



The Role of Common Garden Studies in Adapting Forests to Climate Change in the Northwestern United States

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Taskforce on Adapting Forests to Climate Change

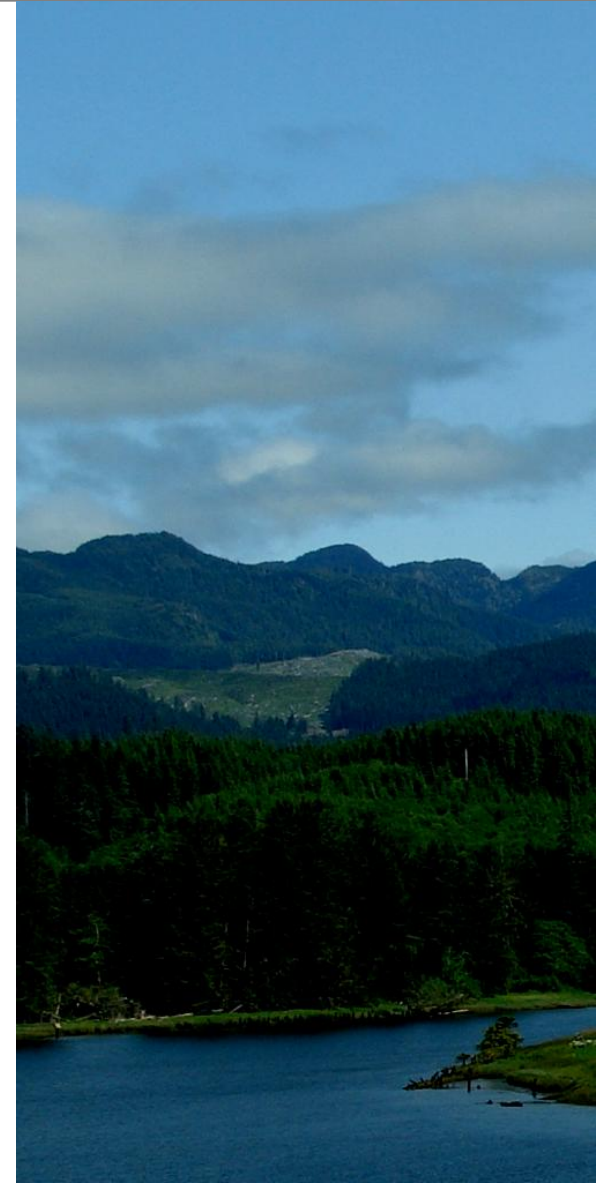
Taskforce on Adapting Forests to Climate Change

The TAFCC is a group of scientists and land managers interested in:

- Understanding the potential effects of climate change on forests in the western U.S.
- Providing forest landowners with science-based management options suitable for meeting diverse management objectives under alternative climate change scenarios

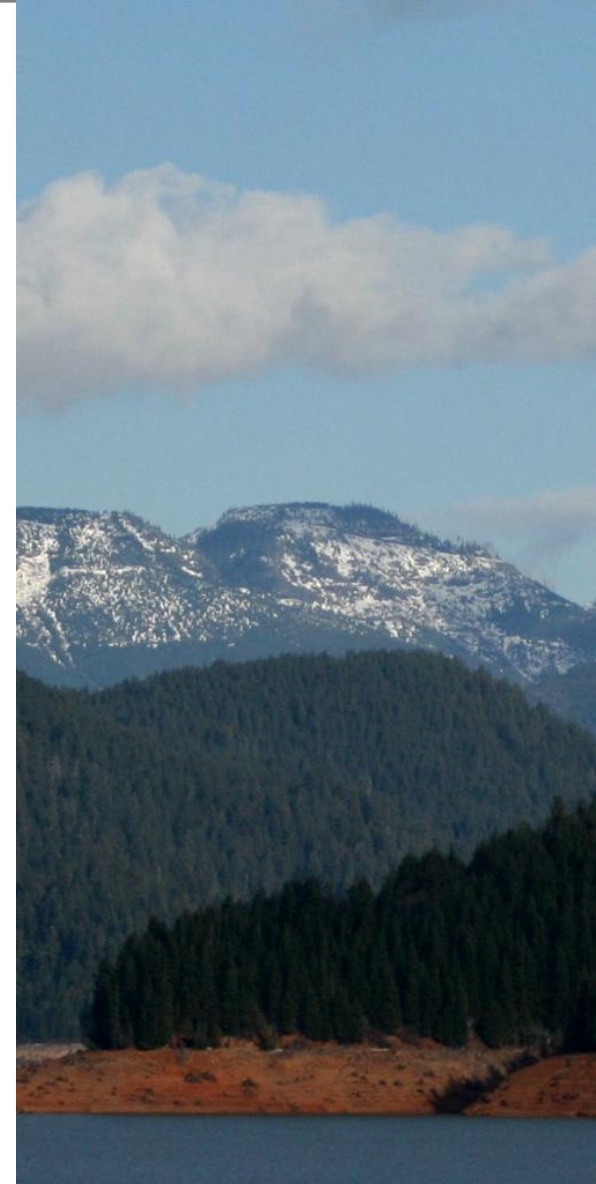


Taskforce on Adapting Forests to Climate Change



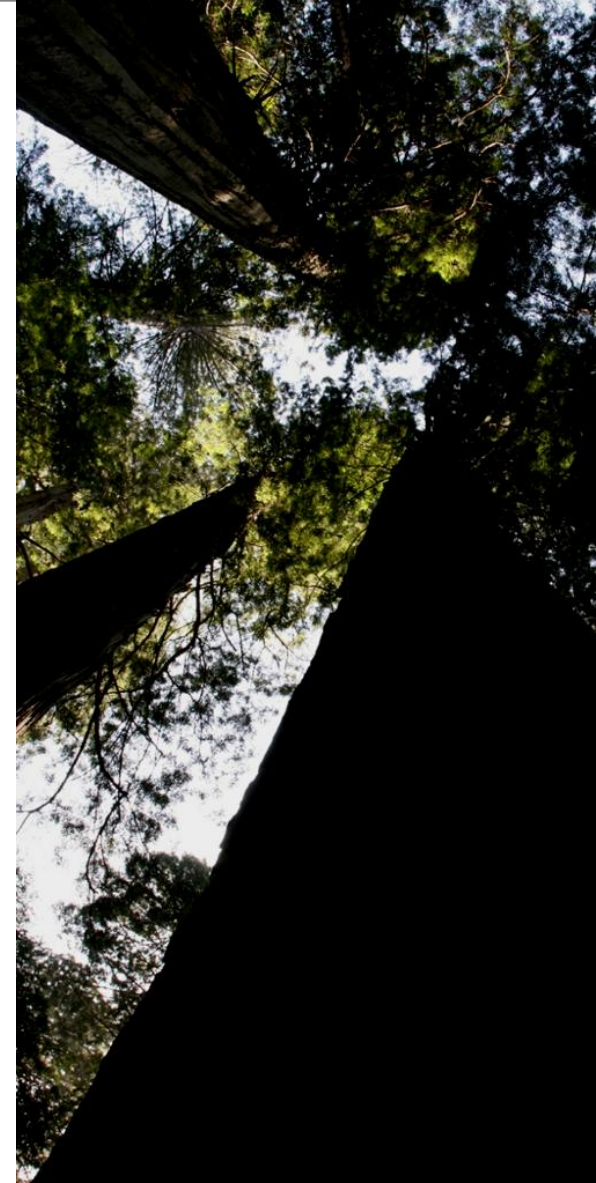
Outline

- The role of genetic variation in forest adaptation to climate change
- How to approach management of genetic resources to help forests adapt to future climates
- Tools for decision support
- Closing remarks



