



# Seed Movement and Climate Change from a Forest Service Perspective

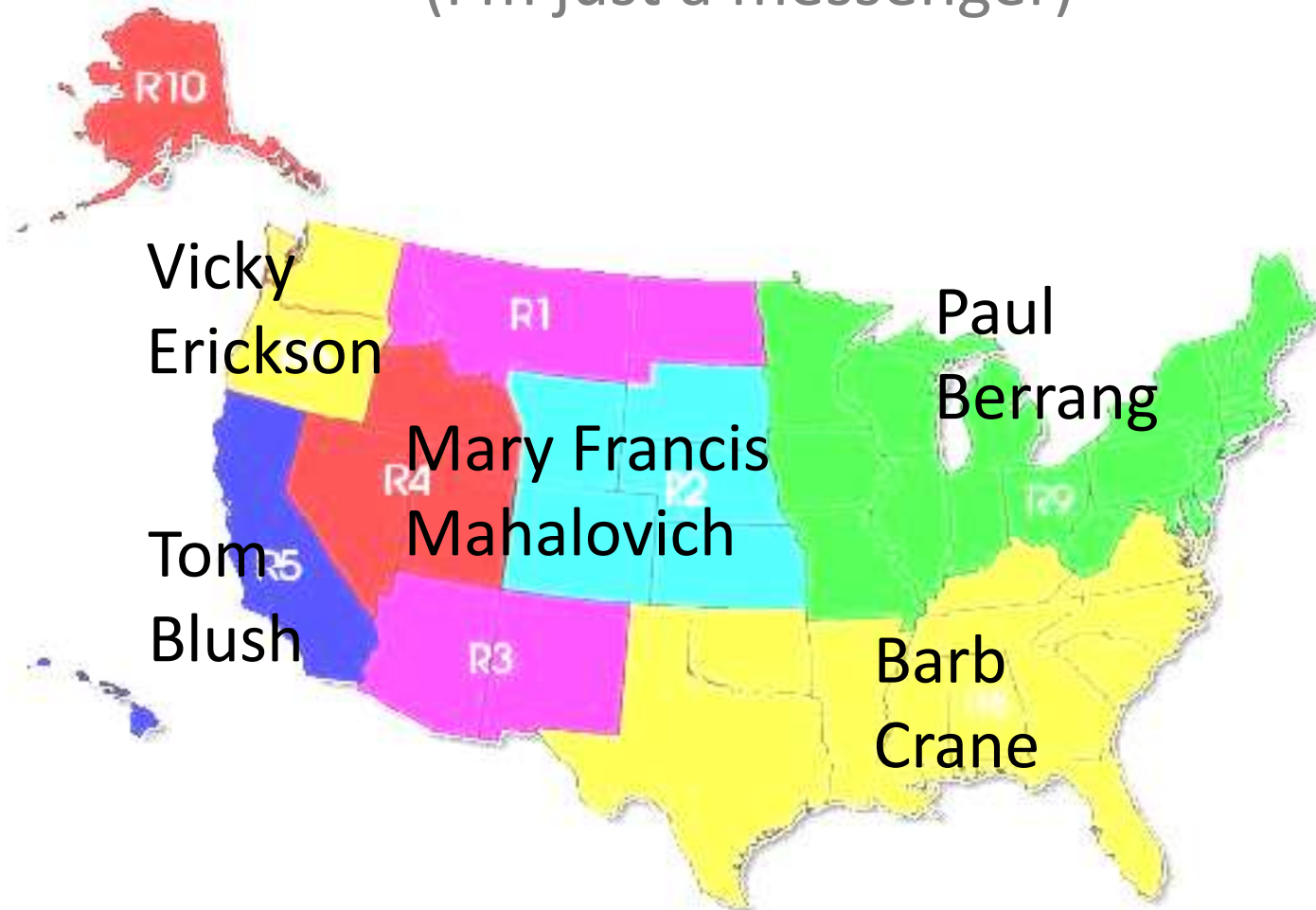
**Randy Johnson**

National Program Leader - Genetics and  
Climate Change Research

Washington DC

# Really this is the effort of the National Forest System Geneticists

(I'm just a messenger)



# Workshop in Corvallis Oregon March 2-4 2010

- National Forest System Geneticists
- Some Forest Service R&D geneticists
- Other Researchers, Oregon State University, University of British Columbia, BC Ministry of Forestry, Climate Change Research Institute & Oregon Climate Service

# Workshop in Corvallis Oregon March 2010

- National Forests System Geneticist
- Some Forest Service R&D geneticists
- Other Researchers, Oregon State University, University of British Columbia, BC Ministry of Forestry
- **Goal - prepare a document that describes a consensus view of what the Forest Service should do with seed movement in light of climate change**
- **Not prescriptions, but concepts**

# Geneticists



- Regeneration Interval
- Inbreeding
- Mating systems
- Range vs Forest Management

# Botanists



# Agreement

- Climate is changing
- Changes probably most evident at ecotones
- Genetic diversity is a good thing
- Start with what has been working:
  - locally-adapted regionally-appropriate seed sources
- Take large risks on small areas, and small risks on large areas
- Need for genetic conservation

# Differing opinions

- Different levels of risk aversion
- Importance of species envelope models

# Starting Points

Randy's musings on Strategic Plan,  
Disturbance, Trajectories, etc.



