

***ApisRAM & O. bicornis* in ALMaSS**

- from a single bee to an entire country

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Christopher John Topping, Elżbieta Ziótkowska, Geoffrey Brian Groom, Trine Poulsen, Liyan Xie, Bjarke Damsgaard Eriksen, Elena Fini, Luna Kondrup Marcussen, Yoko Luise Dupont, ...

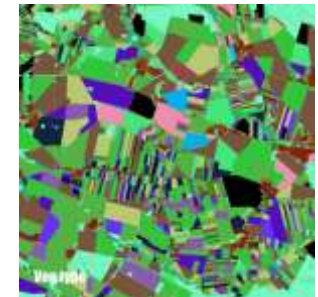
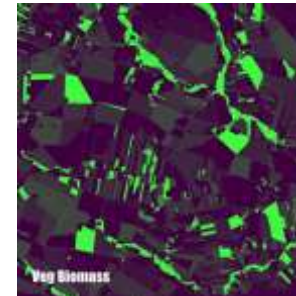
Florian Schunck, Nuno Capela, Noa Simon-Delso, Fani Hatjina, Andreas Focks, Agnieszka Bednarska, ...

What is ALMaSS?

- ALMaSS (the Animal Landscape and Man Simulation System) was founded by Christopher J. Topping in 1998.
- The aim was to create a model **with two main components** to evaluate the impact of human management on wildlife populations.
- It works by creating a simulated **landscape** in high detail and then populating this with individual-based and subpopulation-based **models of animals and people**.

Component 1

Component 2

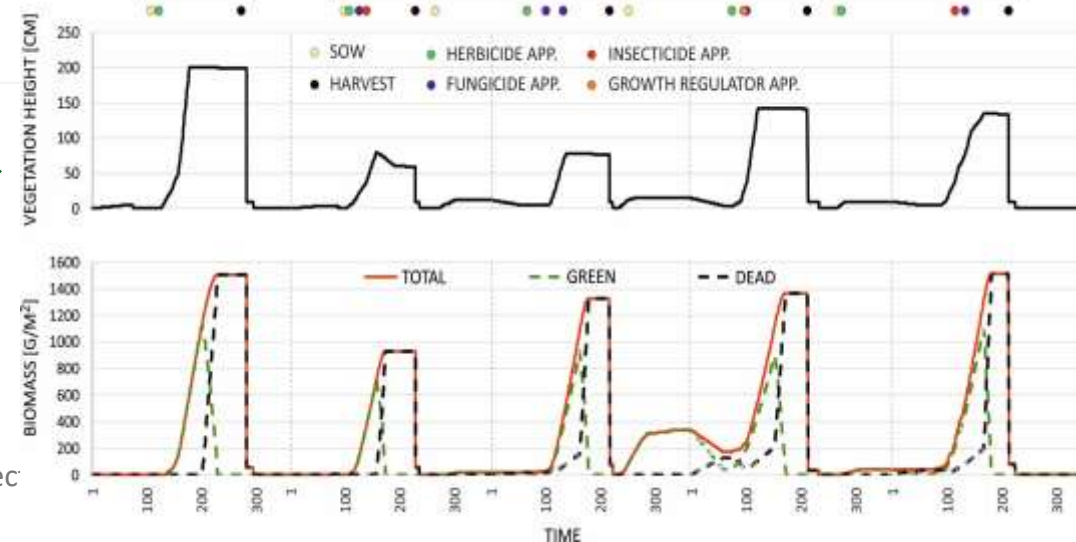
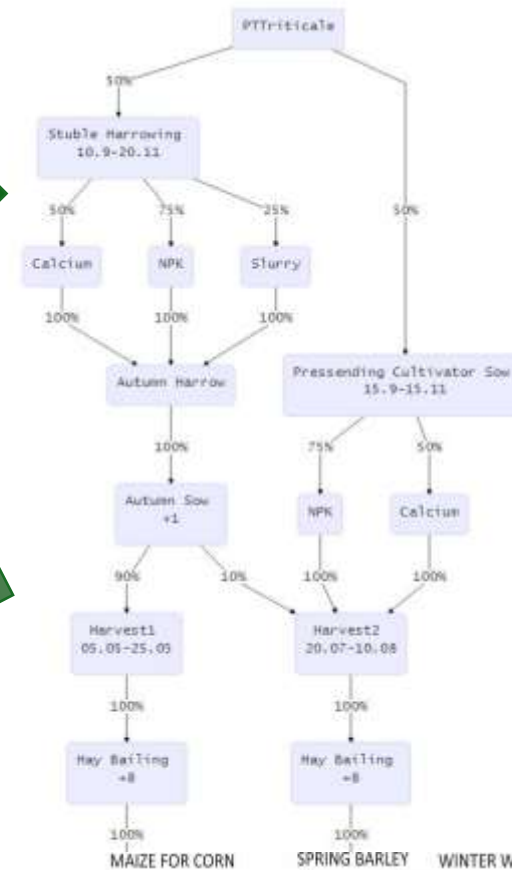
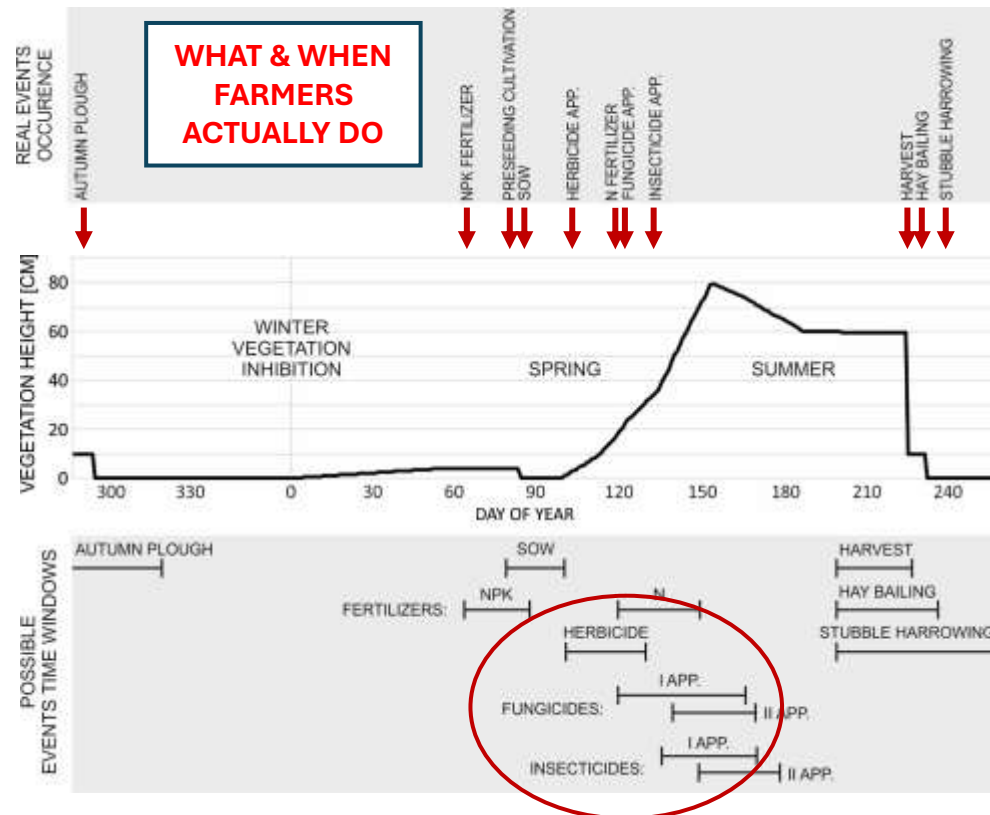


