## Seed Transfer 2.0

- Seed transfer/AM rationale and risks
- AM using focal point ST system
- Migration distance and CSTD
- AM using hybrid ST system


Image: Mike Carlson


Image: Sally Aitken

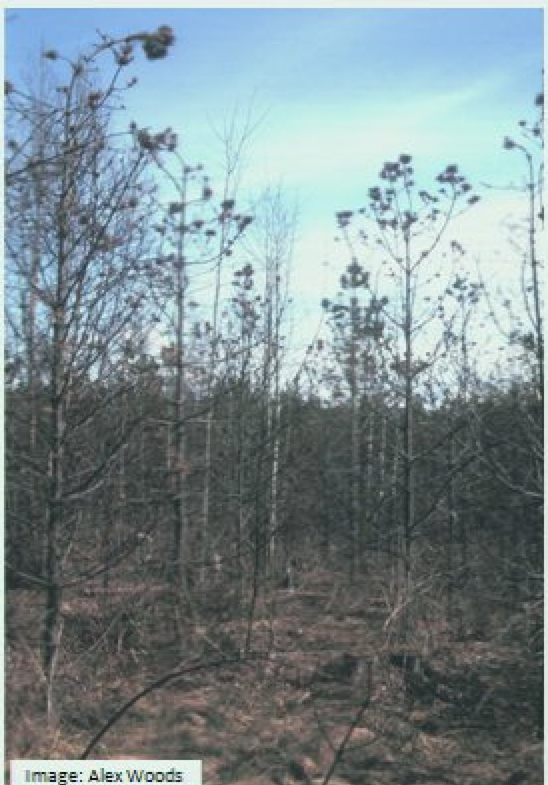


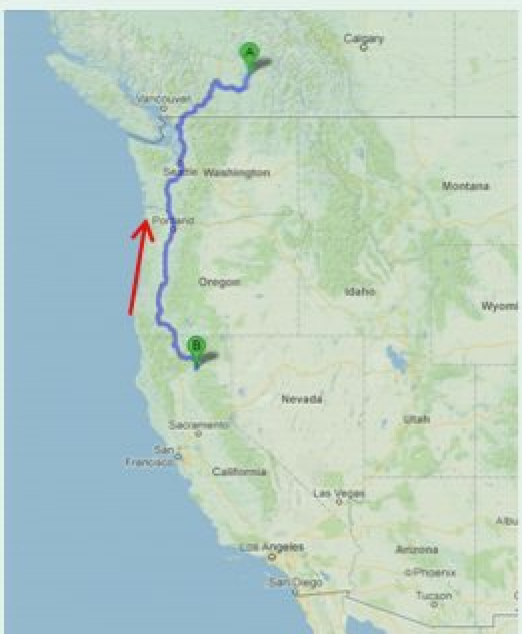
Image: Alex Woods

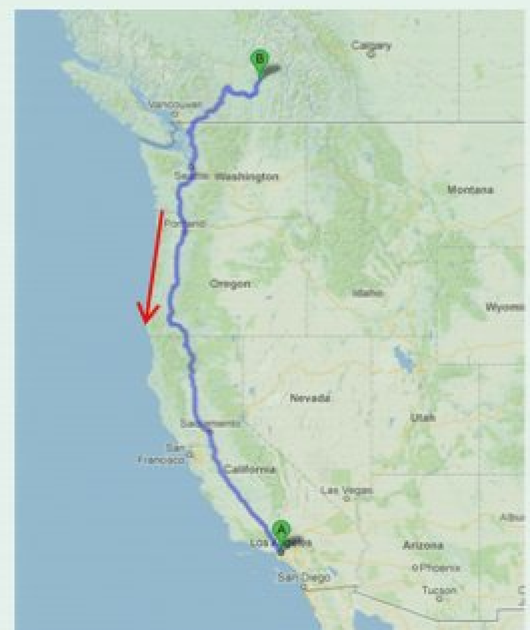

Image: R. Monchak


Image: L.. Vanderveld

# Douglas-fir – long distance seed transfer





# THE FROST HARDINESS OF GEOGRAPHIC STRAINS OF NORWAY PINE[1]

By C. G. Bates

*Silviculturist, Lake States Forest Experiment Station*

NORWAY PINE is a species which covers a comparatively narrow latitudinal range, although in its range from the northeastern coast to the Lake States and southern Canada it encounters summer temperature differences of about 10° F. (say from 56° to 66° F., for the four months, from June to September) and considerably greater differences in midwinter temperatures (say from −35° and −40° F. in the northwestern part of the range to not much below zero in the Alleghenies, these being mean annual minima). Nearly as great differences are found in winter if mean January temperatures be considered, or from 0° to 30° F.

Because of its great commercial value and its extensive use on reforestation projects, Norway pine has been chosen by the Lake States Forest Experiment Station as the first species to be subjected to a scrutinizing study of geographical, varietal, and individual differences, or in other words to a "breeding" study whose primary purpose is to determine what "seed zones" should be recognized in order to avert failures in planting due to lack of local adaptation. But because of the great uniformity of appearance and development of the species, as well as the considerations mentioned in the first paragraph above, the writer has felt some doubts as to whether outstanding differences would be likely to be developed by such a study. Therefore, to "anticipate" to some extent the results of field comparisons which were started at the same time through nursery sowings of 41 different collections of Norway pine seed, an indoor experiment was begun which it was hoped would bring out the existence of physiological differences affecting hardiness. Without going into the question of what comprises hardiness to freezing and what causes the tree to prepare itself for freezing temperatures, it may be stated as more or less obvious that differences within a species should develop according as its local forms have become adapted to long or short growing seasons, to high or low growing temperatures, and to moderately or extremely low winter temperatures.

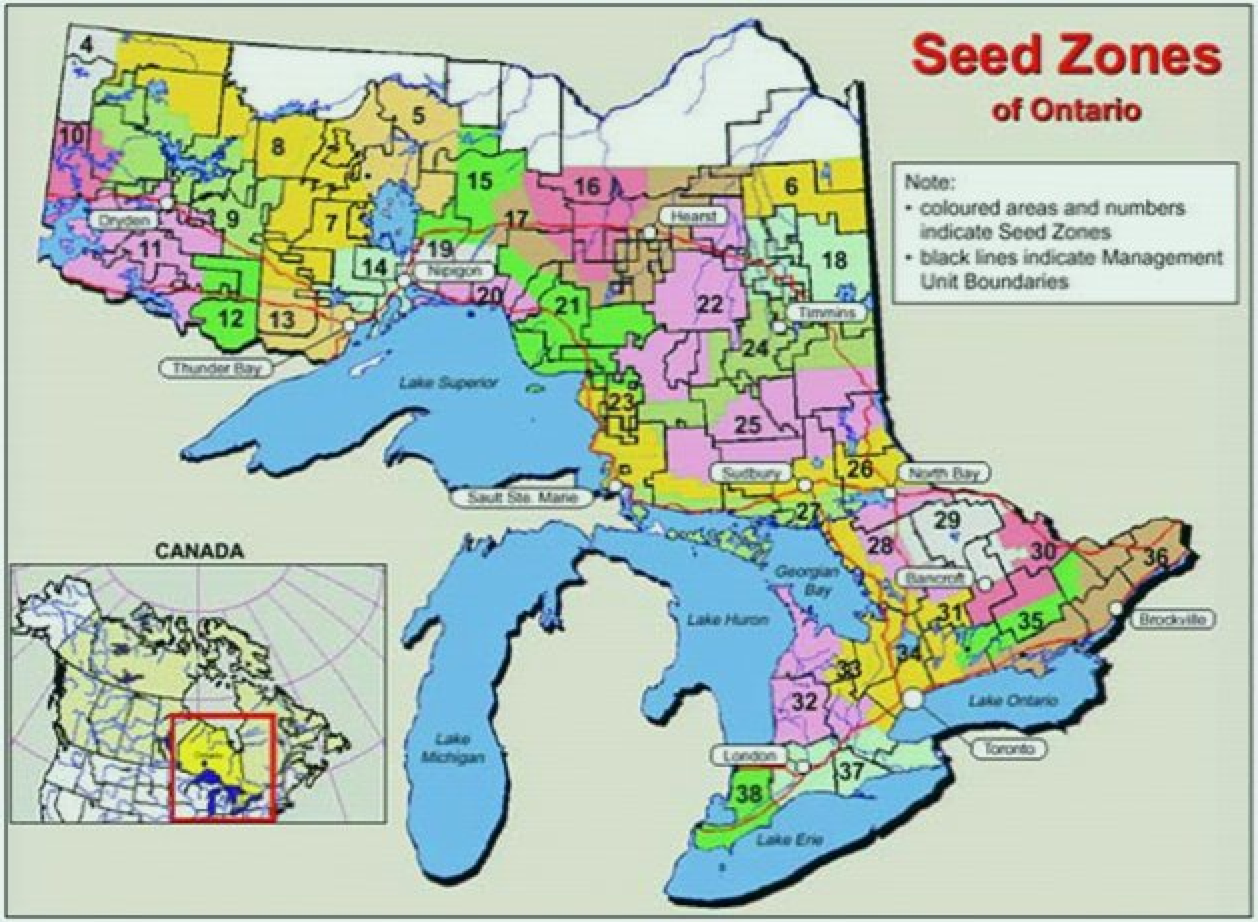
The idea of this experiment was suggested directly by the work of Dr. R. B. Harvey on the hardiness of a great variety of woody and herbaceous plants, and the experiment was made possible by his coöperation and the use of his specially designed equipment for such studies at the University of Minnesota, this being principally in the form of refrigeration rooms which can be set at any reasonable temperature. We wish to express our gratitude for the splendid coöperation given.

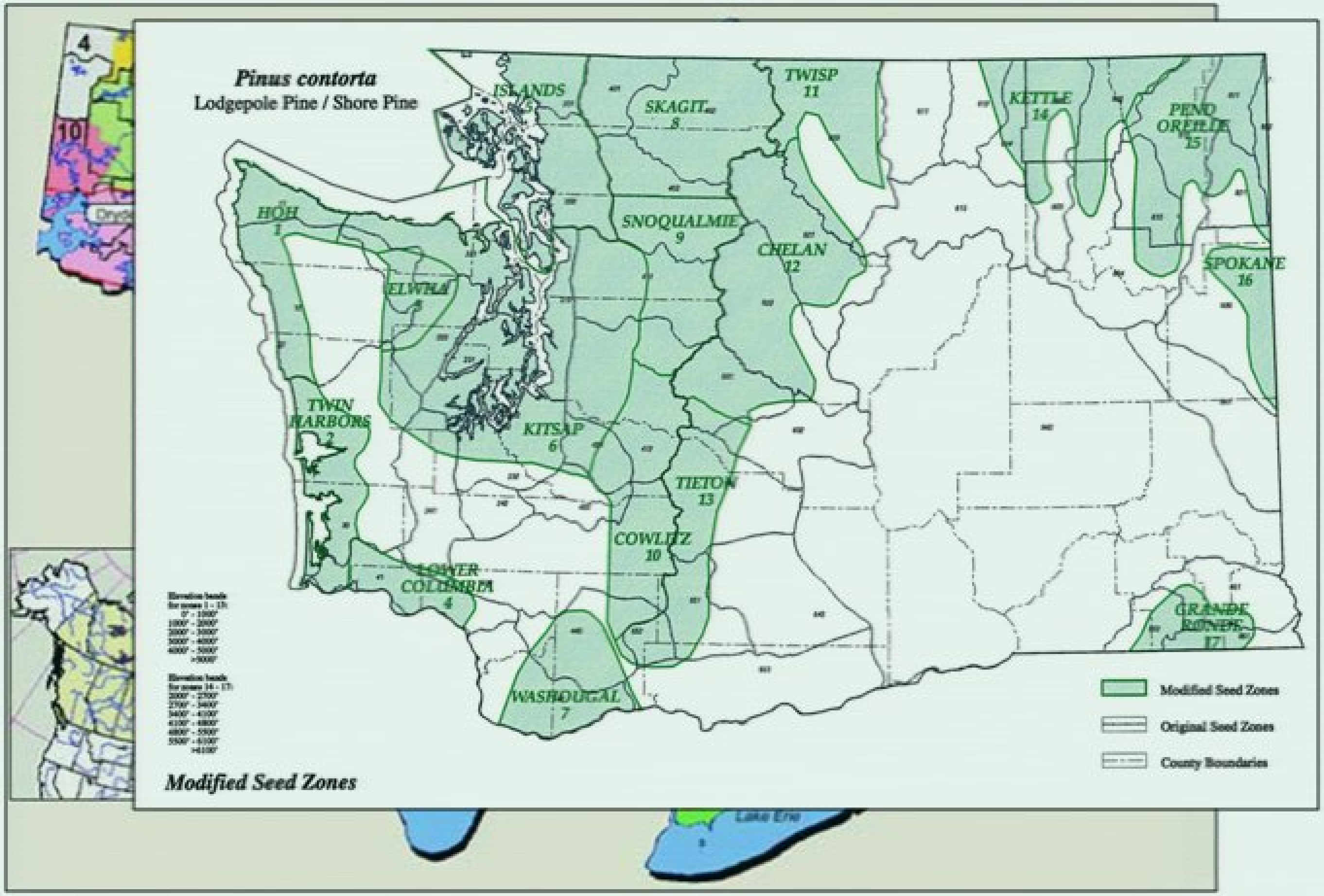
[1] The essential results of the experiment here described were given in Technical Note No. 22 of the Lake States Forest Experiment Station under date of January, 1930.



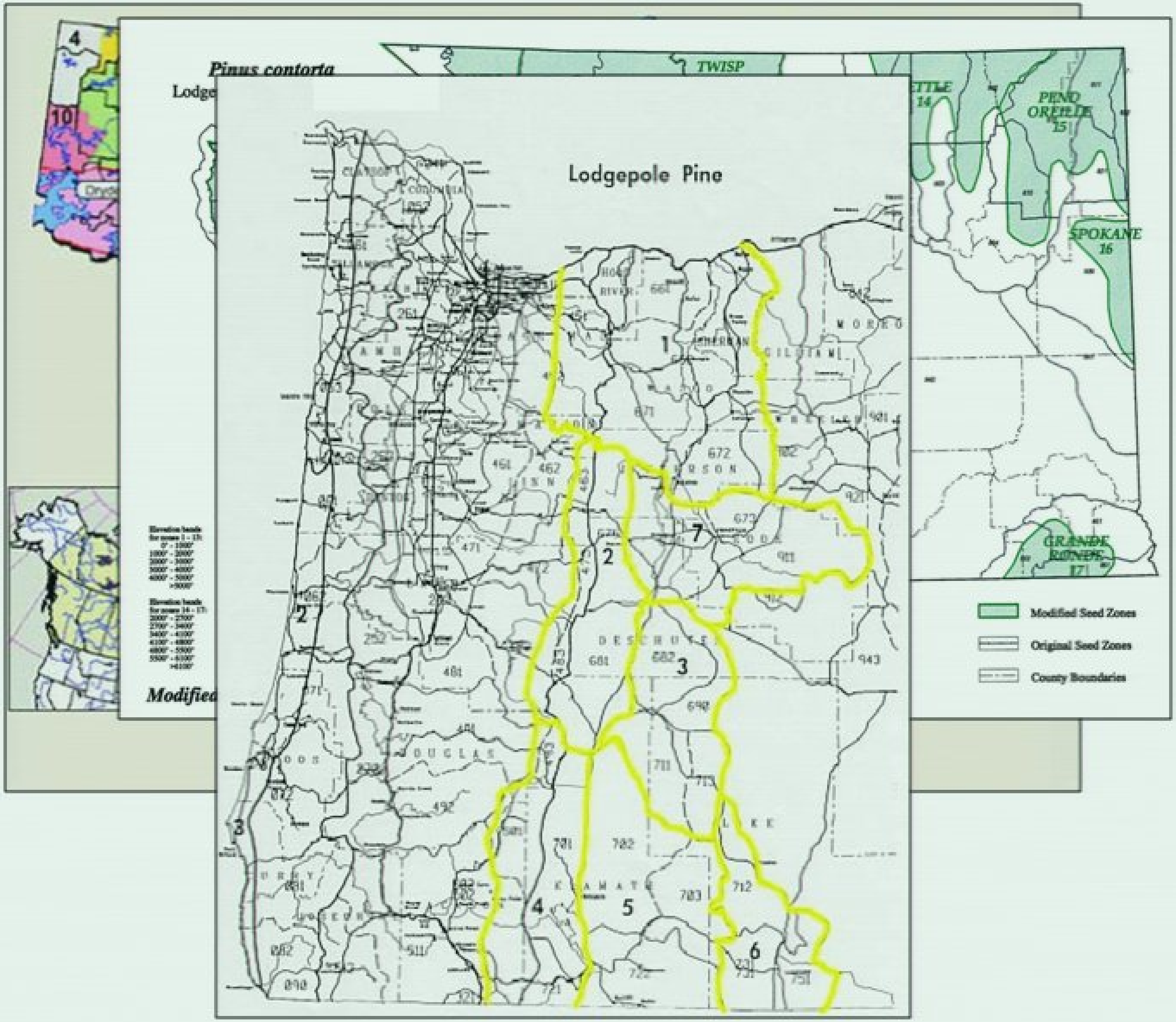
Bates. 1930. Journal of Forestry


Randall and Berrang. 2002

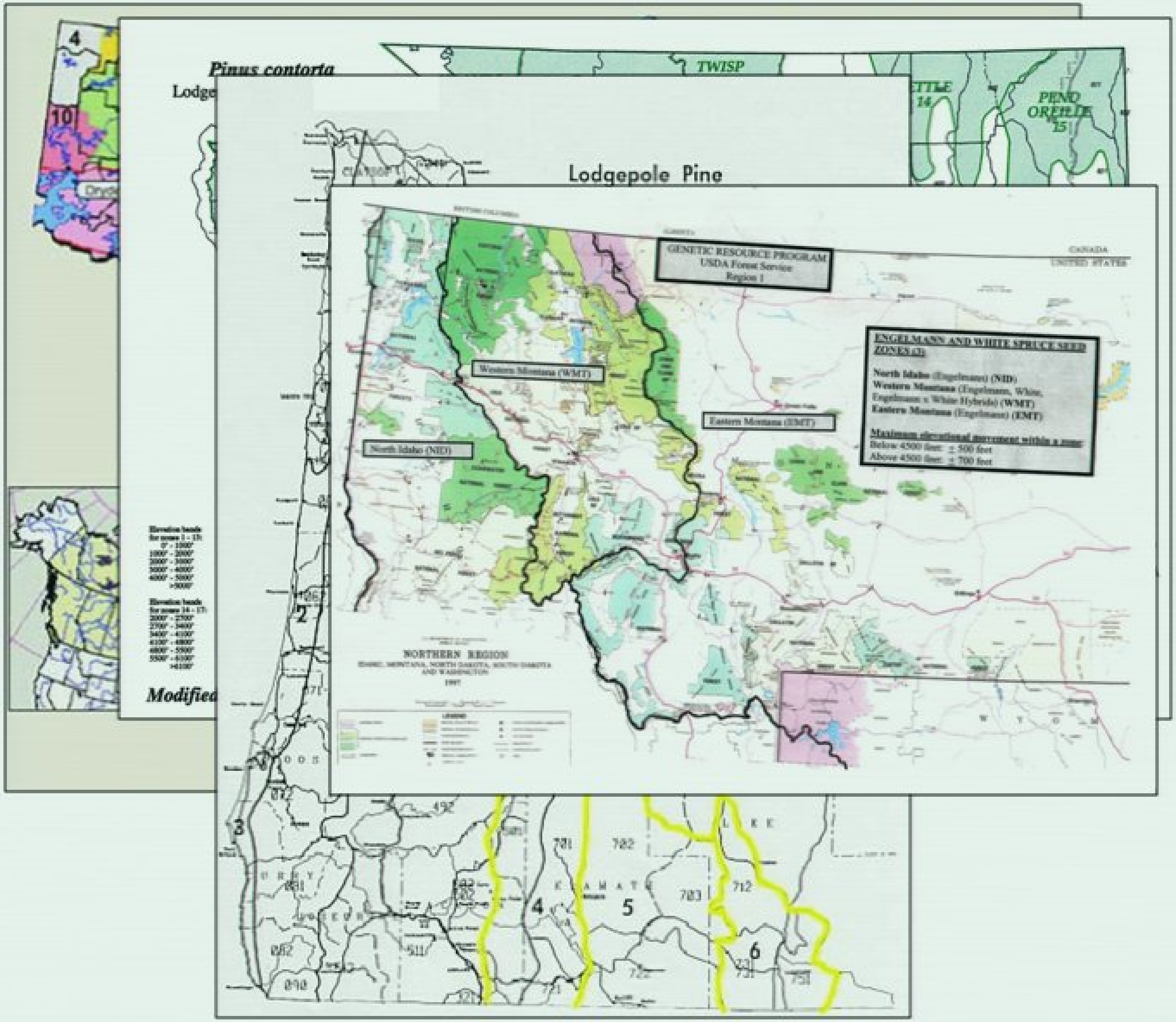

Seed Zones
of Ontario
Note:
• coloured areas and numbers indicate Seed Zones
• black lines indicate Management Unit Boundaries
Dryden
Nipigon
Hearst
Timmins
Thunder Bay
Lake Superior
Sudbury
North Bay
Sault Ste. Marie
Bancroft
Brockville
Georgian Bay
Lake Huron
Lake Ontario
Toronto
London
Lake Michigan
Lake Erie
CANADA



