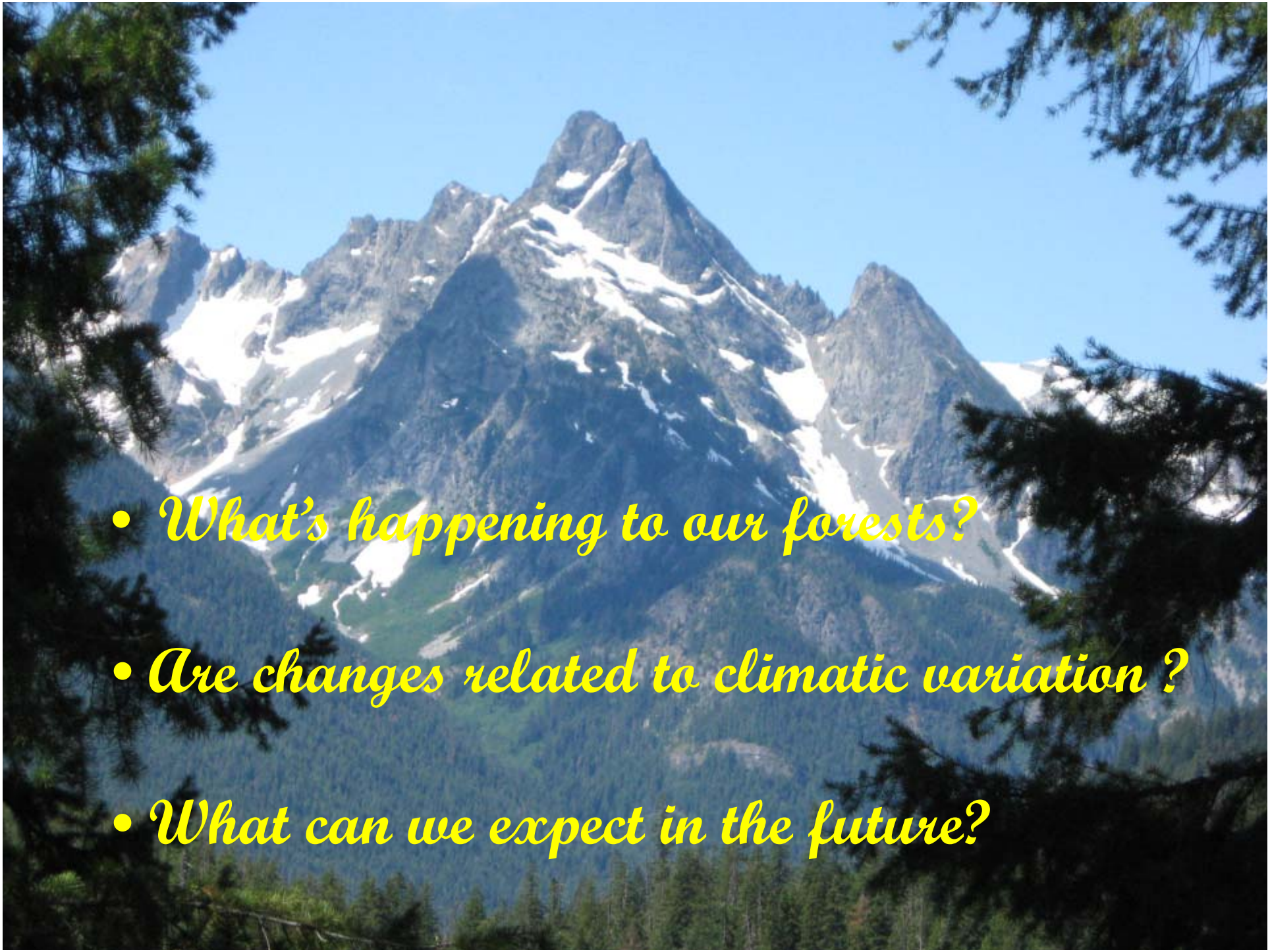
What's the World Coming to?
Climate Change in the Pacific Northwest

Richard Waring

Oregon State University

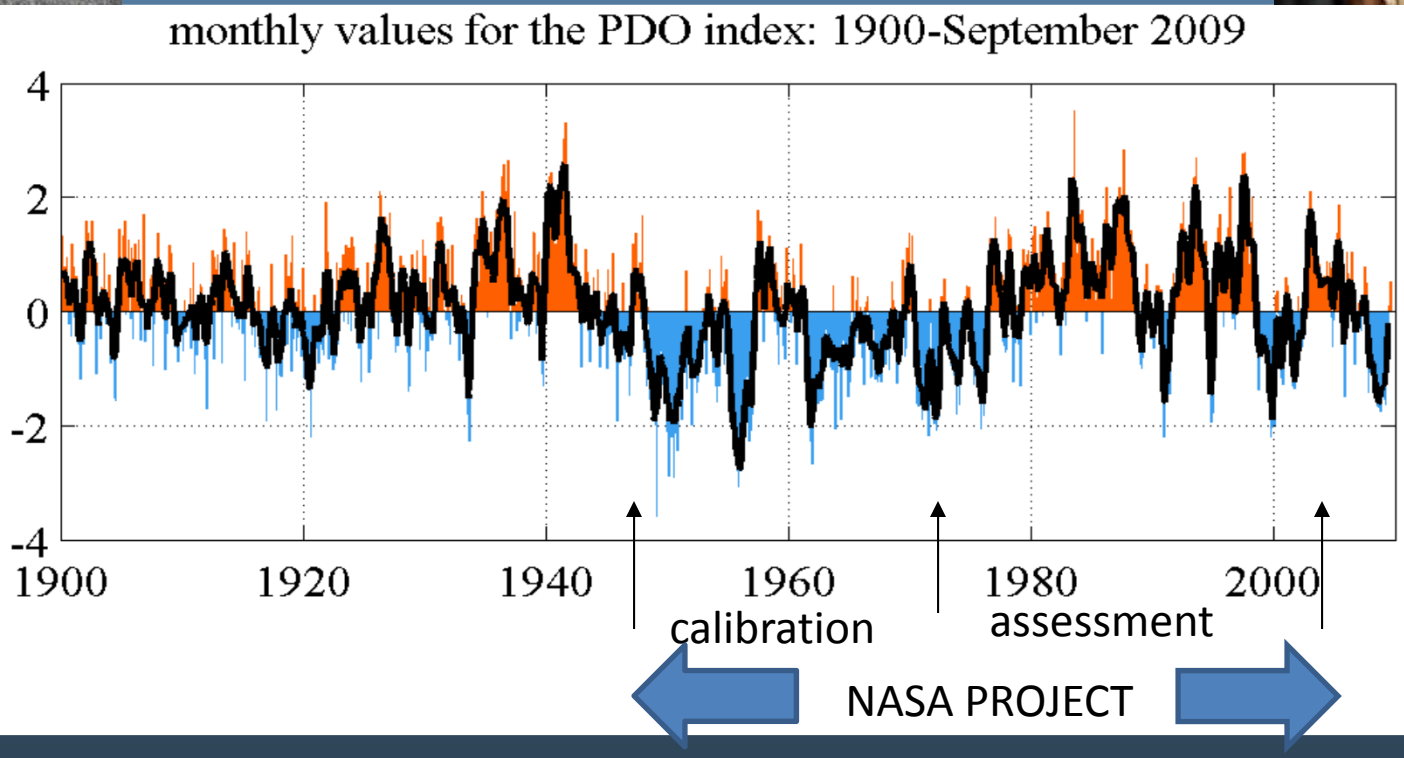


- What's happening to our forests?
- Are changes related to climatic variation ?
- What can we expect in the future?

Times, they are a changing!

1964

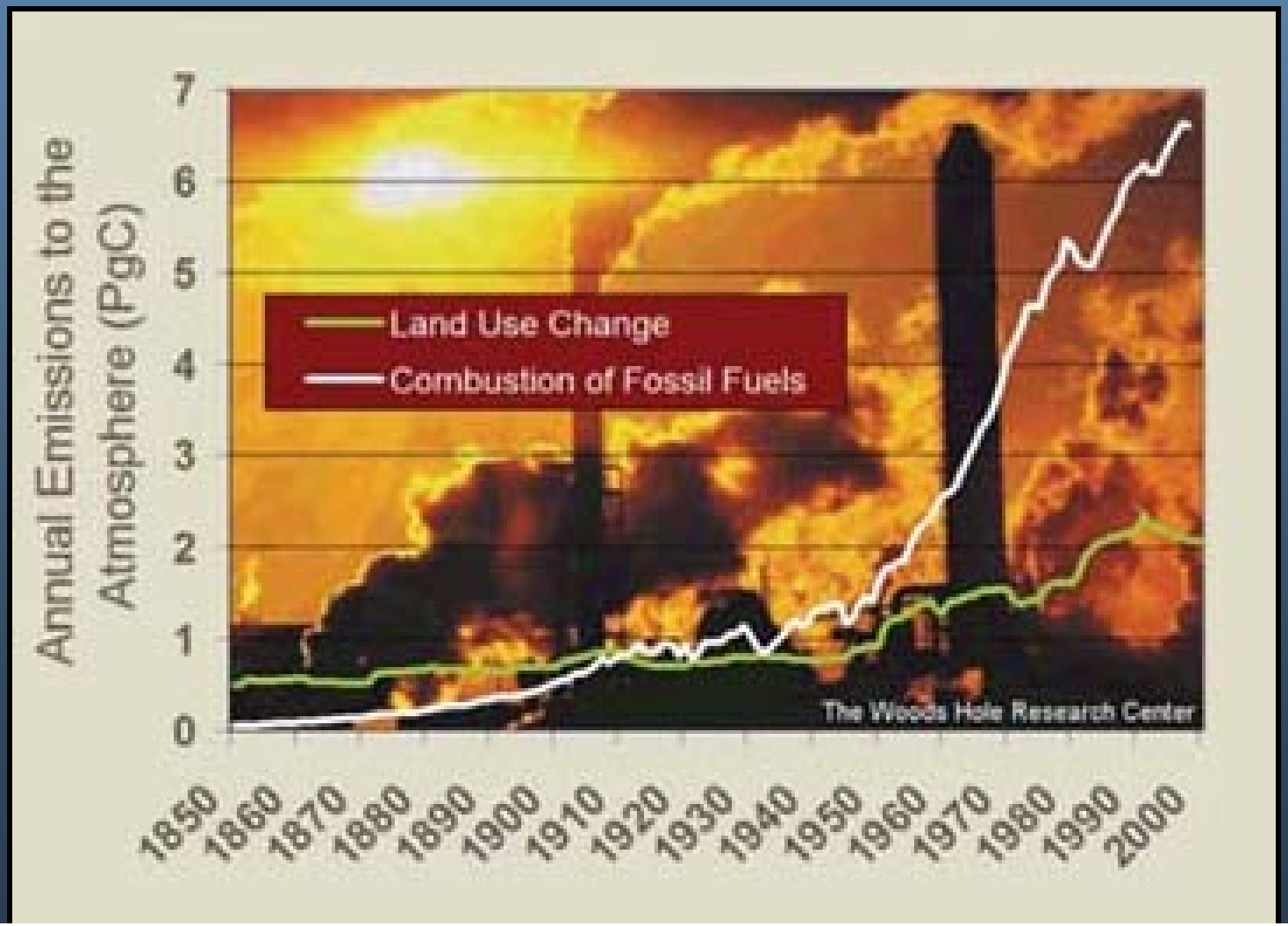
2010



Pacific Decadal Oscillations

warm and cool phases

Background: Since 1975, a significant part of climatic variation is associated with increased fossil fuel consumption and changes in land use



What's happening in western forests?

