

Wolf Virtual Expansion Simulator



v1.0 – *Quick User Manual*

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1. Software information, download and installation

Wolf Virtual Expansion Simulator (WolVES) is a software created by Mariano Rodríguez Recio and Alexander Singer to simulate the expansion of wolf territories in the Scandinavian Peninsula as detailed in the publication by Recio et al. (2020) in *Biological Conservation: "Agent-based models predict patterns and identify constraints of large-carnivore recolonizations, a case study of wolves in Scandinavia"*.

A fully operational version 1.0 of WolVES can be downloaded from wolves.marianorecio.com. A downloaded zip file contains this user manual and an installer WolVES_v1.0.exe that enables the local installation of WolVES without installing NetLogo. This self-contained version is only available for Windows operating systems and an installed Java Platform higher than JDK v1.6 is required. An updated version of a Java Platform can be downloaded from here:

<https://www.oracle.com/technetwork/es/java/javase/downloads/index.html>

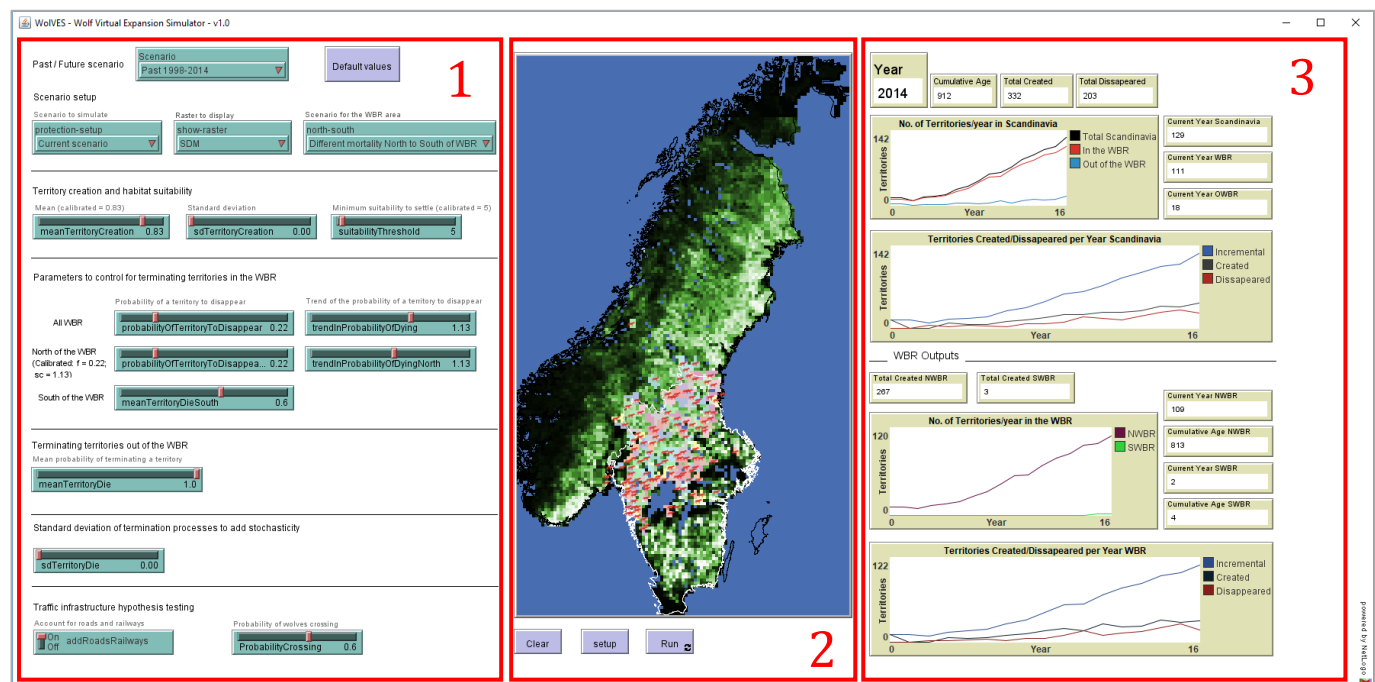
Once WolVES is downloaded, execute the file and follow the installation instructions, choose the installation folder if other than the default is preferred, and complete the installation. To uninstall WolVES, open the Add/Remove programs section in the Control Panel and uninstall "WolVES version 1.0" and then delete the installation folder to ensure full removal of the software.