**FOREST SERVICE MANUAL  
NATIONAL HEADQUARTERS (WO)  
WASHINGTON, DC**

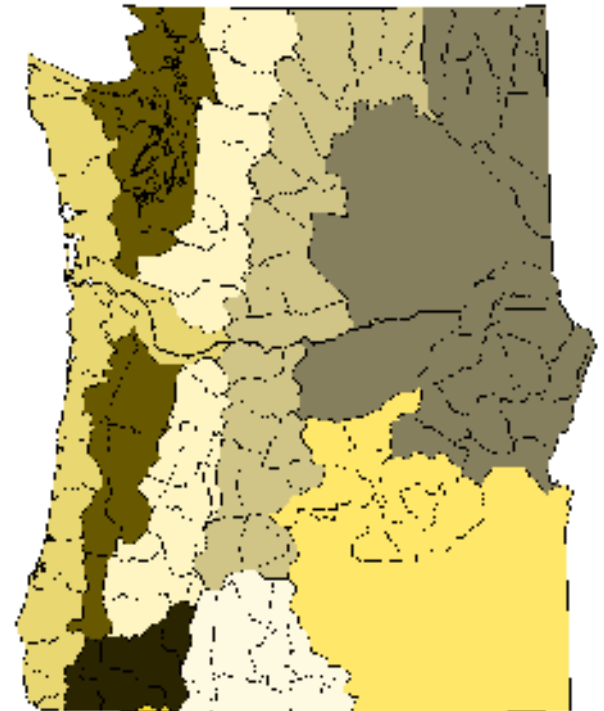
**FSM 2000 – NATIONAL FOREST RESOURCE MANAGEMENT**

**CHAPTER 2070 – VEGETATION ECOLOGY**

**Amendment No.:** 2000-2008-1

**Effective Date:** February 13, 2008

- Native species
- Locally-adapted
- Regionally-appropriate
- Genetically diverse



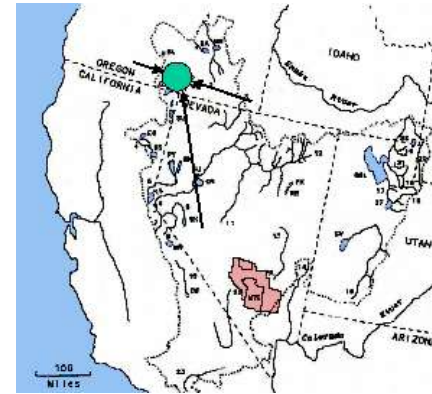
# What are the best seed sources for ecosystem restoration on BLM and USFS lands?

|Randy Johnson, Larry Stritch, Peggy Olwell, Scott Lambert, Matthew E Horning, and Richard Cronn

Native Plant Journal - In Press

## What we want and the scientific basis

"Locally adapted" means different things to different people



And it also means different things to different species



Climate today  $\neq$   
climate 20 years ago  $\neq$   
climate 20 years from now

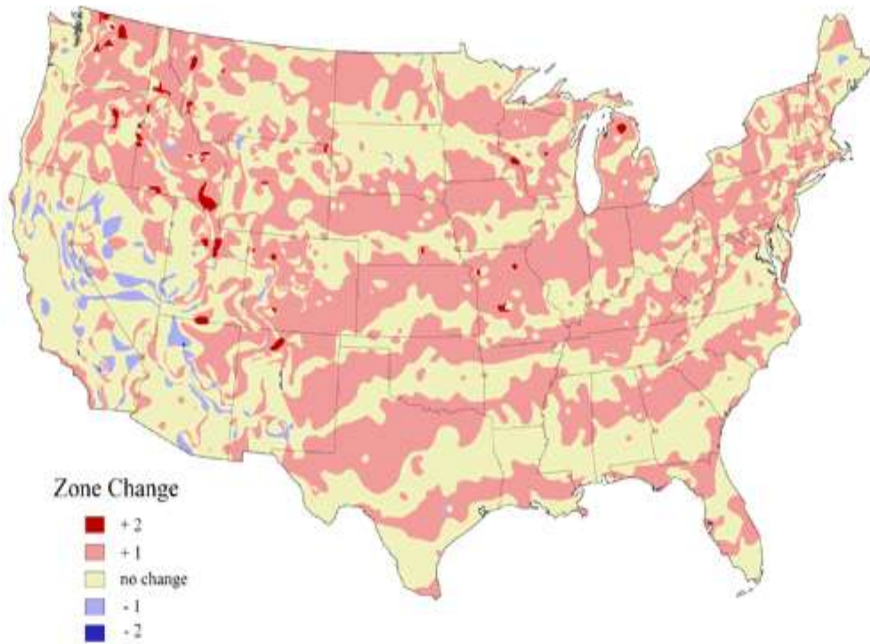
So is local still local?

Climate today ≠  
climate 20 years ago ≠  
climate 20 years from now

So is local still local?