Trees

- Are key components of forest ecosystems
- Are economically important and provide multiple other ecosystem services
- Long-lived - many of today's trees will be exposed to the climate of the end of the century
- Have long generation intervals, meaning that adaptation is slow



Genetic Variation Cannot Be Ignored

- Trees are genetically adapted to their local environments
- Therefore populations, not the species as a whole, should be the management units

Provenance tests

*Douglas-fir in Spain
(Hernandez et al 1993)*



*Lodgepole pine in New
Zealand (Wright 1976)*



*Lodgepole pine
in Finland*



Finnish Forest Research Institute

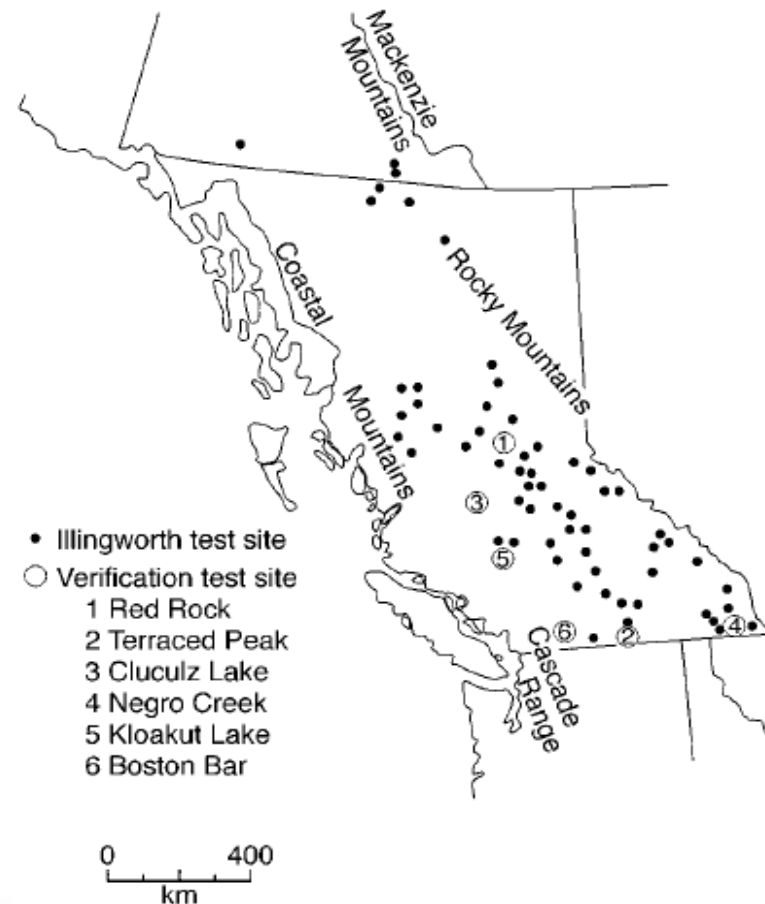


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Using Provenance Data to Project Impact of Climate Change on Forest Trees

