Blue Mountains
Vegetation Vulnerabilities

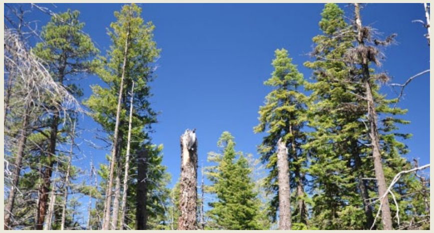
- Lower soil moisture will cause gradual changes in abundance and distribution of species; drought-tolerant species more competitive.
- Increased disturbance (wildfire, insect outbreaks) will facilitate vegetation change; younger forest age/structure.
- Increased non-native plant species will compete with native species.
- High-elevation species may be particularly vulnerable.

Potential vegetation type change (2080)



Expected changes in vegetation by the end of the century include:

- Dominance of ponderosa pine and sagebrush will increase in many locations (e.g., higher elevations).
- The forest-steppe ecotone will move upward in latitude and elevation.
- Subalpine and alpine systems will be replaced by grass species, pine, and Douglas-fir.
- The distribution and abundance of juniper woodlands may decrease if the frequency and extent of wildfire increases.
- Grasslands and shrublands will increase at lower elevations.



Climate change vulnerability: Fire and insect outbreaks

Adaptation strategy

- Increase resilience to disturbance

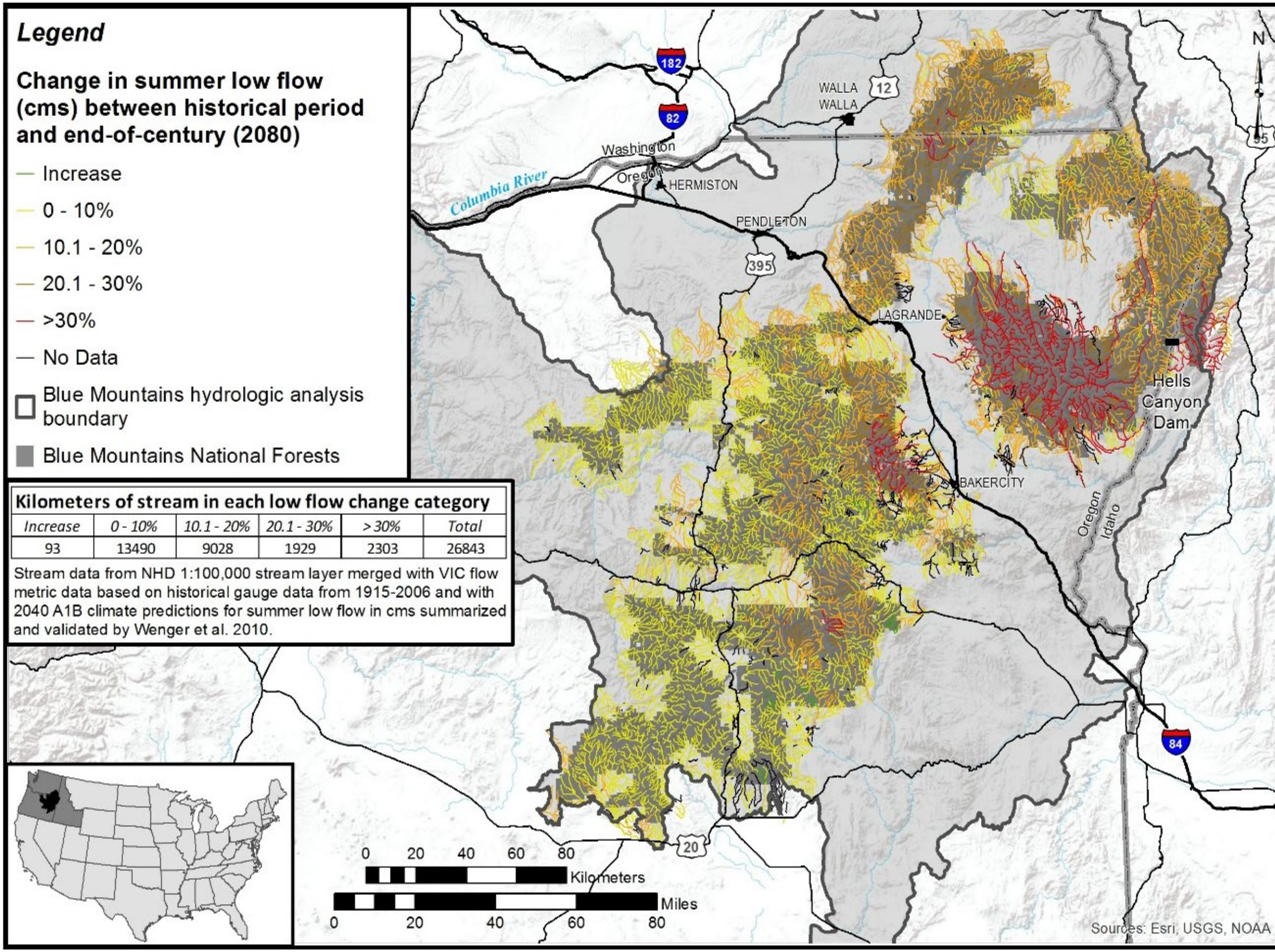
Adaptation tactics

- Restore low-severity fire to lower stand density
- Manage for diversity
- Promote disturbance-resistant species
- Reduce non-native species

Riparian areas and wetlands

- Riparian areas and wetlands will be especially vulnerable to higher air temperature, reduced snowpack, and altered hydrology.
- Decreased establishment, growth, and cover of species such as cottonwood, willow, and aspen; may be displaced by upland species.
- Reduced groundwater discharge will reduce saturated soil, convert perennial springs to ephemeral springs, eliminate some ephemeral springs, and alter local aquatic flora and fauna.

Change in summer low flow (2080)



Kilometers of stream in each low flow change category

Increase	*0 - 10%*	*10.1 - 20%*	*20.1 - 30%*	*> 30%*	*Total*
93	13490	9028	1929	2303	26843

Stream data from NHD 1:100,000 stream layer merged with VIC flow metric data based on historical gauge data from 1915-2006 and with 2040 A1B climate predictions for summer low flow in cms summarized and validated by Wenger et al. 2010.

Climate change vulnerability:
Low flows and disturbance

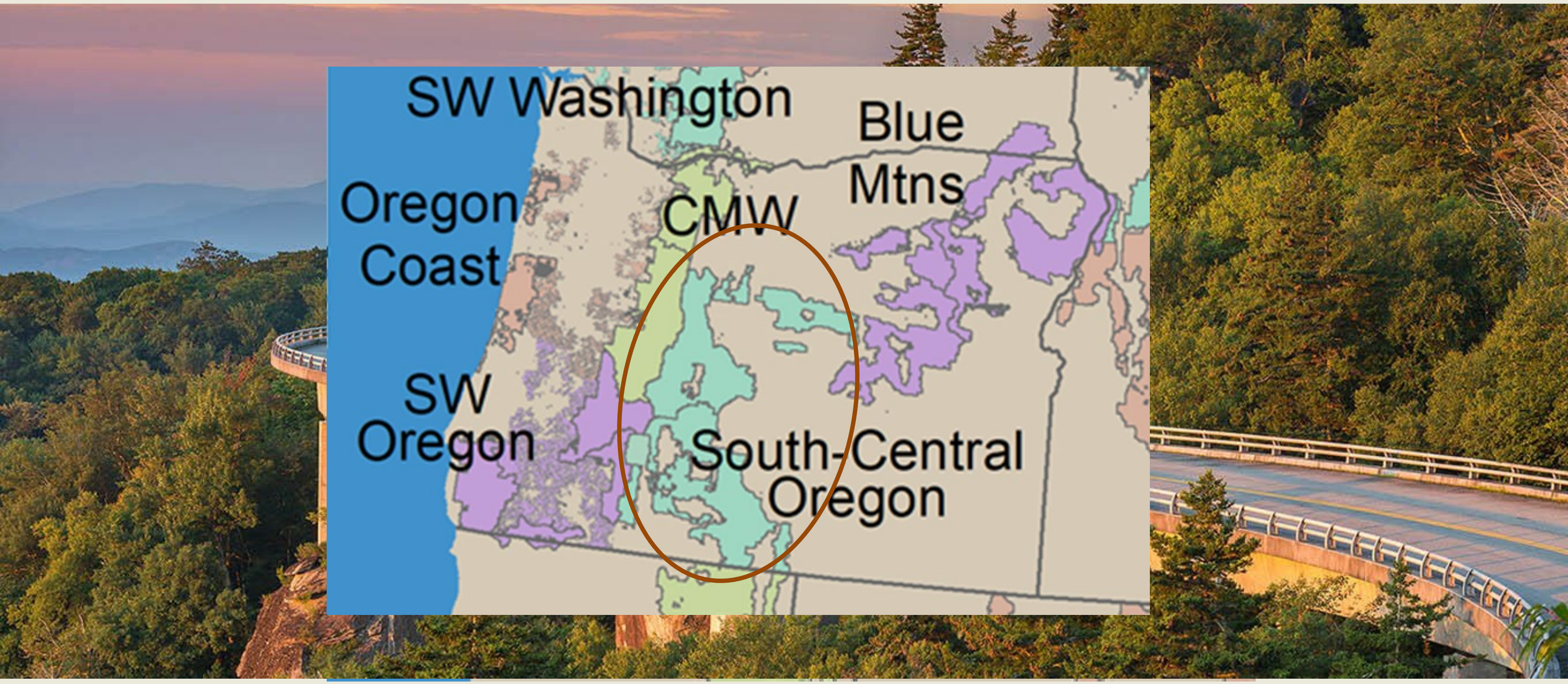
Adaptation strategy

- Increase resilience to drought and disturbance

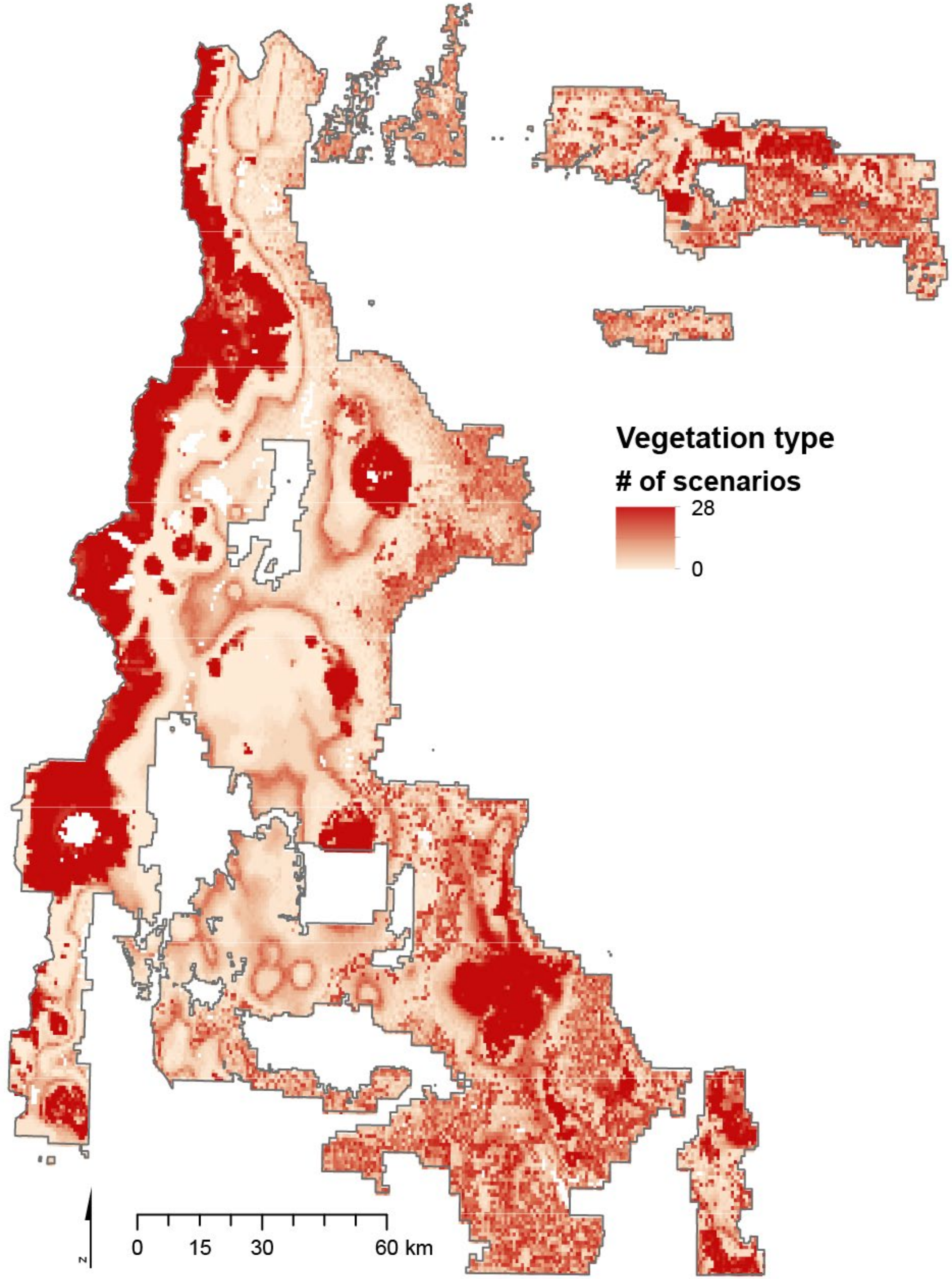
Adaptation tactics

- Promote drought-tolerant native species
- Reduce existing stressors (e.g., invasives, intensive grazing, conifer encroachment)
- Protect wetlands and groundwater-dependent ecosystems