Crop modelling

Crop management

- Farmers' advisors
- Farmers' associations
- Farmers' field management records

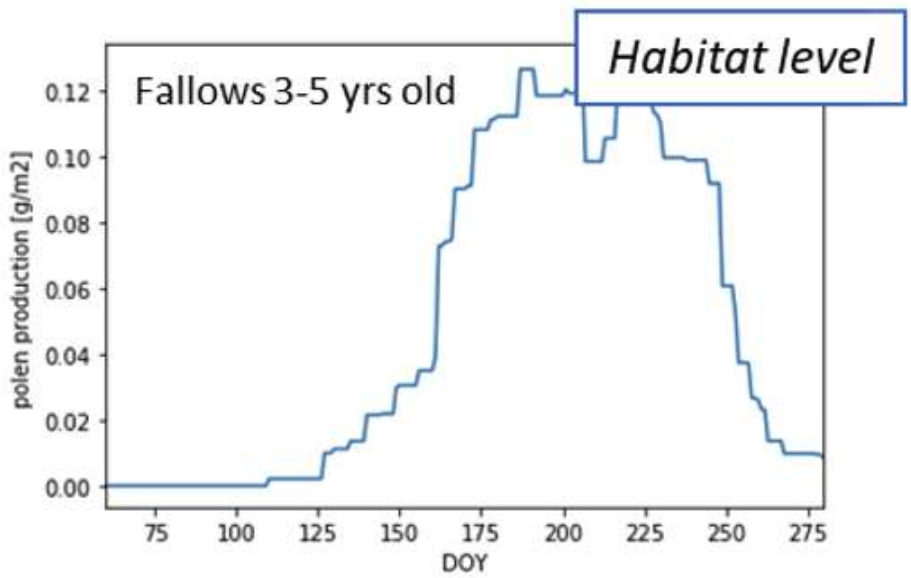
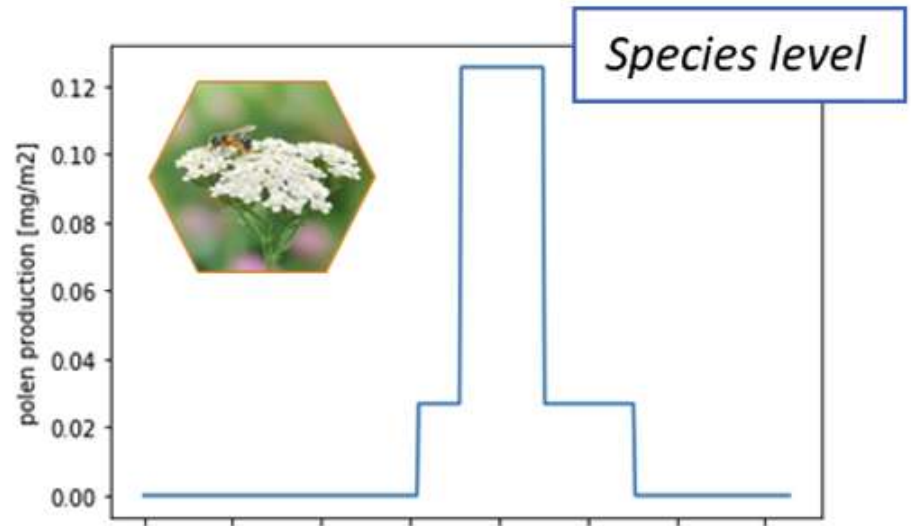
Interviews / Queries



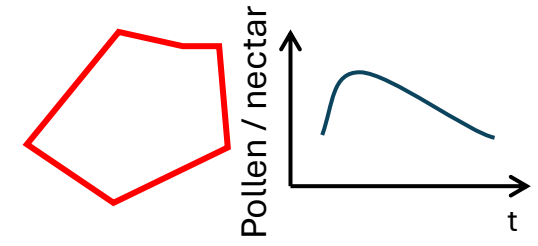
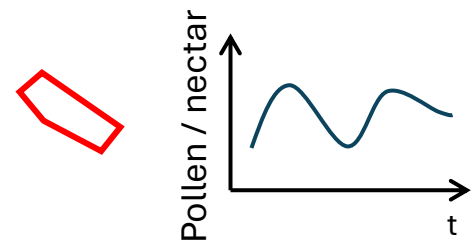
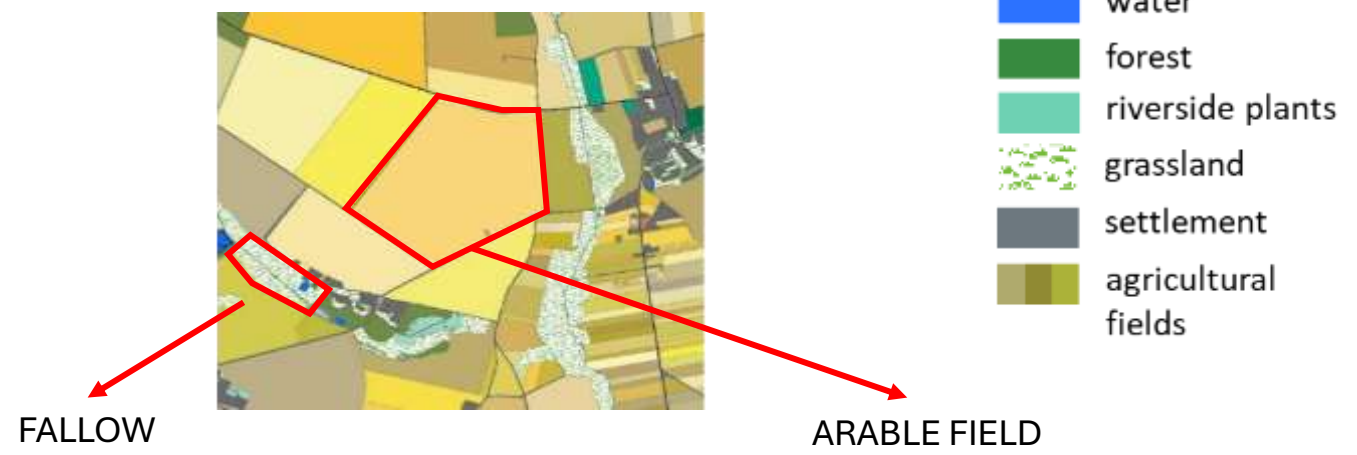
Flower resource model

