



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



June 2022

Table of Contents

Introduction	3
How to Use this Guidebook	6
Step by Step Guide to Using the SST	7
Overview of Scenarios	13
Scenario 1: Identifying seedlot locations adapted to a chosen planting site	14
Scenario 1A – Change to a future time period	20
Scenario 2: Identifying planting site locations suited to a specific seedlot collected from a single location	22
Scenario 2A – Change to a future time period	28
Scenario 2B – Adjust transfer limits	30
Scenario 2C – Change future time period	33
Scenario 3: Identifying planting site locations suited to a seedlot sourced from a breeding zone	35
Scenario 3A – Apply constraints	40
Scenario 3B – Changing transfer limits	41
Scenario 4: Comparing multiple seedlots for a specific planting site “pre-adapted” to different future time periods	43
Scenario 4A – Change future time period	49
Scenario 4B – Changing future time period	51
Scenario 5: Identifying suitable planting sites for a western redcedar seedlot from southwestern Oregon	53
Scenario 6: Seed planning, performing a gap analysis of seed orchard seed suitability under future climate conditions	57
Perform a GAP Analysis using ArcGIS	67

Abstract

The Seedlot Selection Tool (SST) - Guidebook offers six examples that demonstrate the basic operation and settings options for the SST, as well as guidance on use of the application in different reforestation scenarios typically encountered on National Forest System lands in the USFS Pacific Northwest Region 6. The guidebook will help Region 6 silviculturists and reforestation specialists use the SST in planning their nursery and reforestation activities while considering current and future climate conditions.

Credits

This guidebook was created by the Conservation Biology Institute (CBI), USDA Forest Service, and USDA Northwest Climate Hub. The authors include: Andrew Bower, Area Geneticist, U.S. Department of Agriculture Forest Service, Pacific Northwest Region, Olympic National Forest, Olympia, WA 98512; Vicky Erickson, Regional Geneticist, U.S. Department of Agriculture Forest Service, Pacific Northwest Region, Portland, OR 97204; Holly R. Prendeville, Coordinator, U.S. Department of Agriculture Northwest Climate Hub and acting Coordinator, Western Wildland Environmental Threat Assessment Center at the Pacific Northwest Research Station, Portland, OR 97204; and Brad St. Clair, emeritus Research Geneticist, U.S. Department of Agriculture, Forest Service Pacific Northwest Research Station, Corvallis, OR 97331. The guidebook layout, formatting, and technical guidance was provided by the Conservation Biology Institute, including: Gwynne Corrigan, Kai Foster, Gladwin Joseph, Nikolas Stevenson-Molnar, and Deanne DiPietro.



Acknowledgements

Funding for this guidebook was from the U.S. Department of Agriculture Northwest Climate Hub and U.S. Department of Agriculture Forest Service. The authors thank reviewers for making this guidebook better because of their feedback.

Cover photo: Cone Peak from Iron Mountain on the Willamette National Forest. Photo by Matthew Tharp.

Introduction

In the Pacific Northwest, changing climates will result in new environmental conditions and stressors, including warmer temperatures, precipitation extremes, uncharacteristic wildfires, competing invasive plants, and new and intensifying insect and disease infestations. Seeding and planting are increasingly important tools to reduce impacts from these stressors and to match tree species and populations with changing climates and altered disturbance regimes.

Climates have already changed such that many plants are now growing outside their optimal climate. The climate will continue to change faster than plant populations can respond, especially for long-lived species like trees. In these situations, seed sourcing protocols may be modified to shift emphasis from using only seed from local sources to selecting seed sources (or a portion of the seed sources) to match current and future climates. In many cases, the direction of plant movement to suit changes in climate will be from warmer, drier environments to environments where conditions are cooler and wetter. Note, seed zones or breeding zones represent seed sources or plant material from an area to which it is adapted to the local environment. For more information about climate-matched seed zones please see (<https://www.fs.fed.us/wwetac/Seedzonemapping.php>).

Assisted migration is the human-assisted movement of plants to a new habitat so that these plants are adapted to current and future climates to maintain biological diversity and ecosystem function. Assisted migration is a general term that refers to a broad range of management actions that can occur at varying spatial scales. Three types of assisted migration are:

- **Assisted population migration.** This is human-assisted movement of seed sources from populations to a new location within the historical range of a species (e.g., moving among seed zones). This strategy moves plant materials to areas where they are adapted to the current and future climates as well as to increase genetic diversity across the range of a species. In Figure 1, the panel on the left demonstrates movement occurring among distinct seed zones (gray areas).
- **Assisted range expansion.** This is the human-assisted movement of seed sources from populations within the species range to suitable locations that are just beyond the current species range, which mimics a tree's natural ability to disperse to this new habitat. This action expands the species range at a faster rate due to human assistance to support the long-term survival of the species.
- **Assisted species migration.** This is the human-assisted movement of seed sources from populations to locations outside of the established range of the species and farther away than could occur through natural dispersal. In this case, help by humans overcomes any *natural migration boundary* (noted by the dotted line in graphic below). [Assisted species migration is also called species rescue, managed relocation, or assisted long-distance migration].

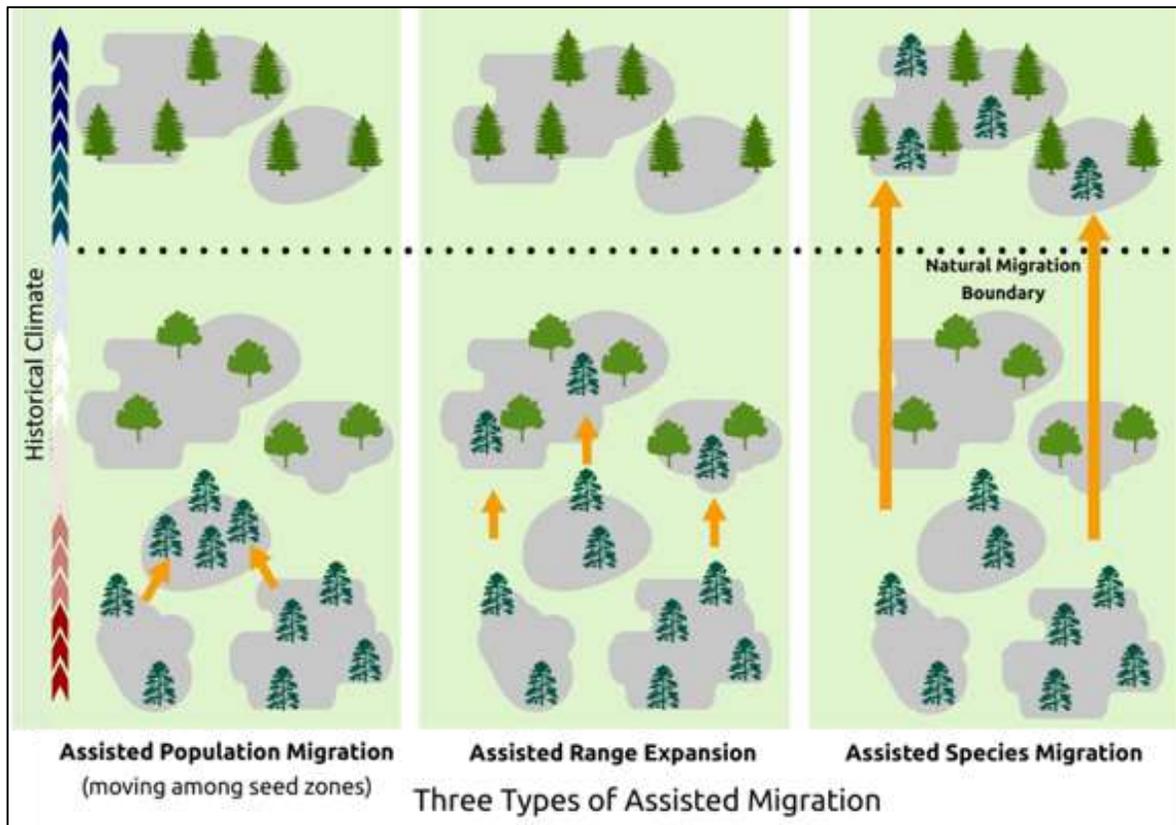


Figure 1. This graphic demonstrates each type of assisted migration using a conifer graphic, though the three types of assisted migration are applicable to all plants. Different populations are represented by distinct grey areas. Orange arrows represent human-assisted movement of plant material to a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

Forest Service Manual (FSM) 2472 is currently under revision to address the different types of assisted migration and define their appropriate use in reforestation activities on National Forest System lands. The revision states that assisted population migration and assisted range expansion are generally considered lower risk (i.e., plant material adapted to local climate, that are non-invasive and resilient to pests and pathogens) actions that may be appropriate over large areas to accommodate projected changes in climate. However, assisted species migration is considered higher risk and should only occur at smaller scales on National Forest System lands. According to the revised Forest Service policy, assisted species migration must be informed by successful performance in evaluation trials, justified by climate model projections, or proven through empirical research.

The Seedlot Selection Tool (<https://seedlotselectiontool.org/sst/>) was developed to assist land managers to identify appropriate seed sources for a reforestation site and informing where to plant the available seed inventory based on historical, current, and future climates. This tool is built to support both assisted population migration and assisted range expansion with the objective that seedlings be adapted to future climates. SST uses climate data important to tree

growth and survival (e.g., mean coldest month temperature) to predict which seed sources will be best adapted to a climate. Also, this tool can help identify where there are gaps in current seed inventories and where future collections could focus to have plant materials that are better adapted to current and future climates (see Scenario #6 as an example). Detailed information on the climate models and data sources used in the SST can be found in the “Background” and “User’s Guide” at <https://seedlotselectiontool.org/sst/>. Further background and examples can be found in [St.Clair et al. \(2022\)](#) which describes both the Seedlot Selection Tool and the Climate Smart Restoration Tool. The Climate Smart Restoration Tool is very similar to SST, but focuses on grasses, shrubs, and forb species.

This guidebook provides case studies that demonstrate the basic operation and settings options for the SST, as well as guidance on use of the application in different reforestation scenarios typically encountered on National Forest System lands in the USFS Pacific Northwest Region 6. In addition to the case studies presented in this guidebook and in [St. Clair et al. \(2022\)](#), many options are available for more advanced application of SST functionality. Examples include creation of GIS overlays of SST output (GeoTiffs) with wildfire risk maps or other geographic focal areas within a forest or region. This information could be used to identify cross-boundary restoration opportunities and the development of strategies for targeted seed collections among affected landowners and the prioritization of seed orchard assets for co-management and protection.

Region 6 seed inventory reference guide

A useful desk reference guide containing essential reference tools for locating, understanding, and managing Region 6 forest seed inventories and conifer seed orchard installations is available online at <https://fsweb.r6.fs.fed.us/natural-resources/seed-genetics/>. The desk reference provides contact information for regional and area genetics staff and clarifies the seedbank contents and supporting roles of regional facilities including Dorena Genetic Resources Center, Bend Seed Extractory, and J. Herbert Stone Nursery.

How to Use this Guidebook

General overview

This guidebook will help silviculturists and reforestation specialists use the SST in planning their nursery and reforestation activities while considering current and future climate conditions. This section describes the seven steps involved in using SST to match seedlots with planting sites or to match planting sites with seedlots adapted to current and future climates (Figure 2). Where appropriate, **User Tips** (in green shaded boxes) are provided to give specific guidance for use of SST in Region 6, as well as information regarding Region 6 breeding zones and regional seed inventory. Subsequent sections contain step-by-step instructions on how to use the SST under six different reforestation scenarios that build on each other and demonstrate various settings and methods to use the tool in reforestation planning. In the step-by-step instructions below, look for this symbol  for a quick reference back to a related **User Tip** from this section.

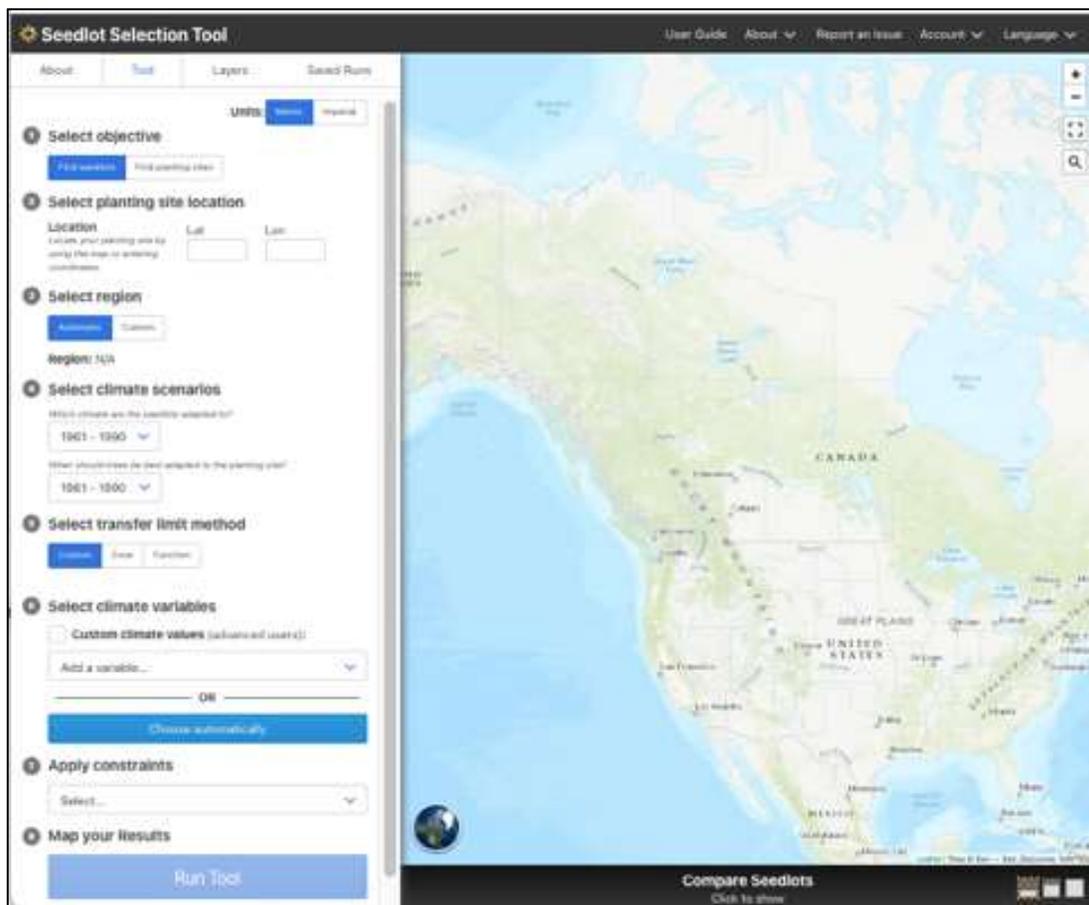


Figure 2. User interface of the Seedlot Selection Tool showing the eight steps for inputting information.

Step by Step Guide to Using the SST

Step 1: Select objective

Select one of the two mapping objectives:

(a) Find seedlots

The objective of finding seedlots for a planting site is to indicate where one would locate seedlots that would be adapted to a past, current, or future climate at a planting site.

(b) Find planting sites

Alternatively, the objective of finding planting sites for a seedlot is to indicate where the current or future climate matches the conditions to which the seedlot is suited (i.e., climate-matched).

 ¹ **User Tip:** A suitable climate match is anything within the climatic transfer limits (as calculated by the scaled Euclidian distance of two or more variables). Of course, 100% is a better match than 68% which is a better match than 33%. The scores can be used to prioritize seedlots with the greatest climate match to a planting site. If the specified transfer limits yield results that are questionable or unacceptable, then users should use a lower transfer limit to reduce the area of lower climatic match.

Step 2: Select planting site or seedlot location

Add the location of the planting site or a seedlot based on the objective selected in the previous step.

 ² **User Tip:** Many existing Region 6 seedlots lack geographic coordinates or spatial information for determining seed origin. In these cases, the seedlot location is specified in SST by setting a point anywhere in the seed zone or breeding zone where the seedlot was collected.

When the **climate center** of the seed zone or breeding zone is selected the average climate of the zone is used to characterize the entire zone. This method is useful for bulked seedlots or seedlots obtained from seed orchards where the parent trees are located throughout the breeding zone.

For new forest seed collections, the geographic coordinates of the stands represented in the seedlot should be documented on cone tags/collection records and in the USFS corporate seed inventory system (currently NMIS, Nursery Management Inventory System). Bulking seed over narrow climate ranges (~1-2°C) within the collection area will facilitate better matching of the seedlot to planting site climates.

Locations may be selected by providing geographic coordinates in decimal degrees (note: enter a negative value for a longitude in North America) or by using the pan and zoom tools to navigate to a location and clicking on the left mouse button to 'set' the map coordinates.

Step 3: Select the region

The SST geographic extent covers all North America. To reduce processing time, the data has been divided into seven overlapping regions. The tool will automatically choose a default region based on the location provided in the previous step. Users can override this default region to map results to a different region by selecting the Custom option and choosing one of the other regions available.

Step 4: Select climate scenarios

Select the time periods for mapping the climatic similarity of the seedlot and planting site. There are two time periods: (1) Which climate are the seedlots adapted to? and (2) When should trees be best adapted (*or expected to be suitable*) to the planting site (*given its climate*)? Note the recommendation in User Tip  below.

The assumption is that the time period to which seedlots are adapted is typically a past climate when the inherited traits of the seedlot's parents greatly influenced its survival, growth, and reproduction. Although adaptation may result from natural selection over generations, one may assume that the adaptation period for long-lived species like trees is represented by the 1961-1990 climate averages (30-year climate normal), a period prior to appreciable warming trends.

 **User Tip:** Select the time period that is most reflective of the climate conditions the seeds are adapted to. Unless you're working with young stands or non-tree species (e.g., grasses and forbs) with shorter life spans, we recommend choosing the 1961-1990 climate normal, especially when finding planting sites for seedlots. Many of our seedlots were collected during the 1980s and 1990s, so the SST 1961-1990 time-period is most reflective of the climate conditions these trees are adapted to. For shorter-lived species with greater potential to respond to natural selection, users can choose the 1981-2010 climate normal.

Future time periods in which seedlot(s) should be suitable to a planting site(s) are represented by a 30-year period (referred to as a climate normal): early-century (2011-2040), mid-century (2041-2070), and late-century (2071-2100). There are two emissions scenarios for each time period known as Relative Concentration Pathways (RCP), the lower emissions scenario RCP 4.5 with an increase in global mean annual temperature of 1.8°C by 2100 (range = 1.1-2.6°C) relative to the 1986-2005 average and the higher emission scenario is RCP 8.5 with an increase of 3.7°C by 2100 (range = 2.6-4.8°C).

Step 5: Select transfer limit method

 **User Tip:** When specifying future climates, the mid-century (2041-2070) is generally recommended for Region 6 national forests. This helps ensure that seedlots moved from warmer to colder locales are not moved so far that they risk cold damage, especially during the early seed and seedling stages when trees are most vulnerable.

The emission scenario RCP 8.5 is generally recommended for use, especially for the near-term period (2011-2040) when the differences between RCP 4.5 and 8.5 are minor. By mid-century, differences become larger, and even larger by late-century (up to 2.6°C difference between RCP 4.5 and RCP 8.5 for mean temperature of the warmest month (MWMT)).

It is prudent to use the higher emissions scenario and choose plant material that is adapted to the near-term climate as well as climates further into the future. Be aware that moving populations too far from a warm to cold climate may lead to higher risk of cold damage, particularly in the seed and seedling stage when plants are most vulnerable.

The transfer limit method selected determines how far climatically a seedlot may be moved and still have an acceptable level of adaptation. The SST uses three approaches to determine and map transfer limits:

Custom – allows for user-defined transfer limits for each climate variable selected in Step 6 based on user knowledge and experience including the best available science.

Zone – suggests transfer limits based on the range of climate conditions within the zone of the planting site or seedlot; these values are based on operational resource management over the past half-century.

Function – allows for species to be selected to determine transfer limits based on a function that is derived from genetic studies that relates population differences in adaptive traits grown in a common environment to the climates of seed sources. The function approach is available for select species.

For more information on the ways the transfer limits are calculated, go to the [SST homepage](#) and select “Background” from the “About” drop down tab in the top banner.

Selecting a species in this step defaults to “generic,” however specific species and associated zones are selectable where they are available. If no species appear in this drop-down menu there are no species-specific zones in the area of interest and the generic seed zones for the area of interest will be selectable.

 **User Tip:** In Region 6, either the USFS Generic Zone or the 1966 OR and WA Seed Zones would generally be used most often since most of our current seed inventory was collected and labeled using these delineations. In Southwest Oregon, species-specific breeding zones have also been delineated and may be selected for use in this area.

Step 6: Select climate variables

When using the **Custom** or **Zone** approach, select one or more of the 16 biologically relevant climate variables listed below.

MWMT	Mean warmest month temperature
MCMT	Mean coldest month temperature
TD	Temperature difference between MWMT and MCMT, or continentality
MAP	Mean annual precipitation
MSP	Mean summer precipitation, May to September
AHM	Annual heat-moisture index
SHM	Summer heat-moisture index
DD_0	Degree-days below 0°C
DD5	Degree-days above 0°C
FFP	Frost-free period
PAS	Precipitation as snow, August to July
EMT	Extreme minimum temperature over 30 years
EXT	Extreme maximum temperature over 30 years
Eref	Hargreaves reference evaporation
CMD	Hargreaves climatic moisture deficit

Do not select too many climate variables, particularly variables that are correlated with each other. The use of more than three climate variables will probably result in overly conservative climate matches; the more climate variables that are included, the smaller the mapped areas will be. You also have the option to choose automatically, in which case, the climate variables chosen will be mean temperature of the coldest month (MCMT) and summer heat: moisture index (SHM). These climate variables are chosen based on the assumption that temperate forest trees (or other plants) are primarily adapted to cold temperatures in the winter and aridity in the summer.