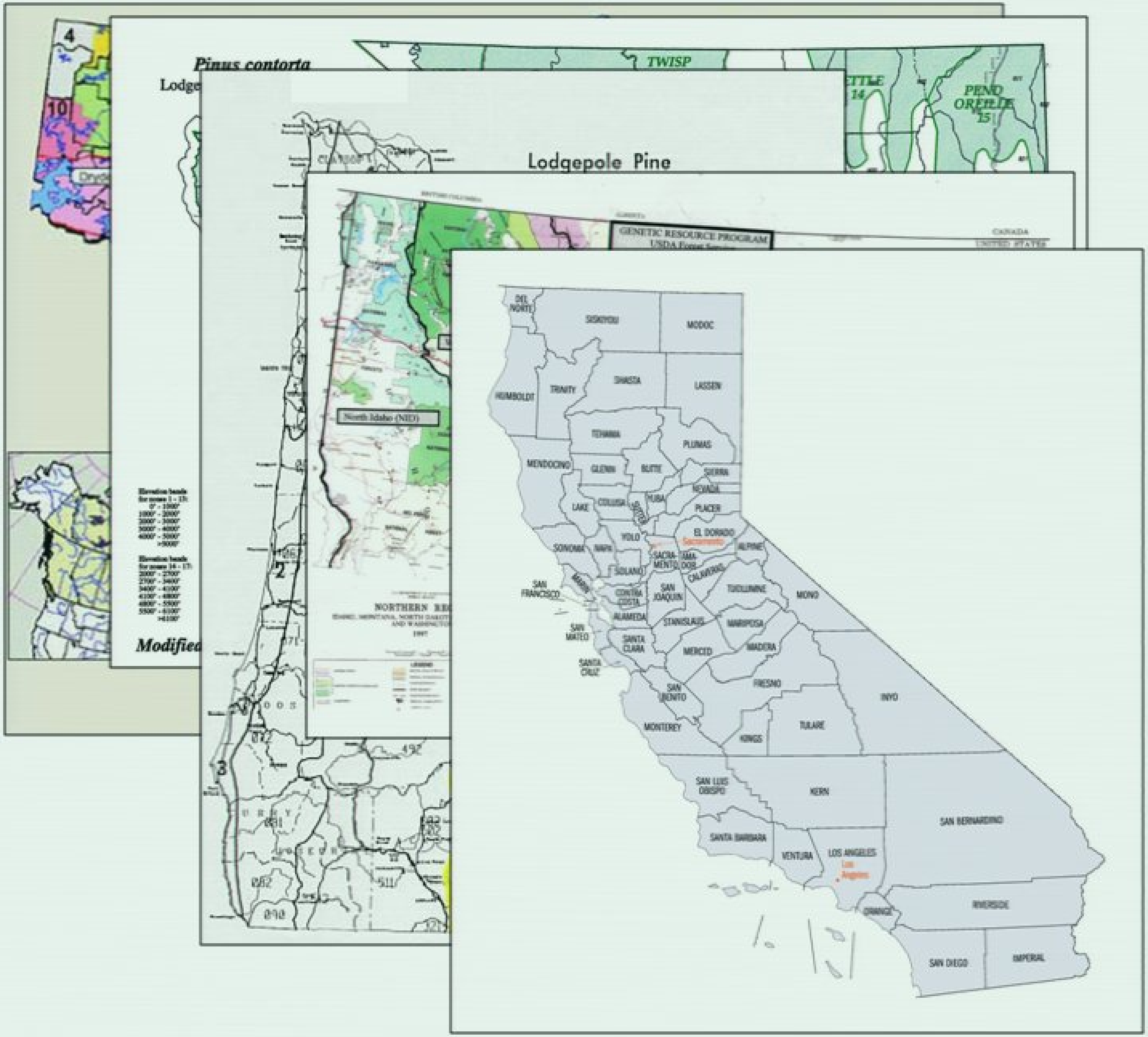
Pinus contorta
Lodgepole Pine / Shore Pine
ISLANDS
SKAGIT
8
TWISP
11
KETTLE
14
PEND
OREILLE
15
HOH
1
SNOQUALMIE
9
CHELAN
12
SPOKANE
16
ELWHA
TWIN
HARBORS
2
KITSAP
6
TIETON
13
COWLITZ
10
LOWER
COLUMBIA
4
GRANDE
RONDE
17
WASHOUGAL
7
Modified Seed Zones
Original Seed Zones
County Boundaries
Modified Seed Zones
Lake Erie

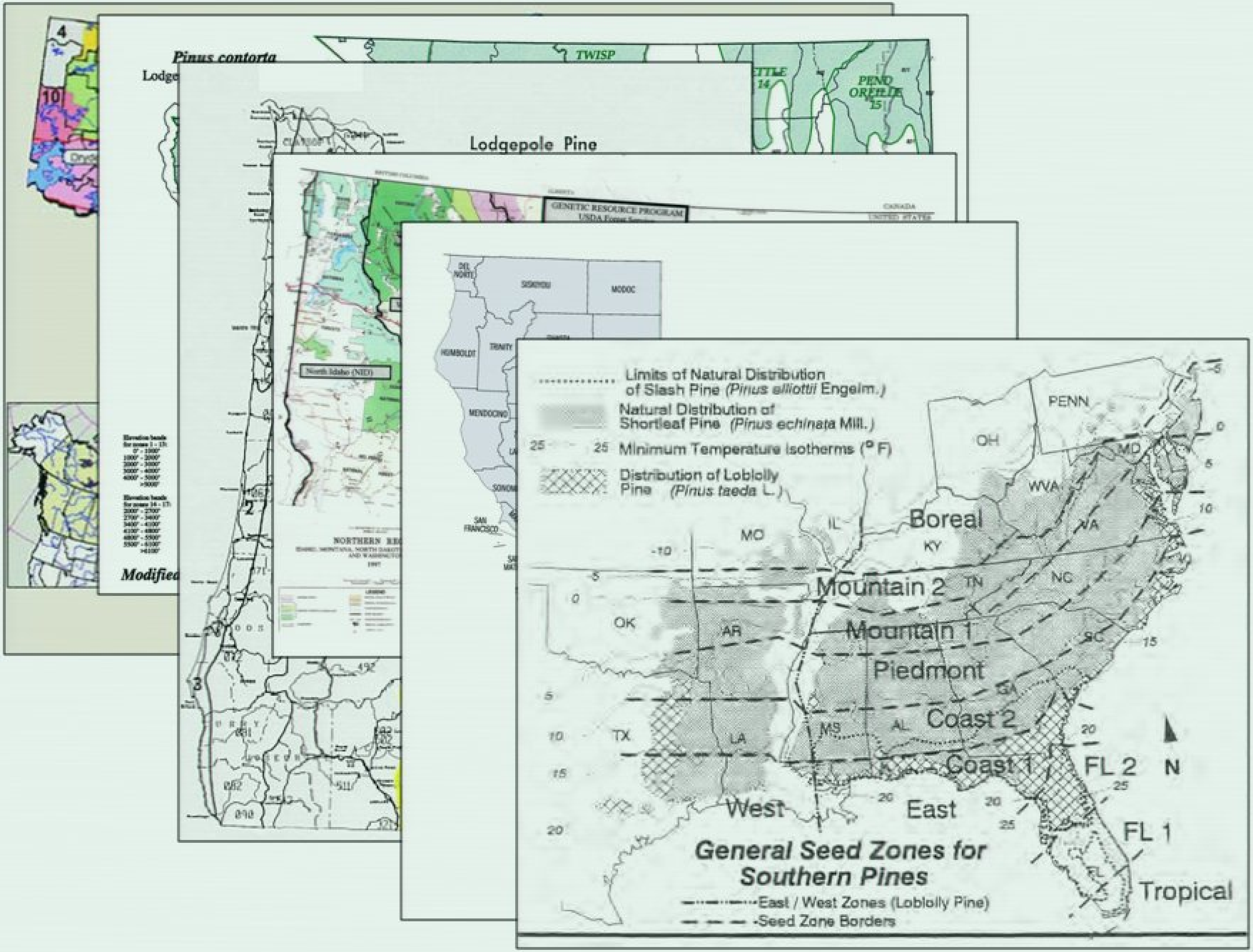


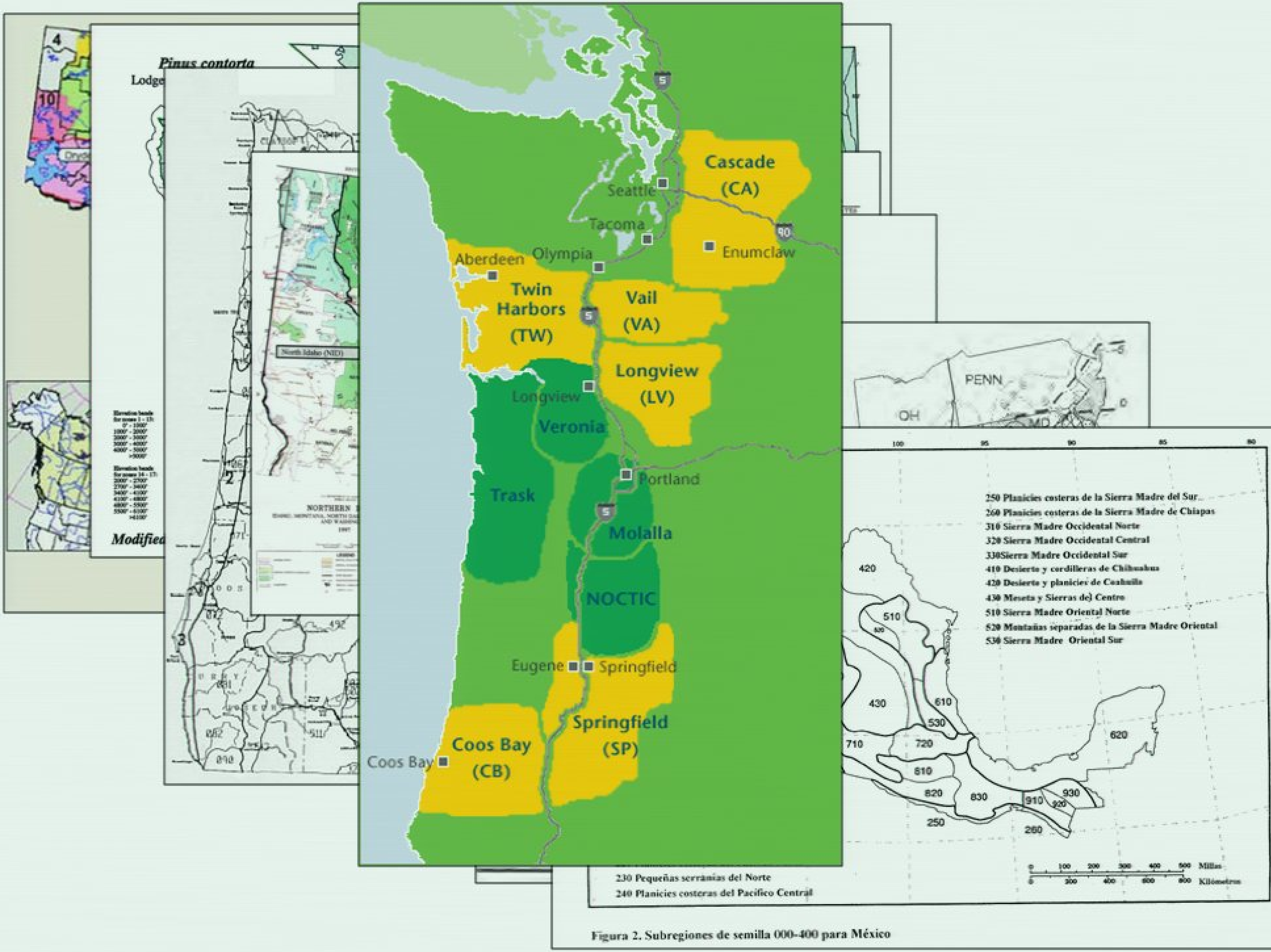
Pinus contorta
Lodgepole Pine
TWISP
PEND OREILLE 15
SPOKANE 16
GRANDE RONDE 17
Modified Seed Zones
Original Seed Zones
County Boundaries
1
2
3
4
5
6
7
DESCHUTES
KLAMATH
LAKE
DOUGLAS
LINN



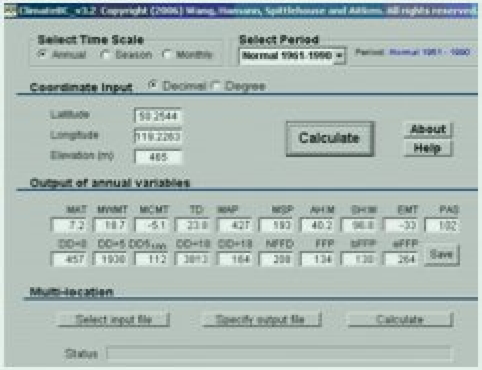
Pinus contorta
Lodgepole Pine
TWISP
PEND OREILLE 15
GENETIC RESOURCE PROGRAM
USDA Forest Service
Region 1
CANADA
UNITED STATES
Western Montana (WMT)
Eastern Montana (EMT)
North Idaho (NID)
NORTHERN REGION

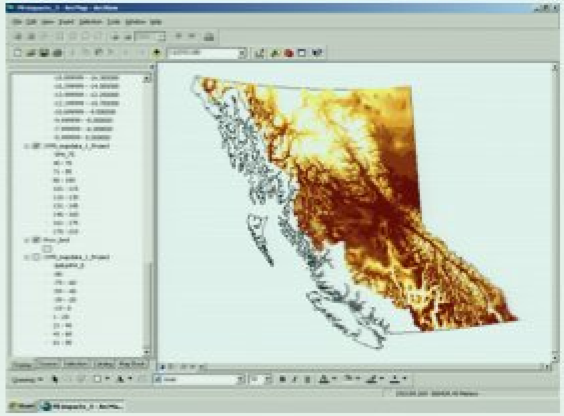

Pinus contorta
Lodgepole Pine
TWISP
PEND OREILLE 15
GENETIC RESOURCE PROGRAM
USDA Forest Service
North Idaho (NID)
NORTHERN RE
CANADA
UNITED STATES
Modified
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
LAKE
COLUSA
SUTTER
YUBA
PLACER
EL DORADO
Sacramento
YOLO
SONOMA
NAPA
ALPINE
SOLANO
SACRA-MENTO
AMA-DOR
MARIN
SAN FRANCISCO
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
SAN BENITO
INYO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
Los Angeles
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL


Pinus contorta
TWISP
Lodgepole Pine
GENETIC RESOURCE PROGRAM
USDA Forest Service
North Idaho (NID)
CANADA
UNITED STATES
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
MENDOCINO
SONOMA
SAN FRANCISCO
Limits of Natural Distribution of Slash Pine (Pinus elliottii Engelm.)
Natural Distribution of Shortleaf Pine (Pinus echinata Mill.)
Minimum Temperature Isotherms (°F)
Distribution of Loblolly Pine (Pinus taeda L.)
Boreal
Mountain 2
Mountain 1
Piedmont
Coast 2
Coast 1
FL 2
FL 1
Tropical
West
East
N
PENN
OH
MD
WVA
VA
KY
IL
MO
TN
NC
SC
OK
AR
GA
MS
AL
TX
LA
FL
General Seed Zones for Southern Pines
East / West Zones (Loblolly Pine)
Seed Zone Borders

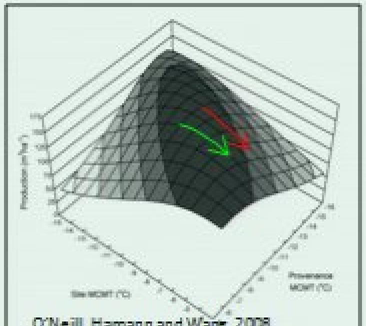


Cascade (CA)
Seattle
Tacoma
Enumclaw
Aberdeen
Olympia
Twin Harbors (TW)
Vail (VA)
Longview (LV)
Longview
Veronia
Trask
Portland
Molalla
NOCTIC
Eugene
Springfield
Springfield (SP)
Coos Bay (CB)
Coos Bay
Pinus contorta
Modified
North Idaho (NID)
PENN
OH
250 Planicies costeras de la Sierra Madre del Sur
260 Planicies costeras de la Sierra Madre de Chiapas
310 Sierra Madre Occidental Norte
320 Sierra Madre Occidental Central
330Sierra Madre Occidental Sur
410 Desierto y cordilleras de Chihuahua
420 Desierto y planicies de Coahuila
430 Meseta y Sierras del Centro
510 Sierra Madre Oriental Norte
520 Montañas separadas de la Sierra Madre Oriental
530 Sierra Madre Oriental Sur
230 Pequeñas serranías del Norte
240 Planicies costeras del Pacífico Central
Millas
Kilómetros
Figura 2. Subregiones de semilla 000-400 para México

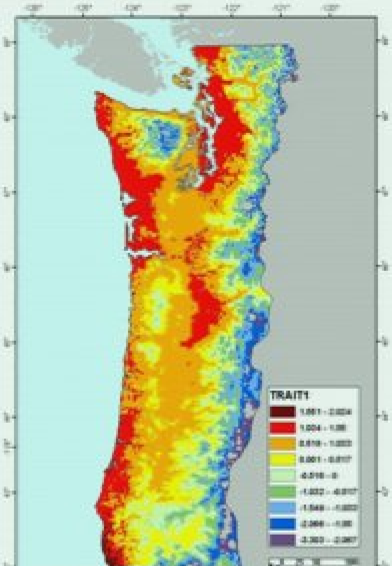


New tools



O'Neill, Hamann and Wang. 2008.




St. Clair et al. 2005

New analysis techniques

Seedlot selection system


Yellow cedar decline. P. Hennon photo.