Since 2000, unprecedented amount of disturbance in British Columbia

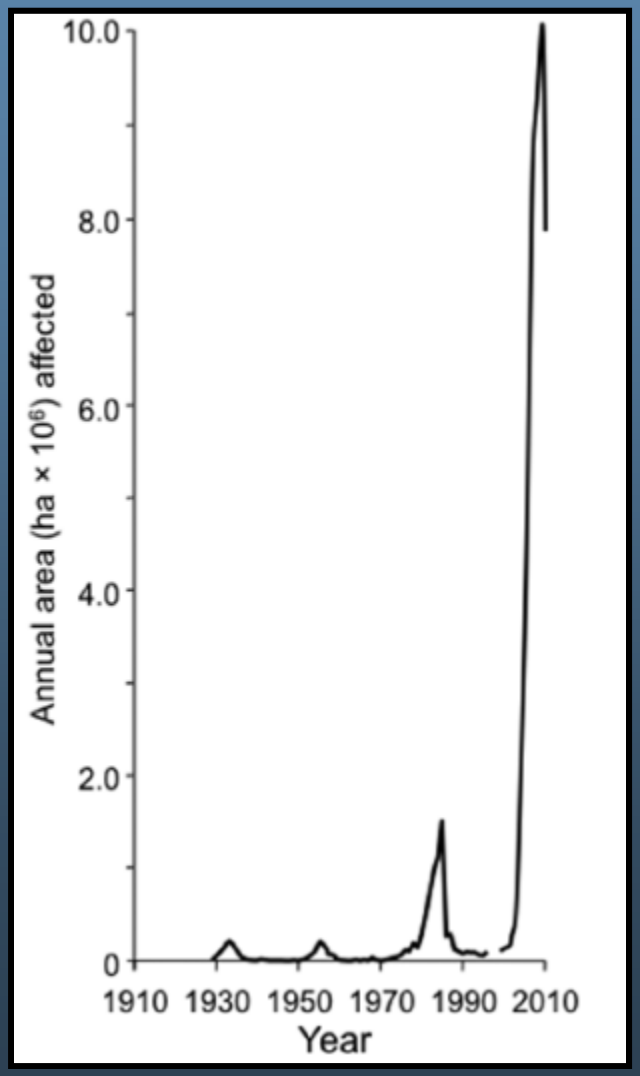
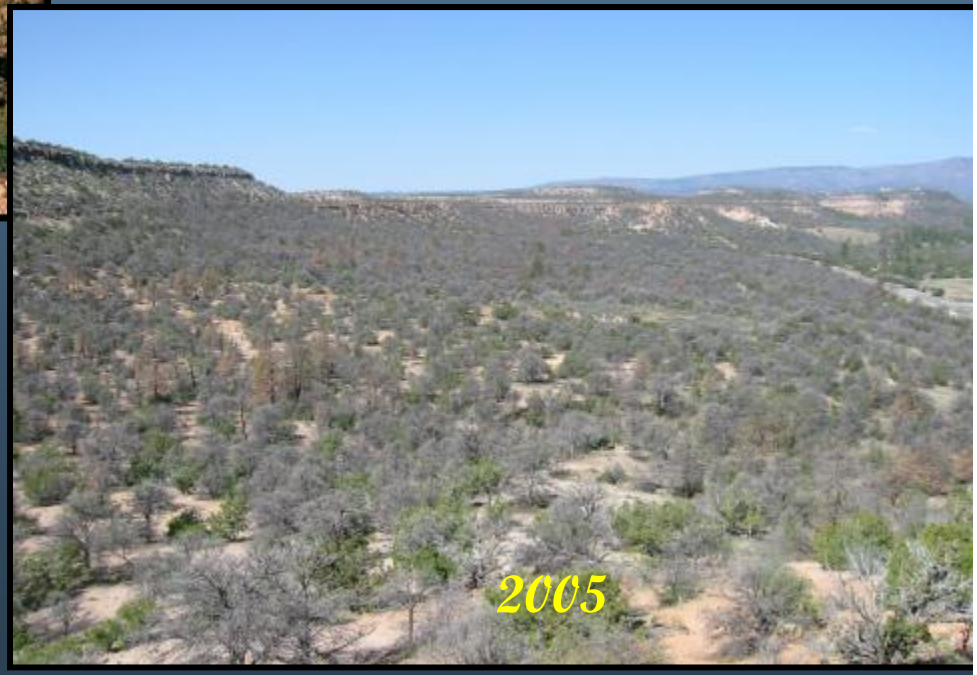


Photo from National Resources Canada, Forest Service

17% of the aspen are dying in Colorado

Photo by Phil Kemp, U.S. Forest Service, S.J. National Forest

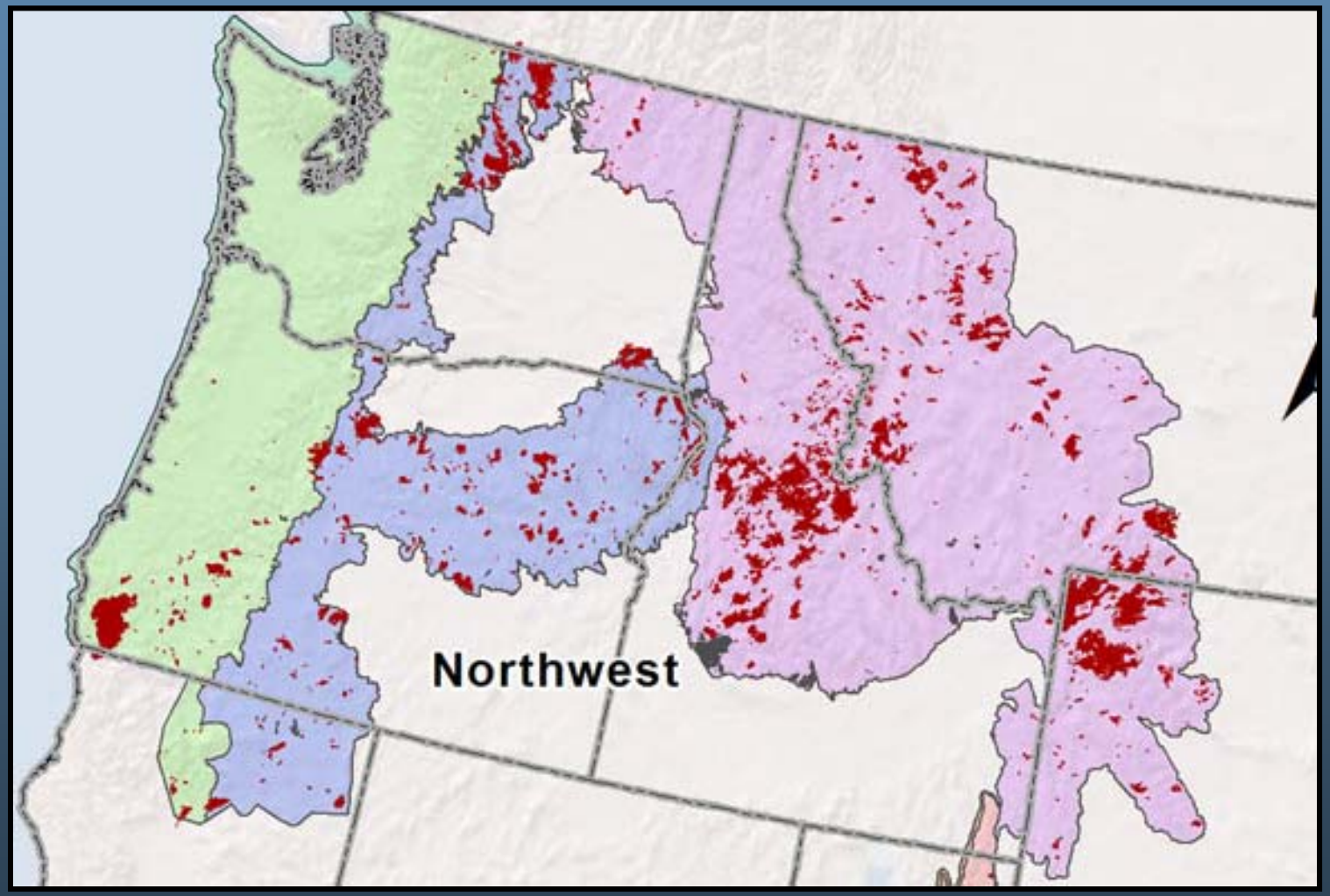
Three million acres of Pinyon Pine died in the Southwest since 2000



Photos: Craig D. Allen, USGS

Little disturbance in Oregon and Washington west of the Cascade crest

Conclude: Increase in disturbance by insects, disease and fire

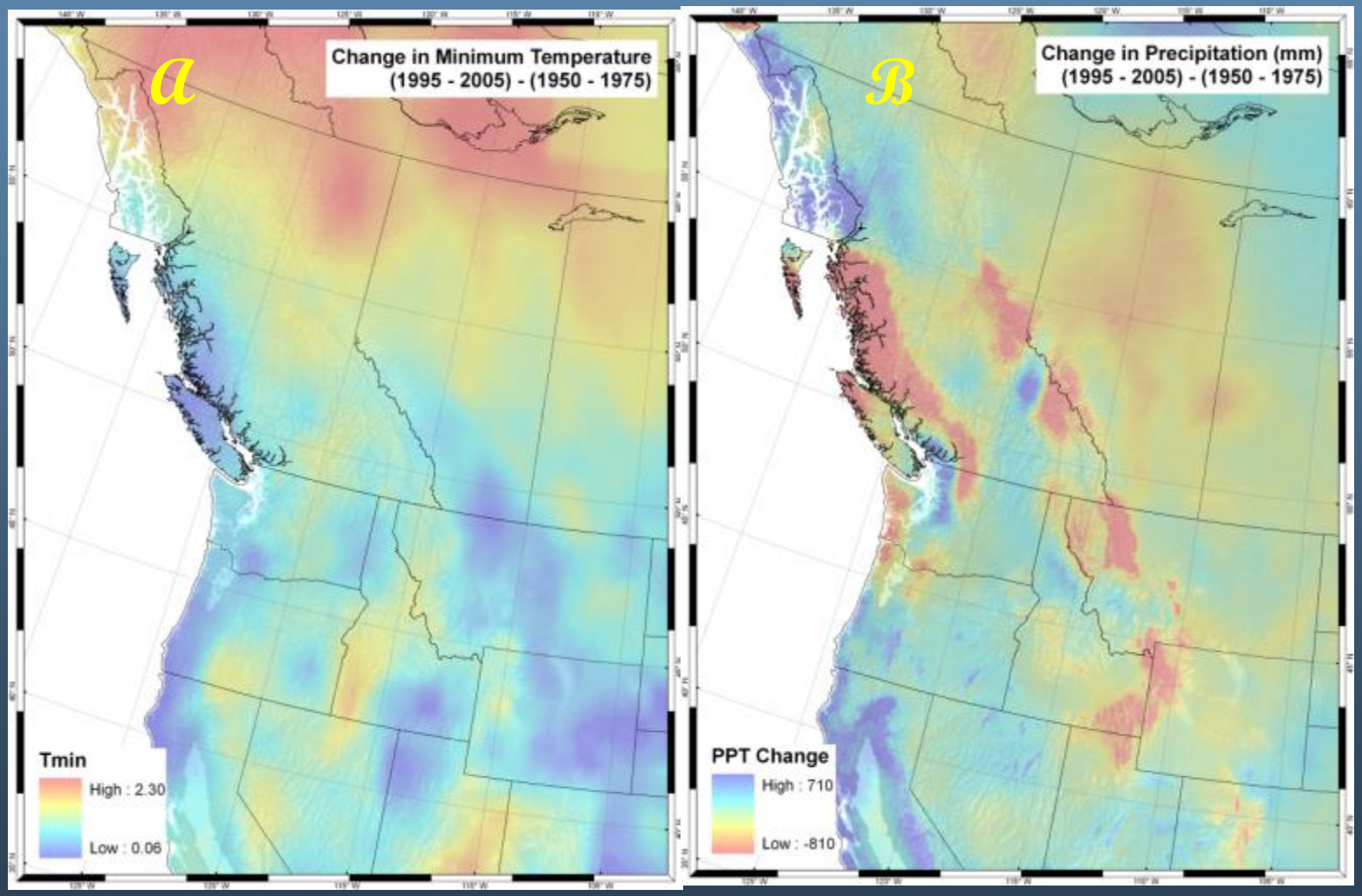


Dillon and others 2011 Ecosphere 2: 1-33

Do patterns in disturbance

match variation in climate ?