"If it ain't broke don't fix it"

Differences between 1990 USDA hardiness zones and 2006 arborday.org hardiness zones reflect warmer climate



# Climate change is already here

- About half of the US has warmed one hardiness zone based on the last 15 years of weather data

1990 Map



2006 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

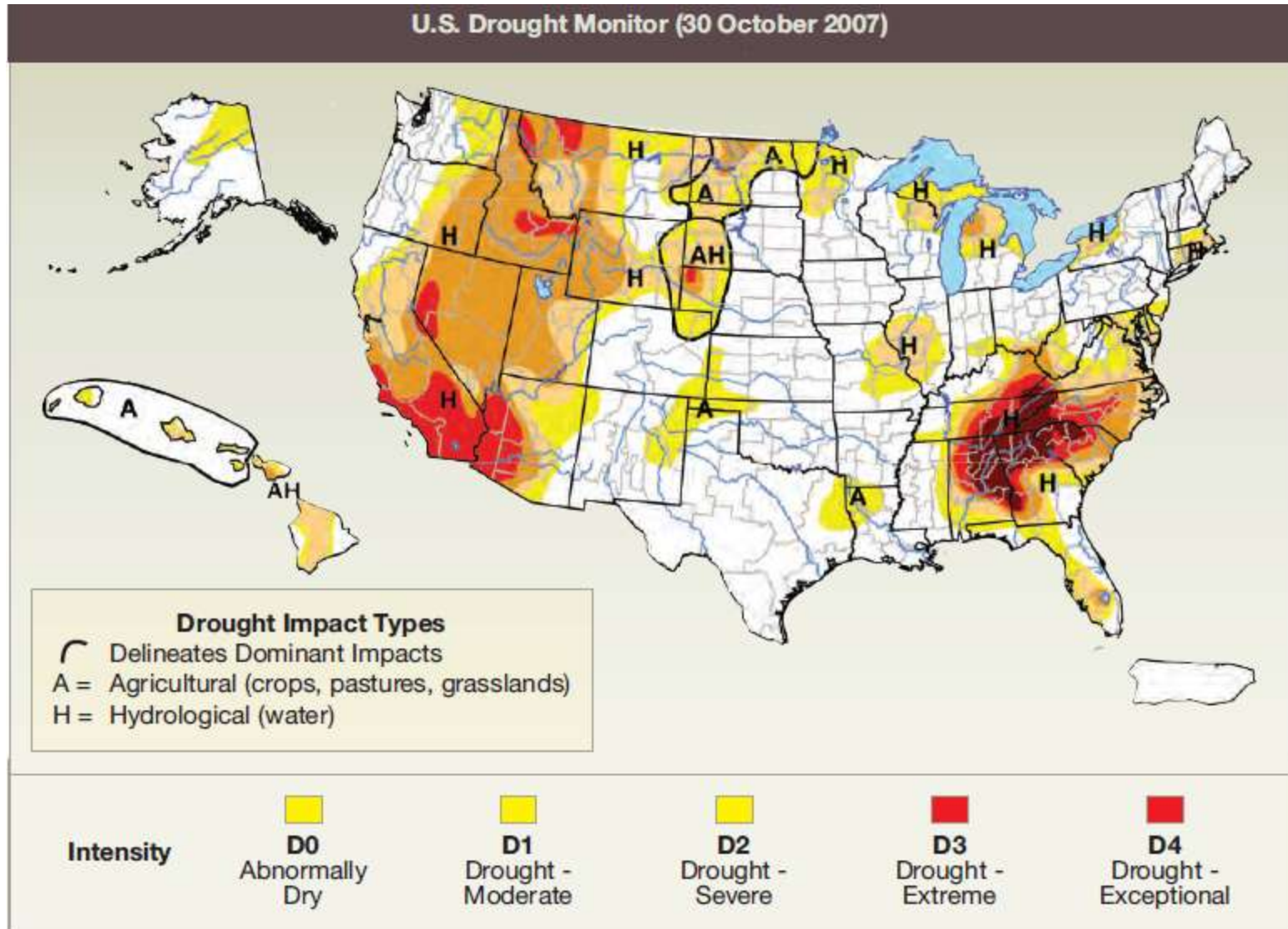
National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.