New climates

Old and new data

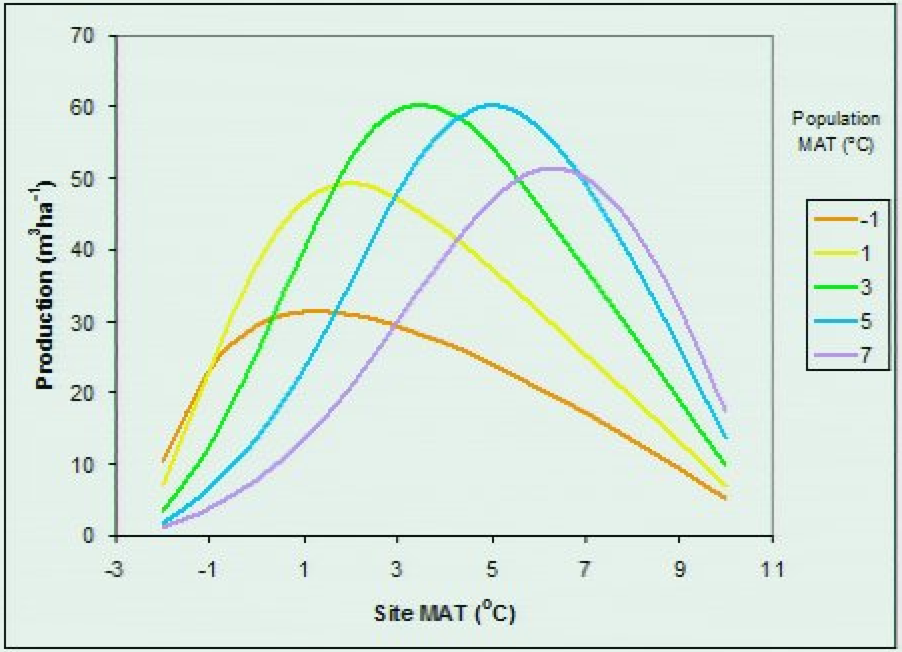
MPB L. MacLauchlan. photo

Trinity Valley Douglas-fir provenance trial. B. Jaquish photo

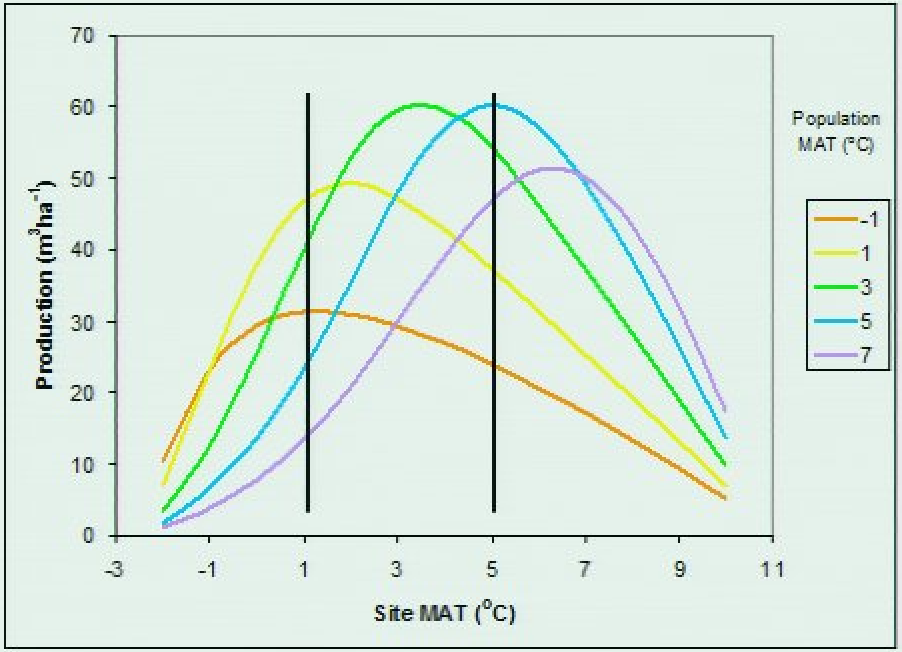
Seed source -1.3 °C
Plantation -1.3 °C

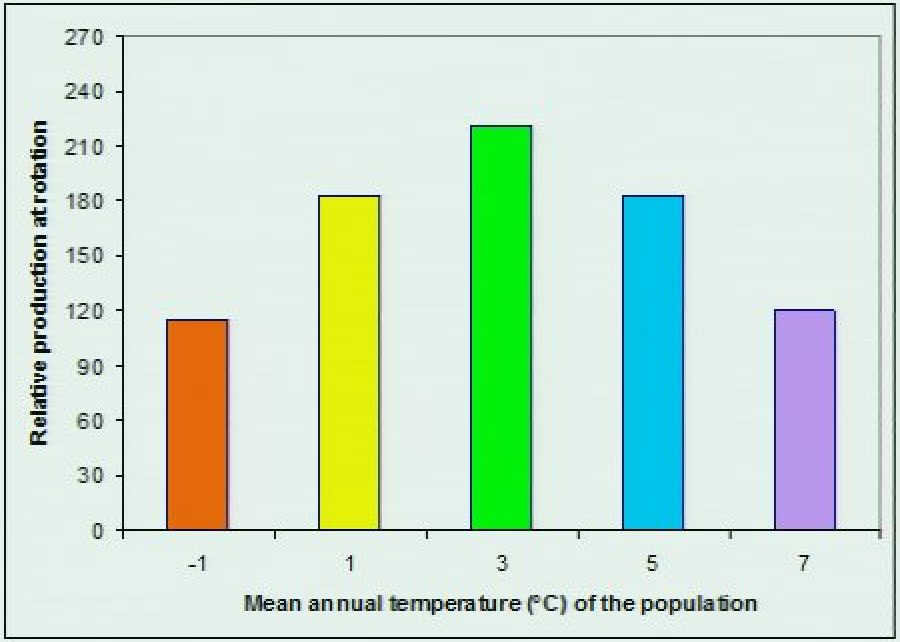
Seed source -1.3 °C
Plantation 2.9 °C

- Climate change is likely to have serious negative consequences on forest growth and health
- AM proposed to help maintain adaptation.



Production (m3ha-1)
70
60
50
40
30
20
10
0
-3
-1
1
3
5
7
9
11
Site MAT (0C)
Population MAT (°C)
-1
1
3
5
7




- Climate change is likely to have serious negative consequences on forest growth and health
- AM in forestry is about maintaining adaptation of forests and dependent ecosystems.

*Forest Ecology and Management*, 50 (1992) 153–169
Elsevier Science Publishers B.V., Amsterdam



# Genetic strategies for reforestation in the face of global climate change

F. Thomas Ledig[a] and J.H. Kitzmiller[b]

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(Accepted 9 April 1991)

## ABSTRACT

Ledig, F.T. and Kitzmiller, J.H., 1992. Genetic strategies for reforestation in the face of global climate change. *For. Ecol. Manage.*, 50: 153–169.

If global warming materializes as projected, natural or artificial regeneration of forests with local seed sources will become increasingly difficult. However, global warming is far from a certainty and predictions of its magnitude and timing vary at least twofold. In the face of such uncertainty, reforestation strategies should emphasize conservation, diversification, and broader deployment of species, seed sources, and families. Planting programs may have to deploy non-local seed sources, imported from further south or from lower elevations, which necessitates a system for conserving native gene pools in seed banks or clone banks. Planting a diverse array of species or seed sources is a hedge against the uncertainty inherent in current projections of warming. Most tree improvement programs already stress genetic diversity and deployment of multi-progeny mixes, but may better prepare for climate change by testing selections in an even wider set of environments than is now the case.

## INTRODUCTION

Numerous stresses threaten forests in the next century. Chlorofluorocarbons will probably deplete the earth's protective ozone layer by 7%, perhaps, reducing yield in some crop plants and forest trees (Caldwell et al., 1989). Other atmospheric pollutants are already destroying forests or changing forest composition in some areas, such as the Los Angeles Basin (Miller, 1973) and the Valley of Mexico. Acid deposition is leaching soils, which may in time affect forest growth even in areas remote from sources of pollution (Schulze, 1989). And finally, mean annual temperatures are projected to increase 2.5°C by the year 2050 as a result of the release of 'greenhouse gases', i.e. methane,

Correspondence to: F.T. Ledig, Institute of Forest Genetics, Pacific Southwest Research Station, USDA Forest Service, P.O. Box 245, Berkeley, CA 94701, USA.

Zebra mussels
photo: US Fish and Wildlife Service

Wihite pine blister rust
Photo: Natural Resources Canada, Canadian Forest Service

Kudzu
photo: S. Erhardt

Cane toad
Photo:E. Greenbaum

Cooley spruce gall adelgid
Photo : Natural Resources Canada, Canadian Forest Service

- In forestry, AM is about maintaining adaptation.
- Transfers involve short ecological, climate, and geographic distance.

Lodgepole pine progeny trial
photo: J. Woods

- In conservation biology, AM is about avoiding extinction.
- Transfers often involve long ecological, climate and geographic distance.

Quino checkerspot butterfly
photo: Berkleygardencoach.com

Golden toad
photo: CH Smith

Whitebark pine
Photo:Richard Sniezko

# Placing Forestry in the Assisted Migration Debate

JOHN H. PEDLAR, DANIEL W. McKENNEY, ISABELLE AUBIN, TANNIS BEARDMORE, JEAN BEAULIEU, LOUIS IVERSON, GREGORY A. O'NEILL, RICHARD S. WINDER, AND CATHERINE STE-MARIE

*Table 1. Comparison between forestry assisted migration (AM) and species rescue AM.*

| Topic | Forestry AM | Species rescue AM |
|---|---|---|
| Intended outcome | Maintain forest productivity and health under climate change | Avoid extinctions among species threatened by climate change |
| Target species | Widespread, commercially valuable species | Species of conservation concern |
| Focal biological unit | Focuses on the movement of populations | Focuses on the movement of species |
| Movement logistics | Often within the current range of the species or within modest range extensions | Often well outside the current natural range of species |
| Risks | Limited potential for creating an exotic invasive, limited potential to hybridize with new species, and limited potential to introduce disease to new populations or to other species | Some potential for creating an exotic invasive, some potential to hybridize with new species, and some potential to introduce disease to other species |
| Feasibility of science-based implementation | Provenance data for many commercial tree species, established seed procurement and storage methods, established best practices around plantation establishment, and autecology often well described | Provenance data not typically available, seeds not typically procured or stored, establishment best practices often not known, and autecology well described for relatively few high-profile and well-studied species |
| Scope | Potential to be employed across the millions of hectares that are regenerated annually in North America | Likely limited to suitable microsites |
| Cost | Adds little to existing forest regeneration costs (see the text for caveats) | Costs vary widely with the scope of the initiative |
| Practice | Already implemented in several regions | Very few known cases being implemented |

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Perspective

# Using assisted colonisation to conserve biodiversity and restore ecosystem function under climate change

Ian D. Lunt[a], Margaret Byrne[b,*], Jessica J. Hellmann[c], Nicola J. Mitchell[d], Stephen T. Garnett[e], Matt W. Hayward[f], Tara G. Martin[g], Eve McDonald-Maddden[g,h], Stephen E. Williams[i], Kerstin K. Zander[e]

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[b] Department of Environment and Conservation, Bentley, WA, Australia
[c] Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, USA
[d] Centre for Evolutionary Biology, School of Animal Biology, University of Western Australia, Crawley, WA, Australia
[e] Research Institute for The Environment and Livelihoods, Charles Darwin University, Casuarina, NT, Australia
[f] Australian Wildlife Conservancy, Nichols Point, Victoria, Australia
[g] Climate Adaptation Flagship, CSIRO Ecosystem Sciences, Dutton Park, Qld, Australia
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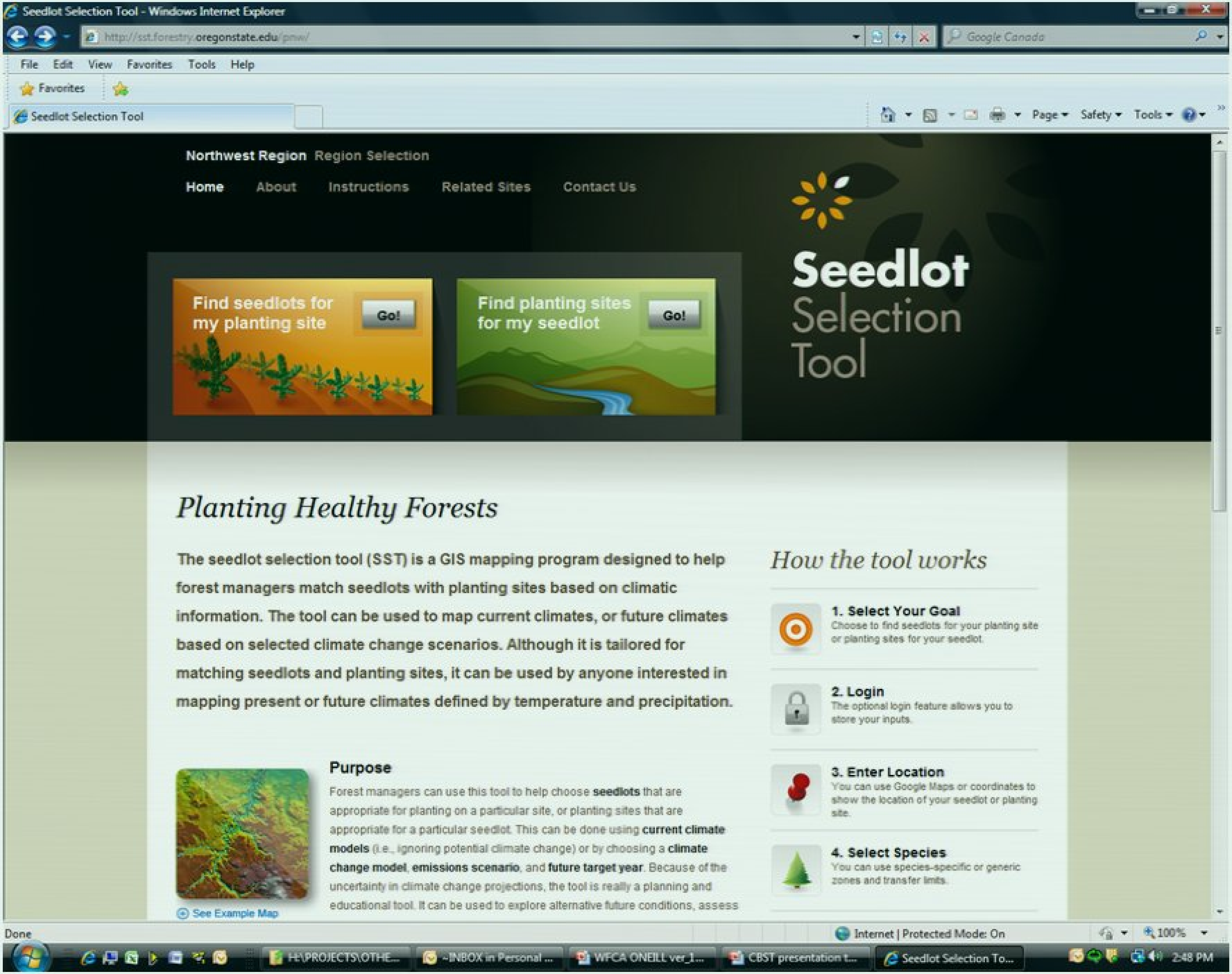
Translocation

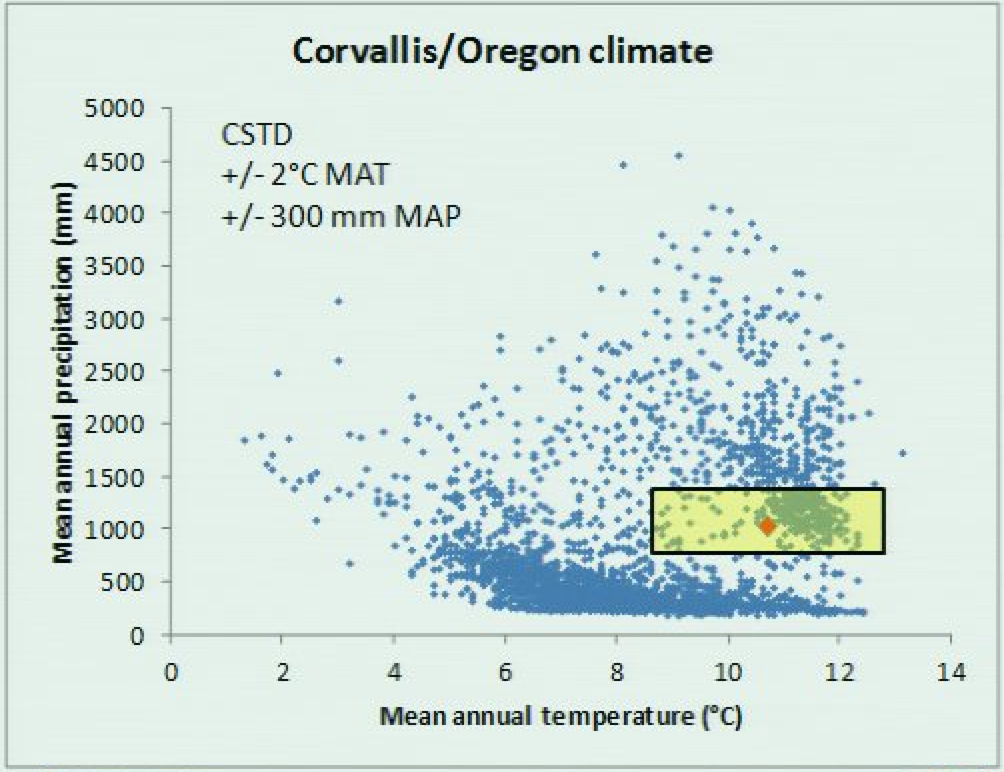
ABSTRACT

Assisted colonisation has received considerable attention recently, and the risks and benefits of introducing taxa to sites beyond their historical range have been vigorously debated. The debate has primarily focused on using assisted colonization to enhance the persistence of taxa that would otherwise be stranded in unsuitable habitat as a consequence of anthropogenic climate change and habitat fragmentation. However, a complementary motivation for assisted colonisation could be to relocate taxa to restore declining ecosystem processes that support biodiversity in recipient sites. We compare the benefits and risks of species introductions motivated by either goal, which we respectively term 'push' versus 'pull' strategies for introductions to preserve single species or for restoration of ecological processes. We highlight that, by focusing on push and neglecting pull options, ecologists have greatly under-estimated potential benefits and risks that may result from assisted colonisation. Assisted colonisation may receive higher priority in climate change adaptation strategies if relocated taxa perform valuable ecological functions (pull) rather than have little collateral benefit (push). Potential roles include enhancing resistance to invasion by undesired species, supporting co-dependent species, performing keystone functions, providing temporally critical resources, replacing taxa of low ecological redundancy, and avoiding time lags in the provisioning of desired functions.

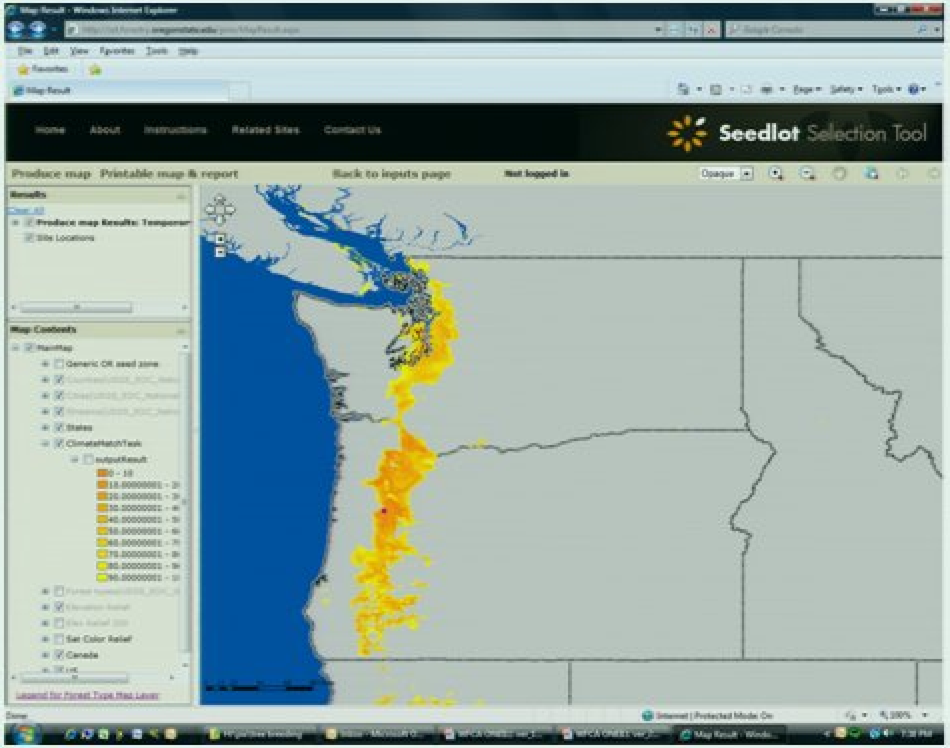
**Seed Transfer 2.0**

- Seed transfer/AM rationale and risks
- AM using focal point ST system
- Migration distance and CSTD
- AM using hybrid ST system