Pollen production [mg/m²]

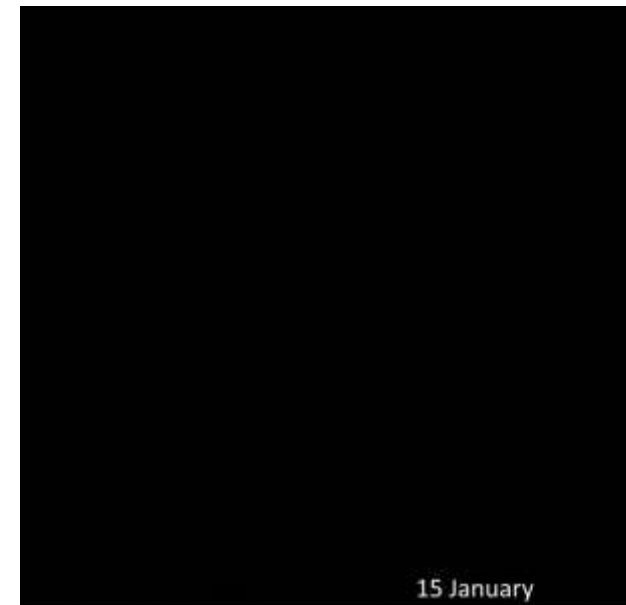
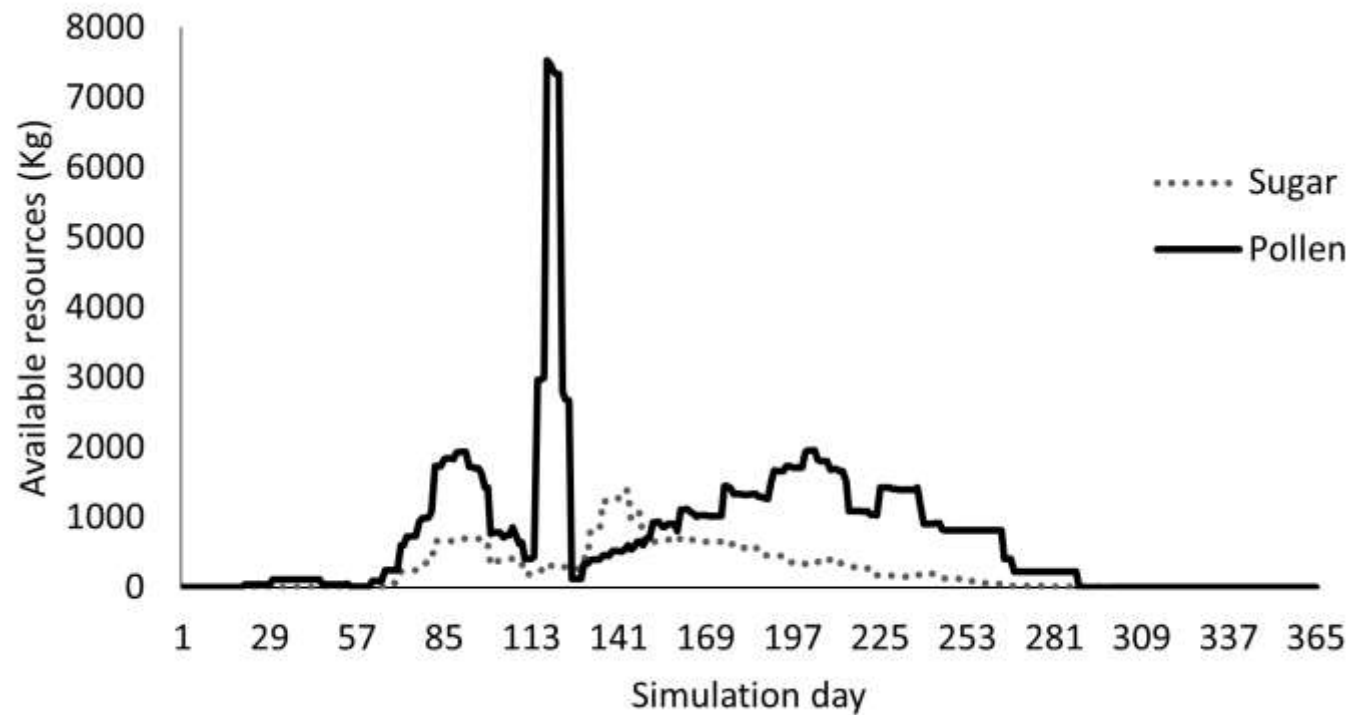
Pollen production [g/m²]