Lodgepole pine
provenance test in BC
Illingworth series

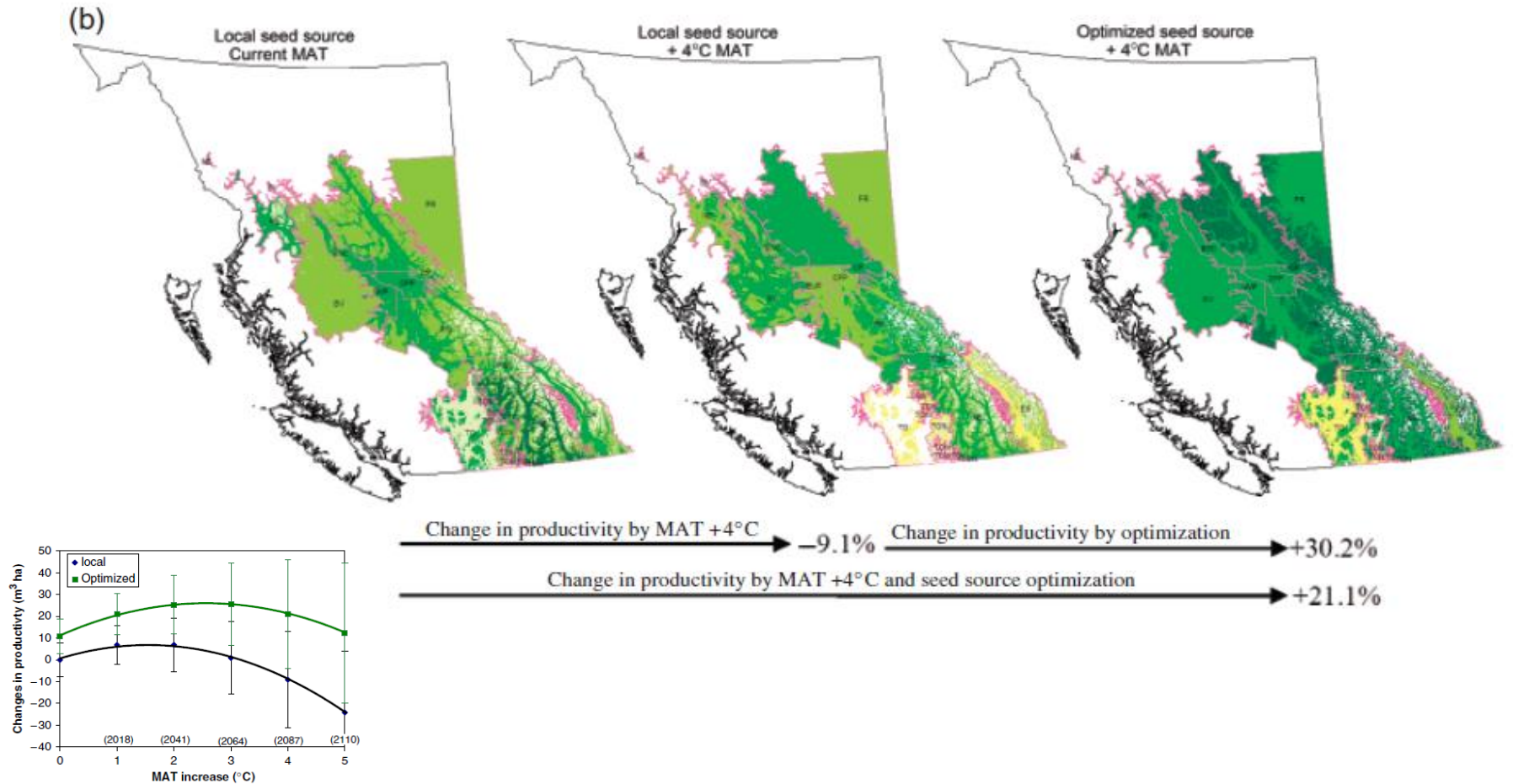
- 60 sites
- 142 populations



Rehfeldt et al. 1999. *Ecol. Monogr.* 69: 375-409



Using Provenance Data to Project Impact of Climate Change on Forest Trees

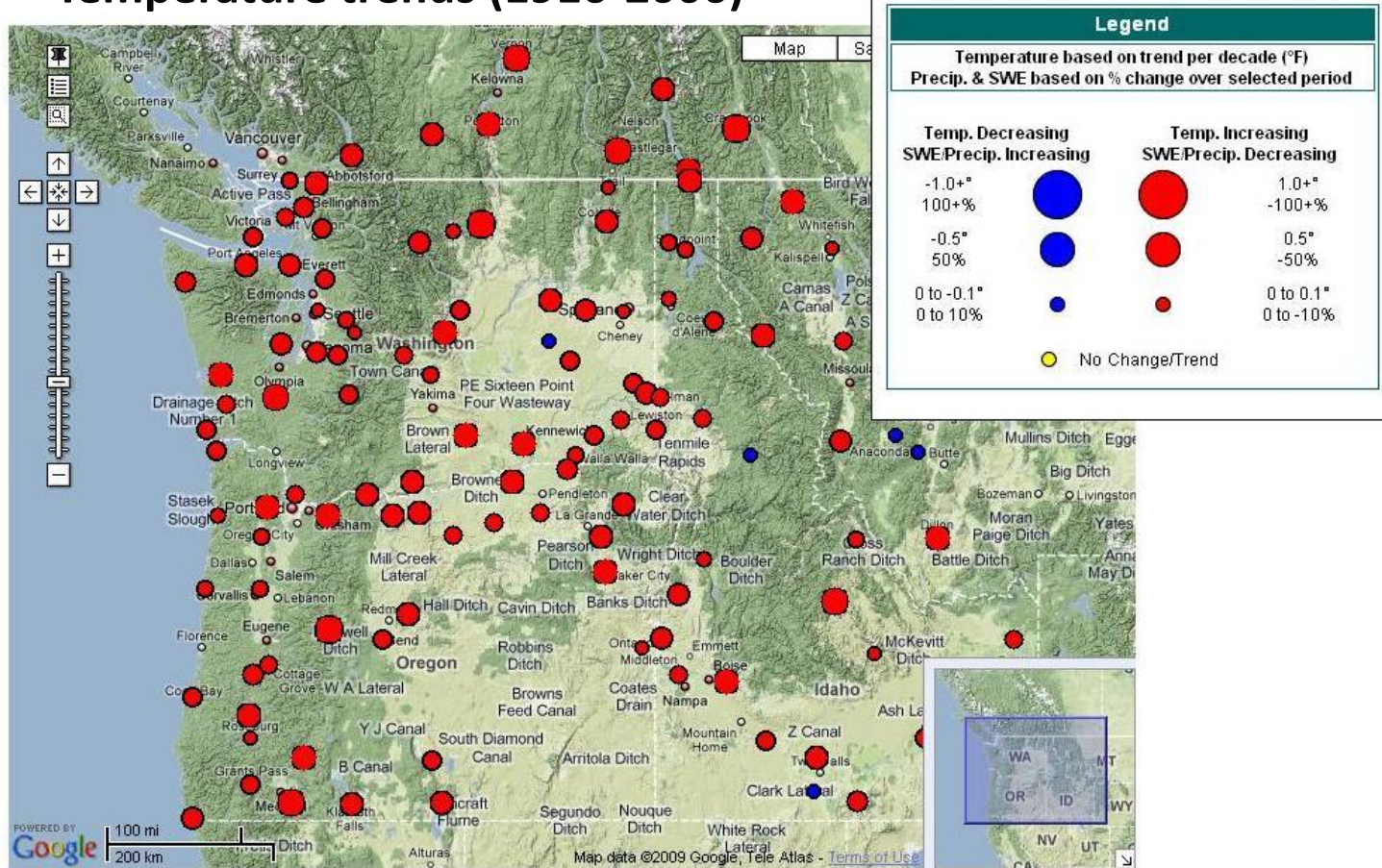


Wang et al. 2006. *Glob. Change Biol.* 12: 2404-2416



The Climate in the Pacific Northwest is Changing

Temperature trends (1916-2006)



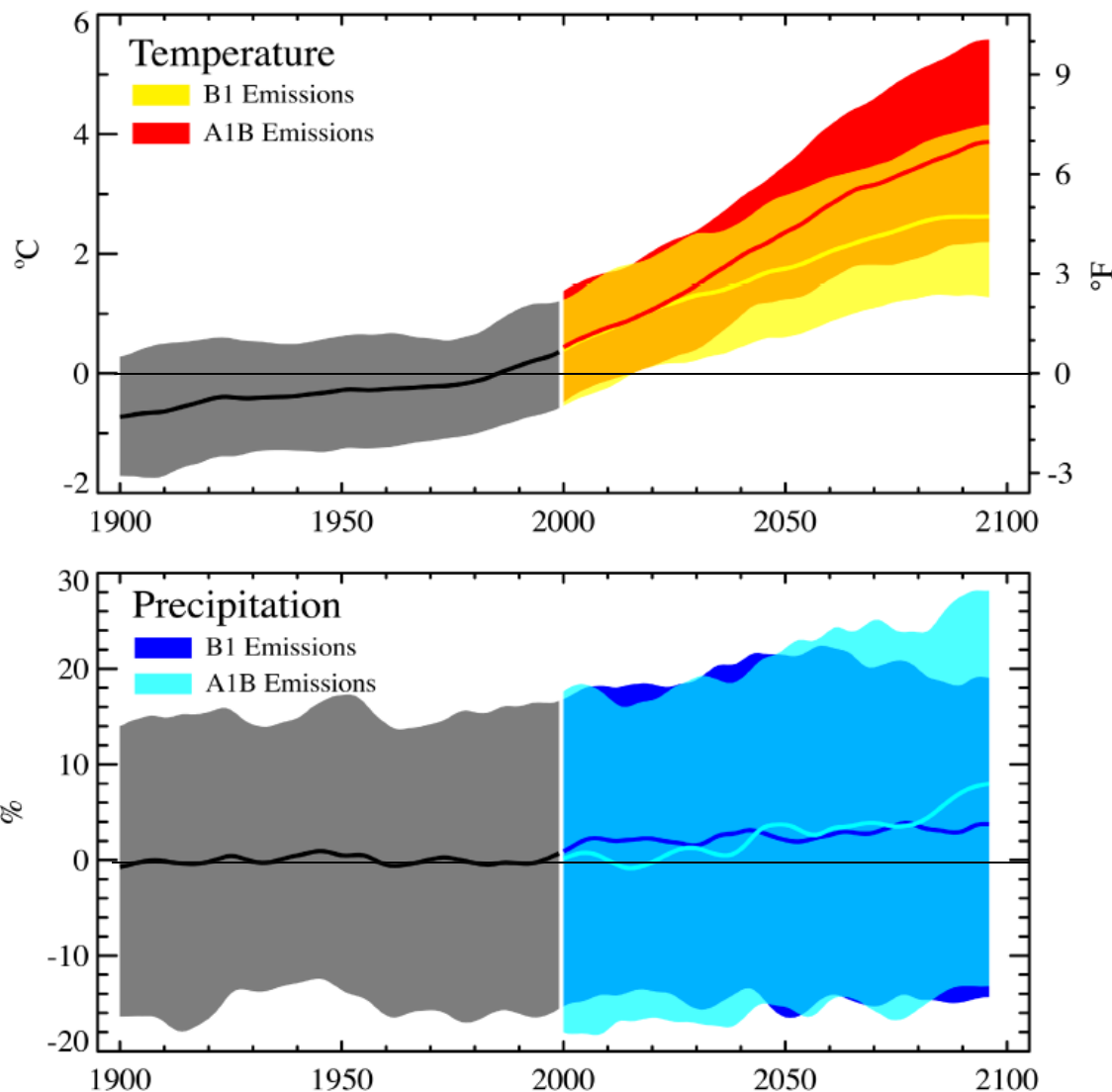
Is the Pacific Northwest Climate Going to Change Further? – Yes

