BiTZ – Biodiversity in transition zones

# Purpose and patterns

The model’s specific purpose(s). • The patterns used as criteria for evaluating the model’s suitability for its purpose

* Wild bees are at thread in an agricultural landscape
* Prediction of impacts of TZ
* To analyse the impact and importance of flowering strips, e.g. areas with an increased nesting and resource pool, for bee diversity, we developed a meta community model.
* The model can be adapted to other species in agricultural landscapes
* Patterns? Use qualitative but testable patterns

# Entities, state variables and scales

* Spatial units: landscape consisting of cells; populations of different functional types
* Dynamic or static variables; type; range
* Spatial and temporal scale

Table 1: Parameters and state variables within BiTZ.

|  |  |  |  |
| --- | --- | --- | --- |
| Entity | Parameter | Description | Units |
| Environment | NameFtFile | Txt file with the definition of the functional types; including all trait parameters |  |
| NameLandscapePatchFile | Grid file of the underlying landscape with single patch IDs |  |
| NamePatchDefFile | Txt file with the definition of each single patch; including different parameters such as land use class, size, etc. |  |
| NameNestSuitabilityFile  NameForageSuitabilityFile | Txt file with the FT specific land use suitabilities for nesting and resources |  |
| t\_max | Maximal time steps simulated | Years |
| y\_max, x\_max | Dimension of the underlying landscape | 10 m |
| nb\_LU | Number of land use classes |  |
| TZ\_width | Width of a transition zone | 10 m |
| TZ\_percentage | Percentage of borders with transition zone |  |
| size\_order | order in which transition zones are selected depending on patch size |  |
| disturbances | Probability of disturbances each year |  |
| Nrep | Number of repetitions |  |
| MC | Number of MC run with the same set of parameters |  |
| SimNb | Number of the simulation |  |
| Landscape | x, y | x, y coordinate of the cell |  |
| LU\_id | Land use class identifier |  |
| pa\_id | Patch identifier |  |
| TZ | Cell is defined as transition zone |  |
| TZ\_pot | Cell is a potential transition zone cell |  |
| distance\_LU | Map of the minimal distances to the other land use classes |  |
| sumCap | Defines the maximal capacity of a patch (for all FT populations in it) |  |
| FT\_pop\_List | List of all FT populations in the cell |  |
| FT\_pop\_size | List of the FT population sizes in the cell |  |
| Functional type | FtLinkList | List of all FT |  |
| FT\_type | Type identifier |  |
| FT\_ID | Type identifier |  |
| R | Growth rate |  |
| b | Density compensation effect |  |
| c | Interspecific competitive strength |  |
| trans\_effect\_nest | Effect of transition zone on nesting suitability |  |
| trans\_effect\_res | Effect of transition zone on resource suitability |  |
| mu | Amount of dispersing individuals |  |
| omega | Densitiy dependent effect on dispersal |  |
| dist\_eff | Susceptibility for disturbances |  |
| dispsd | Standard deviation of dispersal distance | 10 m |
| dispmean | Mean dispersal distance | 10 m |
| LU\_suitability\_nest | Map of land use suitabilities for nesting |  |
| LU\_suitability\_forage | Map of land use suitabilities for resource uptake |  |
| Population | cell | Link to the cell in which the population is (incl. all cell parameters) |  |
| Traits | Link to the list of traits of the FT |  |
| xcoord, ycoord | x, y coordinates of the population |  |
| nestCap | Nest capacity of the current cell for the specific FT |  |
| MaxNestSuitability | Maximal nest suitability in the dispersal distance radius |  |
| resCap | Resource uptake for the FT in the specific cell (sum of all resources in dispersal range) |  |
| Trans\_effect\_res | Copy of the FT trait trans\_effect\_res |  |
| Trans\_effect\_nest | Copy of the FT trait trans\_effect\_nest |  |
| Pt | Current population size |  |
| Pt1 | New population size |  |
| Emmigrants | Number of emmigrants |  |
| Immigrants | Number of immigrants |  |