© 2006 by The National Arbor Day Foundation®

## From Kay Haven's Talk Earlier

# We have seen precipitation changes too



Future Climate Model

IPCC Fourth Assessment

Emission Scenario

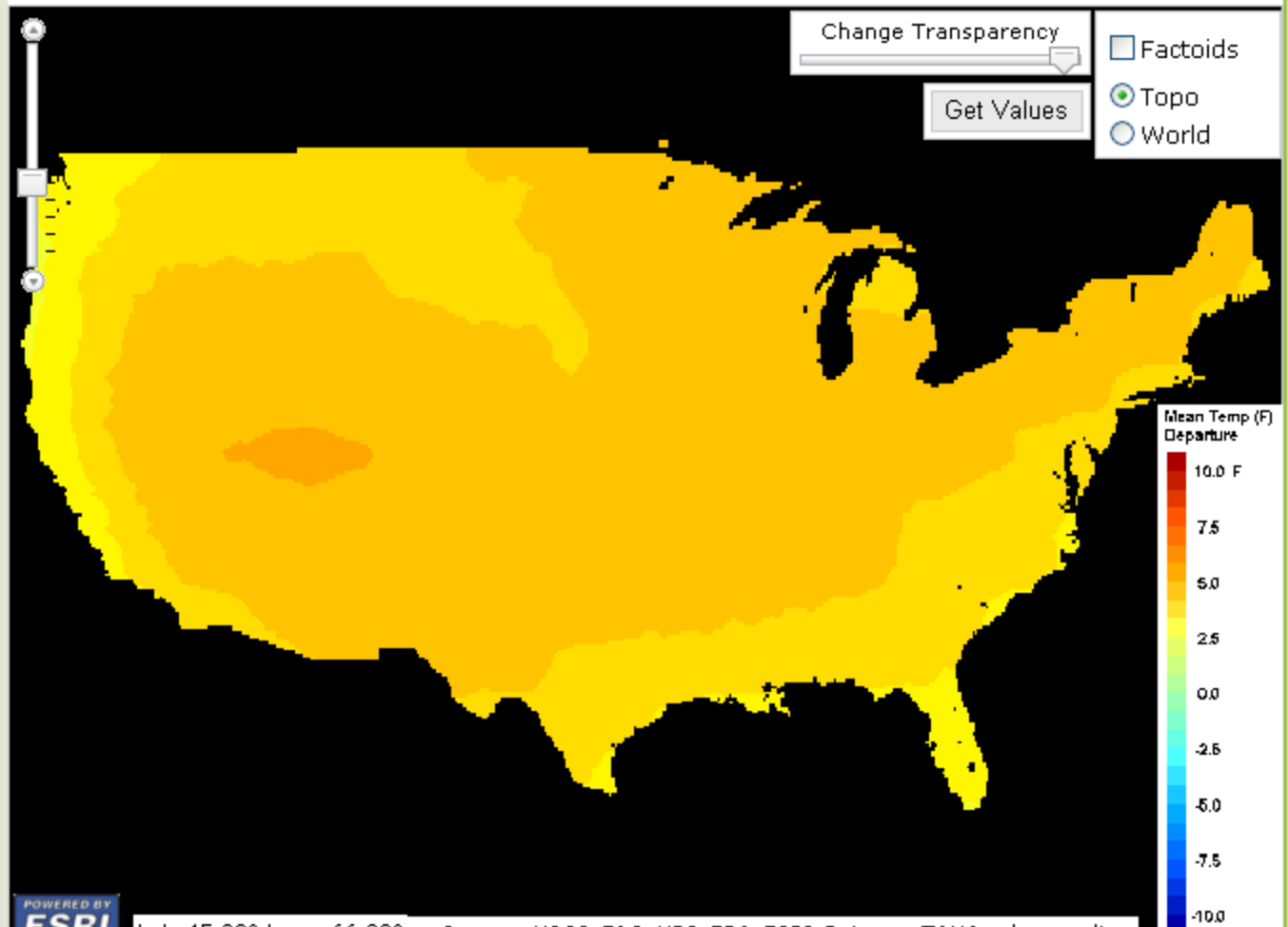
High A2

General Circulation Model

Ensemble Average

Change in Annual Temperature by the 2050s

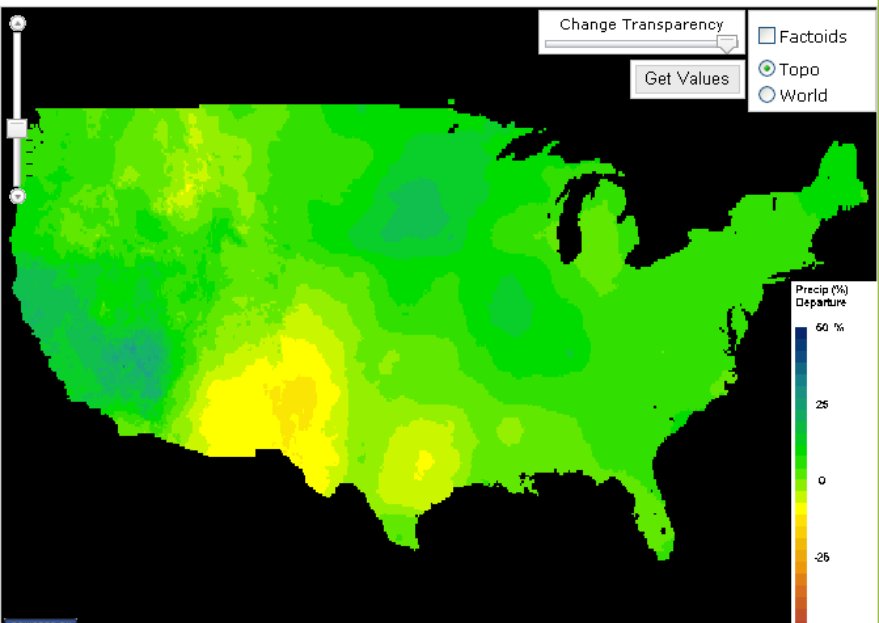
Model: Ensemble Average, SRES emission scenario: A2



50%: This map shows the temperature change projected by the middle model. That is, **half of the models project a greater amount of change, and half of the models project less change** as compared to the 1961-1990 baseline average.

