

Climate Informed Seed Sourcing: principles, practices, and use of the SeedLot Selection Tool

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Climate



Outline

Climate change impacts on trees

- Relationship between trees and climate

What is climate-informed seed sourcing?

Assisted Migration

Seedlot Selection Tool

Climate Change Impacts on Trees

Abiotic Stressors:

- Summer heat and drought
- Warm winters

Biotic Stressors:

- Insect and disease outbreaks

Forest Impacts:

- Losses in productivity
- Changes in species distributions
- Ecosystem loss



Drought related tree mortality.
Sequoia National Park.

Nate Stephenson, US Geological Survey



Mountain pine beetle tree mortality.

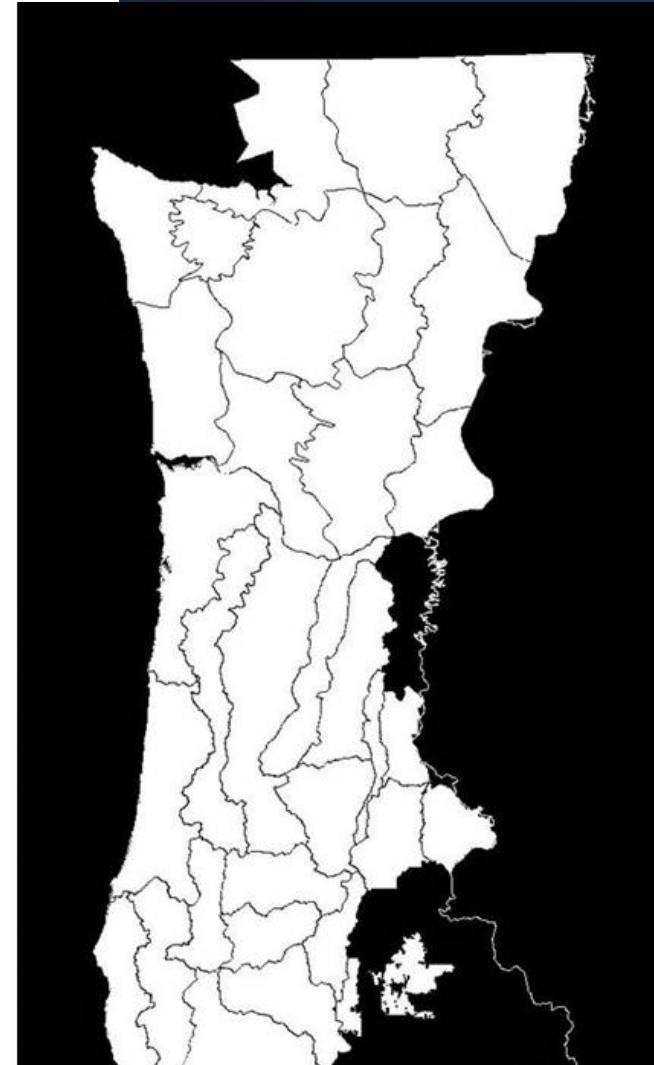
William M. Ciesla, Forest Health Management
International, Bugwood.org

What IS climate-informed
seed sourcing?

The relationship between trees and climate

Provenance Trials (seed source variation)

- 100+ years of data: trees are adapted to local climate
- Productivity declines outside of certain thresholds, or transfer distances
- These studies were the basis for creating seed zones
- Provenance tests can be used to infer the effects of climate change