# Process overview and scheduling

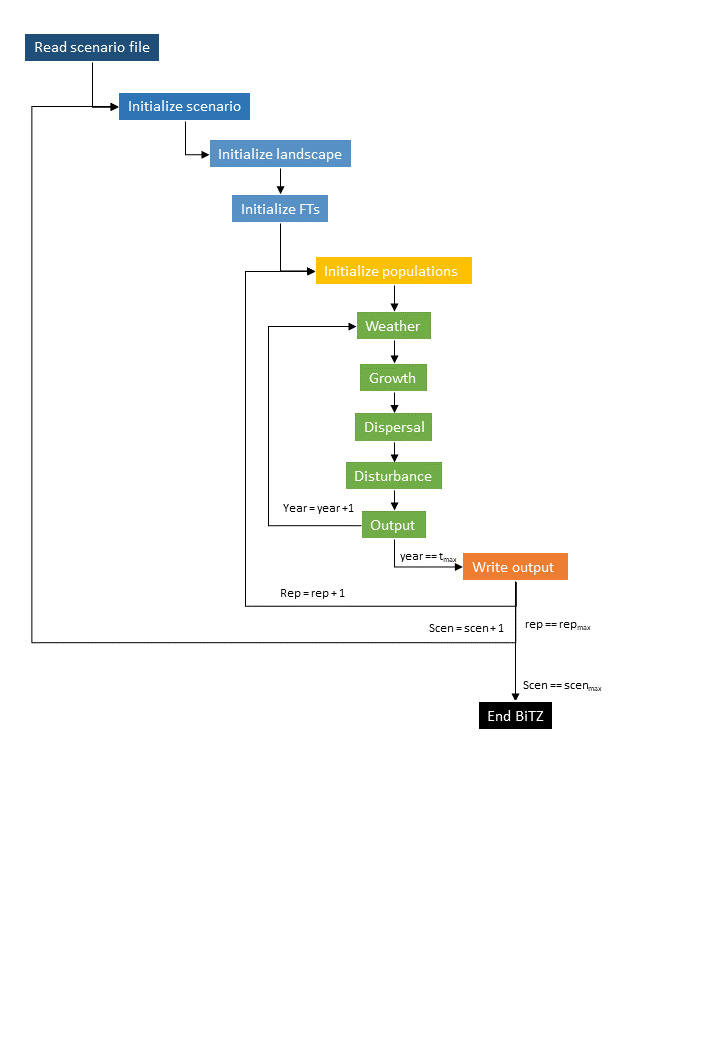


Figure 1: Flowchart of one BiTZ simulation including all single processes

* Which entity execute which process that changes which state variables and the order in which the entities execute the process 🡪 include also the updates

# Design concepts

## Basic principles

* population growth is based on a logarithmic growth function by maynard-smith and slatkin
  + A interspecific competition factor was integrated to account for interactions between different FTs (e.g. competition for resources and nesting sites)
* Dispersal is simulated on an individual basis
* Landscape level disturbances
* Trait and parameter assumptions classification of species

## Emergence

Which key model results or outputs are modeled as emerging from the adaptive decisions and behaviors of agents. These results are expected to vary in complex and perhaps unpredictable ways when particular characteristics of the agents or their environment change. • For those emergent results, the agent behaviors and characteristics and environment variables that results emerge from. • The model results that are modeled not as emergent but as relatively imposed by model rules. These results are relatively predictable and independent of agent behavior. • For the imposed results, the model mechanisms or rules that impose them. • The rationale for deciding which model results are more vs. less emergent.

## Adaptation

* Dispersal search for suitable nesting site

## Objectives

## Learning

n.a.

## Prediction

Directed dispersal

## Sensing

Directed dispersal

## Interaction

Interspecific competition integrated in the growth function

## Stochasticity

Wheather, dispersal, disturbance

## Collectives

n.a.

## Observation

How information is collected and analyzed

# Initialisation

## Scenarios

* Scenario file includes: Simluation number, NameFtFile, NameLandscapePatchFile, NamePatcDefFile, NameNestSuitabilityFile, NameForageSuitabilityFile, Number of repetitions, maximal time steps simulated, dimensions of the underlying landscape (x\_max, y\_max), Number of land use classes, Transition zone width, Percentage of borders with transition zones Probability of disturbances

## Landscape

* Read the patch definition file
* Read the landscape file
* Define potential transition zone cells in the landscape: for all arable cells: if one of the neighbouring cells is a forest or grassland cell, it is marked as a potential transition zone cell
* Select transition zone cells: depending on the determined size order parameter, arable patches are ordered depeding on their size. Starting with the first patch (either smallest or largest), potential transition zone cells are randomly selected and all arable cells within the range of TZ\_width are marked as TZ cell.

## Functional types

* Read FT definition file
* Read nest suitability file
* Read forage suitability file

## Populations

* 1000 populations are initialised per FT
* Wherever a population is initialized on the grid:
  + Transition zone effects are set
  + Nest capacity is set (100 x (suitability+trans effect nest)
  + Maximal nest capacity within the dispersal range is set
  + Resource capacity in the cell is set: sum of all resource suitabilities in the dispersal distance; for transition zone cells, trans effect res is added
* Initial population size is a random start size of 1-10 individuals multiplied by the nest capacity/max. nest capacity of the certain patch for the specific FT

# Input data

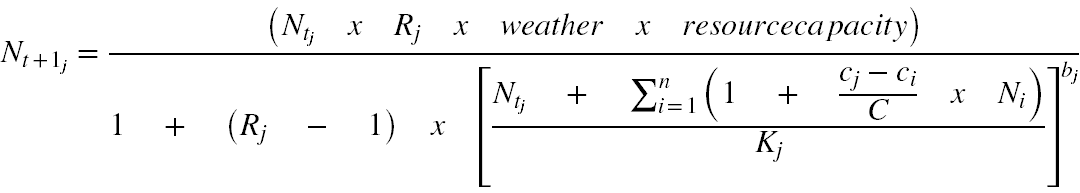
* Input files are: simulation parameters, landscape, patch, FT: Traits, suitability nest + res

# Submodels

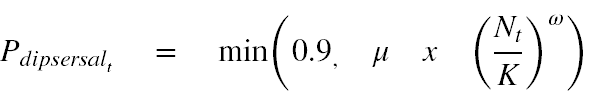
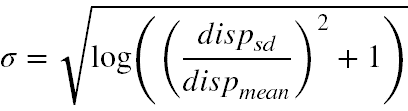
## Weather

* Stochastic impact for good and bad years:
  + Eps=normal distributed variable with a mean of 0.0 and a standard deviation of 0.15
  + Weather\_year= 1+eps;

## Growth

* Based on the Maynard-Smith and Slatkin function; modified by Jeltsch et al.:
* 

## Dispersal

* Fraction of dispersing individuals is determined by the amount of dispersing individuals, and a density dependent impact of the carrying capacity, current population size, and the impact factor omega; maximal 90% of the population is dispersing
* 
* Each individual is searching for the most suitable patch for nesting in the dispersal kernel; with increasing number of attempts, the probability is increasing, that it decides to take a less suitable patch
* Direction of dispersal:
* dispersal distance:

## Disturbances

Only occurs in non TZ cells and only with a probability of disturbance

Each LU class has its own probability; with a probability of dist\_eff a Pop is disturbed on the specific cell.

* Eigentlich müsste ich für arable fields: pro patch ID gehen
* Im grassland ähnlich
* Im Forest/urban/bare auf Zellebene

## Management options