Relative to the 1970-1999 mean,
at the end of the 21st century:

- Annual temperatures are likely to be warmer
- Annual precipitation may slightly increase

There is substantial variability associated with these projections.

Mote and Salathé (2009)



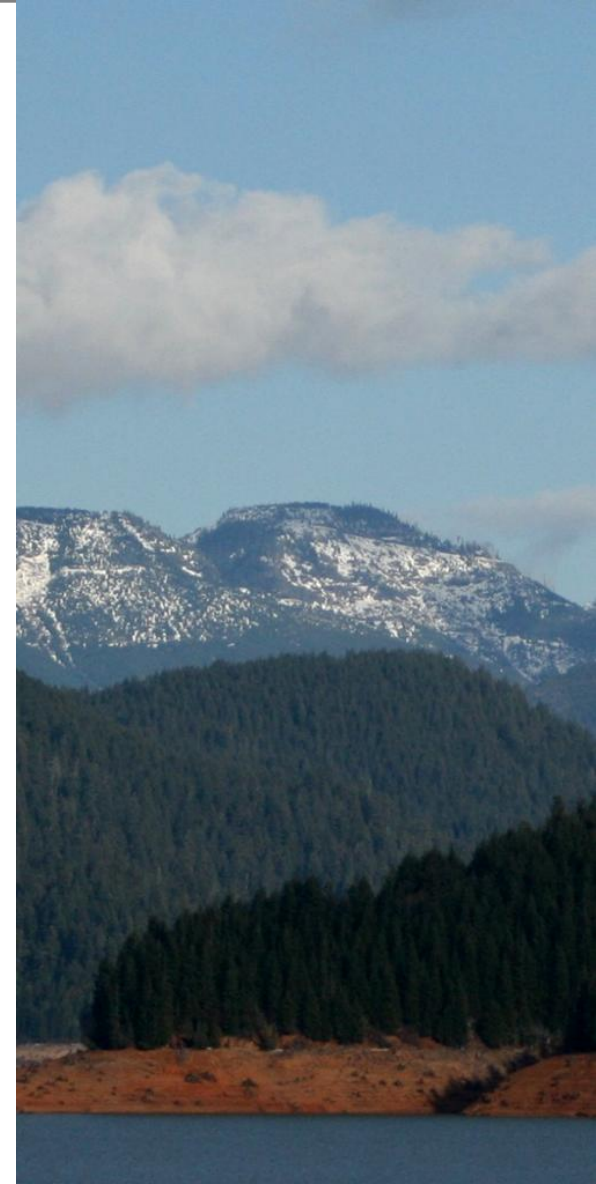
Trees and Forests Will be Challenged by Climate Change

- **Abiotic stressors**
 - Wildfires
 - Summer droughts
 - Summer heat
 - Warm winters
 - Spring and fall frosts – even with general warming
- **Biotic stressors**
 - Insects and pathogens
 - Competition, including invasive exotic species



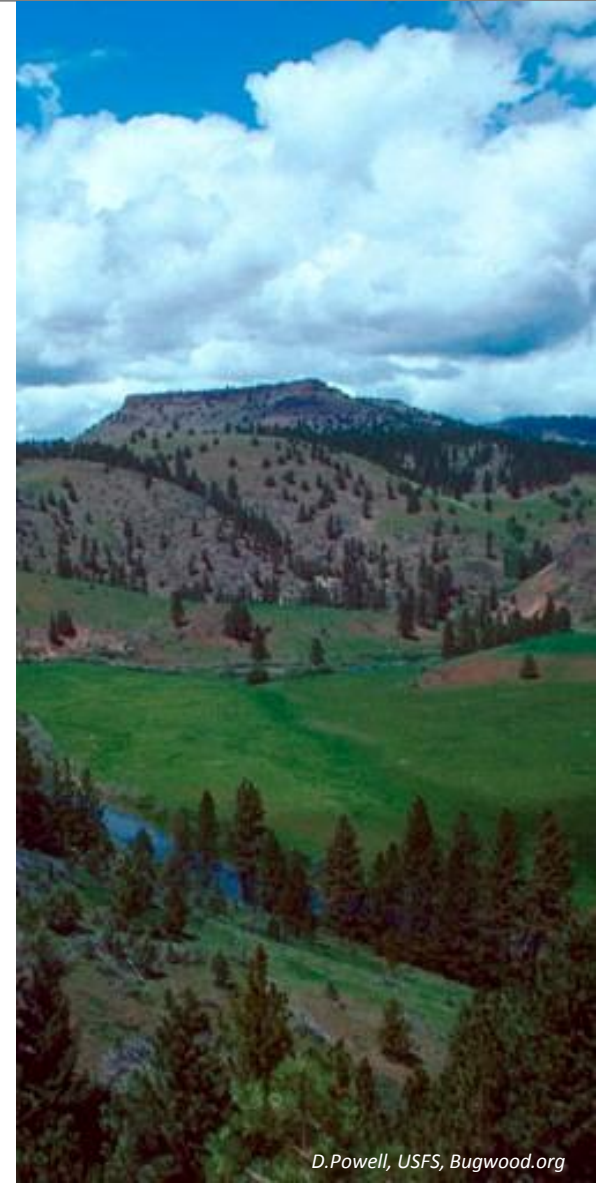
What Can We Do?

