



Nassella Tussock Population Dynamics Web Application User Guide

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Contents

Purpose of the app.....	2
How the app works	2
The science behind the app	2
Non-spatial simulations (within a block of land)	3
Spatial simulations (between adjacent blocks of land)	12
Acknowledgements.....	15
References	15

Purpose of the app

- To visualise a range of grubbing strategies for the management of nassella tussock on pastoral farms in Canterbury and other invaded regions of New Zealand.
- The **‘non-spatial’** simulation shows how the number of nassella plants on a block of land will change in future years under different grubbing scenarios (season, frequency, intensity).
- The **‘spatial’** simulation shows how adjacent nassella populations affect each other.
- Simulations are displayed as graphs and can be downloaded for separate analysis, or for later upload, display, and modification in the app.

How the app works

- The app uses a model that counts the number of nassella tussock plants twice per year (summer and winter). *It is best used on a computer rather than on a small-screen device.*
- The model identifies seven ‘life stages’ of nassella tussock and keeps track of their contributions to the total population as this grows or declines over successive years.

	Life stage	Symbol used in the app	Description	Visibility during grubbing
1	Seedbank (ephemeral)	SB1	Seeds in the soil less than a year	-
2	Seedbank (persistent)	SB2	Seeds in the soil more than a year	-
3	Immature	Imm	0 - 10 mm basal diameter	Non-visible
4	Very small	VS	10 - 20 mm basal diameter	Non-visible
5	Small	S	20 - 60 mm basal diameter	Visible
6	Medium	M	60 - 140 mm basal diameter	Visible
7	Large	L	Greater than 140 mm basal diameter	Visible



The science behind the app

- The population dynamics model deployed in the app, and its underpinning experiments, are described by Lamoureaux et al. (2011) and Lamoureaux et al. (2015). These papers are available for download from the About window of the app along with a ‘further information’ document describing how the spread of nassella tussock seeds between blocks of land is modelled in the app.

Non-spatial simulations (within a block of land)

On start-up, the [Non-spatial] window is displayed ⁽¹⁾. It has two tabs on the left, [Initiation] ⁽²⁾ and [Grubbing] ⁽³⁾ and a blank [Simulation] tab on the right where your simulation results will be displayed ⁽⁴⁾. In the example that follows we compare, step by step, three different grubbing scenarios to demonstrate how to use this 'non-spatial' function of the app.

Step 1: In the initiation tab, we will keep the default value of 19 visible plants per ha, the total number of plants in the population across all three visible life stages. All cells are pre-populated with default values representing a typical North Canterbury infestation. They can be changed to better reflect the modelled population and reset to their default values using [Reset All Inputs] ⁽⁵⁾.

Note: When changing the total [Initial visible plants per ha] from its default of 19, the numbers of seeds in the two seedbanks and numbers of individuals in the five plant size classes are scaled accordingly and updated in their respective input boxes. If you alter the number of plants in any of the seven individual life stages, the sum is calculated and used in the simulation although not updated in the [Initial visible plants per ha] box. For this example, we use the default values for the seven life stages; recommended unless data is available to justify a change.

Step 2: The default simulation period of 50 years is used in our example.

Step 3: Click on the Grubbing tab and set the first grubbing scenario to be [No Grubbing].

Step 4: To give this first scenario a name, overwrite the default name [Scenario 1] under 'Name your scenario' ⁽⁶⁾, with [No Grubbing].

Step 5: Now run the 'No Grubbing' simulation by clicking on [Add Scenario]. There are now two graphs displayed showing the 50-year trajectories of visible plants per ha (top graph) and the % of

ground covered by the population (bottom graph). By hovering over the graphs, a popup appears giving the numbers in each life stage, and % cover, at any point along the trajectory. The parameter values selected for the simulation are shown at the bottom under the [No Grubbing] tab ⁽⁷⁾.



Immediately below the bottom graph we can:

- Clear the graphs [Reset Predictions] ⁽⁸⁾
- Download the data [Download data] ⁽⁹⁾ and then save the file for later analysis outside the app or for later upload, display, and modification in the app.
- Browse [Browse....] ⁽¹⁰⁾ to select a previously saved set of simulations for redisplay/modification within the app.