Possibly, big changes noted recently in temperature (A) and precipitation patterns (B)

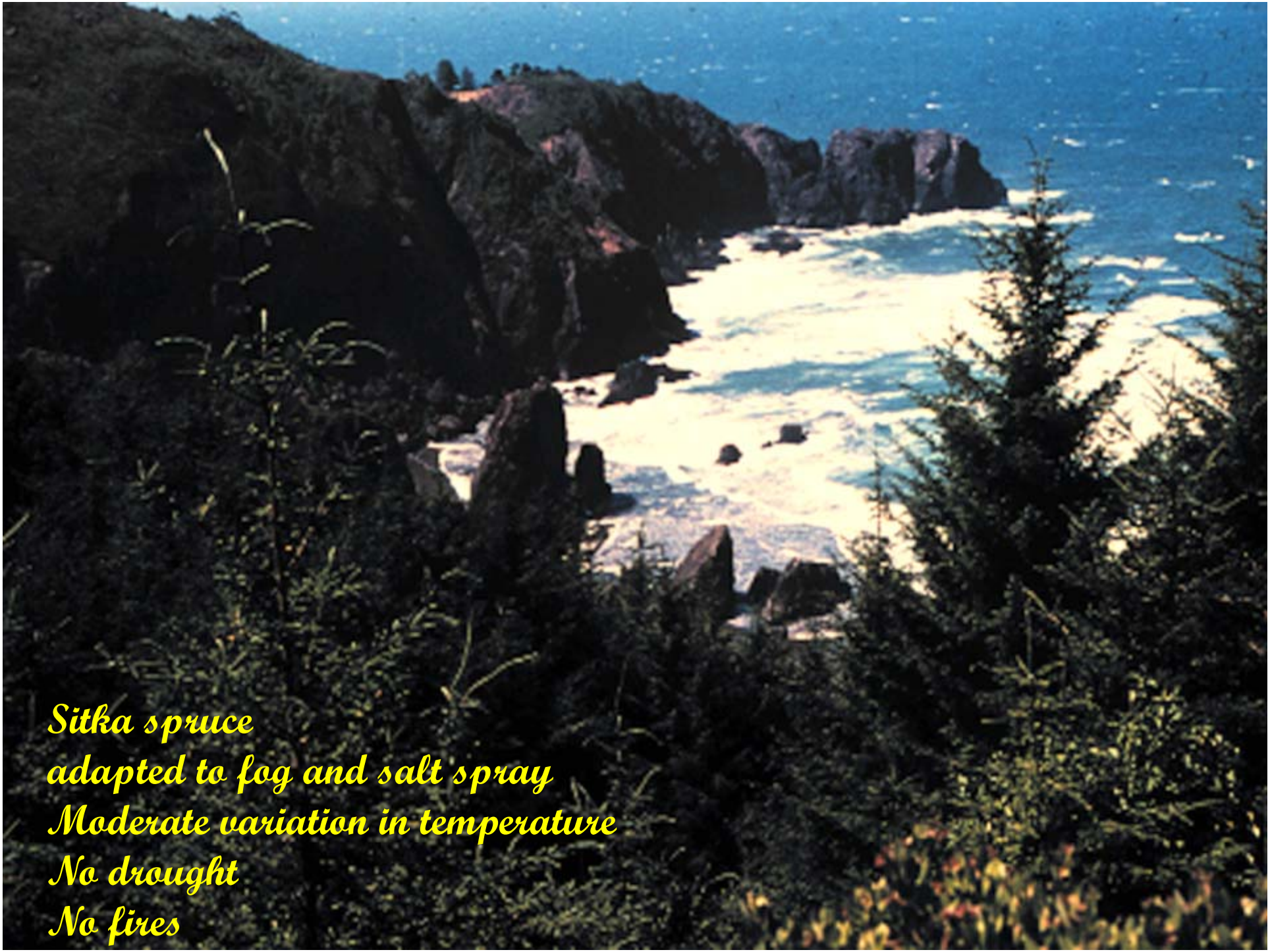


Waring, Coops & Running. 2011. Remote Sensing of Environment 115:3554-3566

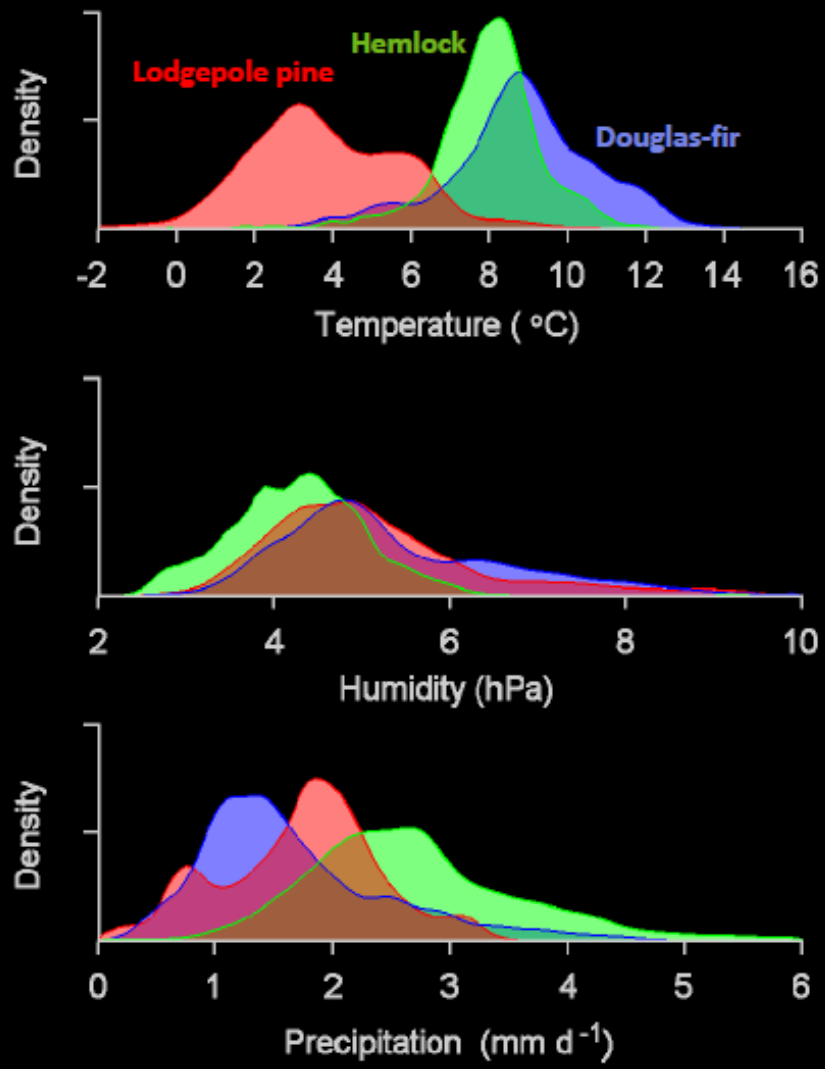
How do we relate tree distribution to climate?

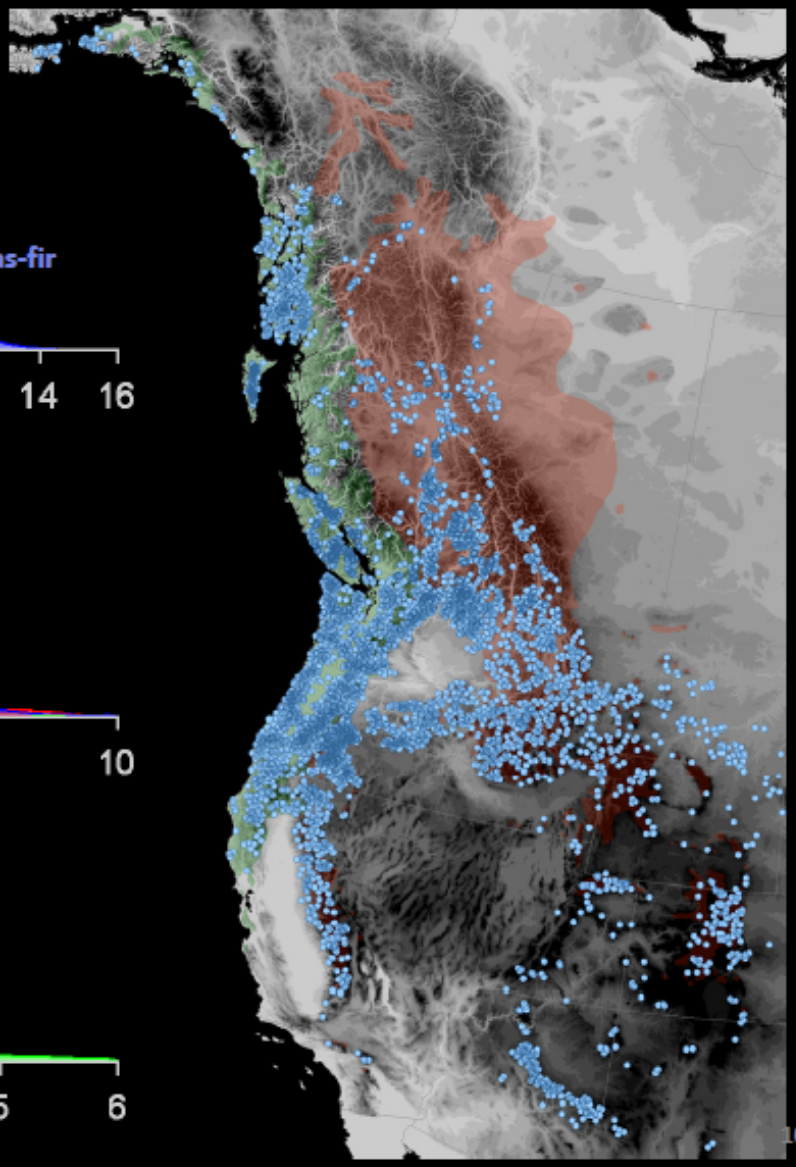
First, we recognize that tree species occupy different niches


Ponderosa pine
adapted to little snow
warm temperatures
drought
fires


Sitka spruce
adapted to fog and salt spray
Moderate variation in temperature
No drought
No fires

