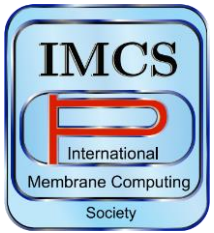
Developing Computational Models for Exotic Invasive Species: tools for prevention, control and decision making



BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

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Developing Computational Models for Exotic Invasive Species: tools for prevention, control and decision making

BIODIVERSITY CONSERVATION

We have **PROBLEMS** threatening biodiversity conservation

Habitat loss / transformation/ fragmentation

Climate change

Pollution

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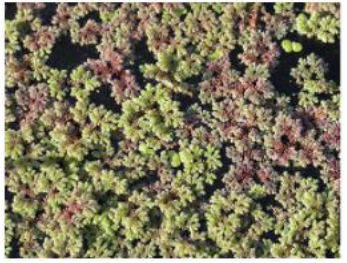
INVASIVE SPECIES

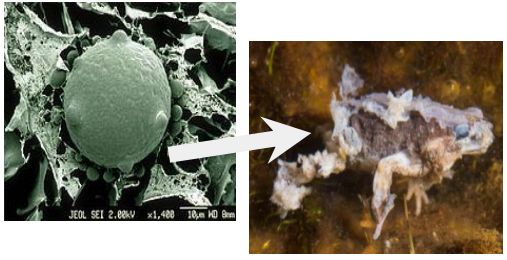
Silurus glanis

Procambarus clarkii



Azolla filiculoides

Alternanthera philoxeroides



Batrachochytrium dendrobatidis

+ MANY, MANY, MORE

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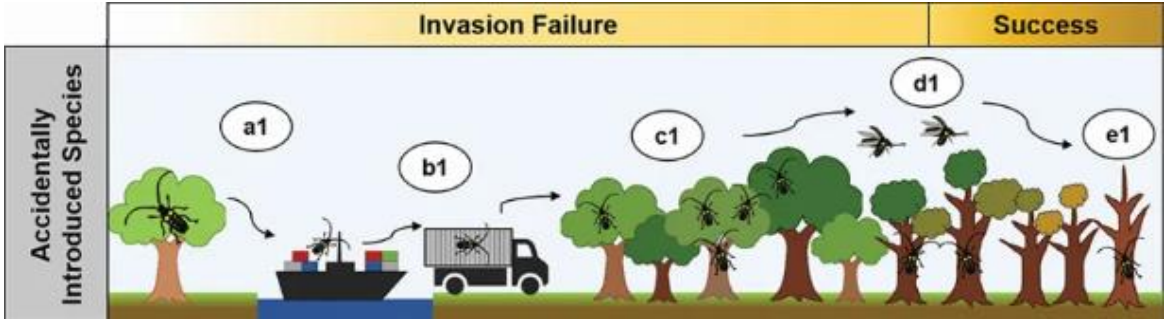
SOLUTIONS? NOT SO FAST

- **Understanding your system first**
- **Modelling**
  - Biodiversity
  - Biological invasions



Schulz et al 2021

WHAT IS A GOOD MODEL?

- **Explicative**

  Does a model have even sense to exist if it does not explain a bit of reality?

(Gilbert, Boulter & Rutherford, 1998)

- **Predictive**

  Will help us simulate scenarios, and making better choices

(Woodell & Peters, 1992; Di Castri & Hadley 1986)

- **Flexible**

  Being useful in different context ➡ best models

(Gilbert, Boulter & Rutherford, 1998)

Do “perfect” models like this exist? Maybe not…
(Gilbert, Boulter & Rutherford, 1998).