Note: The 'Name your scenario' box ⁽⁶⁾ is now populated with [Scenario 2], in preparation for specifying and running a second scenario. The second scenario we will add for comparison will be grubbing every year in spring (Steps 6 - 10 below).

Step 6: Under [Grubbing frequency] on the Grubbing tab, select [Every year].

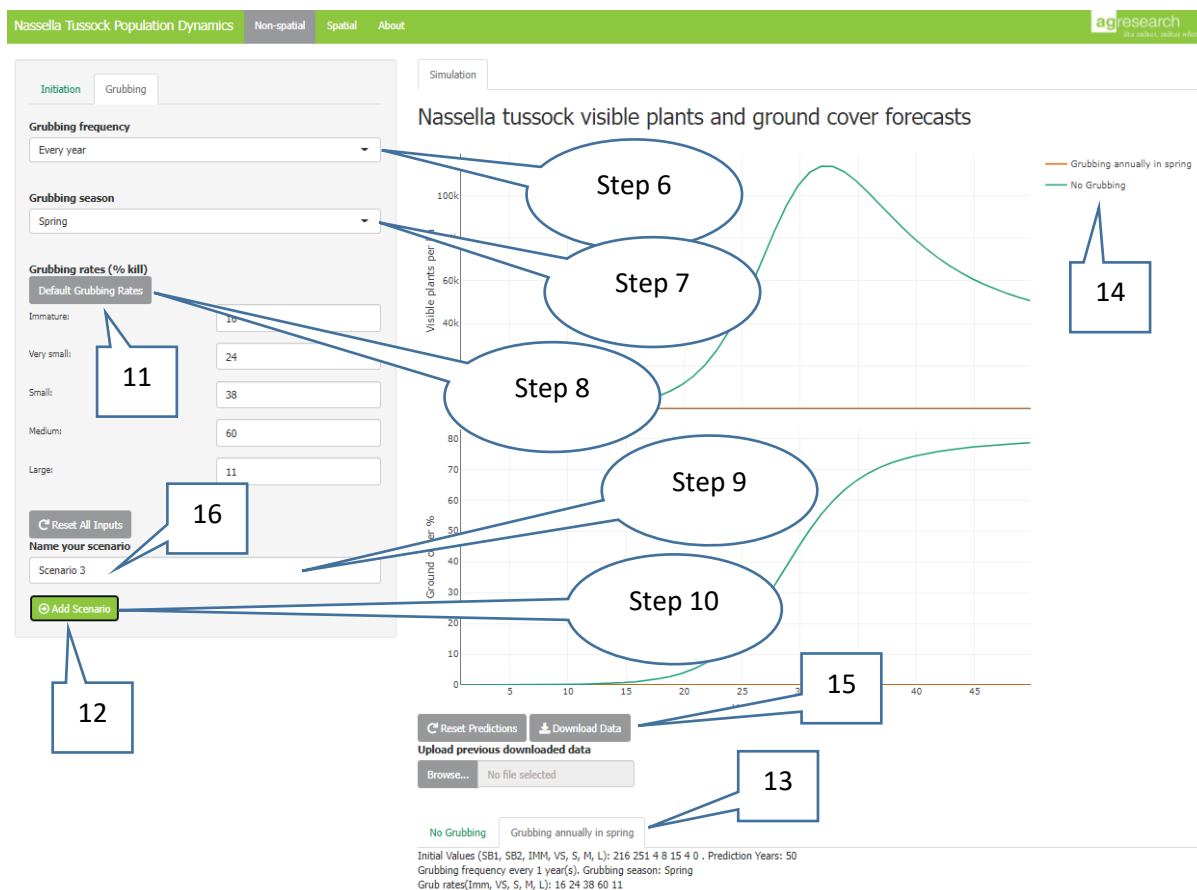
Step 7: Under [Grubbing season] on the Grubbing tab, select [Spring].

Step 8: Under 'Grubbing rates (% kill)', select the default rates [Default Grubbing Rates] ⁽¹¹⁾.

Note: These are average rates for the Hurunui district and can be changed to better reflect the effectiveness of grubbing in the population being simulated, or to test hypotheses regarding how the effectiveness of grubbing influences the trajectories of plants per ha and ground cover.