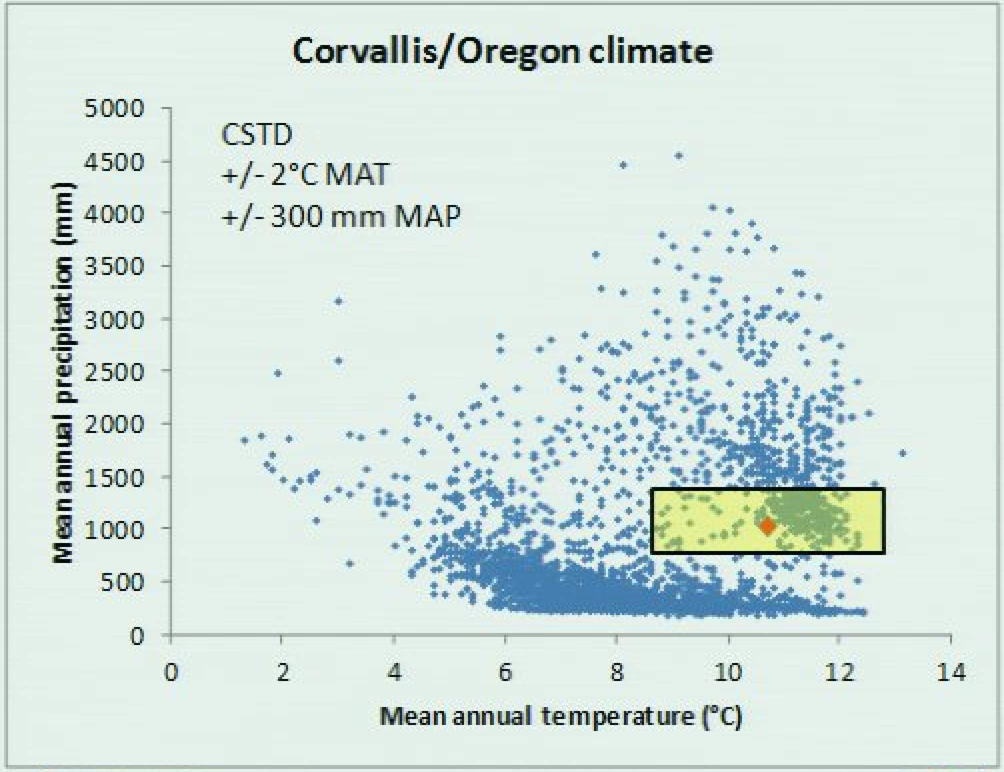

Seedlot Selection Tool - Windows Internet Explorer
http://sst.forestry.oregonstate.edu/pnw/
File Edit View Favorites Tools Help
Favorites
Seedlot Selection Tool
Page Safety Tools
Northwest Region Region Selection
Home About Instructions Related Sites Contact Us
Find seedlots for my planting site
Go!
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
See Example Map
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.
Done
Internet | Protected Mode: On
100%
2:48 PM

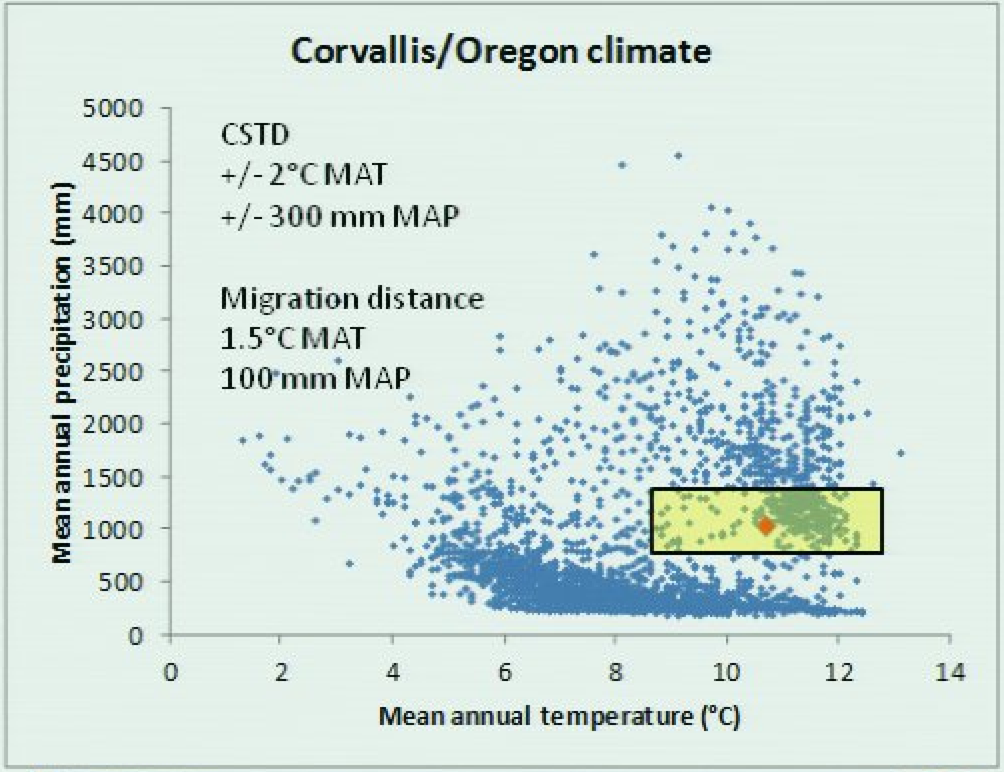


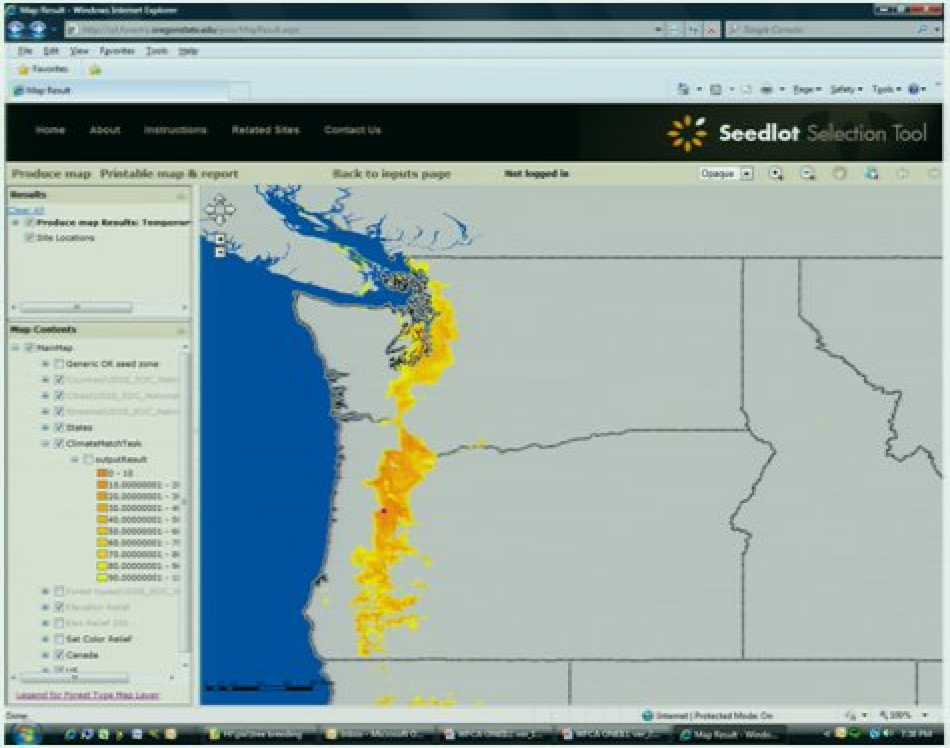
Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Mean annual precipitation (mm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
Mean annual temperature (°C)

Seedlot Selection Tool
Home
About
Instructions
Related Sites
Contact Us
Produce map
Printable map & report
Back to inputs page
Not logged in
Results
Map Contents


Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Mean annual precipitation (mm)
Mean annual temperature (°C)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14


Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Migration distance
1.5°C MAT
100 mm MAP
Mean annual precipitation (mm)
Mean annual temperature (°C)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14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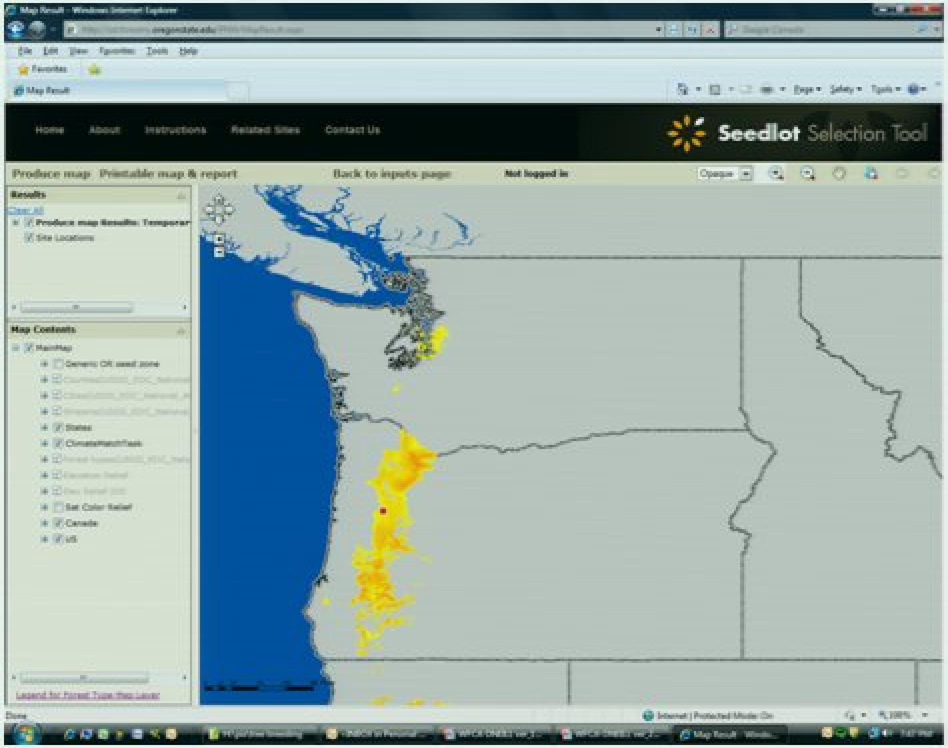
About
Instructions
Related Sites
Contact Us
Seedlot Selection Tool
Produce map
Printable map & report
Back to inputs page
Not logged in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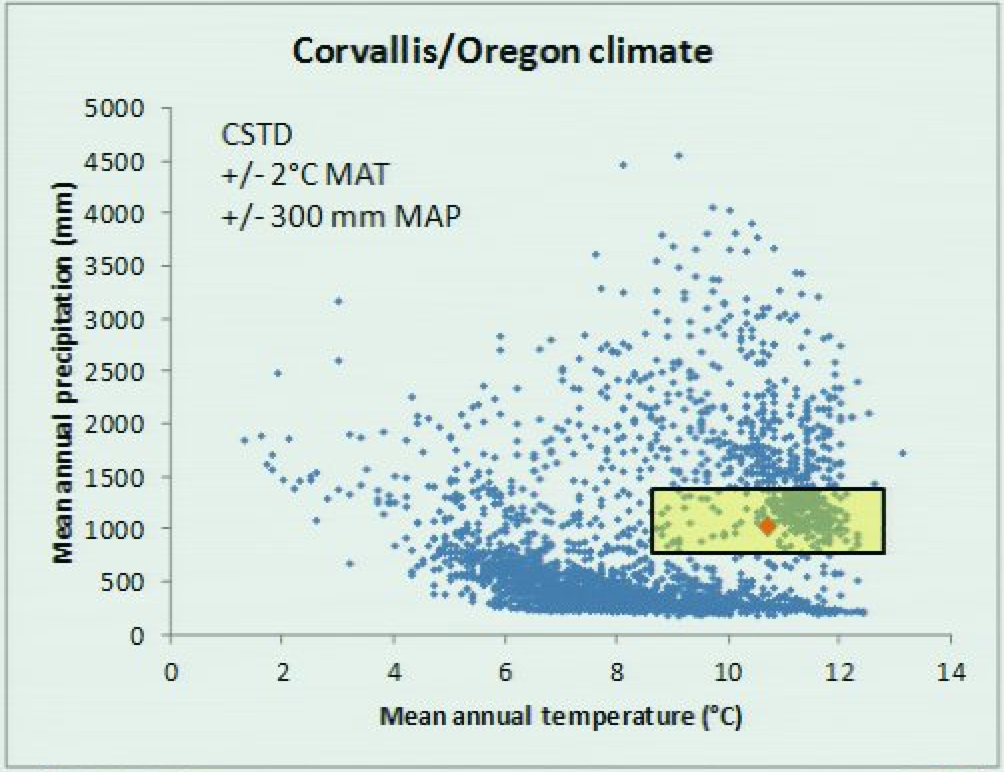
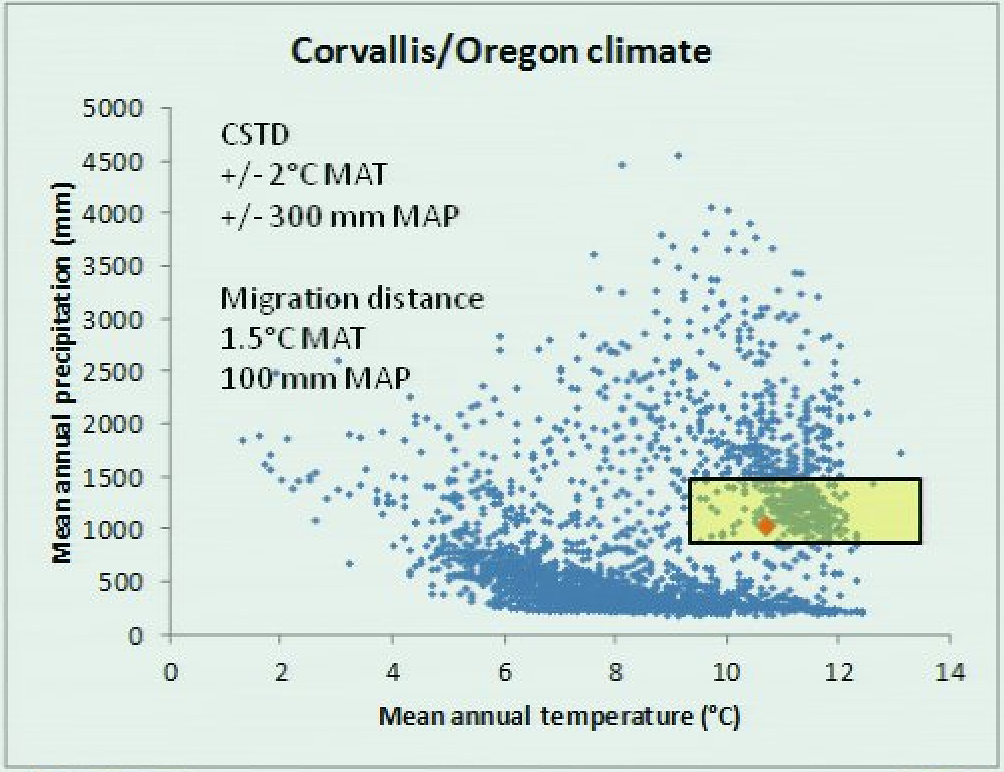
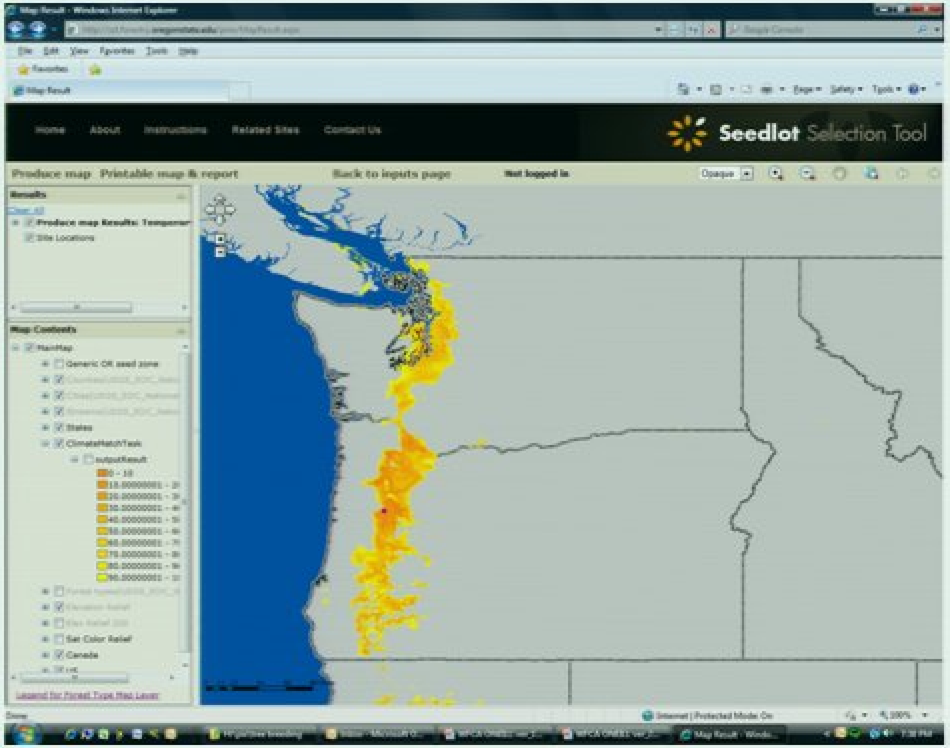
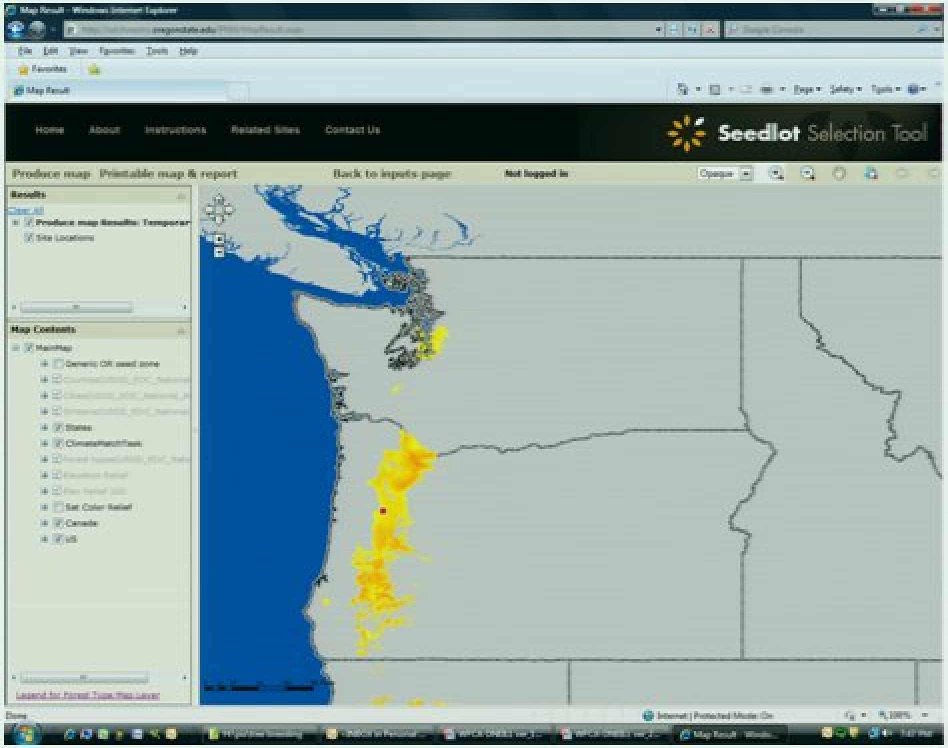

Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Mean annual precipitation (mm)
Mean annual temperature (°C)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14


Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Migration distance
1.5°C MAT
100 mm MAP
Mean annual precipitation (mm)
Mean annual temperature (°C)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
2
4
6
8
10
12
14