- Understand climate variability and climate change
- Understand climate change impacts on forests
- Help forests adapt to climate change – use Genetic Options for adaptation



Genetic Options for Adaptation

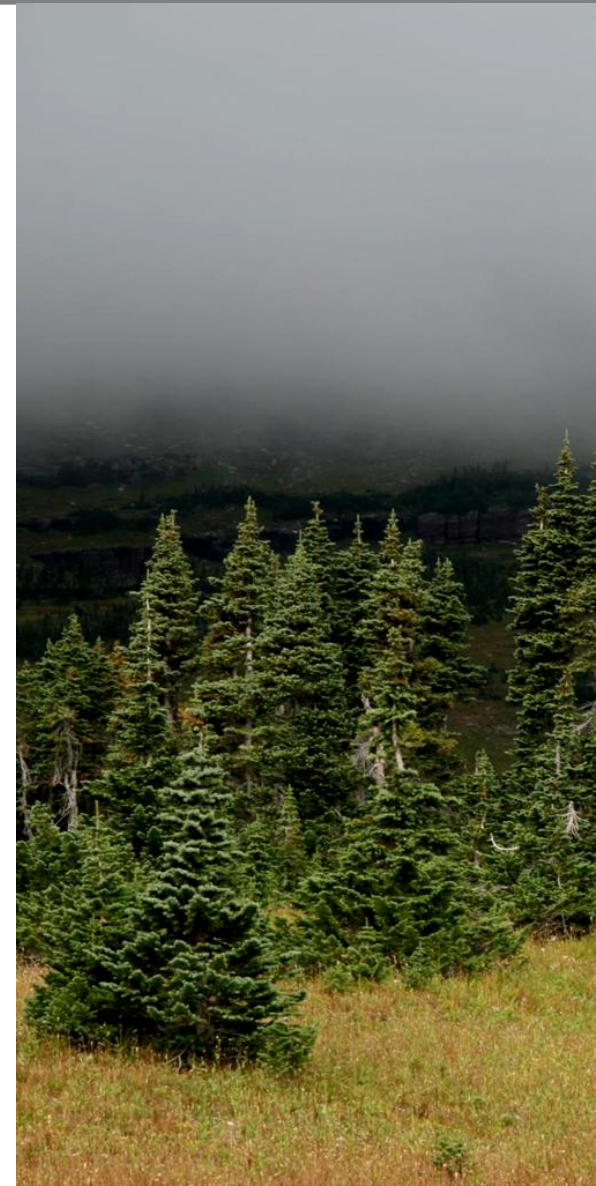
- Conserve genetic diversity
 - In situ (on site)
 - Ex situ (outside)
- Understand and manage populations within the species
 - Seed zones
 - Breeding zones
- Help populations migrate
 - Natural migration
 - Assisted migration
- Develop improved genotypes
 - Selection and breeding
 - Genetic engineering



Conserve Genetic Diversity

Maintain species diversity and within-species variation

- *In situ* (on site) reserves
 - Valuable populations
 - Areas of high environmental and genetic diversity
- *Ex situ* (outside) reserves
 - Endangered populations
 - Seed and tissue collections for long-term storage
 - Assisted migration
 - **Provenance tests** – provided enough variation is represented



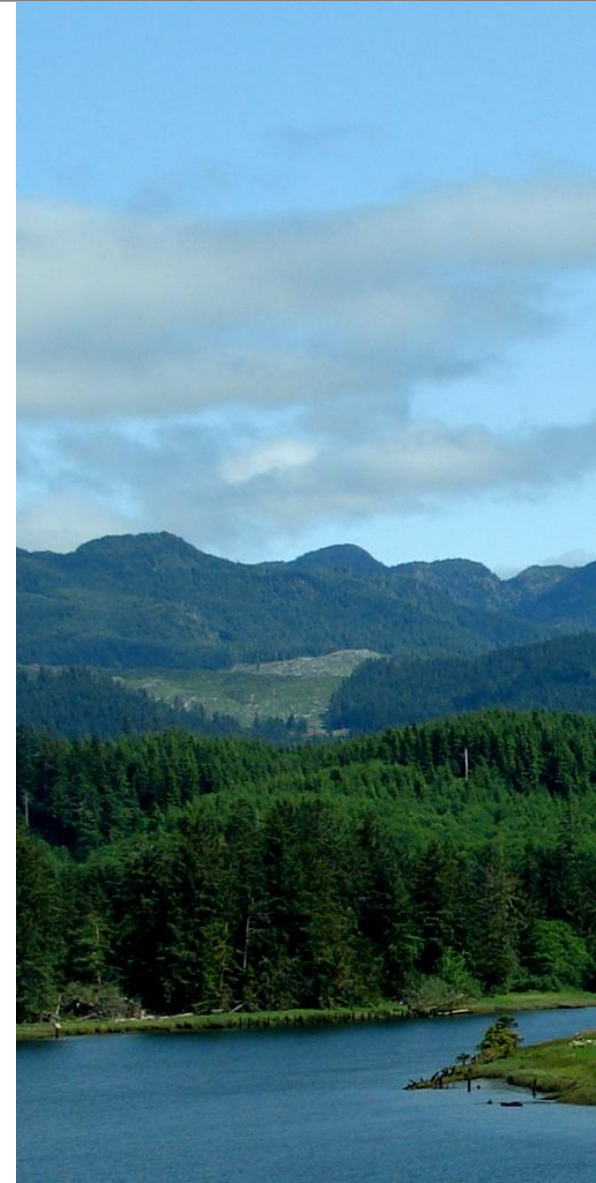
Promote Migration

Natural migration

- Avoid landscape fragmentation to facilitate migration via pollen and seed
- Maintain forests in all succession stages (age classes) across the landscape

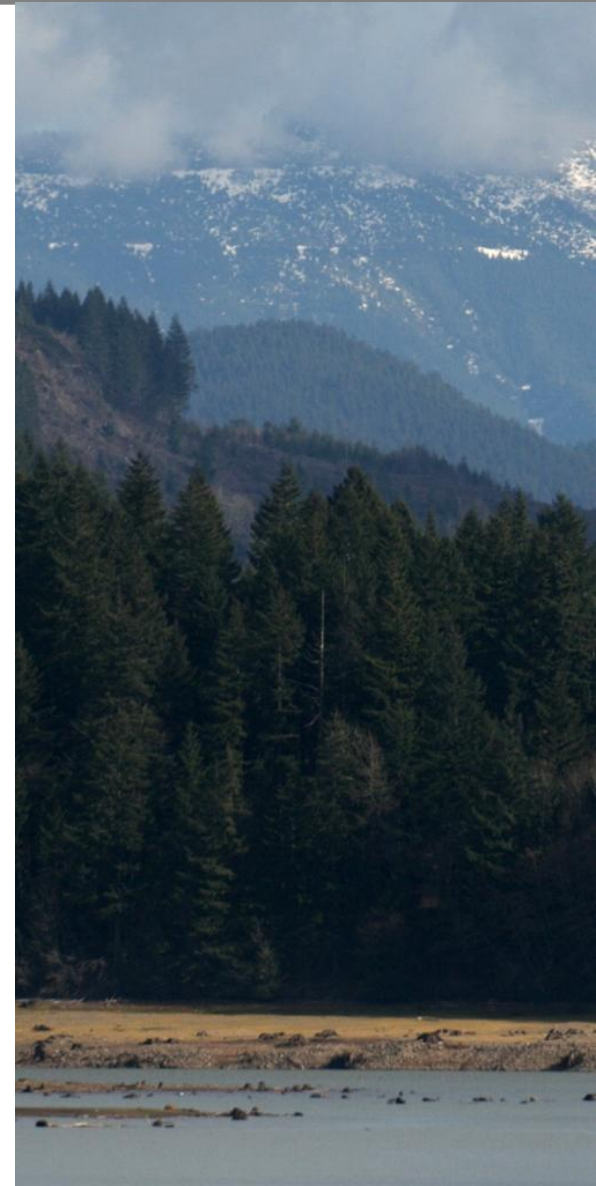
Assisted migration - planting

- Facilitate migration of populations within the species to help track the climate