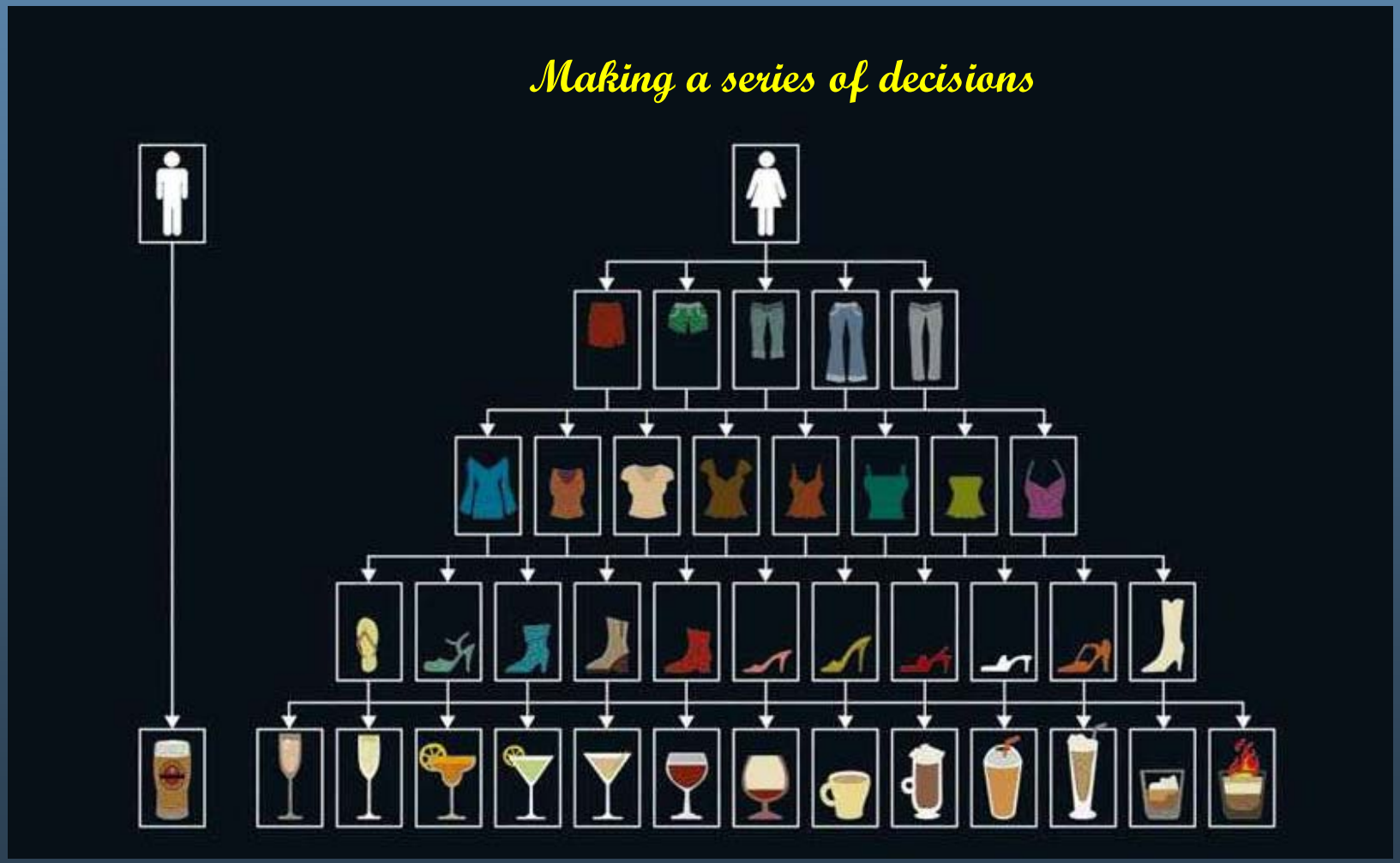
Study Area & Data



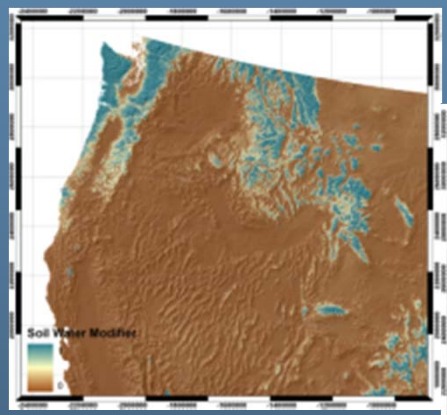


Robbie Andrew Hember , Post-Doctoral Fellow, Univ. of British Columbia

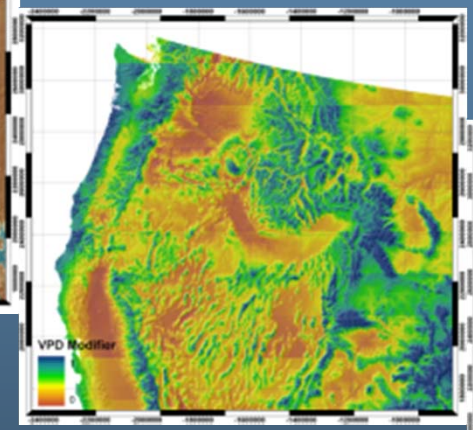
Need to develop models to predict where a species is likely to be found. This is similar to predicting the kind of clothing a person will wear in reference to his/her choice of drinks



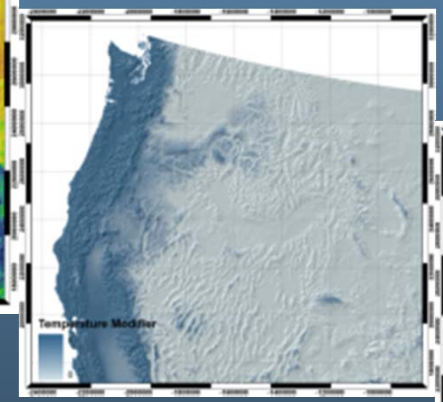
Recognize that environmental constraints vary seasonally and spatially



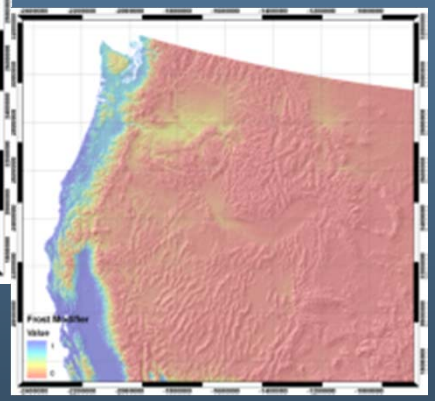
soil water



evaporative demand



suboptimal temperature



Frost limitations

Autumn

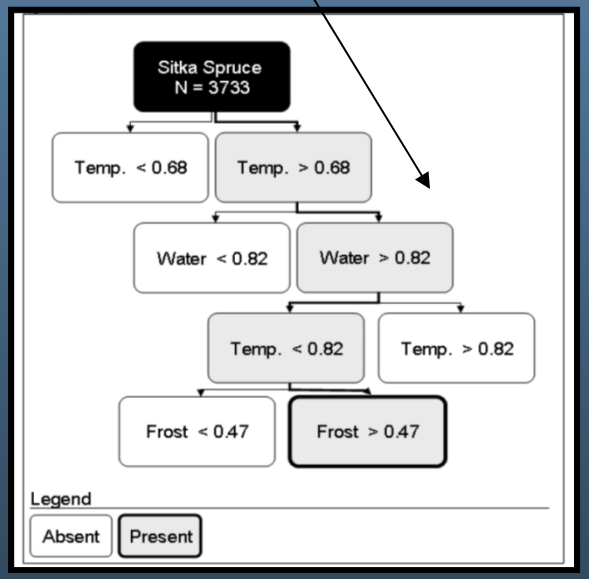
Summer

Winter

Spring

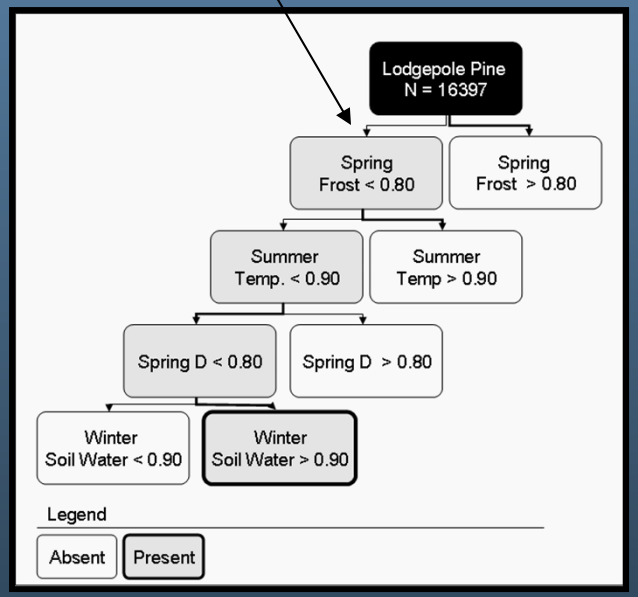
We can model how species differ from one another in reference the environmental distribution of Douglas-fir, the most widely distributed tree species in the West