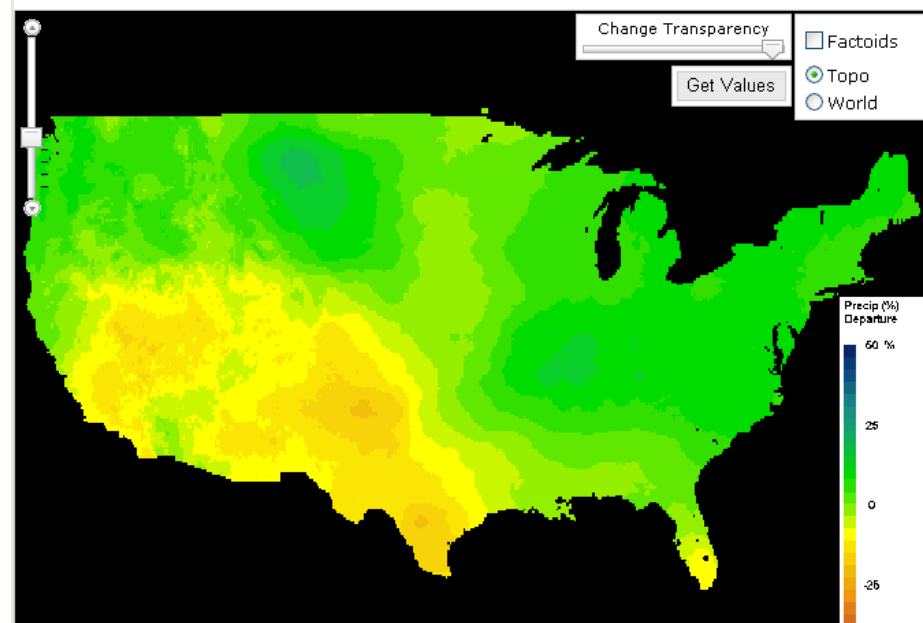
### Change in Annual Precipitation by the 2050s

Model: MRI-CGCM2.3.2, SRES emission scenario: A2



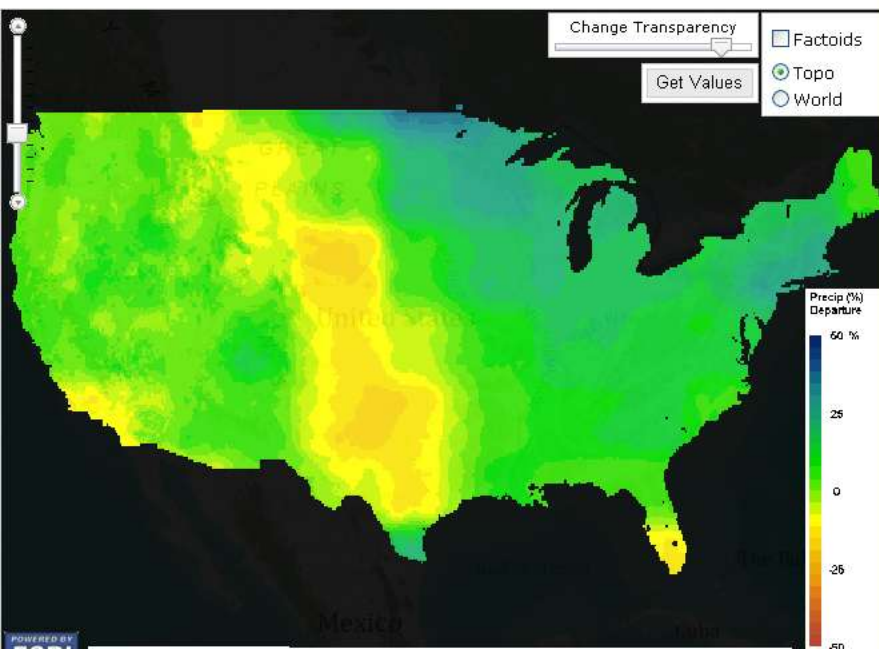
### Change in Annual Precipitation by the 2050s

Model: BCCR-BCM2.0, SRES emission scenario: A2



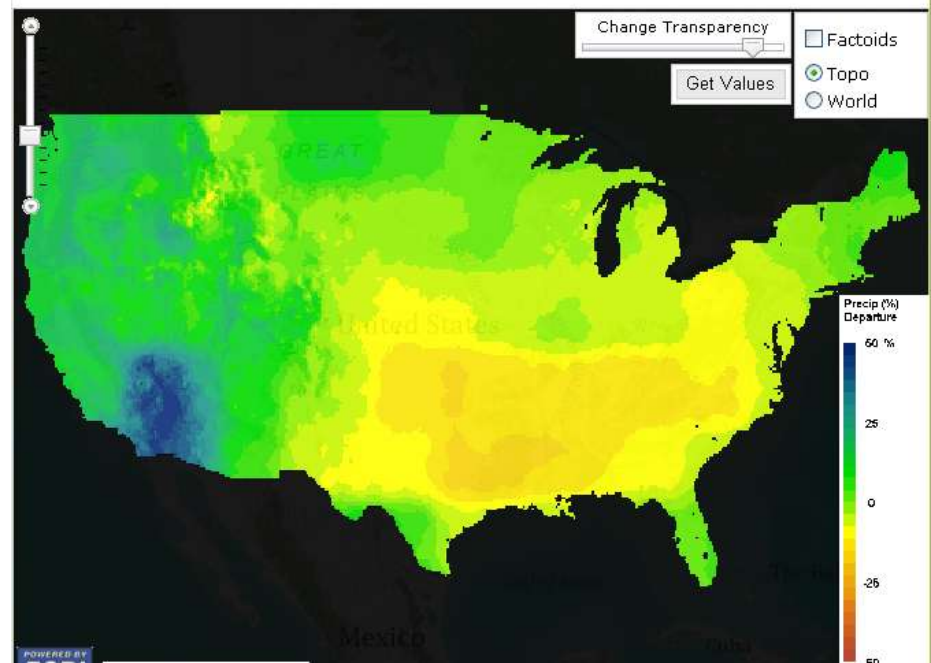
### Change in Annual Precipitation by the 2050s