Applications

- Seedlot Selection Tool
- Center for Forest Provenance Data



Seedlot Selection Tool

- On-line seed transfer decision-support tool:
- helps foresters select seedlots that are adapted to current and future climates at their sites
 - works for multiple species with a user choice of **multiple climatic variables** and **various climate change scenarios**



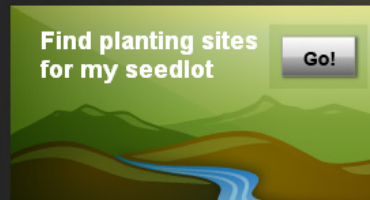
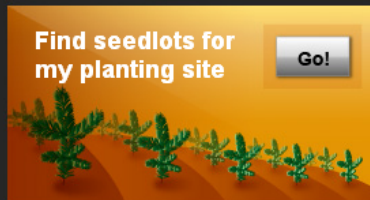
The screenshot shows the website for the Seedlot Selection Tool. At the top, there is a navigation menu with links for Home, About, Instructions, Related Sites, and Contact Us. The main header features a logo with a stylized sun and leaves, and the text "Seedlot Selection Tool". Below the header, there are two prominent buttons: "Find seedlots for my planting site" and "Find planting sites for my seedlot", both with "Go!" buttons. The main content area is titled "Planting Healthy Forests" and contains a paragraph describing the tool as a GIS mapping program. To the right, there is a section titled "How the tool works" with four numbered steps: 1. Select Your Goal, 2. Login, 3. Enter Location, and 4. Select Species. Each step includes a small icon and a brief description of the action. A "Purpose" section on the left includes a small map image and text explaining the tool's use for forest managers.

<http://sst.forestry.oregonstate.edu/>

Contact Glenn Howe or Ron Beloin at OSU for details

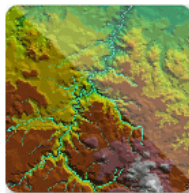


Seedlot Selection Tool



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.



[+ See Example Map](#)

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 practices, climate change assumptions, and risk tolerance of the user.

Background

Populations of trees, such as those from native stands or **seed orchards**, are genetically different from one another, and are adapted to different climatic conditions. Therefore, forest managers must match the

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 inputs.



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 use an existing zone to calculate a limit.

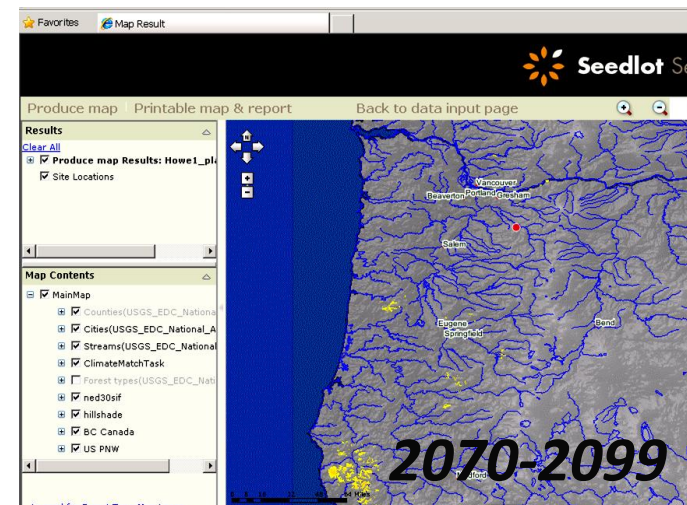
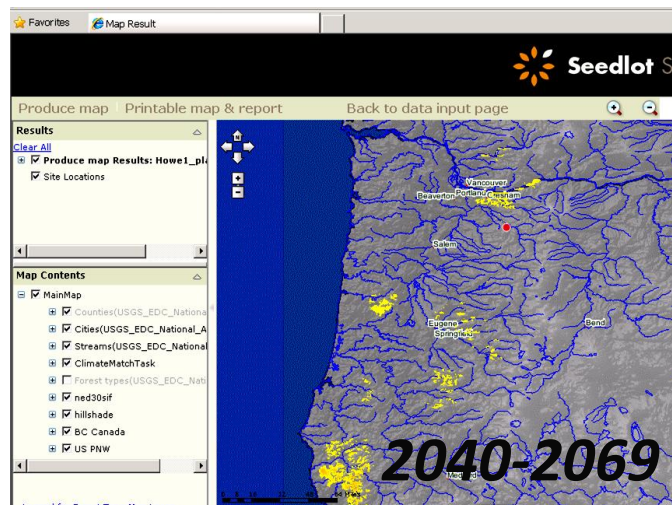
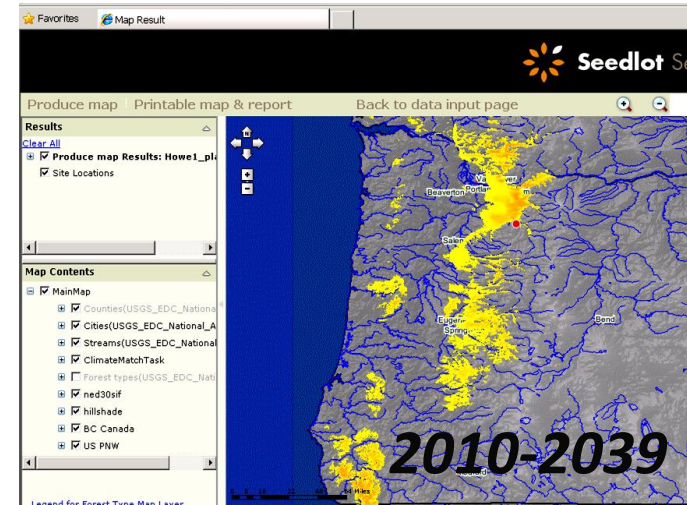
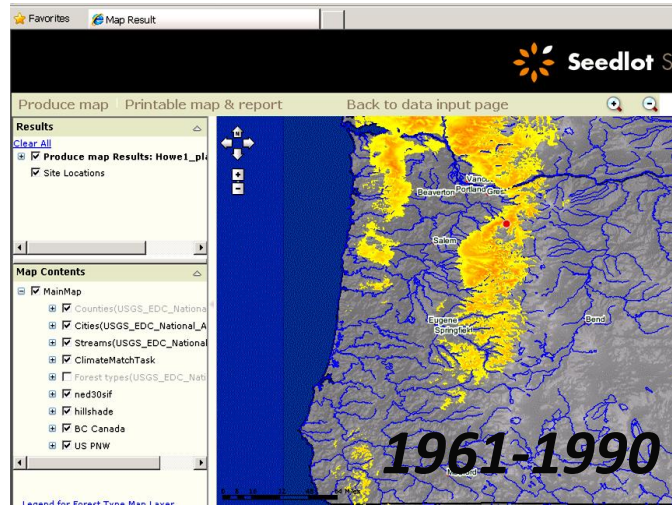


6. Select Climate Models

Use present climate only, or present and future climates by selecting an emissions scenario, future climate model, and year.