More drought adverse



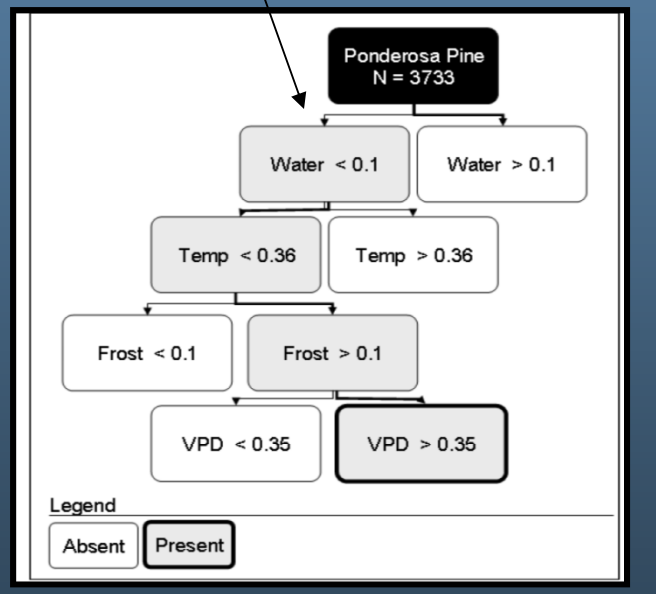
Sitka spruce

More frost tolerant



Lodgepole pine

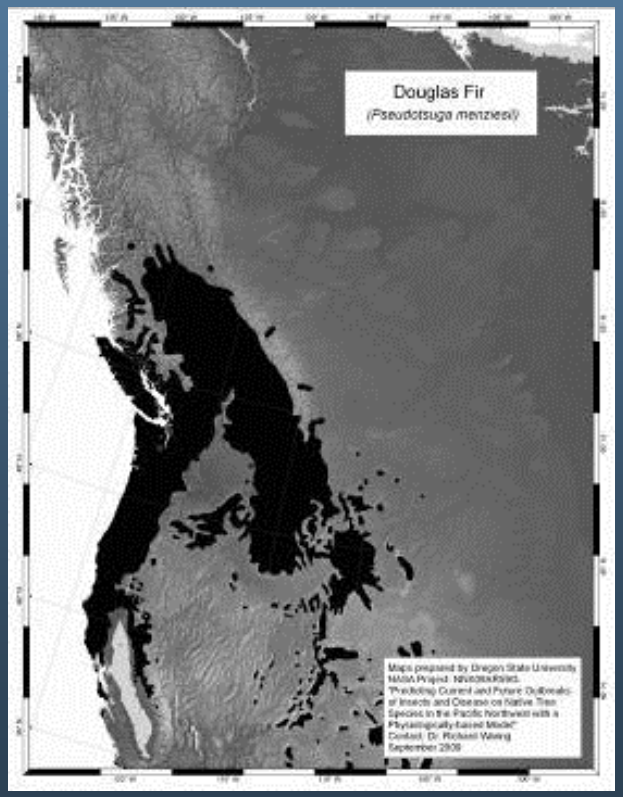
More drought tolerant



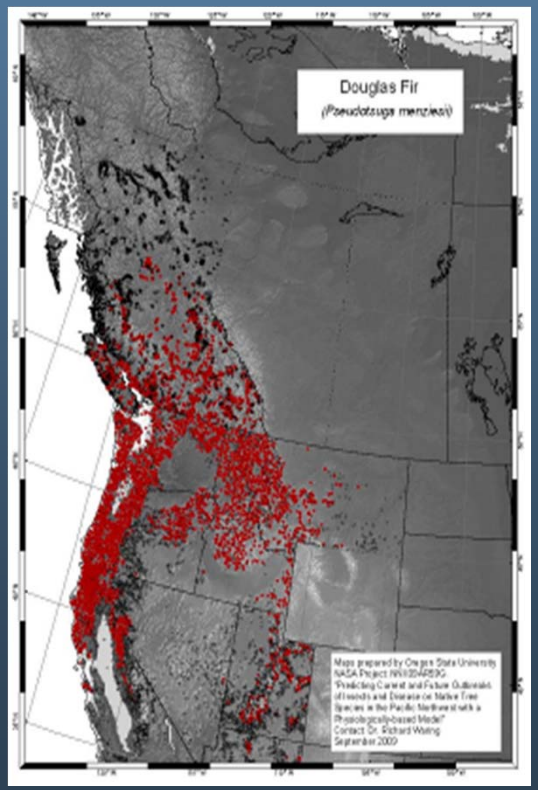
Ponderosa pine

Models work well to predict the recorded distribution of Douglas-fir on 22,771 permanent field plots based on climatic conditions (1950-1975).

General range map



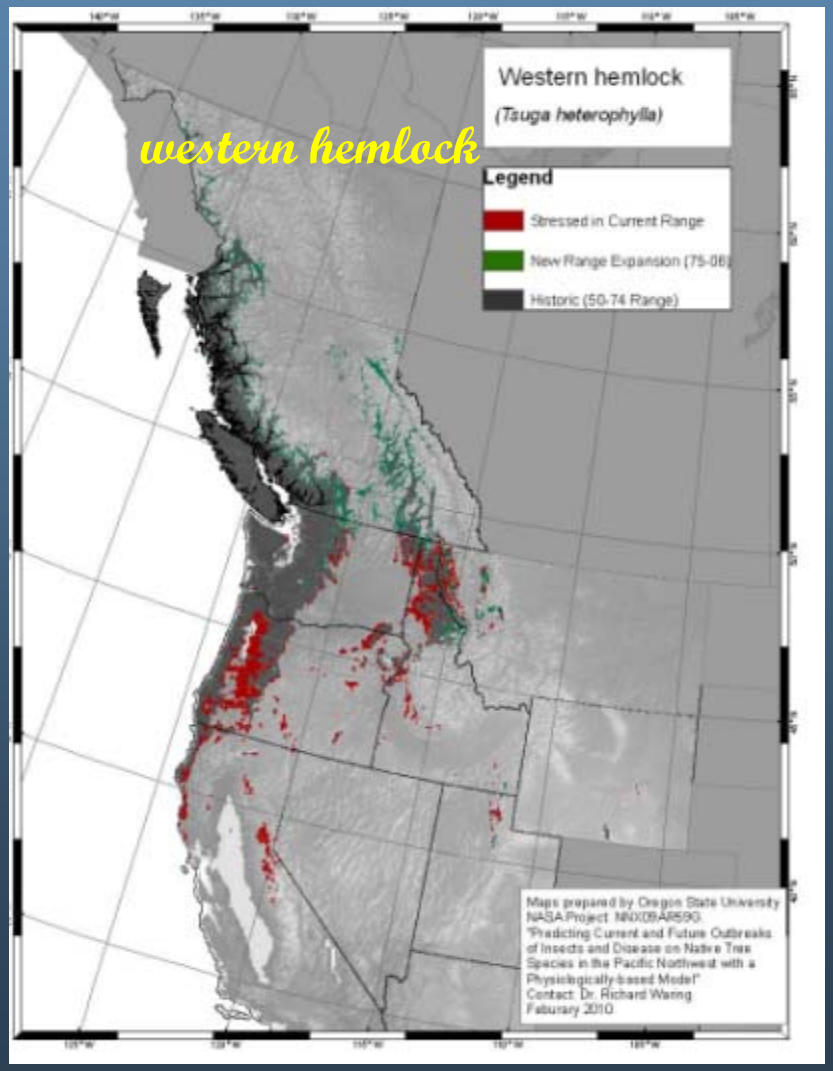
field records:
present (red),
absent (black)

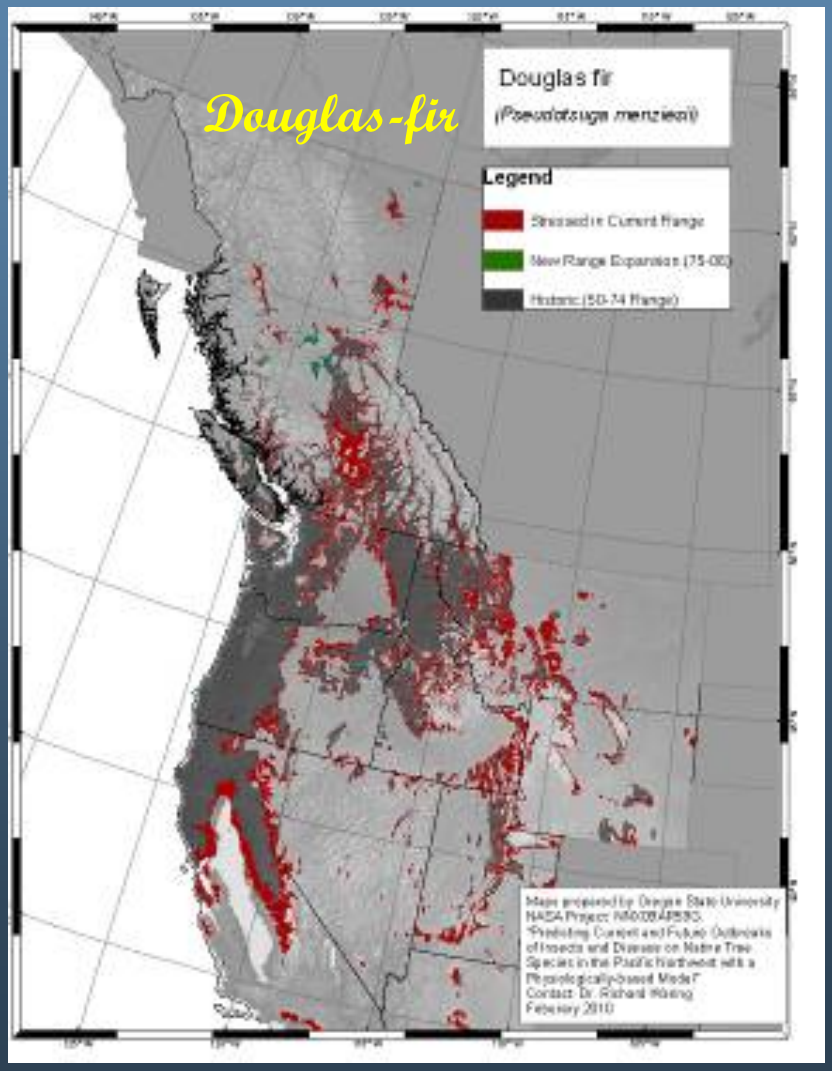


Predicted range based on average climatic conditions 1950-75

Coops & others. 2011. Applied Vegetation Science

The same models predict that climatic conditions have changed sufficiently to increase the probability of range contraction (red) or expansion (green) for some species

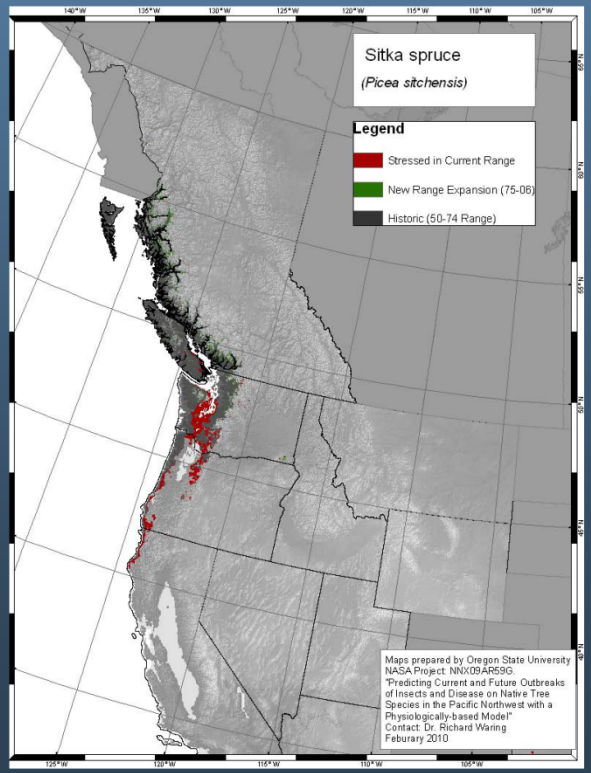




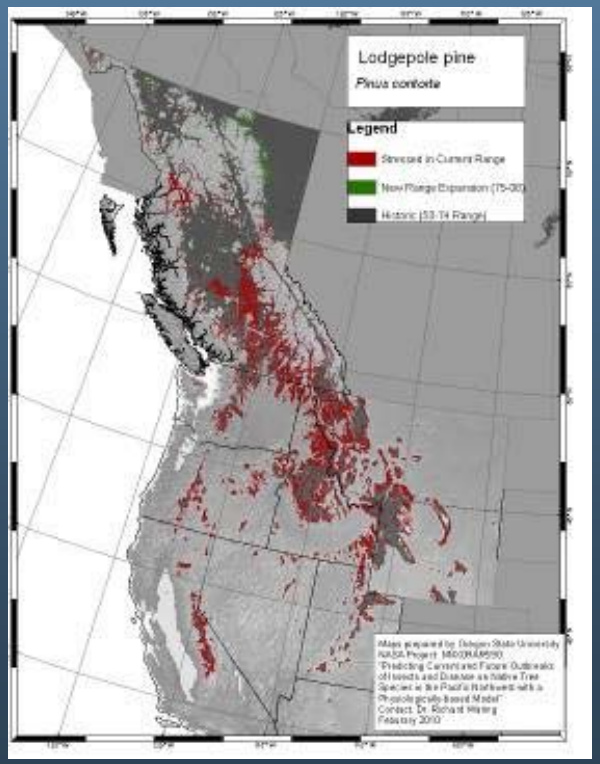
http://www.pnwspecieschange.info/

Areas where the distributions of many species are predicted to change represent flash-points for major disturbances