Model: GISS-ER, SRES emission scenario: A2



### Change in Annual Precipitation by the 2050s

Model: INM-CM3.0, SRES emission scenario: A2



Uncertainty with regard to future  
climates

# Both Direct and Indirect Effects



Regardless of uncertainty, Federal  
land managers will need to address  
climate change

*National Environmental Policy Act*  
*(NEPA)*

Species and population movement



Contents lists available at ScienceDirect

# Forest Ecology and Management

journal homepage: [www.elsevier.com/locate/foreco](http://www.elsevier.com/locate/foreco)



## Selecting tree species for testing climate change migration hypotheses using forest inventory data

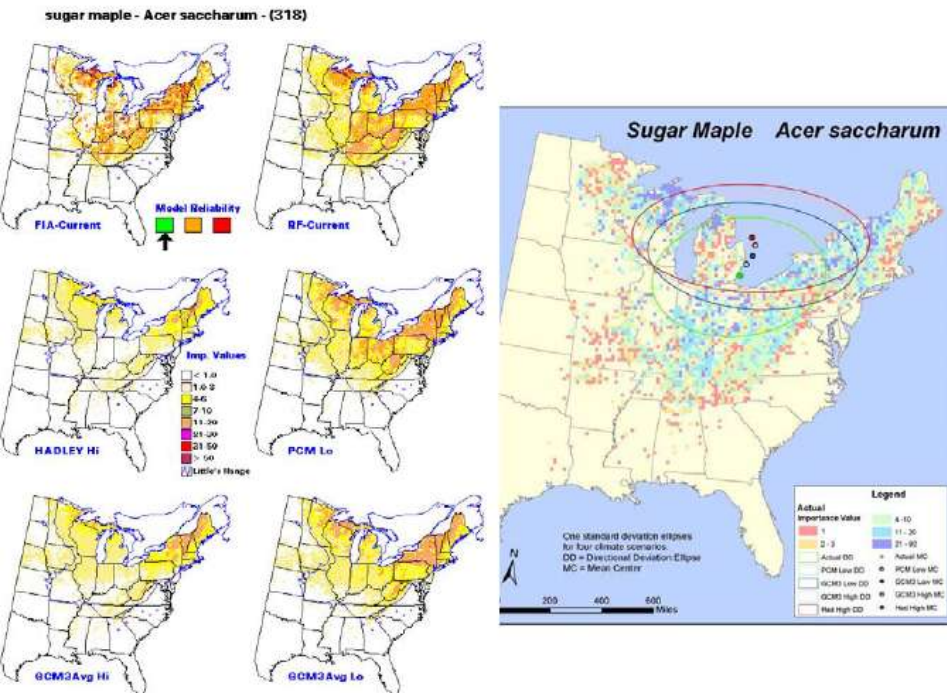
C.W. Woodall <sup>a,\*</sup>, C.M. Oswalt <sup>b</sup>, J.A. Westfall <sup>c</sup>, C.H. Perry <sup>a</sup>, M.D. Nelson <sup>a</sup>, A.O. Finley <sup>d</sup>

<sup>a</sup>USDA Forest Service, Northern Research Station, St. Paul, MN, United States

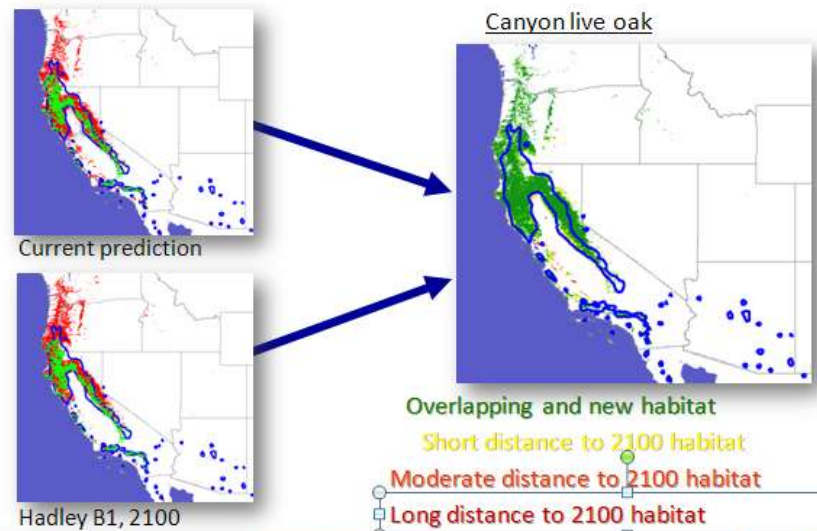
<sup>b</sup>USDA Forest Service, Southern Research Station, Knoxville, TN, United States

<sup>c</sup>USDA Forest Service, Northern Research Station, Newtown Square, PA, United States

<sup>d</sup>Michigan State University, East Lansing, MI, United States



## Distance to future suitable habitat



# Predicting Appropriate Species / Seed Source

## Complicating factors Influencing Species Presence:

- Uncertainty of future climate
- Temperature
  - Extremes (more so than means)
- Precipitation
- Soils
- Competition
- Disease and insects
- Fragmentation

# Future environmental conditions many not exist right now?

- Photoperiod vs heat sums
- Warmer winters but still late frosts
- Different disease triangle relationships
- etc