Oregon Road Trip



Climate change effects on vegetation type



Areas in red indicate where models agree that there will likely be a change in vegetation type

Subalpine forests

- Limited by cold temperatures and snowpack
- Warming temperature, declining snowpack = increased growth
- Lower-elevation competitors moving in
- Increase in fires, insects, and diseases
- Seedling establishment a challenge

© Parks Canada / Simon Hunt

USFS

Moist and mesic forests

- Increased growth and productivity
- Drought stress could limit expansion and favor drier forest species
- High amounts of biomass could result in severe fires
- Pumice soils could limit expansion of some species
- Insects and diseases

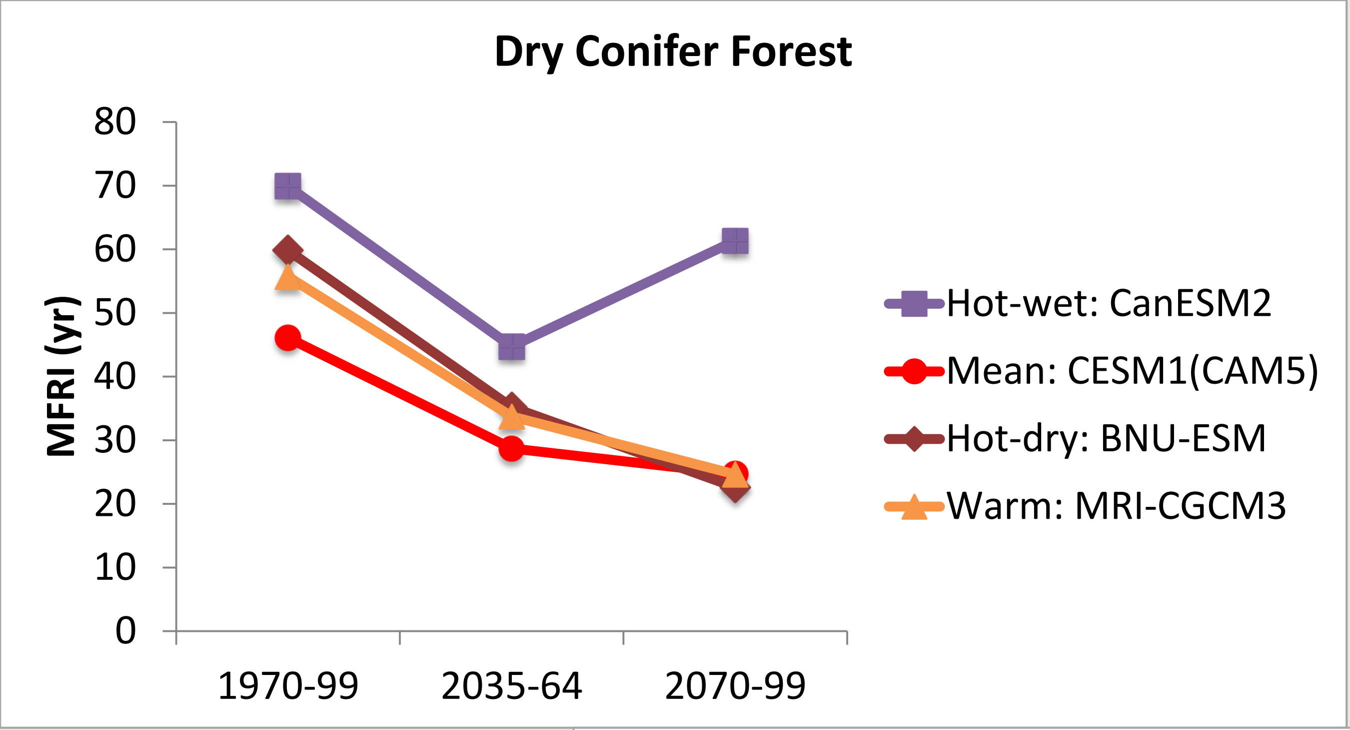
Dry forests

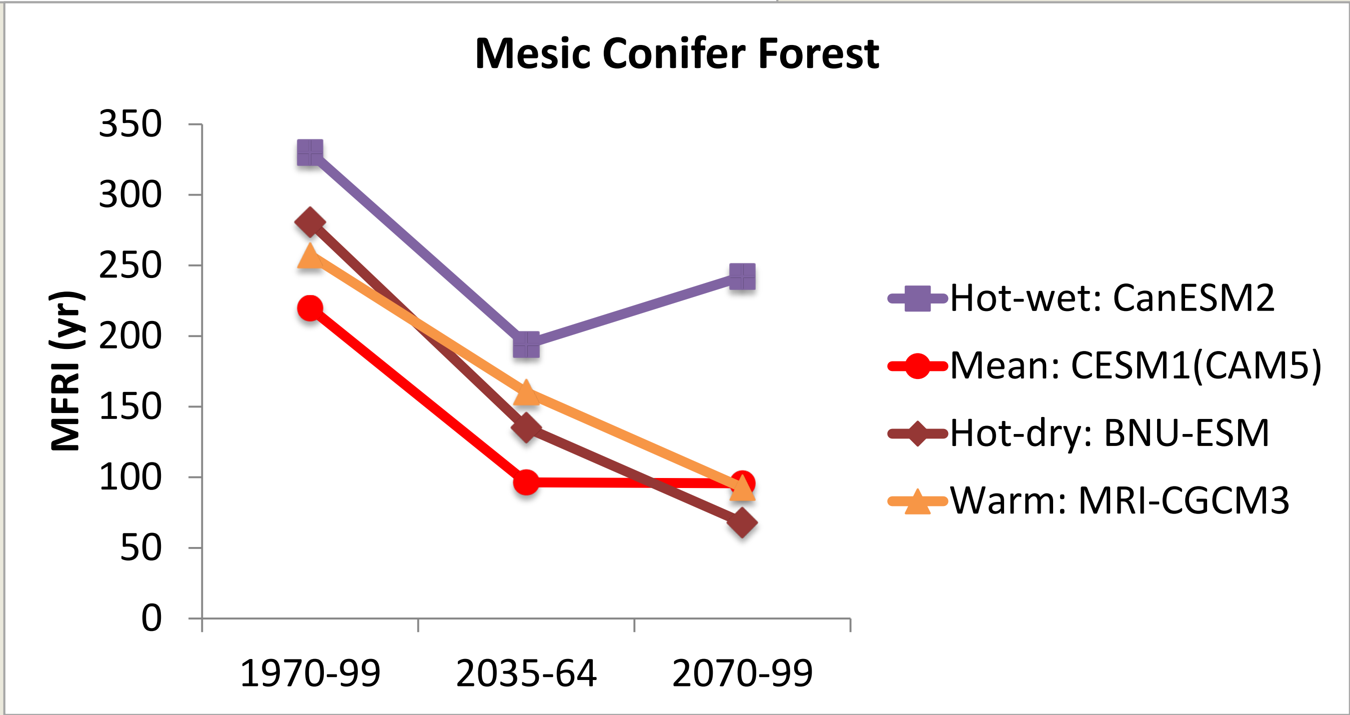
- Less sensitive to temperature changes
- More sensitive to the duration and severity of summer drought stress
- Establishment and growth will be impacted by water availability
- Compounding stresses could lead to mortality
- Fire will continue to be an important factor

Disturbance resets the stage

- Forests have long-lived dominant species
  - compositional changes could be slow even in a rapidly warming climate
  - mature individuals can survive at the edges of their ranges
- Disturbance is expected to be the principal agent of change

Mean fire return intervals will decrease





Climate change vulnerability:
Increased disturbance will negatively affect whitebark pine

Adaptation strategy

- Increase competitive ability of whitebark pine

Adaptation tactics

- Control beetles
- Daylight (thin) to reduce competition
- Create fuelbreaks
- Plant disease-resistant genotypes

Climate change vulnerability:

Fire, drought, and insect outbreaks in mesic forests

Adaptation strategy

- Increase resilience to disturbance

Adaptation tactics

- Favor early-seral species that are more tolerant of drought and defoliator outbreaks
- Promote structural heterogeneity of fuels