The automatic selection of climate variables will calculate default transfer limits of +/- 2.0°C for Mean Coldest Month Temperature (MCMT) and +/- half of value at the location of the planting site or seedlot for Summer Heat-Moisture Index (SHM).

 **User Tip:** As transfer limits increase, the amount of climate-matched area increases, but the areas indicating the best match stay the same (see Scenario 3a). Widening the transfer limits simply broadens the areas of lower climatic match. In addition to transfer distance, silviculturists should also consider the directionality of seed movement. For example, while it would be acceptable to move seed from maritime to continental climates, movement from a continental to a maritime climate would generally be inadvisable due to concerns over problems with needless diseases.

Step 7: Apply constraints

This is an optional step that applies constraints to limit the geographic extent of the mapped results. There are two choices for constraining the results: 1) Geographic constraints including latitude, longitude, elevation, distance, photoperiod, or 2) Species ranges that include a list of results from species distribution models for contemporary climates. Users also have the option to import their own geographic boundary to use as a constraint under the geographic constraints, by selecting a shapefile. Using constraints will exclude that part of the climatic output that is beyond the geographic limits imposed or beyond the species range.

Step 8: Map your Results

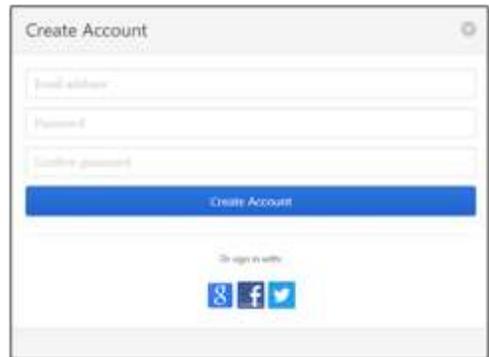
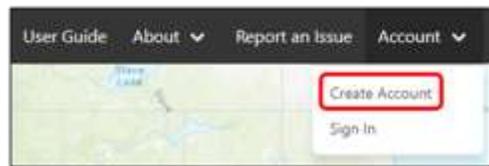
For the initial run and each time you make any change to any of the above steps, you will need to click **Run Tool** to generate a new map that displays the changes you made. Note, each time you click **Run Tool**, previous runs are overwritten unless maps are saved to your account. Once a map has been generated you are able to **Save Last Run** or **Export As...** the map as one of three different file types (i.e. PDF, PPT, or GeoTIFF).

 **User Tip:** To see how a setting change affects the map output, export or take screenshots of maps every time you change a setting (e.g. different time periods or RCPs). Then, viewing these maps together will make it easier to see how things changed.

Getting Started

Creating an account

- Create an account on the Seedlot Selection Tool to save a 'run' for future reference.
 - To get started, go to seedlotselectiontool.org/sst/ and at the top right of the page click on **Account** and then **Create Account**.
 - Use an email address and password to create an account. The email address will only be used to reset a password.
 - Or use a third-party sign-in (i.e. Google, Facebook, or Twitter), though this will not link to a USDA email account.



Saving work

- An SST account makes it possible to save your work.
 - Set up a scenario and run the tool
 - Select **Save Last Run** under Step 8 **Map your Results**.
 - Give the scenario you ran a title and **Save**.



- Go to the Saved Runs tab in the upper left-hand side of the main page.
 - Select saved run and then Load to see the saved run in the application.



- Export outputs from the SST as PDF, PPT, or GeoTIFF
 - Select **Export As...**, below the Run Tool button.



Overview of Scenarios

This guidebook provides six reforestation scenarios that build on each other by demonstrating various settings in the SST and methods for using this tool in reforestation planning. The table below summarizes the general question addressed by each scenario along with various setting modifications to show the flexibility in this tool. If you are interested in exploring the tool while focusing on the objectives of which seedlots to use in a planting site, see Scenarios 1, 4, and 6. If identifying the best plantings sites is your focus, then explore Scenarios 2, 3, and 5.

SST Scenario	Objective	Seedlots Adapted To	Target Climate Period			SST Scenario Modification(s)
		1961-1990	2011-2040	2041-2070	2071-2100	
<i>Which seedlots should I use in my planting site?</i>						
1	Find seedlots	X	X			
1a	Find seedlots	X		X		Change future time period (2041-2070)
<i>Where should I plant a seedlot?</i>						
2	Find planting sites	X	X			
2a	Find planting sites	X		X		Change future time period (2041-2070)
2b	Find planting sites	X		X		Change transfer limits
2c	Find planting sites	X			X	Change future time period (2071-2100)
<i>Where should I plant a seedlot from a breeding zone?</i>						
3	Find planting sites	X		X		
3a	Find planting sites	X		X		Constraint: species ponderosa pine
3b	Find planting sites	X		X		Increase transfer limit
<i>Which seedlot is best for my planting site, a comparison?</i>						
4	Find seedlots	X	X			
4a	Find seedlots	X		X		Change future time period (2041-2070)
4b	Find seedlots	X			X	Change future time period (2071-2100)
<i>Which planting sites are best for a species-specific seedlot?</i>						
5	Find planting sites	X		X		
<i>Seed collection planning, will the seed orchard provide what we need in the future?</i>						
6	Find seedlots	X		X		Long Ridge, McCurdy, Elk, and Soldier Creek seed orchards

Scenario 1: Identifying seedlot locations adapted to a chosen planting site.

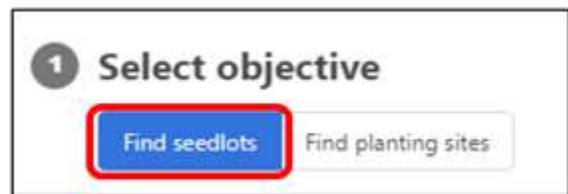
In this scenario, select a planting site in northwest Oregon and the tool will locate seedlot sources that are best adapted to the planting sites' current climate conditions 2011-2040 RCP 8.5 using automatic variables selected and default transfer limits. Three seedlot locations are compared using current climate conditions and resulting in a percent match summary table. In scenario 1a, the tool will locate seedlot sources that are best adapted to the planting sites' future climate conditions in 2041-2070 RCP 8.5. On your own, explore how the map results change by the end of the century (2071-2100 RCP 8.5).

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>.
 - Click on the Tool tab on the top left of the screen.

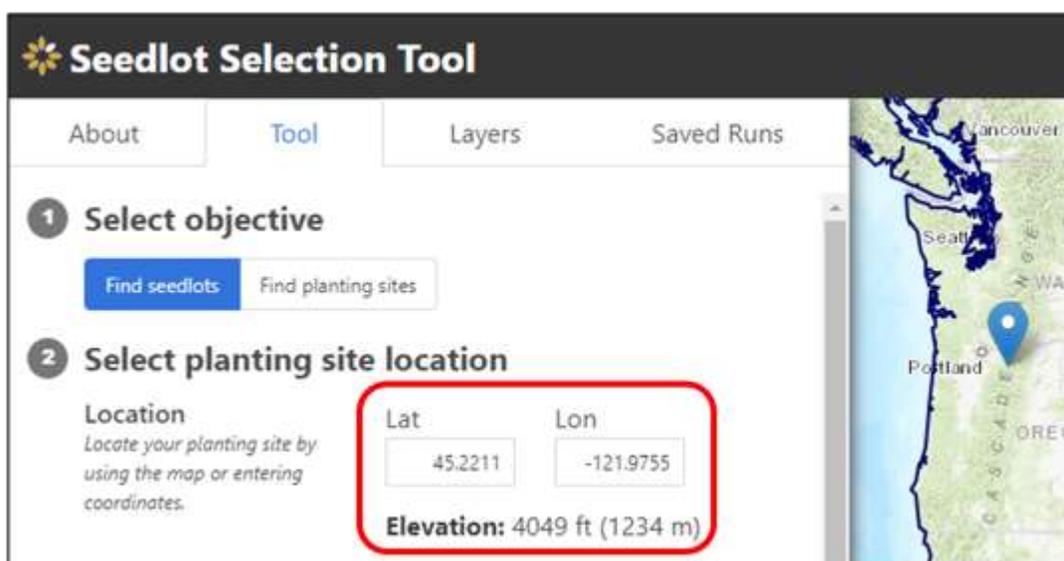
Select objective

- Select **Find seedlots**.



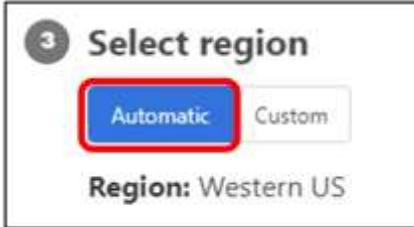
Select planting site location

- Enter coordinates (you don't need to enter the degree symbol) or select a location on the map to add a set point:
 - **Latitude = 45.2211°**
 - **Longitude = -121.9755°**
 - Elevation = 4,049 feet (this is automatically generated for you)



Select region

- Select **Automatic**



3 Select region

Automatic Custom

Region: Western US

Select climate scenarios

- Which climate are seedlots adapted to?
 - Select 1961-1990 (this is also the default) ☼3.
- When should trees be best adapted to the planting site?
 - Select **2011-2040** from the drop-down menu. ☼4
 - Select emissions scenario, **RCP8.5**, from the drop-down menu.
Note: when you select the current time period, the data is based on historical climates for that location. Future time periods are based on projections from an ensemble of 15 climate models.



4 Select climate scenarios

Which climate are the seedlots adapted to?

1961 - 1990 ▾

When should trees be best adapted to the planting site?

2011 - 2040 ▾ RCP8.5 ▾

Select transfer limit method

- Select **Custom** to use existing seed zones (this is the default). ☼6

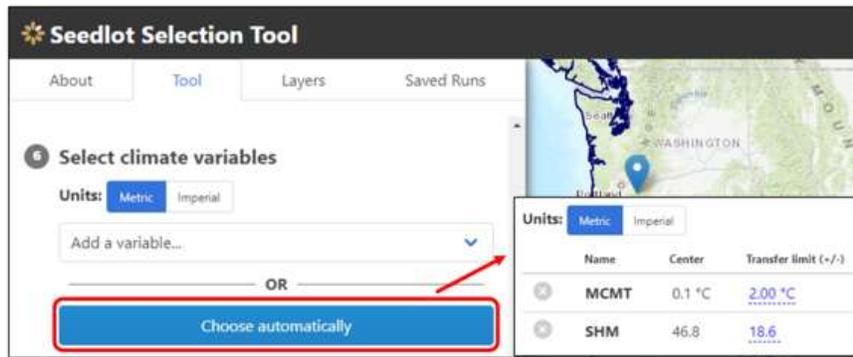


5 Select transfer limit method

Custom Zone Function

Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - Two recommended variables will automatically populate:
 - MCMT: Mean Coldest Month Temperature
 - SHM: Summer Heat-moisture Index Month



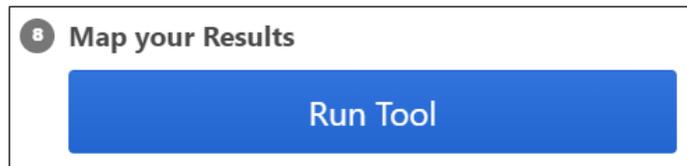
Apply constraints

- For this exercise do not constrain by geography or species range.



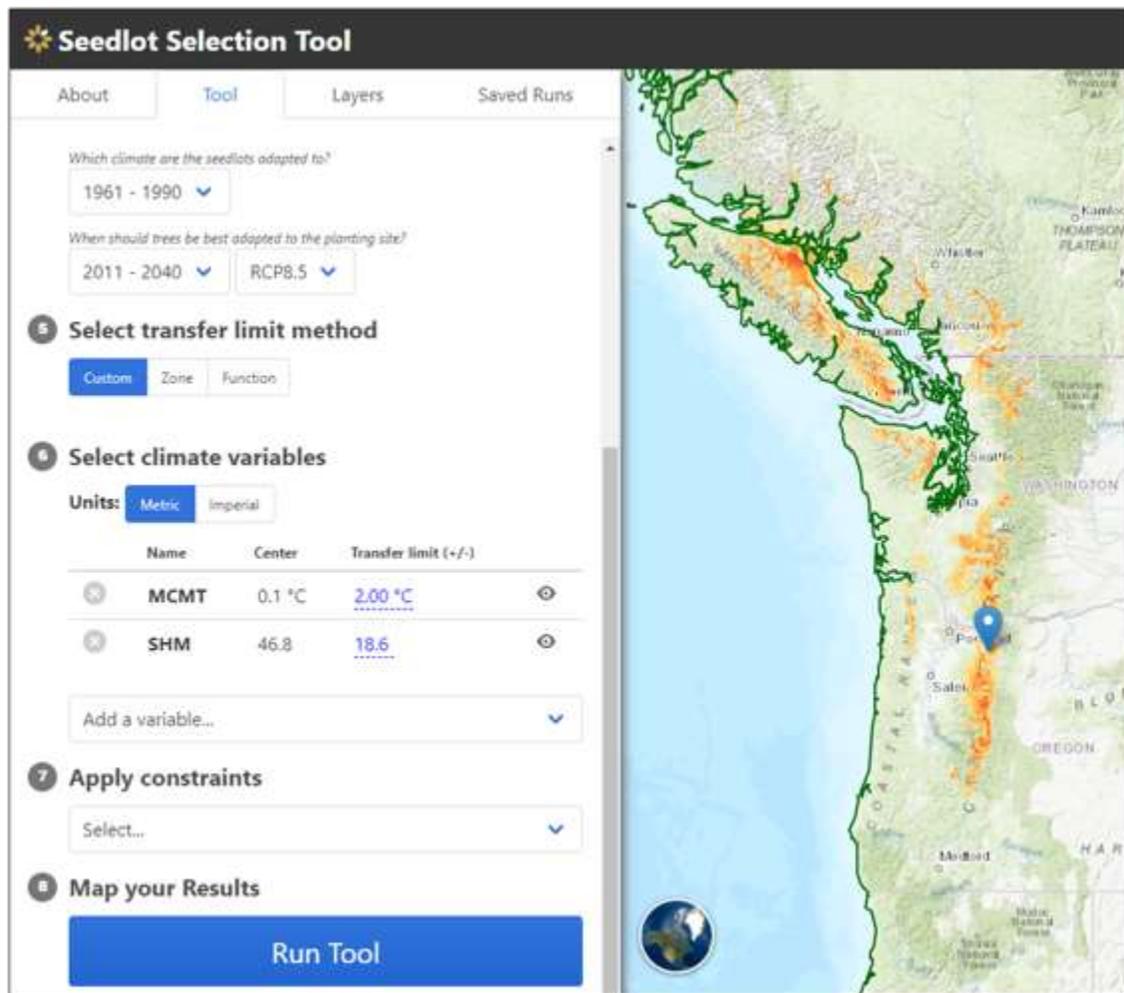
Map your Results

- Select, **Run Tool.** 



Explore Results - Scenario 1

- Identify planting sites that are the best match for the seedlot.
 - The map shows all the areas within the specified transfer limits for the climate variables of interest (in this case, mean coldest month temperature and summer heat-moisture index month), which indicates how far climatically a seedlot may be moved while still suited to the climate (minimizing maladaptation).
 - The color indicates the match of seed sources to the climate of the planting site ranging from yellow (low match) to dark orange (high match) for the time period of interest (in this case 2011-2040).



Follow these steps to determine how good of a climate match this site is to seedlots.

- Select **Compare Seedlots** at the bottom of the map.
 - Select **Add Seedlot** using latitude and longitude.



- For this exercise enter latitude, longitude, and name of a site below by hand and click **Add Seedlot**:
 - **44.52, -122.10 (Site 1)**
 - **45.00, -122.10 (Site 2)**
 - **44.13, -121.97 (Site 3)**
- Explore the high match areas (dark orange) by clicking on the map, a window will pop up, showing the:
 - Location, climate, and available zones

The screenshot shows a web application interface. At the top, a map of the Pacific Northwest region is displayed. A popup window is open over the map, showing the following information:

- Location:** 46.54, -121.75
- Elevation:** 1473 ft (449 m)
- Climate:** MCMT 1.3 °C, SHM 60.5
- Available Zones:**
 - Washington (1966/1973) Zone 430, 1001' - 1500'
 - Washington (2002) Douglas-fir Zone 9, 1001' - 2000'
 - Washington (2002) western redcedar Zone 4, 0' - 2000'
 - Washington (2002) western white pine Zone 4, 9' - 12...
 - Washington (2002) lodgepole pine Zone 10, 1001' - 2...
 - USFS Western white pine Breeding Zone 06020, 0 - 1...
 - CONUS Provisional Zone 4596, 721' - 5968'

Below the popup is a blue button labeled "Set Point". To the right of the map is a vertical "Match" legend with a color scale from red to yellow. Below the map is a table titled "Compare Seedlots" with the following data:

Location	Name	Match
44.52, -122.10	Site 1	N/A
45.00, -122.10	Site 2	N/A
44.13, -121.97	Site 3	N/A

Map your Results

- Select **Run Tool** again.

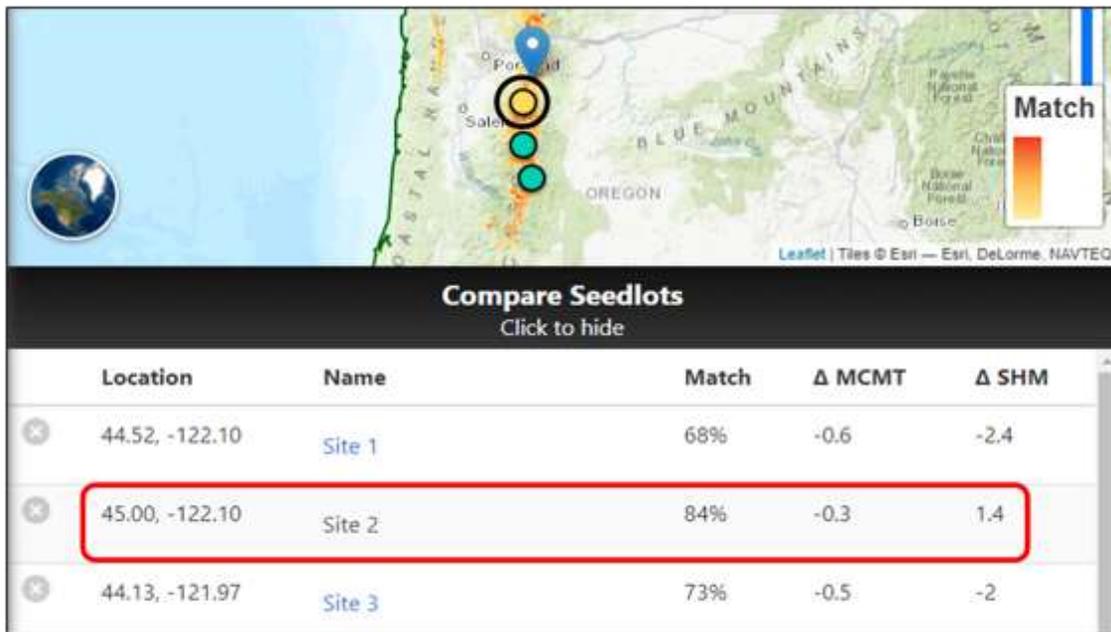
8 Map your Results

Run Tool

- This generates the percent match of seedlot locations you have added to the comparison table.

Explore Results for the Compared Seedlots

- Site 2 has an 84% match, the seedlot is highlighted and circled on the map below. The other seedlots have a lower match score. 🌱1



Scenario 1A – Change to a future time period

- Change time period to **2041-2070** and **RCP8.5** emissions scenario (higher emissions).

Note the change in climate center values to MCMT 1.2°C and SHM 54.7 🌡️4.