TRADITIONAL ECOLOGICAL MODELS

- **Explicative** ✓

  Ecology focused on the processes, not numbers

(Anderegg & HilleRisLambers, 2019)

- **Predictive** ✗

  More realistic or complex models requires a lot of data and computational power

(Civantos-Gómez et. al 2021)

MEMBRANE COMPUTING

Computational paradigm

- Bio-inspired in cells
- Objects, compartments, rules

Computing with membranes
Gheorghe Păun 2000

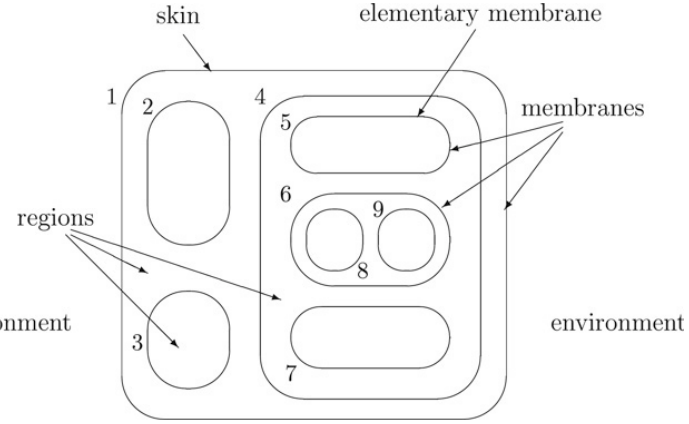
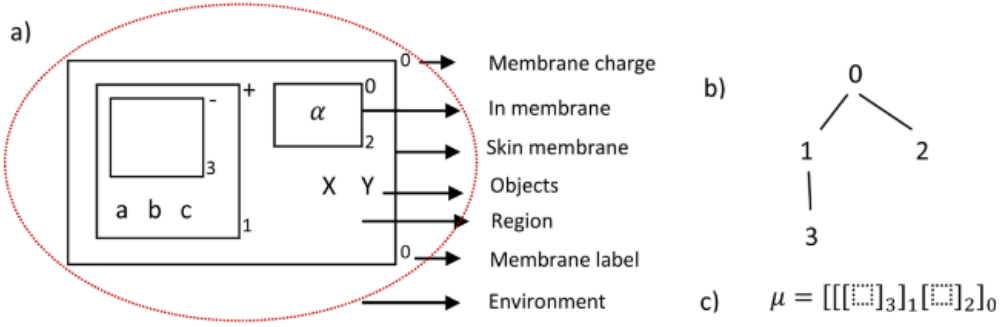


Fig. 1. A membrane structure.

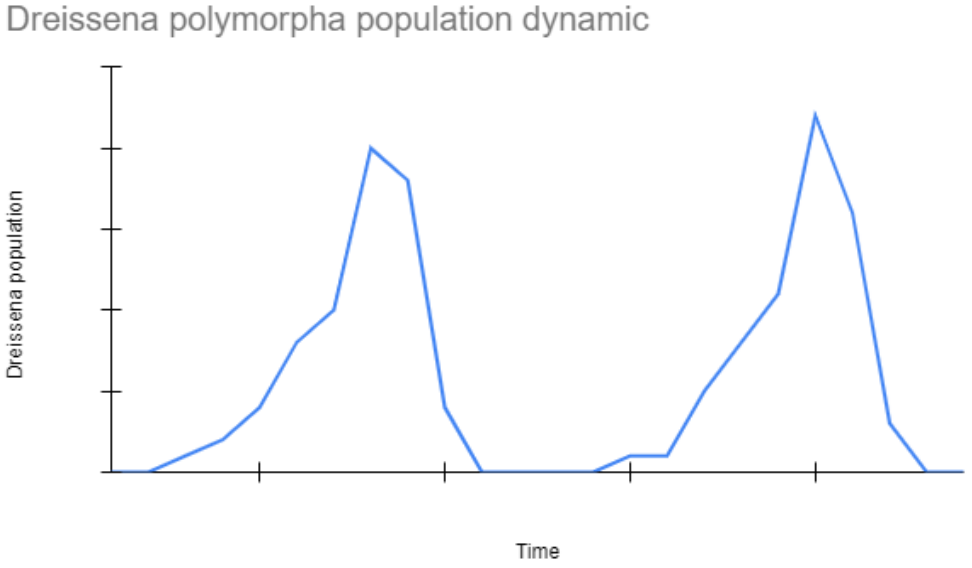
POPULATION DYNAMICS P SYSTEMS (PDP)

- Computational tool based on membrane computing, used to model complex problems
- Can work in parallel
- Modular
- High computational efficency
- Some examples (Colomer et al., 2014)