Step 9: Under 'Name your scenario', overwrite the default name [Scenario 2] with [Grubbing annually in spring].

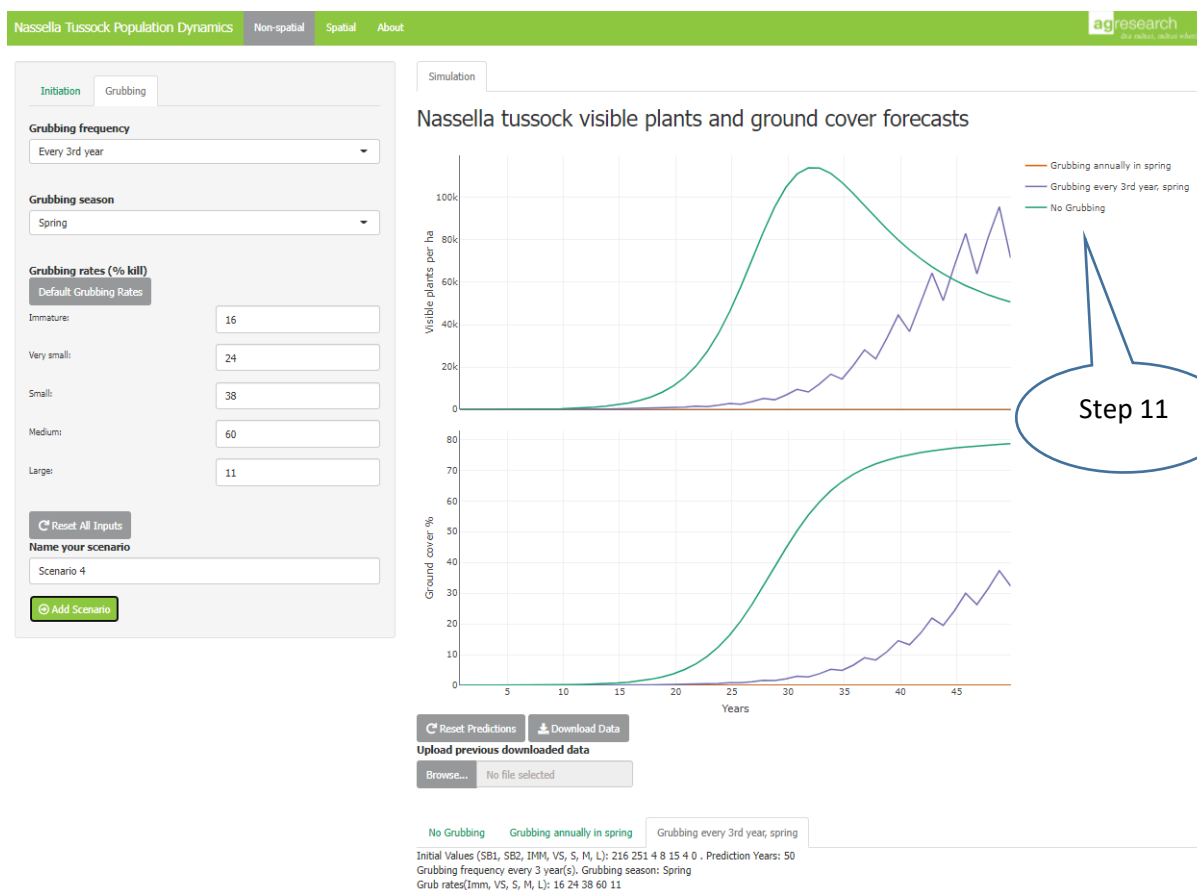
Step 10: Run this second scenario by clicking on [Add Scenario] ⁽¹²⁾.



Note:

- Two graphs are displayed as before, but there are now two trajectories in each, one for each of the two scenarios, 'No Grubbing' and 'Grubbing annually in spring'.
- The parameter values for the newly added scenario are shown at the bottom under the [Grubbing annually in spring] tab ⁽¹³⁾.
- There is now a legend for the two simulations in the top right-hand part of the top graph ⁽¹⁴⁾.
- The downloaded file [Download data] ⁽¹⁵⁾ would contain the data generated for both simulations.
- The 'Name your scenario' box is now populated with [Scenario 3] ⁽¹⁶⁾ in preparation for specifying and running a third scenario.