Climate change vulnerability:
Fire, drought, and insect outbreaks in dry forests

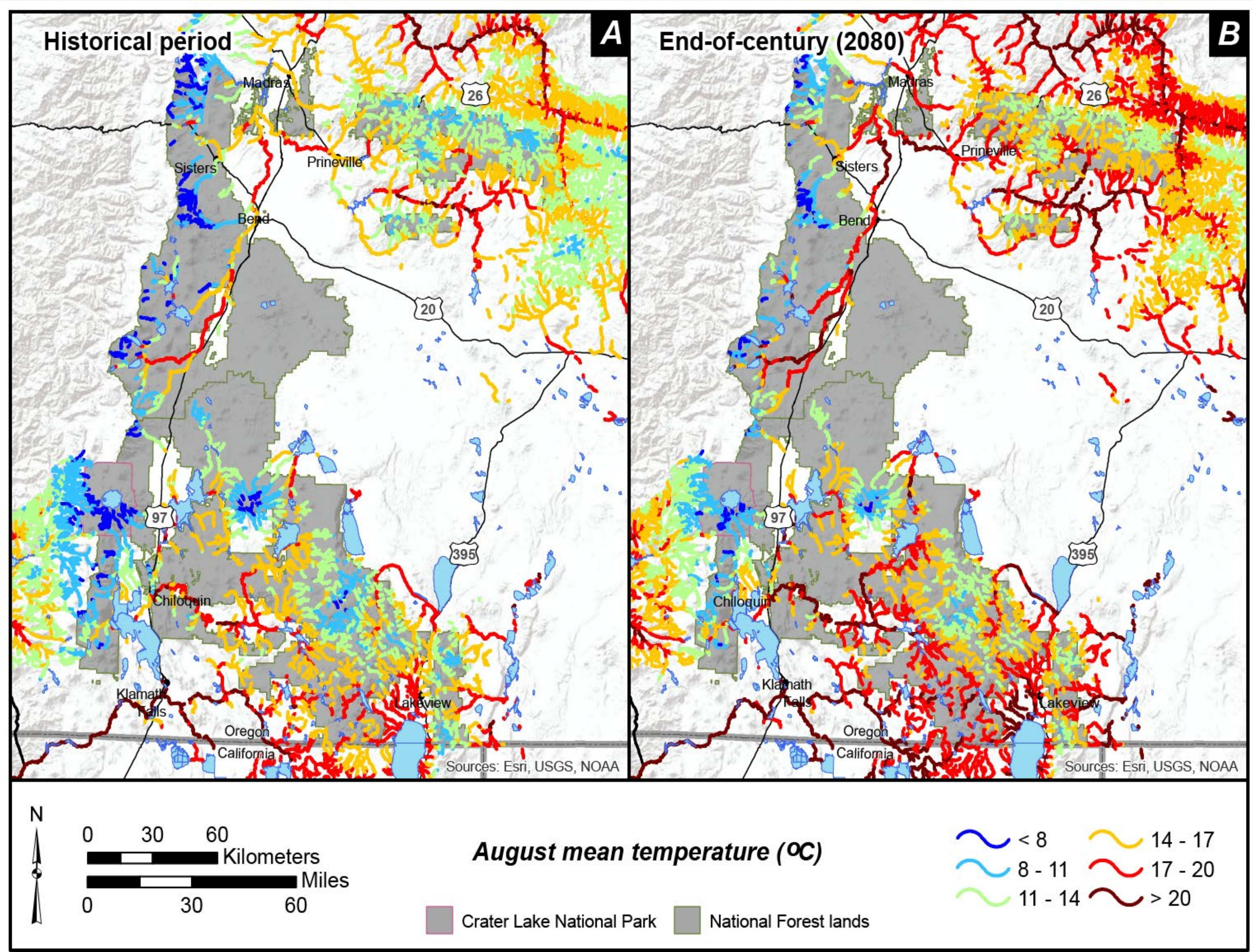
Adaptation strategy

- Increase resilience to disturbance

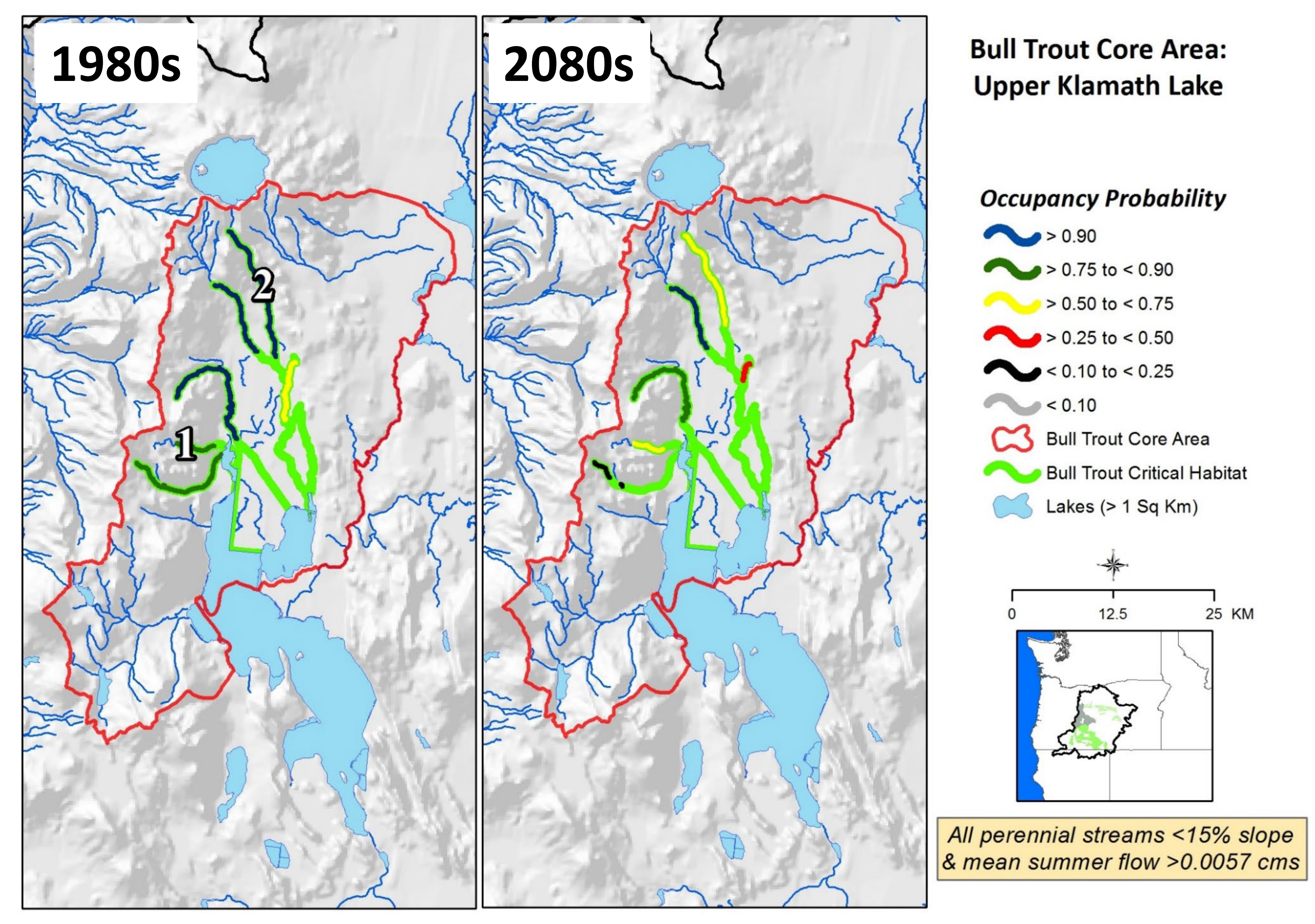
Adaptation tactics

- Conduct more intensive thinning
- Conduct prescribed burns and allow frequent fire
- Promote persistence of healthy trees
- Promote drought- and disturbance-tolerant ponderosa and Jeffrey pine with frequent fire

Climate change effects on fish: increased stream temperatures



Bull Trout Habitat



Climate change vulnerability: Increased stream temperatures

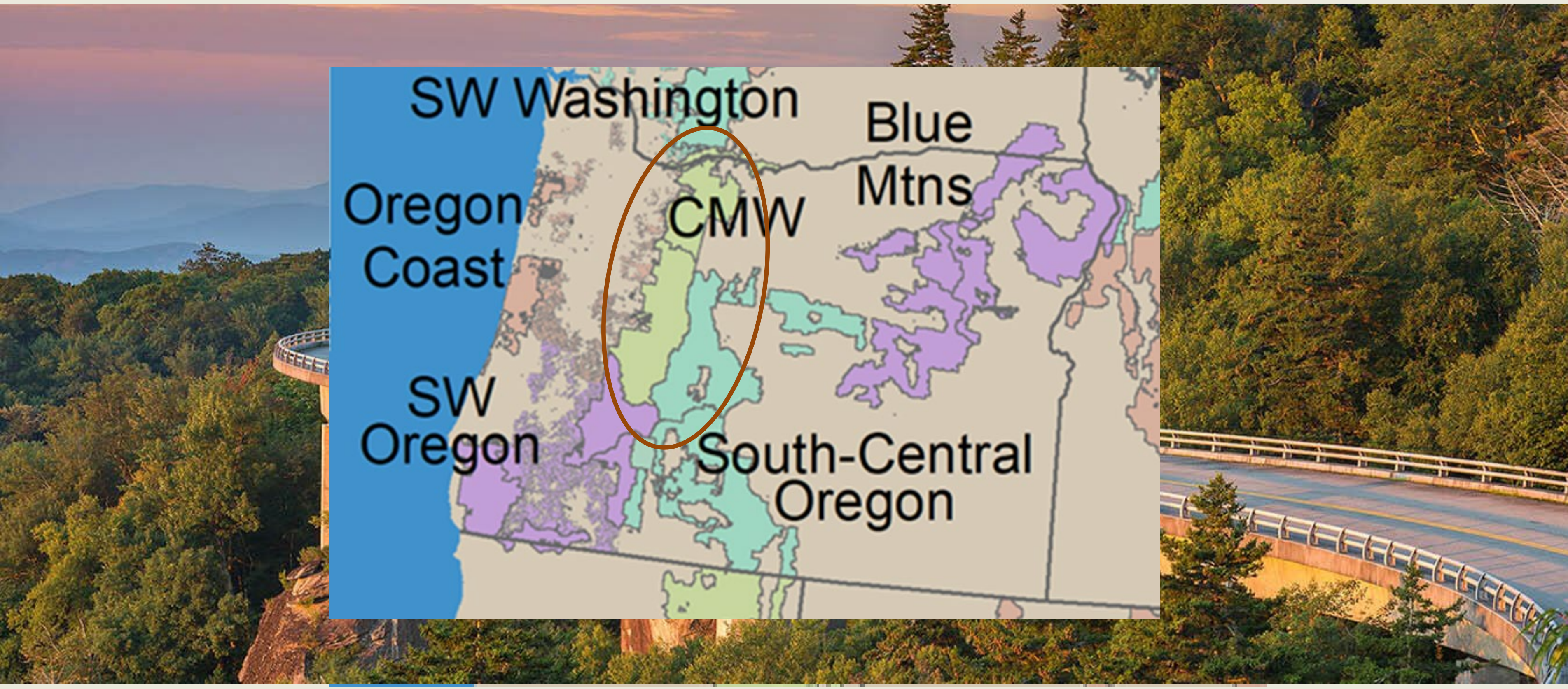
Adaptation strategy

- Restore and maintain cold-water habitat

Adaptation tactics

- Decrease fragmentation of stream networks
- Restore and maintain natural flow regimes
- Increase shade in riparian areas

Oregon Road Trip

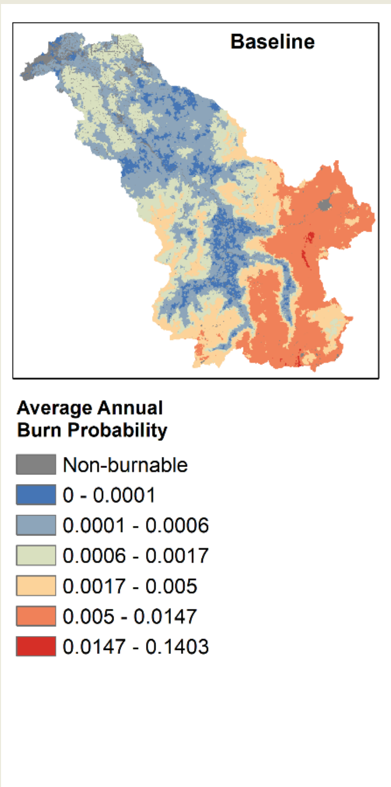


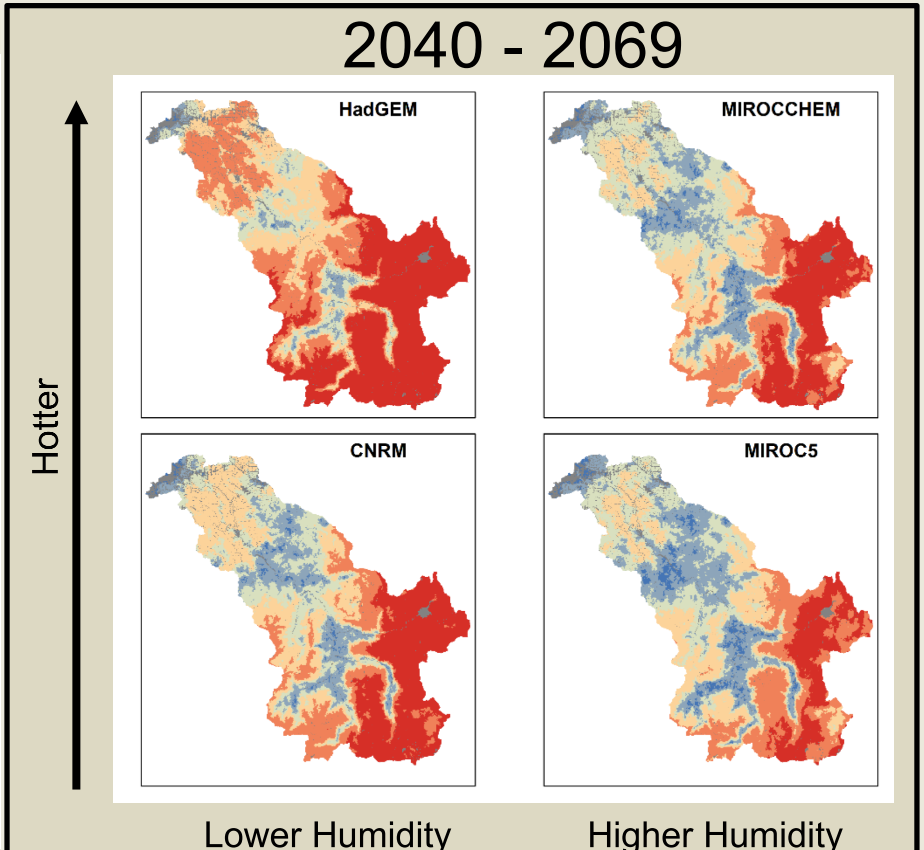
Vegetation and disturbance in the north-central Cascades

- Lower growth; higher mortality from biotic disturbances
- Larger fires, more area burned
- More non-native species
- Loss of some subalpine forests
- Decreased conifer dominance, younger forests

Clackamas wildfire hazard

2000 - 2020

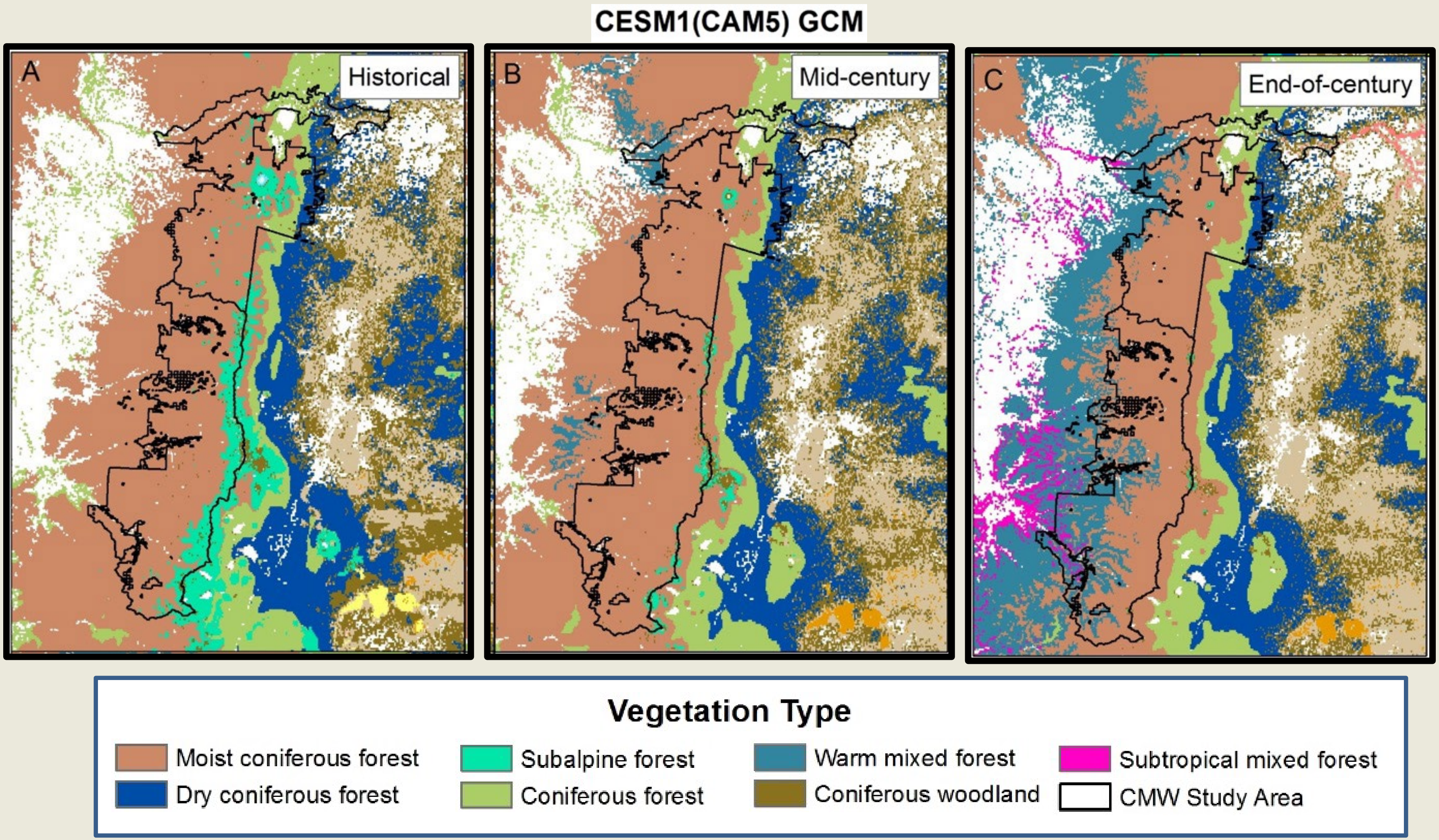




- Mid-century increases in wildfire hazard are driven by increased burn probability
- Climate change is projected to increase wildfire risk exposure in human communities
- Mid-century wildfire hazard may represent a completely novel disturbance regime

