Model Parameter Estimation

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1 Introduction

The correct SPOM parametrization is one of the most crucial steps of every simulation procedure allowed by the package. The parameters are the numeric translation of the relation of the species with the landscape. Although this is not the main focus of this package, MetaLandSim offers some basic tools that will help to estimate the parameters to run the simulations. However, the user can have the parameters values available from other sources (whether published papers or estimated with other software tools) in each case the simulations can be run using those parameters. For a good overview of the several methods to parametrize the SPOM see Etienne et al. (2004). Most of the methods described can be implemented with MetaLandSim. Also, it is recommended that the user reads the book by Hanski (1999) in order to acquire the basic knowledge about metapopulation ecology and the first estimation procedures. The function parameter.estimate is the package tool to parametrize the spom function. This vignette clarifies the options available and gives a step-by-step guide of the function usage. The current version of the package does not executes all computations. Rather, some of the methods ((’MCsim’,’rescue’and ’norescue’) create the files needed as input to two applications provided by Moilanen (1999) (MCsim) and ter Braak and Etienne (2003) ((’rescue’ and ’norescue’). Future versions of the package should incorporate these procedures in the R code. The objective of this vignette is to describe the parametrization procedures, allowing the user to produce robust estimates of the parameters in order to proceed with the landscape simulation process or with the range expansion simulation. Third vignette is run with made up data based upon real information.

2 Which method to choose

Currently, the following methods are available:

- *Rsnap_1* - Regression of snapshot data, using one snapshot (based on Oksanen, 2004).

- *Rsnap_x* - Regression of snapshot data, using more than one snapshot (based on Oksanen, 2004).
- *MCsim* - Monte Carlo simulation (Moilanen, 1999).
- *norescue* - Bayesian MCMC, not considering Rescue effect (ter Braak and Etienne, 2003).
- *rescue* - Bayesian MCMC, considering Rescue effect (ter Braak and Etienne, 2003).

Amongst the five methods allowed by MetaLandSim, the choice is facilitated by a careful consideration of the characteristics of each method and the dataset (such as number of snapshots). An examination of each method's advantages and drawbacks is available in Etienne et al. (2004). The methods 'rescue' and 'norescue' are computed using the application provided by ter Braak, and Etienne (2003) and the method 'MCsim' is computed using the application provided with Moilanen (1999). 'Rsnap_1' and 'Rsnap_x' are computed using the R code based on Oksanen (2004). Using the function parameter.estimate, the first three methods only create the needed files to run the applications. Next the user can use the function create.parameter.df to create a data frame with the estimated parameters. The application of Moilanen (1999) allows the estimation of the following parameters: x, y, e, A0, e' and alpha. The application by ter Braak and Etienne (2003) allow the estimation of the following parameters: e, x, y, z, alpha and b. Future versions of the package should include the virtual migration model (Hanski et al. 2000), allowing the estimation of b (which scales patch areas to population size and emigration rates) and c (here c1, which scales immigration with patch area).

3 Work-flow

3.1 Regression on Snapshot Data - method Rsnap_1 or Rsnap_x

This is the simplest approach; it runs faster but provides the least reliable estimates of the parameters. It does not use turnover, only spatial structure and occupancy status.

```
> library(MetaLandSim)
> data(occ.landscape)
> data(occ.landscape2)
> #Using data with only one snapshot of the occupancy status
> param1 <- parameter.estimate (occ.landscape, method='Rsnap_1')
> param1
```

```
       par_output
alpha 0.008333333
```

```
x     0.256707865
y     0.016724074
e     0.211572786
```

```
> #Using data with more than one snapshot of the occupancy status
> param2 <- parameter.estimate (occ.landscape2, method='Rsnap_x', nsnap=10)
> param2
```

```
        par_output
alpha  0.008333333
x     -0.172333542
y      0.021030749
e      0.742599240
```