Happy simulations!

2. WolVES - Interface overview



After installing WolVES, the icon to the left appears in your desktop to open the application. Once you open WolVES, the supported Java interface below displays the different options to run the expansion simulations.



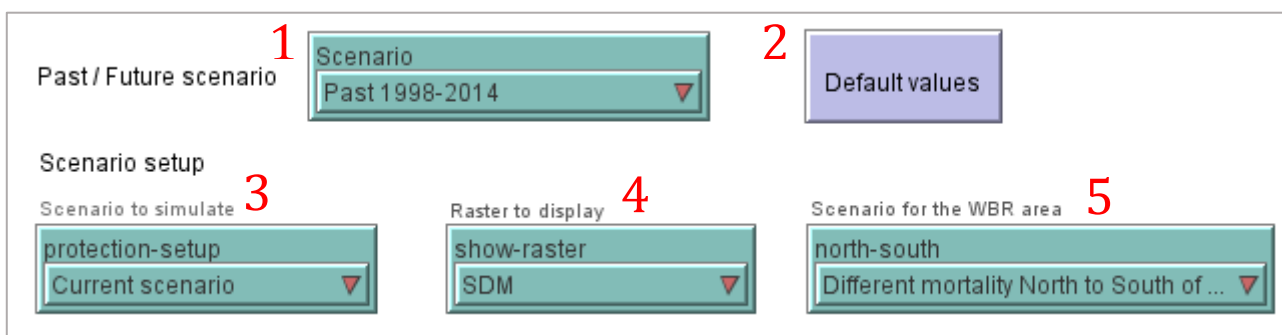
Three main modules complete WOLVES interface:

- 1 – Simulation input options.
- 2 – Setup and running options as well as the visualization of the executed simulation.
- 3 – Simulation outputs.

3. Input options

1.1. Scenario setup

On top of module 1, the following controls allow you to configure the setup of the scenario, map visualization and the possibility to return to the default values of the parameters selected in these controls.

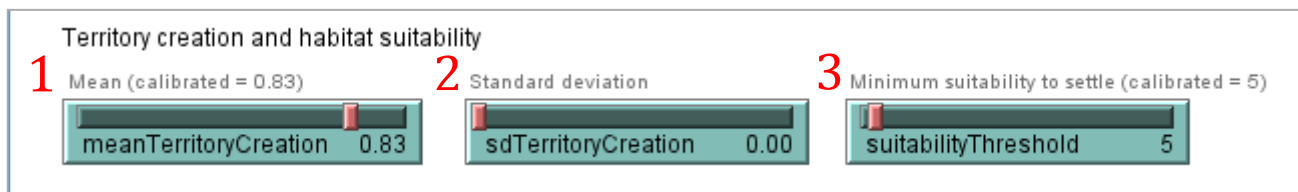


- Description:

- 1 – Combo box for running simulations on the past (1998-2014) or future (2014-2030) scenarios of wolf recolonization in the Scandinavian Peninsula.
- 2 – Button to establish the default selection of the control and parameter values in Module 1. By clicking this button, you will set up the parameter values used to calibrate the model to reproduce the observed scenario of wolf recolonization in the period 1998-2014.
- 3 – This combo allows to apply the differential scenario on wolf management applied in the Scandinavian Peninsula (“**current scenario**” option) as described in Recio et al. (2019, 2020) or the hypothetical scenario of equal management actions applied all over the peninsula (“**Reproduction area scenario applies to all Scandinavia**” option).
- 4 – Combo box to select the map to visualize along with the simulation. You can select “**SDM**” to visualize the species distribution model on wolves in Scandinavia (Recio et al. 2019), “**Roe deer density**” to visualize the density of roe deer (*Capreolus capreolus*) all over the peninsula, “**Road/Railways**” to visualize the combined presence in each pixel map of main roads and railways, and “**None**” if no background visualization is required.
- 5 – Combo box to select different mortality of wolves to the north of the wolf breeding range (WBR) and thus, of territory termination (“**Different mortality North to South of the WBR**” option), or equal mortality all over the WBR (“**Equal mortality estimators in WBR**” option). This option allows for the virtual experiments conducted in Recio et al. (2020) to calibrate the model on the observed patterns of wolf recolonization and their extrapolations to the future.

1.2. Parameters on territory creation

The following controls allow you to configure the rates of territory creation, which depends on the pressure caused by culling and poaching activities. Less mortality caused by culling and poaching means increased rates in the creation of new territories.