The third scenario, we will add for comparison, is grubbing every third year in spring. The steps to run this scenario are the same as Steps 6 – 10 above.



The two graphs now each contain three trajectories, one for each of the three scenarios.

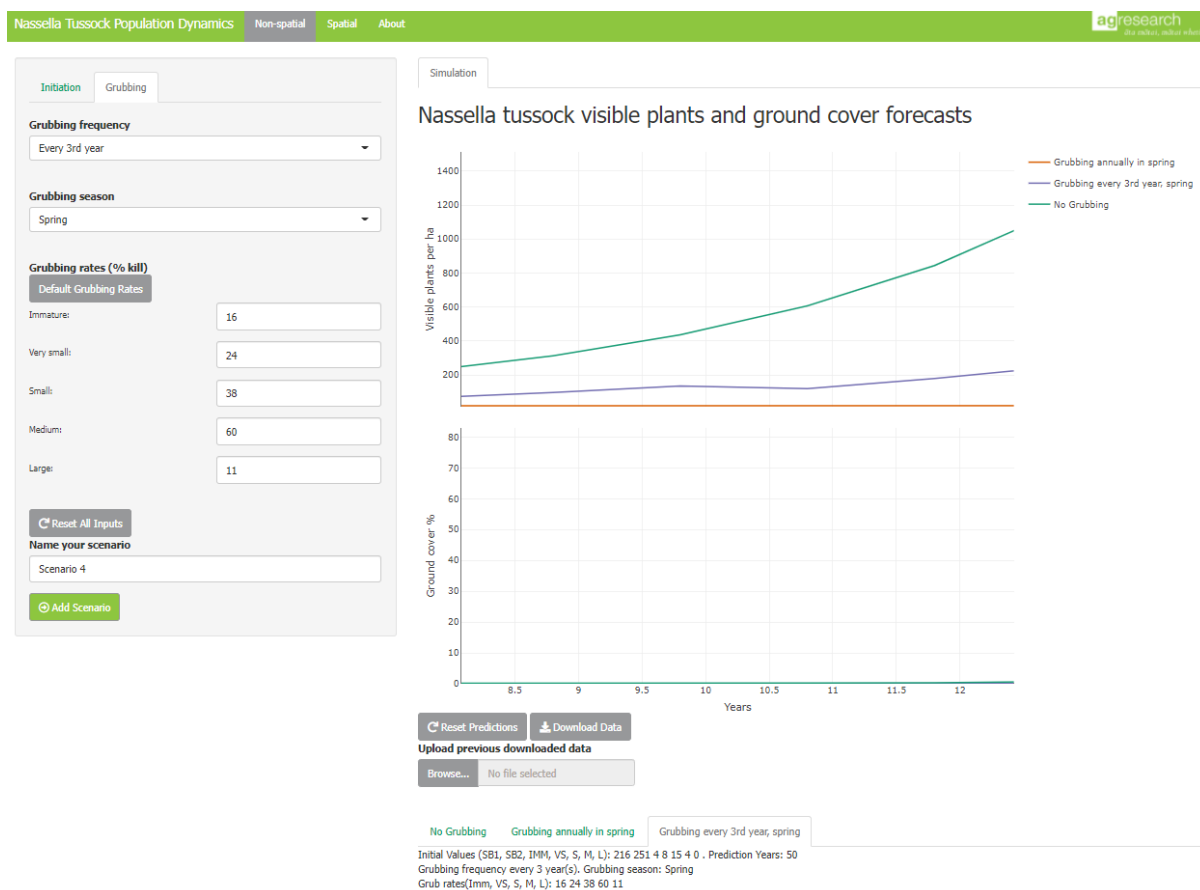
Step 11: In the legend in the top right-hand part of the top graph, any of the three scenarios can be toggled on/off by clicking on the scenario name. This can be a useful way to reveal more detail in trajectories of relatively effective scenarios such as our 'Grubbing every year in spring'.

Step 12: By hovering over the legend, ten additional options for drilling down into the scenarios are available. They are selectable by clicking on the icon.