Map your Results

- **Run Tool** 🌡️7

The screenshot shows the 'Seedlot Selection Tool' interface. The 'Tool' tab is active. The configuration is as follows:

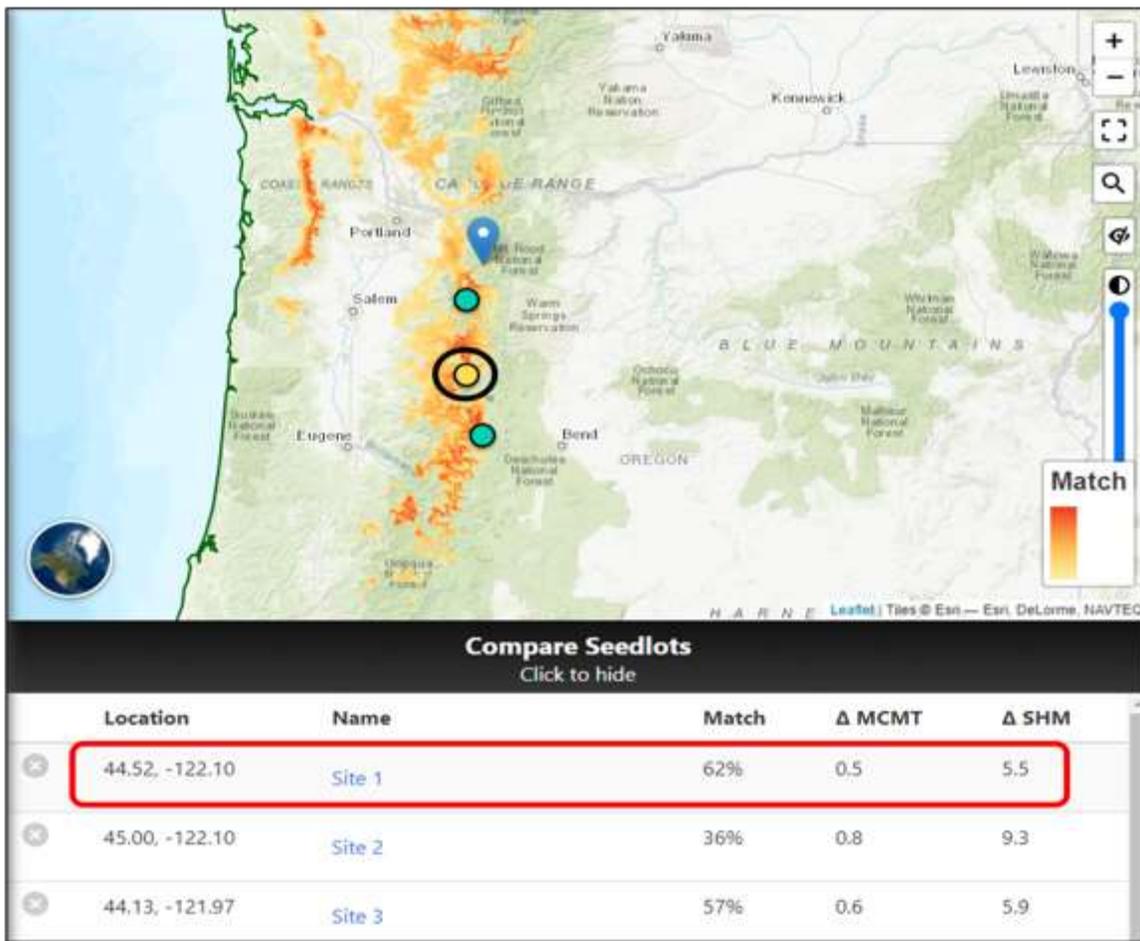
- Which climate are the seedlots adapted to? 1961 - 1990
- When should trees be best adapted to the planting site? 2041 - 2070, RCP8.5
- Select transfer limit method: Custom
- Select climate variables: Units: Metric
- Table of climate variables:

Name	Center	Transfer limit (+/-)
MCMT	1.2 °C	2.00 °C
SHM	54.7	18.6

At the bottom, the 'Map your Results' section contains a large blue 'Run Tool' button.

Explore Results - Scenario 1A

- Review the results table under the future climate (2041-2070 RCP8.5).
 - Note that suitable seed sources for this location moved south and to lower elevations.
 - In this mid-century scenario the best matched seedlot is Site 1 with a 62% match 🌡️1.
 - Site 2 from the previous run under early-century conditions was the best match at 84%, while in the mid-century this same site is a 36% match.



- **Click on yellow point** to see seedlot details (but do not click “Set point” or the location of your planting site will change):
 - Location, Elevation, Climate, and Available Zones.

Location: 44.52, -122.11 Elevation: 3245 ft (989 m)

Climate
 MCMT: 6.7 °C
 SHM: 58.5

Available Zones

Oregon (1966/1973) Zone 452, 3001' - 3500'
 Oregon (1996) Douglas fir Zone 12, 3001' - 2500'
 Oregon (1996) lodgepole pine Zone 0, 3001' - 4000'
 Oregon (1996) ponderosa pine Zone 0, 3001' - 4000'
 Oregon (1996) western redcedar Zone 3, 0' - 3500'
 Oregon (1996) western white pine Zone 3, 459' - 10130'
 USFS Mountain hemlock Breeding Zone undefined, elev...
 USFS Noble fir Breeding Zone 18074, elevation < 4500
 USFS Engelmann spruce Breeding Zone 18030, 0 - 1...
 USFS Ponderosa pine Breeding Zone undefined, elev...
 USFS Generic Breeding Zone 18033, 3000 - 4000
 USFS Incense cedar Breeding Zone 18073, 3000 - 4000
 USFS Alaska yellow cedar Breeding Zone 18073, 300...
 USFS Lodgepole pine Breeding Zone 18043, 3000 - 4...
 USFS Sugar pine Breeding Zone undefined, elevation...
 USFS Western white pine Breeding Zone 18030, 0 - 1...
 USFS Red alder Breeding Zone 18053, elevation = 25...
 USFS Douglas fir Breeding Zone 18033, 3000 - 4000
 USFS Pacific silver fir Breeding Zone 18074, elevation...
 USFS Grand fir Breeding Zone 18073, 3000 - 4000
 USFS Pacific yew Breeding Zone 18043, elevation >...
 USFS Western red cedar Breeding Zone 18073, elev...
 USFS Western hemlock Breeding Zone 18053, 3000 -...
 CONUS Provisional Zone 4499, 2795' - 3741'

Set Point

Scenario 2: Identifying planting site locations suited to a specific seedlot collected from a single location.

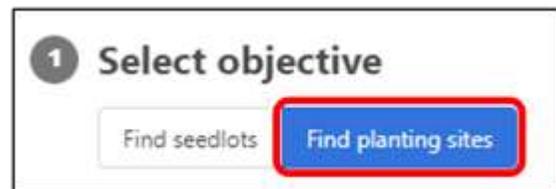
In this scenario, select the source location of a seedlot collected from a single location in northwest Oregon and the tool will identify planting sites that the seedlot is adapted to considering its 2011-2040 climate, RCP8.5. Three planting sites are compared in this scenario using current climate conditions and resulting in a percent match summary table.

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>.
 - Click on the **Tool** tab on the top left of the screen.

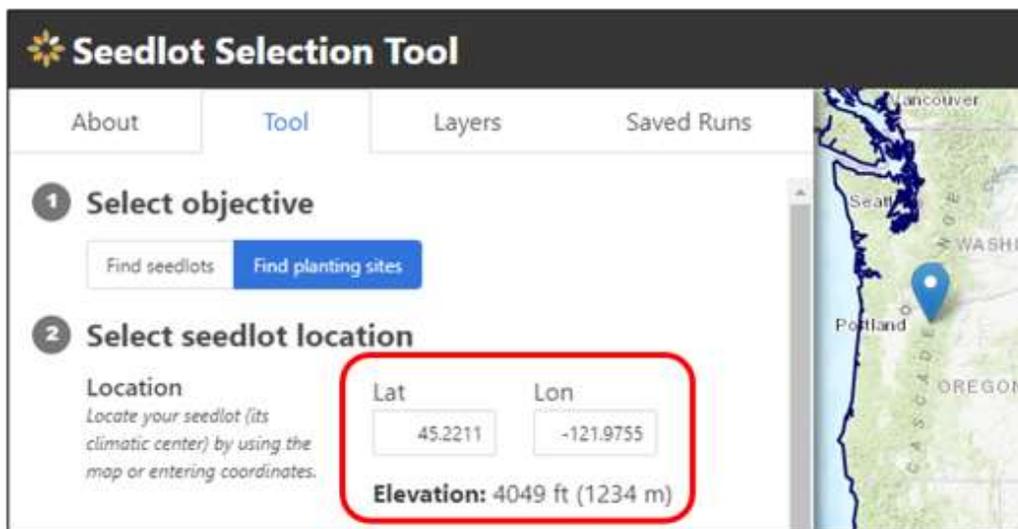
Select objective

- Select **Find planting sites**.



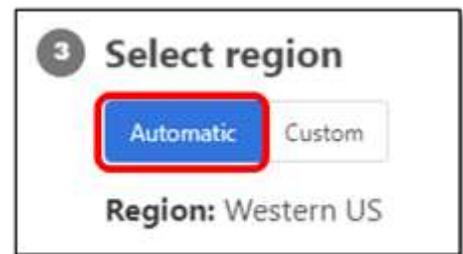
Select seedlot location

- Enter coordinates (note you don't need to enter the degree symbol) 📍2:
 - **Latitude = 45.2211°**
 - **Longitude = -121.9755°**
 - Elevation = 4,049 feet (this is automatically generated for you)



Select region

- Select **Automatic**.



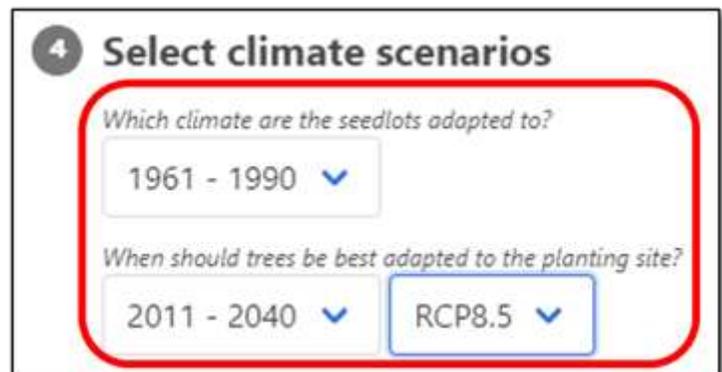
3 Select region

Automatic Custom

Region: Western US

Select climate scenario

- Which climate are the seedlots adapted to?
 - Select **1961-1990** (this is the default setting). ☀️3
- When should trees be best adapted to the planting site?
 - Select **2011-2040** from the drop-down menu. ☀️4
 - Select emissions scenario, **RCP8.5**, from the drop-down menu.



4 Select climate scenarios

Which climate are the seedlots adapted to?

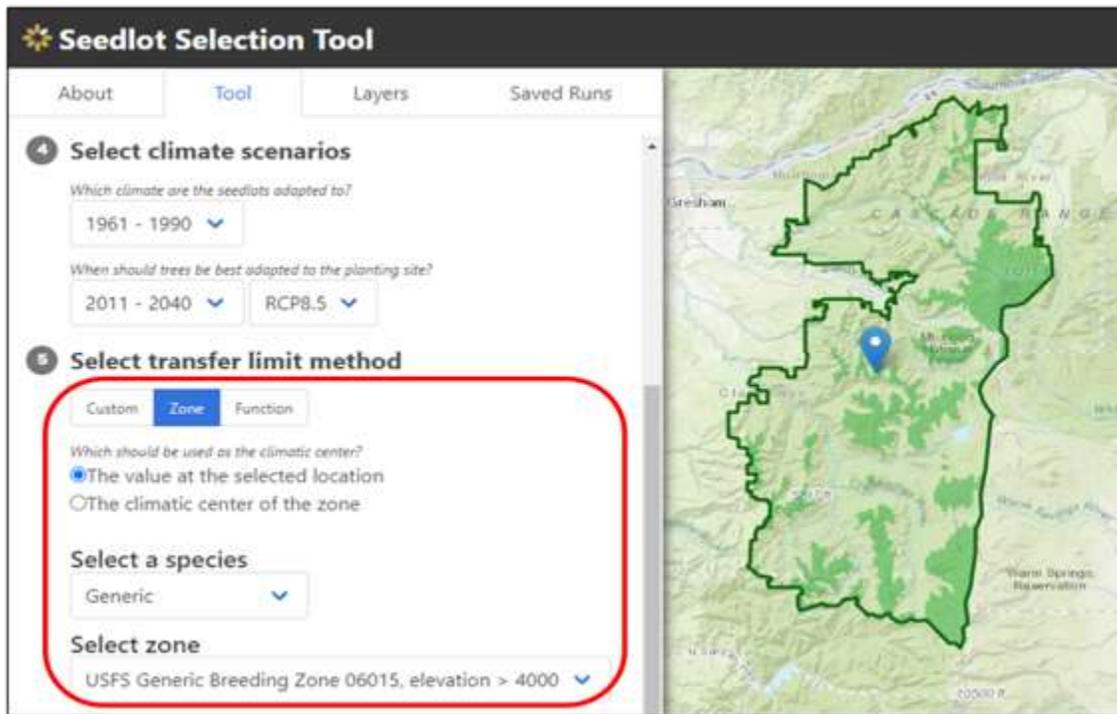
1961 - 1990 ▼

When should trees be best adapted to the planting site?

2011 - 2040 ▼ RCP8.5 ▼

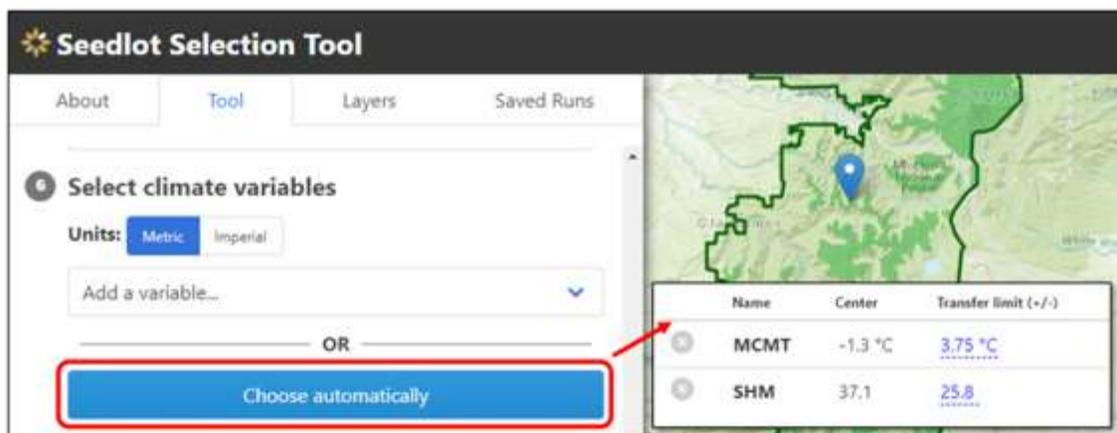
Select transfer limit method

- Select **Zone** to use existing seed zones
 - Which should be used as the climatic center?
 - Select **the value at the selected location**. ☀️2
- Select a species
 - Select **Generic** in species drop-down menu
 - For most USFS National Forests in the Pacific Northwest; seed zones and breeding zones for species other than sugar pine and western white pine are not species specific. Species specific zones have been delineated for most species only in southwestern Oregon national forests.
- Select zone
 - Select **USFS Generic zone 06015, elevation > 4000 ft.** from the drop-down menu. ☀️4
 - Once the zone is selected, the entire seed zone is outlined in dark green, and the elevation band is shaded in bright lime green.



Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - Two recommended variables will automatically populate:
 - MCMT: Mean Coldest Month Temperature
 - SHM: Summer Heat-moisture Index Month



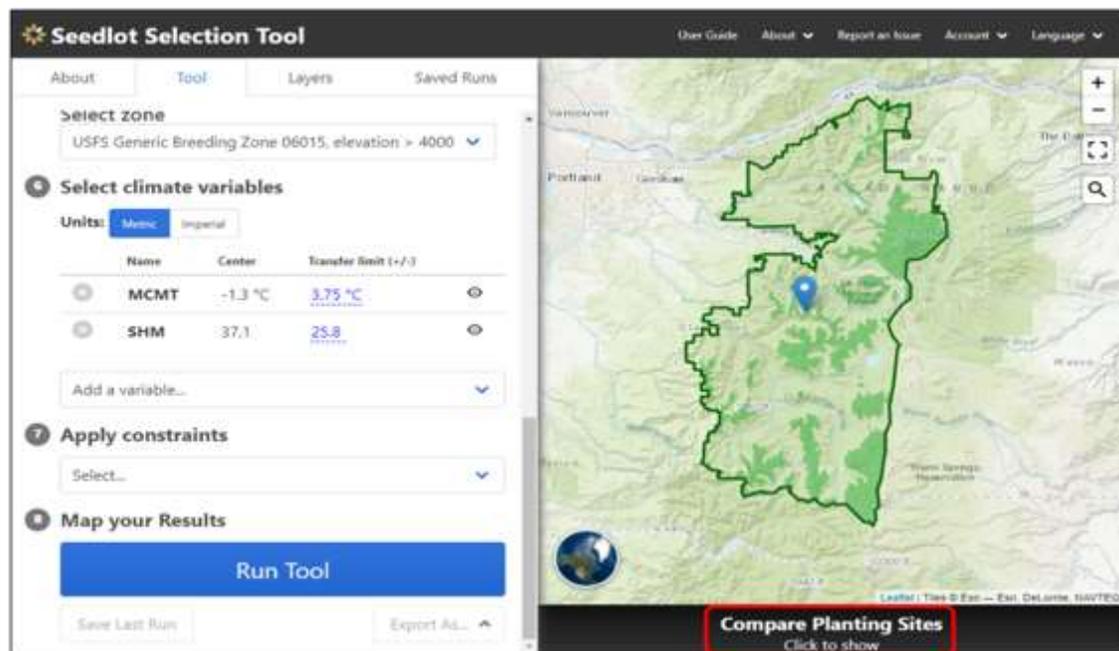
Apply constraints

- For this exercise do not constrain by geography or species range.



Add planting sites to compare

- At the bottom right of the page, click on **Compare Planting Sites** to enter multiple planting sites to compare.



- Click on **Compare Planting Sites**.
 - Click **Add Planting Site**, enter latitude, longitude, and name of a planting site in the text boxes and click **Add**.
 - Optional: add more descriptive site names in the place of numbers.
 - **Site 1: 45.32, -121.72**
 - **Site 2: 45.55, -121.81**
 - **Site 3: 45.45, -121.73**



Compare Planting Sites
Click to hide

Location	Name	Match
45.32, -121.72	Site 1	N/A
45.55, -121.81	Site 2	N/A
45.45, -121.73	Site 3	N/A

➤ When exploring SST on your own, if you don't have a specific latitude and longitude, click on the map of a potential planting site of interest and **Add Location**.

○ The latitude and longitude will populate automatically.

➤ To **Upload CSV** with planting site information, the file needs to include columns with these headers "x" and "y" (or "long" and "lat" or "longitude" and "latitude").

Location: 45.25, -121.83 Elevation: 4308 ft (1313 m)

Available Zones

- Oregon (1966/1973) Zone 451, 4001' - 4500'
- Oregon (1996) western white pine Zone 2, 13' - 10817'
- Oregon (1996) Douglas Fir Zone 12, 4001' - 4500'
- Oregon (1996) lodgepole pine Zone 1, 4001' - 5000'
- Oregon (1996) ponderosa pine Zone 0, 4001' - 5000'
- Oregon (1996) western redcedar Zone 3, 3501' - 10817'
- USFS Generic Breeding Zone 06015, elevation > 4000
- USFS Western white pine Breeding Zone 06020, 0 - 1...
- CONUS Provisional Zone 4596, 721' - 5968'

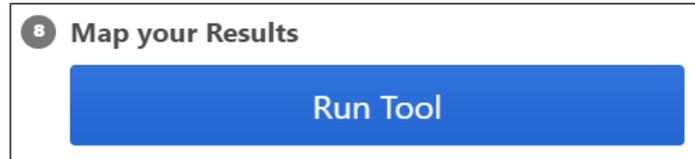
Add Location

- Optional column called “name” or “label”, when populated will show up under name in the comparison tool.



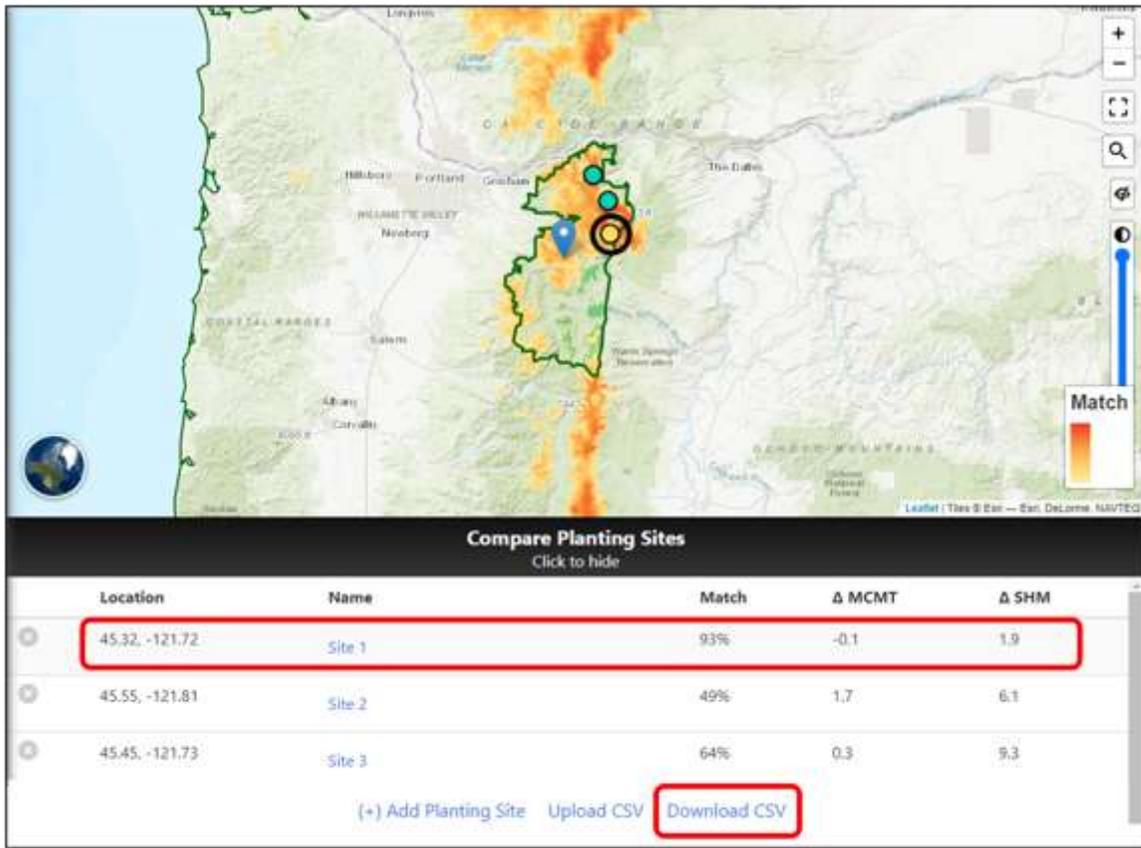
Map your Results

- Click **Run Tool**. 7



Explore Results - Scenario 2

- Identify the best match for planting sites.
 - Low match planting sites appear in yellow and high match planting sites appear in dark orange.
 - The map shows all the areas within the transfer limits, which indicates how far climatically the seedlot may be moved and still have an acceptable level of adaptation for the chosen variables.
 - Site 1 planting site is a good climatic match (93%) in the 2011-2040 RCP8.5 climate for the seedlot. 1
 - Note: click on each site and the associated dot on the map will turn yellow.
 - The output also shows that this seedlot is a good match for planting sites locally to the south at higher elevations and large areas to the north.
- These results can be exported as a .csv by clicking on **Download CSV**.