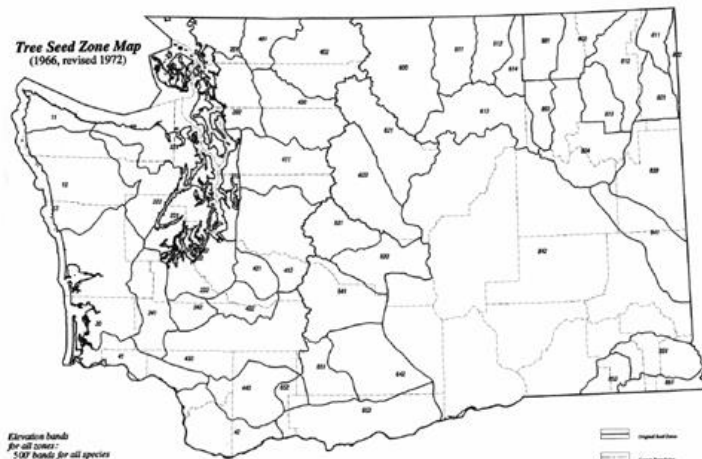
Plant adaptation to climate



Photo courtesy of S. Aitken

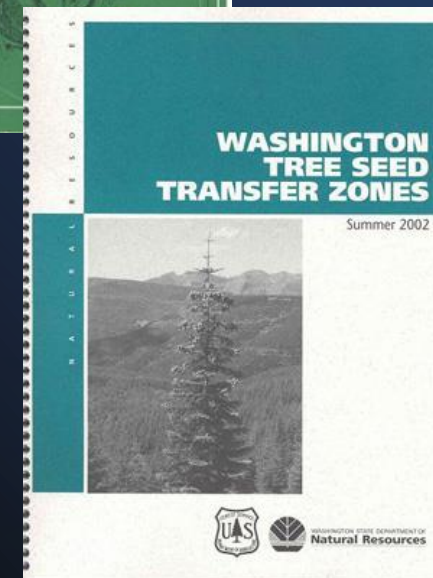
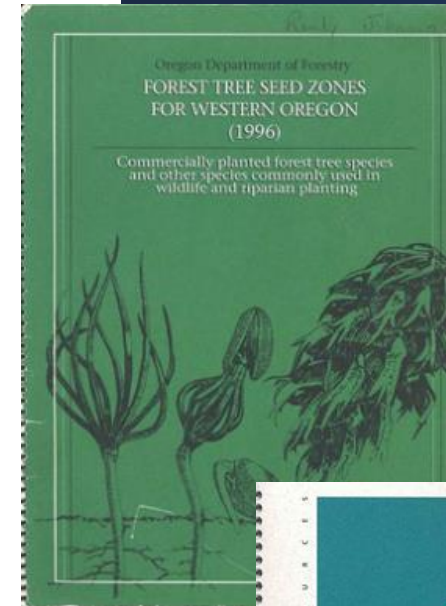
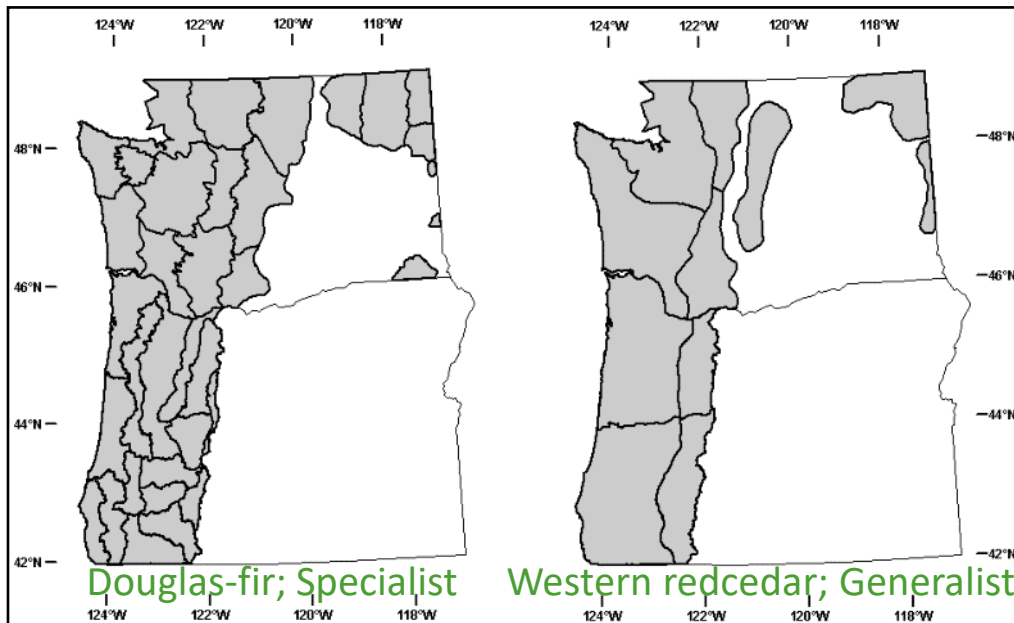
Certification system and more detailed maps and guidelines for Oregon and Washington in 1966, California in 1970

- Based primarily on collective knowledge of climate and vegetation types
- Includes 500 ft (150 m) elevation bands within zones.



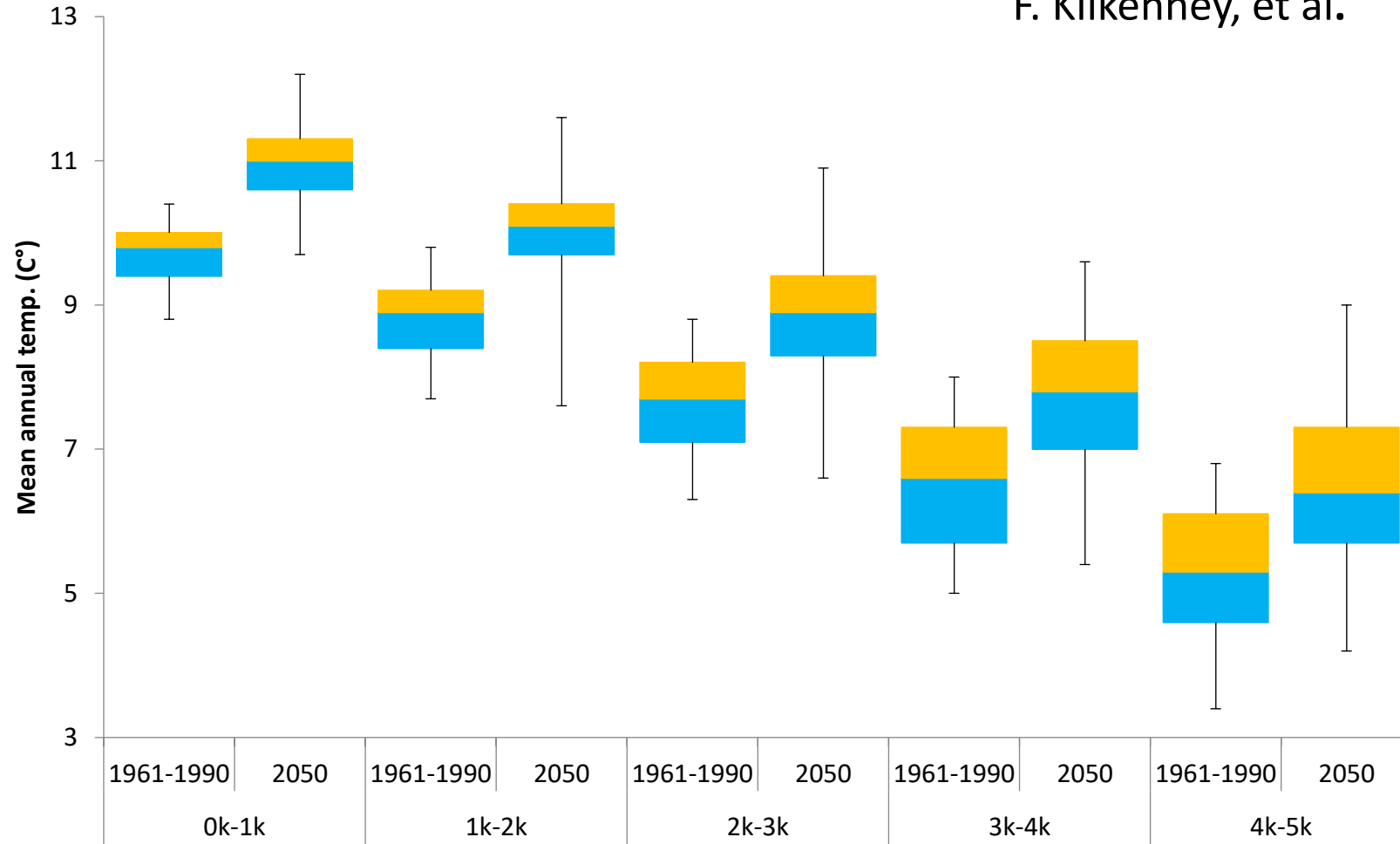
Seed zones revised for Oregon in 1996 and Washington in 2002