3.2 Monte Carlo Simulation - method MCsim

This approach is more time-consuming (depending on computing power). This option calls for the functions on the paper by Moilanen (1999). Here, create.parameter.df only creates the files to be used as input to the application. The user should read the paper thoughtfully, as well as the available help files. A file with the settings (inputMCsim.set) and a file with the data (inputMCsim.dat) will be created into the working directory. Editions to the settings file will be needed in order to run the application using the three step procedure described in the readme.txt file. First run the application using Nlr, then using Bnlr and finally using mc (between each step the setting file should be edited to change the method). After running Nlr and Bnlr replace, in the settings file, 'edit x', 'edit y' and 'edit e' with those values (these are the priors to the simulation). The application and help files can be downloaded from the Ecological Archives, available (here).

```
> library(MetaLandSim)
> data(occ.landscape2)
> #First, generate the files to be the input of the application
> parameter.estimate (occ.landscape2, method='MCsim')
> #run the application mcm.exe from Moilanen (1999).
> #Previously read the readme.txt file #available with the
> #application.
> #Consider particularly the three step procedure for estimation,
> #using nonlinear regression (Hanski, 1994) to produce priors
> #for the Monte Carlo simulation). In the command line (first put
> #the application and the files in a folder with no spaces in the name.
> #e.g.: 'C:/moilanen/'):
>
> #mce.exe inputMCsim.dat inputMCsim
>
> #Or, from R:
>
```

```
> system('mce.exe inputMCsim.dat inputMCsim')
> #After, create a data frame, with create.parameter.df,
> #using the estimated parameters:
> param3 <- create.parameter.df(alpha, x, y, e)
>
```

3.3 Bayesian MCMC - methods 'rescue' and 'norescue'

This is the approach developed in the paper by ter Braak et al. (2003). The parameter.estimate function only produces the files needed to be used as input in this application. It produces a dataset file (input_rescue.dat or input_norescue.dat), a parameter file (input_rescue.par or input_norescue.par) and a distance file (input_rescue.dis or input_norescue.dis). Then, by using create.parameter.df, a data frame can be created with the parameters computed with the application. To understand what the created files contain, and to understand the method the user should read the paper by ter Braak et al. (2003) as well as the help files available with the application. Editions to the parameters file will be needed in order to run the application. It is recommended to run one of the simplest methods to provide priors to the Bayesian MCMC simulation. Then, in the parameter file, replace 'edit x', 'edit y' and 'edit e' with those values. Be attentive to the fact that the output is given log-transformed. Before using the parameters in the simulation procedure they need to be back-transformed, using an exponential. This application, the source code, help files and sample data can be downloaded from the Ecological Archives, available (here).

```
> library(MetaLandSim)
> data(occ.landscape2)
> #Method 'rescue'
> parameter.estimate (occ.landscape2, method='rescue')
> #run the application file fmetapop_rescue.exe from
> #the command line (first put the application and the
> #files in a folder with no spaces in the name.
> #e.g.: 'C:/terbraak/'):
>
> #fmetapop_rescue input_rescue
>
> #Or, from R:
>
> system('fmetapop_rescue input_rescue')
> #After, create a data frame, with create.parameter.df,
> #using the estimated parameters:
> #param4 <- create.parameter.df(alpha, x, y, e)
>
> #Method 'norescue'
> parameter.estimate (occ.landscape2, method='norescue')
> #run the application file fmetapop_norescue.exe from
> #the command line (first put the application and the
> #files in a folder with no spaces in the name.
> #e.g.: 'C:/terbraak/'):
>
> #fmetapop_norescue input_norescue
>
> #Or, from R:
>
> system('fmetapop_norescue input_norescue')
> #After, create a data frame, with create.parameter.df,
> #using the estimated parameters:
>
> param5 <- create.parameter.df(alpha, x, y, e)
>
```

4 References

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2. Hanski, I. (1994). A practical model of metapopulation dynamics. Journal of Animal Ecology, 63: 151-162.

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4. Hanski, I. (1999). Metapopulation Ecology. Oxford University Press. 313 pp.

5. Moilanen, A. (1999). Patch occupancy models of metapopulation dynamics: efficient parameter estimation using implicit statistical inference. Ecology, 80(3): 1031-1043.

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7. Ter Braak, C. J., and Etienne, R. S. (2003). Improved Bayesian analysis of metapopulation data with an application to a tree frog metapopulation. Ecology, 84(1): 231-241.