McEvoy et al. 2020

Projected vegetation change



Climate change vulnerability:
Drought stress and bark beetle outbreaks in dry oak and pine forests

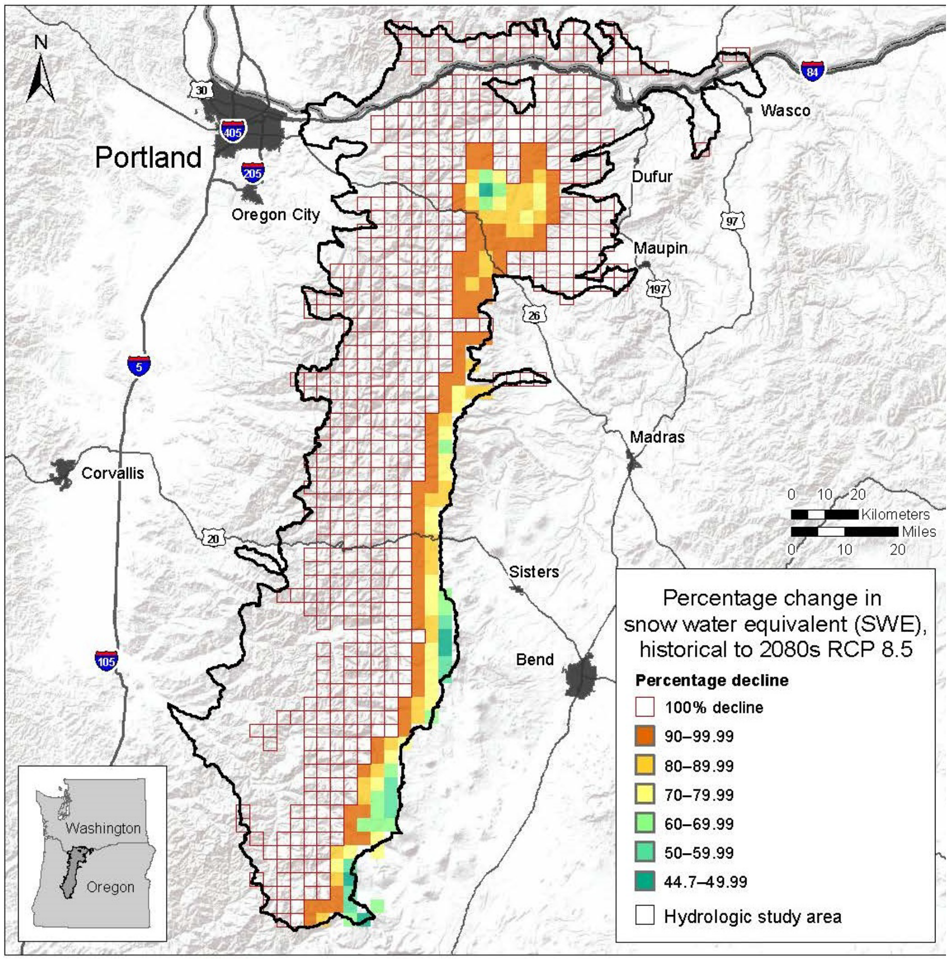
Adaptation strategy

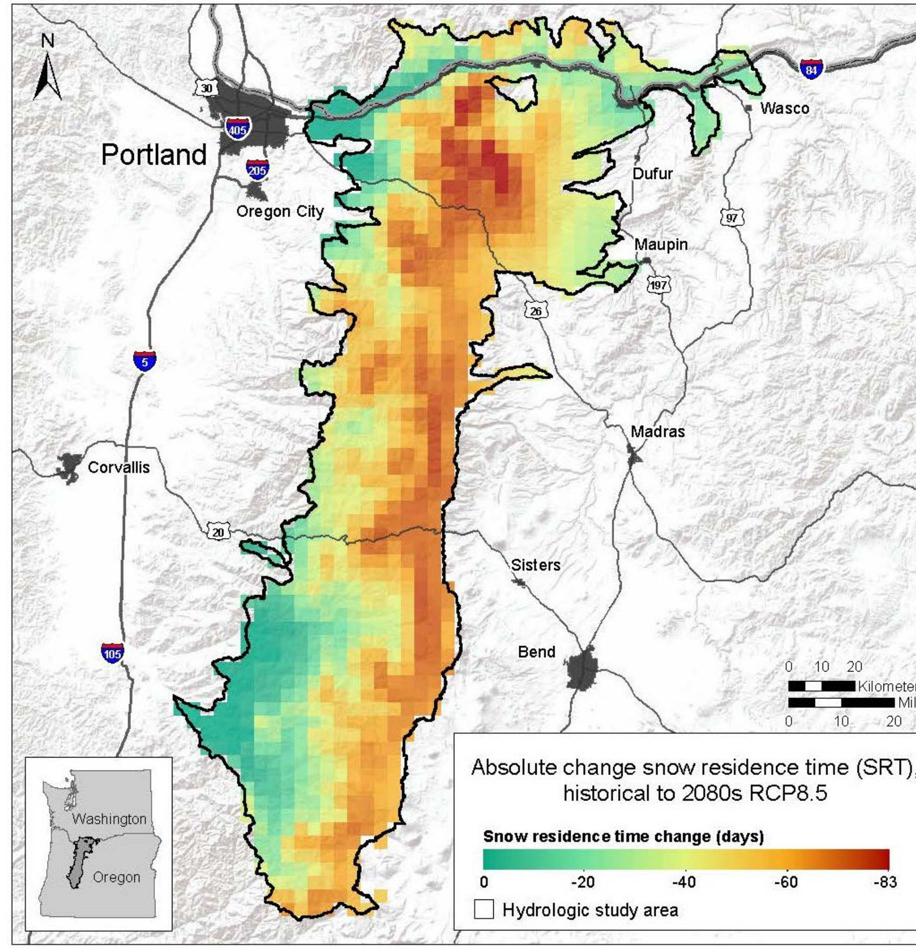
- Decrease susceptibility to bark beetle outbreaks

Adaptation tactics

- Reduce stand density and set density and structural goals based on predicted future conditions
- Reforest sites considering appropriate genetics and species composition to reduce susceptibility to future outbreaks.

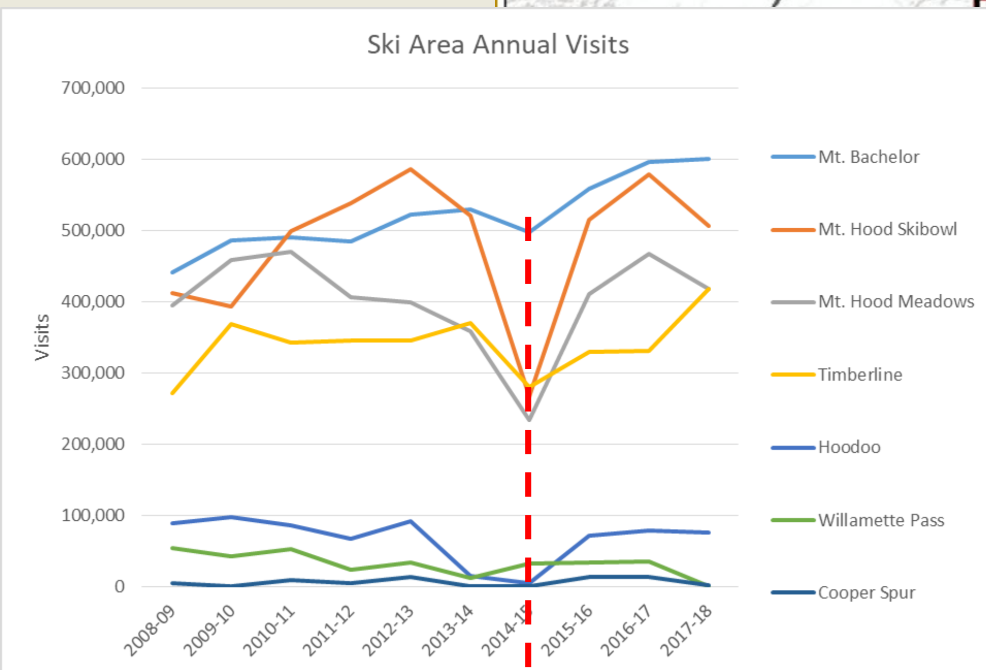
Snowpack changes: Snow water equivalent and snow residence time, 2080s