Looking at the list of options from left to right, we can:

- Download the plot as a *.png file ⁽¹⁷⁾
- Zoom into on any part of the graphs (example below zoomed in to first 12 years) ⁽¹⁸⁾
- Pan around ⁽¹⁹⁾
- Zoom in ⁽²⁰⁾
- Zoom out ⁽²¹⁾
- Autoscale ⁽²²⁾
- Reset the axes to their original scales ⁽²³⁾
- Add axis spike lines for easier reading of forecasted values (example below) ⁽²⁴⁾
- Show data for one scenario whilst hovering over its trajectory (example below) ⁽²⁵⁾
- Compare data between scenarios whilst hovering over a trajectory (example below) ⁽²⁶⁾



Zoomed in to the period from year 8 to year 12 ⁽¹⁸⁾.



Axis line spikes added at 25 years ⁽²⁴⁾ and the box showing the forecasted number of individuals in each life stage and % ground covered. The example shown is for the 'No grubbing' scenario.



The forecasted number of individuals in each life stage and % ground covered at year 25 without the axis line spikes. The example shown is for the 'No grubbing' scenario ⁽²⁵⁾.



Comparing between all three scenarios at 27 years ⁽²⁶⁾.

Spatial simulations (between adjacent blocks of land)

The Spatial window ⁽²⁷⁾, where the effects of nassella populations and their respective management on an adjacent block of land can be simulated, has two tabs on the left, [Initiation] ⁽²⁸⁾ and [Grubbing] ⁽²⁹⁾, where settings are made, and two tabs on the right [Visible plants & ground cover] ⁽³⁰⁾ and [Changes in plants grubbed & seed bank] ⁽³¹⁾ where simulation results will be displayed. The [Visible plants & ground cover] tab ⁽³⁰⁾ will be displayed when the Spatial window is first opened.

The screenshot shows the 'Spatial' window of the 'Nassella Tussock Population Dynamics' application. The 'Grubbing' tab is selected, showing configuration options for two adjacent blocks of land. The settings are as follows:

Parameter	Block 1	Block 2
Initial visible plants per ha	19	19
Seed dispersal to other block (%)	6.7	6.7
Simulation period (years)	50	

Three steps are highlighted with callouts:

- Step 1:** Points to the 'Initial visible plants per ha' input fields for Block 1 and Block 2.
- Step 2:** Points to the 'Seed dispersal to other block (%)' input fields for Block 1 and Block 2.
- Step 3:** Points to the 'Simulation period (years)' input field.

In the example below, two blocks of land (Block 1 and Block 2) are compared. They have different initial densities of nassella tussock and are implementing different grubbing programmes.

Under the [Initiation] tab ⁽²⁸⁾:

Step 1: Use the default setting, 19, for 'Initial visible plants per ha' for Block 1 and set Block 2 to 200.

Step 2: Use the default setting for 'Seed dispersal to other block (%)' of 6.7 for both blocks. This assumes each block disperses the same % of its seeds to other block; in our example this will mean more seeds disperse from Block 2 to Block 1 than from Block 1 to Block 2 because of the greater population of plants in Block 2.

Note: Changes to this parameter can be used to simulate differential dispersal between blocks, e.g., due to wind, topography etc.

Step 3: Use the default setting of 50 years for the 'Simulation period (years)'.