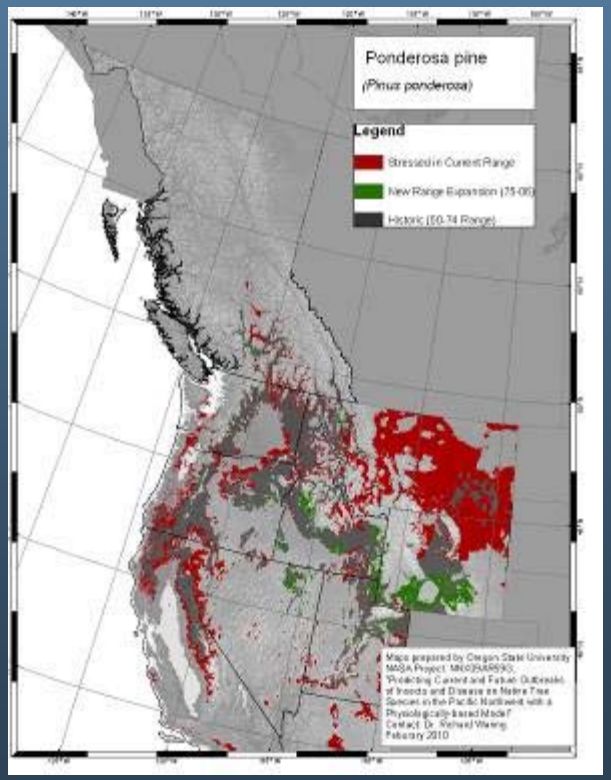
Sitka spruce



Lodgepole pine



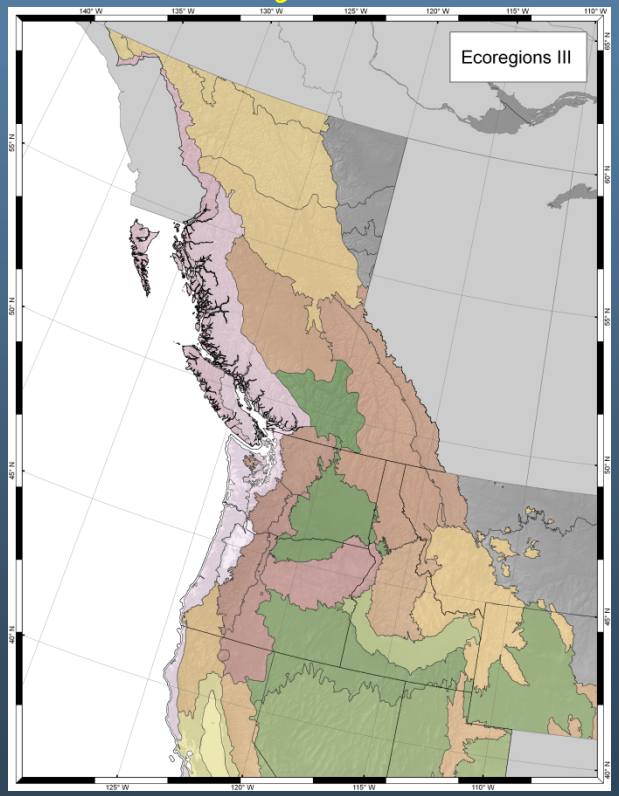
Ponderosa pine



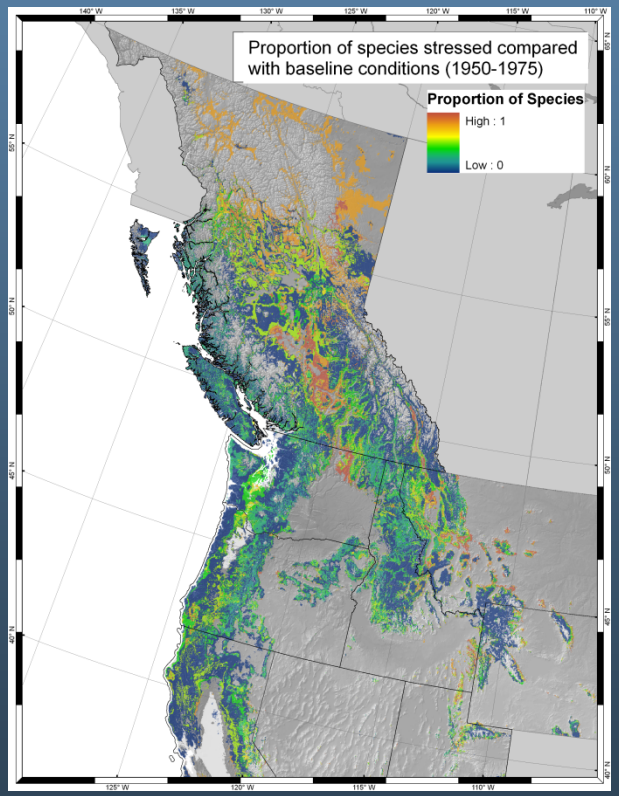
From Coops & others. 2011. Applied Vegetation Science 14: 402-414

Predicted vs. observed disturbance in Pacific NW ecoregions

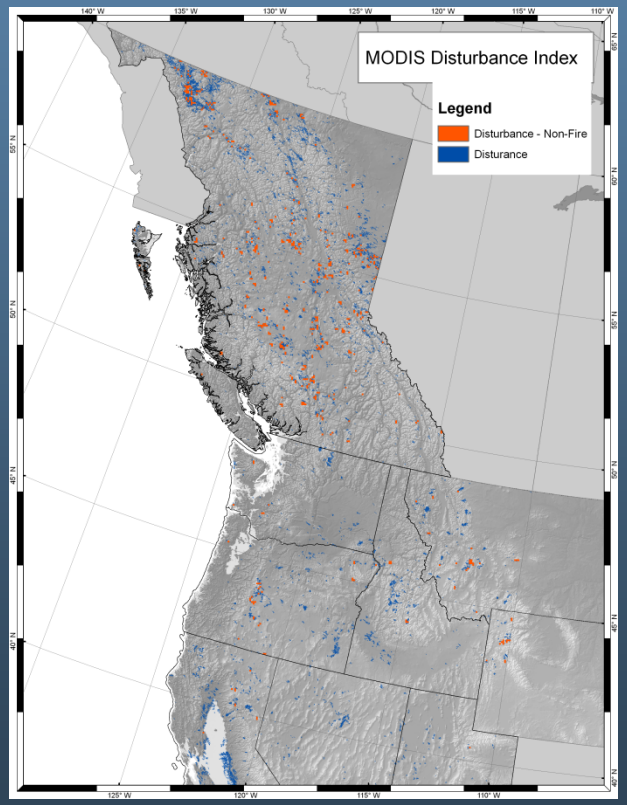
EPA defined ecoregions



Predicted vulnerable areas (1995-2005)

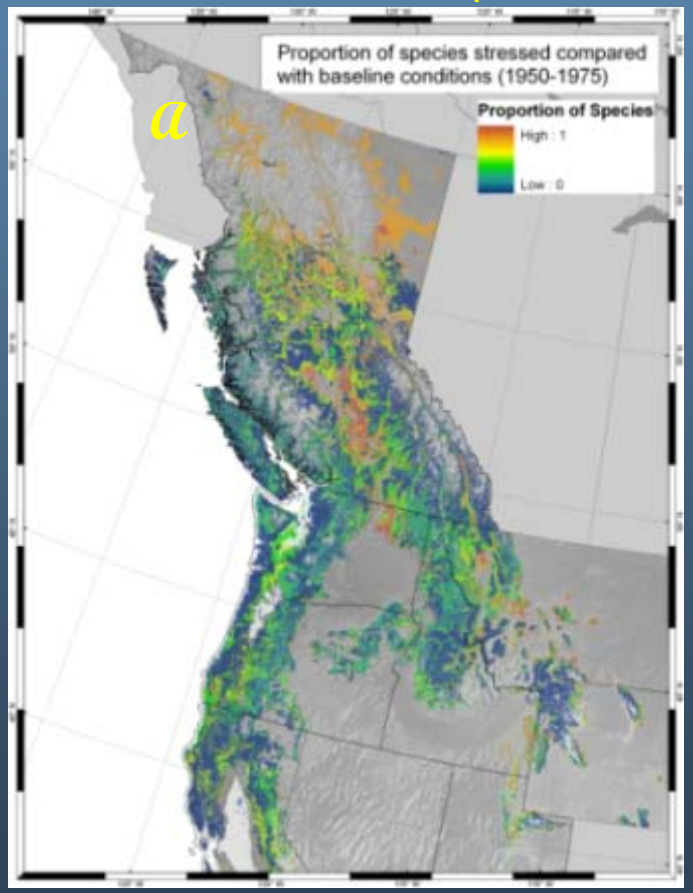


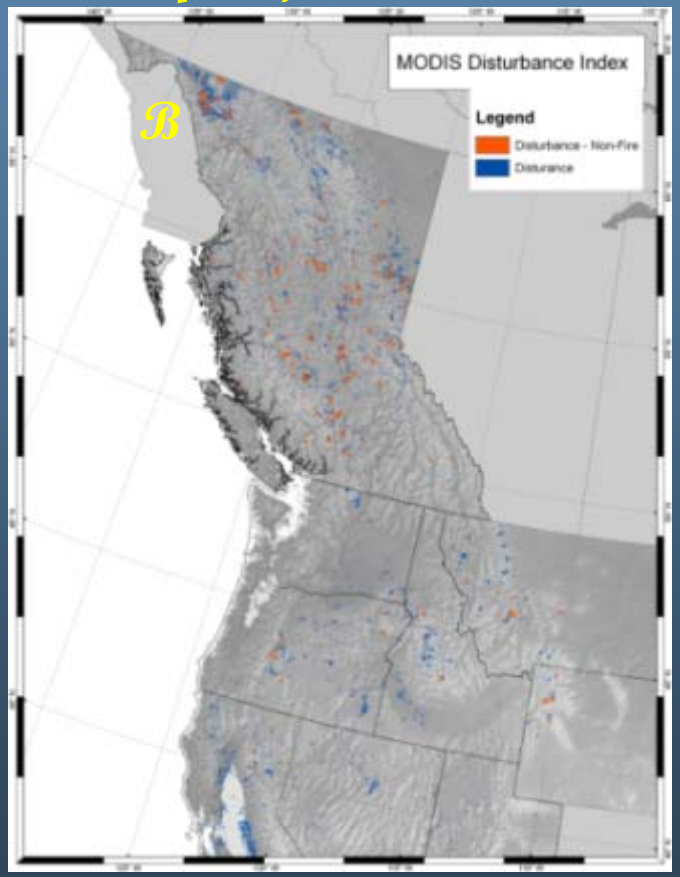
Satellite-observed disturbance (2005-2009)