- Based on best available knowledge of genetic structure (genecology studies by Campbell, Sorensen, Rehfeldt)
- Differ by species
- Generally enlarged (fewer, less restrictive)
 - Mostly expanded in a north-south direction
 - Elevational guidelines often also expanded



Variation within PNW Seedzones: current vs. future climate

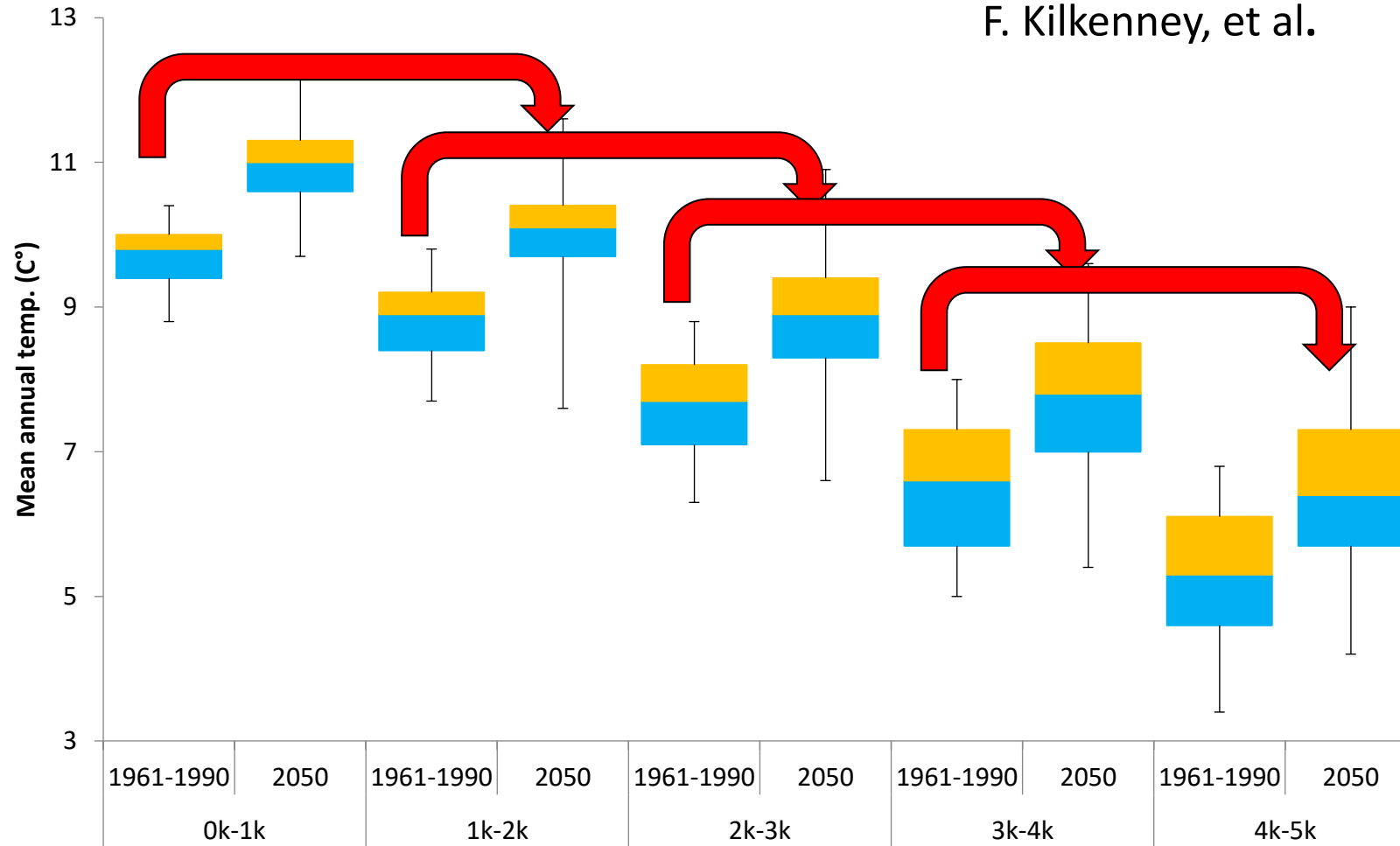
F. Kilkenney, et al.