Action Principles we agreed  
on:

# Principle 1

Diversity (Genetic Variation)  
provides insurance

If we need something new  
the pieces need to be there

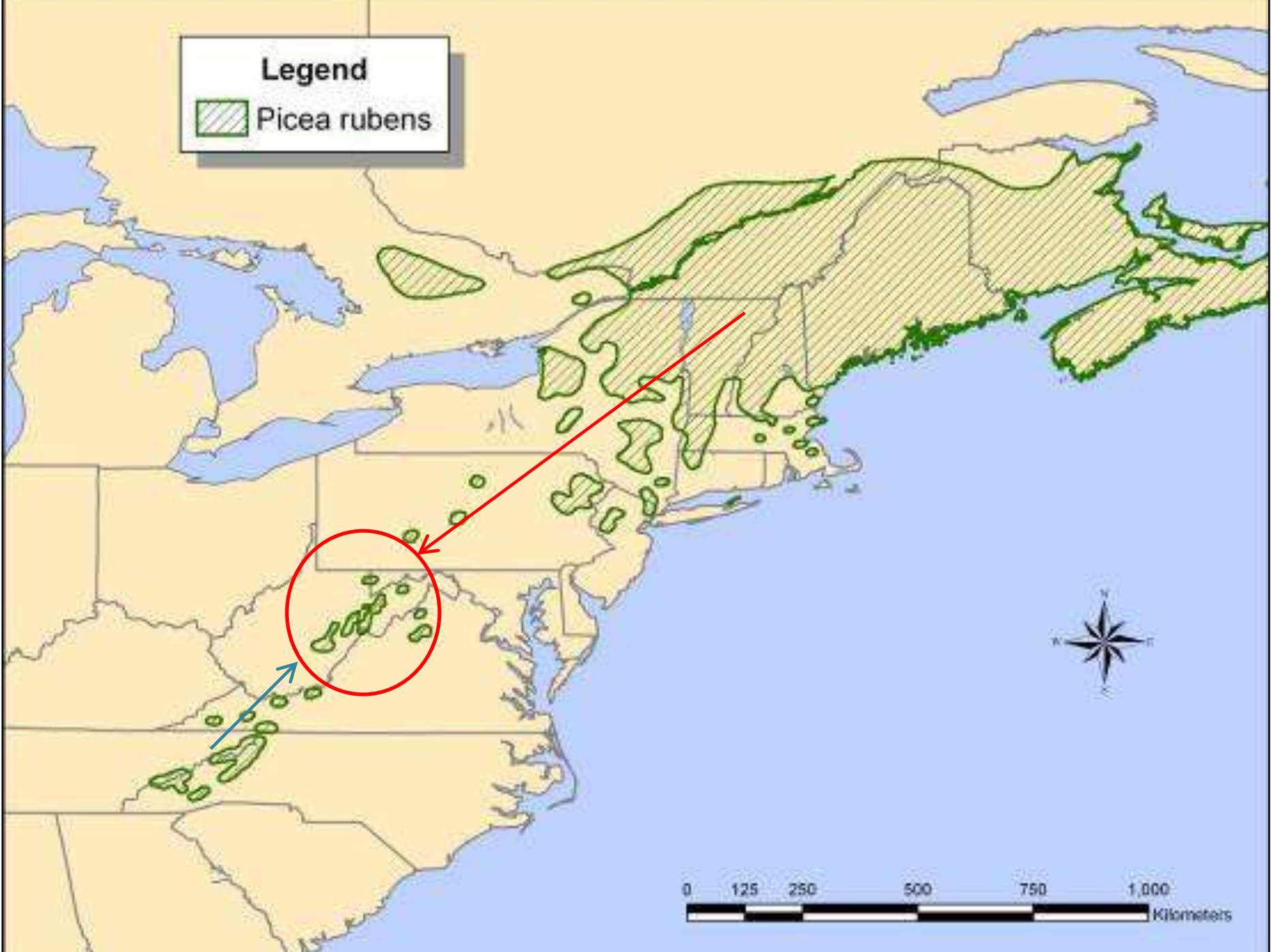
# Principle 1

Diversity provides insurance

But we need the right  
diversity... maladapted  
diversity will decrease fitness

**Legend**

 *Picea rubens*



# Principle 2

Large Risks over Small Areas

Small Risks over Large Areas

# Small Risks over large areas

- Some seed zones have already shifted > 1,000 ft
- Not replacement of seed sources, but mixing
- Some regions already moving seed from the adjacent warmer seed zone



# Brewer Spruce

Large moves on  
experimental  
basis

# Principle 3

## Need for Gene Conservation Programs

*(in situ and ex situ)*

# Genetic Conservation

- Climate Change
- Exotics
  - Diseases
  - Insects
  - Animals
  - Plants
- Native bugs and crud

# Examples of current Forest Service funded species

- Whitebark pine
- Elms
- Eastern hemlocks
- Boyton Oak
- Butternut
- Beech

## Principle 4

Having the seed  
ready for the future

- Knowing our seed needs (nationally)
- Having seed information available
  - Where it is (coordination)
  - Where it came from
- Breeding programs
  - Disease, drought
- Having decision tools in hand

# Seedlot Selection Tool (SST)

Seedlot Selection Tool - Windows Internet Explorer

http://seedlotselectiontool.dev.forestry.oregonstate.edu/Sample2/index.html

File Edit View Favorites Tools Help

Favorites Seedlot Selection Tool

Home About Instructions Related Sites Contact Us

Find seedlots for my planting site Go!