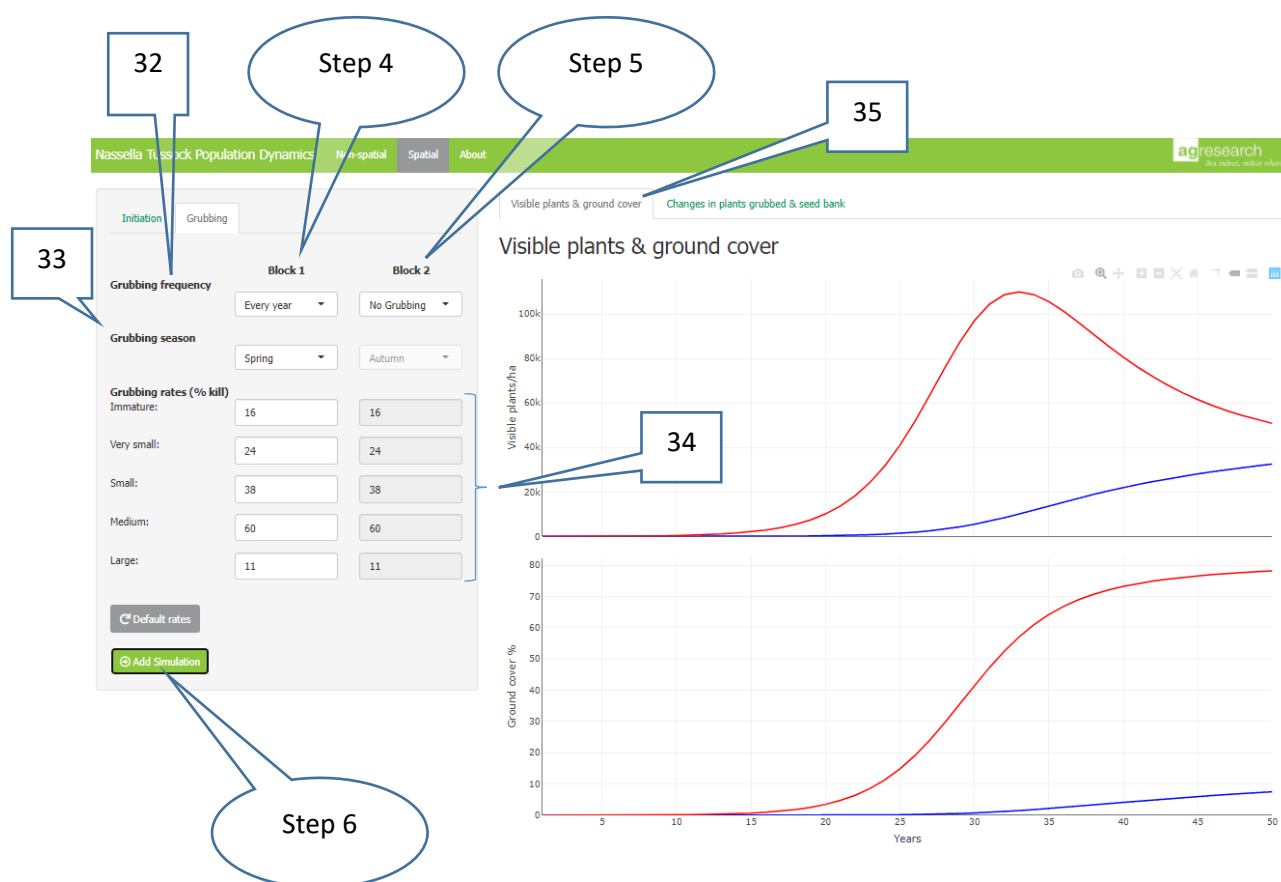
Under the [Grubbing] tab ⁽²⁹⁾:

Step 4: For Block 1, set 'Grubbing frequency' ⁽³²⁾ to [Every year], 'Grubbing season' ⁽³³⁾ to [Spring] and retain the default settings under 'Grubbing rates (%kill)' ⁽³⁴⁾.

Step 5: For Block 2, set 'Grubbing frequency' to [No Grubbing] ⁽³²⁾. Note that 'Grubbing season' ⁽³³⁾ and 'Grubbing rates (%kill)' ⁽³⁴⁾ will be greyed out and unable to be adjusted.

Step 6: Run the simulation by clicking on [Add Scenario].