Land cover / land use map



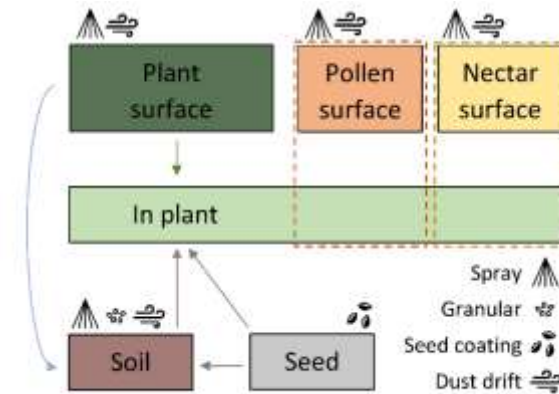
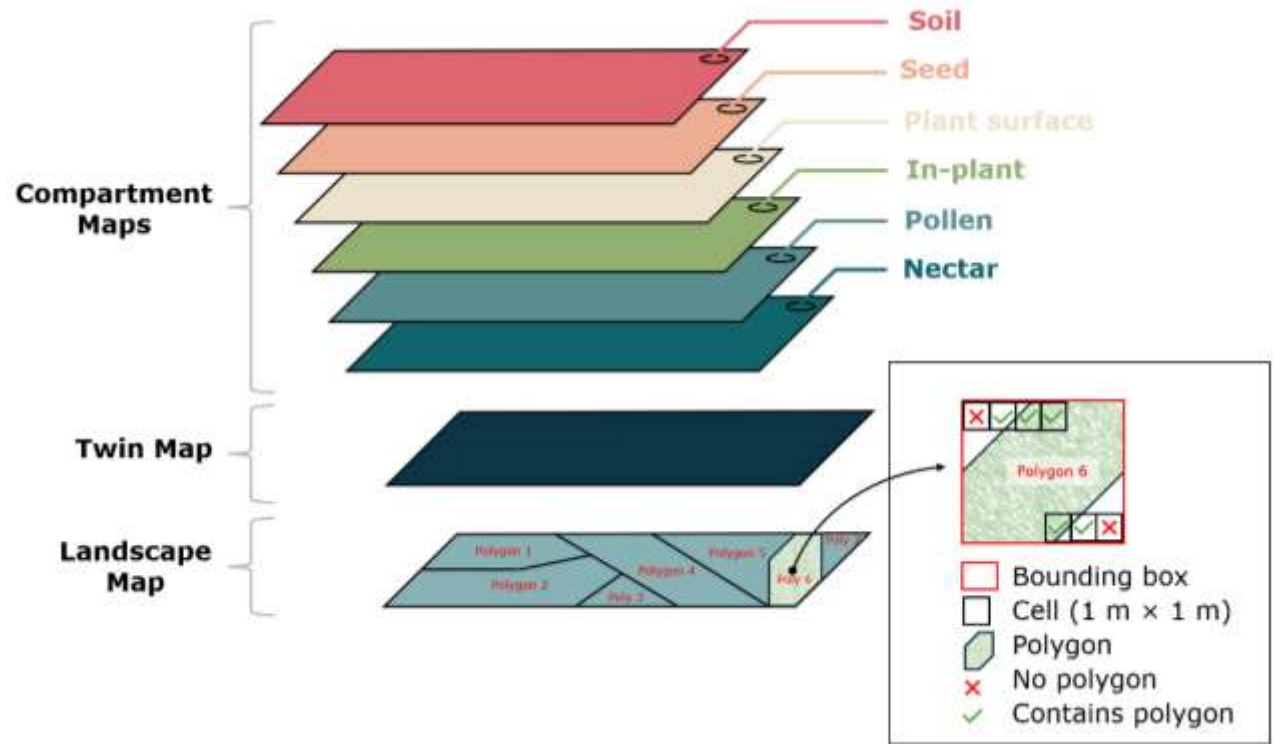
Flower resource model



Pesticide Engine

Three application types:

- Spray
- Seed coating
- Granular



Species models



ApisRAM: an agent-based model for a honeybee colony

- Development

Three castes

- Worker
- Drone
- **Queen**

Four life stages

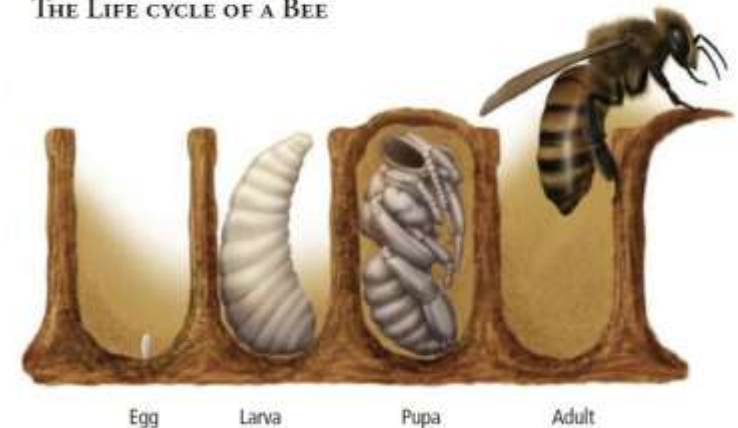
Egg → Larva → Pupa → Adult

honeybee
(*Apis mellifera*)



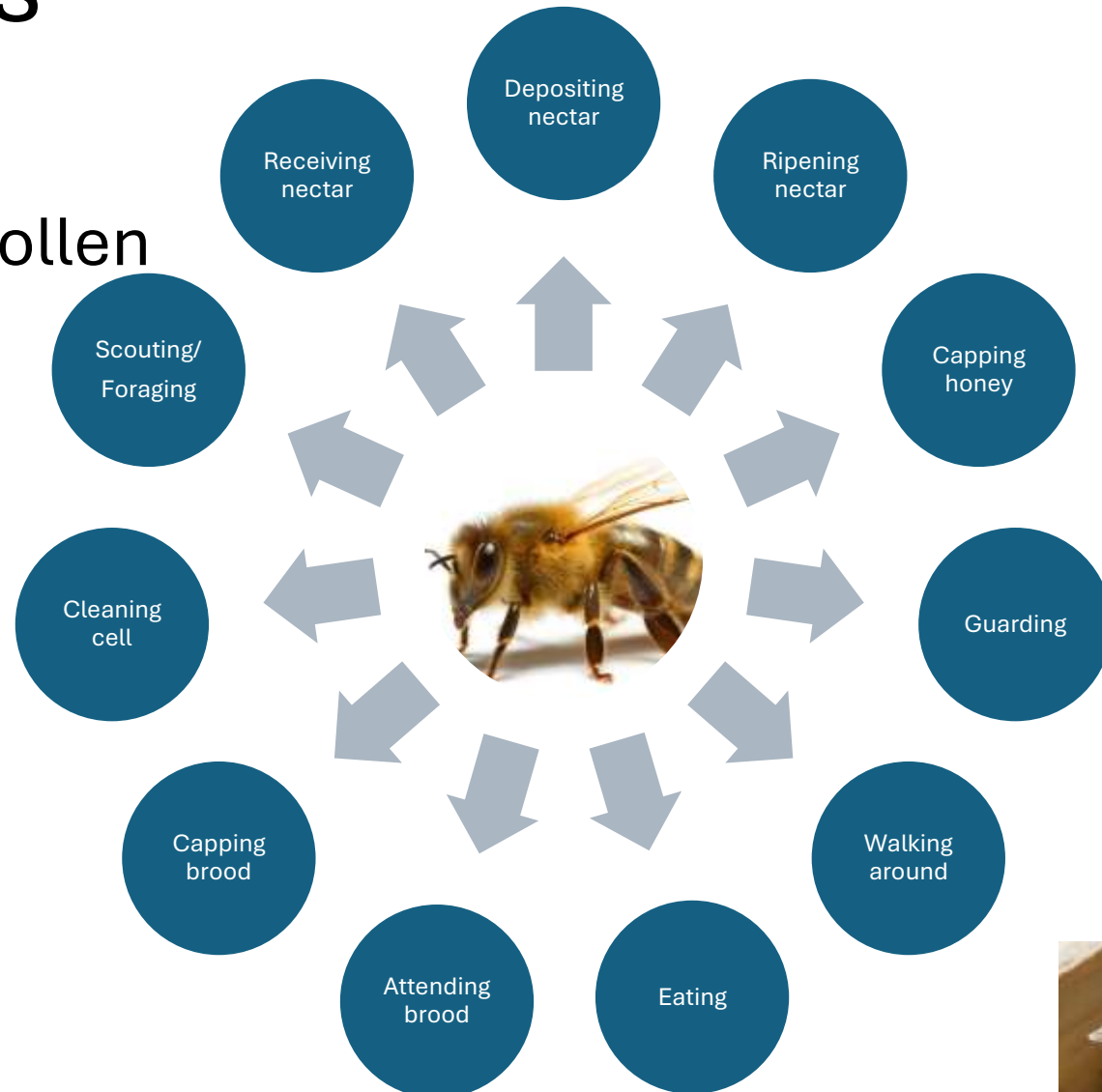
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THE LIFE CYCLE OF A BEE



