



Seed source evaluation trials to evaluate the feasibility of operational assisted migration

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Introduction

It is well established that trees and plants are locally adapted to their environment, and this adaptation is driven by local climate. This knowledge led to the development and implementation of seed zones for forest trees and native plants under the general concept that “local is best”. However, due to climate change, there is a growing body of evidence that this assumption may no longer be valid.

Geneticists with US Forest Service Pacific Northwest Region and Pacific Northwest Research Station are installing a series of seed source evaluation trials on National Forest lands in Washington and Oregon. Working with the National Forests to identify areas in need of restoration either due to timber harvesting, wildfire, or other disturbance, the goal of these trials is to evaluate the success of seedlots that evolved under different climate regimes that match predicted future climates of the planting site (preadapted) and to assess whether assisted population migration is a feasible alternative. One of the uncertainties regarding assisted migration is whether using seed sources “preadapted” to a future climate (i.e., warmer) will suffer from frost damage in the current climate.

Seedlot Selection Tool (SST) output

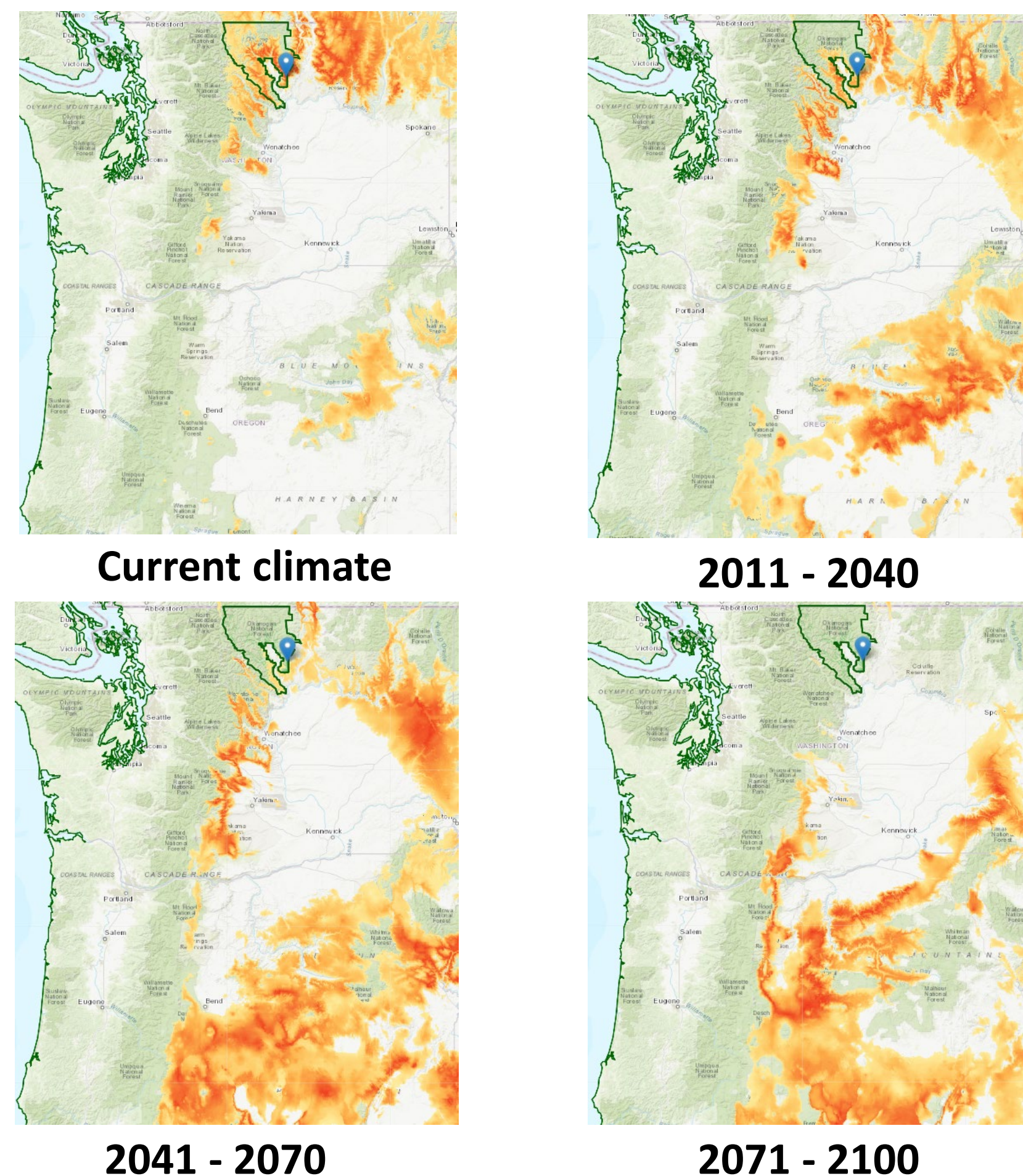


Figure 1. SST output maps showing climate matches for Carlton trial site (blue “pin”) for current climate, 2011-2040, 2041-2070, and 2071-2100 time periods (clockwise from upper left). Colors correspond to climatic matches, darkest red = best match, light orange = least match