- Description:

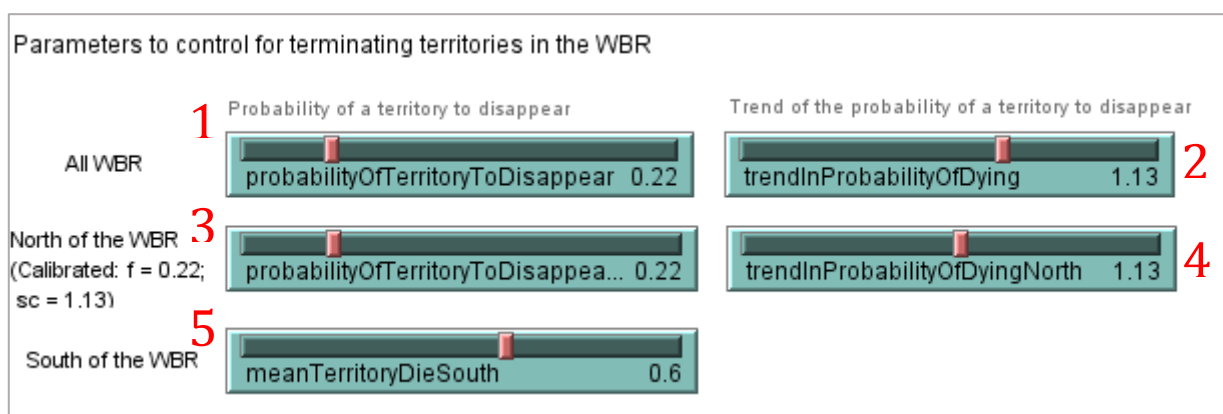
1 – Selectable values of the mean territory creation for the entire Scandinavia. The observed mean territory creation quantified empirically in Recio et al. (2020) is 0.83, which corresponds with the calibrated value.

2 – Selectable values of the standard deviation of the mean territory creation for the entire Scandinavia to add stochasticity.

3 – Selectable threshold to establish the minimum suitability value (between 0 and 100% suitable) required by wolves to settle new territories. For a generalist animal like the wolf, the suitability that best reproduced the observed recolonization of wolves was 5 (calibrated value).

1.3. Parameters on territory termination within the wolf breeding range (WBR)

A set of controls allow you to configure the parameters of the empirically identified distributions ruling the termination and disappearance of wolf territories in the wolf breeding range (WBR). Territory termination in the WBR can be configured to apply under the same probabilities to the entire WBR, or independently to the north and south of the WBR. Discriminating the probability of territory termination allows for simulating the observed and future recolonization of wolves to the north of the lake Vättern (in Sweden) as geographic reference for the different observed expansion of wolves to the northern and southern parts of the WBR to this lake.



- Description:

1 & 2 – These controls determine the value of the probability and the trend of territory to disappear in the empirically identified Weibull distribution ruling the territory termination in the north of the

WBR. However, when configuring parameters 1 and 2, the probability and trend apply to the entire WBR under the assumption wolf territory termination is equal to the north and south of the WBR.

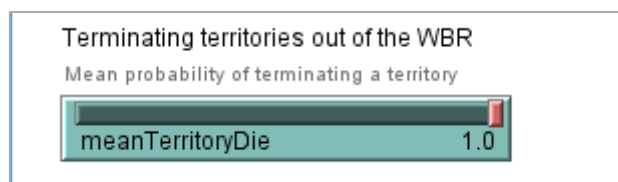
3 & 4 – These controls determine the same parameters than 1 and 2 but applied only to the north of the WBR, assuming that, as empirically observed, the termination rate is different to the north and south of the WBR. By leaving out the south of the WBR make hypothesis testing independent from the model calibration (Recio et al., 2020).

5 – A normal distribution applies to the value of the mean territory disappearance to the south of the WBR.

By clicking on the “Default settings” button described in subsection 2.1 (label 2), all the parameter values above are re-established to the default calibrated values.

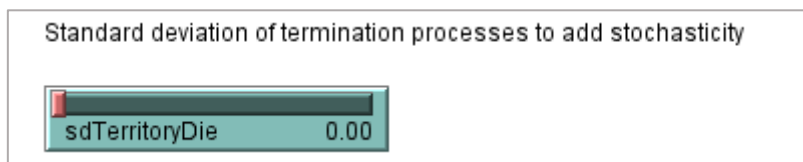
1.4. The parameter on territory termination out of the WBR

This parameter sets up the probability of a territory to terminate outside of the WBR. Because out of the WBR wolves are rapidly killed (Recio et al., 2018, 2020), the default probability selected is 1.