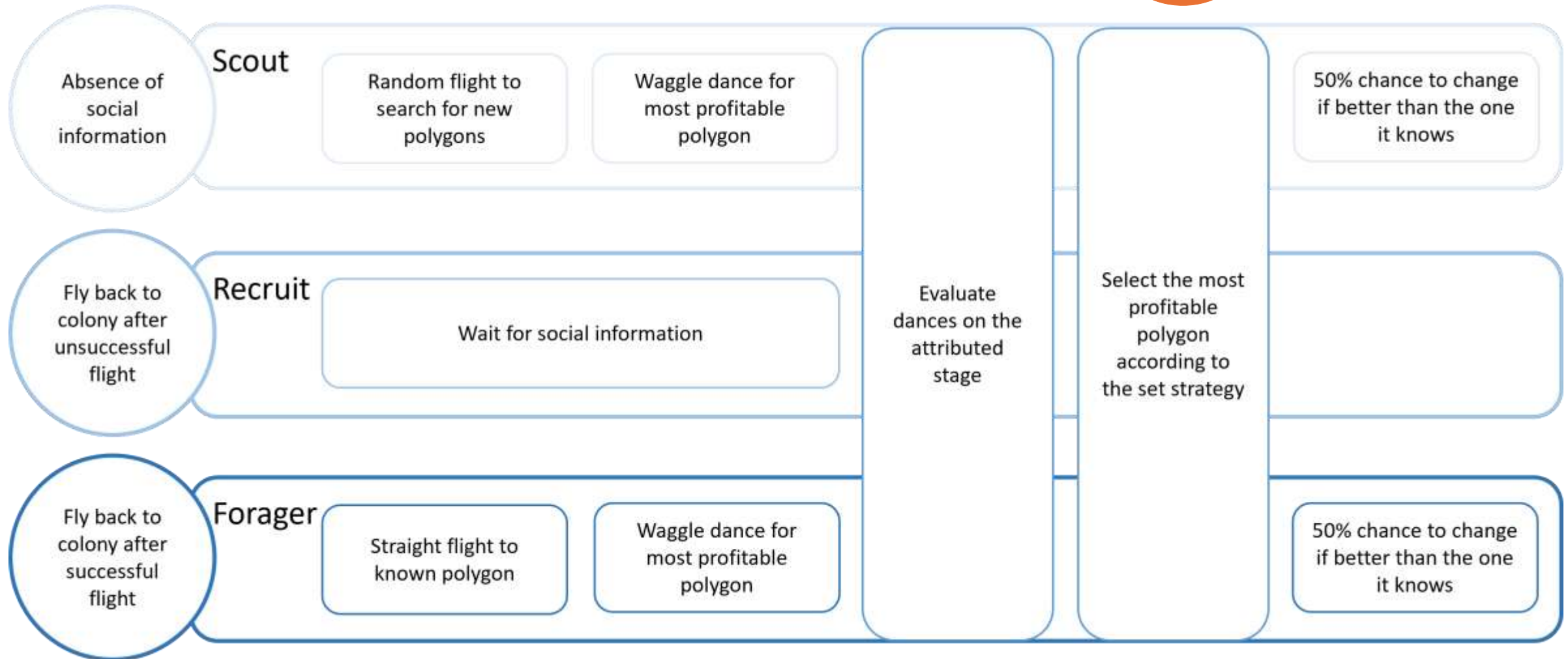
*Apis*RAM: Activities

- Time budget
- Energy in term of sugar and pollen