Selecting Seedlots

- The Seedlot Selection tool (www.seedlotselectiontool.org/sst) was used to identify seed sources where the climate of their place of origin is a close analog to the future climate of the planting site.
- Four time periods are utilized (see Figure 1)
 - present – “local” seed source (1961-1990)
 - near-future (2011-2040)
 - mid-century (2041-2070)
 - late-century (2071-2100)
- Once appropriate seed sources were identified, the Regional seed inventory was reviewed to determine which specific seedlots were available for use.
- Climatic transfer distances between the planting site and the candidate seedlots were calculated for the near-term and long-term future climates of the planting site to find the best matched seedlot. (see Tables 1 and 2)
- Appropriate seedlots are identified by finding the smallest climatic transfer distance between the seedlot and the planting site for the future climate while remaining within an acceptable transfer limit for cold temperatures in the near-term to avoid risk of cold damage.

Table 1. Climate data for Carlton trial site for current and 3 future climates under RCP 8.5 emissions scenario. MCMT = mean coldest month temp SHM = summer heat:moisture index TD = temperature differential

Past and future climate and climate change at the planting site:							
Planting site ID:	Okanogan-Wenatchee NF Carlton site near Pole Pick						
Other information:	SZ 08013 3500-4000' 1966 zone 600 3500-4000'						
Latitude:	48.341						
Longitude:	-119.907						
Elevation:	1209m						
Climate	MCMT	SHM	TD	Climate change (from 1961-1990)			
1961-1990	-6.3	109.5	22.6	na	na	na	
2011-2040 RCP8.5	-4.5	132.7	22.9		1.8	23.2	0.3
2041-2070 RCP8.5	-3.1	155	23.7		3.2	45.5	1.1
2071-2100 RCP8.5	-1.1	180.3	24.4		5.2	70.8	1.8

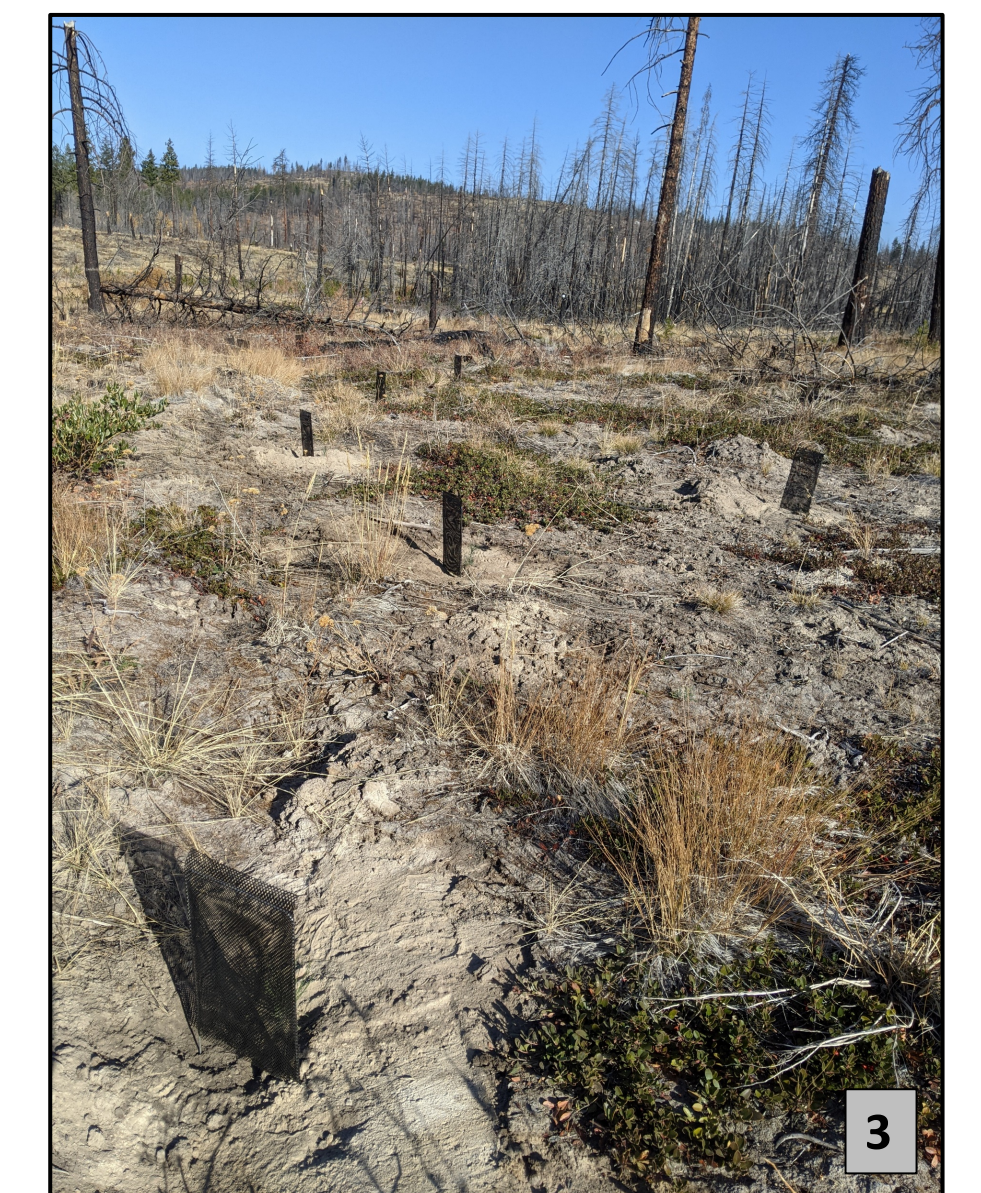
Table 2. Calculated climatic transfer distance for 4 seedlots chosen for different time periods for Carlton trial site. Green highlights indicate best match for MCMT (low climatic transfer distance), red highlights indicate seedlots beyond transfer limits for this site/time period.