1.5. Adding stochasticity to the territory termination processes

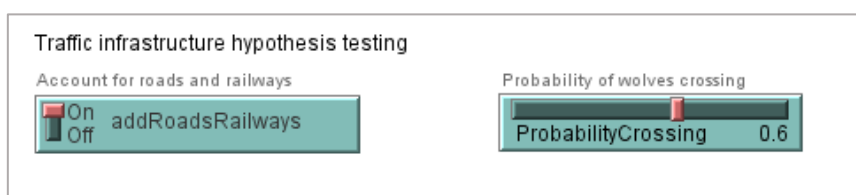
A control to select a value of the standard deviation of the mean territory disappearance in Scandinavia allows you to add stochasticity to this process.



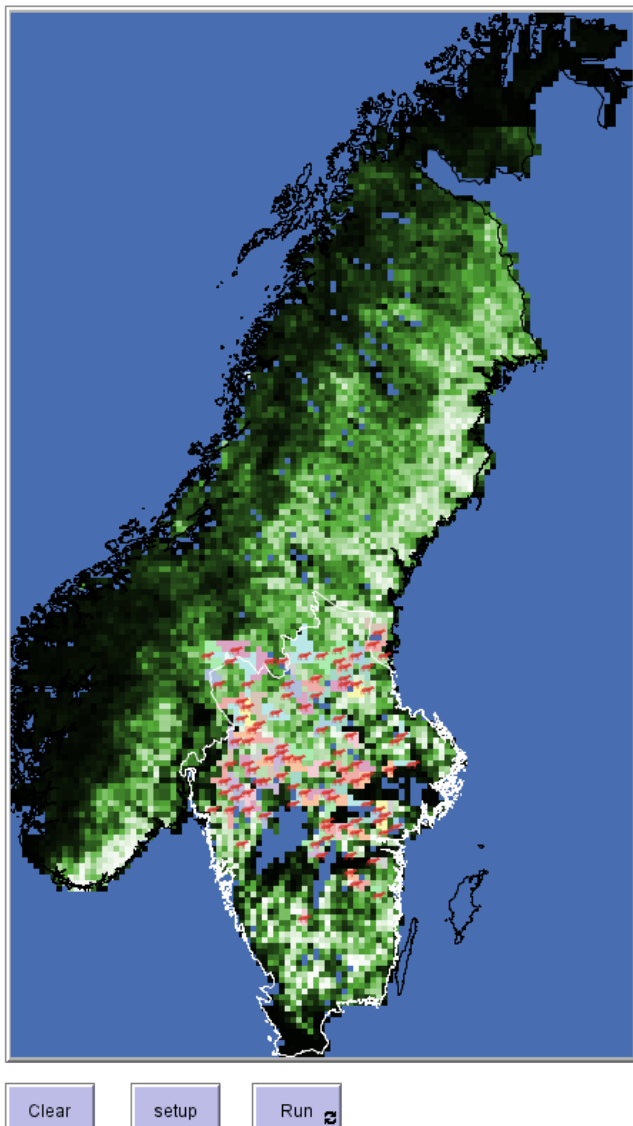
The default value for this control is 0.

1.6. Traffic infrastructure parameters

Two controls are added here to account for main roads and railways (switcher to the left) in the recolonization process and to establish the value of the probability of crossing (slider to the right). The default value is to account for traffic infrastructures (“on” position in the switcher). The calibrated value for the probability of wolves crossing traffic infrastructure is 0.6, which is the default value of the slider. As for the rest of controls, by clicking the button “Default values” described in section 2.1 label 2, the configuration is restored to the default values.



4. Setup and running



- Description:

The setup and running module 2 contains a panel for visualizing an executed simulation added to three buttons below.

- “Clear” button: Resets and cleans previous simulations from the memory and the visualization panel.