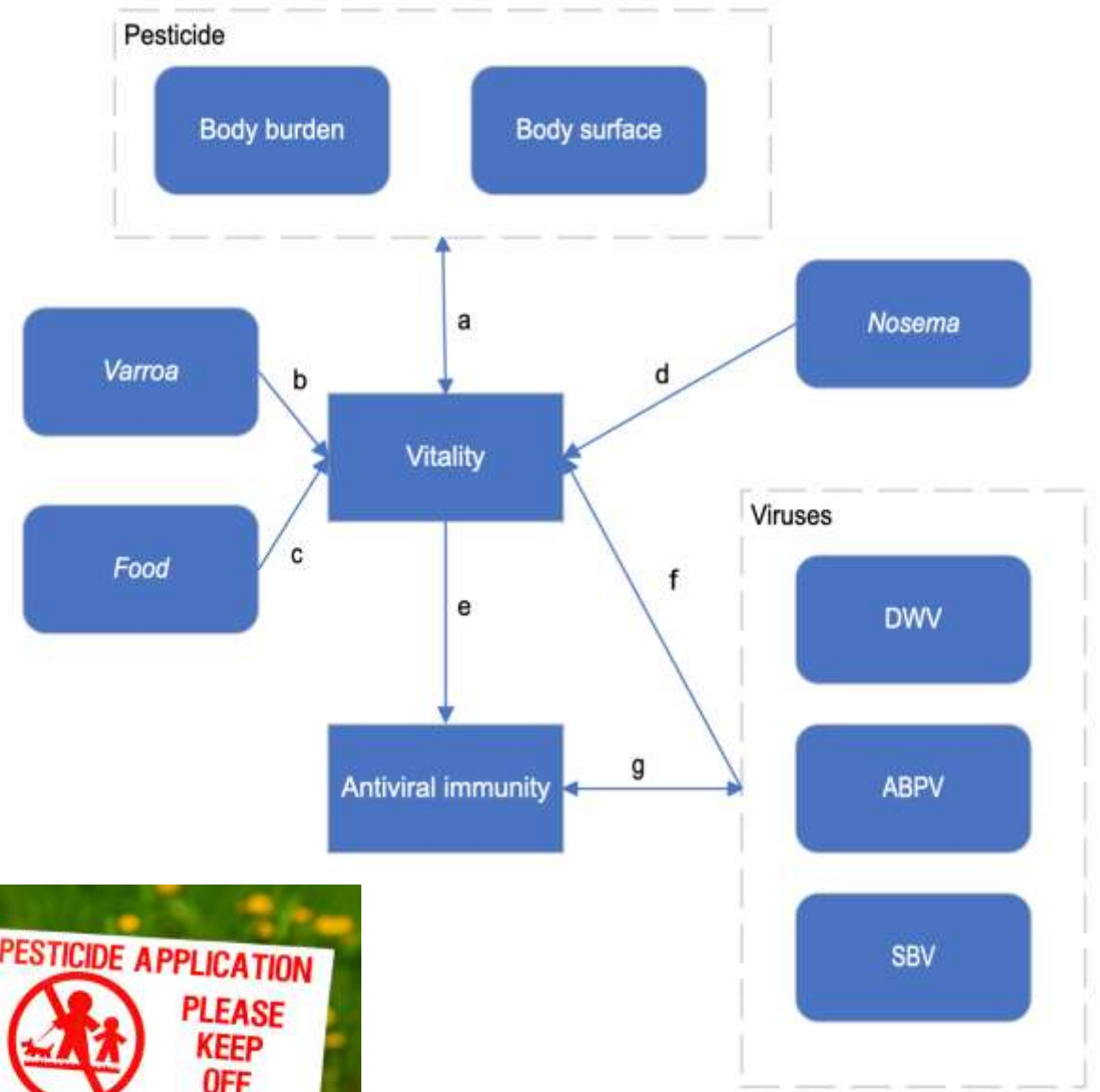
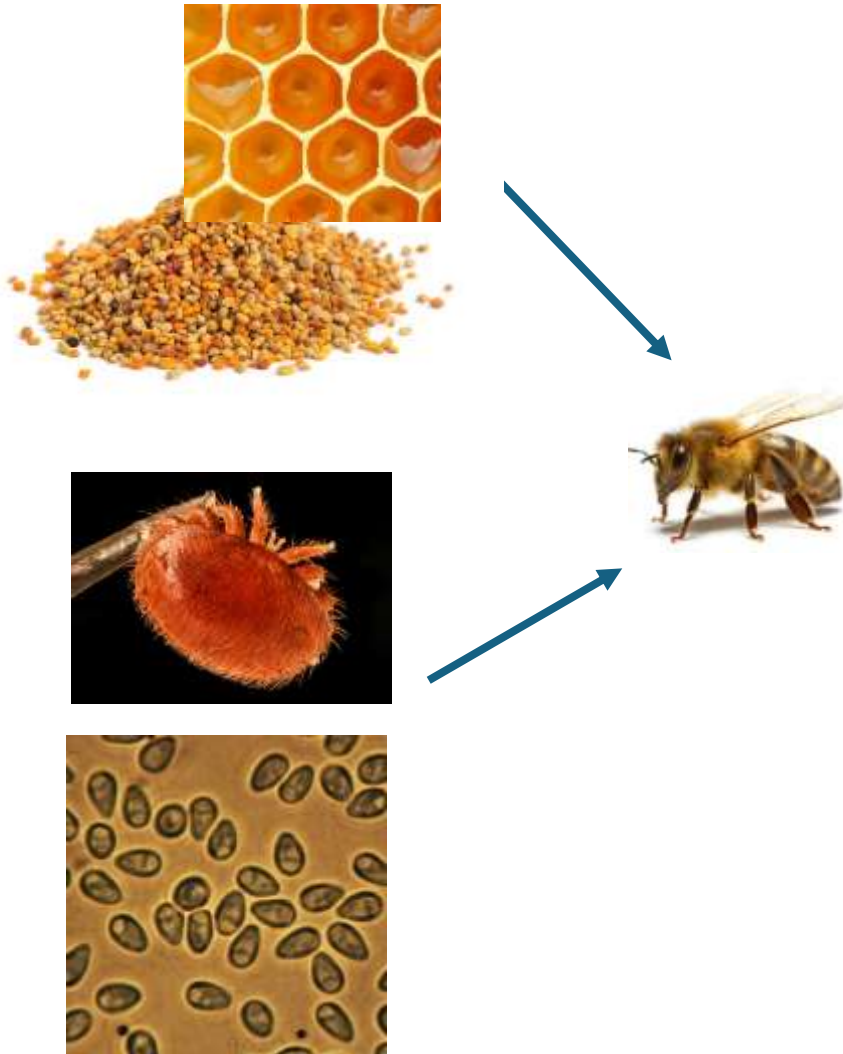
ApisRAM: Foraging