- Dogma in reforestation and restoration has been “local is best”

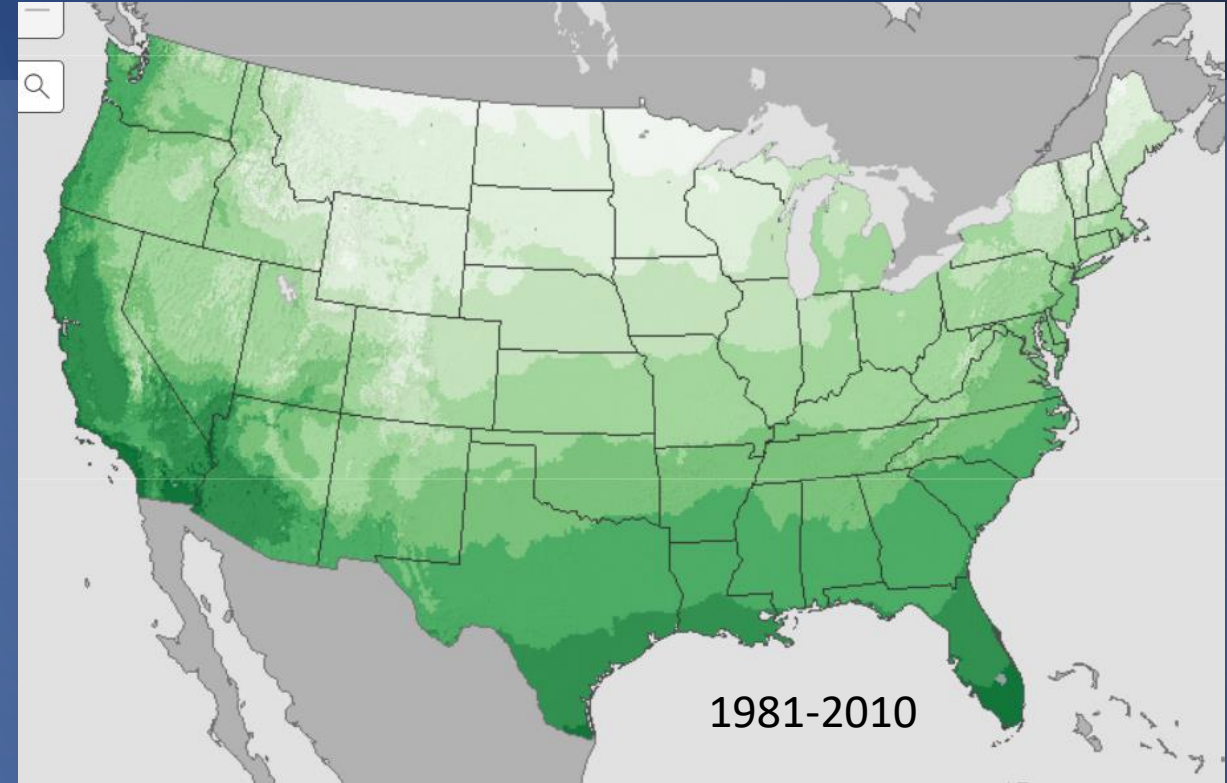
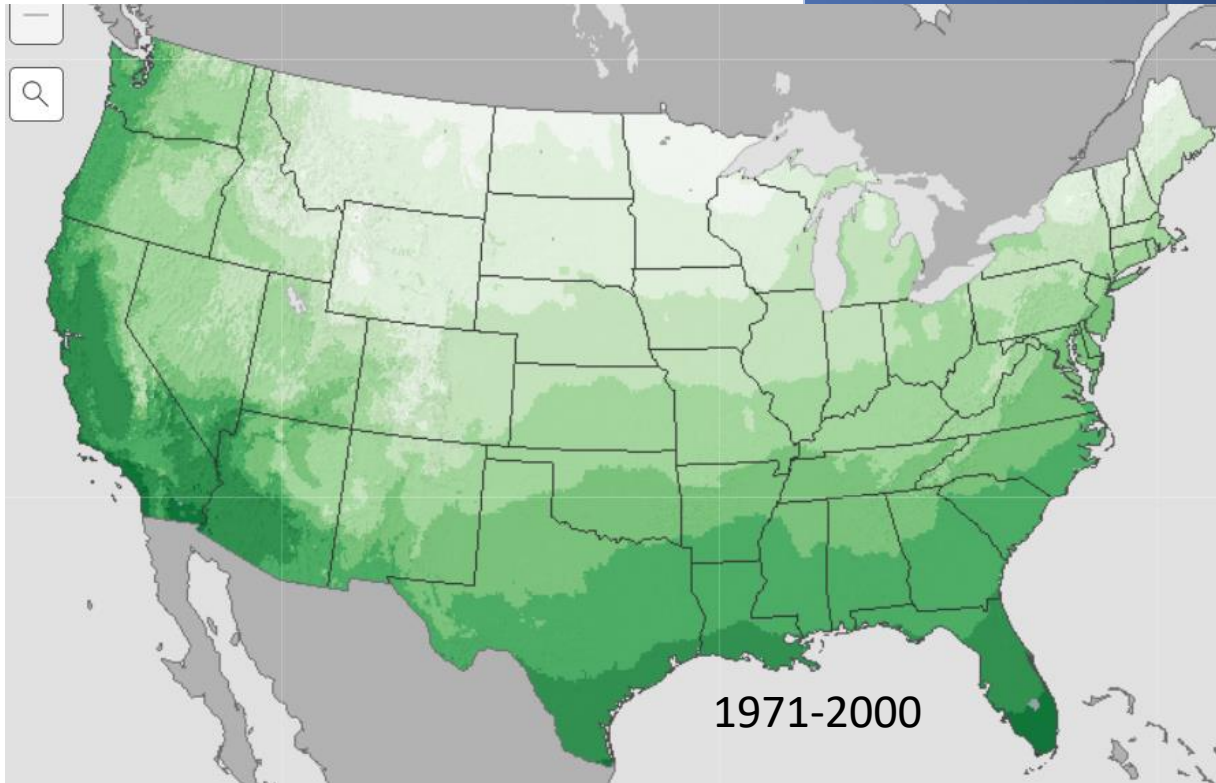
Variation within PNW Seedzones: current vs. future climate

