When is a population a metapopulation?

A conceptual modelling approach to conservation principles learning

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Facing habitat fragmentation, how the populations are going to behave?

Habitat destruction poses the greatest threat to the long-term survival of species on Earth (Hanski, 1999). Fragmentation means that the remaining habitat for a species is located in smaller and more isolated discrete fragments (patches) of the original area. The consequences of habitat fragmentation on habitat quality may influence metapopulation dynamics via effects on effective patch areas and hence on extinction rate, on colonization rate and by creating source-sink dynamics.

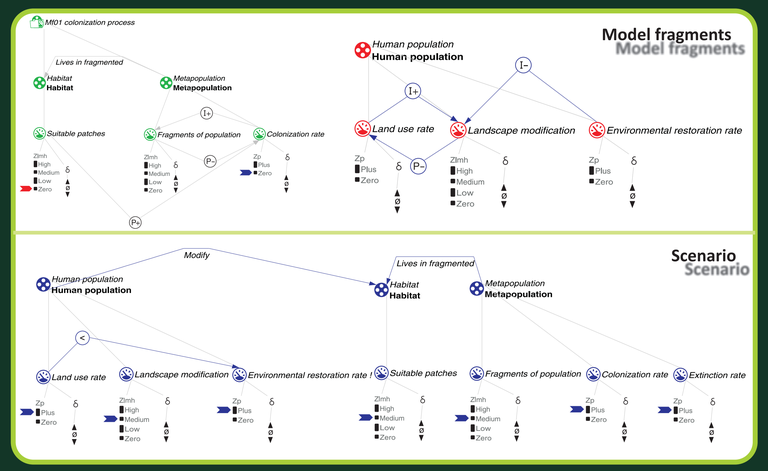
To assess the consequences of habitat loss and fragmentation is complex task due to phenomena happening at different scales and to environmental heterogeneity, for which there will never be enough data to support rigorous empirical analyses. A general theoretical framework is needed, based on a clear conceptual understanding of metapopulations' behavior. This is a urgent task due to accelerating changes and modification on natural landscapes imposed by human activities

Qualitative Reasoning: better understanding and learning by modelling

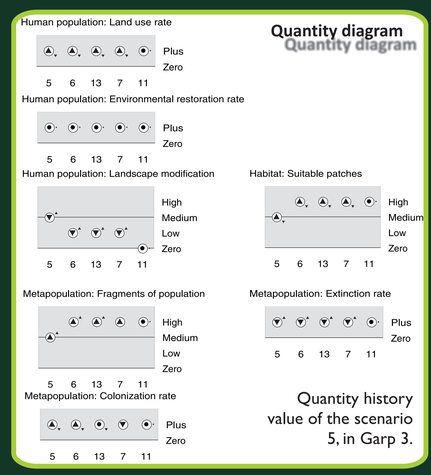
Following current theory on education that advocates learning by doing, modelling is considered fundamental to human cognition and scientific inquiry (Bredeweg & Struss, 2003). Qualitative Reasoning captures human interpretation of reality, and provides a conceptual account that explains why a system has certain behaviors. The Qualitative Reasoning vocabulary used in the model (in fact a symbolic logic-based vocabulary) mimic the way humans understand and explain observable behaviours. This way learners can formulate their insights on how systems behave in an appropriate qualitative and causal way.

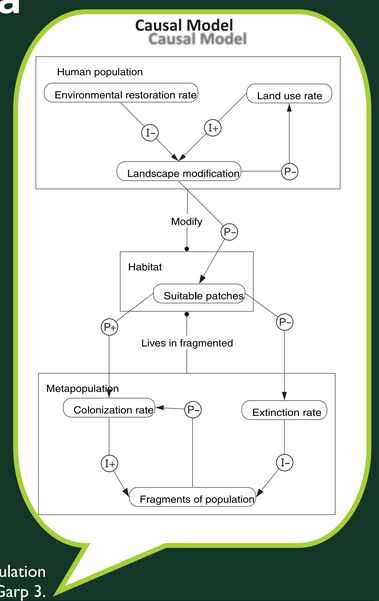
Qualitative Models about the Metapopulation Theory

A set of qualitative models was developed in the Qualitative Reasoning engine Garp3 (www.Garp3.org) and in the learning spaces with different levels of complexity of the workbench DynaLearn (www.DynaLearn.eu, Bredeweg *et al.,* 2009). The models capture and formalize knowledge and the main principles of conservation biology involved in the metapopulation theory for application in educational settings. Qualitative Reasoning modeling has been considered as a tool for integration and exploration of conceptual knowledge in ecological systems and population dynamics (Bredeweg & Salles, 2009). We emphasized the importance of conservation biology principles recommended by the Education Committee of the Society for Conservation Biology (Trombulak *et al.*, 2004).