Connect the colony with the landscape



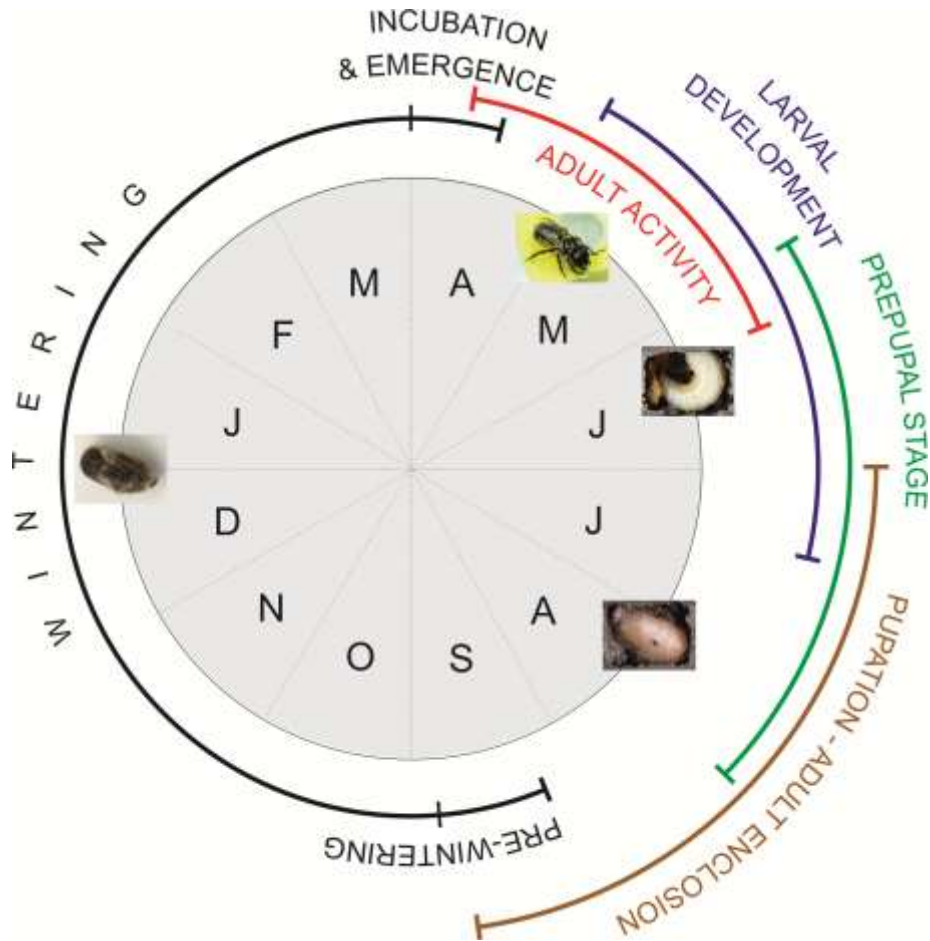
ApisRAM: Vitality

- A method to integrate all the stressors

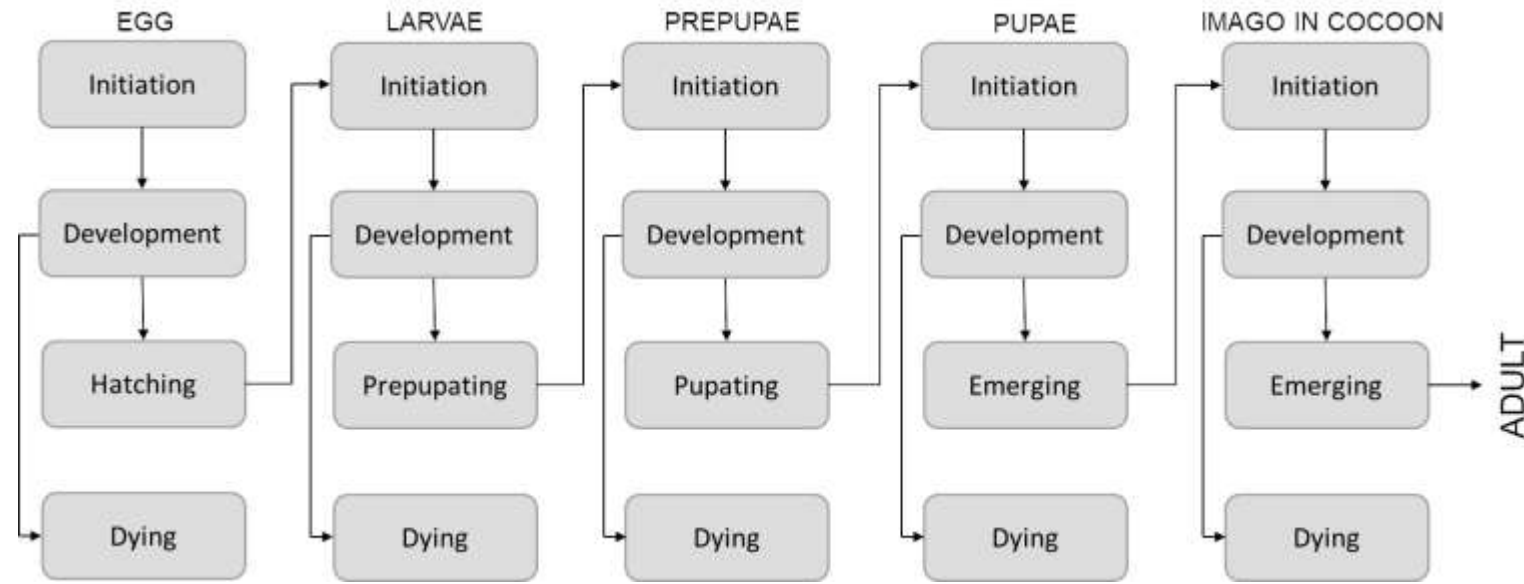


Toxicokinetic-Toxicodynamic modelling

O. bicornis: development in the nest



From eggs to adults in the cocoon



- Temperature-dependent
- Implemented with the degree-day model
- Probability of dying assigned to each stage

O. bicornis: foraging

Toxicokinetic-Toxicodynamic modelling



The interconnection between the *Osmia* and the landscape simulations

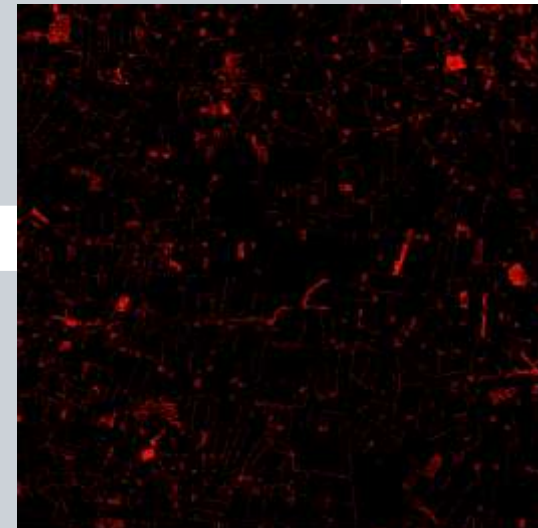
Pollen and nectar
Pesticide
1m² spatial resolution