F. Kilkenney, et al.



- Location of seed collection \neq area of seed deployment (i.e. local is no longer best)

USDA Plant Hardiness Zones



Shift in Plant Hardiness Zones

Zone Changes in Past 10 Years
In color of New Planting Zone



Zone Changes in Next 30 Years
In color of New Planting Zone



Average Annual Extreme Minimum Temperature by Climate-Related Planting Zone



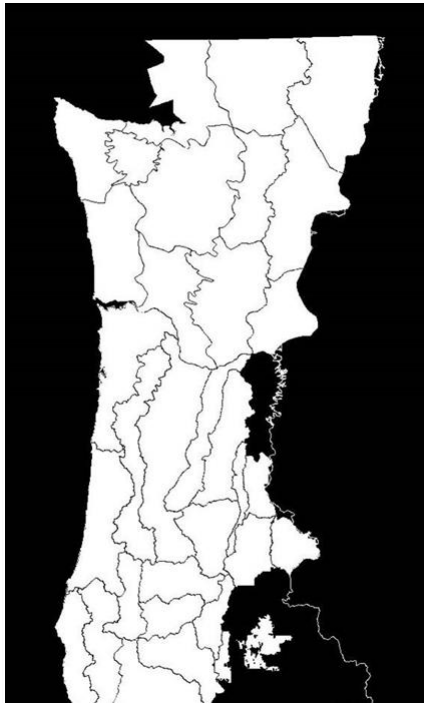
What if we do nothing?

Likely to see:

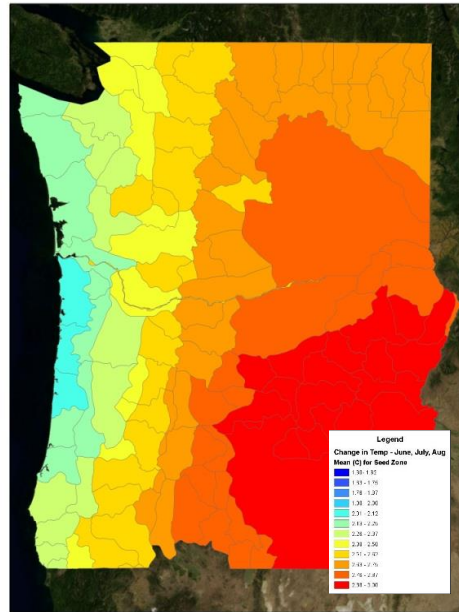
- Increases in tree mortality
- Decreases in forest health and productivity
- Increases in insect and disease outbreaks because trees are stressed
- Leading to increased fuel loads and combined with past management this will contribute to megafires

“But won’t forests just adapt and respond over time?”

What if we do nothing?



Static Zones



Projected mid-century summer
temperature increases
in PNW seed zones

Species Migration:

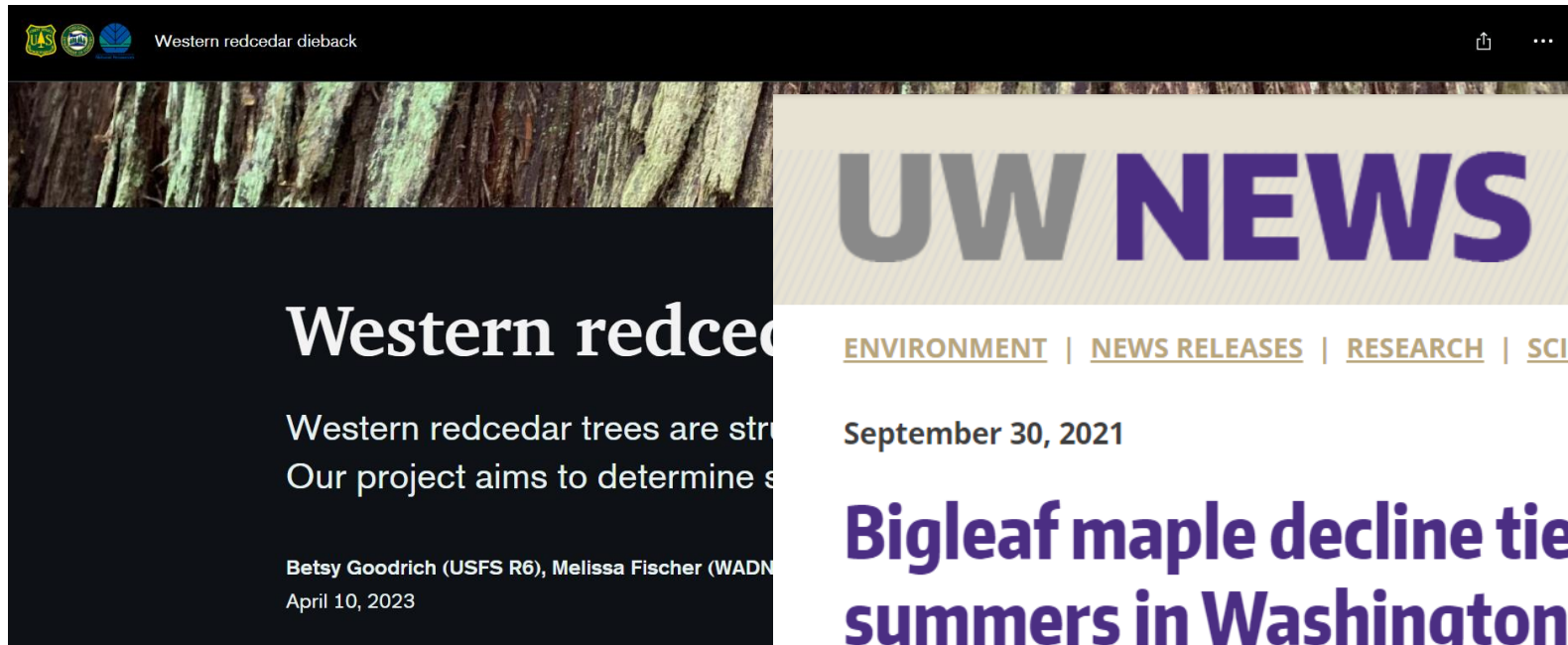
- Historical rates: < 100 m/yr.
- Needed to keep pace with climate change: > 1000 m/yr.