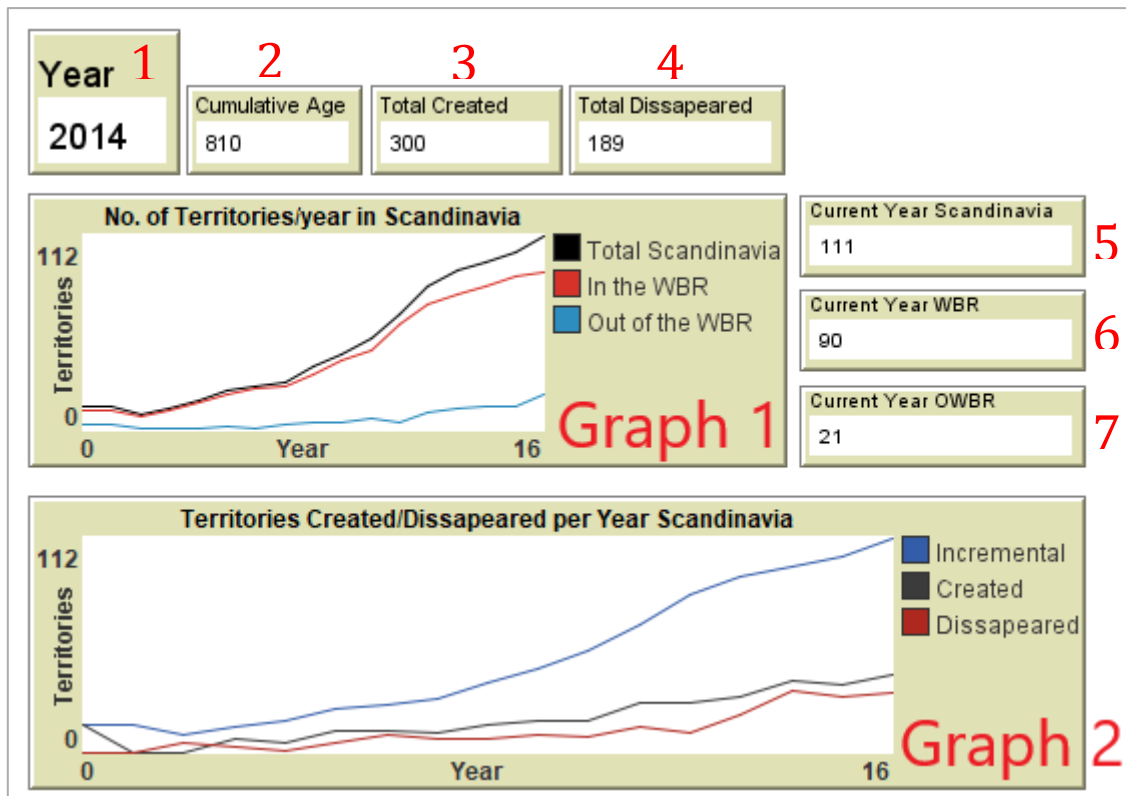
- “Setup” button: Loads the simulation according to the parameters configured in module 1 and ready to be executed.

- “Run” button: Executes the simulation until its completion.

5. Simulation outputs

4.1. Simulation outputs for the Scandinavian Peninsula

Module 3 reports all the simulation outputs. The panels below placed on the top-part of module 3 display information involving the entire Scandinavia.