Waring, Coops & Running. 2011. Remote Sens. of Env. 115:3554-3566

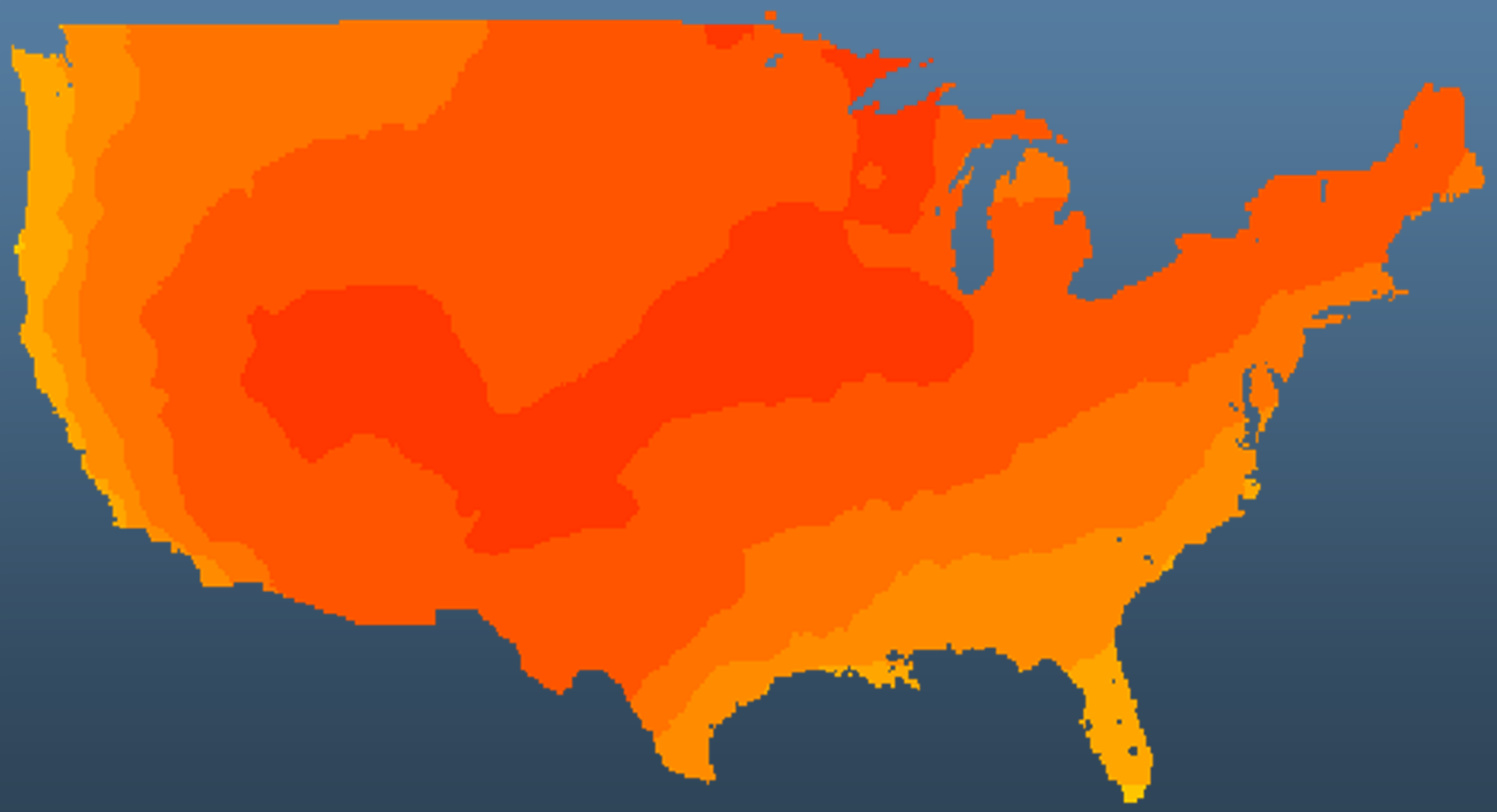
A. orange indicate where the majority of tree species are predicted as no longer well adapted. B. Satellite observations of disturbance since 2005 (include or exclude fire)



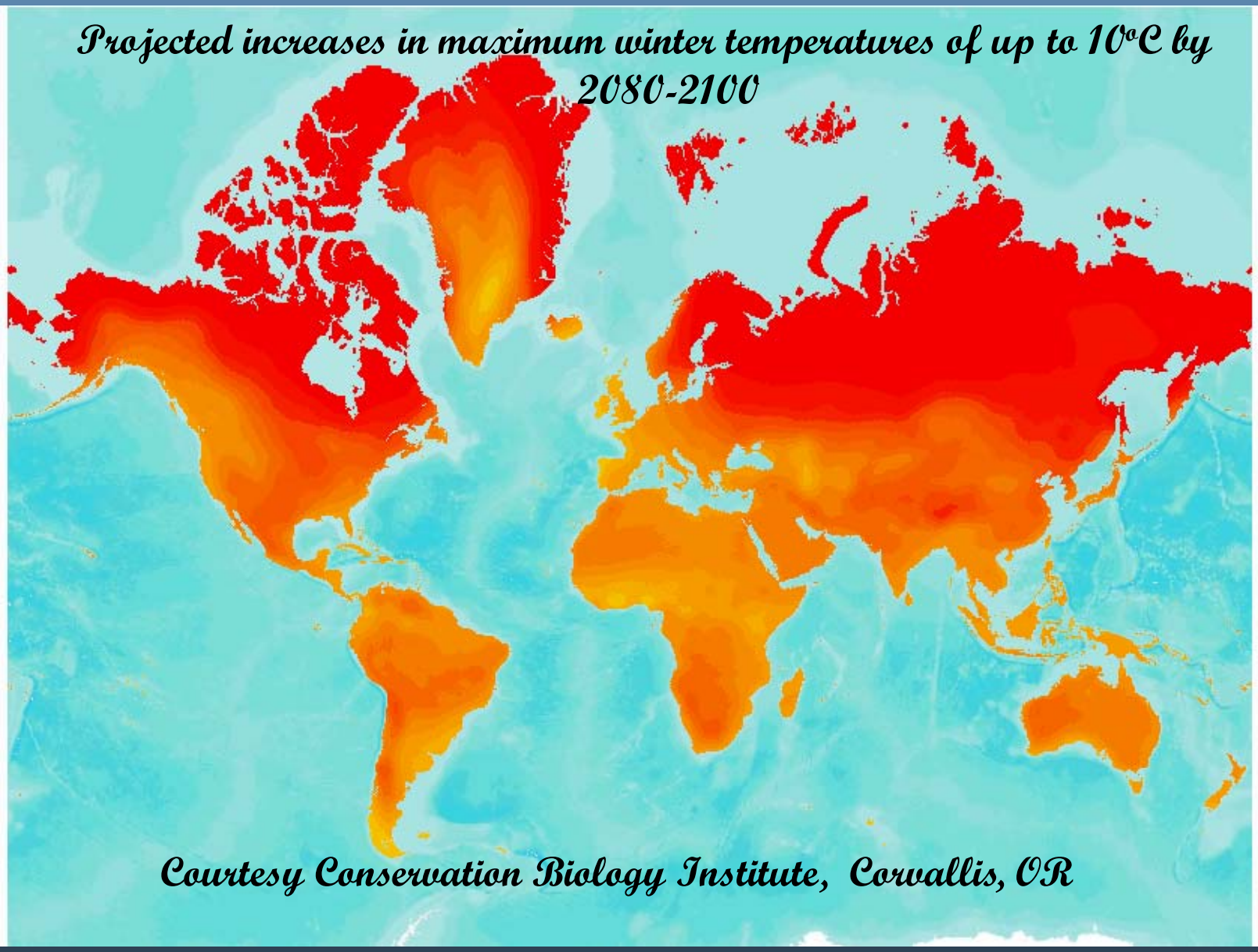


Waring, Coops & Running. 2011. Remote Sensing of Environment 115: 3554-3566

U.S. projected average changes in temperature for 2080 derived from 20 global climatic models (source: Nature Conservancy's Climate Wizard Projections)

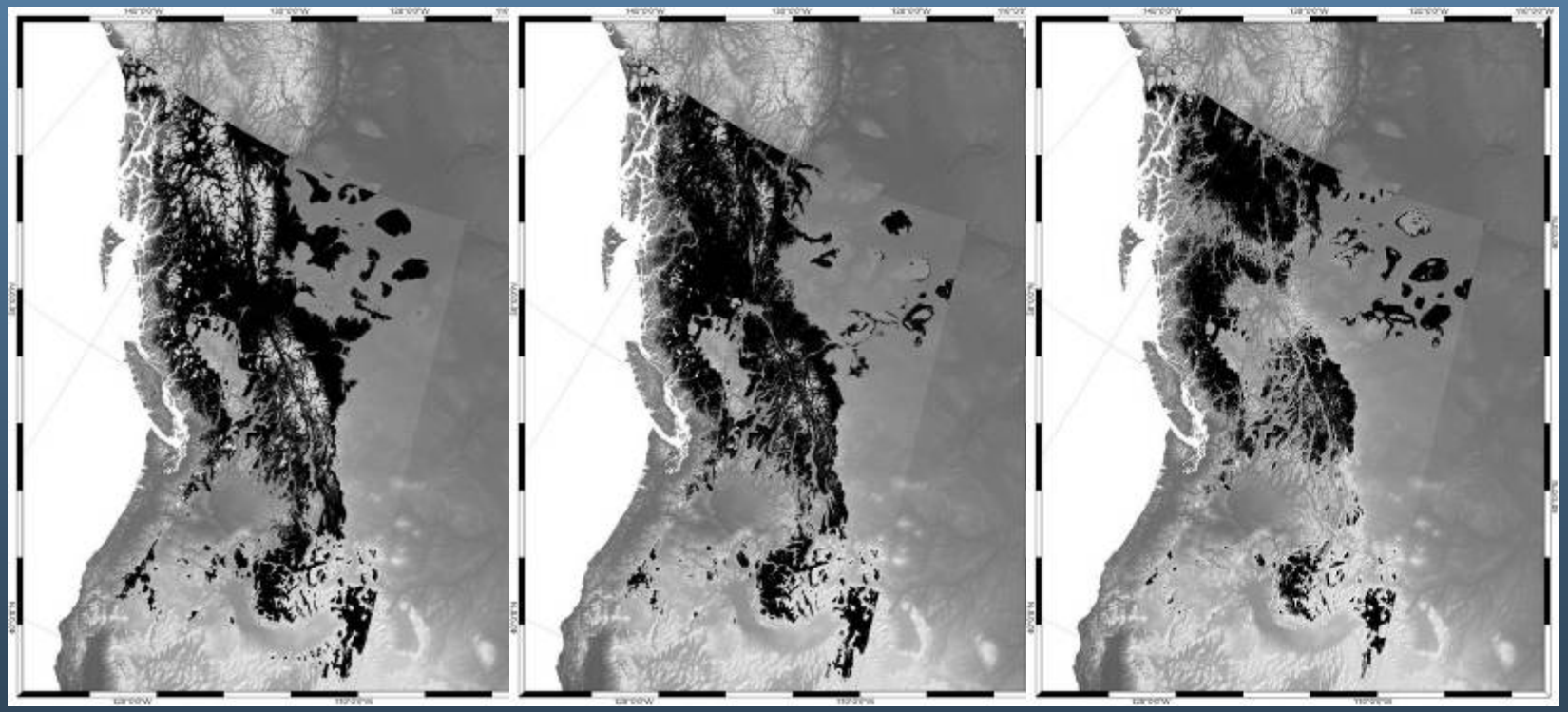


/www.climatewizard.org/


Projected increases in maximum winter temperatures of up to 10°C by 2080-2100
Courtesy Conservation Biology Institute, Corvallis, OR