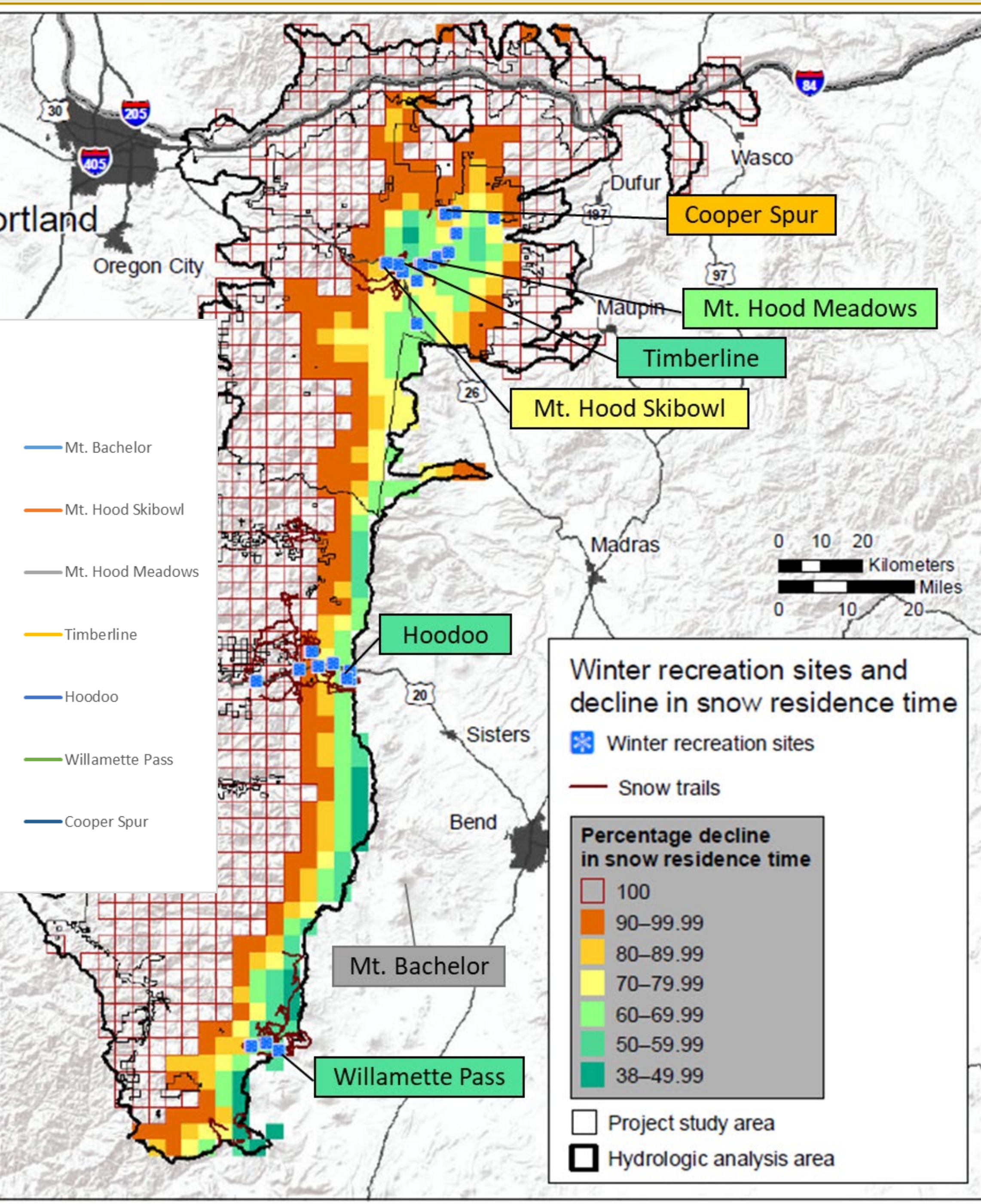




Luce et al. 2014

Snow-based recreation





Climate change vulnerability: Shorter winters and less snow

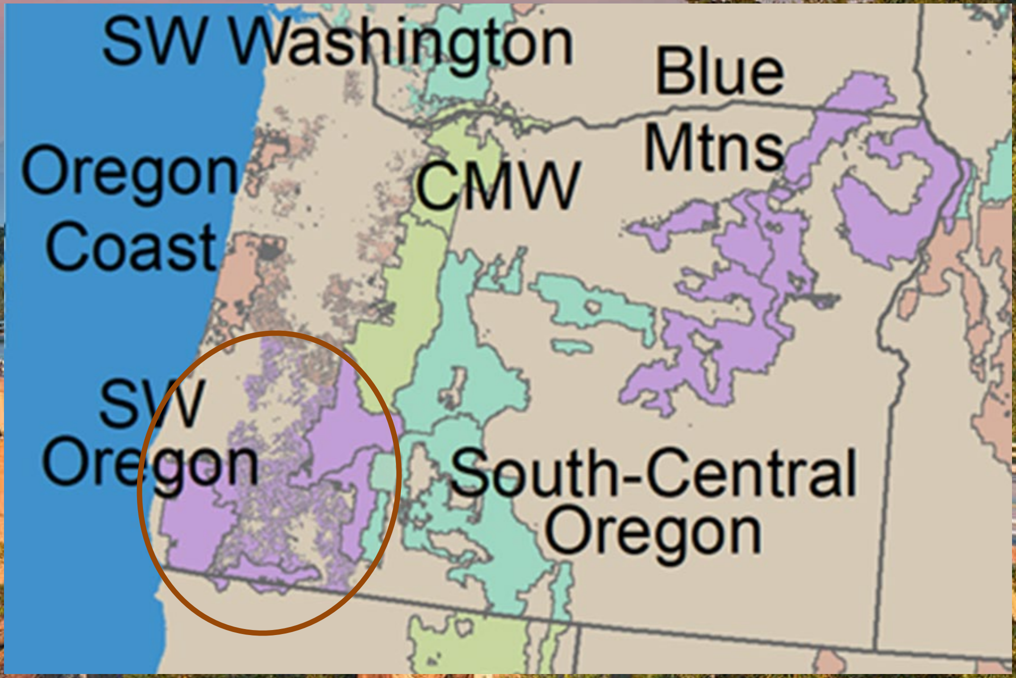
Adaptation strategy

- Increase recreation management flexibility

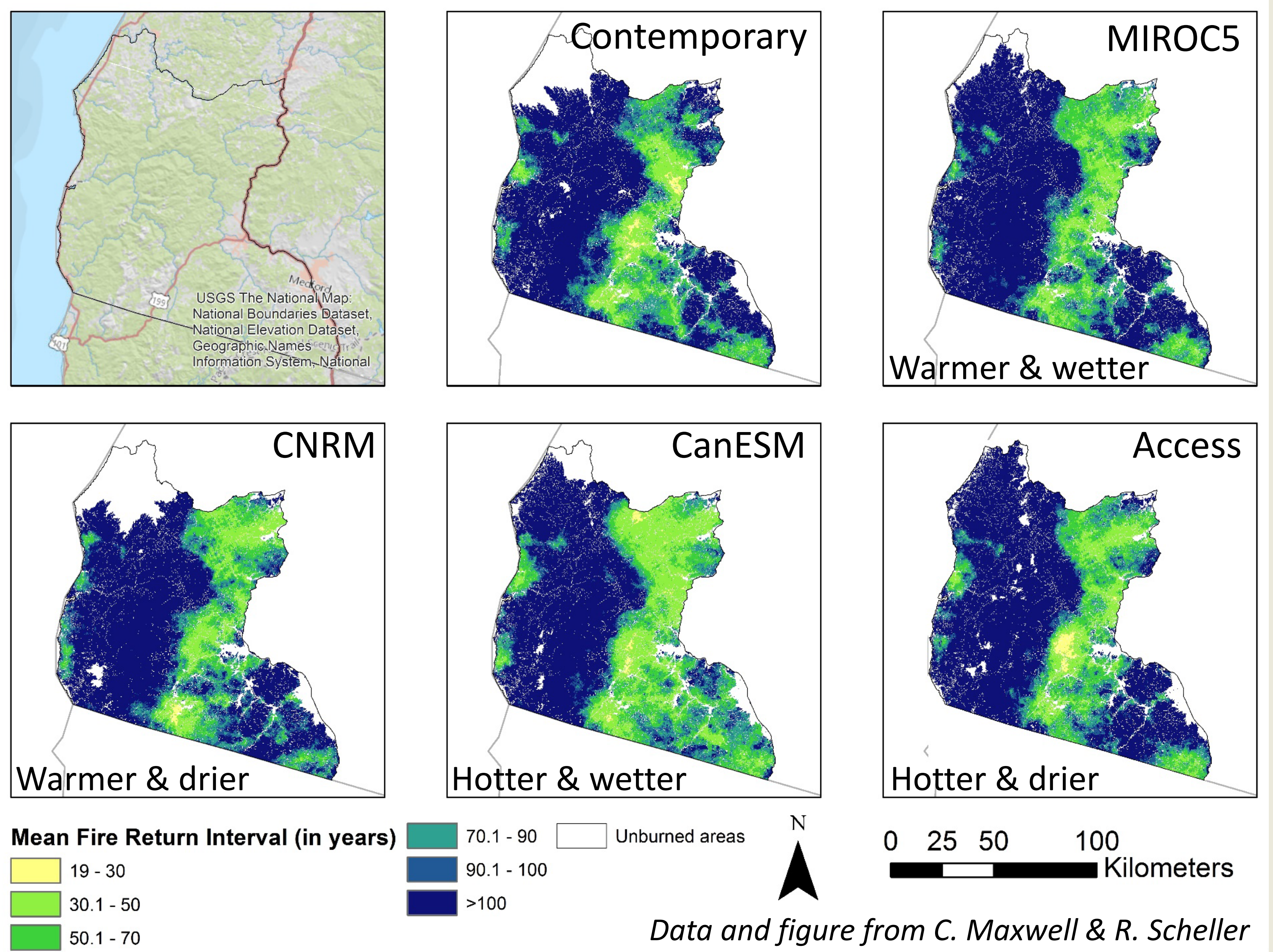
Adaptation tactics

- Expand facilities in areas where concentrated use increases
- Develop options for diversifying snow-based recreation

Oregon Road Trip



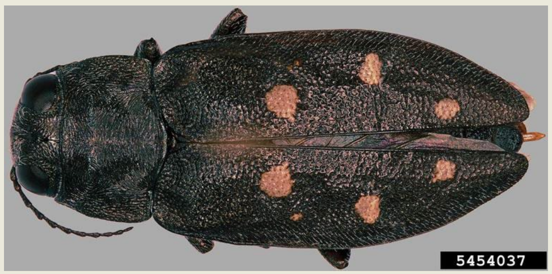
Projected mean fire return interval
(LANDIS-II)



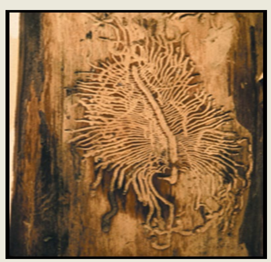
Data and figure from C. Maxwell & R. Scheller

Potential Future Insect Issues of Concern

Stress-induced "secondary" insects becoming primary tree killers



- Flatheaded fir borer on Douglas-fir

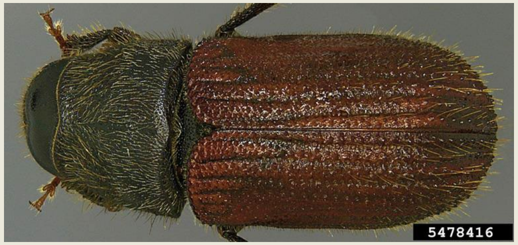


- Douglas-fir mortality complex on smaller trees (fungi, twig weevil, Douglas-fir engraver, Douglas-fir pole beetle)