Home
About
Instructions
Related Sites
Contact Us
Seedlot Selection Tool
Produce map
Printable map & report
Back to inputs page
Not logged in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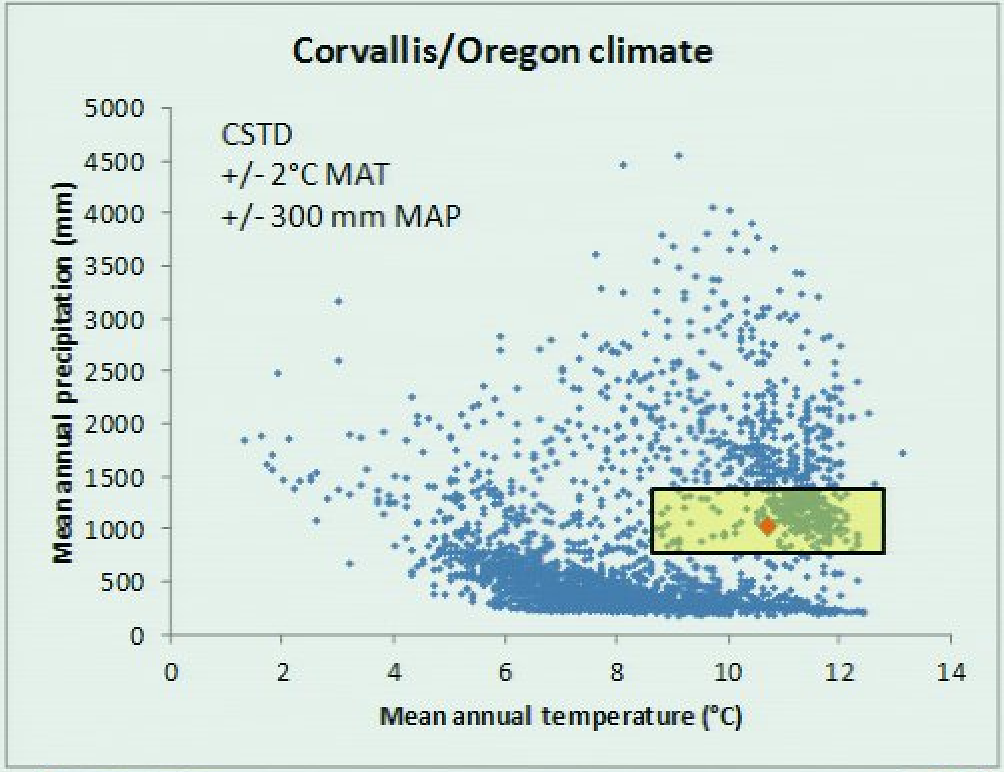
Corvallis/Oregon climate
CSTD
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Mean annual precipitation (mm)
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500
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4500
5000
0
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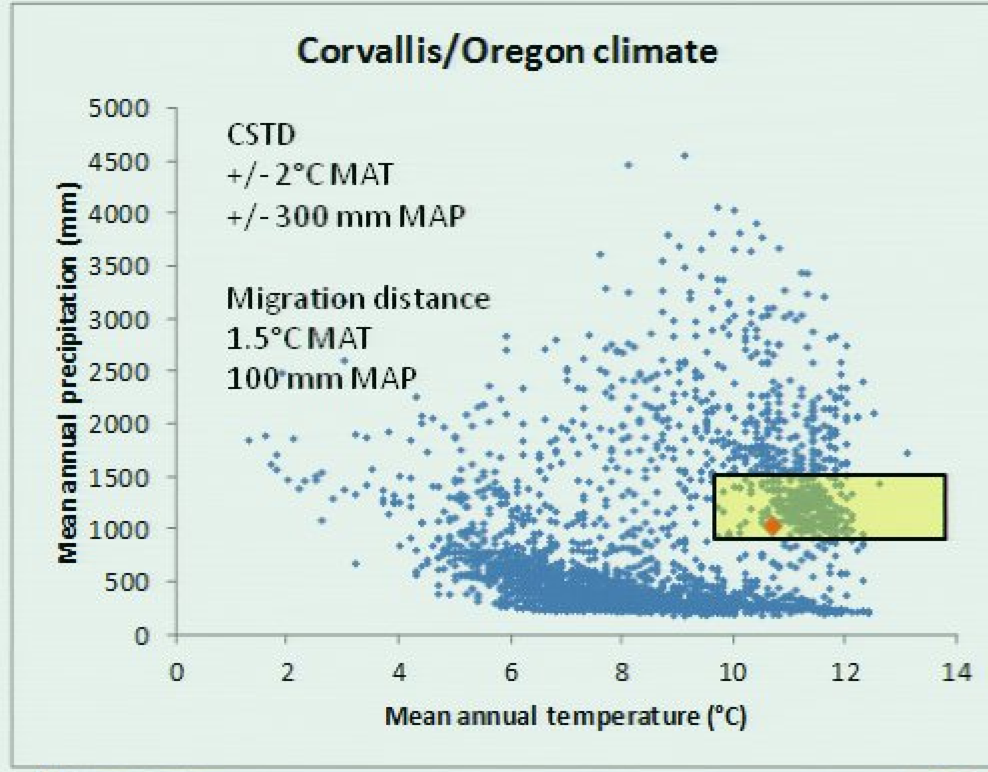
8
10
12
14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100 mm MAP
Mean annual precipitation (mm)
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0
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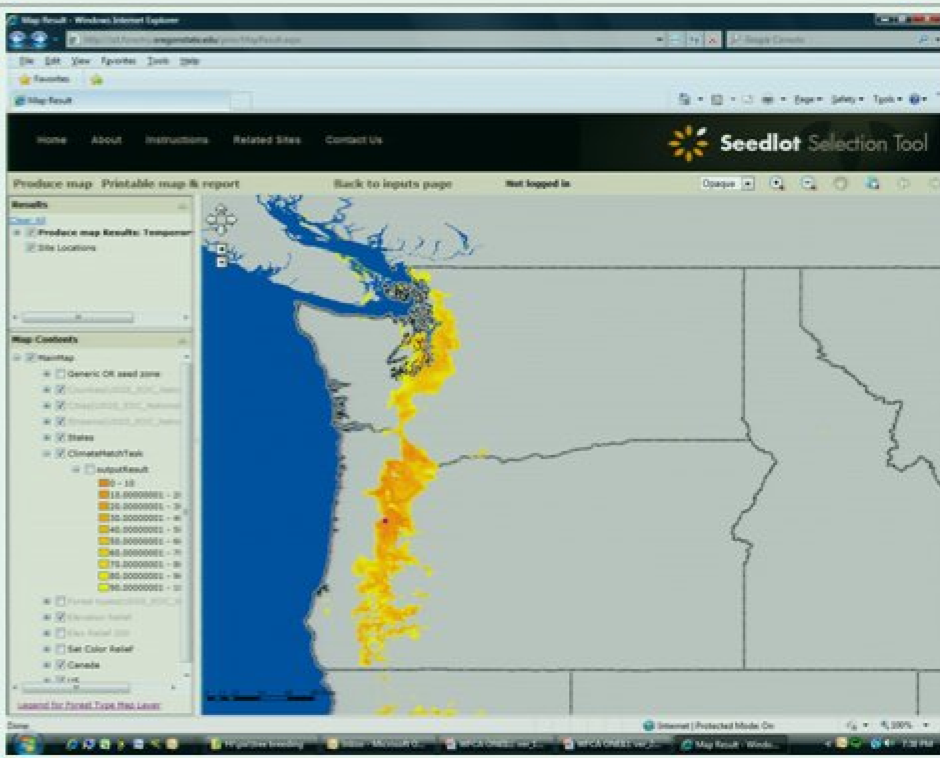
10
12
14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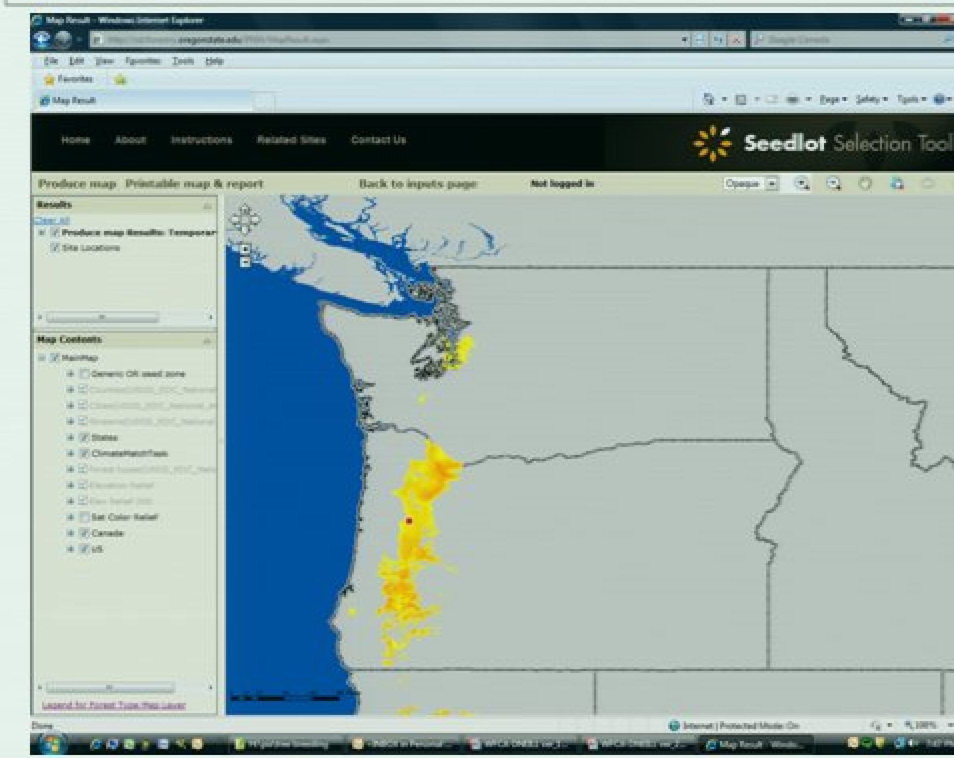
Results
Map Contents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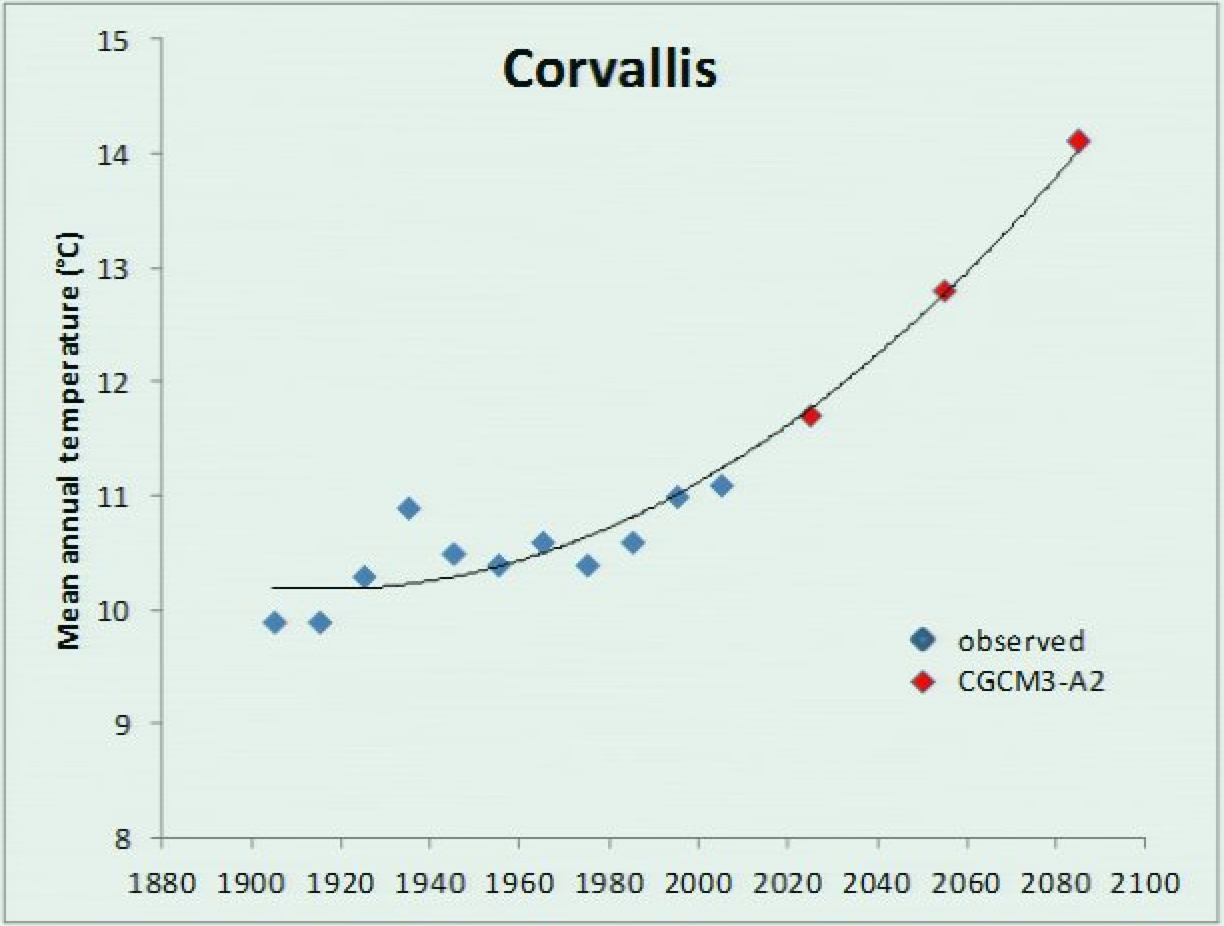
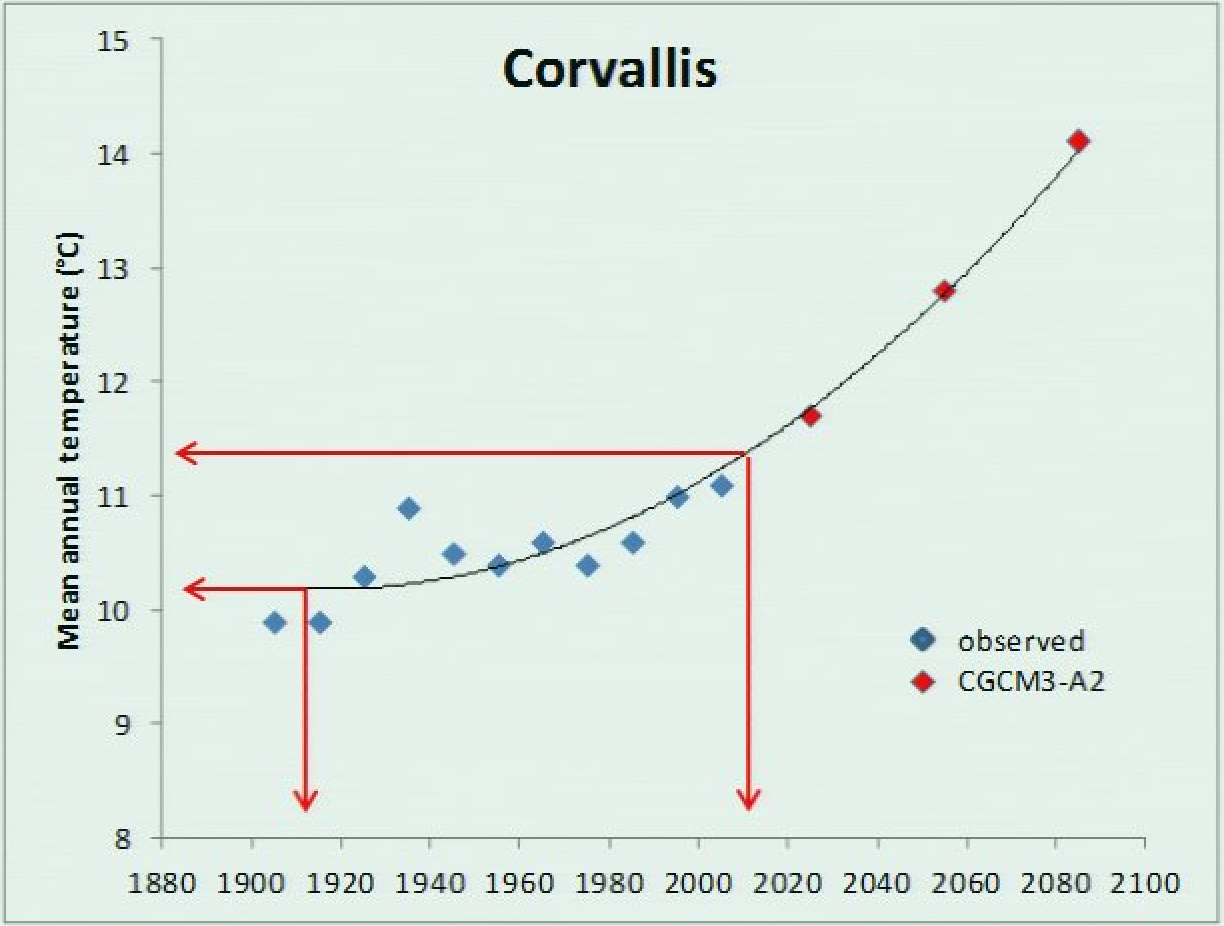
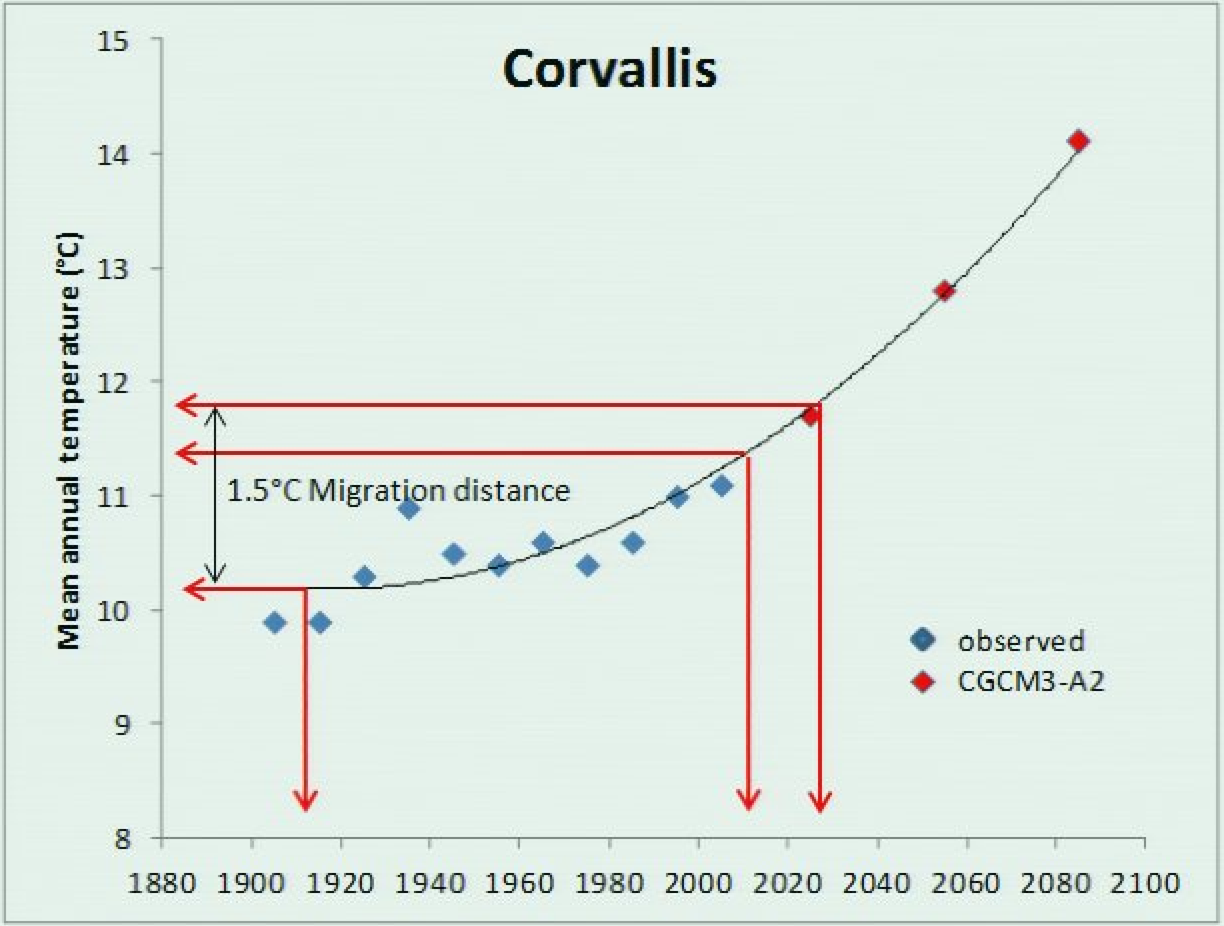
## Seed Transfer 2.0