Searching for a nest first



Foraging pollen for egg provisions

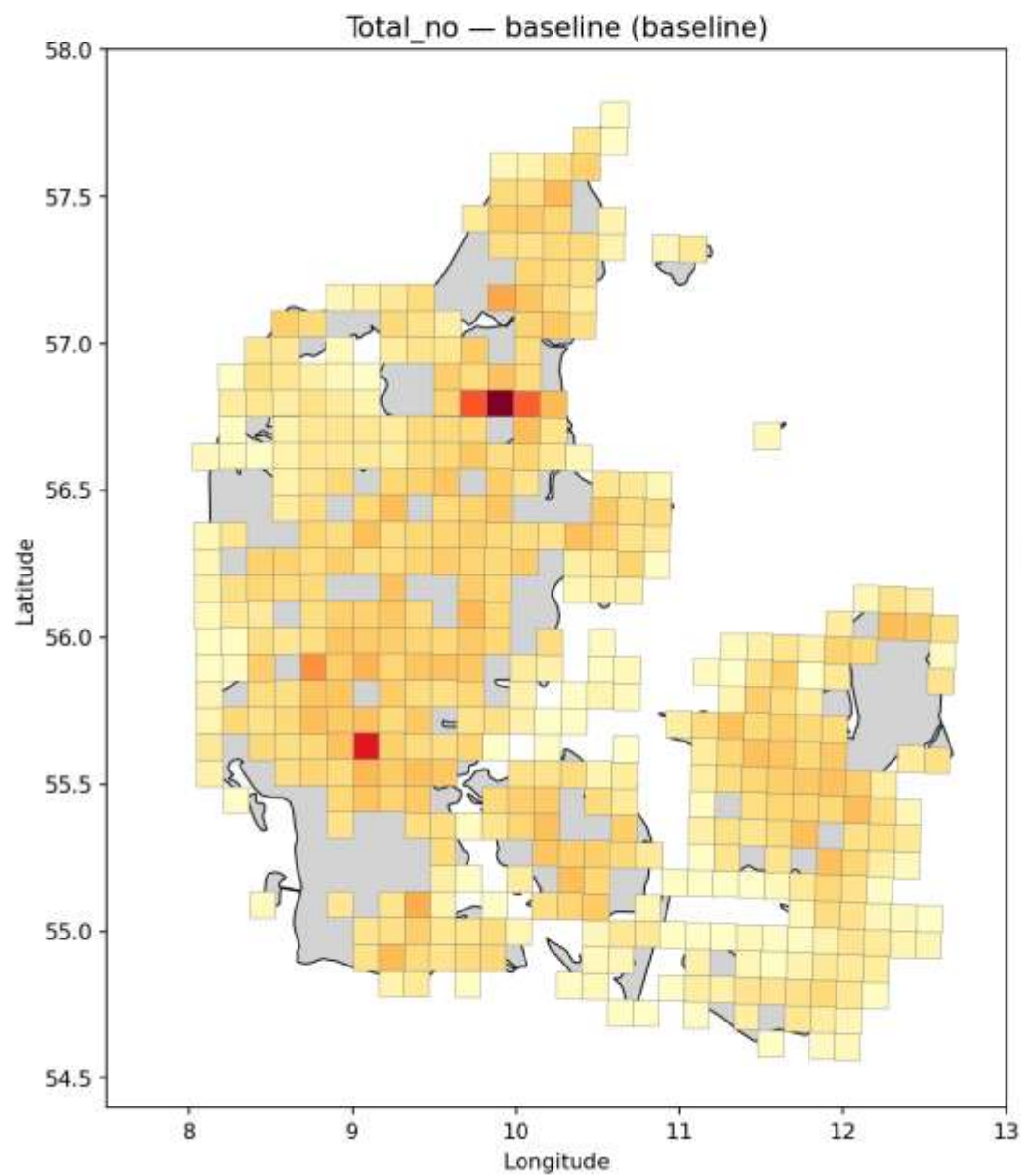


Simulations

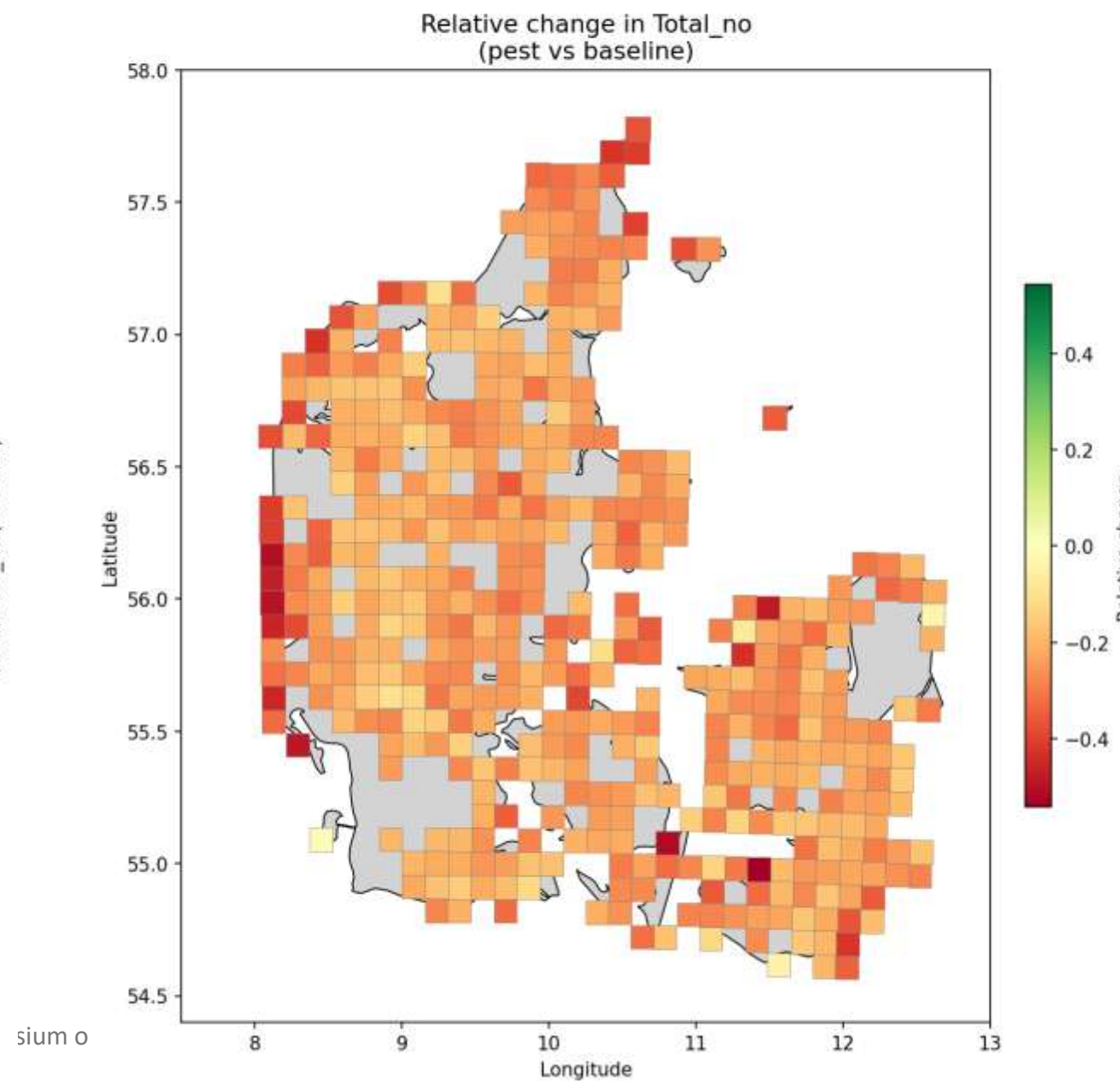
- ALMaSS (landscape, species) is developed using C++
- Simulations run on HPCs



ALMaSS Osmia — Denmark



ALMaSS Osmia — Denmark



Thanks!