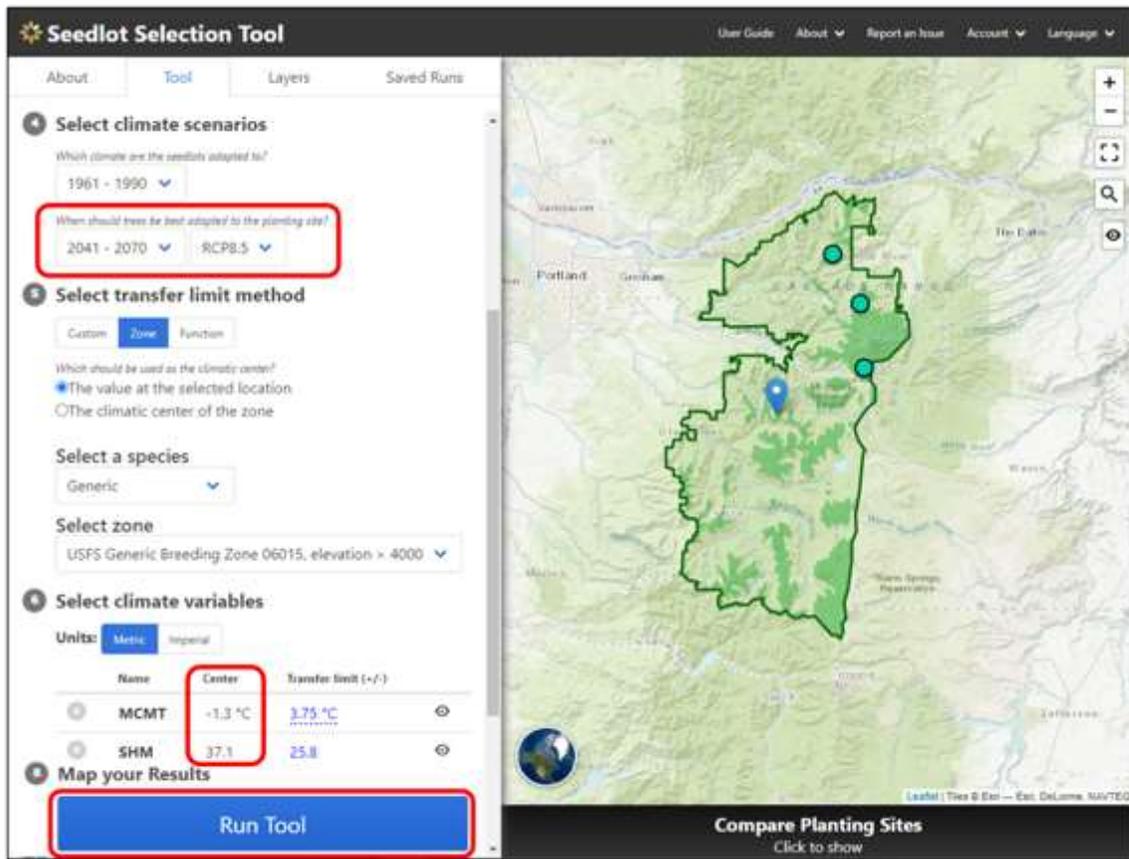


Scenario 2A – Change to a future time period

- Under Select Climate Scenarios
 - Change to **2041-2070** keep the emissions scenario **RCP8.5**.
 - Note the change in climate center values.

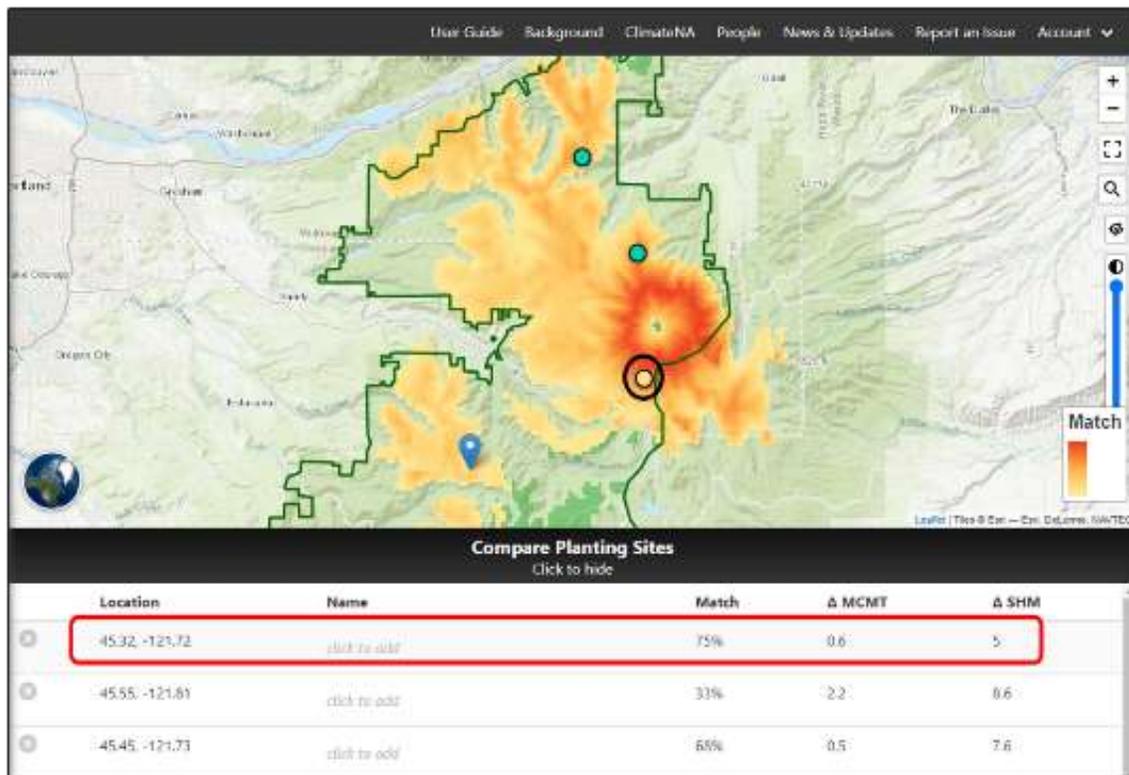
Map your Results

- **Run Tool**



Explore Results - Scenario 2A

- Identify the best match for planting sites
 - The suitable planting sites in the dark orange area are north of the seedlot site and at higher elevation.
 - Site 1 is a 75% match under the future climate project (2041-2070 RCP8.5). In the previous run Site 1 was a 60% match under the early-century climate. 🌱1



Scenario 2B – Adjust transfer limits

- The default transfer limit for this seed zone is MCMT: 3.75°C.
 - This is very wide, beyond the recommendation of + or -2.0°C.
 - Change transfer limit by clicking on the transfer limit (+/-) value and an editable box will appear. 🌱6
 - **Change: MCMT to 2.0 and SHM to 18.5**

Map your Results

- **Run Tool**

Seedlot Selection Tool

About | Tool | Layers | Saved Runs

The climatic center of the zone

Select a species
Generic

Select zone
USFS Generic Breeding Zone 06015, elevation > 4000

6 Select climate variables

Units: Metric Imperial

Name	Center	Transfer limit (+/-)
MCMT	-1.3 °C	2.00 °C (modified)
SHM	37.1	18.5 (modified)

Add a variable...

7 Apply constraints

8 Map your Results

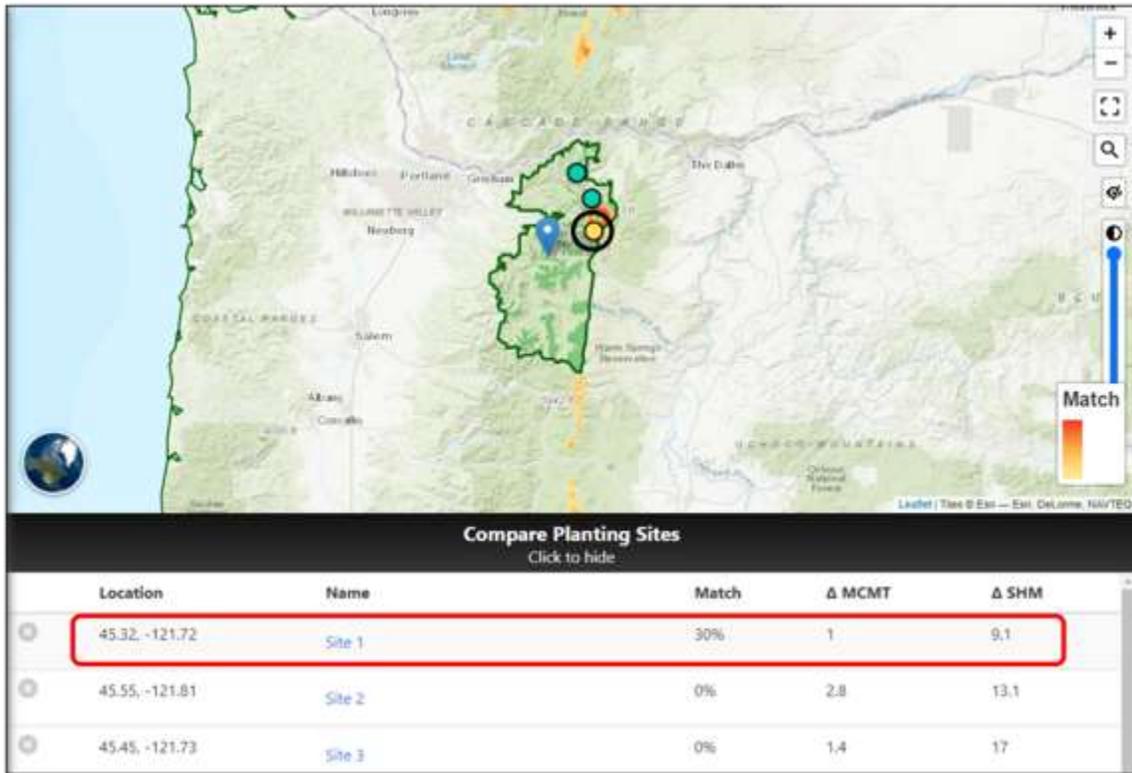
Run Tool

MCMT: Mean coldest month temperature
Value at point: -1.3
Transfer limit (+/-): 2.00 °C (modified)
Avg. transfer limit for zone set: 1.66 °C
Zone climatic center: -3.5 °C

SHM: Summer heat-moisture index
Value at point: 37.1
Transfer limit (+/-): 18.5 (modified)
Avg. transfer limit for zone set: 34.6
Zone climatic center: 42.1

Explore Results - Scenario 2B

- Review the changes from the previous scenario.
 - The area mapped is narrower so it easier to find suitable planting site.
 - The darker areas are still dark, indicating highly suitable planting sites.
 - Only the areas outside the + or -2.0°C temperature difference are no longer included.
 - Site 1 is the only good match at 30% under the future climate project (2041-2070 RCP8.5) with the narrower (or decreased) transfer limit. In the previous run with the wider transfer all three sites are good matches with Site 1 at 75%. 🌱1

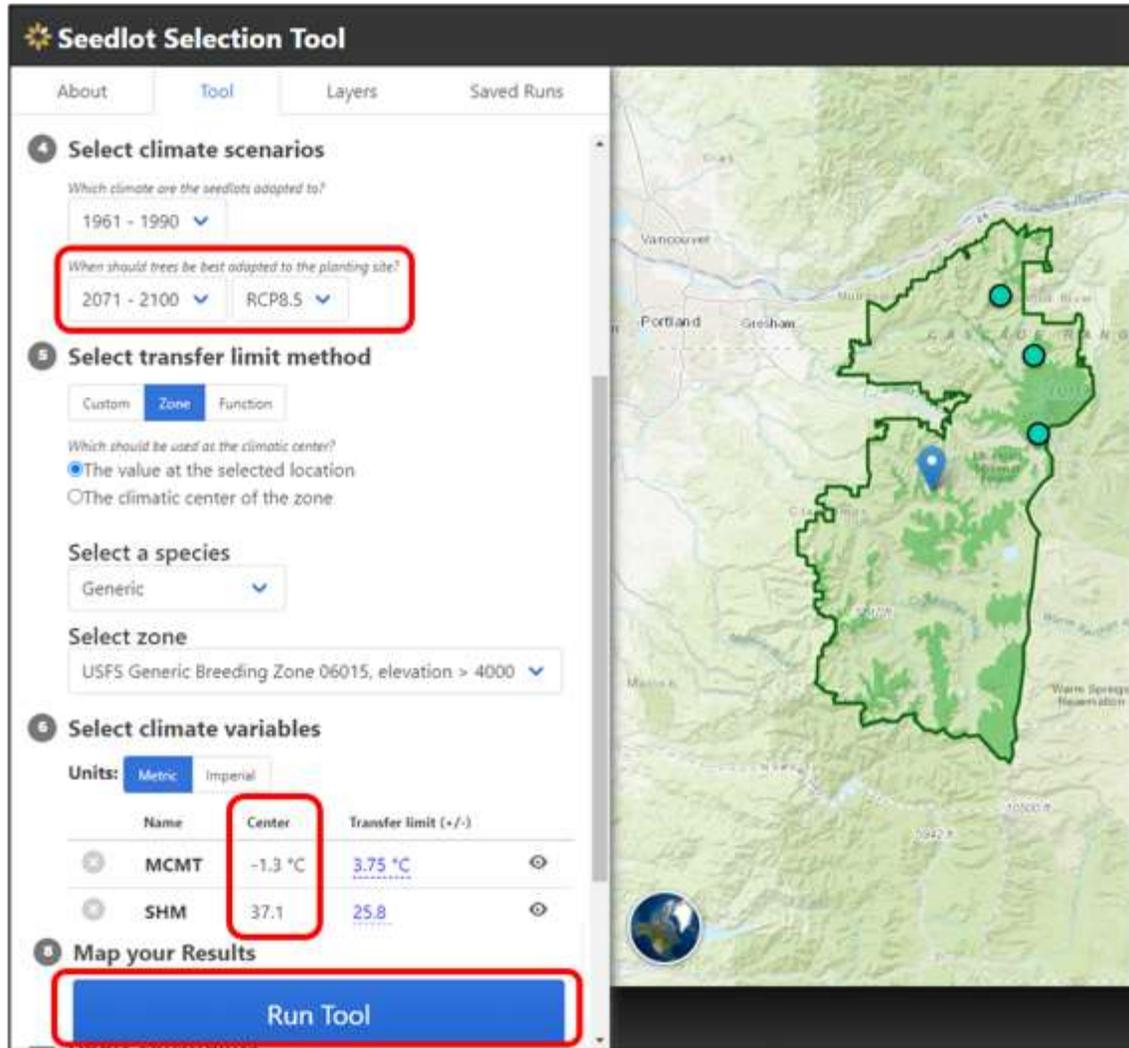


Scenario 2C – Change future time period

- Under Select Climate Scenarios
 - Change the time period to **2071-2100** with the emissions scenario **RCP8.5**. 4
 - Note the change in the climate center.

Map your Results

- **Run Tool** 7



Seedlot Selection Tool

About Tool Layers Saved Runs

4 Select climate scenarios

Which climate are the seedlots adapted to?

1961 - 1990

When should trees be best adapted to the planting site?

2071 - 2100 RCP8.5

5 Select transfer limit method

Custom Zone Function

Which should be used as the climatic center?

The value at the selected location

The climatic center of the zone

Select a species

Generic

Select zone

USFS Generic Breeding Zone 06015, elevation > 4000

6 Select climate variables

Units: Metric Imperial

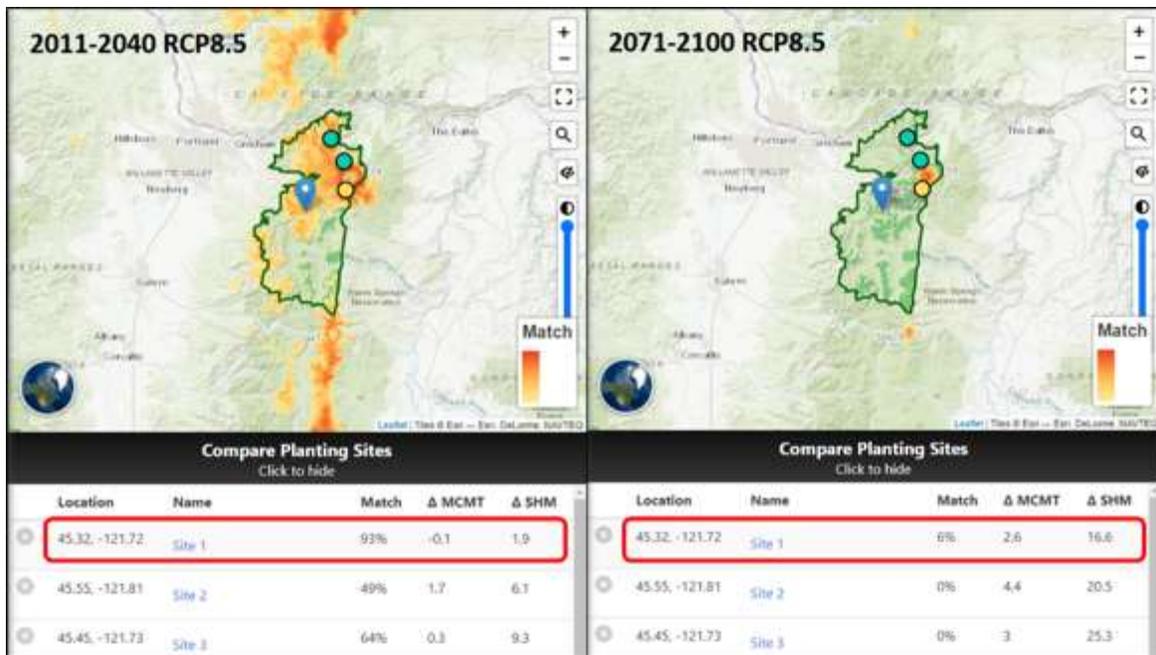
Name	Center	Transfer limit (+/-)
MCMT	-1.3 °C	3.75 °C
SHM	37.1	25.8

8 Map your Results

Run Tool

Explore Results - Scenario 2C

- Review the changes from the first scenario.
 - The planting site are all the same in the comparison image below, the left panel shows results for the early-century time period (2011-2040 RCP8.5) and the right panel shows results for the late-century time period (2071-2100 RCP8.5)
 - Site 1 is the best match in both panels but a wide difference in match quality, 93% match in climate future 2011-2040 RCP8.5 and 6% match in climate future 2071-2100 RCP8.5. 🌱1



Scenario 3: Identifying planting site locations suited to a seedlot sourced from a breeding zone.

In this scenario, select a seedlot collected from multiple locations within a single breeding zone in northeast Oregon and the tool will locate planting sites. These planting sites will be compared for the best match to future climate conditions (2041-2070, RCP8.5).

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>
 - Click on the **Tool** tab on the top left of the screen.

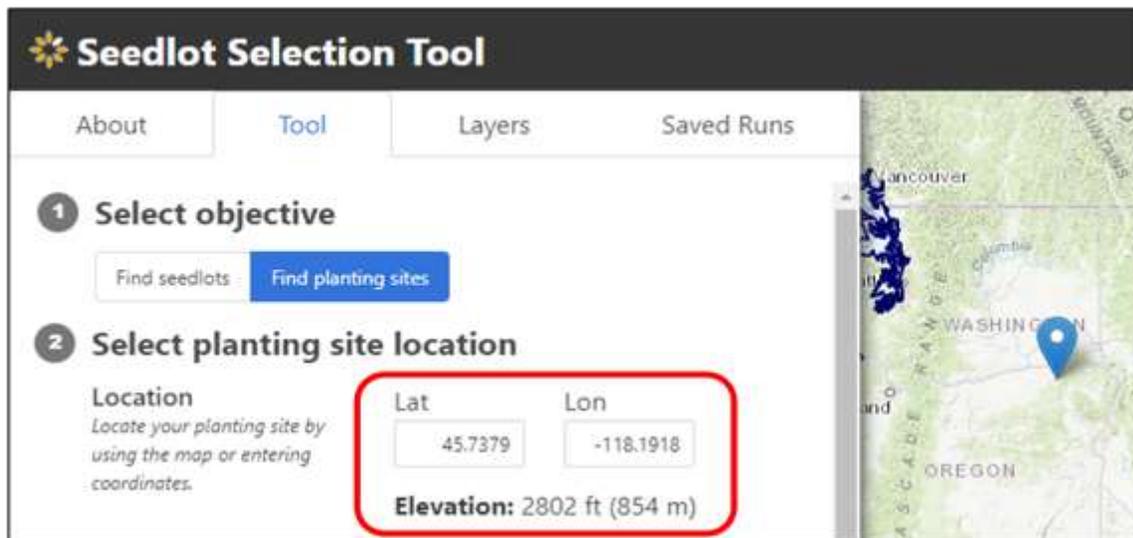
Select objective

- Select **Finding planting sites**



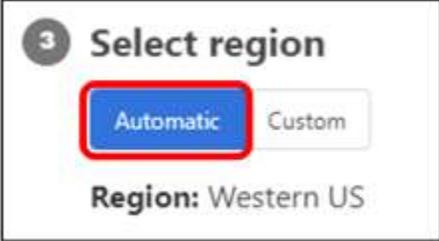
Select planting site location

- Enter coordinates (note you don't need to enter the degree symbol):
 - **Latitude = 45.7379°**
 - **Longitude = -118.1918°**
 - Elevation = 2,802 feet (this is automatically generated)



Select region

- Select **Automatic**.