Predicted change in the distribution of lodgepole pine

Current 2020 2050



Coops & Waring. 2011. Climatic Change 105:313-325

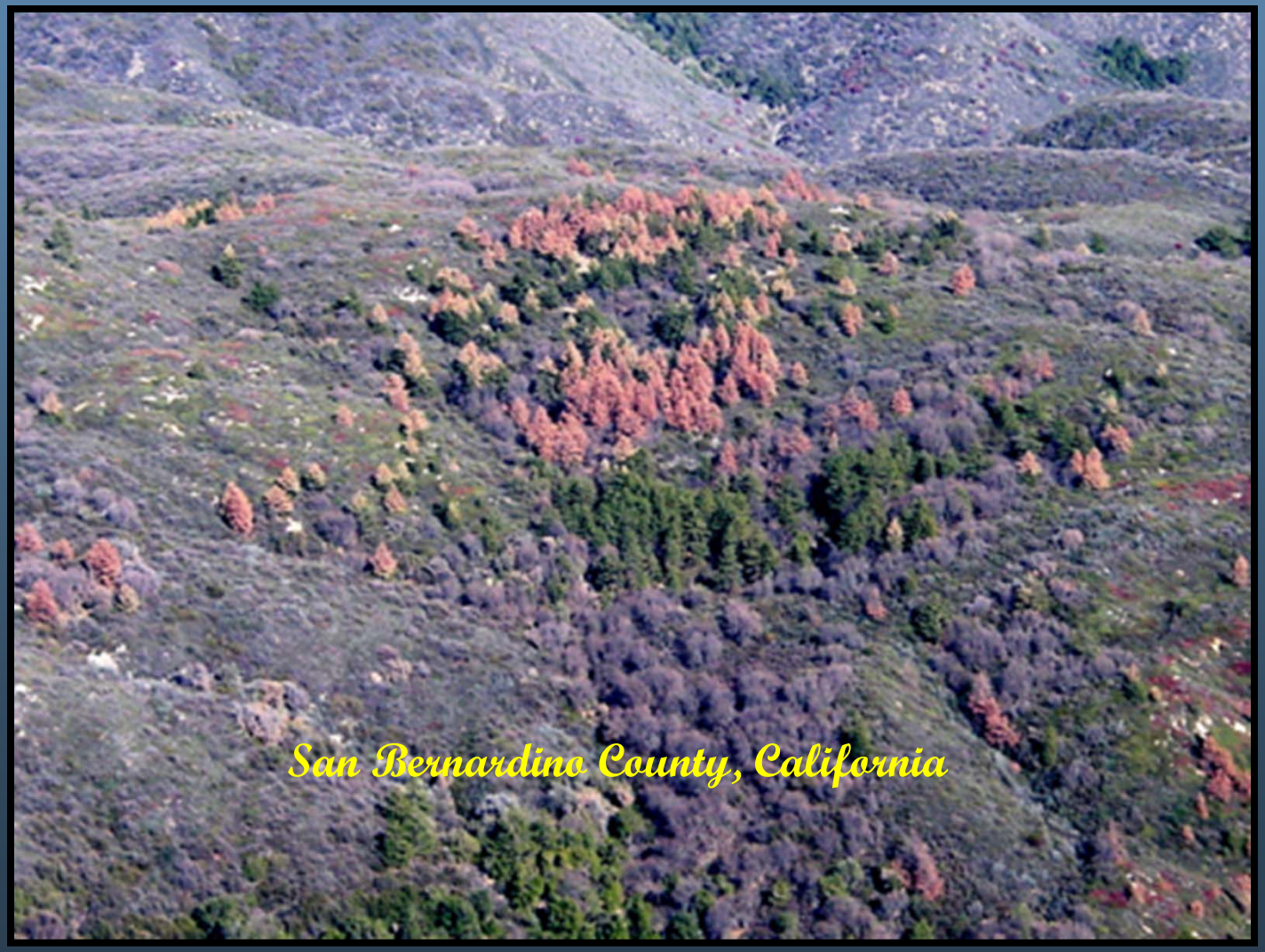
What's likely to happen in the future, with and without intervention?

Expect more disturbance

Expect younger forests

Lodgepole pine established following the Yellowstone fire in 1988

Expect forests to change in composition and to disappear in some places



Adapting to climate change

No, no! Try it again!.....Remember, this is our one & only ticket out of here

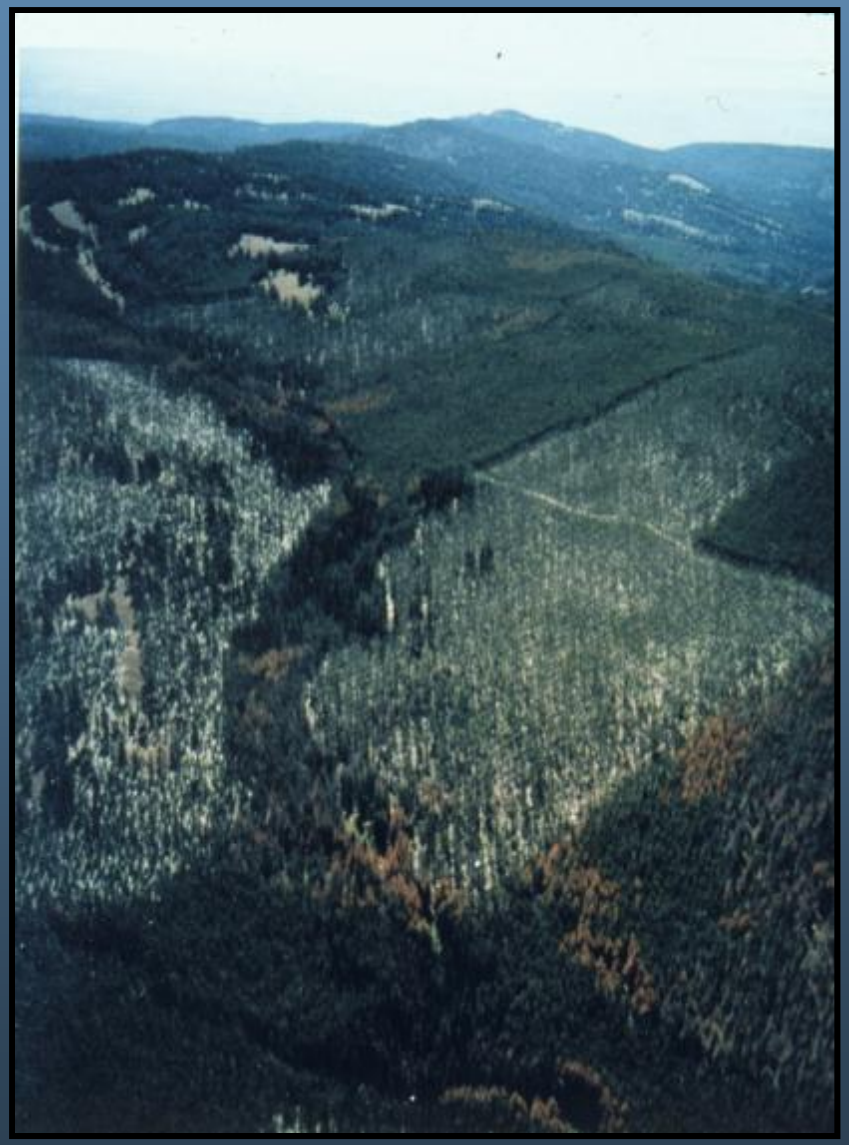
Larson

"No, no, no! Now, try it again! . . . Remember, this is our one and only ticket out of here!"

Bark Beetles

Thin to provide more resources to surviving trees

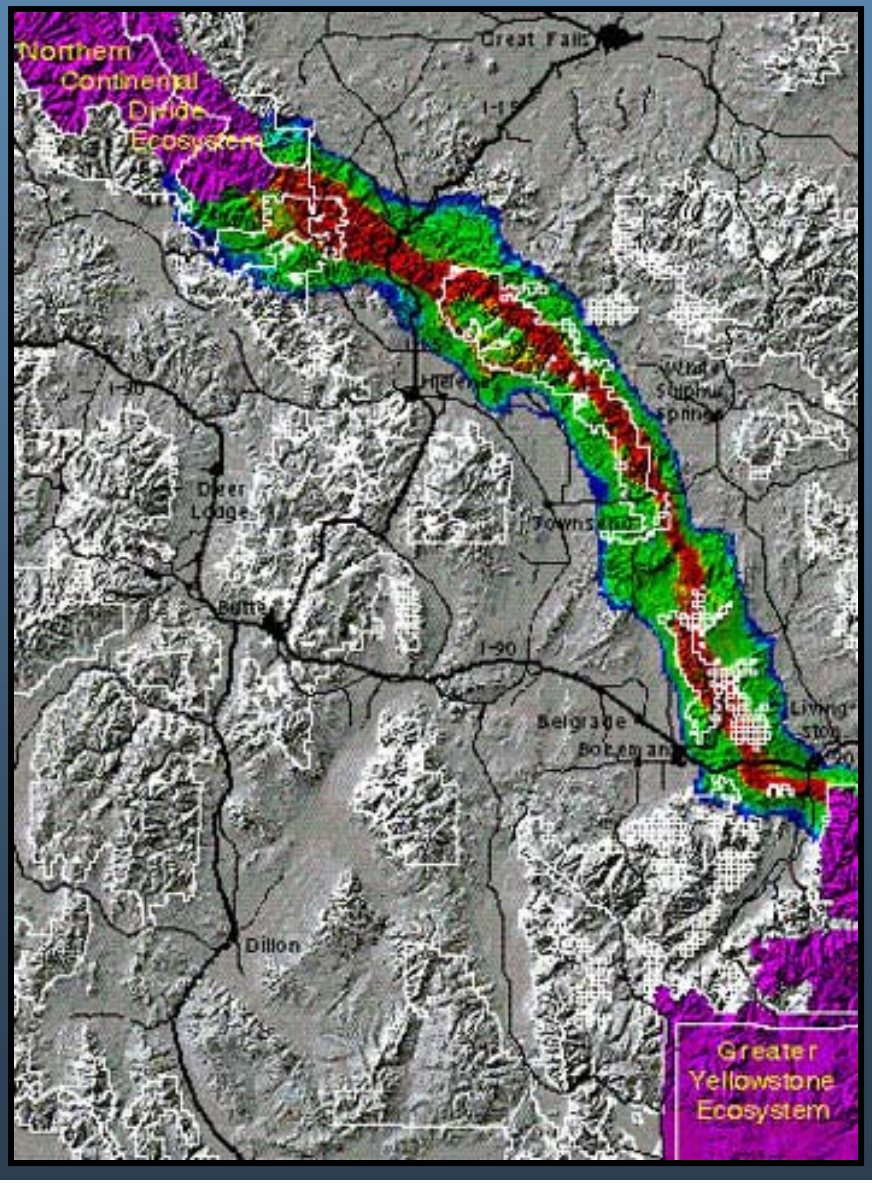
If trees are given more growing space, they are able to decrease their vulnerability to some insects and diseases



Coops et al. 2009.Remote Sensing of Environment 12: 1058-1066

Maintain species richness

Establish & maintain corridors for migration



Impose more frequent, smaller disturbances

Photos by John Bailey, OSU College of Forestry

Genetic selection, some cautions

Photo by Nicholas Wheeler, OSU

Photo by L Maclaughlan

Conclusions

- Unprecedented disturbances appear related to climate change.
- Ecological models predict where changes in forest composition are expected.
- Expect more disturbance in the future.
- Consider options to allow forests to adapt.

Publications available:

www.fsl.orst.edu/~waring

Project webpage:

www.pnwspecieschange.info/