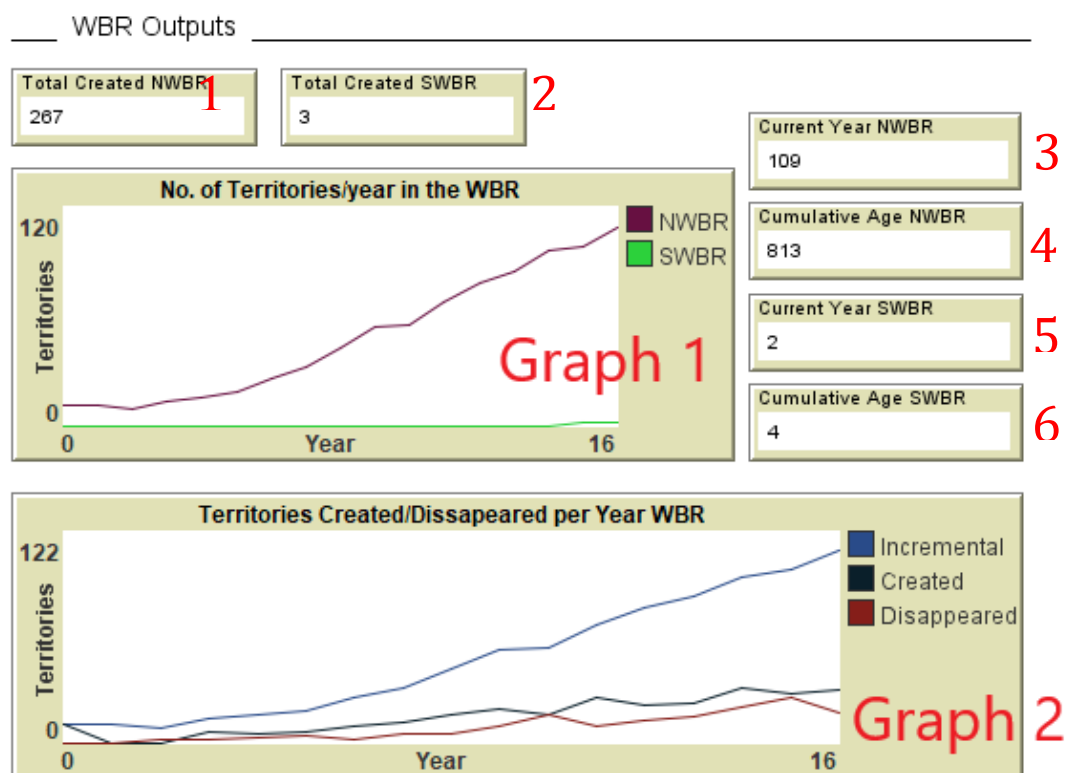
- Description:

- 1** – “Year” displays the current year lap in the executing simulation.
- 2** – “Cumulative Age” indicates the addition of the age of all the territories created during the simulation.
- 3** – “Total Created” shows the total number of territories created in the Scandinavian Peninsula during the simulation.
- 4** – “Total Disappeared” reports the total number of territories terminated during the simulation in the Scandinavian Peninsula.
- 5** – “Current Year Scandinavia” is the total number of territories existing in the Scandinavian Peninsula in each year lap of the simulation.
- 6** – “Current Year WBR” is the total number of territories existing in the WBR in each year lap of the simulation.
- 7** – “Current Year WBR” is the total number of territories existing outside of the WBR (OWBR) in each year lap of the simulation.
- Graph 1** – This graph displays the cumulative number of territories created in the entire Scandinavian Peninsula, the WBR, and OWBR.
- Graph 2** – This graph reports three trends on wolf territories in the entire Scandinavia. The blue trend line shows the incremental number of territories created during the simulation. The black line

reports the number of territories created per year. The red line shows the number of territories that disappear per year.

4.2. Simulation outputs for the wolf breeding range (WBR)

The panels below placed on the low part of module 3 display specific information concerning the WBR.



- Description:

1 – “Total Created NWBR” displays the total number of territories created in the north of the WBR (NWBR) during the simulation. The north of the WBR involves the part of the WBR located to the north of the most southern shore of lake Vättern as described in Recio et al. (2020).

2 – “Total Created SWBR” displays the total number of territories created in the south of the WBR (SWBR) during the simulation. The south of the WBR involves the part of the WBR located to the south of the most southern shore of lake Vättern as described in Recio et al. (2020).

3 – “Current Year NWBR” shows the total number of territories existing in the NWBR at each year step of the simulation.

4 – “Cumulative Age NWBR” reports the addition of the age of the territories during the simulation in the NWBR.

5 – “Current Year SWBR” shows the total number of territories existing in the SWBR at each year step of the simulation.

6 – “Cumulative Age SWBR” reports the addition of the age of the territories during the simulation in the SWBR.

Graph 3 – This graph displays the number of territories created each year in the NWBR and SWBR, respectively.

Graph 4 – This graph reports three trends on wolf territories in the entire WBR. The blue trend line shows the incremental number of territories created during the simulation. The black line reports the number of territories created per year. The red line shows the number of territories that disappear per year.

REFERENCES

- Recio, M.R., Singer, A., Wabakken, P., Sand, H., 2020. Agent-based models predict patterns and identify constraints of large-carnivore recolonizations, a case study of wolves in Scandinavia. *Biological Conservation*.
- Recio, M.R., Zimmermann, B., Wikenros, C., Zetterberg, A., Wabakken, P., Sand, H., 2018. Integrated spatially-explicit models predict pervasive risks to recolonizing wolves in Scandinavia from human-driven mortality. *Biological Conservation* 226, 111–119. <https://doi.org/10.1016/j.biocon.2018.07.025>