3 **Select region**

Automatic Custom

Region: Western US

Select climate scenarios

- Which climate are the seedlots adapted to?
 - Select **1961-1990** (this is the default)
- When should trees be best adapted to the planting site?
 - Select **2041-2070** from the drop-down menu
 - Select emissions scenario, **RCP8.5**, from the drop-down menu.



4 **Select climate scenarios**

Which climate are the seedlots adapted to?

1961 - 1990

When should trees be best adapted to the planting site?

2041 - 2070 RCP8.5

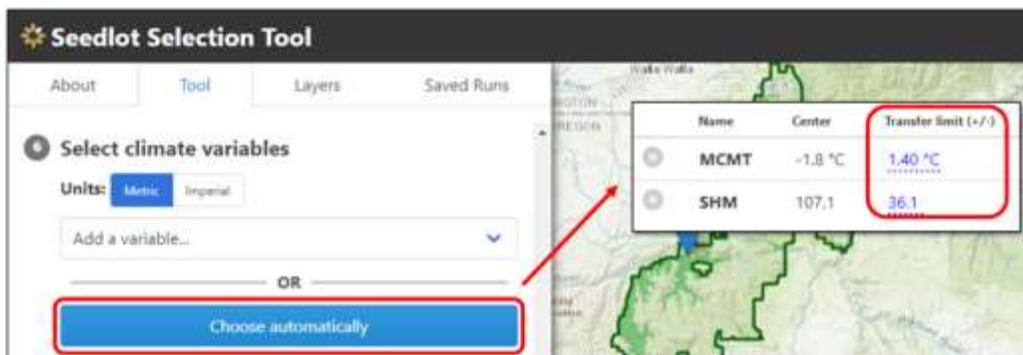
Select transfer limit method

- Select **Zone** to use existing seed zones
 - Which should be used as the climatic center?
 - Select **the climatic center of the zone** 
- Select a species
 - **Generic**
- Select zone
 - Select **USFS Generic zone 14063, elevation <3500** from drop-down menu 
 - Once the zone is selected, the entire seed zone is outlined in dark green, and the elevation band is shaded in bright lime green.



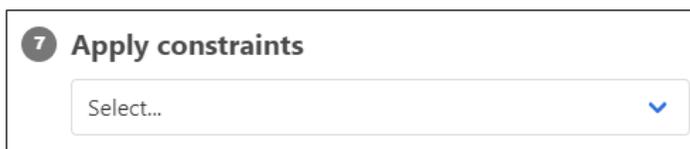
Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - Two recommended variables will automatically populate:
 - MCMT: Mean Coldest Month Temperature
Note: MCMT= -1.8 °C (transfer limits are 1.4°C)
 - SHM: Summer Heat-moisture Index Month
Note: SHM = 107.1 (transfer limits are 36.1)



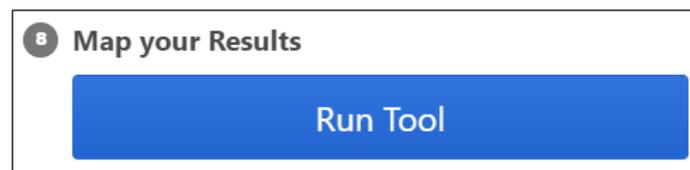
Apply constraints

- For this exercise do not constrain by geography or species range.



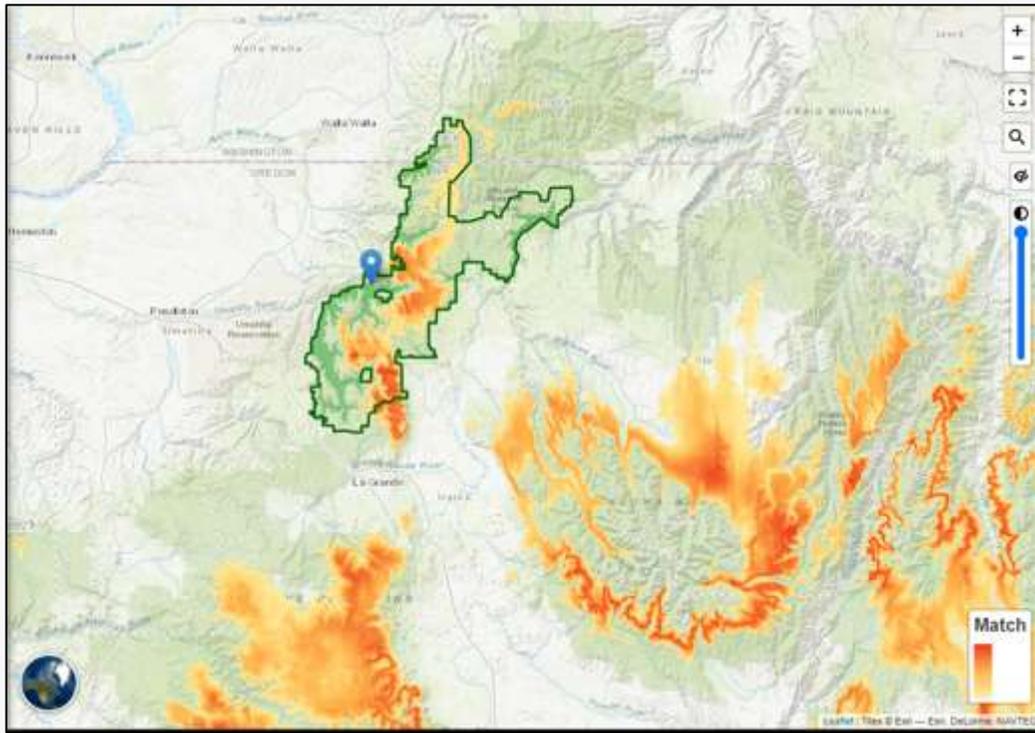
Map your Results

- Select, **Run Tool.** 

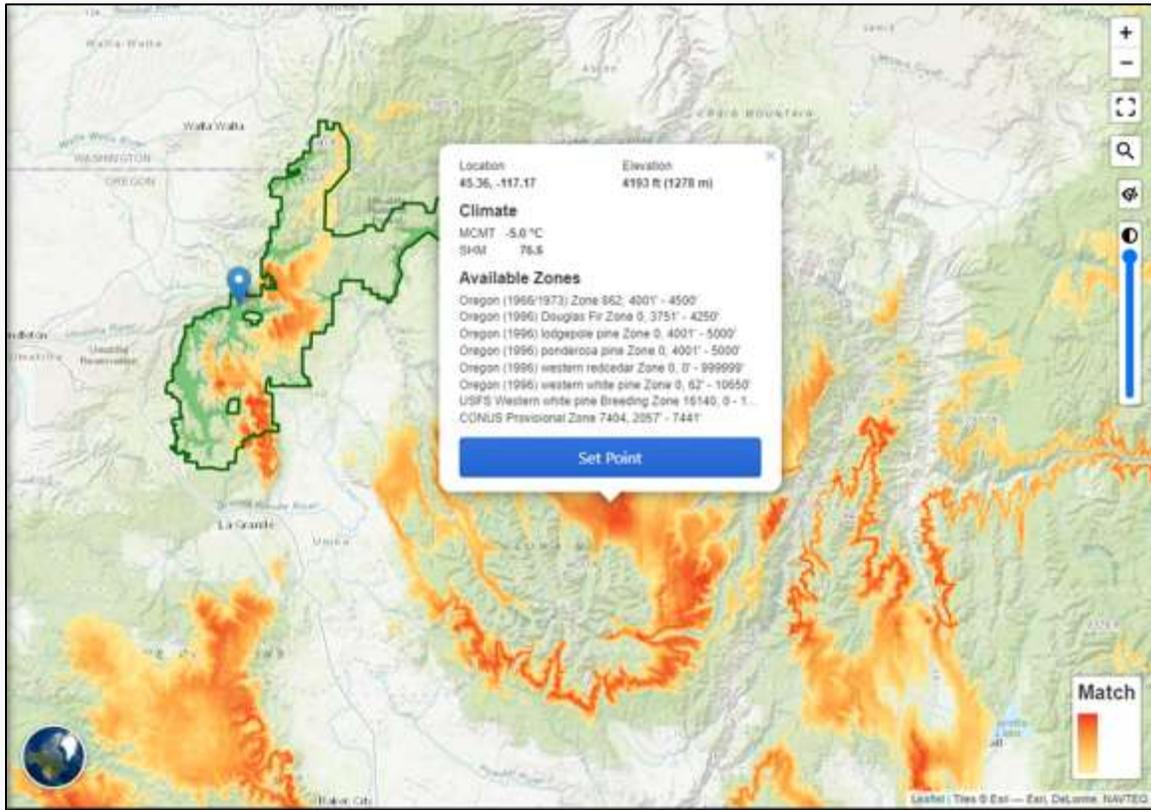


Explore Results - Scenario 3

- Identify the best match for planting sites
 - Match color range (yellow to orange). Note, the darker the color, the better the match.
 - The map shows all the areas within the transfer limits, which indicates how far climatically a seedlot may be moved while still suited to the climate (minimizing maladaptation).



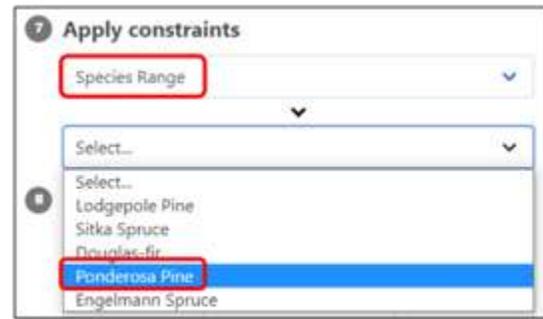
- Click on any dark orange area to get a pop-up window to see which breeding zones these high match areas are in.



Scenario 3A – Apply constraints

In this scenario, constrain the mapped results to Ponderosa Pine because much of the areas mapped in Scenario 3 are either non-forested, or outside the species range of Ponderosa Pine.

- Under Apply constraints
 - Select **Species Range**
 - **Ponderosa Pine**



7 Apply constraints

Species Range

Select...

Select...

Lodgepole Pine

Sitka Spruce

Douglas-fir

Ponderosa Pine

Engelmann Spruce

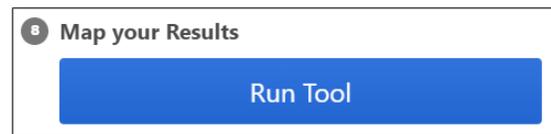


7 Apply constraints

Name	Value	Range (+/-)
Ponderosa Pine	2041 - 2070 RCP 8.5	

Map your Results

- **Run Tool** 



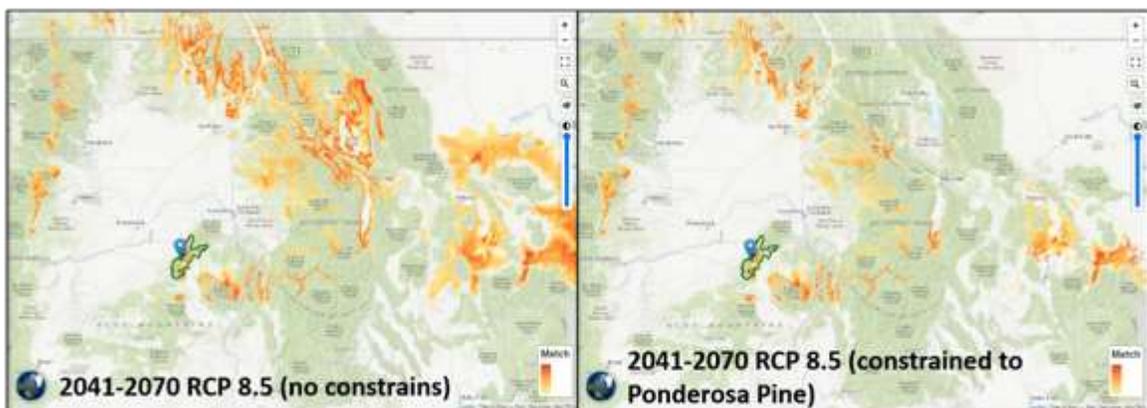
8 Map your Results

Run Tool

Explore Results - Scenario 3A

- Review the changes from the previous scenario.
 - Now only areas that are suitable habitat for Ponderosa Pine are mapped, making site selection easier.

Note: the dark orange to yellow coloring does not change, only where colors are displayed.
 - With the results restricted to the species range of ponderosa pine, the potential suitable sites are somewhat limited for this breeding zone.



Scenario 3B – Changing transfer limits

In this scenario, widen (or increase) the transfer limit associated with the USFS Generic zone 14063 for Mean Coldest Month Temperature (MCMT) and Summer Heat-moisture Index (SHM). This will widen the results for suitable climatic matches. 🌱6

- Under Select Climate Variables, click the value for MCMT under the transfer limit (the value will become editable).
 - Change **MCMT** value from 1.4°C to **2°C**.
 - Change **SHM** value from 36.1 to **53.5**

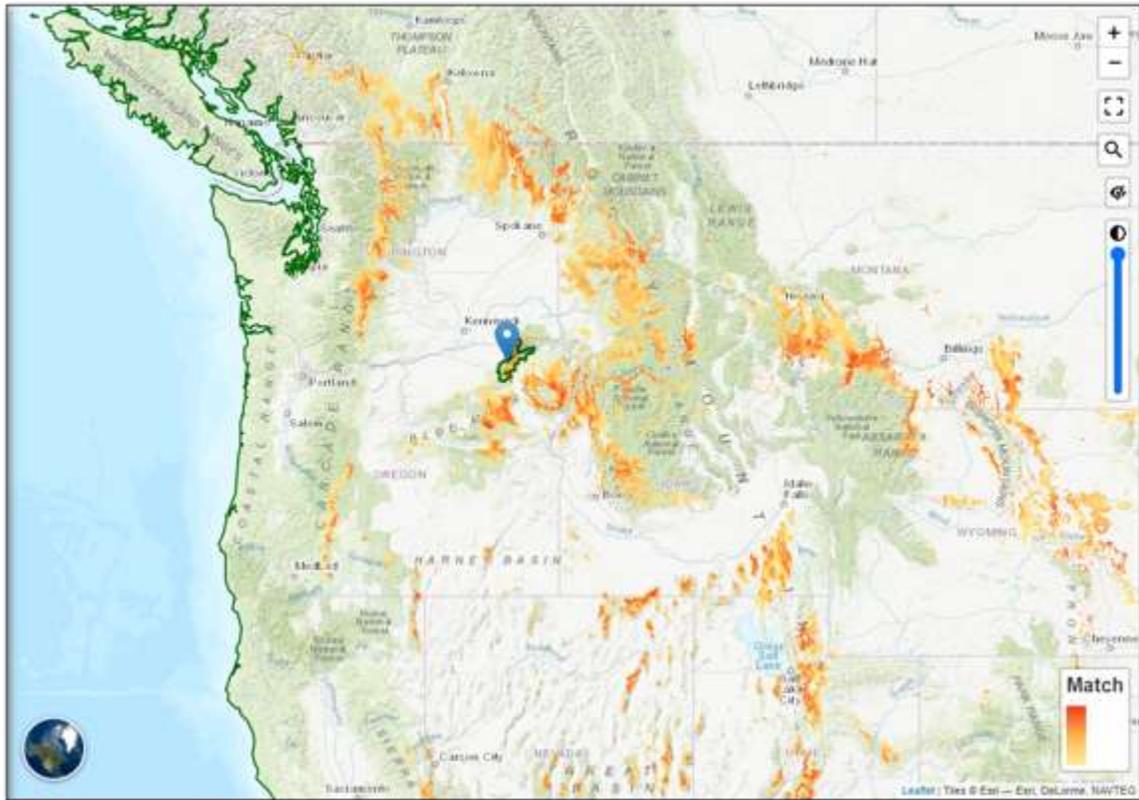
Map your Results

- **Run Tool** 🌱7

The screenshot displays the 'Seedlot Selection Tool' interface. It features a navigation bar with 'About', 'Tool', 'Layers', and 'Saved Runs'. The main content is divided into three sections: '6 Select climate variables', '7 Apply constraints', and '8 Map your Results'. In the 'Select climate variables' section, the 'Units' are set to 'Metric'. A table lists two variables: MCMT and SHM. The 'Transfer limit (+/-)' column for MCMT is highlighted with a red box and contains the value '2.00'. The 'Transfer limit (+/-)' column for SHM is also highlighted with a red box and contains the value '53.5'. Below the table is a 'Run Tool' button, which is also highlighted with a red box. To the right of the interface, two information panels are visible. The top panel is for MCMT, showing 'Value at point: -1.8', 'Transfer limit (+/-): 2.00 °C (modified)', 'Avg.transfer limit for zone set: 1.66 °C', and 'Zone climatic center: -1.8 °C'. The bottom panel is for SHM, showing 'Value at point: 102.0', 'Transfer limit (+/-): 53.5 (modified)', 'Avg.transfer limit for zone set: 34.6', and 'Zone climatic center: 107.1'. The background of the interface shows a map of the Blue Mountains region.

Explore Results - Scenario 3B

- Review the changes from the previous scenario.
 - The dark orange to yellow coloring increases overall, but the darker orange areas remain the same.
 - Widening the transfer limit simply broadens the areas that have lower climatic match but illustrates a wider area where this seed may be suitable, including into British Columbia.



Scenario 4: Comparing multiple seedlots for a specific planting site “pre-adapted” to different future time periods.

In this scenario, select a planting site in southwest Washington and the tool will identify seedlot source locations that are adapted to projected future climates for different time periods (2011-2040, 2041-2070, 2071-2100 under RCP8.5).

Background: A seed source evaluation trial was established in 2021 on the Cowlitz Valley Ranger District of the Gifford Pinchot National Forest. The objective was to plant several blocks of trees representing different seedlots that are selected to match the predicted future climate of the planting site at different times in the future. The seed sources included the “local” seed zone, and a seed lot adapted to the site for the climate predicted for each of the future time periods (2011-2040, 2041-2070, and 2071-2100 under RCP8.5).

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>
 - Click on the **Tool** tab on the top left of the screen.

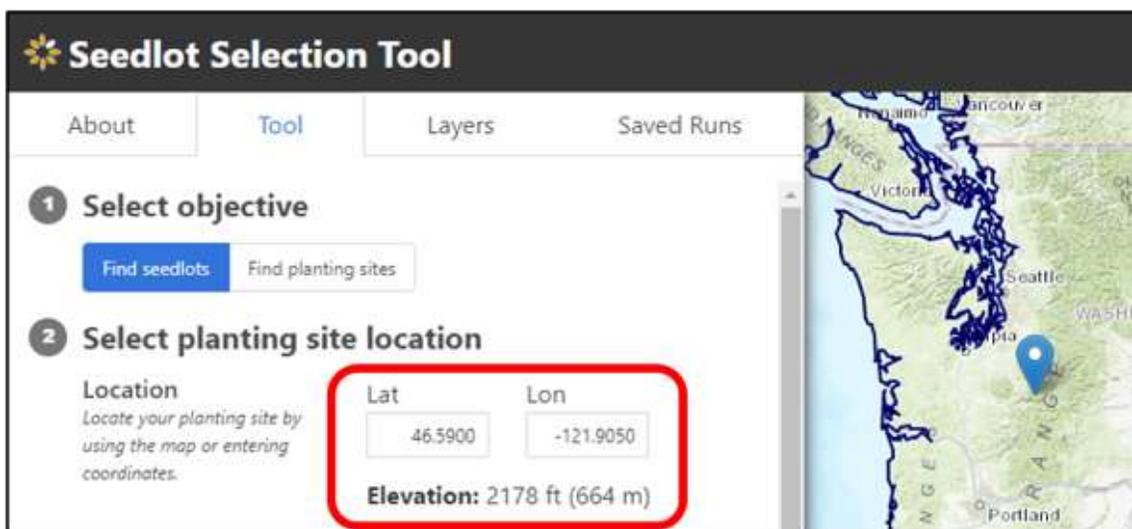
Select objective

- Select **Find seedlots**.



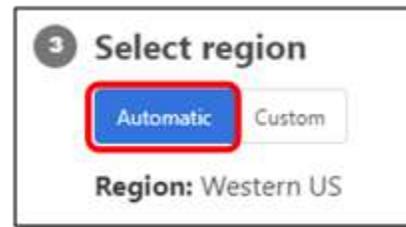
Select planting site location

- Enter coordinates (note you don't need to enter the degree symbol):
 - **Latitude = 46.59°**
 - **Longitude = -121.905°**
 - Elevation = 2,178 feet (this is automatically generated)



Select region

- Select **Automatic**.



Select climate scenarios

- Which climate are the seedlots adapted to?