Species Adaption:

- Too slow

What if we do nothing?

Signs of maladaptation are already evident



The image shows a screenshot of a news article from UW News. The article is titled "Bigleaf maple decline tied to hotter, drier summers in Washington" and is dated September 30, 2021. The author is Michelle Ma. The article is categorized under "ENVIRONMENT | NEWS RELEASES | RESEARCH | SCIENCE". The article text is partially obscured by a dark overlay on the left side of the image, which contains the text "Western redcedar dieback" and "Western redcedar trees are str... Our project aims to determine s... Betsy Goodrich (USFS R6), Melissa Fischer (WADN... April 10, 2023".

Western redcedar dieback

UW NEWS

[ENVIRONMENT](#) | [NEWS RELEASES](#) | [RESEARCH](#) | [SCIENCE](#)

September 30, 2021

Bigleaf maple decline tied to hotter, drier summers in Washington

[Michelle Ma](#)

UW News

Western redcedar trees are str...
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Betsy Goodrich (USFS R6), Melissa Fischer (WADN...
April 10, 2023

Assisted Migration

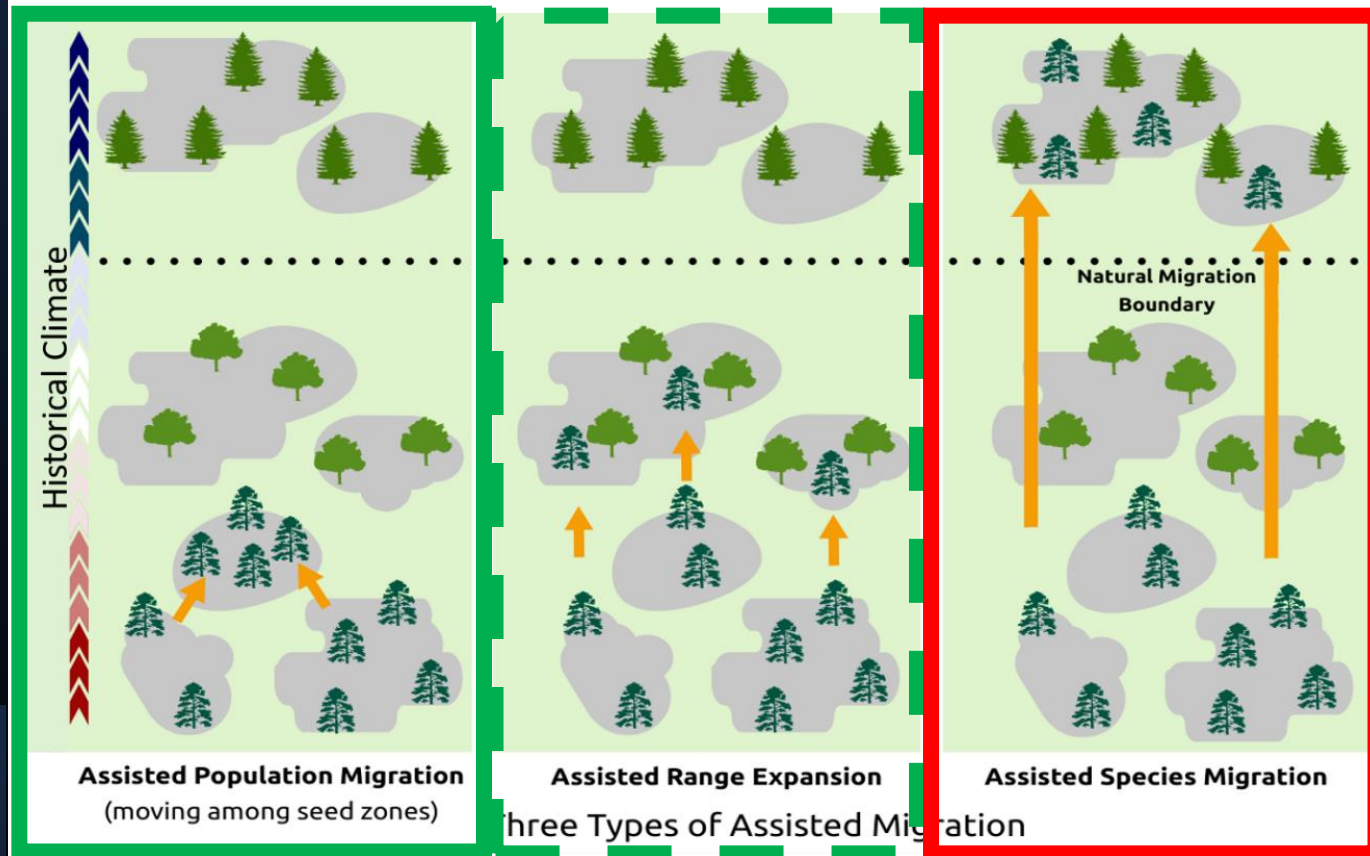


Figure 1. This graphic demonstrates each type of assisted migration using a conifer icon, though the three types of assisted migration are applicable to all plants. Different seed zones or populations are represented by distinct grey areas. Orange arrows represent human-assisted movement of plant material to a new location. The historical climate bar on the left notes the movement of plant material from warmer, drier climates (red) to historically cooler (blue), wetter climates.

What IS climate-informed seed sourcing?