Slide by Bill Schaupp

Potential Future Insect Issues of Concern

Major “eastside” insect agents attain elevated importance in southwest Oregon



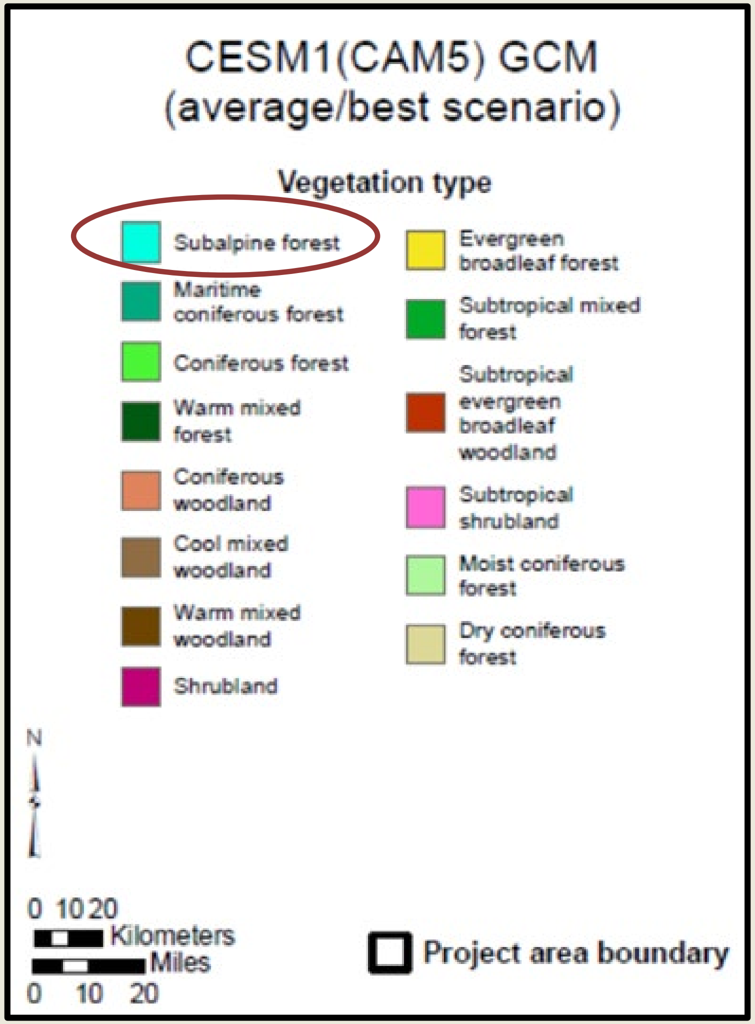
Douglas-fir beetle

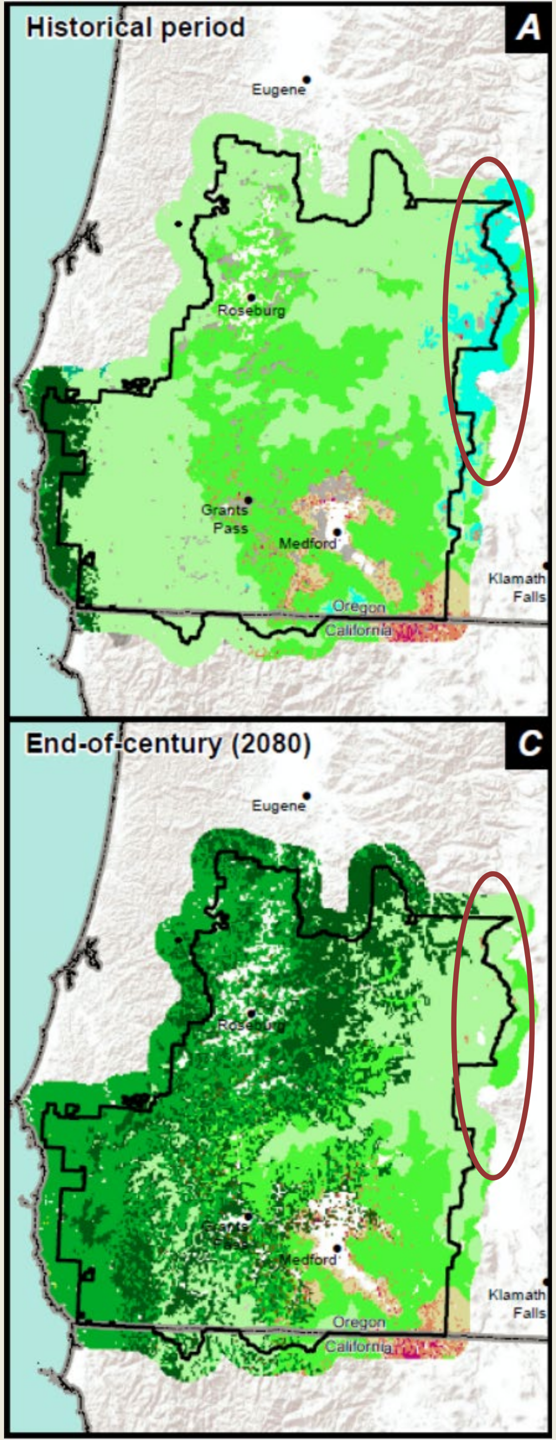
Douglas-fir tussock moth

Western spruce budworm

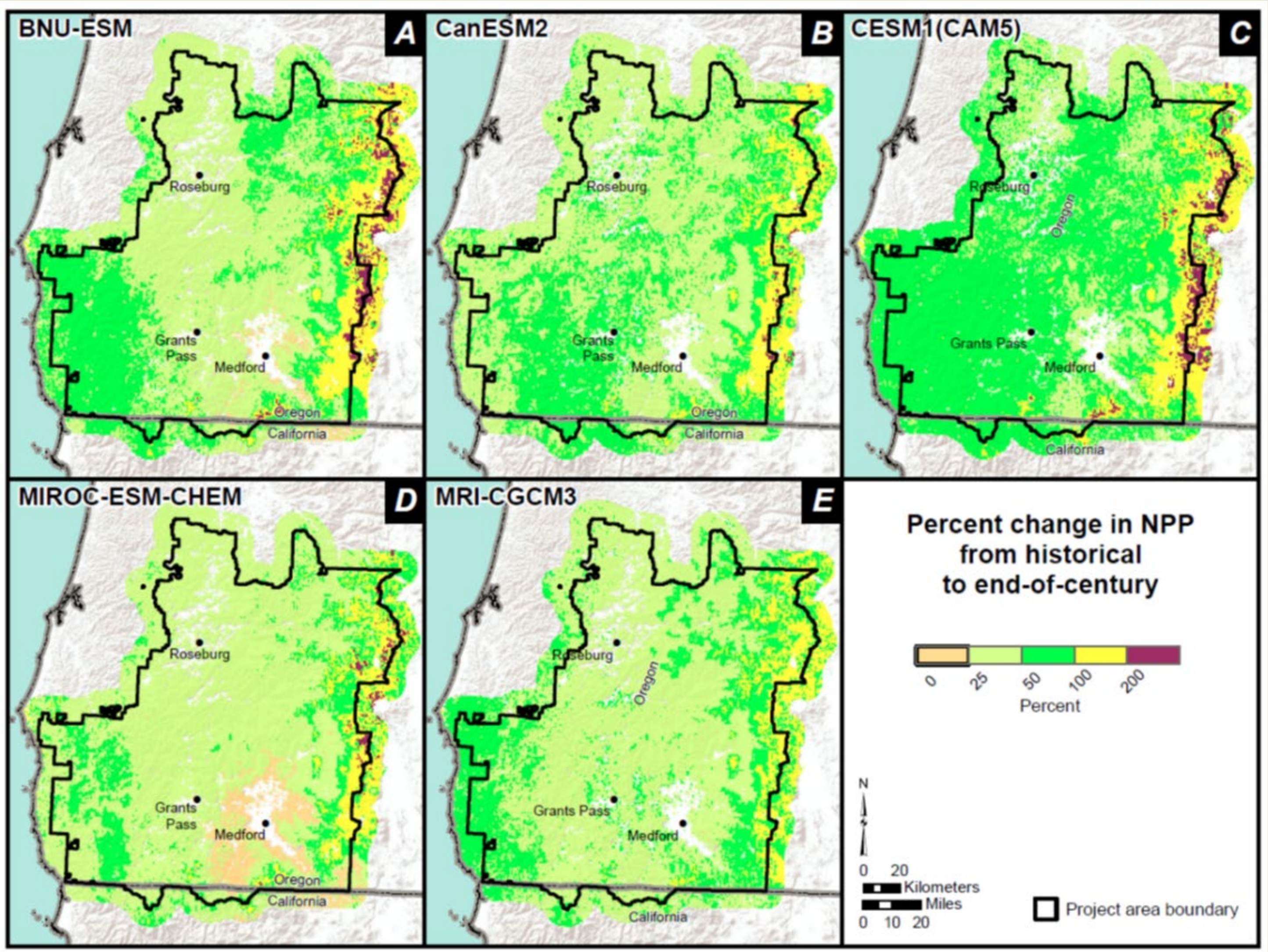
Slide by Bill Schaupp

Climatically-suitable habitat for high-elevation forest will likely decrease





Moist forest will likely continue to be dominated by Douglas-fir and may increase in productivity



Mesic forest will likely transition to more xeric forest, with increases in abundance of species such as:

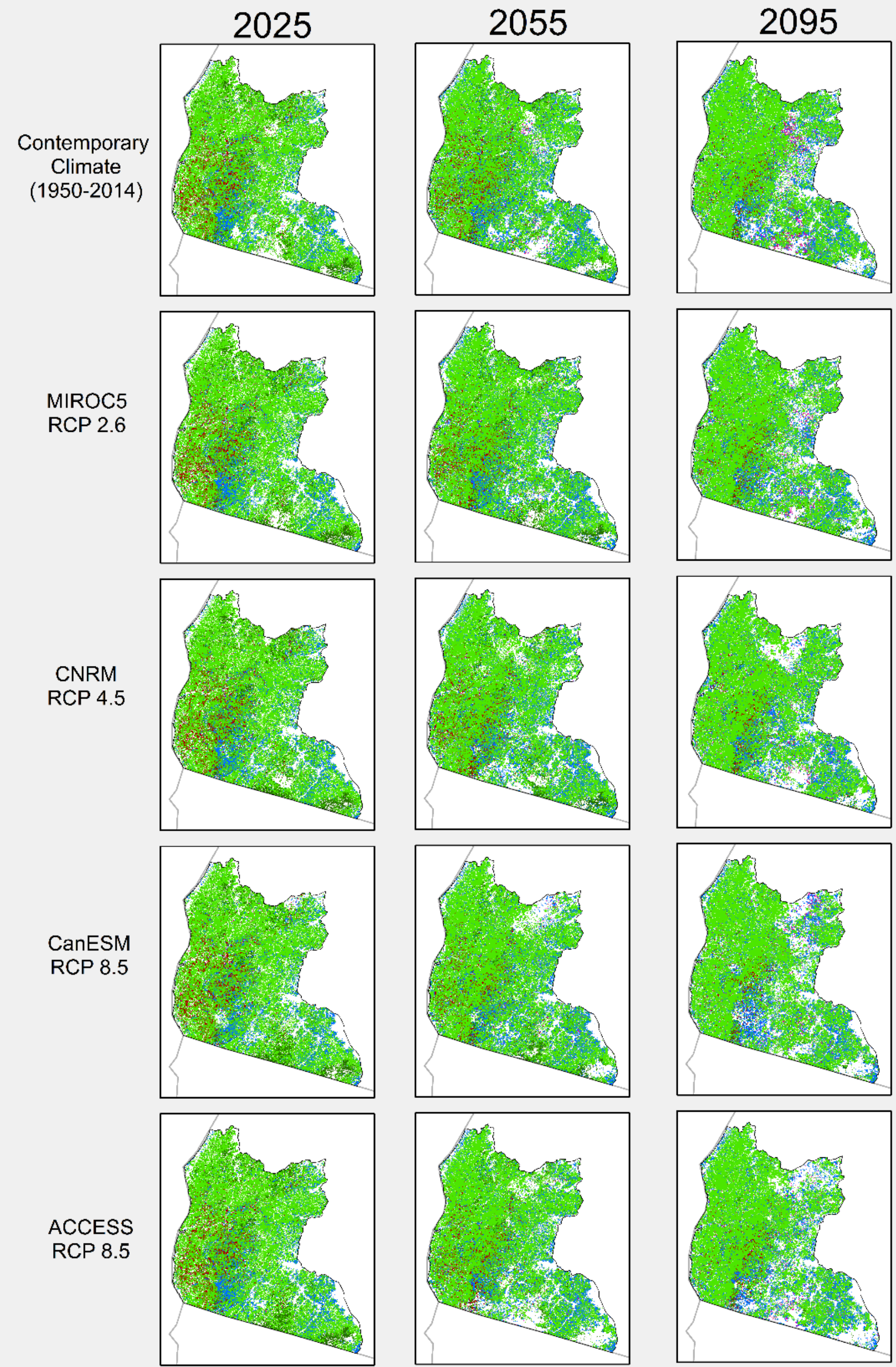
- Douglas-fir
- Incense cedar
- Tanoak

- But not white fir

Some dry forests may shift to woodlands or shrublands

Forest Cover Type:

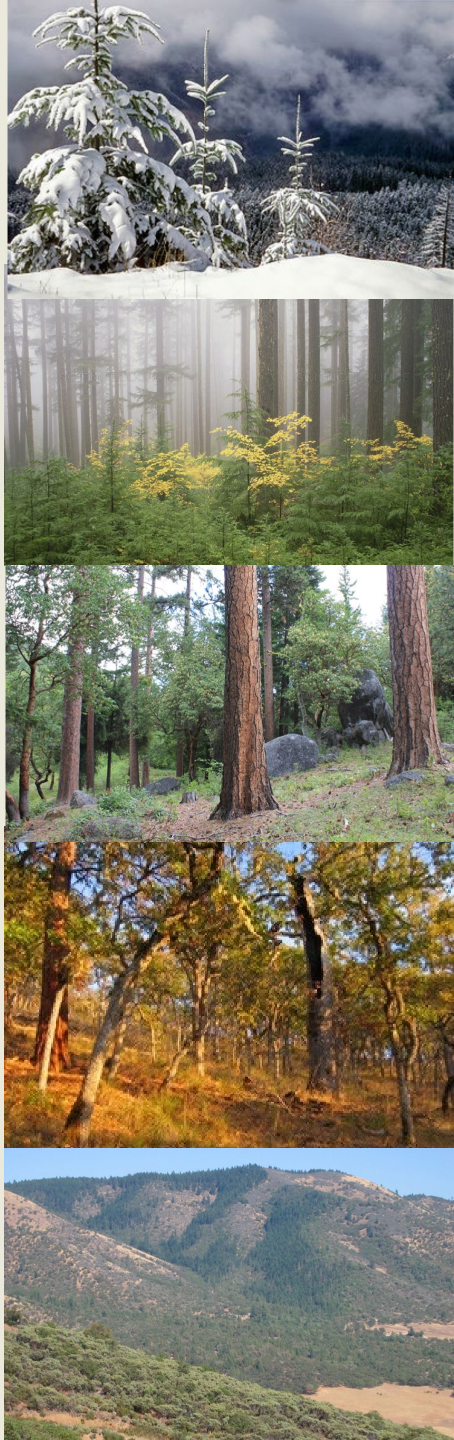
- Tanoak
- Klamath Mixed Conifer
- High Elevation Mixed Conifer
- Shrub, Chapparal, Hardwood
- Hardwood
- Other Shrub/Grassland



Chapparal/shrublands will likely expand in area with increasing moisture deficits and more frequent, high-severity fire

Southwest Oregon: Climate change and vegetation

- Expect more fire.
- Interaction among disturbances (e.g., drought, fire, insects and disease) will like drive vegetation change.
- Vegetation shifts are likely at the elevation extremes.
- There is potential for resilience to climate change in the region because of topographic heterogeneity and microclimates.



