Seedlot Selection Tool (SST)

User Guide

Table of Contents

Introduction

The Seedlot Selection Tool (SST) is a web-based mapping application designed to help natural resource managers match seedlots with planting sites based on climatic information. Because of natural selection to different climatic conditions at a location, plant populations are genetically differentiated from one another and are generally locally adapted. As a result, differences in climates among seedlots reflect differences in adaption. The SST maps locations where a seedlot matches a planting site assuming the seedlot was locally adapted to the past climate. The climates of the planting sites can be chosen to represent past climates, or future climates based on selected climate change scenarios. The SST allows the user to control many input parameters, allowing them to explore different assumptions about climate change, how plant populations are adapted to climate, and the risk tolerance of the user. The eight steps described below will provide guidelines to tailor the tool to your specific reforestation or restoration needs.

Step 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.

Step 2. Select Location

You can either enter coordinates or click on the map to indicate the location of your planting site or seedlot. If looking for seedlots for a planting site, indicate the location of the planting site. If looking for planting sites for a seedlot, indicate the location of the seedlot. 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. (Note: enter a negative value for a longitude in North America.)

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 pop-up will show the latitude, longitude, and elevation of your location, and any seed or breeding zones associated with that location. 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 have already selected climate variables in Step 6, it will also show their values.

NOTE

Optional

You can map multiple seedlots for comparison to a planting site, or multiple planting sites for comparison to a seedlot, by clicking on the `Add Seedlots` or the `Add Planting Sites` button, respectively. After clicking on the button, you can either enter the coordinates of each location or click on the map and select `Add Location` in the pop-up. Be sure to click on the `Add` button each time you add a location or you could inadvertently shift the initial location to which you are comparing seedlots or planting sites by selecting Set Point. After running the tool, a similarity index is calculated between the initial planting site or seedlot and the locations to be compared to it (initially set as N/A until the tool is run; see Step 8 for details).

(Under construction: (1) Calculating climatic transfer distances for each climate variable for each location. (2) Ability to enter a batch of locations. (3) Ability to output a table showing the results of all the comparisons.)

Step 3. Select Region

North America is divided into regions to reduce processing time. You can let the tool automatically choose the region which best fits the location you selected (default), or you can 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 an alternative region 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, in which case the tool will map the results for the region you select.

Step 4. Select Climate Scenarios

Which climate are the seedlots adapted to?

The first step is to select the time period (given as a 30-year average known as a climate normal) that represents the climate to which seedlots are adapted. It is typically assumed to be the climate having the greatest influence on the seedlot's parents. 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.

Using the drop-down menu, select either:

- 1961 - 1990

- 1981 - 2010

When should plants be best adapted to the planting site?

The next step is to choose a time period that represents the climate to which the planted trees should be optimally adapted to their planting site. This may be a bit of a conundrum for forest managers since long-lived trees must be adapted to the near-term in addition to being adapted to the long-term. Climate is a moving target. Aim too far into the future and one might see cold damage in the near-term for trees moved from warmer to cooler climates.

The SST allows users to explore different scenarios of climate change by looking at different future time periods and assumed relative concentration pathways (RCPs). The SST also allows users to consider adaptation to past climates—that is, if climate change were ignored (1961 - 1990 before appreciable climate change) or considering recent changes in climate (1981 - 2010). Note that the current time period (2011-2040) represents modeled projections and not observations.

Use the drop-down menu to select either:

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

For future climates (i.e., 2011 to 2100), also select the relative concentration pathway (RCP), which is associated with different levels of atmospheric greenhouse gases and climate change. According to IPCC AR5, the RCP 4.5 "stabilization" scenario has a projected increase in mean annual temperature of 1.8°C by 2100 (range = 1.1-2.6°C), whereas the RCP 8.5 higher-emissions 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:

- RCP 4.5
- RCP 8.5

Step 5. Select Transfer Limit Method

The transfer limit indicates how far climatically a seedlot may be moved and still have an acceptable level of adaptation. The SST uses three alternative approaches to determine and map transfer limits: **Custom**, **Zone**, and **Function**. *(Note: the Function approach is under construction)*

The **Custom** and **Zone** approaches allow user-defined transfer limits for each climate variable selected in Step 6. Transfer limits for the **Custom** approach may be selected based on the experience of the user including the best available science. They may also be adjusted based on the user's level of acceptable risk.

The SST suggests a transfer limit for the Zone approach based on the range of climates within the

zone for the location of the planting site or seedlot chosen in Step 2. The idea is that the user would feel comfortable with that climatic difference given that we have been operationally moving populations within zones for 60 or more years. If you use the Zone method, the SST obtains the transfer limit (`TL`) for each climate variable using the selected zone: `TL = \frac{xmax-xmin}{2}`, where `xmax` and `xmin` are the maximum and minimum climate values for the zone. The assumption is that half the range of climates represents a "typical" past transfer. Because some zones show greater climatic variation than the typical zone, we also provide the average transfer limit for all zones in the selected zone set. This and other information will show up in a pop-up window in Step 6 if you hover over the "eye" icon to the right of the climate variable in the climate variable table. The transfer limit may be modified by the user.

The **Function** approach uses a genecological function to select an acceptable difference in one or more adaptive traits based on research from common-garden studies. Genecological functions are an association between the adaptive traits identified in a common-garden and the climate derived from seed-source locations. The trait usually represents a multivariate climate.