Find planting sites for my seedlot Go!

Seedlot Selection Tool

### Planting Healthy Forests

The seedlot selection tool (SST) is a GIS mapping program designed to help forest managers match seedlots with planting sites based on climatic information. The tool can be used to map current climates, or future climates based on selected climate change scenarios. Although it is tailored for matching seedlots and planting sites, it can be used by anyone interested in mapping present or future climates defined by temperature and precipitation.

#### Purpose

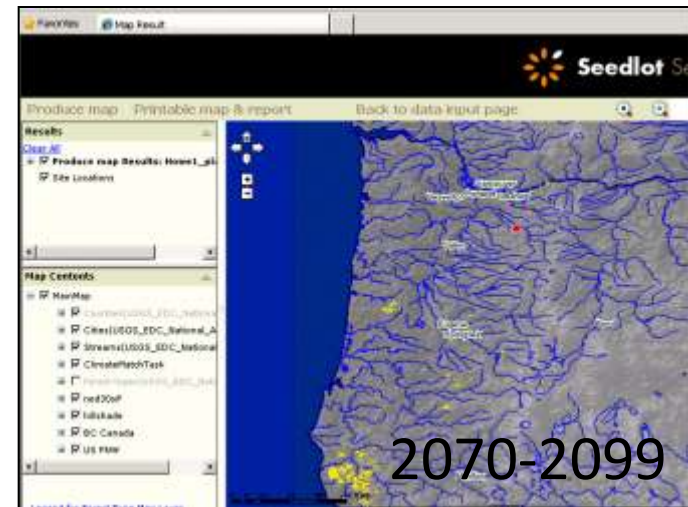
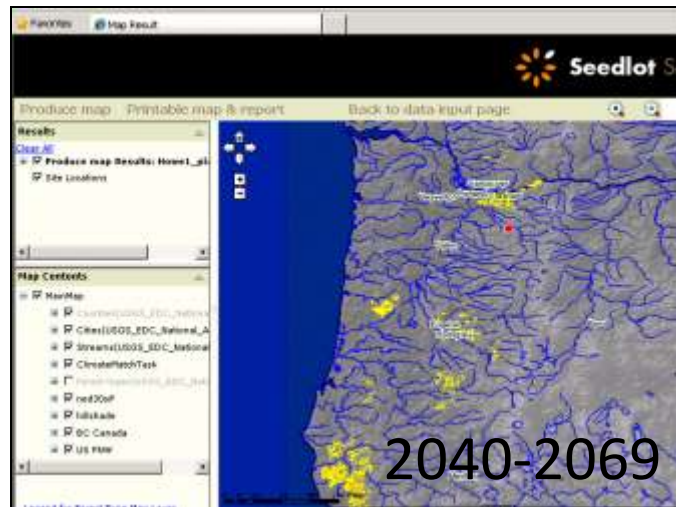
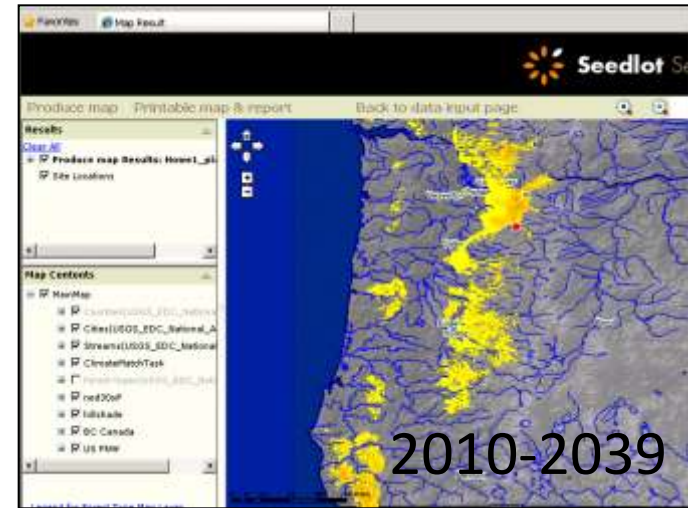
Forest managers can use this tool to help choose **seedlots** that are appropriate for planting on a particular site, or planting sites that are appropriate for a particular seedlot. This can be done using **current climate models** (i.e., ignoring potential climate change) or by choosing a **climate change model, emissions scenario, and future target year**. Because of the uncertainty in climate change projections, the tool is really a planning and educational tool: it can be used to explore alternative future conditions, assess risk, and plan potential responses, but cannot tell the user exactly which seedlots will be optimally adapted to a particular planting site in the future. The tool allows the user to control many input parameters so the results are appropriate for the management.

#### How the tool works

- 1. Select Your Goal**  
Choose to find seedlots for your planting site or planting sites for your seedlot.
- 2. Login**  
The optional login feature allows you to store your results.
- 3. Enter Location**  
You can use Google Maps or coordinates to show the location of your seedlot or planting site.
- 4. Select Species**  
You can use species-specific or generic zones and transfer limits.
- 5. Determine Transfer Limit**  
Use one of our recommended limits, enter your own limit, or click an existing zone to...

[See Example Map](#)

# Find seedlots for my planting site



Questions?