Climatic Transfer Distances		MCMT				SHM					
For seedlots in USFS Region 6 inventory		1961-1990	2011-2040 RCP8.5	2041-2070 RCP8.5	2071-2100 RCP8.5	1961-1990	2011-2040 RCP8.5	2041-2070 RCP8.5	2071-2100 RCP8.5		
Current climate at planting site:		-6.3	-4.5	-3.1	-1.1	109.5	132.7	155	180.3		
Predicted future climate change at planting site:		0	1.8	3.2	5.2	0	23.2	45.5	70.8		
Sort ID	Zone Set	Breeding zone	Elevation Band	1961-1990	2011-2040 RCP8.5	2041-2070 RCP8.5	2071-2100 RCP8.5	1961-1990	2011-2040 RCP8.5	2041-2070 RCP8.5	2071-2100 RCP8.5
84	PIPO-01-675-05000-40-85 SIA	675_4000	4000-5000	-5.40	-3.60	-2.20	-0.20	-38.61	-15.41	6.89	32.19
591	PIPO-17-17064-08200-0040-95 SIA	17064	<4000	-3.26	-1.46	-0.06	1.94	-32.05	-8.85	13.45	38.75
533	PIPO-17-17004-07-100-3.5-09	17004	3000-4000	-2.15	-0.35	1.05	3.05	-57.38	-34.18	-11.88	13.42
917	PIPO-08-08014-100-3040-94 SIA	08014	3000-4000	-0.19	1.61	3.01	5.01	13.35	36.55	58.85	84.15

Trial Establishment

Trails will be established with seedlings grown and outplanted using the same specifications as “operational” reforestation projects including

- Species
 - Nursery stock type
 - Nursery culling standards
 - Tree spacing,
 - Planting season,
 - Planting technique, etc.
- Randomized 1.5-acre blocks of each seedlot are replicated at least 4 times across the landscape to reduce the impact of local environmental variation on measured variables.
 - While these trials are not intended to be intensively measured for adaptive traits, survival and growth will be monitored regularly to determine if differences develop among seed sources, and which seed sources have the greatest survival and performance over time.



Figures 2 & 3. 1 year old ponderosa pine seedlings planted at the Carlton trial site. Shade cards were installed to provide shelter as this site was salvage logged after a fire and no natural shade was available.

Trial Sites

- Carlton – Okanogan-Wenatchee NF, Methow Valley RD – ponderosa pine – planted Oct 2021
- Randle – Gifford Pinchot NF, Cowlitz Valley RD – Douglas-fir – to be planted Nov. 2021
- Goat Mtn – Mt. Hood NF, Clackamas River RD – Douglas-fir – to be planted fall 2022
- Detroit – Willamette NF, Detroit RD – Douglas-fir – to be planted Fall 2022
- Blue River – Willamette NF, McKenzie River RD – Douglas-fir – to be planted Fall 2022
- Keeps Mill – Mt. Hood NF, Barlow RD – ponderosa pine – to be planted spring 2023
- Corral Pass – Mt. Baker-Snoqualmie NF, Snoqualmie RD – noble fir – to be determined
- TBD – Colville NF, TBD – ponderosa pine – to be determined