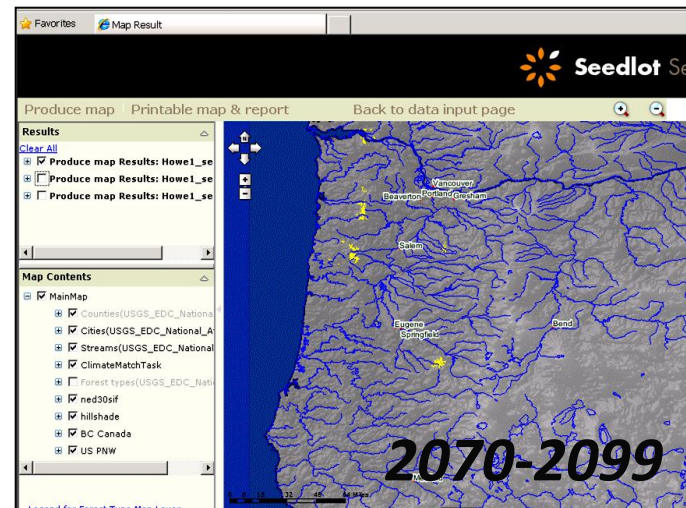
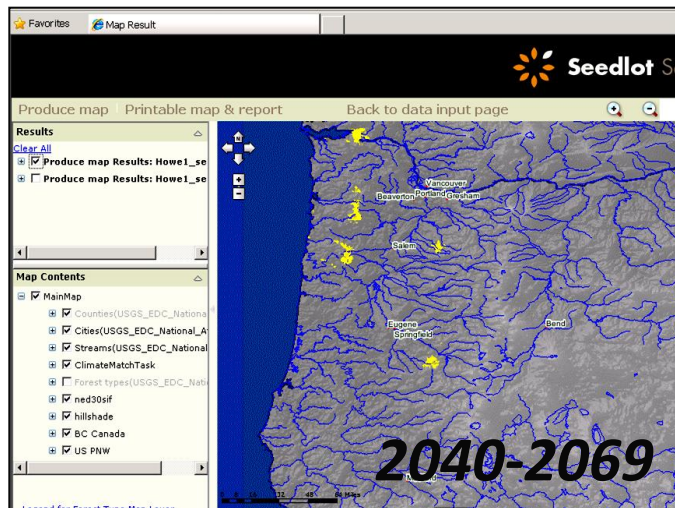
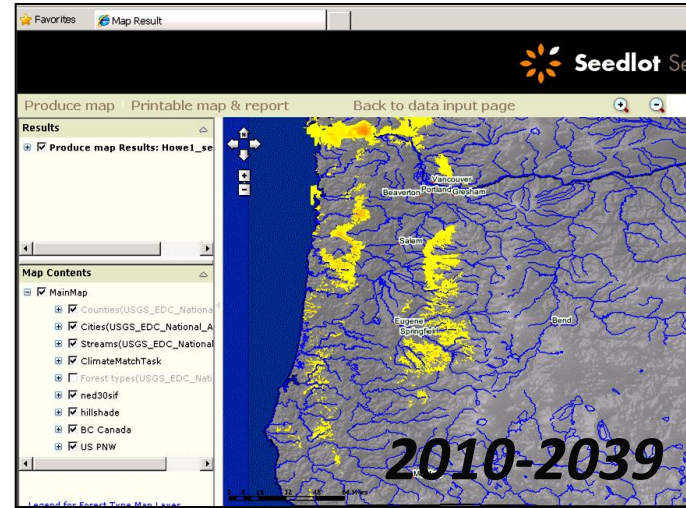
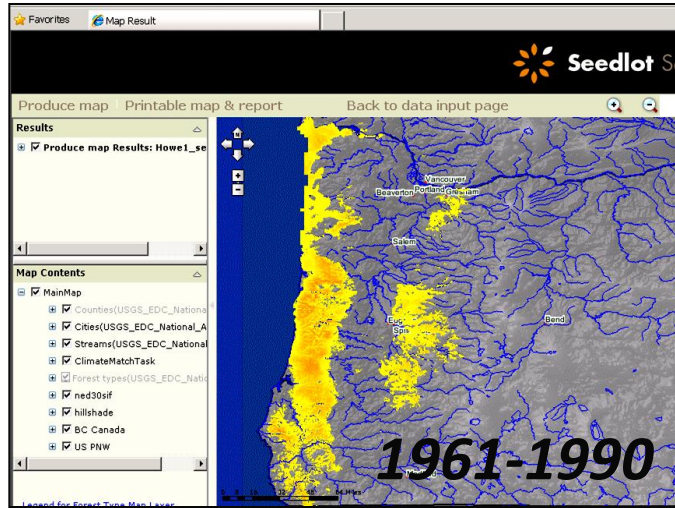
Seedlot Selection Tool

Find Seedlots for My Planting Site



Seedlot Selection Tool

Find Planting Sites for My Seedlot



Center for Forest Provenance Data

- A centralized data and information management system to archive, maintain, and distribute forest genetics data
- Data will be available to researchers for promoting national and international collaboration to study forest genetics, plant adaptation, and responses to climate change
- Hardware and software has been configured to ensure that the data are safely archived and accessible now and in the long term

<http://cenfor.gen.forestry.oregonstate.edu/>





Center for Forest Provenance Data



Retrieve Data

Search for and download datasets from forest provenance studies



Submit Data

Upload data from long-term provenance tests and seedling geneecology tests



Healthy forests for a changing world

The Center for Forest Provenance Data is a place for researchers to go to archive their data from provenance and geneecology studies of forest trees and make those data available for collaboration with other researchers.

Provenance and geneecology studies consider genetic variation among forest trees from different source locations by growing them in replicated tests in a common environment such that observed differences are primarily due to genotype and not the environment. Consistent differences among sources that are associated with environmental gradients are indicative of adaptively significant variation. Provenance and geneecology studies are important for understanding adaptive variation across the landscape and managing genetic resources for reforestation, restoration, gene conservation, and responding to climate change.

The Center for Forest Provenance Data has sections for submitting and retrieving data from the database. There is also a search tool for determining studies that are currently in the database.

To submit or retrieve data, you will be asked to create a profile including a username and password for logging onto the site. Creating a profile provides us with contact information that will allow us contact you with questions or updates. The contact information will not be used for any purposes not related to managing the database.

[Learn More](#)

Retrieve Data

Submit Data

Search and Retrieve Studies

View study with ID#

Retrieve Data

Use the search tools to the right to find the study of interest. You can either search the database using keywords that are part of a study or you can search the database by species names (scientific or common). The species drop-down menu includes only those species that are currently in the database. You can view all studies in the database by clicking on the View All Studies button.

If you download data, we strongly encourage you to contact the primary contact to discuss collaboration. It is important to recognize people who conducted these experiments and made the data available (Sieber 2005*), and they may have important insights into data quality, analysis, and interpretation. Please use these data in a spirit of appreciation and open collaboration.