Model Fragments, scenario and causal model of the scenario 5, in the model *Metapopulation dynamics* simulated in Garp 3.

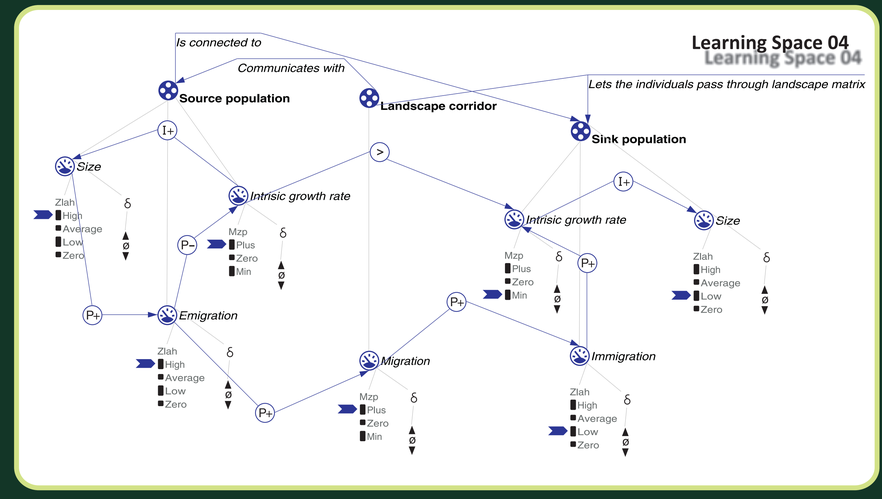




Causal model of the scenario 5, in the model Metapopulation dynamics simulated in Garp 3.

The main goals of the developed set of models are:

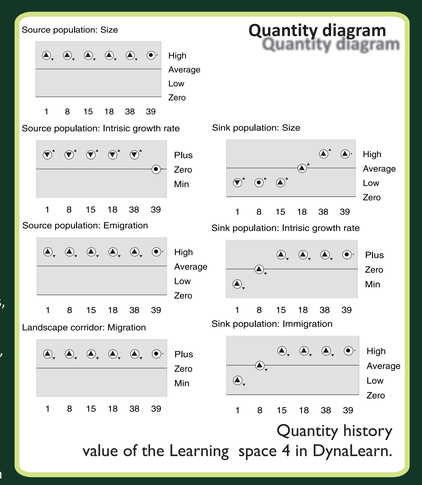
- To address the problem of habitat fragmentation and the effects of conservation biology measures on the metapopulation dynamics
- To formalize causal explanations about the source-sink metapopulation approach
- To predict differences between the behaviour of two populations depending on their size and carrying capacity
- To represent relevant influences driving population dynamics according to the metapopulation theory
- To investigate the use of laws from physics and chemistry, such as diffusion and osmosis, could be used to explain metapopulation behaviour
- To investigate the possibility of design and run experiments exploring both population movements and patchy sizes



Representation of the model '*Source-sink dynamics*' in the Learning Space 04 in the DynaLearn.

Learning conservation principles

This study indicates that Qualitative Reasoning modeling may be a valuable tool for exploring population dynamics and to provide better understanding of complex scenarios dealing with landscape modification, habitat loss and conservation efforts on fragmented areas. This challenge is of great importance, mainly when conservation efforts are needed in a changing planet.



Literature Cited

BREDEWEG, B.; LINNEBANK, F.; BOUWER, A.; LIEM, J. Garp3 -- Workbench for qualitative modelling and simulation. Ecological Informatics, v. 4, n. 5-6, p. 263-281, 2009.

BREDEWEG, B.; SALLES, P. Qualitative models of ecological systems -- Editorial introduction. Ecological Informatics, v. 4, n. 5-6, p. 261-262, 2009.

BREDEWEG, B.; STRUSS, P.: Current Topics in Qualitative Reasoning. AI Magazine 24(4): 13-16, 2004.

HANSK, I. Metapopulation Ecology. Eastbourne, Oxford University Press, 313 p., 1999.

TROMBULAK, S. C., OMLAND, K. S., ROBINSON, J. A., LUSK, J. J., FLEISCHNER, T. L., BROWN, G. & DOMROESE, M. Principles of Conservation Biology: Recommended Guidelines for Conservation Literacy from the Education Committee of the Society for Conservation Biology 18:1180-90, 2004.

Habitat fragmentation
Habitat fragmentation

Amazon Brazilian Forest, picture from the PDBFF/INPA (2008)

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