

# Spatial stochastic Patch model with 2 stages

## Mean field model

There are 2 kinds of algae (A) patches small (s) and big (b) and 2 species,  $A_{1s}$  is a species 1 small patch. Small patches represent a lower algae density than big patches.

First formulation:

$$dE/dt = -k_1 E A_{1b} - k_2 E A_{2b} + u_1 A_{1s} + u_2 A_{2s}$$

$$dA_{1s}/dt = k_1 E A_{1b} - u_1 A_{1s} - g_1 A_{1s} A_{1b} - c_{12} A_{1s} A_{2b} + p_1 A_{1b}$$

$$dA_{2s}/dt = k_2 E A_{2b} - u_2 A_{2s} - g_2 A_{2s} A_{2b} + c_{12} A_{1s} A_{2b} + p_2 A_{2b}$$

$$dA_{1b}/dt = g_1 A_{1s} A_{1b} - p_1 A_{1b}$$

$$dA_{2b}/dt = g_2 A_{2s} A_{2b} - p_2 A_{2b}$$

Second formulation:

$$dA_{1s}/dt = k_1 A_{1b} (E - g_1 A_{1s} A_{1b} - c_{12} A_{1s} A_{2b}) + p_1 A_{1b} - u_1 A_{1s}$$

$$dA_{2s}/dt = k_2 A_{2b} (E - g_2 A_{2s} A_{2b} + c_{12} A_{1s} A_{2b}) + p_2 A_{2b} - u_2 A_{2s}$$

## Stochastic spatial model

The spatial model can have N species. Species  $i$  replaces species  $j$  with rate *CompetitionRate* if  $i < j$ .

### Parameters

*ColonizationRate*: Big patches disperse colonizers ( $p_i$ )

*GrowthRate*: From small to big patches ( $g_i$ )

*CompetitionRate*: Replacement of species  $i < j$  ( $c_i$ )

*ExtinctionRate*: Small patch extinction ( $u_i$ )

*PerturbationRate*: Perturbations transform big patches into small ones ( $p_i$ )

The events of the model are:

Patch	Event	Result	Event1	Result1
Small	Extinction	Empty		
Big	Colonization	Send propagule		
		If empty		small actual spc
		If small==spc	Growth	Big
		If small>spc	Compite	Small actual spc

## Source code

The principal process is in the file `IpsPatchStage.cpp` and the following functions make the principal processes:

```
IPSPatchStage::Evaluate()  
IPSPatchStage::EvalCell(int x,int y)
```

## Parameter files

**inp files** The files with extension **inp** have the parameters for the species. The structure line by line is:

- 1: xdim ydim
- 2: number of species
- 3: Parameters of species spreading from this to the following lines

The structure of the lines with species parameters is

```
speciesNum GrowthRate ColonizationRate ExtinctionRate PerturbationRate CompetitionRate DispersalDistance
```

**set files** The files with extension **set** have the number and stages of individuals to set the initial conditions with random spatial distribution, the structure of the file have 4 columns, and can have several lines for different stages:

```
Specie stage numberofindividuals 0
```

## Bibliography

1. Quartino ML, Deregibus D, Campana GL, Latorre GEJ, Momo FR (2013) Evidence of Macroalgal Colonization on Newly Ice-Free Areas following Glacial Retreat in Potter Cove (South Shetland Islands), Antarctica. PLoS One 8: e58223. doi:10.1371/journal.pone.0058223.
2. Durrett R, Levin SA (2000) Lessons on Pattern Formation from Planet WATOR. J Theor Biol 205: 201–214. doi:10.1006/jtbi.2000.2061.
3. Pascual M, Levin SA (1999) Spatial scaling in a benthic population models with density-dependent disturbance. Theor Popul Biol 56: 106–122.

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