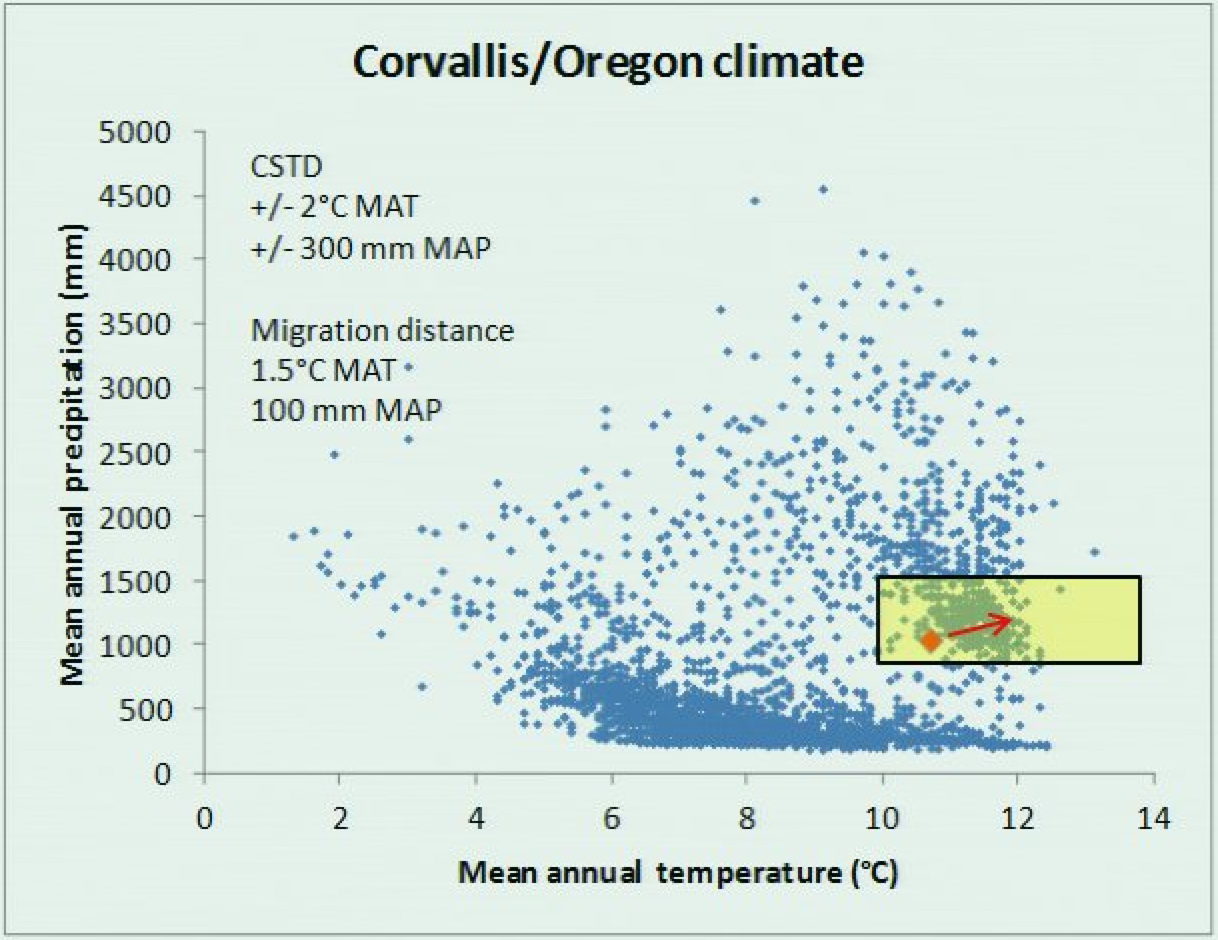
- Seed transfer/AM rationale and risks
- AM using focal point ST system
- Migration distance and CSTD
- AM using hybrid ST system



Corvallis
Mean annual temperature (°C)
15
14
13
12
11
10
9
8
1880 1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100
observed
CGCM3-A2

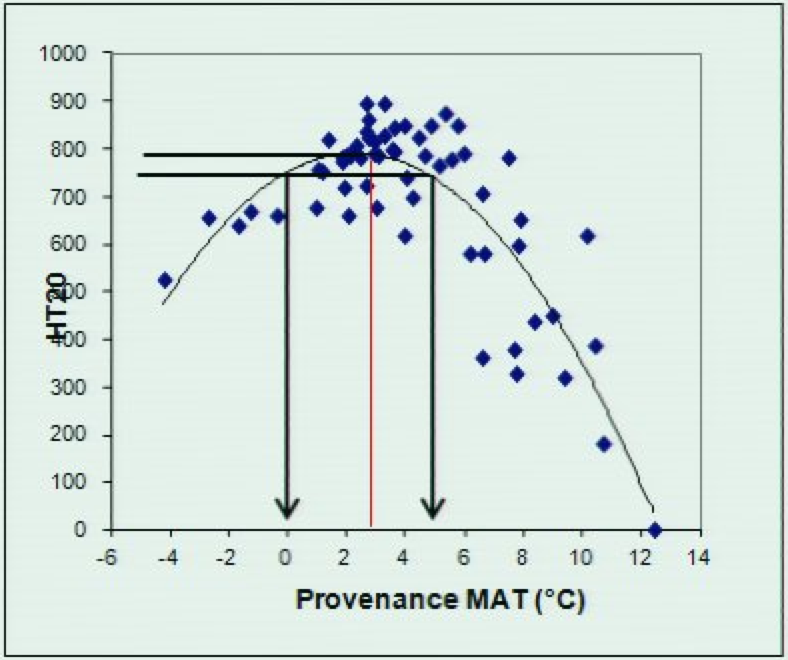

Corvallis
Mean annual temperature (°C)
15
14
13
12
11
10
9
8
1880 1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100
observed
CGCM3-A2


Corvallis
Mean annual temperature (°C)
15
14
13
12
11
10
9
8
1880
1900
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
1.5°C Migration distance
observed
CGCM3-A2


Corvallis/Oregon climate
CSTD
+/- 2°C MAT
+/- 300 mm MAP
Migration distance
1.5°C MAT
100 mm MAP
Mean annual precipitation (mm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
Mean annual temperature (°C)

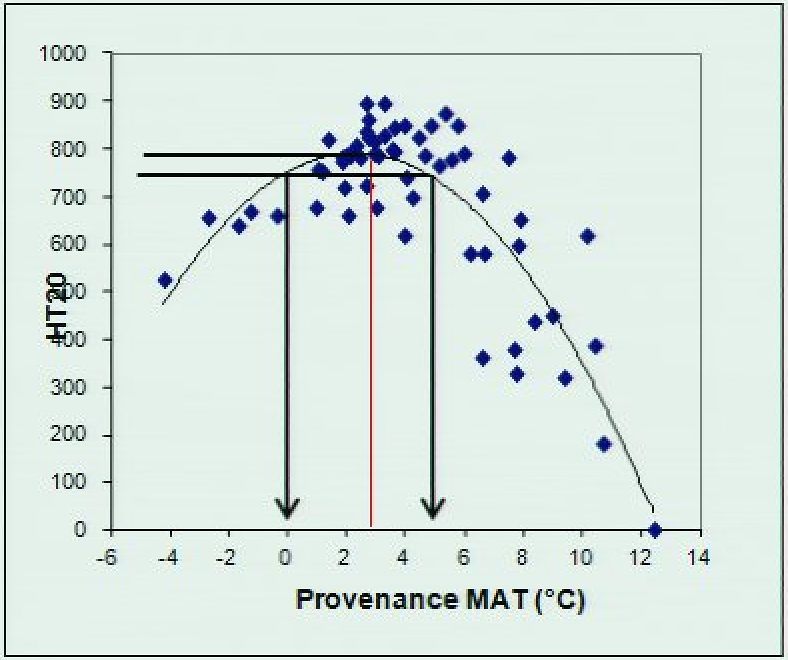
Illingworth Lodgepole Pine Provenance Test

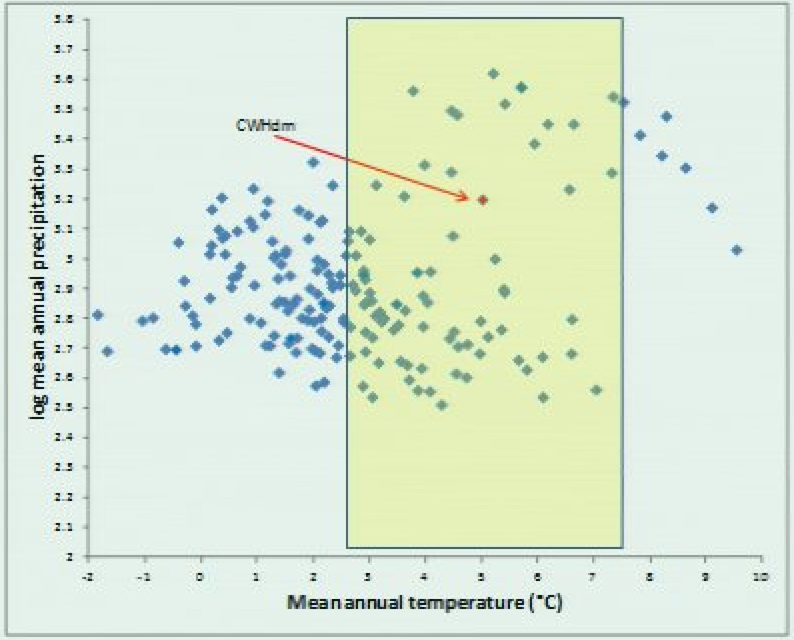
Test site = Community Lake



Illingworth Lodgepole Pine Provenance Test

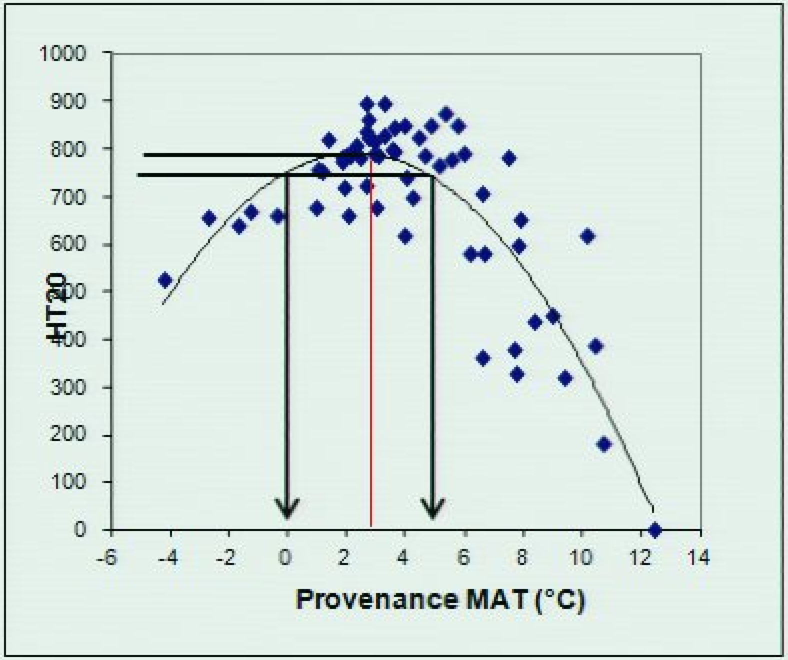
Test site = Community Lake

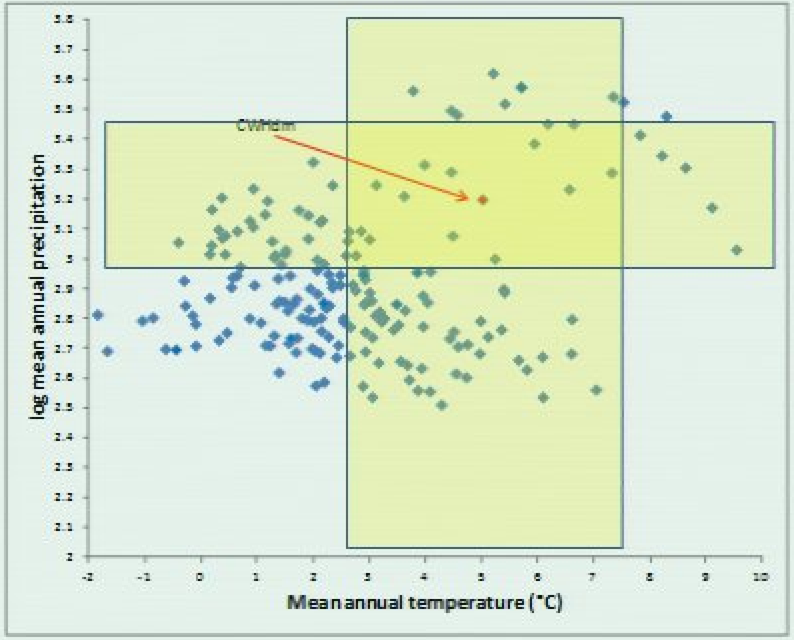


Illingworth Lodgepole Pine Provenance Test

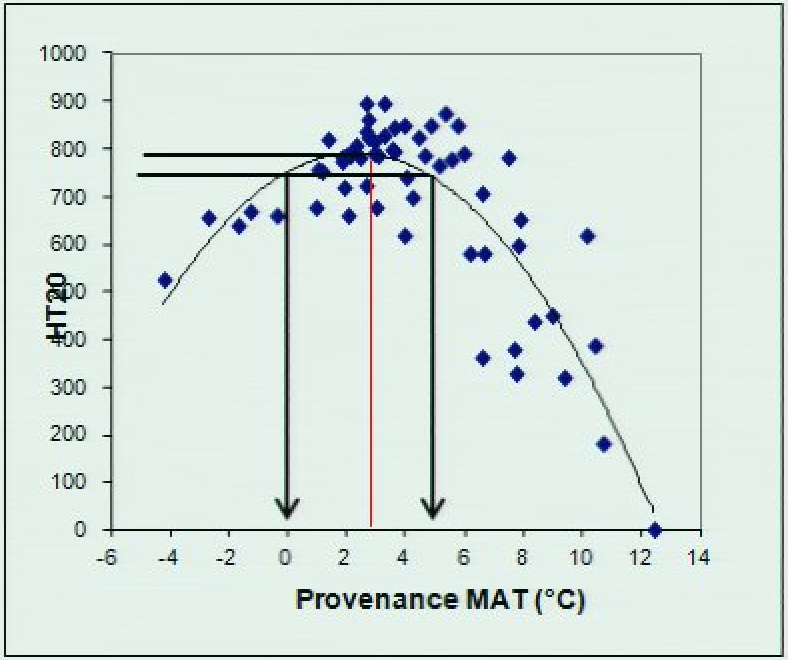
Test site = Community Lake

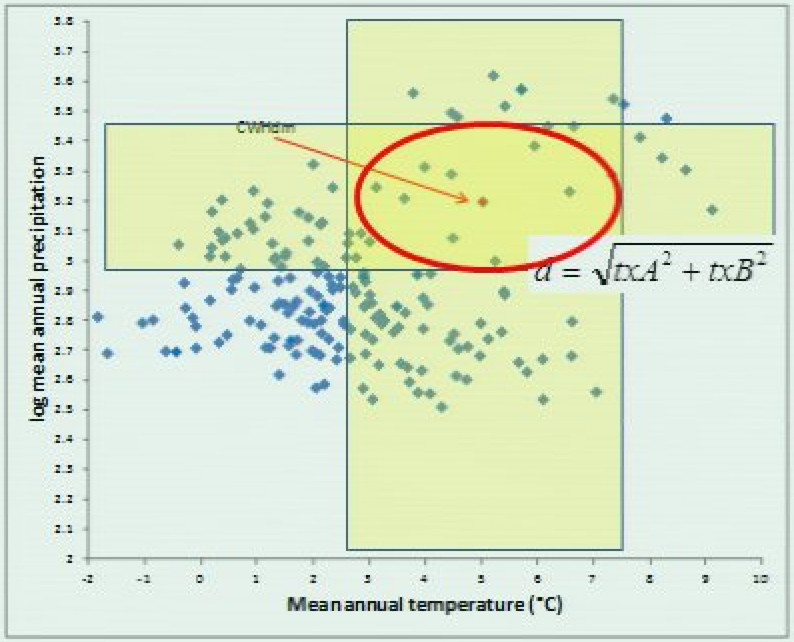


Illingworth Lodgepole Pine Provenance Test

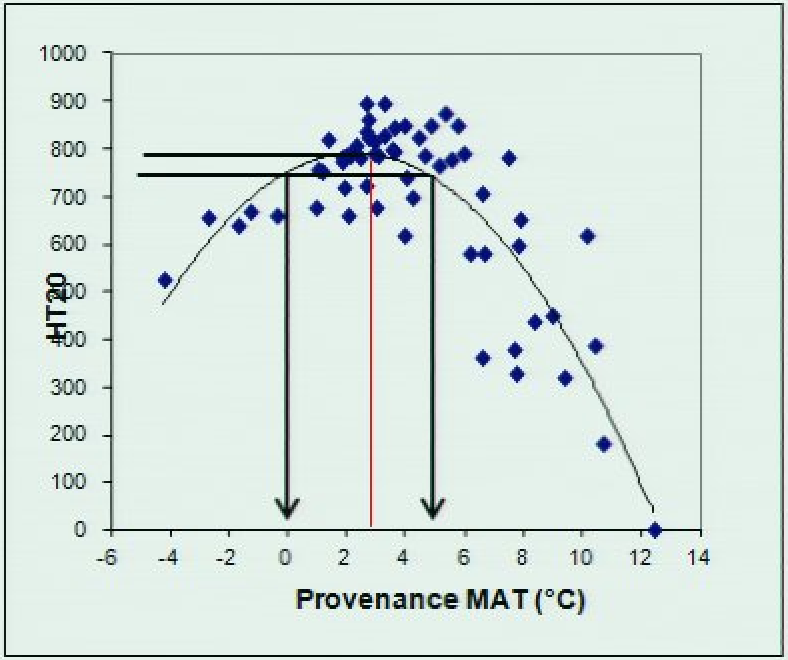
Test site = Community Lake

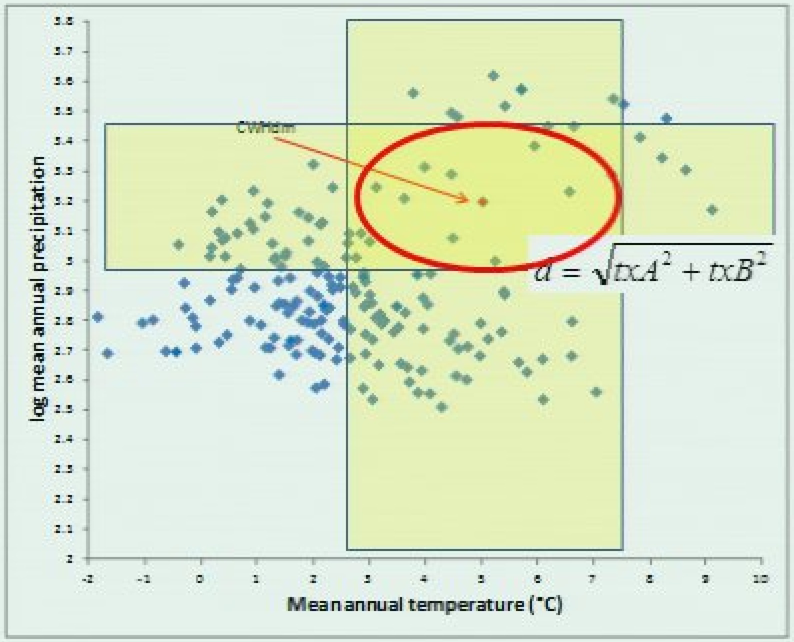


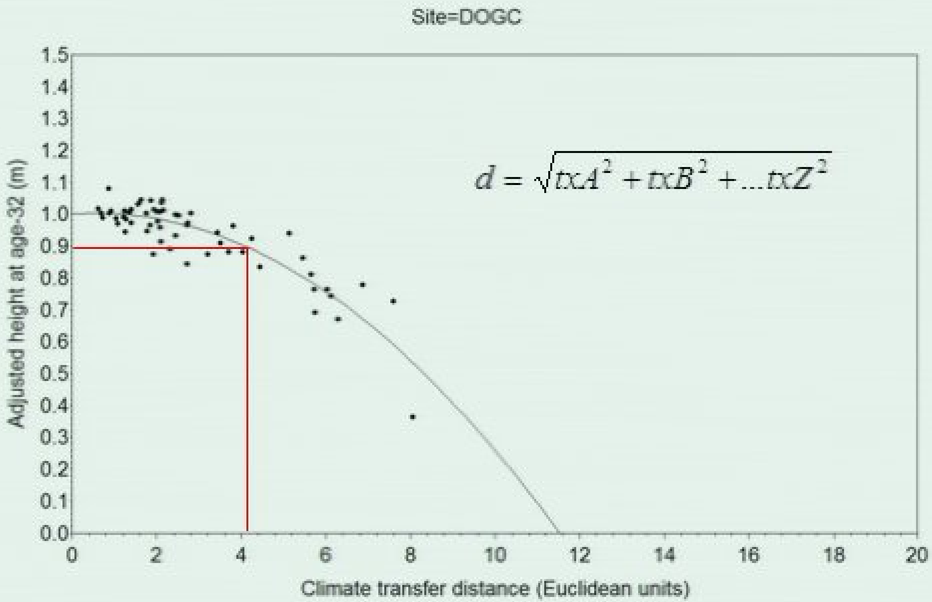



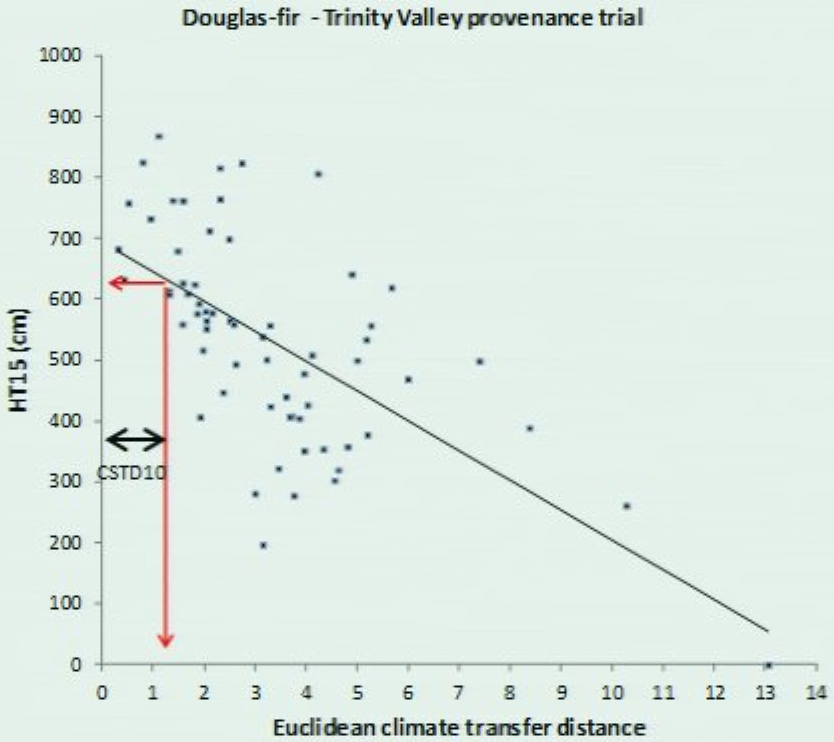
# Illingworth Lodgepole Pine Provenance Test