Climate change vulnerability: Greater area burned

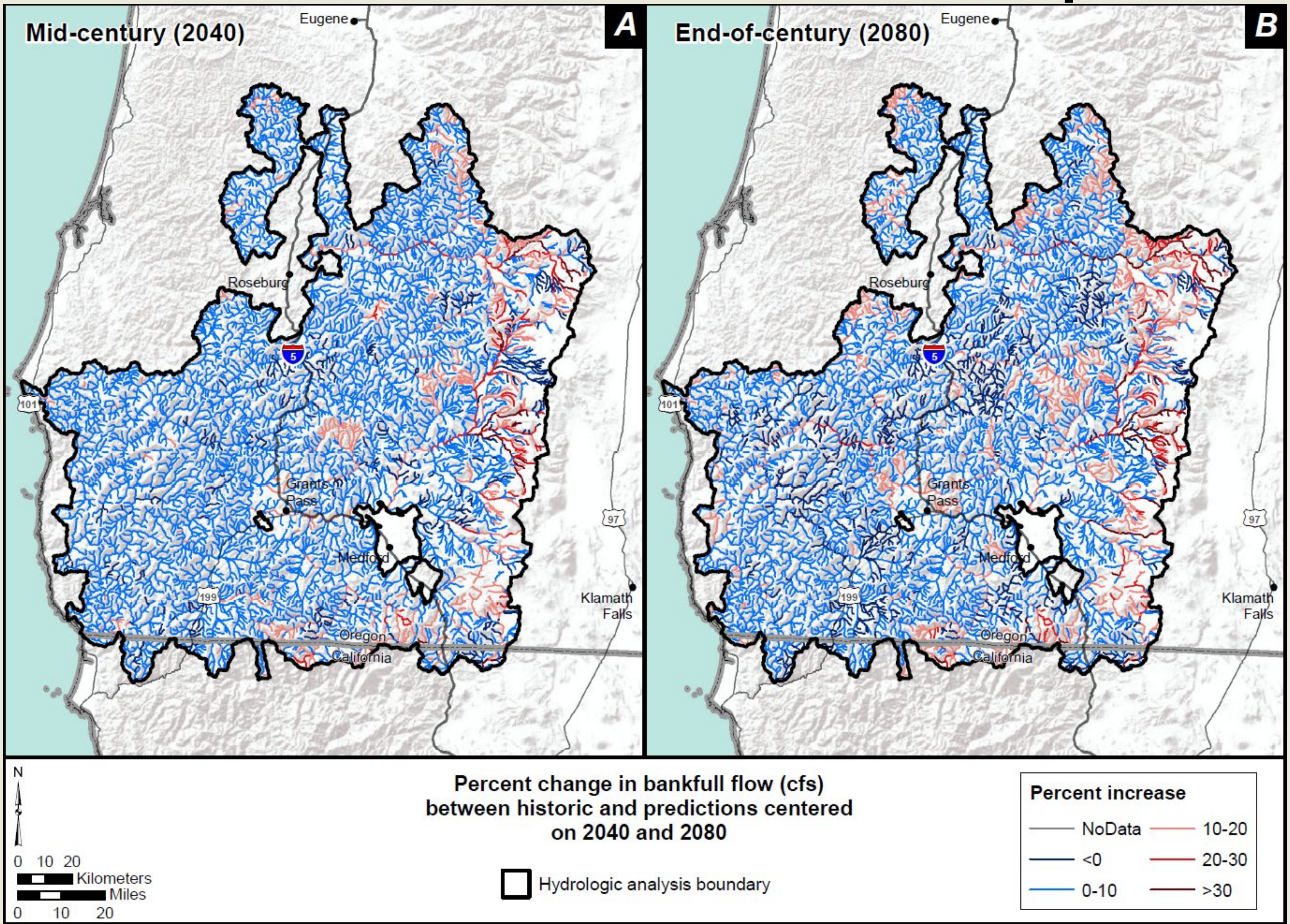
Adaptation strategy

- Increase resilience through post-fire management

Adaptation tactics

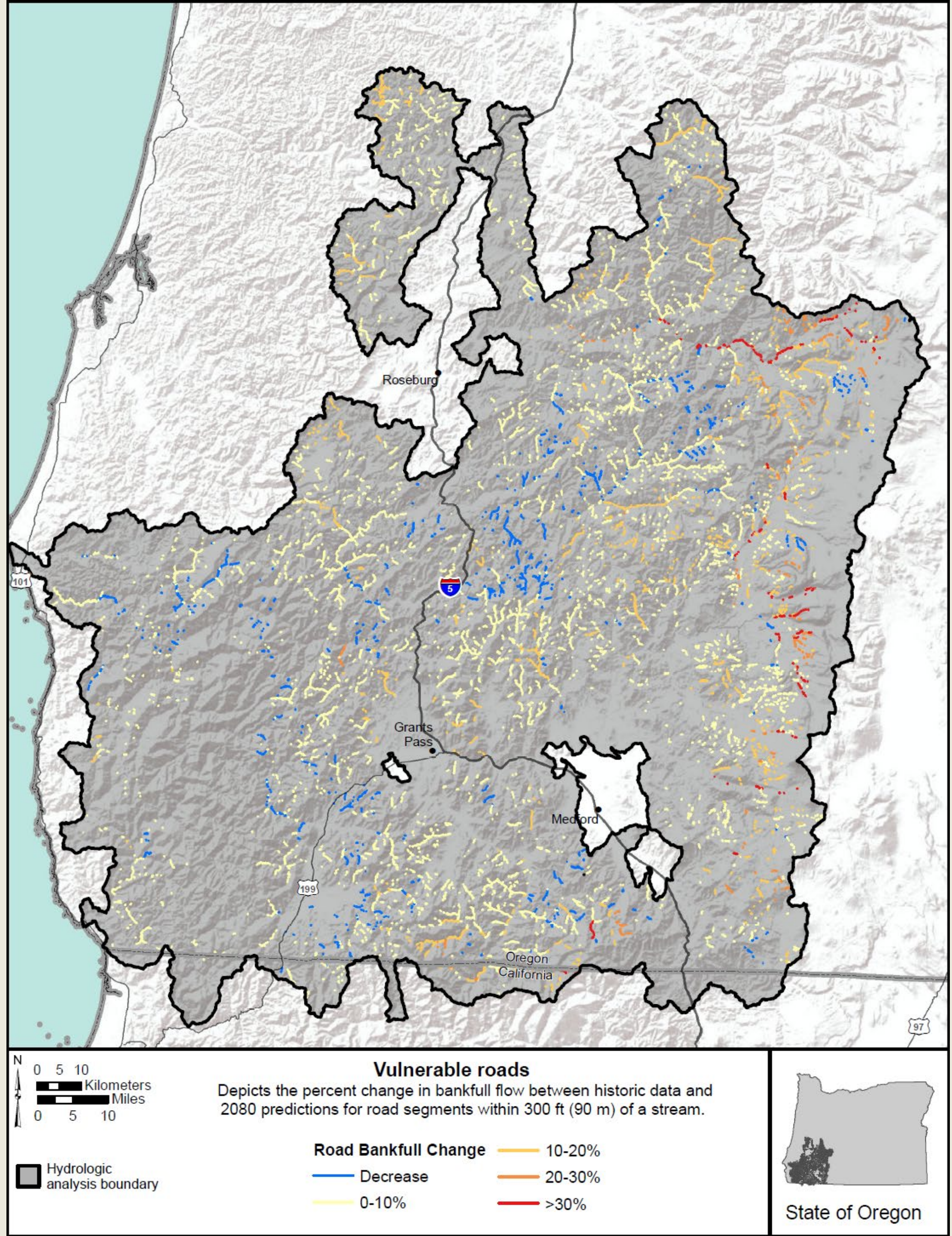
- Consider climate change in post-fire rehabilitation
- Determine where native seed may be needed for post-fire planting
- Anticipate greater need for seed sources and propagated plants
- Increase post-fire monitoring in areas not currently monitored.

Peak flow will increases in locations that shift from seasonal to intermittent snowpack



Vulnerable roads

- Vulnerable roads defined: roads or trails within 90 meters of a perennial stream
- Risks and concerns:
  - Increased flooding
  - Shallow landslides and debris flows
  - Right-sized culverts
  - Resilient bridges



Climate change vulnerability: Higher peak streamflows

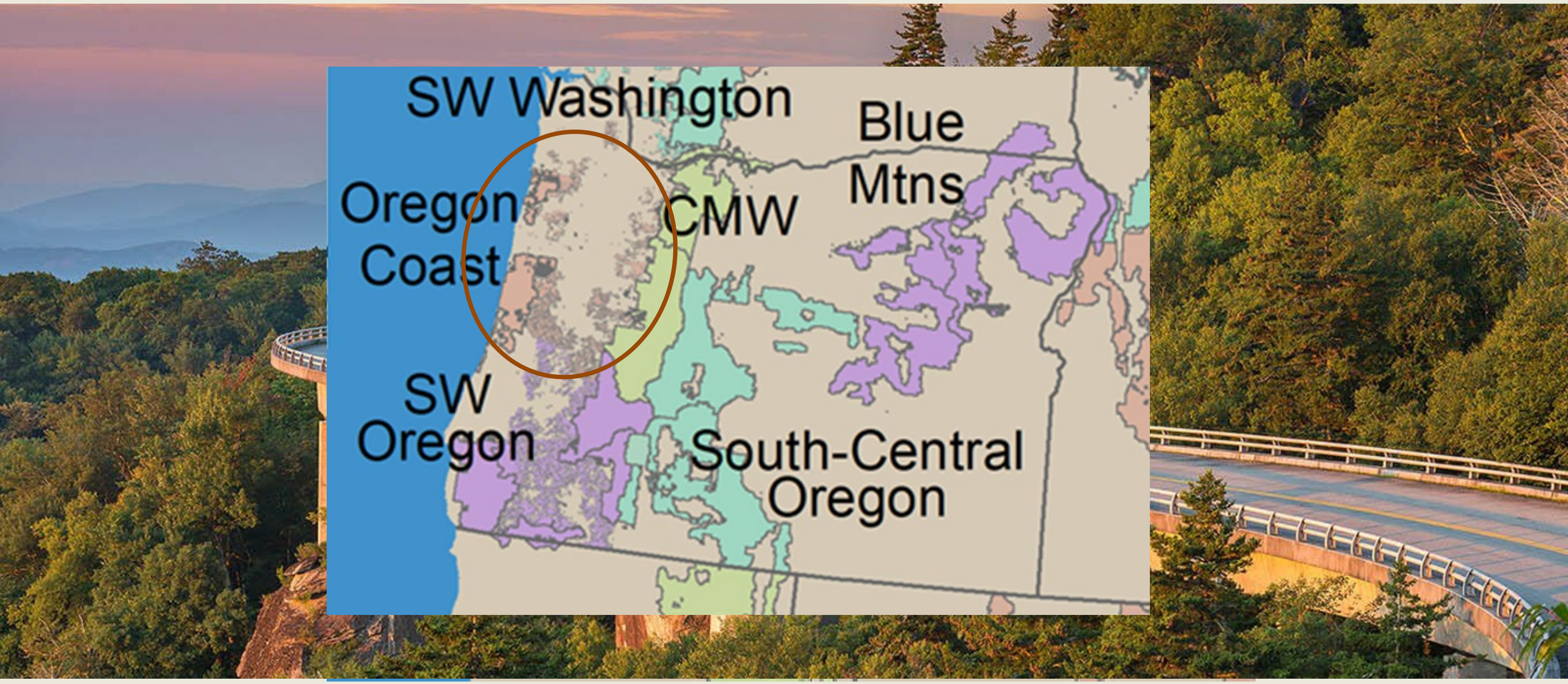
Adaptation strategy

- Design infrastructure to accommodate higher peak flows

Adaptation tactics

- Install larger culverts
- Decommission roads in floodplains
- Relocate campgrounds subject to flooding

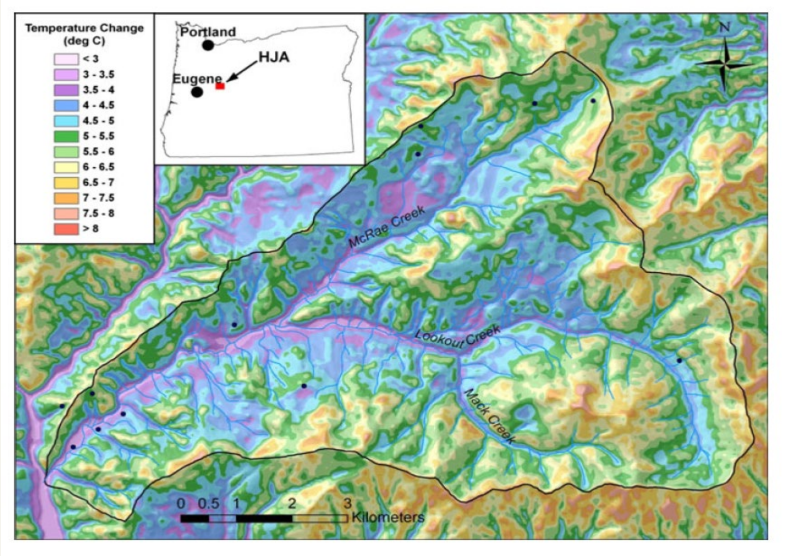
Oregon Road Trip



Moist forest vulnerabilities

- Douglas-fir will likely still be a dominant species
- Declines of shade-tolerant, late-successional conifers are likely
- Potential for refugia for these species in topographically sheltered sites and towards the north
- Increases in mixed forests farther inland

Climate refugia



Daly et al. 2010

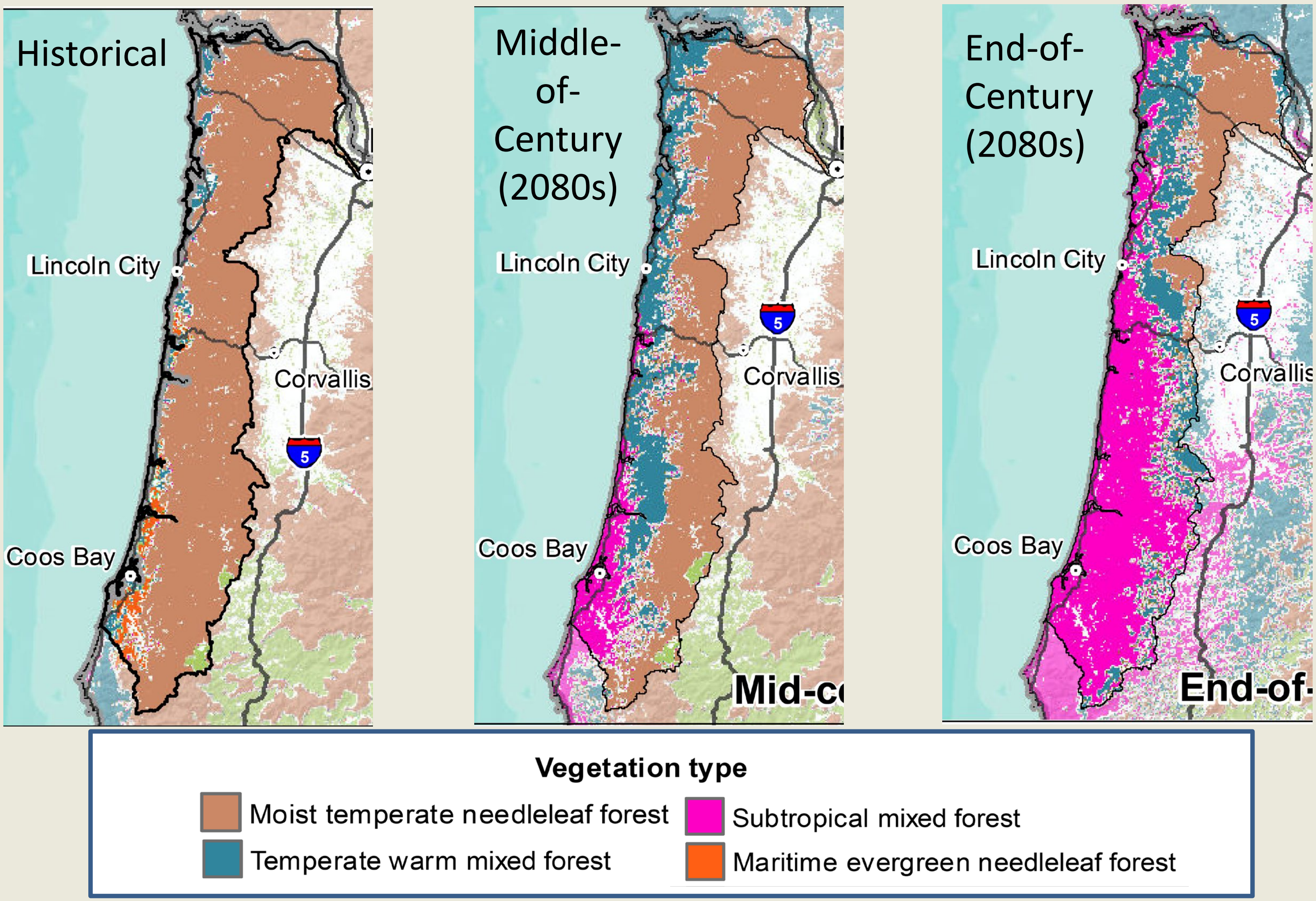
Moist forest vulnerabilities

- Loss of fog
- Reduced climate space for noble fir
- Swiss needle cast
- Changes in winter wind frequency
- Large, high-severity wildfires
- Non-native species