Select 1961-1990 (this is the default)



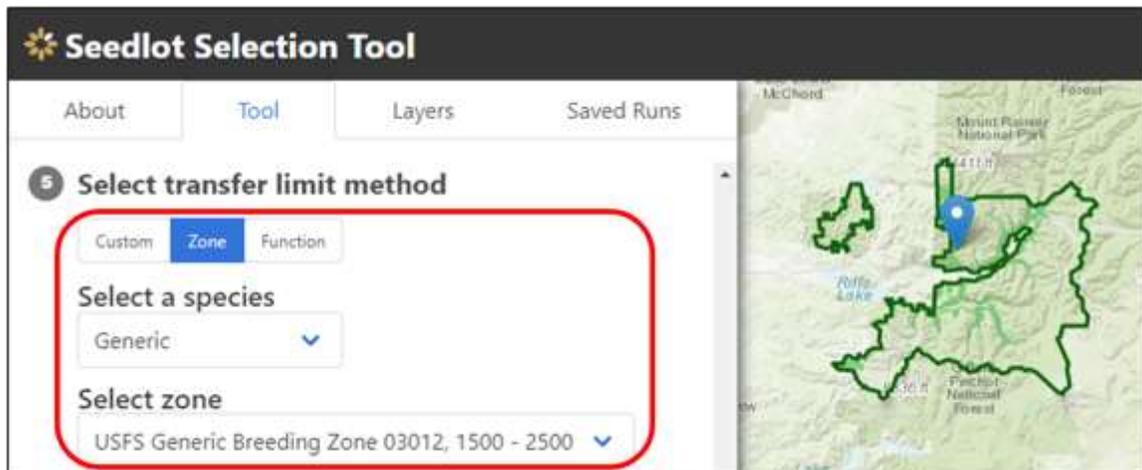
- When should trees be best adapted to the planting site?
 - Select **2011-2040** from the drop-down menu.



Select emissions scenario, **RCP 8.5**, from the drop-down menu. 

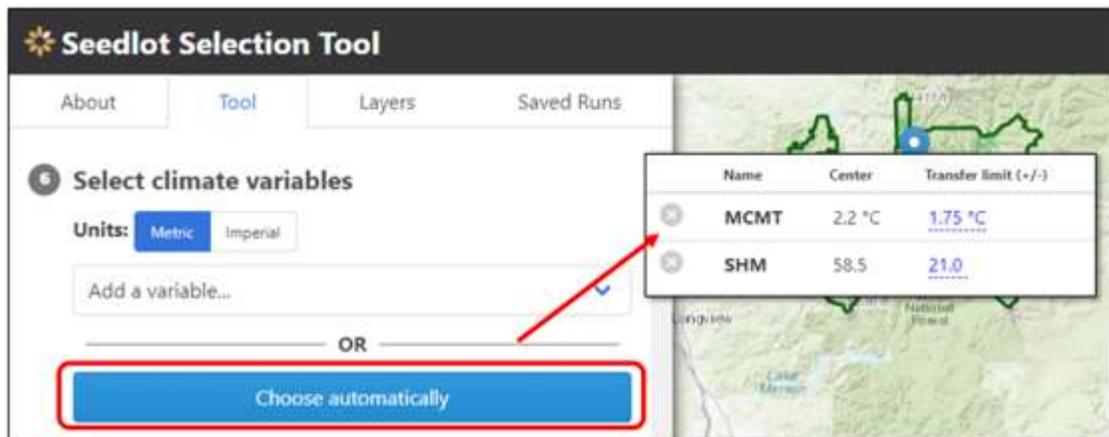
Select transfer limit method

- Select Zone to use existing seed zones
 - In this exercise select **Zone**, to get the species drop-down menu.
- Select a species
 - **Generic**
- Select zone
 - Select USFS Generic Breeding Zone 03012, 1500 - 2500 from drop-down menu.
 - Once the zone is selected, the entire seed zone is outlined in dark green, and the elevation band is shaded in light green.



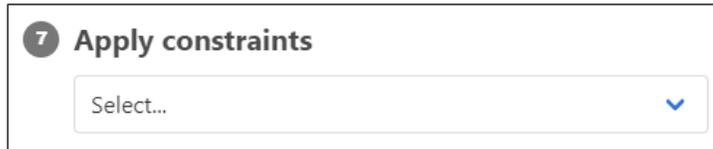
Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - Two recommended variables will automatically populate:
 - MCMT: Mean Coldest Month Temperature
 - SHM: Summer Heat-moisture Index Month



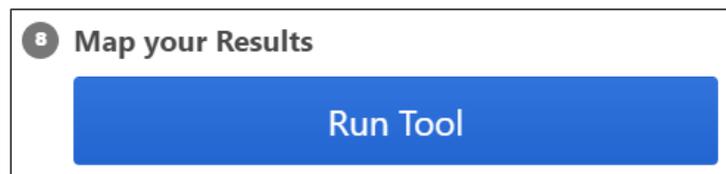
Apply constraints

- For this exercise do not constrain by geography or species range.



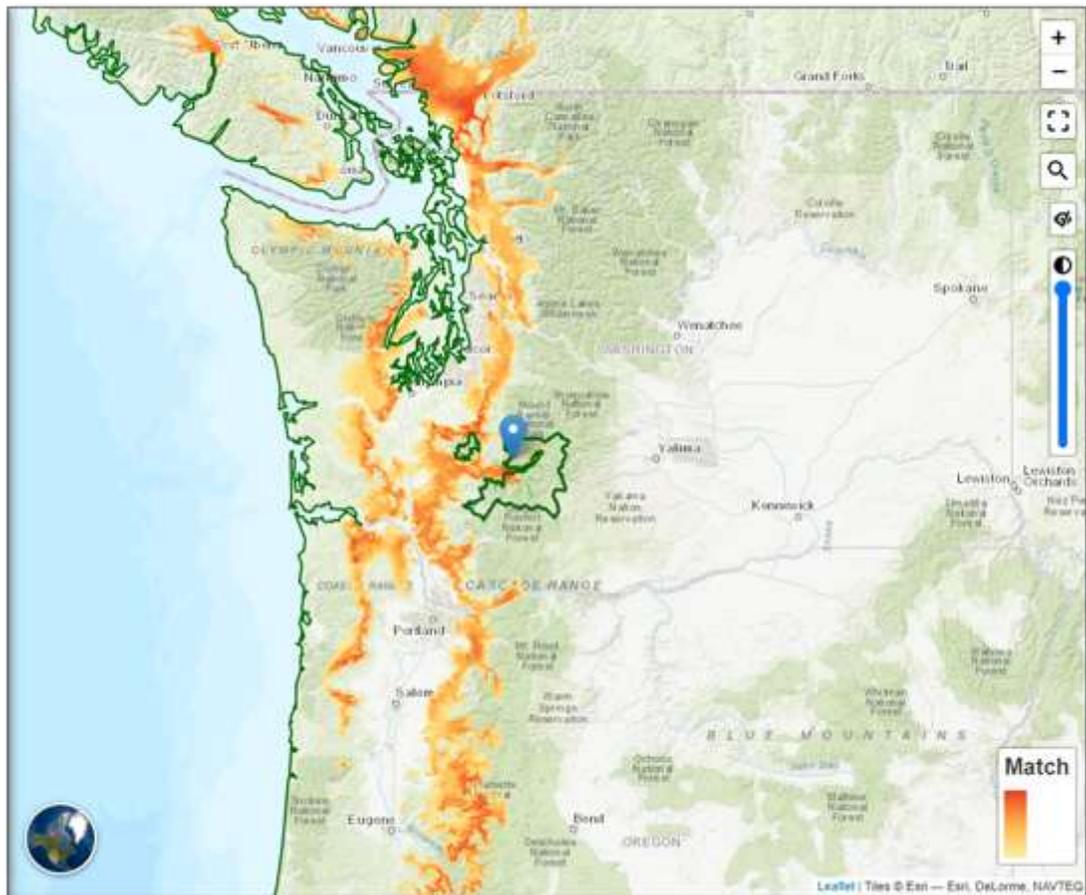
Map your Results

- Select **Run Tool**. 🌟



Explore Results - Scenario 4

- Identify seedlots with the best match.
 - The map shows all the areas within the transfer limits, which indicates how far climatically a seedlot may be moved while still suited to the climate (minimizing maladaptation).
 - The darker the orange color, the better the match.



- Identify seedlots to compare.
 - Select **Compare Seedlots** at the bottom of the map.
 - Select **Add Seedlot** using latitude and longitude.



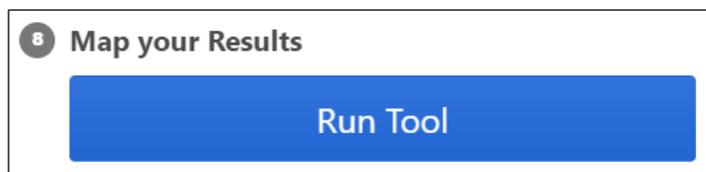
- For this exercise add seedlots:
 - **Site 1: 46.50, -121.91**
 - **Site 2: 44.03, -122.42**
 - **Site 3: 44.33, -123.74**
 - **Site 4: 42.45, -123.87**

Compare Seedlots		
Click to hide		
Location	Name	Match
⊗ 46.50, -121.91	Site 1	N/A
⊗ 44.03, -122.42	Site 2	N/A
⊗ 44.33, -123.74	Site 3	N/A

(+) Add Seedlot Upload CSV Download CSV

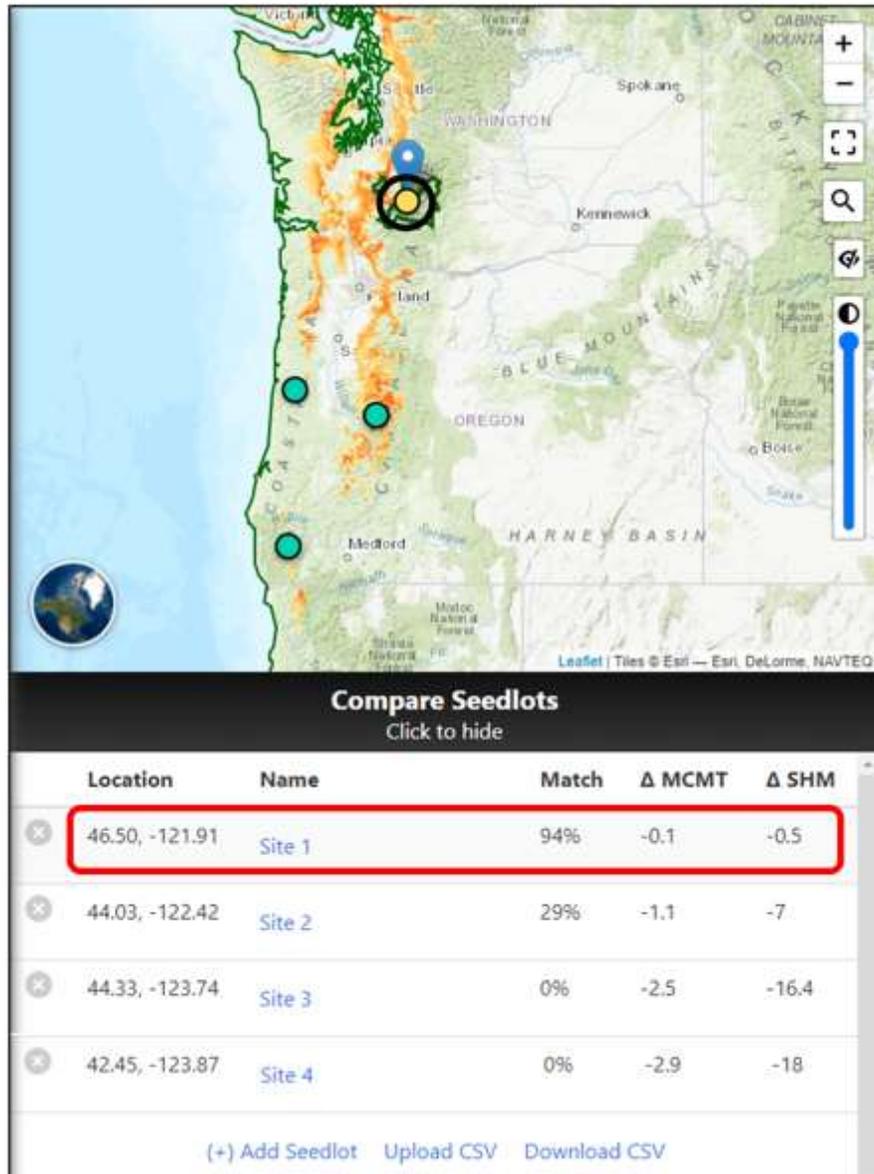
Map your Results

- Select **Run Tool**



Explore Results - Scenario 4 (Seedlot comparison)

- This generates the percent match of seedlot locations you have added to the comparison table.
 - Seedlot site 1 has a 94% match and is in the dark orange.

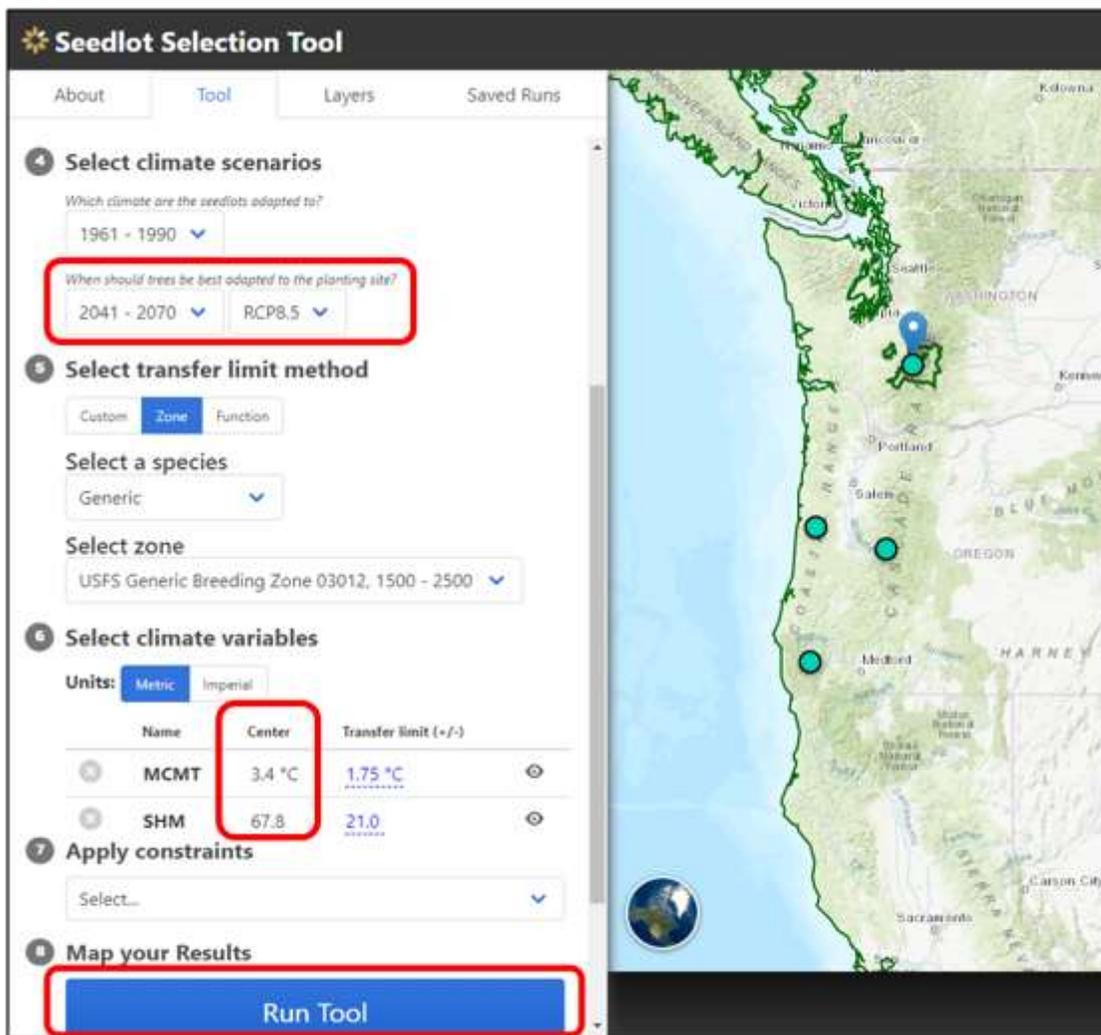


Scenario 4A – Change future time period

- Under Select climate scenarios
 - Change to 2041-2070, keep RCP8.5 4
 - Note, the change in temperature at the site when the time period changed.
 - MCMT: Mean Coldest Month Temperature from 2.2°C to 3.4°C
 - SHM: Summer Heat-moisture index from 58.6 to 67.8

Map your Results

- Run Tool 7



Seedlot Selection Tool

About Tool Layers Saved Runs

4 Select climate scenarios
Which climate are the seedlots adapted to?
1961 - 1990
When should trees be best adapted to the planting site?
2041 - 2070 RCP8.5

5 Select transfer limit method
Custom Zone Function
Select a species
Generic
Select zone
USFS Generic Breeding Zone 03012, 1500 - 2500

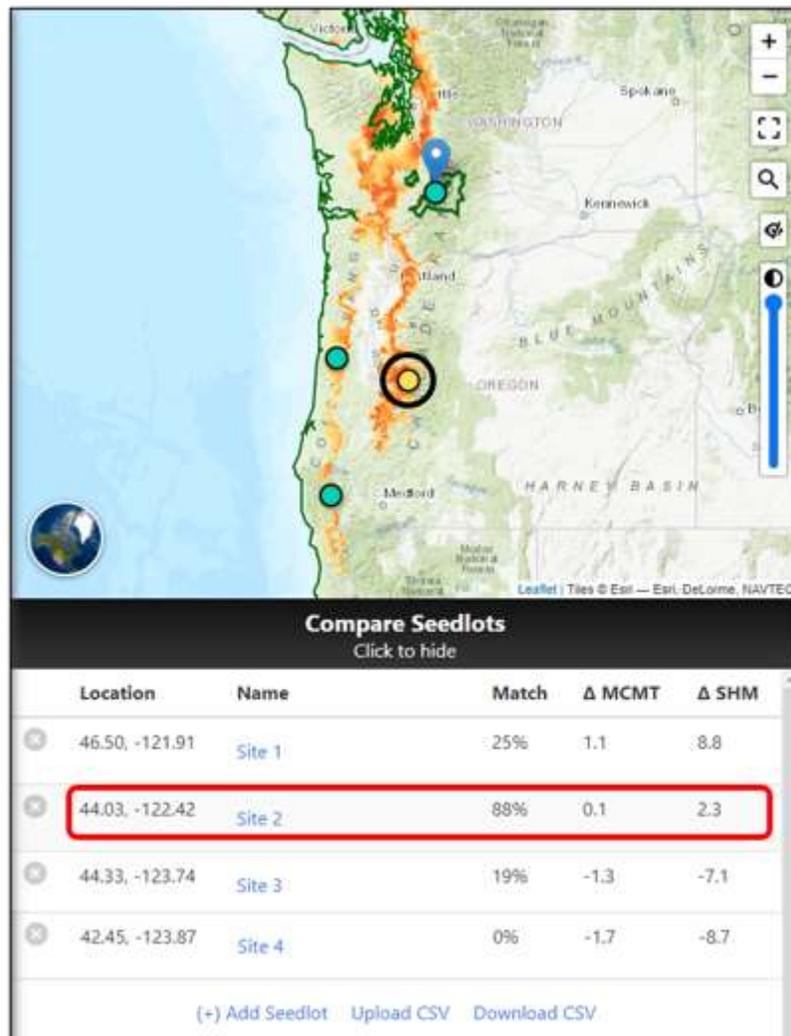
6 Select climate variables
Units: Metric Imperial
Name Center Transfer limit (+/-)
MCMT 3.4 °C 1.75 °C
SHM 67.8 21.0

7 Apply constraints
Select...

8 Map your Results
Run Tool

Explore Results - Scenario 4A

- Review the changes from the previous scenario.
 - Seedlot site 2 has an 88% match and is now in the dark orange area. 🌱1



Scenario 4B – Changing future time period

- Under Select climate scenarios
 - Change to future time period 2071-2100.
 - Note, the change in temperature at the site when the time period changed. ☀️4
 - MCMT: Mean Coldest Month Temperature from 3.4°C to 5.1°C
 - SHM: Summer Heat-moisture index from 67.8 to 77.2

Map your Results

- Run Tool ☀️7

The screenshot displays the 'Seedlot Selection Tool' interface. The 'Tool' tab is active. The configuration is as follows:

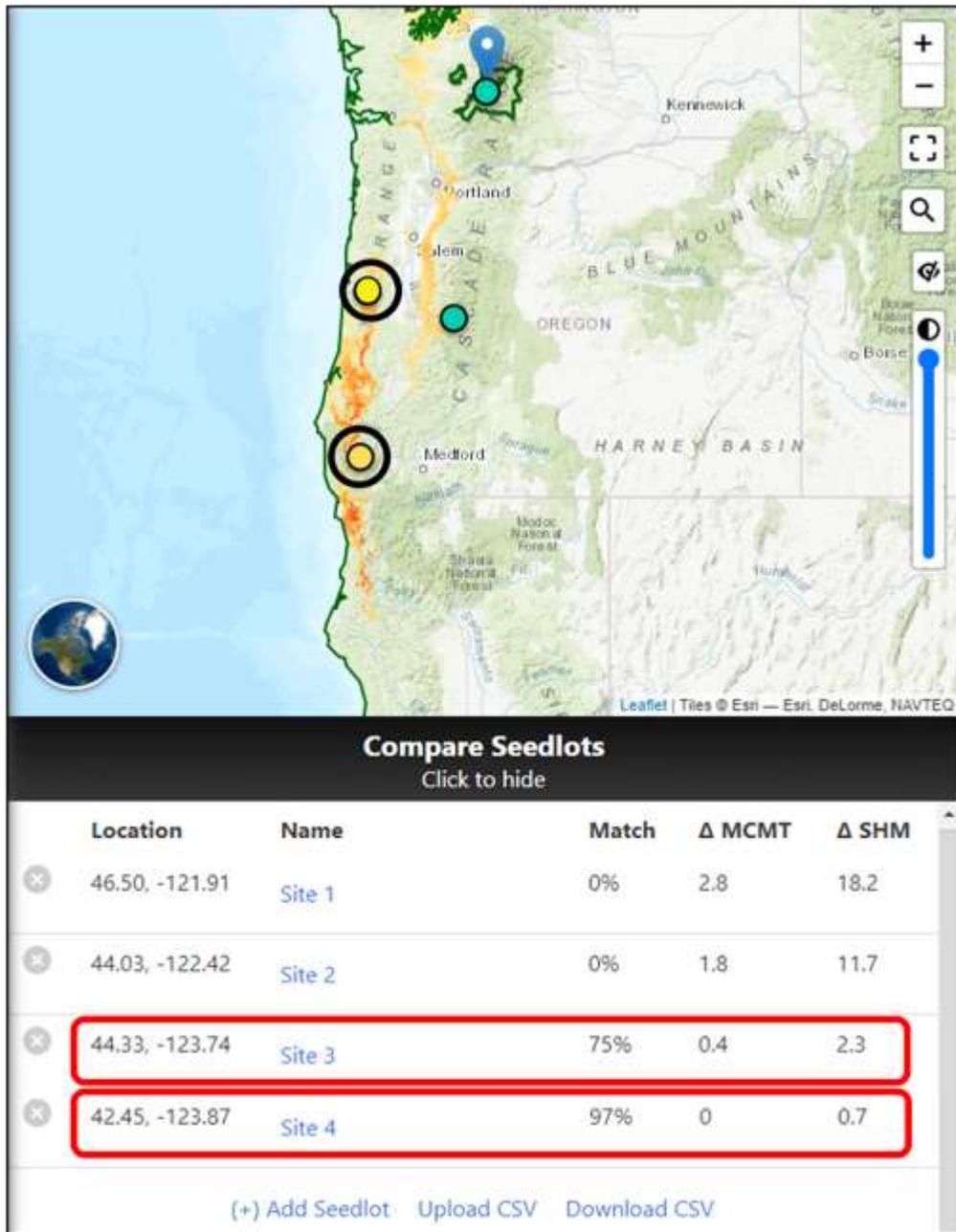
- Select climate scenarios:** 'Which climate are the seedlots adapted to?' is set to '1961 - 1990'. 'When should trees be best adapted to the planting site?' is set to '2071 - 2100' and 'RCP8.5'.
- Select transfer limit method:** 'Custom', 'Zone', and 'Function' options are present. 'Zone' is selected.
- Select a species:** 'Generic' is selected.
- Select zone:** 'USFS Generic Breeding Zone 03012, 1500 - 2500' is selected.
- Select climate variables:** 'Units' are set to 'Metric'. A table shows the following values:

Name	Center	Transfer limit (+/-)
MCMT	5.1 °C	1.75 °C
SHM	77.2	21.0
- Apply constraints:** A dropdown menu is set to 'Select...'. A 'Run Tool' button is visible at the bottom.

The right side of the interface shows a map of the Pacific Northwest region of the United States, with several green circular markers indicating seedlot locations. A blue location pin is also visible on the map.

Explore Results - Scenario 4B

- Identify seedlots with the best match
 - Note the suitable seedlot sources shifted even further south and/or to lower elevation
 - Site 3: 75% match in central coast of Oregon and Site 4: 97% (highlighted in yellow) in southwestern Oregon. 🌱1



Scenario 5: Identifying suitable planting sites for a western redcedar seedlot from southwestern Oregon.

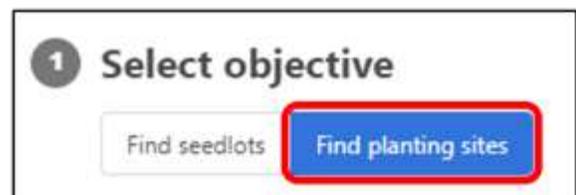
In this scenario, select the source location of a western redcedar seedlot from a species-specific seed zone on the Willamette National Forest and the tool will locate planting sites that are best adapted to future climate conditions (2041-2070, RCP8.5).

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>
 - Click on the **Tool** tab on the top left of the screen.

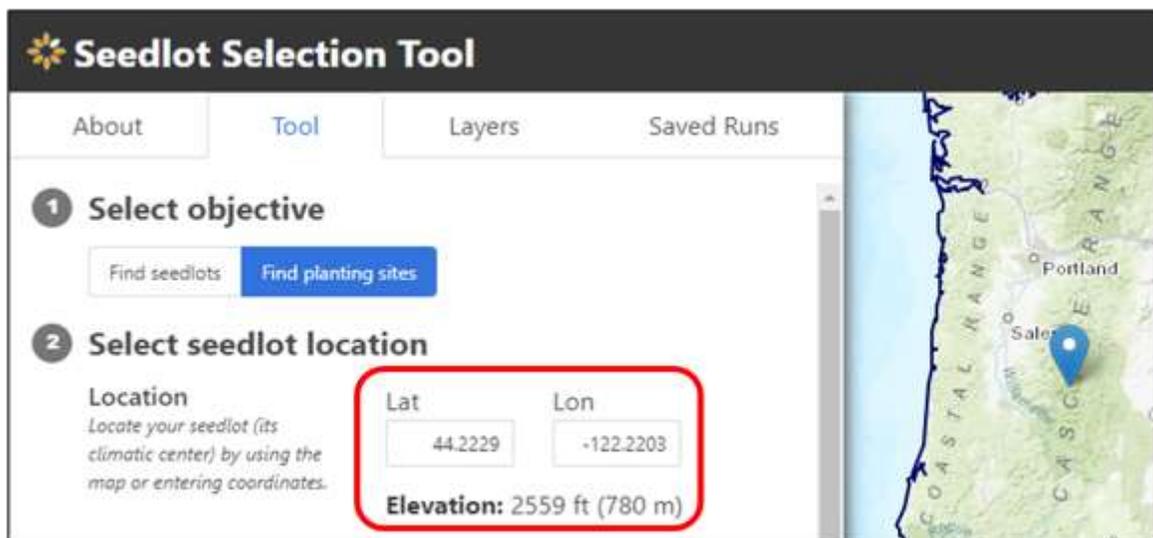
Select objective

- Select **Find planting sites**



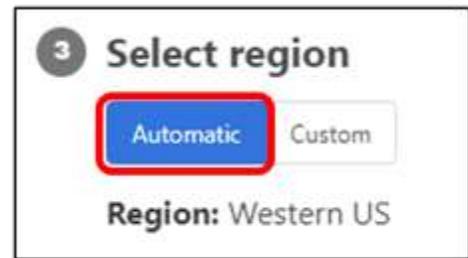
Select seedlot location

- Enter coordinates (note you don't need to enter the degree symbol):
 - **Latitude = 44.2229°**
 - **Longitude = -122.2203°**
 - Elevation = 2,559 feet (this is automatically generated)



Select region

- Select **Automatic**.



Select climate scenario

- Which climate are the seedlots adapted to?
 - Select **1961-1990**

- When should trees be best adapted to the planting site?
 - Select **2041-2070** from the drop-down menu.
 - Select emissions scenario, **RCP8.5**, from the drop-down menu.

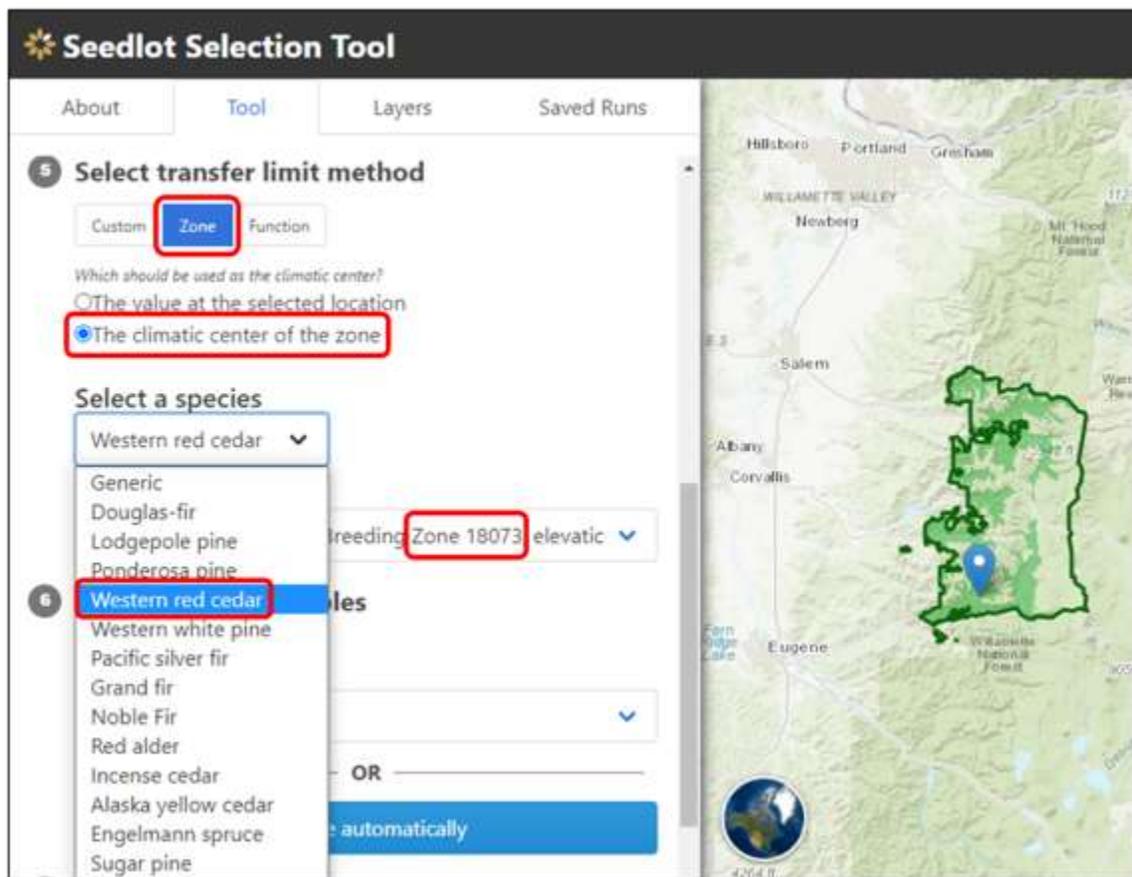


Select transfer limit method

- Select **Zone** to use existing seed zones.
 - Which should be used as the climatic center?
 - For this exercise, select **the climatic center of the zone**.
 - Select this when your seedlot represents the entire zone or if you are unsure from where exactly the seedlot was collected.
- Select a species
 - **Western red cedar**

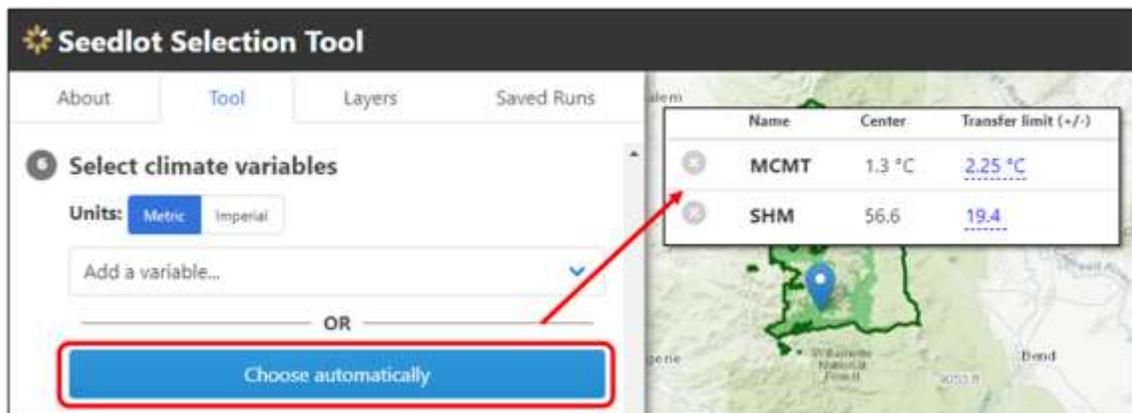
Note: Species-specific seeds zones differ from generic zones in the climate values at the center of each zone and associated transfer limits. This is because each species-specific seed zone differs in shape, geographic extent, and elevation band width from generic seed zones.

- Select zone
 - Select **USFS Western red cedar Breeding Zone 18073, elevation < 3500'** from drop-down menu. 🌲5
 - Once the zone is selected, the entire seed zone is outlined in dark green, and the elevation band is shaded in light green.



Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - Two recommended variables will automatically populate:
 - MCMT: Mean Coldest Month Temperature
 - SHM: Summer Heat-moisture Index Month



Apply constraints

- For this exercise do not select any constraints.

7 Apply constraints

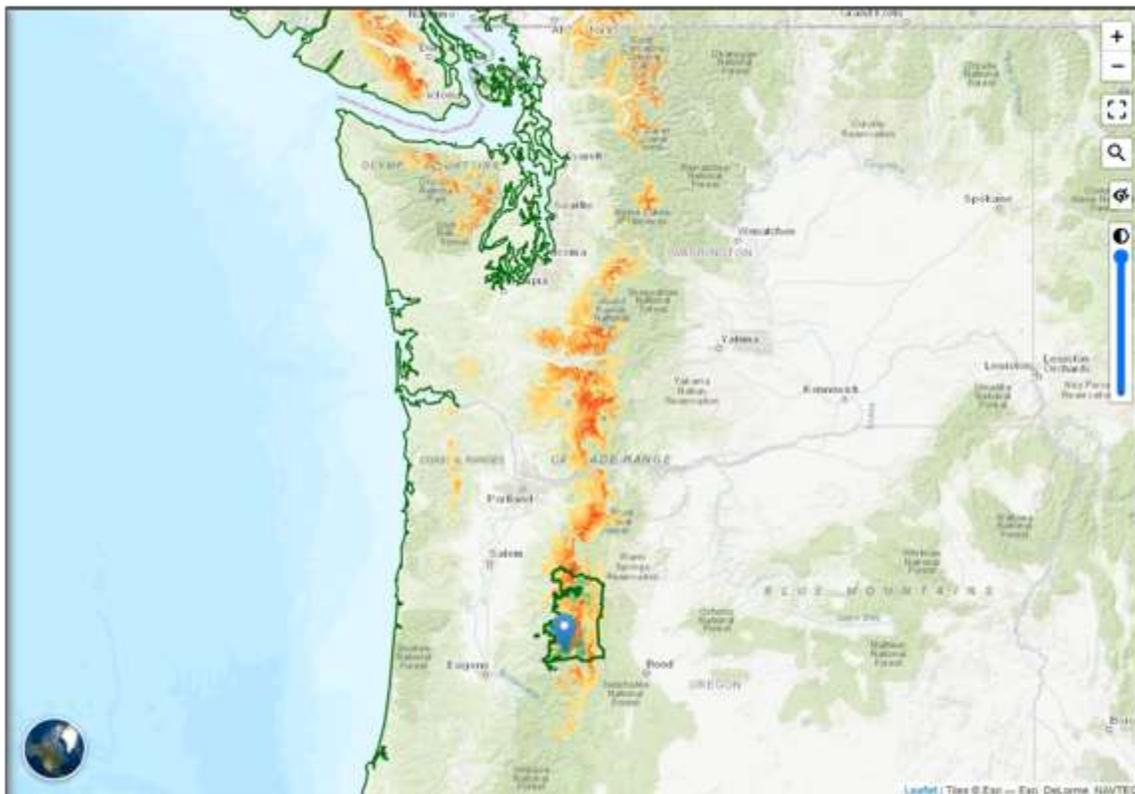
Map your Results

- Select **Run Tool**. 

8 Map your Results
Run Tool

Explore Results - Scenario 5

- Identify planting sites with the best climate match.
 - The map shows all the areas within the transfer limits, which indicates how far climatically a seedlot may be moved while still suited to the climate (minimizing maladaptation).
 - The darker the color, the better the match.
 - These results show that the seedlot will be suitable for areas within this seed zone (outlined in dark green) but at higher elevations, or further north.



Scenario 6: Seed planning, performing a gap analysis of seed orchard seed suitability under future climate conditions.

This scenario will illustrate how to perform a gap analysis using SST and ArcGIS. In this scenario, select Douglas-fir blocks in multiple seed orchards on the Rogue River-Siskiyou National Forest (Long Ridge, McCurdy, Elk, Soldier Creek seed orchards) are evaluated to determine planting locations where seeds from the orchard parents (which originate from different breeding zones and elevation bands) will be adapted to the future climate (2041-2070, RCP8.5). The outputs are then saved and imported to ArcGIS and combined to identify gaps in coverage of seed orchard seed for predicted future climates.

NOTE: Knowledge of ArcGIS is required to complete a full gap analysis.

Navigate to the Seedlot Selection Tool

- In your web browser, go to the Seedlot Selection Tool at <https://seedlotselectiontool.org/sst/>
 - Click on the **Tool** tab on the top left of the screen.

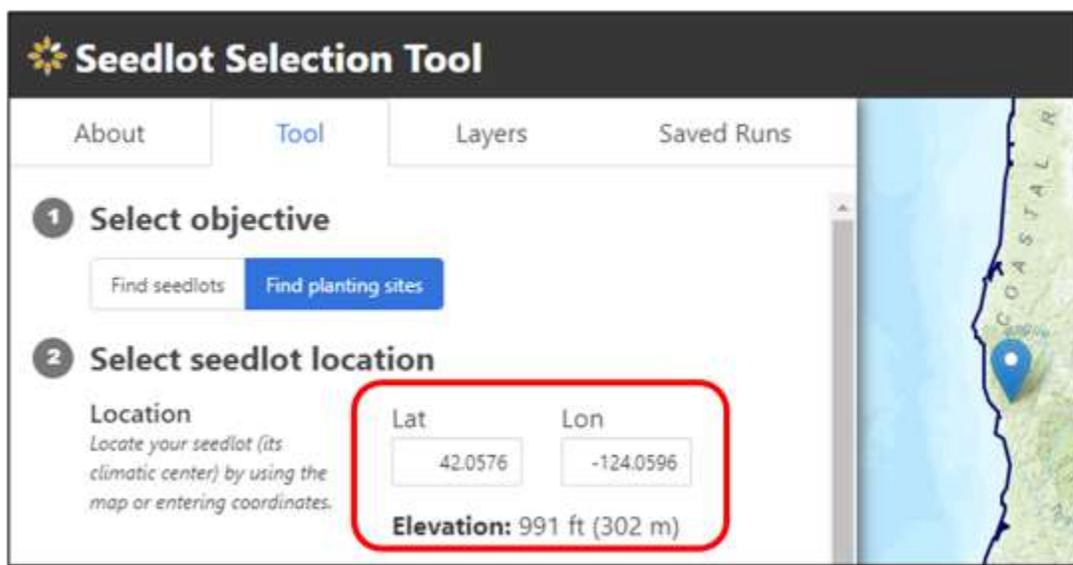
Select objective

- Select **Find planting sites**



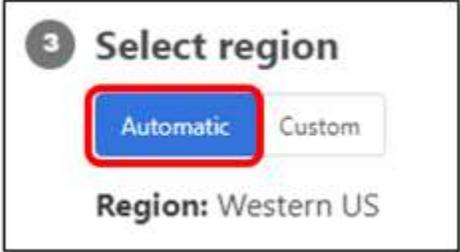
Select a seedlot location

- Enter coordinates for the block located at **Long Ridge Seed Orchard** (note you don't need to enter the degree symbol):
 - **Latitude: 42.0576°**
 - **Longitude: -124.0596°**
 - Elevation: 991 feet (this will automatically generate)



Select region

- Select **Automatic**.



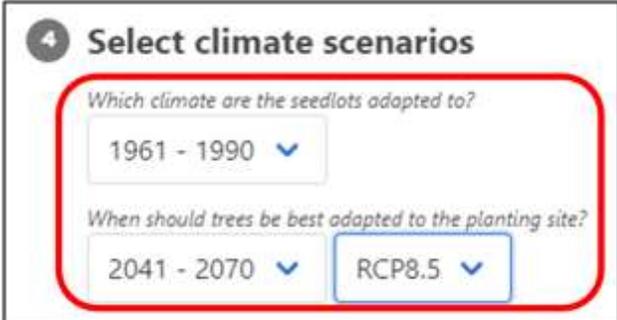
3 **Select region**

Automatic Custom

Region: Western US

Select climate scenarios

- Which climate are the seedlots adapted to?
 - Select **1961-1990**
- When should trees be best adapted to the planting site?
 - Select **2041-2070** from the drop-down menu.
 - Select emissions scenario, **RCP8.5**, from the drop-down menu.



4 **Select climate scenarios**

Which climate are the seedlots adapted to?