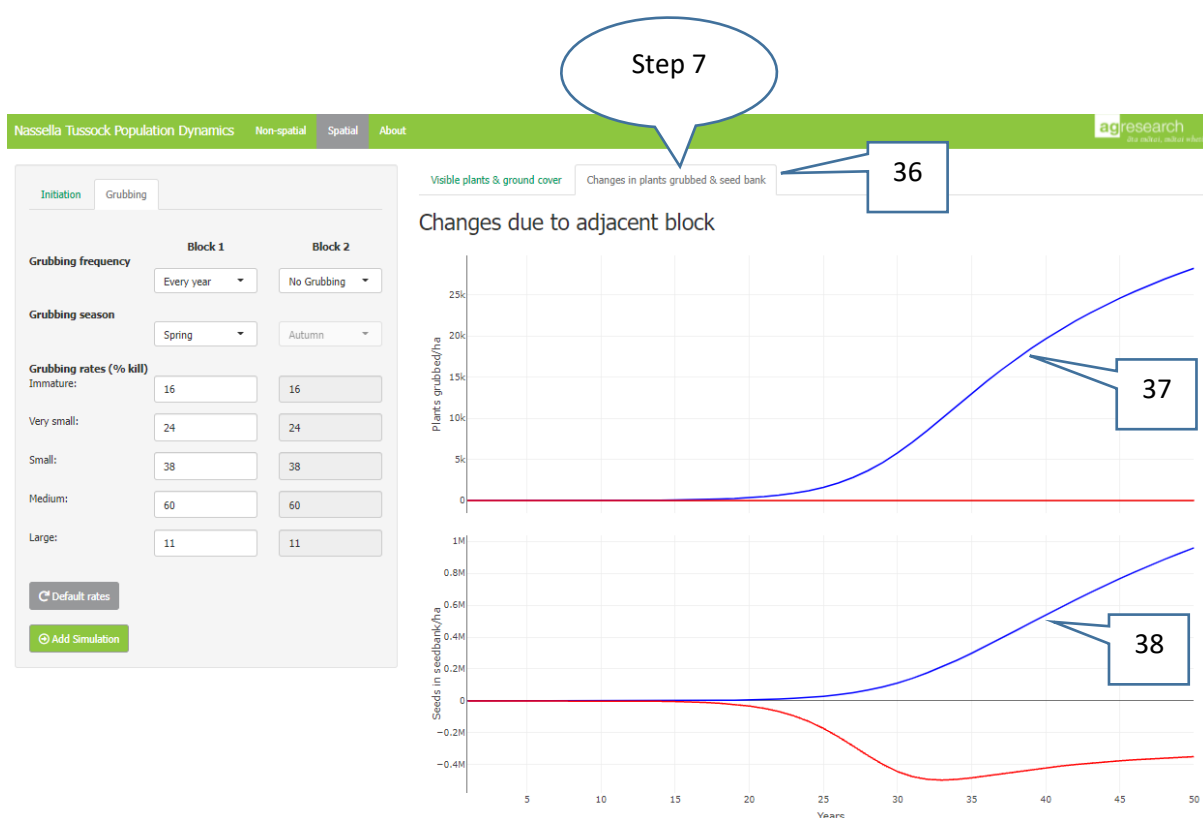
The first set of results are displayed in the [Visible plants & ground cover] window ⁽³⁵⁾; the blue line is Block 1 and the red is Block 2. The graphs can be examined in detail by hovering over the trajectories as described above.



Step 7: Click on the [Changes in plants grubbed & seed bank] tab ⁽³⁶⁾ to view graphs showing the changes in nassella plants grubbed per ha ⁽³⁷⁾ and changes in the number of seeds in the soil (bottom graph) ⁽³⁸⁾ in Block 1 due to Block 2 (blue line), and Block 2 due to Block 1 (red line).

In this example we see that number of nassella plants grubbed per ha in Block 1 (blue line) ⁽³⁷⁾ increases over time. This is due to the immigration of seeds from Block 2 outweighing the emigration of seeds from Block 1 resulting in more plants in Block 1 than otherwise would be the case. In addition, the gain in plants in Block 1 results in more seeds in its soil seed bank (blue line) ⁽³⁸⁾.

There are no changes in grubbed plants in Block 2 because there is no grubbing in this Block (red line) ⁽³⁷⁾. But there is a reduction over time in the number of seeds in the soil seedbank of Block 2 (red line) ⁽³⁸⁾ because Block 2 exports more seeds to Block 1 than it imports from Block 1.



Acknowledgements

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References

- Lamoureaux SL, Bourdôt GW, Saville DJ 2011. Population growth of *Nassella trichotoma* in grasslands in New Zealand slower today than in the past. *Acta Oecologica* 37: 484-494.
- Lamoureaux SL, Basse B, Bourdôt GW, Saville DJ 2015. Comparison of management strategies for controlling *Nassella trichotoma* in modified tussock grasslands in New Zealand; a spatial and economic analysis. *Weed Research* 55: 449-460.