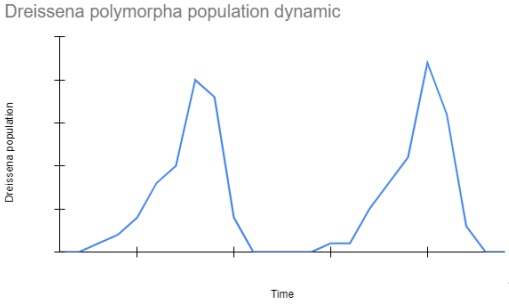


(Colomer, Margalida & Pérez-Jiménez, 2013)

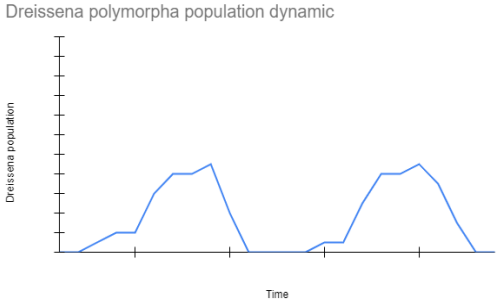
OUR MODEL: EXPECTATION



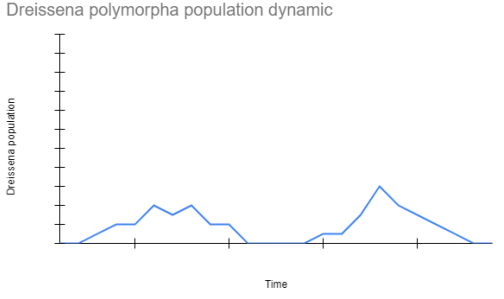
OUR MODEL: EXPECTATION



REMOVING MANUALLY ½ OF ADULTS

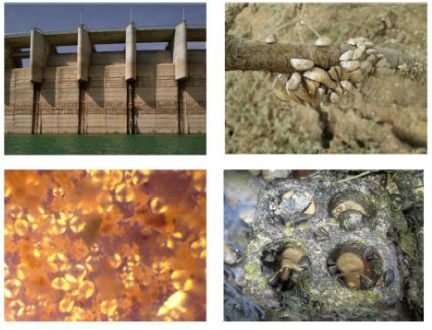


INCREASING WATER OUTPUT IN MAY



OUR MODEL: REALITY

EVOLUCION DE LA ESPECIE INVASORA "*Dreissena polymorpha*" (MEJILLON CEBRA) EN LA CUENCA DEL GUADALQUIVIR Y EN DIVERSAS INFRAESTRUCTURAS HIDRAULICAS. 2017.



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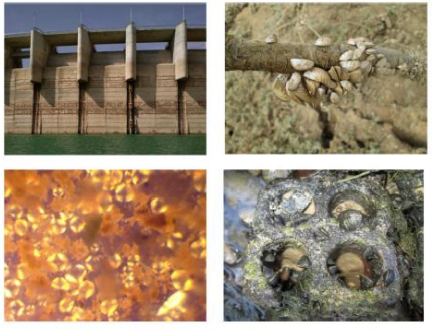

Dams, channels, rivers, etc., sampled

- Iznájar dam
- Breña II dam
- Genil River
- Genil channel Cabra
- Bajo Guadalquivir channel
- La verduga dam
- El villar
- Bembézar channel
- Peñaflor dam
- Guadalmellato channel

Lots of promising data,
lots of sampling points, but…

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OUR MODEL: CHALLENGES

- Amount of data (how many places/times?)
- Data quality (noise? missing info? relevance of recorded attributes?)
- Computational cost
- Reading & validating the output

DATA NEEDED

PROBABILITIES

pro_1 : probability for an adult to die

pro_2 : probability for a larvae to die

pro_{2+i} : probability for an adult to reproduce in the month i

PARAMETERS

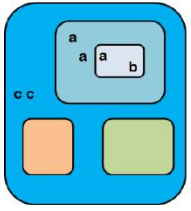
par_i : multiplicity of larvae, adults, etc.

THIS IS THE WAY






Experts

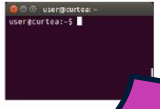


PLI

Parser & Debug

Compiler

Simulator



IMPACT

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- Civil Engineering
- Management
- AI
- Software Engineering
- …

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