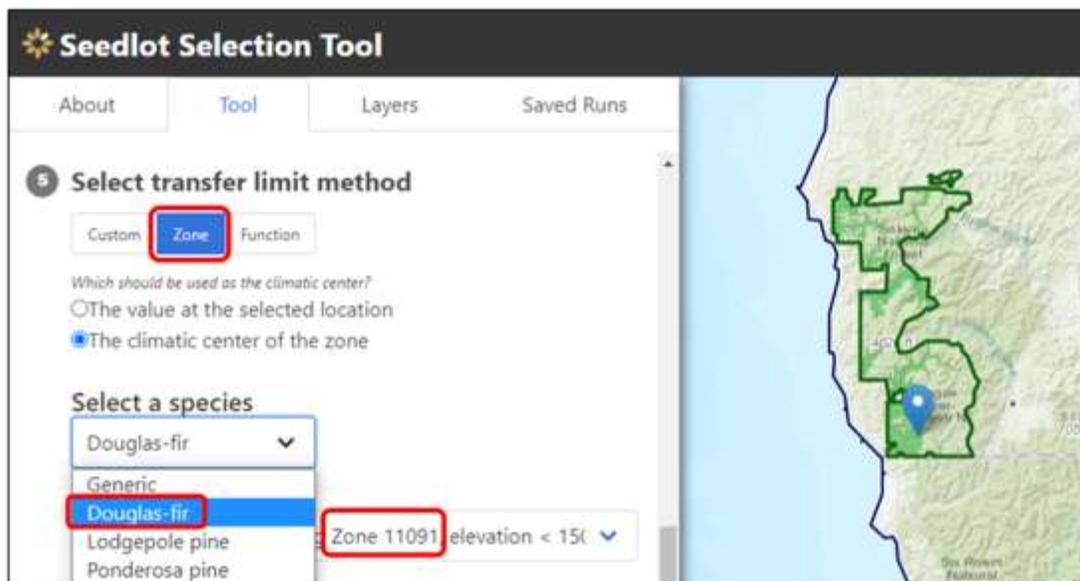
1961 - 1990 ▾

When should trees be best adapted to the planting site?

2041 - 2070 ▾ RCP8.5 ▾

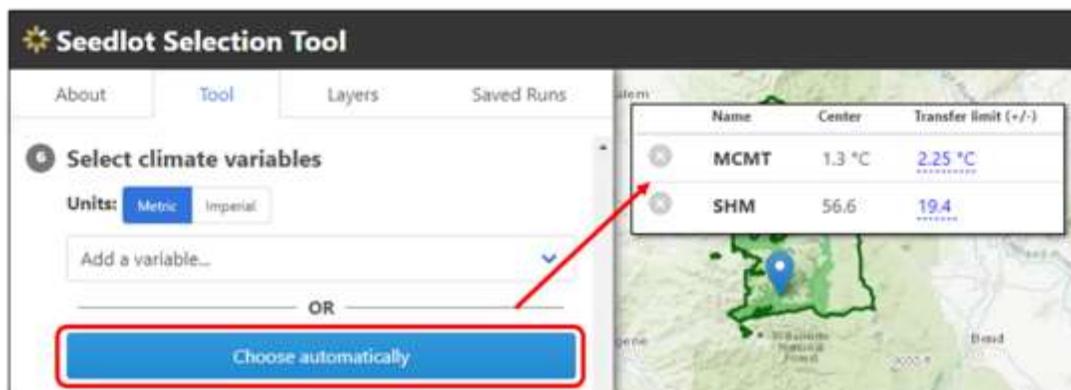
Select transfer limit method

- Select **Zone** to use existing seed zones
 - Which should be used as the climatic center?
 - Select **the climatic center of the zone**. The seedlot represents a whole breeding zone.
- Select **Species**
 - Select **Douglas-fir**
- Select Zone
 - **USFS Douglas fir Breeding Zone 11091, elevation <1500** ☀️5
 - Once the zone is selected, the entire seed zone is outlined in dark green, and the elevation band is shaded in light green.



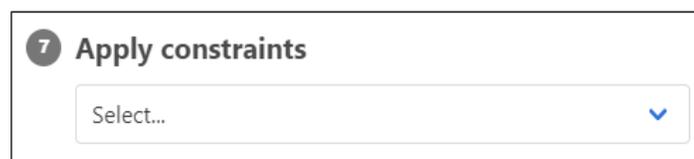
Select climate variables

- Choose the unit of measurement (metric or imperial) you prefer to use for your climate variables.
- For this exercise, select **Choose automatically**.
 - MCMT: Mean Coldest Month Temperature
 - SHM: Summer Heat-moisture Index



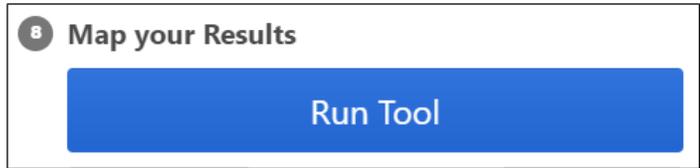
Apply constraints

- For this exercise do not constrain by geography or species range.



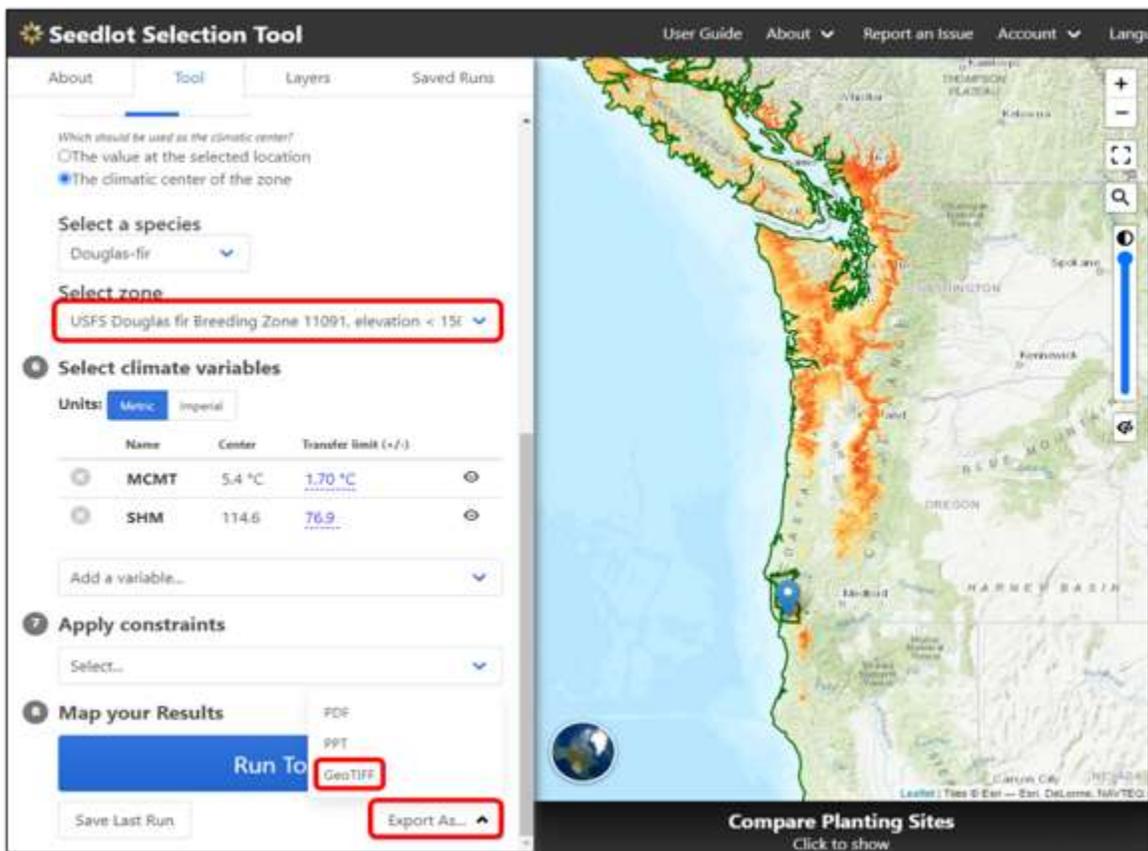
Map your Results

- Select **Run Tool**.



Explore Results - Scenario 6 (Long Ridge Seed Orchard)

- The following maps show all the areas within the transfer limits, which indicates how far climatically a seedlot may be moved while still suited to the climate (minimizing maladaptation).
 - The maps show the results for USFS Douglas fir Breeding Zone 11091.
 - **Export this map as a GeoTIFF**



McCurdy Seed Orchard – Change location coordinates and seed zone

- Change seedlot coordinates (note you don't need to enter the degree symbol):
 - **Latitude: 42.0645°**
 - **Longitude: -124.0225°**
 - Elevation: 2,162 feet (this will automatically generate)
- Notice the transfer limit seed zone changes automatically.
 - **USFS Douglas fir Breeding Zone 11092, 1500-2500**

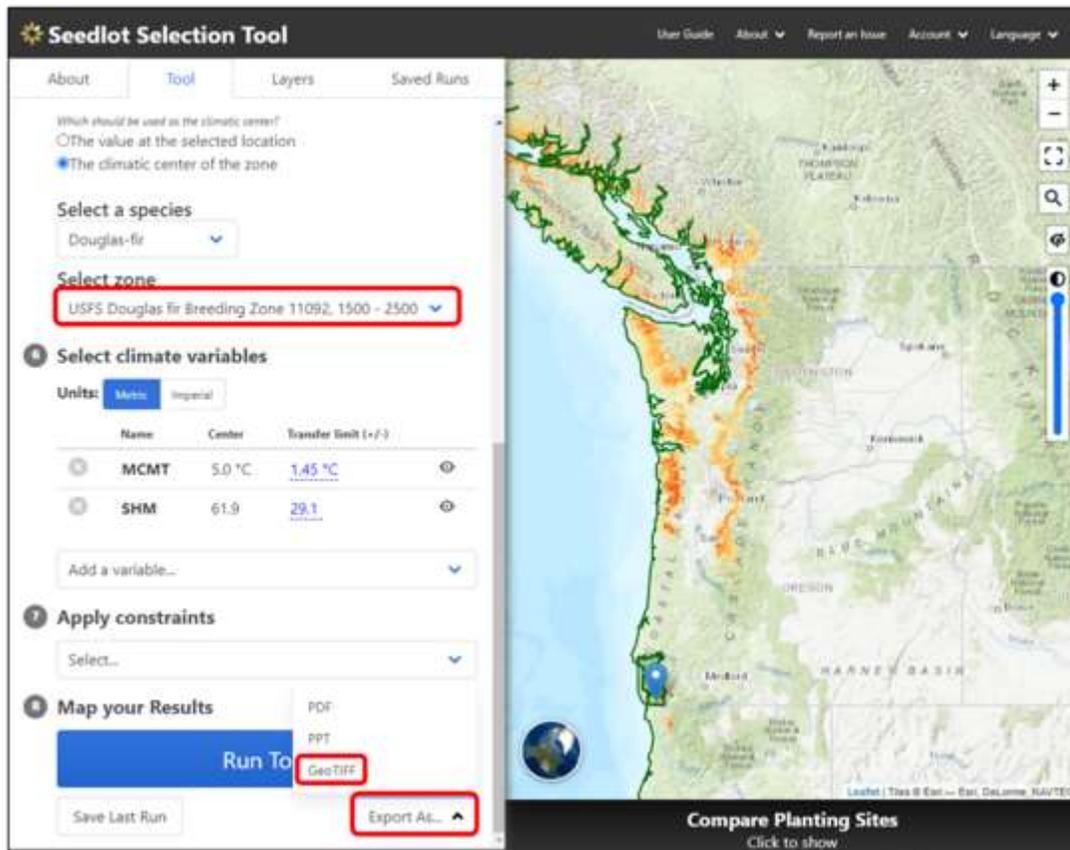
Map your Results

- **Run Tool**

The screenshot displays the 'Seedlot Selection Tool' interface. The left sidebar contains a numbered list of steps: 2. Select seedlot location, 3. Select region, 4. Select climate scenarios, 5. Select transfer limit method, 6. Select climate variables, 7. Apply constraints, and 8. Map your Results. The 'Select seedlot location' section has input fields for 'Lat' (42.0645) and 'Lon' (-124.0225), with 'Elevation: 2162 ft (659 m)' displayed below. The 'Select transfer limit method' section has 'Zone' selected. The 'Select a species' dropdown is set to 'Douglas-fir'. The 'Select zone' dropdown is set to 'USFS Douglas fir Breeding Zone 11092, 1500 - 2500'. A blue 'Run Tool' button is at the bottom. The right side shows a map of the Pacific Northwest with a blue location pin and a green shaded area. A 'Compare Planting Sites' button is at the bottom right.

Explore Results - Scenario (McCurdy Seed Orchard)

- The maps show the results for USFS Douglas fir Breeding Zone 11092.
- **Export this map as a GeoTiff**



Elk Seed Orchard – Change location coordinates and seed zone

- Change seedlot coordinates (note you don't need to enter the degree symbol):
 - **Latitude: 42.0738°**
 - **Longitude: -123.9309°**
 - Elevation: 3,392 feet (this will automatically generate)
- Notice the transfer limit seed zone changes automatically.
 - **USFS Douglas fir Breeding Zone 11093, 2500-3500**

Map your Results

- Select **Run Tool**

Seedlot Selection Tool

User Guide About Report an Issue Account Language

About Tool Layers Saved Runs

- Select seedlot location
- Select region
- Select climate scenarios
- Select transfer limit method
- Select a species
- Select zone
- Select climate variables
- Apply constraints
- Map your Results

Location
Locate your seedlot (its climatic center) by using the map or entering coordinates.

Lat: 42.0645 Lon: -124.0225
Elevation: 2162 ft (659 m)

Select region

Select climate scenarios

Select transfer limit method

Custom **Zone** Function

Which should be used as the climatic center?
 The value at the selected location
 The climatic center of the zone

Select a species

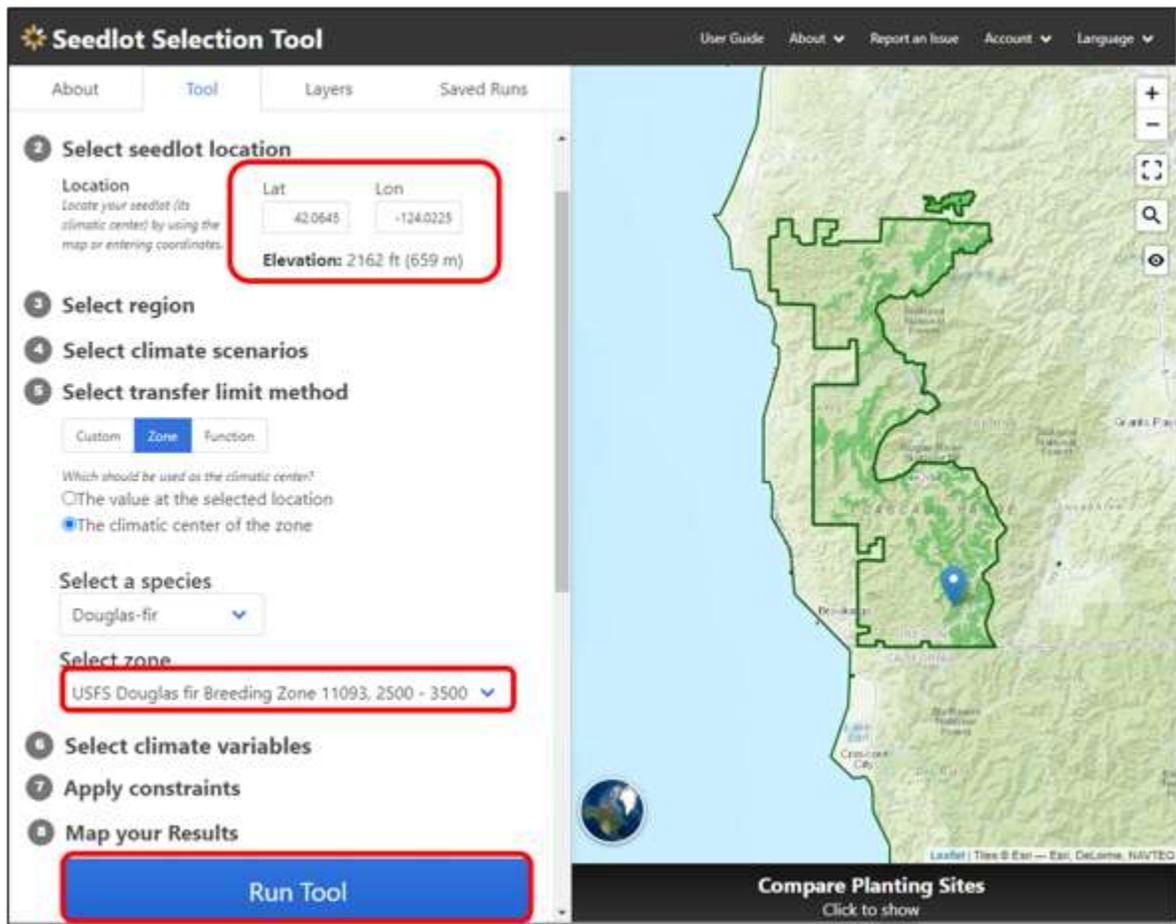
Douglas-fir

Select zone

USFS Douglas fir Breeding Zone 11093, 2500 - 3500

Run Tool

Compare Planting Sites
Click to show



Explore Results: Seedlots from Elk Seed Orchard

- The maps show the results for USFS Douglas fir Breeding Zone 11093.
- **Export this map as a GeoTiff**

The screenshot displays the 'Seedlot Selection Tool' interface. The left sidebar contains configuration options, and the right side shows a map of the Pacific Northwest region.

Configuration Options:

- Which should be used as the climatic center?**
 - The value at the selected location
 - The climatic center of the zone
- Select a species:** Douglas-fir
- Select zone:** USFS Douglas fir Breeding Zone 11093, 2500 - 3500
- Select climate variables:**
 - Units: Metric (selected), Imperial
 - Table:

Name	Center	Transfer limit (+/-)
MCMT	4.5 °C	1.50 °C
SHM	57.3	25.8
 - Add a variable...
- Apply constraints:** Select...
- Map your Results:** Run To (PDF, PPT, GeoTIFF), Save Last Run, Export As...

Map: Shows the Pacific Northwest region with a color-coded overlay representing the results for the selected breeding zone. A blue location pin is visible on the map.

Soldier Creek Seed Orchard – Change location coordinates and seed zone

- Change seedlot coordinates (note you don't need to enter the degree symbol):
 - **Latitude: 42.1476°**
 - **Longitude: -123.7828°**
 - Elevation: 4,288 feet (this will automatically generate)
- Notice the transfer limit seed zone changes automatically.
 - **USFS Douglas fir Breeding Zone 11064, 3500-4500**

Map your Results

- Select **Run Tool**

The screenshot displays the 'Seedlot Selection Tool' interface. The left sidebar contains a vertical list of steps: 2. Select seedlot location, 3. Select region, 4. Select climate scenarios, 5. Select transfer limit method, 6. Select climate variables, 7. Apply constraints, and 8. Map your Results. The 'Select seedlot location' section is highlighted with a red box and contains input fields for 'Lat' (42.1476), 'Lon' (-123.7828), and 'Elevation' (4288 ft (1307 m)). The 'Select transfer limit method' section has 'Zone' selected. The 'Select zone' dropdown is also highlighted with a red box and shows 'USFS Douglas fir Breeding Zone 11064, 3500 - 4500'. At the bottom of the sidebar, a large blue 'Run Tool' button is highlighted with a red box. The right side of the interface shows a topographic map of the seedlot area with a green outline and a blue location pin. The map includes navigation controls like zoom in (+), zoom out (-), full screen, search, and location. At the bottom right, there is a 'Compare Planting Sites' button with the text 'Click to show'.

Explore Results: Seedlots from Soldier Creek Seed Orchard

- The maps show the results for USFS Douglas fir Breeding Zone 11064.
 - **Export this map as a GeoTiff**

The screenshot displays the 'Seedlot Selection Tool' interface. The left sidebar contains configuration options, and the right side shows a map of the Pacific Northwest region with a color-coded overlay representing seedlot suitability. A 'Match' legend is visible on the map.

Seedlot Selection Tool

Which should be used as the climatic center?
 The value at the selected location
 The climatic center of the zone

Select a species
Douglas-fir

Select zone
USFS Douglas fir Breeding Zone 11064, 3500 - 4500

Select climate variables

Units: Metric Imperial

Name	Center	Transfer limit (-/+)
MCMT	2.8 °C	1.20 °C
SHM	88.6	48.7

Add a variable...

Apply constraints
Select...

Map your Results

Run Tool

Save Last Run

Export As...

Compare Planting Sites
Click to show

Perform a GAP Analysis using ArcGIS

NOTE: Knowledge of ArcGIS is required to complete a full gap analysis.

- Import the four GeoTIFF files into ArcGIS to do advanced analysis.
 - In ArcGIS use your preferred method to add data and navigate to the folder where you saved the exported SST output as a GeoTIFF and find the *.tif files for all 4 outputs and add these layers to your map.
 - To select the maximum value for each pixel among the four grids in ArcToolBox under Spatial Analyst Tools>Local open the “Cell Statistics” tool.
 - In the “Input rasters or constant values” dialog box, use the drop-down menu to select the four layers you just added.
 - In the “output raster” dialog box, select the folder location where you want to save the output raster and name the output file.
 - In the “overlay statistic” dialog box select “MAXIMUM”.
 - Make sure that “Ignore NoData in calculations is checked.
 - Click OK.
 - The resulting output layer comprises the maximum value from all four input layers and shows where there are gaps in suitable planting sites for seed from these four seed orchard blocks. Other seed sources will need to be found in the mid-century time period to fill in these gaps.