Custom method

Click on the `Custom` button to enter your own transfer limits after selecting one or more climate variables in Step 6.

Zone method

Click on the `Zone` button to use an existing zone to calculate transfer limits for one or more climate variables.

For the objective of finding seedlots for a planting site, the **Zone** approach involves two steps. First, select a species. Second, select a zone from the drop-down menu of available options. If you know that a species has a species-specific zone and you would like to use it, select the zone from the drop-down menu of available species-specific zones for that location. Otherwise select generic for zones at that location that apply across all species. Note that the available zones are dependent upon the specific location selected (e.g., USFS zones may apply only to USFS lands).

For the objective of finding planting sites for a seedlot, the **Zone** approach involves three steps. First, you need to specify the climatic center of the mapped output. If you have a seedlot from a specific known location, you will typically use the climate of that specific location. If you have a seedlot that represents an entire zone, or you are unsure from where within the zone the seedlot was collected, it is probably more appropriate to use the climatic center of your zone. After specifying the climatic center to be used for mapping, the next two steps are as above — select the species followed by selecting the zone of interest.

Function method *(under construction February 2021)*

For the **Function** approach, select the species using the drop-down menu. The values and transfer limits for the adaptive traits from genecology studies will be prepopulated in Step 6 for the locations chosen in Step 2. 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.

NOTE	*In the future, the Function approach will also offer an option of creating your own*

> *function that allows differential weighting of different climate variables as representative of adaptive variation.*

Step 6. Select Climate Variables

Select one or more climate variables to be mapped. The climate information is derived from a climate downscaling application called ClimateNA (see tab for more information). 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. This option specifies a transfer limit for MCMT of `/- 2.0°C` and for SHM of `/-` half the value at the location specified in Step 2. These transfer limits may be modified. After choosing climate variables, the resulting table includes:

- **Name** — the abbreviated name of the ClimateNA variable
- **Center** — the climatic value at the center of the mapped output
- **Transfer limit** — the transfer limit used in showing the extent of the mapped output

We caution users from selecting too many climate variables, particularly variables that are unrelated to adaptation. The use of many climate variables will probably result in overly conservative climate matches; the more climate variables that are included, the smaller the mapped areas will be. It is also best to avoid variables that are highly correlated with one another.

Step 7. Apply Constraints

The mapped output of the SST may be further constrained using geographic limits or a species range. Using constraints will exclude that part of the climatic output that is beyond the geographic limits imposed or beyond the current species range. The geographic constraints include latitude, longitude, elevation, distance, and photoperiod. The species range constraints are based on recent climate-niche models. There is also an option to import your own shapefile to use as a constraint.

Step 8. Map Your Results

Click `Run Tool` to produce a map that shows where you can find appropriate seedlots or planting sites for the locations specified in Step 2 and the climate of the time period specified in Step 4. The map shows the degree of match between the past climate to which a seedlot is adapted and the climate of the time period in which the trees are expected to be best adapted to the planting site. The darkest orange indicates the best match and the lightest orange indicates the match that is at the edge of the transfer limit. Note that using a greater transfer limit does not affect the best match but does result in a larger geographic area of suitability.

The process for determining the degree of match is, first, re-scaling the gridded data for each climate variable (or associated trait from a genecology function) as: `y = \frac{|x - xmid|}{TL}`, where xmid is the midpoint value, or climatic center. Second, the multivariate climatic distance (`d`) from the climatic center to each grid point is calculated as the Euclidean distance for `n` climate

variables: `dn = ({y_1}^2 + {y_2}^2 + ... + {y_n}^2)0.5`. Finally, the climate match (`m`) (also called a similarity index in Step 2) is calculated as `m = -(d-1)*100`. Values of `m < 0` are not mapped, whereas values between `0` and `100` are mapped using the color scale ranging from light to dark orange.

Note that the slider bar at the right side may be used to better see the map underlying the climatic match output.

If you have set up an account and are signed in, you can save your inputs by clicking on the `Save Last Run` button. You will be asked to provide a name for the saved run. Once saved, the saved run will show up in the `Saved Runs` window (see below).

You can also export your results to a PDF, PowerPoint, or GeoTIFF file by clicking on the `Export As⋯` button. Another option is to use `Print Scrn` on your keyboard to copy a picture of the screen that can be pasted into another file such as a PowerPoint presentation.

Layers

The **Layers** tab allows the user to map different overlays onto the results. Options include gray-scaled values for different climate variables, seed and breeding zone boundaries, U.S. Level III Ecoregion boundaries, and U.S. county boundaries. *(Under construction: some species ranges will be added as an option for layers.)*

Saved Runs

The **Saved Runs** tab will list each of your saved runs. Click on the name of the saved run to `Load` or `Delete` the inputs. Once a saved run is loaded, you can recreate the map by clicking on the `Run Tool` button in the Tool tab.

Account

Use the **Account** menu in the upper right corner of the web site to create or sign into an account. Use an email address and password to create an account. We will use this email address only if you lose your password. If you want to receive updates on the SST, sign up for our newsletter by clicking the `News & Updates` button in the menu.

Video Tutorial

The following video tutorial demonstrates how to use the Seedlot Selection Tool. The tutorial was developed for silviculturists working in the Pacific Northwest region. It's also applicable to any region in the US where trees are being planted to be resilient to future climate.

Watch the tutorial at https://youtu.be/HYuOTY8WgEc