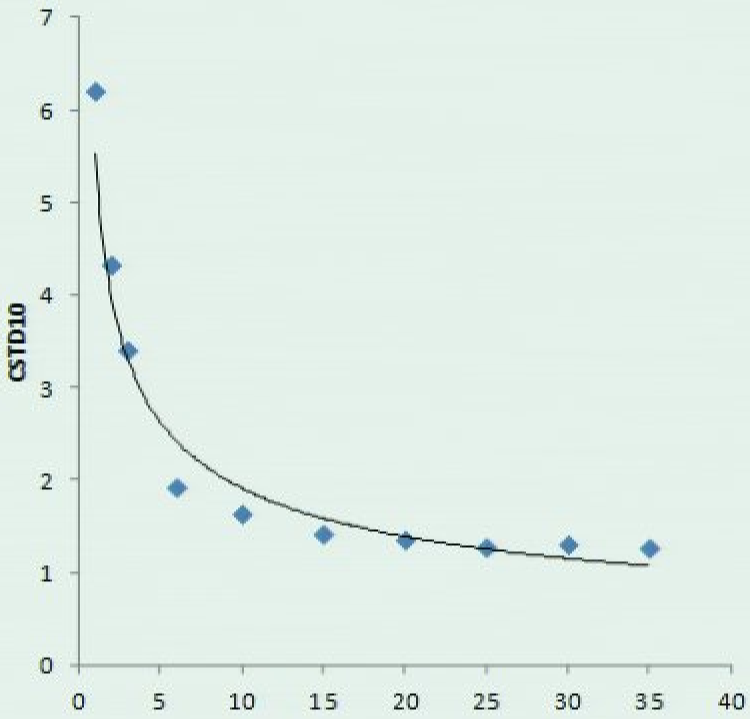
## Test site = Community Lake

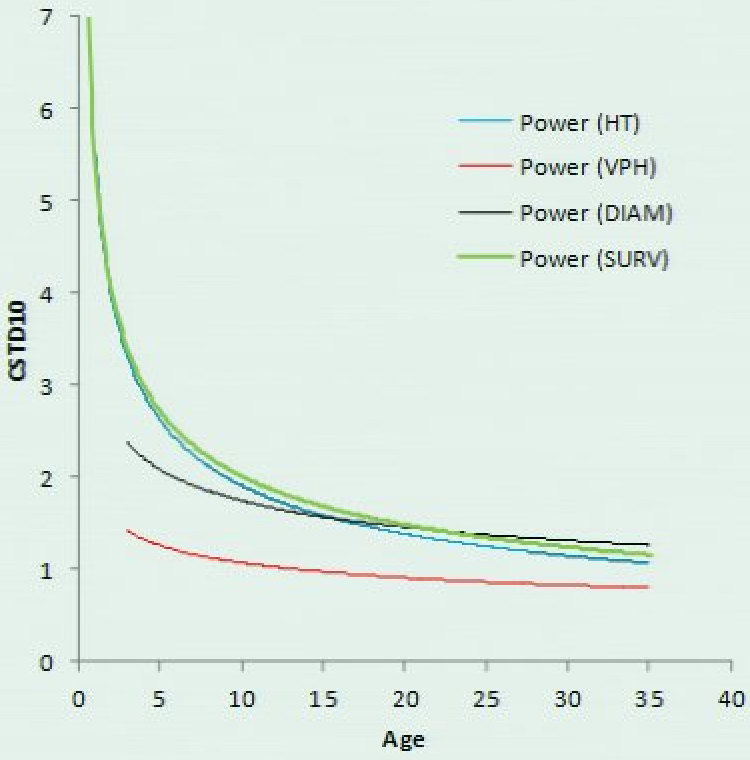





O'Neill and Jaquish, unpublished

**Seed Transfer 2.0**

- Seed transfer/AM rationale and risks
- AM using focal point ST system
- Migration distance and CSTD
- AM using hybrid ST system

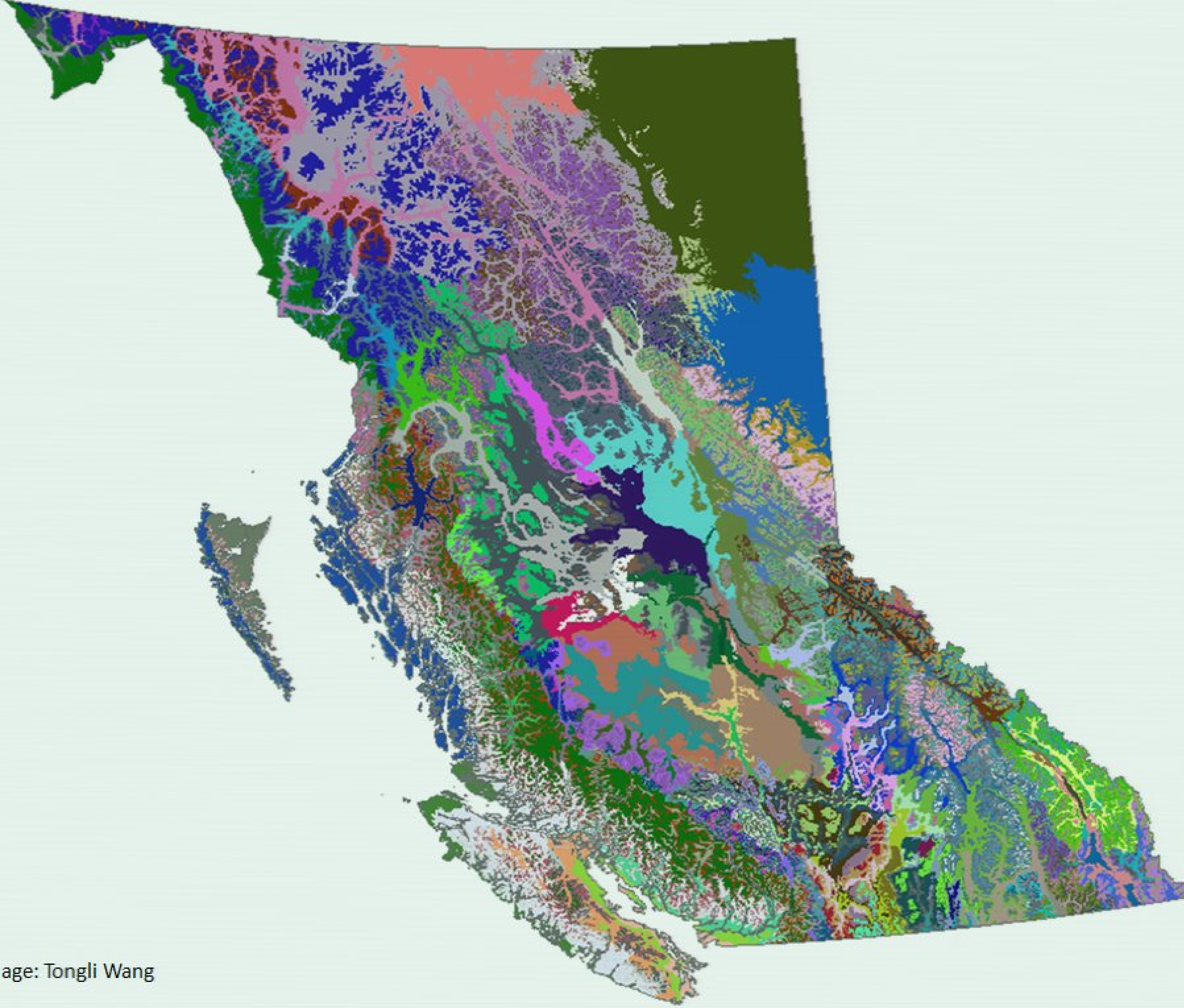
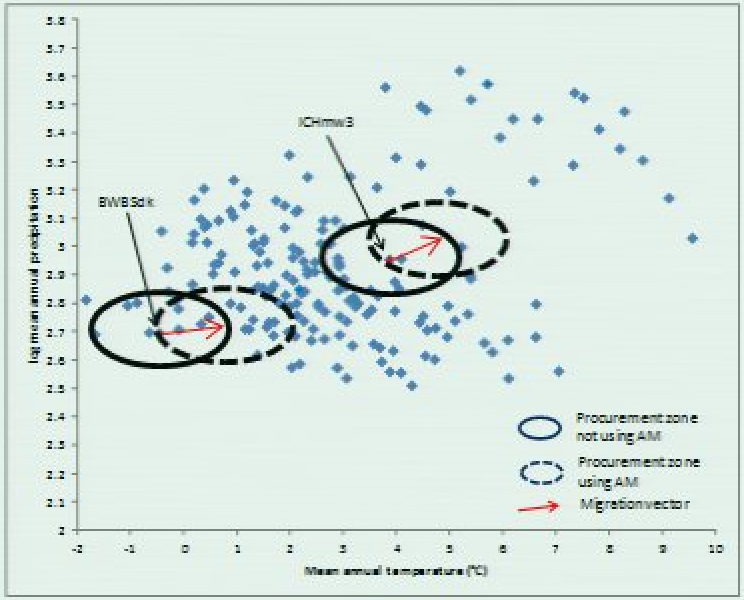


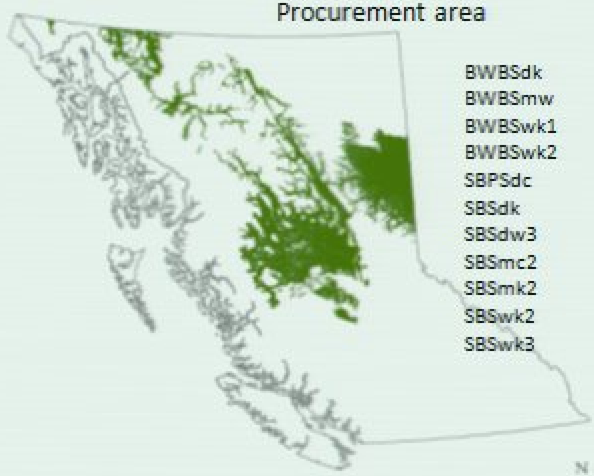
Image: Tongli Wang




# Hybrid seed transfer system

| | | plantation BECvar | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| prov BECvar | A | 1 | 1 | 0 | 0 | 1 |
| | B | 0 | 1 | 0 | 0 | 0 |
| | C | 0 | 1 | 1 | 0 | 1 |
| | D | 0 | 0 | 0 | 1 | 0 |
| | E | 0 | 1 | 1 | 0 | 1 |


Procurement area



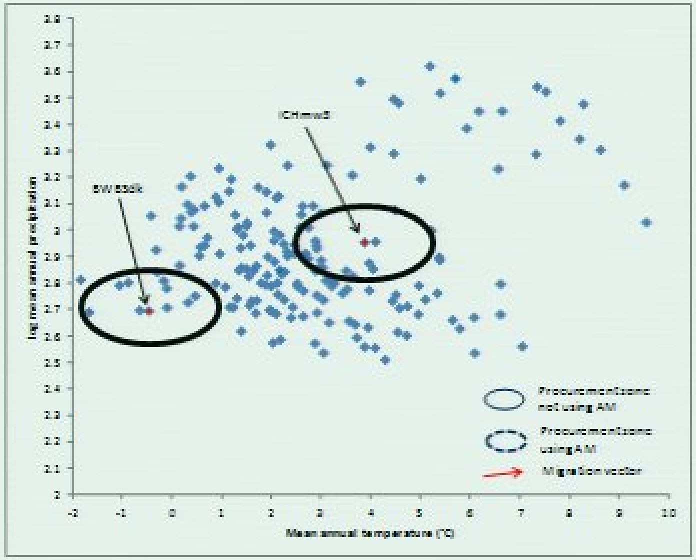

- ○ I have seed. Where can I use it?
- ● I have a cutblock. Where can I get seed?

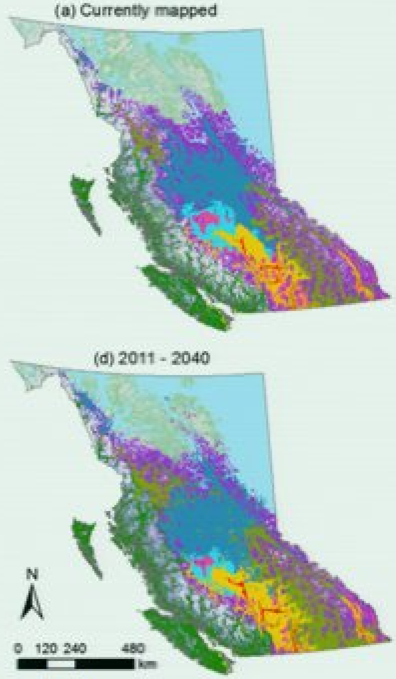
Current BECvar of seed or plantation

Go

Procurement or deployment BECvars

# Hybrid seed transfer system




Wang et al. 2012


| | | plantation BECvar | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| prov BECvar | A | 1 | 0 | 0 | 0 | 1 |
| | B | 0 | 1 | 1 | 0 | 0 |
| | C | 0 | 1 | 1 | 0 | 1 |
| | D | 0 | 0 | 0 | 1 | 0 |
| | E | 1 | 0 | 1 | 0 | 1 |

- I have seed. Where can I use it?
- I have a cutblock. Where can I get seed?

Seed or plantation

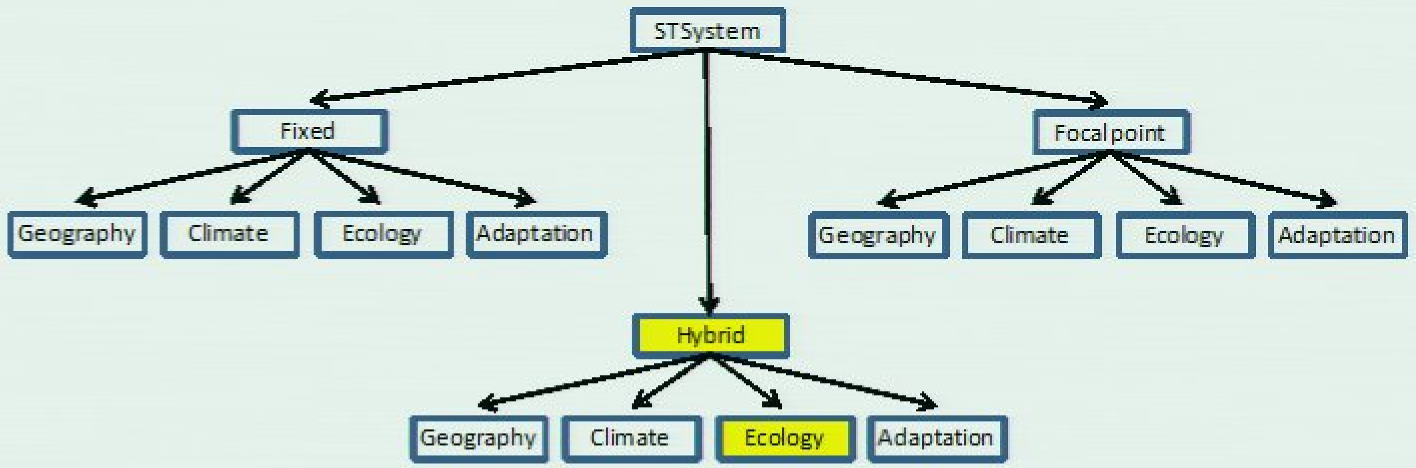
Latitude Longitude

Go

Current BECvar of plantation

Future BECvar of plantation

Procurement or deployment BECvars


STSystem
Fixed
Focalpoint
Hybrid
Geography
Climate
Ecology
Adaptation
Geography
Climate
Ecology
Adaptation
Geography
Climate
Ecology
Adaptation