Dry forest vulnerabilities

- Douglas-fir will likely still be a dominant species
- Fire-mediated transitions towards mixed forests in inland landscapes to the south
- Forests may resemble those to the south in the Klamath Mountains

Projected vegetation change on the Oregon Coast



Effects of climate change on Oregon Coast forests

- Loss of fog is a major threat but is not yet well understood
- Increases in pathogen and insect activity during drought
- Persistence of Douglas-fir with potential for loss of late-seral tree species and increases in hardwood abundance
- Large, high-severity wildfires and short-interval reburns will likely be important mechanisms of ecological change
- Invasions of non-native species could alter disturbance regimes and threaten forests and special habitats

Climate adaptation options in forests with stand-replacing fire regimes

esa ECOSPHERE

INNOVATIVE VIEWPOINTS

The nature of the beast: examining climate adaptation options in forests with stand-replacing fire regimes

Joshua S. Halofsky,[1,†] Daniel C. Donato,[1,2] Jerry F. Franklin,[2] Jessica E. Halofsky,[2] David L. Peterson,[3] and Brian J. Harvey[2]

- Big events are part of the system
- Pre-disturbance climate adaptation management options are relatively few, or ineffective (e.g., fuel management)
- Fire suppression may be a reasonable strategy (in these systems)
- Key: Have post-disturbance plans in place

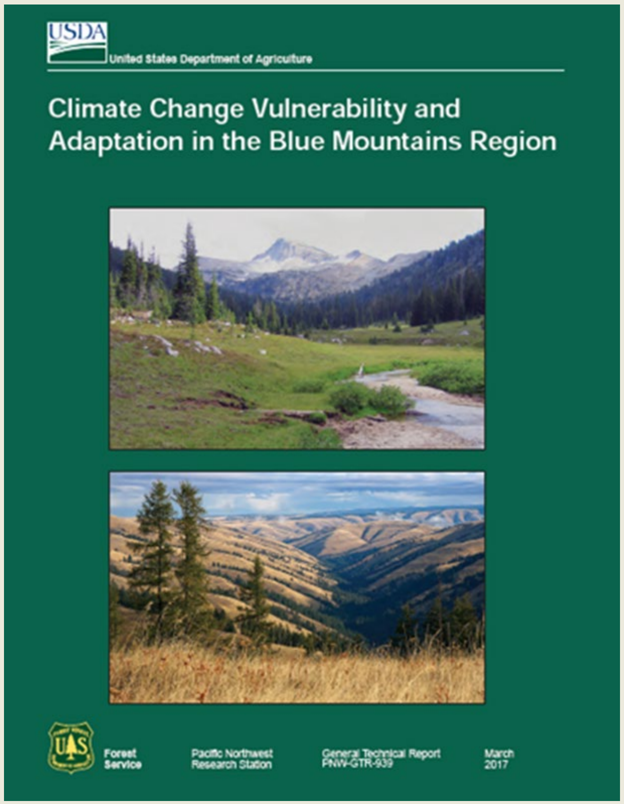
What do you do after a fire?

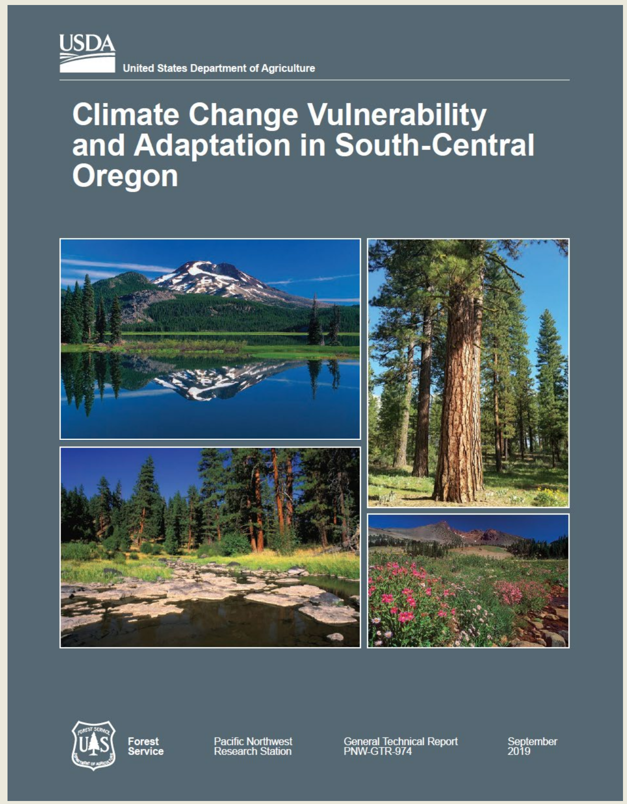
Post-fire management options
Leverage natural regeneration — inexpensive, diverse, can't replant everywhere
Promote species diversity within and across stands when planting, especially hardwoods
Promote structural diversity within and across stands when feasible
Coordinate post-fire activities with adjacent landowners/managers
Use events as learning opportunities (research, monitoring, trials, adaptive management)

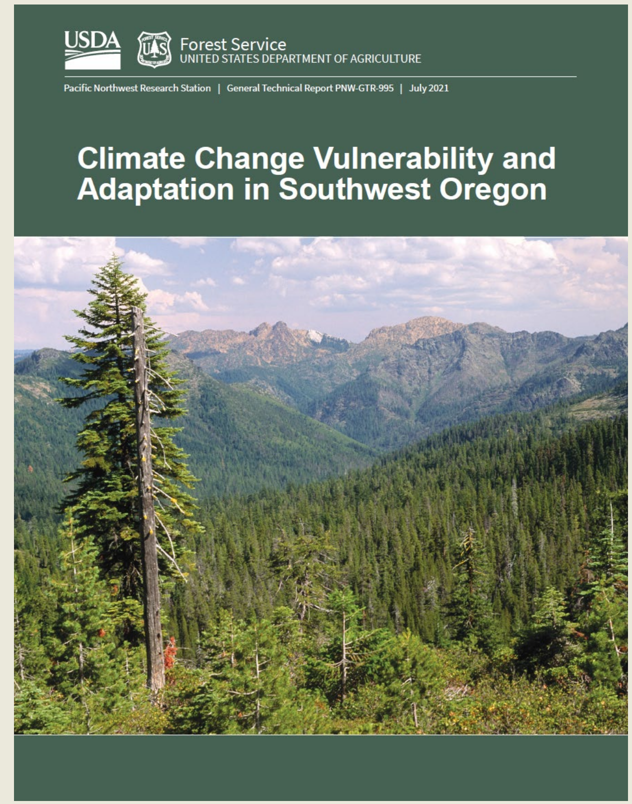
Halofsky et al. 2018

Products

Best available science to inform "climate-smart" decisions







http://adaptationpartners.org

The Climate Change Adaptation Library

http://www.adaptationpartners.org/library.php

CLIMATE CHANGE ADAPTATION LIBRARY FOR THE WESTERN UNITED STATES

Climate Change
ADAPTATION
Library

Information in the Library is derived from climate change vulnerability assessments conducted by Adaptation Partners (adaptationpartners.org), which collaborates with a diversity of organizations and stakeholders to develop multi-resource assessments. A science-management partnership including research scientists and natural resource specialists provides a foundation for all projects. Adaptation options are intended to inform sustainable management of natural resources, reduce the negative effects of climate change, transition ecosystems to a warmer climate, and help integrate climate change in natural resource management, planning, and business operations of federal land management agencies.

Adaptation Partners has elicited expertise on management responses to climate change from land managers in the U.S. Forest Service, National Park Service, and other organizations throughout the western United States. Specifically, adaptation options in the Library were developed by resource specialists during workshops convened to examine climate change vulnerability assessments. These climate change adaptation actions are organized by categories of 1) sensitivity to a particular climate change effect, 2) corresponding strategies to mitigate the impacts of this climate change effect, and 3) specific tactical actions that can take place as an implementation of that particular strategy. We have also provided citations of general technical reports that either originated or include these strategies and tactics.

Adaptation Partners Library | AP Library References

Download Entire Library (MS Excel) (Updated 11/2019)

Filter summaries by:

USFS Region [Map]

- ☐ Region 1: Northern
- ☐ Region 2: Rocky Mountain
- ☐ Region 3: Southwestern
- ☐ Region 4: Intermountain
- ☐ Region 5: Pacific Southwest
- ☐ Region 6: Pacific Northwest
- ☐ Region 10: Alaska

Resource Area

- ☐ Cultural
- ☐ Ecosystem Services
- ☐ Fish
- ☐ Forest Vegetation
- ☐ Non-Forest Vegetation
- ☐ Recreation
- ☐ Riparian Areas/Wetlands/GDEs
- ☐ Soils
- ☐ Water Resources/Infrastructure
- ☐ Wildlife

Climate Change Effect

- Altered distribution and abundance of fish species
- Altered distribution and abundance of plant species
- Altered distribution and abundance of wildlife species
- Altered hydrologic regime
- Altered precipitation patterns
- Changes in ecosystem services
- Changes in phenology
- Changing fish habitat suitability
- Changing habitat suitability
- Changing plant habitat suitability
- Changing wildlife habitat suitability
- Enhanced disturbance

Keyword

- Alpine
- Aquatic
- Aspen
- Beavers
- Beetles
- Biodiversity
- Birds
- Bridges
- Campgrounds
- Carbon
- Conifers
- Connectivity

APPLY FILTER | RESET

Showing all 161 sensitivities, across all categories.

Jump to resource:

Cultural | Ecosystem Services | Fish | Forest Vegetation | Non-Forest Vegetation | Recreation | Riparian Areas/Wetlands/GDEs | Soils | Water Resources/Infrastructure | Wildlife

Resource Area: Cultural

Sensitivity: Climate change adaptation management for other resources may affect cultural resources.

Applications

- National Forest plan revisions

- Environmental assessments (NEPA)

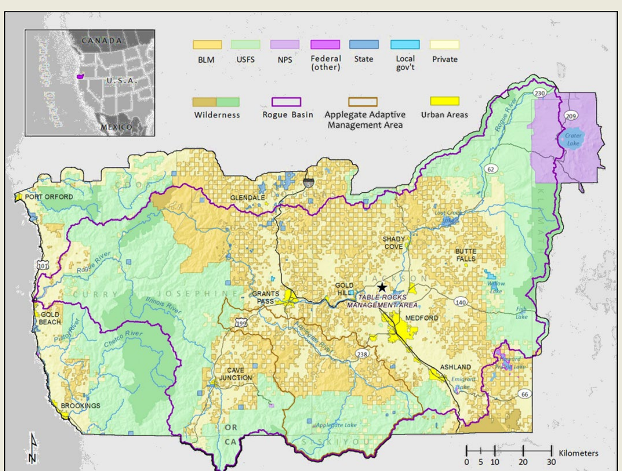
- Local management projects

- Restoration planning

- Monitoring programs

Climate change and vegetation management

- Rogue River-Siskiyou National Forest and Bureau of Land Management considered a vulnerability assessment in project planning for a jointly-managed unit in southwestern Oregon.
- Modification to project activities include:
  - Increasing thinning in dry forests and woodlands, particularly in wildland-urban interface
  - Protecting wildlife habitat structures from fire



Thank you

Jessica.Halofsky@usda.gov

https://www.climatehubs.usda.gov/hubs/northwest

https://www.fs.fed.us/wwetac/

http://adaptationpartners.org/