* Sieber, J.E. 2005. Ethics of sharing scientific and technological data: a heuristic for coping with complexity and uncertainty. *Data Science Journal* 4: 165-170.

Keyword Search

Species Dropdown Menu

[View All Studies](#)

Douglas-fir

Search



Retrieve Data

Submit Data

Search and Retrieve Studies

View study with ID#

Search Results

Sort by

1 result(s) found for 'Douglas-fir'

STUDY ID
1

[Provenance Study of Douglas-fir in the Pacific Northwest Region](#)

The purpose of this study was to detect genetic variations of this widely distributed species and to correlate the existence of distinct races if any, with geographical variables such as latitude and altitude.

SCIENTIFIC NAME	Pseudotsuga menziesii
COMMON NAME	Douglas-fir
STUDY TYPE	field
CONTACT	Glenn Howe
ESTABLISHED BY	Kim K. Ching

Search and Retrieve Studies

View study with ID#

STUDY ID

1

Provenance Study of Douglas-fir in the Pacific Northwest Region

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COMMON NAME Douglas-fir

STUDY TYPE field

CONTACT Glenn Howe

ESTABLISHED BY Kim K. Ching

View Data

Tables may be viewed for each component of the study. If only the header appears for that set of records, it means there are no records for that particular study component.



Study Information

View Data

Accession / Provenance Information

View Data

Test Site Information

View Data

Response Data

View Data

Contact Information

View Data

Download Data

Alternatively, you may download the tables for this study in an Excel workbook. Check the components you would like to include and hit submit.

 Study Information Accession / Provenance Information Test Site Information Response Data Contact Information

Name your file

File Format

 xls (Excel 2003) xlsx (Excel 2007)

[Retrieve Data](#)[Submit Data](#)Center for
Forest Provenance Data [Overview](#)[Download Templates](#)[Upload Files](#)

Submit Data

Contributing data from your provenance study to the Center for Forest Provenance Data consists of three steps:



Download

the Excel templates
from this web site

[Download Templates](#)

Enter

the data from your
study into the Excel
files



Upload

your Excel files back
to this web site

[Upload Files](#)

Downloading the Five Template Files

Information from provenance tests is submitted to the Center for Forest Provenance Data in five parts. To contribute data from your provenance study, you must download and complete an Excel file for each of the five components of the database. Each Excel file will be used to fill in the corresponding tables in the database. The spreadsheet program used is Microsoft Excel version 2003.

The five components of the database are described below:

1. Study Information. General information about the study including a name for the study, the type of study (field, nursery, greenhouse, or controlled-environment), the species involved, the overall number of accessions, provenances and test sites, general information about the geographic range of

Entering Your Data

Data for your specific provenance study is entered into each of the five template files. The Study Information template is an Excel file that is in the format of a form for which you enter general information about the study. The other four templates involve inserting your Excel worksheet into the first worksheet of the template, then indicating the variables that are in each column in the second worksheet of the template (the "Metadata"). The second worksheet includes a list of variables that might be expected for each component of the database, along with descriptions of the variables, formatting rules, and a place to indicate the units used. Not everyone will use every variable suggested in the metadata worksheet. Some variables, however, are a necessary part of a provenance study (e.g.,

Uploading Your Files

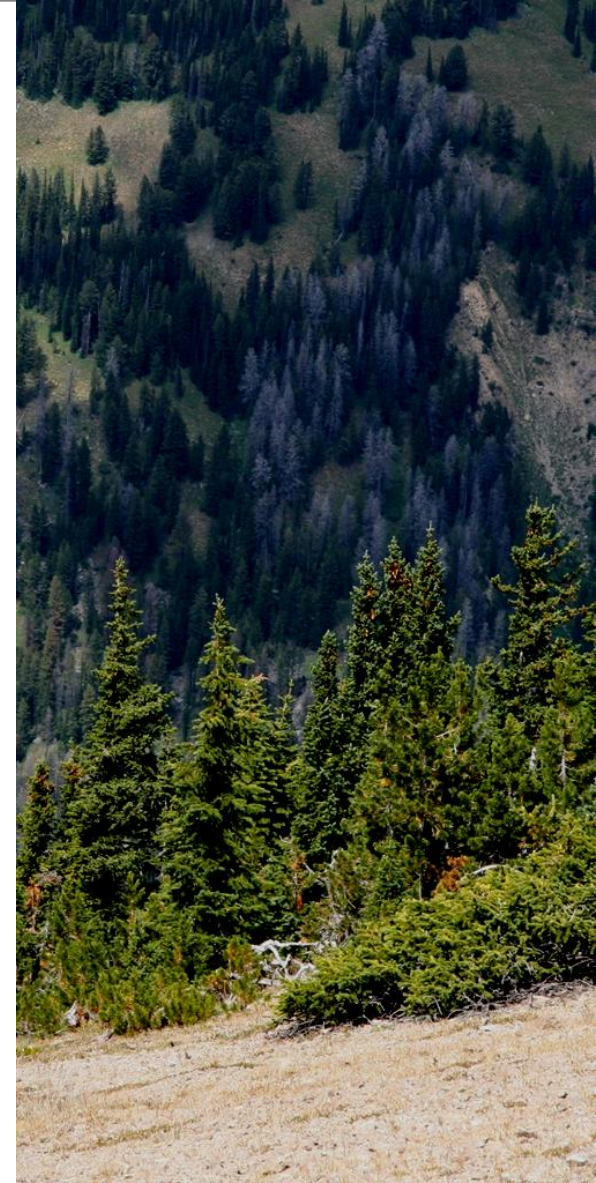
To submit files (or retrieve files from the database), you must create a profile using an email address and password. The email address and password are used to log-in on subsequent visits when submitting or updating files. Creating a profile provides us contact information in case we need to contact you with questions or updates. The contact information will not be used for any purposes not related to managing the database. Once you have logged-in, submitting your data is simply a matter of choosing the files from your computer and clicking Submit.

The submission process allows users to enter all or part of the data at one time, and return to enter additional data in the future. You may enter:

- Only the study information

Needs

- Better projections of local climate
- Information on population responses to climate – especially for non-commercial species
- Information to populate database
- Resolve ownership issues – credits to original scientists, proprietary datasets, data release, etc.



Conclusions

- Common garden studies play a profound role in advancing our understanding of population's responses to climate
- Information generated in this kind of tests have been used to develop the information-sharing tools and decision support tools
- These tools can and should be used to help adapt forest to future climates



Acknowledgements

Ron Beloin SST <http://sst.forestry.oregonstate.edu/>

Denise Cooper CFPD <http://cenfor.gen.forestry.oregonstate.edu/>

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- Oregon State University
- Oregon Forest Resources Institute
- USDA Forest Service Pacific Northwest Research Station
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- Oregon Department of Forestry
- USDA Forest Service Western Wildlife Environmental Threat Assessment Center
- USDA Forest Service Region 6
- Washington Department of Natural Resources
- USDI National Park Service

SST is a joint project by: OSU and USDA Forest Service PNW Research Station

CFPD is a joint project by: OSU, USDA Forest Service PNW Research Station, and USDA Forest Service PSW Research Station



Thank You

Visit us at <http://tafcc.forestry.oregonstate.edu/index.html>



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