Climate-
informed
seed
sourcing

≈

Assisted
population
migration

Potential Benefits of Assisted Migration

Assisted migration can:

- increase the likelihood of maintaining trees as dominant life forms in forested ecosystem
- Increase ecosystem resilience by maintaining or increasing genetic diversity
- Help maintain forest health and productivity and carbon sequestration and associated ecosystem services
- Help maintain economic value of forests by preventing losses due to maladaptation and tree mortality

Risks of Assisted Migration

- Species invasion



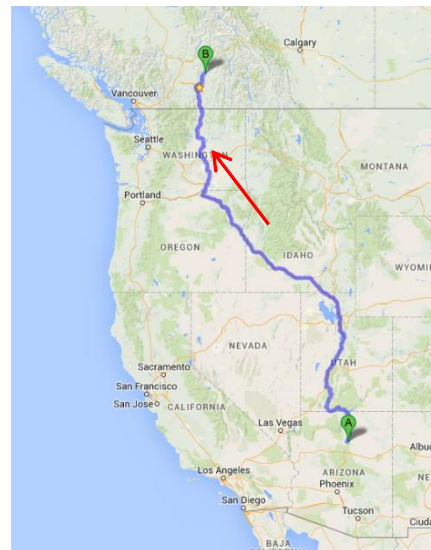
Risks of Assisted Migration

- Species invasion
- Hitch hiking pathogens or insects

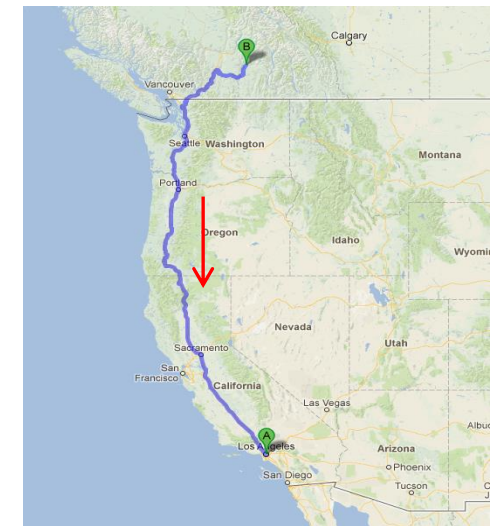


Risks of Assisted Migration

- Species invasion
- Hitch-hiking pathogens or insects
- Over-transfer



Douglas-fir
20 years old



Risks of Assisted Migration

- Hitch hiking pathogens or insects
 - Legitimate concern – but no different with AM vs. regular reforestation
- Species invasion
 - If only moving populations *within* existing species range then no issue
 - Most invasive species are from international translocations
- Over-transfer
 - Use of decision support tools for climate-informed seed sourcing will prevent this

Risks of Assisted Migration

“There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction.” - John F. Kennedy

How to *DO* climate informed seed sourcing

Seedlot Selection Tool

seedlotselectiontool.org

Seedlot Selection Tool

seedlotselectiontool.org

Seedlot Selection Tool

User Guide About Report an Issue Account Language

About Tool Layers Saved Runs

Units: Metric Imperial

- Select objective**
Find seedlots Find planting sites
- Select planting site location**
Location
Locate your planting site by using the map or entering coordinates.
Lat: 48.6262 Lon: -120.3412
Elevation: 5732 ft (1747 m)
- Select region**
Automatic Custom
Region: Western US
- Select climate scenarios**
Which climate are the seedlots adapted to?
1961 - 1990
When should trees be best adapted to the planting site?
1961 - 1990
- Select transfer limit method**

Compare Seedlots
Click to show

- Developed by OSU and the PNW Research Station
- Helps managers match seedlots with planting sites based on climatic information.
- The climates of the planting sites can be chosen to represent current climates, or future climates based on selected climate scenarios.



Can address two objectives:

Given a planting site

Which seedlot is well adapted today...or in the future?



Find



Given a seedlot

Where is it well adapted today...or in the future?



Find



Seedlot Selection Tool

seedlotselectiontool.org

The screenshot displays the Seedlot Selection Tool interface, which is used for selecting planting sites based on various criteria. The interface is divided into a left sidebar with navigation and configuration options, and a main map area showing the results of the selection process.

Navigation and Configuration:

- Seedlot Selection Tool** (Logo)
- Navigation: [User Guide](#), [About](#), [Report an Issue](#), [Account](#), [Language](#)
- Menu: [About](#), [Tool](#), [Layers](#), [Saved Runs](#)
- Units: **Metric** (selected), Imperial

Configuration Steps:

- Select objective:** [Find seedlots](#) (selected), [Find planting sites](#)
- Select planting site location:** Location: *Locate your planting site by using the map or entering coordinates.*
Lat: Lon:
Elevation: 5732 ft (1747 m)
- Select region:** [Automatic](#) (selected), [Custom](#)
Region: Western US
- Select climate scenarios:** Which climate are the seedlots adapted to?
 (selected)
When should trees be best adapted to the planting site?
 (selected)
- Select transfer limit method:**

Map Area:

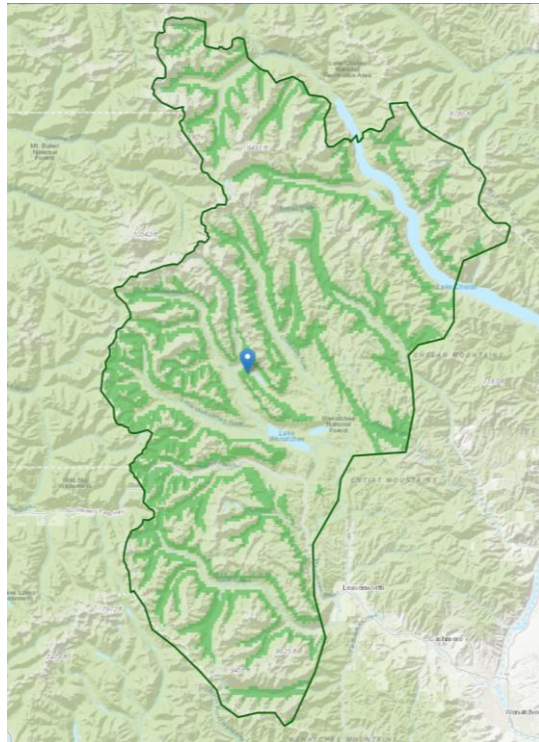
- Two side-by-side maps showing the same geographic area (Chelan Mountains region).
- The left map shows the results for the 1961-1990 climate scenario, with seedlots highlighted in orange and red.
- The right map shows the results for the 2011-2040 climate scenario, with seedlots highlighted in yellow and orange.
- Map controls: Zoom in (+), Zoom out (-), Full screen, Search, Layer visibility, and a globe icon.
- Map labels: Ross Lake National Recreation Area, Okanogan National Forest, Lake Chelan National Recreation Area, CHELAN MOUNTAINS, Chelan River, Okanogan River, Baker Lake, Okanogan, Chelan, 9497 ft, 3817 ft.
- Map footer: Leaflet | Tiles © Esri — Esri, DeLorme, NAVTEQ

Comparison Controls:

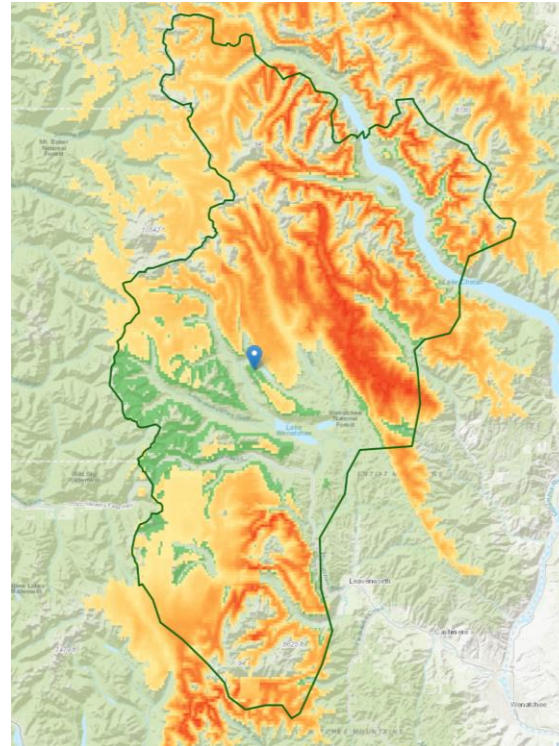
- Compare Seedlots** (Click to show) -
- Compare Seedlots** (Click to show) -

Seed Collection Area \neq Seed Deployment Area

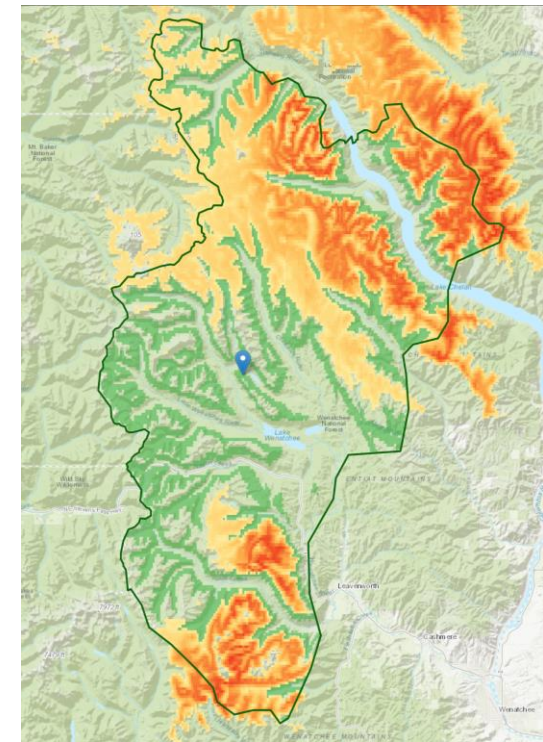
- Plants are adapted to prevailing climate, not lat./long. or elevation
- Collection area is static, appropriate deployment area is a moving target



Seed Collection Area 3500' – 5000'
Historic climate



Seed Deployment Area
Current Climate





Seed Deployment Area
Mid Century Climate

Key questions on using the SST


- What time period(s) to look at?
- Which RCP?
- What climate variables to use?

Resources

ECOSPHERE
AN ESA OPEN ACCESS JOURNAL

ARTICLE | [Open Access](#) |  

Seedlot Selection Tool and Climate-Smart Restoration Tool: Web-based tools for sourcing seed adapted to future climates

John Bradley St.Clair  Bryce A. Richardson, Nikolas Stevenson-Molnar, Glenn T. Howe, Andrew D. Bower, Vicky J. Erickson, Brendan Ward, Dominique Bachelet, Francis F. Kilkenny, Tongli Wang
... [See fewer authors](#) ^



USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northwest Climate Hub | Pacific Northwest Research Station | Pacific Northwest Region

Seedlot Selection Tool Guidebook for USFS Region 6 Silviculturists

<https://www.climatehubs.usda.gov/content/seedlot-selection-tool-guidebook-usfs-region-6-silviculturists>

Summary

Climate change is a threat to Forest productivity and health

Climate informed seed sourcing is using the seed from the right source

Local is best but not necessarily geographically local but climatically local

Assisted population migration - important tool to ensure plantings are adapted to current and future climates

The Seedlot Selection Tool is a powerful analytical tool for climate matched seed sourcing

Thank You!