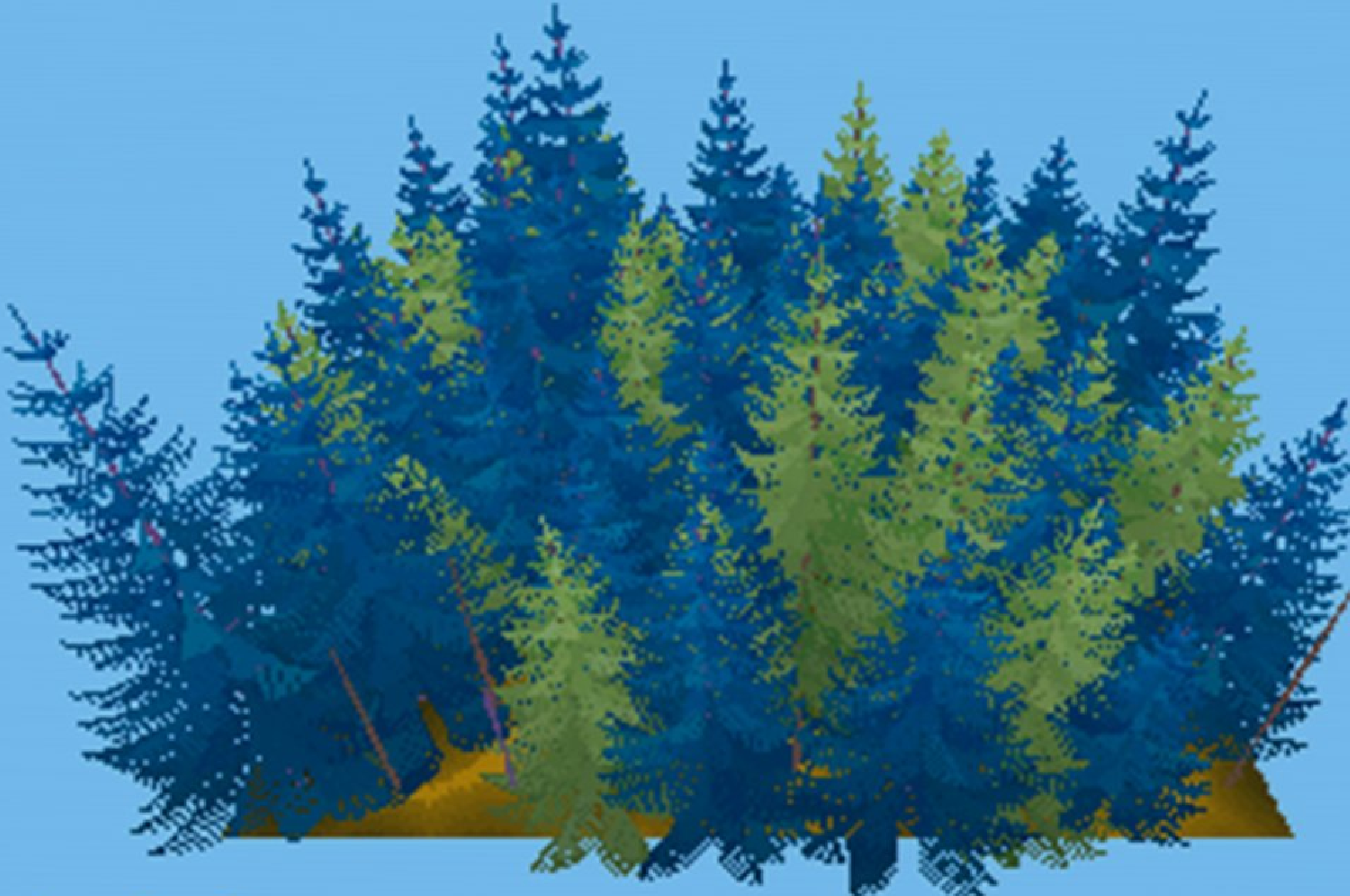


Image: Dave Simpson

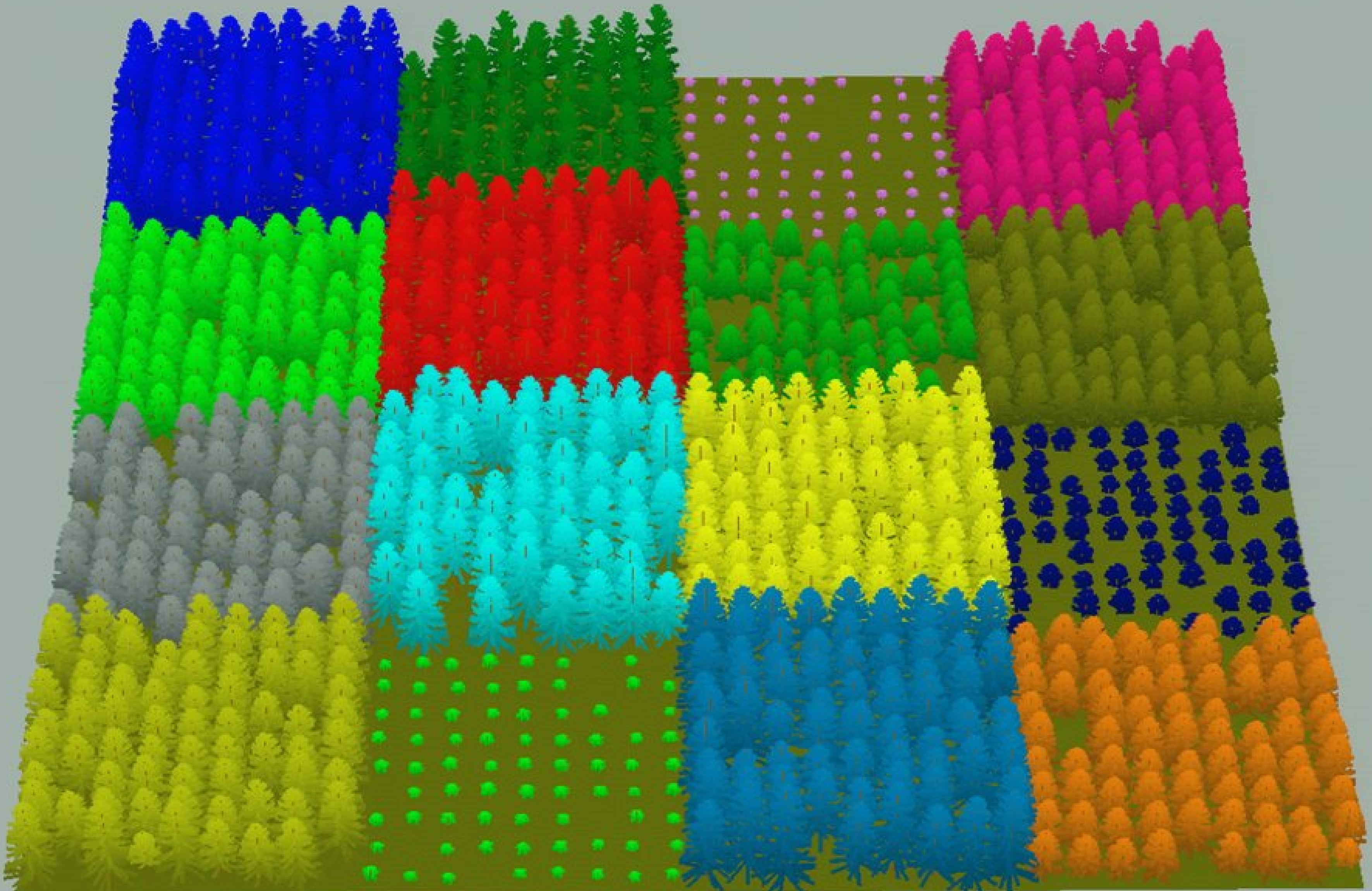


Image: Ian Cameron

# Assisted Migration Adaptation Trial (AMAT)

Greg O'Neill, Vicky Berger, Michael Carlson, Nick Ukrainetz
Tree Improvement Branch, BC Ministry of Forests, Lands and Natural Resource Operations

Feb 2013

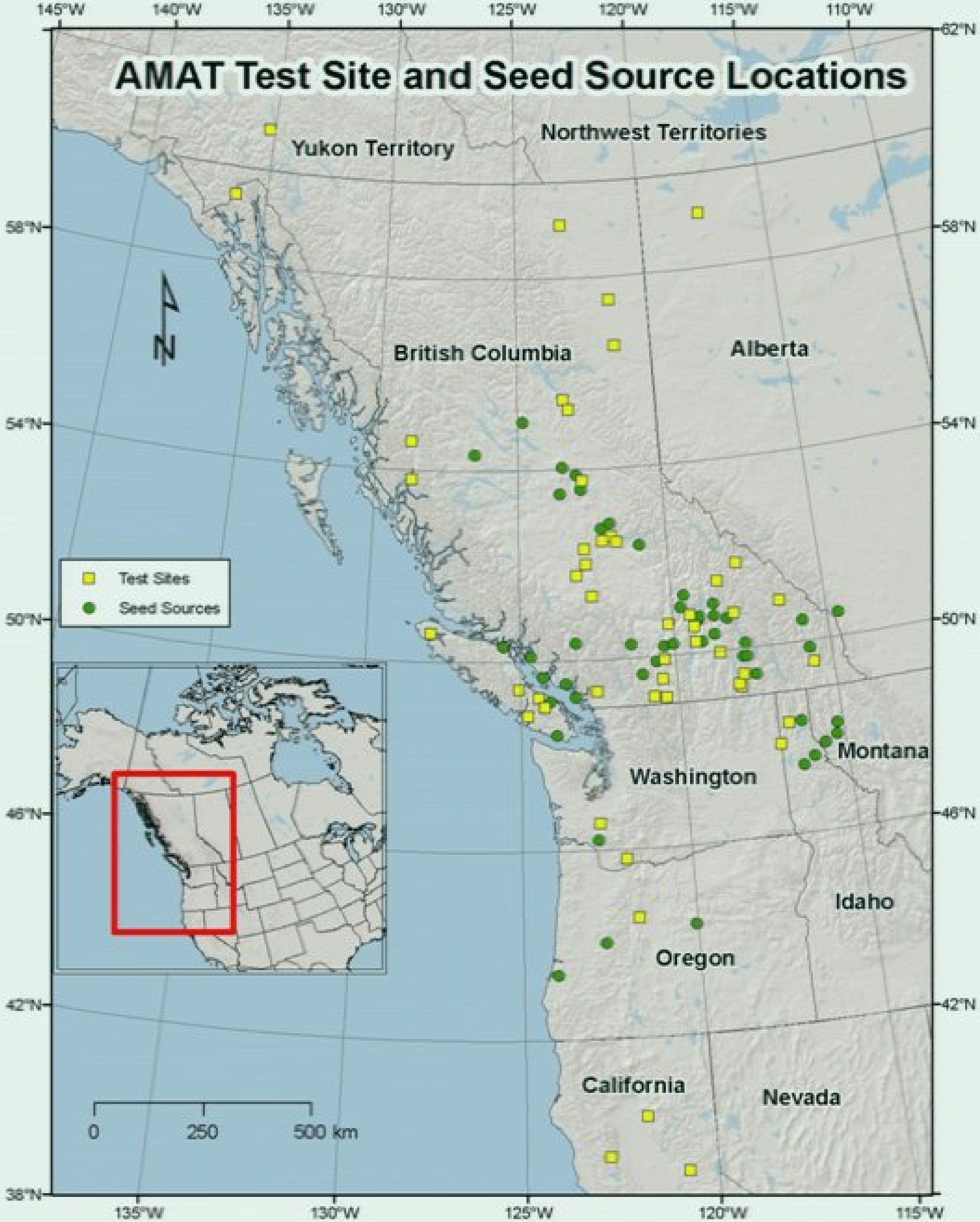
Forest Genetics Council of British Columbia
FGC

## Methods

48 orchard seed sources from 15 native western North American tree species

| Species | SItype | SPZ | Orchard_num | Lat | Long | Elev | MAT | MWMT | MCMT | TD | MAP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| At | PseudoA | At_SouthInt | At_SouthInt | 49.90 | 120.63 | 1060 | 4.3 | 15 | -6.3 | 21.3 | 513 |
| Ba | PseudoA | Ba_SouthInt | Ba_SouthInt | 49.65 | 121.10 | 1175 | 4.9 | 14.9 | -4.6 | 19.5 | 2215 |
| Bg | PseudoA | Bg_Koot | Bg_Koot | 49.45 | 117.48 | 850 | 5.7 | 16.8 | -5.6 | 22.4 | 966 |
| Bl | PseudoA | Bl_SouthInt | Bl_SouthInt | 50.98 | 119.70 | 1524 | 2.3 | 13.3 | -8.3 | 21.6 | 733 |
| Cwrc | Class A | M Low | 140 | 49.83 | 124.66 | 229 | 8.3 | 16.1 | 1.7 | 14.3 | 2364 |
| Cwri | PseudoA | Cwri_Koot | Cwri_Koot | 50.72 | 118.61 | 410 | 4.8 | 16.1 | -7.1 | 23.2 | 834 |
| Ep | Class A | southBC | Skim_Kal | 50.61 | 118.67 | 670 | 5.4 | 16.9 | -6.7 | 23.6 | 705 |
| Fdc | Class A | SM | 181 | 50.36 | 123.16 | 558 | 5.8 | 15.5 | -3.8 | 19.3 | 1867 |
| Fdc | Class A | M Low | 166 | 49.22 | 123.43 | 409 | 8.4 | 16.4 | 1.3 | 15.1 | 2351 |
| Fdc | Class A | CoosBayOR | CoosBay OR | 43.39 | 124.03 | 238 | 11.4 | 17.2 | 6.2 | 11.0 | 1763 |
| Fdc | Class A | Longview WA | Longview WA | 46.21 | 122.72 | 335 | 10.0 | 17.5 | 2.7 | 14.8 | 1893 |
| Fdc | Class A | Springfield OR | Springfield OR | 44.03 | 122.63 | 447 | 11.2 | 18.9 | 4.7 | 14.2 | 1541 |
| Fdi | Class A | PG | 225 | 53.58 | 122.78 | 772 | 3.2 | 14.5 | -9.7 | 24.2 | 648 |
| Fdi | Class A | QL | 226 | 52.35 | 120.92 | 925 | 3.2 | 14.3 | -8.9 | 23.2 | 681 |
| Fdi | Class A | CT | 231 | 52.74 | 122.17 | 853 | 3.6 | 14.7 | -8.9 | 23.7 | 591 |
| Fdi | Class A | NE | 321 | 50.74 | 118.63 | 641 | 5.5 | 17.0 | -6.6 | 23.6 | 824 |
| Fdi | Class A | NE | 324 | 50.13 | 117.71 | 1086 | 4.1 | 15.7 | -7.6 | 23.3 | 926 |
| Fdi | Class A | ID | Cherry Lane | 47.44 | 116.40 | 870 | 6.9 | 17.9 | -3.5 | 21.4 | 895 |
| Hwi | PseudoA | Hw_Monashee | Hw_Monashee | 50.77 | 119.10 | 800 | 5.2 | 16.7 | -7.0 | 23.6 | 867 |
| Hwc | Class A | M Low | 133 | 50.32 | 125.53 | 139 | 8.5 | 15.8 | 2.0 | 13.7 | 2308 |
| Hwc | Class A | M | 196 | 49.53 | 123.53 | 773 | 6.6 | 15.0 | -0.8 | 15.8 | 2575 |
| Lw | Class A | NE Low | 332 | 49.83 | 117.83 | 865 | 4.9 | 16.5 | -6.9 | 23.4 | 828 |
| Lw | Class A | EK | 333 | 49.85 | 115.70 | 1096 | 3.7 | 15.9 | -9.1 | 25.0 | 640 |
| Lw | Class A | ID | IETIC/USDA | 48.36 | 116.30 | 1120 | 5.5 | 16.9 | -5.5 | 22.4 | 901 |
| Lw | PseudoA | OR | OchocoNatFor | 44.33 | 120.04 | 1501 | 6.9 | 17.0 | -1.1 | 18.2 | 754 |
| Pli | Class A | CP | 218 | 54.06 | 123.40 | 798 | 2.7 | 14.2 | -10.3 | 24.5 | 645 |
| Pli | Class A | BV | 219 | 53.49 | 123.51 | 858 | 3.0 | 14.2 | -9.4 | 23.5 | 662 |
| Pli | Class A | PG Low | 222 | 52.84 | 121.85 | 827 | 3.7 | 14.9 | -8.6 | 23.5 | 710 |
| Pli | Class A | TO Low | 311 | 50.53 | 119.07 | 952 | 4.7 | 16.0 | -7.1 | 23.0 | 631 |
| Pli | Class A | NE Low | 337 | 50.69 | 119.16 | 910 | 5.1 | 16.4 | -6.7 | 23.2 | 670 |
| Pli | PseudoA | Pli_IETIC_MO | Pli_IETIC_MO | 47.84 | 115.64 | 792 | 6.1 | 17.6 | -5.4 | 23.0 | 960 |
| Pw | Class A | M Low | 175 | 48.15 | 123.85 | 660 | 7.7 | 15.7 | 0.7 | 15.0 | 1762 |
| Pw | Class A | KQ | 335 | 47.59 | 116.04 | 1157 | 5.9 | 16.8 | -3.9 | 20.7 | 1189 |
| Py | Class A | ID | Plains | 47.98 | 115.26 | 897 | 7.0 | 18.6 | -4.6 | 23.3 | 605 |
| Py | PseudoA | Py_SouthInt | Py_SouthInt | 50.28 | 121.40 | 560 | 6.3 | 17.8 | -5.8 | 23.6 | 539 |
| Ss | Class A | M All | 172 | 49.45 | 124.04 | 65 | 9.1 | 16.9 | 2.1 | 14.8 | 1572 |
| Sx | Class A | PG | 206 | 55.01 | 124.80 | 942 | 1.7 | 13.3 | -10.8 | 24.1 | 642 |
| Sx | Class A | PG | 211 | 53.88 | 122.94 | 834 | 2.8 | 14.3 | -10.2 | 24.5 | 668 |
| Sx | Class A | TO | 303 | 50.23 | 120.04 | 965 | 4.6 | 15.6 | -6.7 | 22.3 | 522 |
| Sx | Class A | TO | 303 | 50.21 | 120.33 | 1329 | 3.2 | 14.0 | -7.4 | 21.4 | 604 |
| Sx | Class A | EK | 304 | 50.45 | 115.83 | 1192 | 2.6 | 14.9 | -10.5 | 25.4 | 766 |
| Sx | Class A | NE Mid | 305 | 50.66 | 118.42 | 1160 | 3.4 | 14.6 | -8.1 | 22.7 | 845 |
| Sx | Class A | NE High | 306 | 51.24 | 119.57 | 1633 | 1.3 | 12.1 | -9.5 | 21.6 | 1003 |
| Sx | Class A | NE | 341 | 50.51 | 114.61 | 524 | 5.4 | 17.0 | -7.6 | 24.6 | 727 |
| Sx | Class A | BV | 620 | 54.33 | 126.52 | 792 | 2.7 | 13.7 | -9.4 | 23.1 | 561 |
| Sx | PseudoA | Se_IETIC_MO | Se_IETIC_MO | 48.03 | 115.19 | 1052 | 6.1 | 17.5 | -4.9 | 22.4 | 718 |
| Ycc | Class A | M All | CLRShedge | 49.67 | 124.26 | 1000 | 5.4 | 14.2 | -1.9 | 16.1 | 3100 |
| Yci | PseudoA | Yci_Koot | Yci_Koot | 49.85 | 117.70 | 1700 | 2.2 | 13.7 | -9.2 | 22.8 | 1160 |

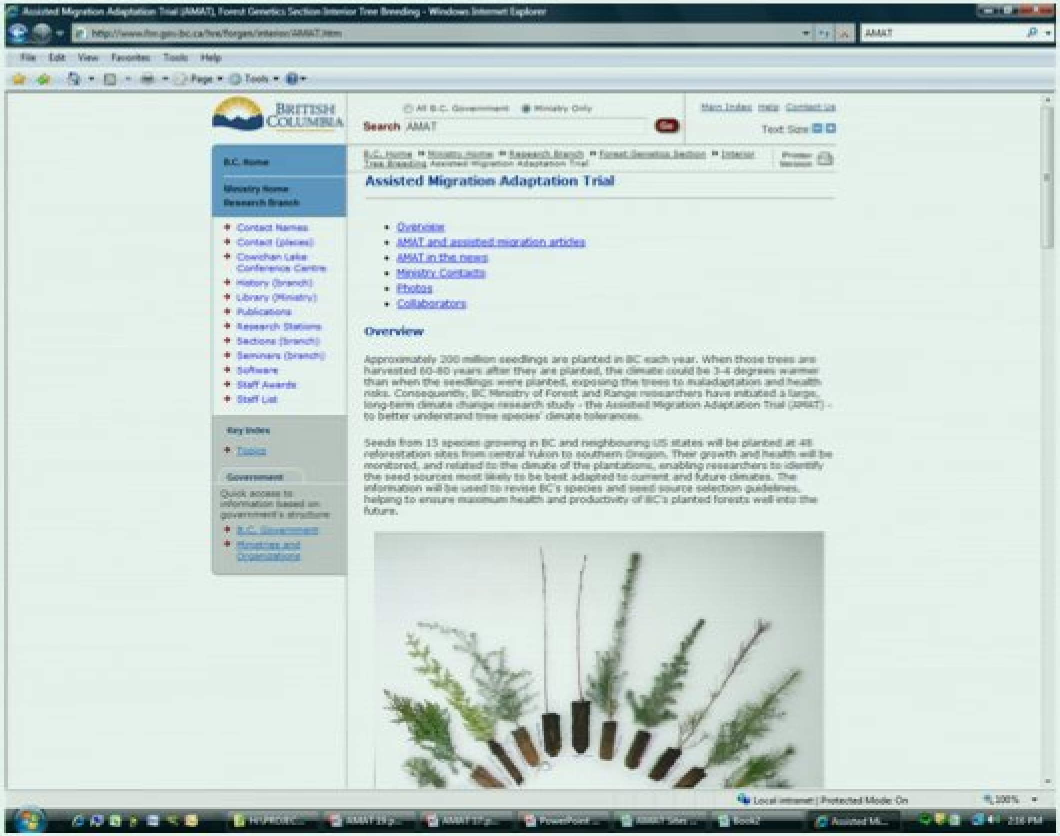
*Abies amabilis - Amabilis fir*
*Abies grandis - Grand fir*
*Abies lasiocarpa - Sub-alpine fir*
*Betula papyrifera - Paper Birch*
*Callitropsis nootkatensis - Yellow cypress*
*Larix occidentalis - Western larch*
*Picea glauca × P. engelmannii - Interior spruce*
*Picea sitchensis - Sitka spruce*
*Pinus contorta - Lodgepole pine*
*Pinus monticola - Western white pine*
*Pinus ponderosa - Ponderosa pine*
*Populus tremuloides - Trembling aspen*
*Pseudotsuga menziesii - Douglas-fir*
*Thuja plicata - Western redcedar*
*Tsuga heterophylla - Western hemlock*




**Methods**

Establish seedlots at 48 test sites spanning wide climate and latitudinal range

## Website




http://www.for.gov.bc.ca/hre/forgen/interior/AMAT.htm

For more information, please visit the US Forest Service Reforestation, Nurseries & Genetics Resources website at **http://rngr.net**