

Climate-Smart Restoration Tool (CSRT)

User Guide

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Introduction

The CSRT calculates and maps seed transfer limits for plant species. This versatile tool uses two types of data input, empirical trait data from preloaded genecological studies or provisional data from user-defined climate variables, to construct site-specific seed transfer limits for ecological restoration and planning. The tool is intended to inform land managers, seed vendors and scientists of seed transfer limits for individual plant taxa. The eight steps described below will provide guidelines to tailor the tool to your specific restoration needs.

1. Select Objective

Find seedlots for my planting site

Click on the Find seedlots button if you have a planting site for which you want to find adapted seedlots.

Find planting sites for my seedlot

Click on the Find planting sites button if you have a seedlot and you want to know where you can plant it.

2. Select Location

You can either enter coordinates or click on the map to indicate the location of your seedlot or planting site. The location of a seedlot represents the geographic location where it is best adapted—that is, the center of its adaptive climate space.

Enter your location as coordinates

You can enter the latitude and longitude of your location in decimal degrees.

Use the map to select your location

Alternatively, use the pan and zoom tools to navigate to your area of interest, and then click on the map. This will show the latitude, longitude, and elevation of your location. If you have already selected climate variables or species and function in Step 5, it will also show their values.

If you click on the Set Point button, your current coordinates and other location information will be automatically set for use by the program. If you click outside of the areas covered by the SST, you will see “N/A” listed for elevation.

Note: North America is divided into regions to reduce processing time. When you use the Set Point button, the SST automatically shows the options associated with your selected region. If you click in a new region, new options become available.

3. Select Region

You can let the tool automatically choose the region which best fits the location you selected, or you use the custom option to manually select any available region.

Automatic

Click on the Automatic button to let the tool select the best region for your location. The region which contains your location and with a center point closest to your location will be selected. Before selecting a location, you can click on the map to see which region will be selected.

Custom

Click on the Custom button to select a region yourself from a drop-down list of available regions. When you choose a region from the drop-down menu, it will be outlined on the map. You can choose a region that does not contain your location; the tool will be run for the region you select.

4. Select Climate Scenarios

Which climate are the seedlots adapted to?

Select time period - The first step is to identify which climate the seedlots are adapted to, which is typically assumed to be the climate having the greatest influence on the seedlot's parents. Using the drop-down menu, select either:

- 1961 - 1990
- 1981 - 2010

For longer-lived plants (e.g. trees) it is recommended to choose 1961 -1990. For shorter-lived species (e.g., grass and forbs) a 1981-2010 period may be more suitable.

When should plants be best adapted to the planting site?

Select time period - The next step is to choose when you want the plants to be optimally adapted to their planting site. Typical choices are the 'current' climate (e.g., 1981-2010), or if you want to account for climate change, some future time period. Use the drop-down menu to select either:

- 1961 – 1990
- 1981 – 2010
- 2011 - 2040
- 2041 – 2070
- 2071 - 2100

Select representative concentration pathway (RCP) - For future climates (i.e., 2011 to 2100), also select the RCP, which is associated with different levels of atmospheric greenhouse gases and climate change. According to IPCC AR5, the RCP4.5 "stabilization" scenario has a projected increase

in mean annual temperature of 1.8°C by 2100 (range = 1.1-2.6°C), whereas the RCP8.5 “business as usual” scenario has a projected increase of 3.7°C by 2100 (range = 2.6-4.8°C). Use the drop-down menu to select either:

- RCP4.5
- RCP8.5

5. Select Transfer Limit Method

The CSRT uses three approaches to construct and map transfer limits. The “custom” and “zone” approaches are based on user-defined climatic variables and thresholds. The “function” approach uses genecological functions. Genecological functions are an association between common garden trait data and the climate derived from seed source populations. A limited number of species are currently available for the “function” approach, but more species will be added from existing and ongoing common garden studies. If the species of interest is available for the Function method, we suggest using this approach. Below the methods are described in more detail.

Select the Custom method to enter your own custom transfer limit, use the Zone method to use an existing zone to calculate a transfer limit, or selection the Function method to calculate seed transfer distances for certain species.

Function method

Select the species using the drop-down list. Traits, genecological values and limits will be pre-populated in Step 6. The trait values are based on statistical models developed from the literature (see Reference and additional information section).

Custom method

Click on the Custom button to enter your own transfer limits for one or more climate variables.

Zone method

Click on the Zone button to use an existing zone to calculate transfer limits for one or more climate variables. Using the zone approach involves three steps.

Select the climatic center for mapped output

If you have chosen to find planting sites for a seedlot, you need to specify the climatic center of the mapped output. If you have a seedlot from a specific known location, you would typically use that specific location (i.e., your selected coordinates). If you have a seedlot that represents an entire seed zone, it is probably more appropriate to use the climatic center of your chosen zone. Thus, for finding planting sites, you must choose between the following two alternatives:

- The value at the selected location – If you choose this option, your current coordinates (selected in Step 2) will be used as the climatic center of your mapped output.
- The climatic center of the zone - If you choose this option, the calculated climatic center of the selected zone is used as the climatic center of your mapped output.

6. Select Traits

Traits will be populated based on the species selection. We recommend the seed transfer limit default setting to be used for mapping transfer distances.

7. Apply Constraints

The CSRT is capable of constraining seed transfer based on available species distribution models (SDMs), geographic distance, ecoregions, etc. If a SDM is available for the species of interest, we suggest using this as a constraint. The SDM constraint is aligned with the climate scenario in Step 4 when available.

For sagebrush seed transfer, we recommend constraining projections based on the respective subspecies SDM (Wyoming or mountain big sagebrush) and by geographic distance using a 300 km extent. Since seed transfer distances can be large in big sagebrush, setting a geographic constraint is a conservative approach to maintain potential genetic structure among populations.

8. References

Big sagebrush

Still, S. M., & Richardson, B. A. (2015). Projections of Contemporary and Future Climate Niche for Wyoming Big Sagebrush (*Artemisia tridentata* subsp. *wyomingensis*): A Guide for Restoration. *Natural Areas Journal*, 35(1), 30–43. <http://doi.org/10.3375/043.035.0106>

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