Project proposal 4: Understanding Food Web Stability for Real-World Food Webs across Spatial Scales

Introduction & Background

Studying the stability of food webs is an important research matter in ecology, due to its role in maintaining biodiversity and controlling the food resources (Stouffer & Bascompte, 2010). Several attempts have been made to model the food webs and comparing them with the real world data, and to infer the stability of larger systems based on the results from the small, isolated models. Although, most studies – empirically or theoretically- have been focused on small sub webs, called trophic modules, due to their higher tractability compared to large whole food webs (Stouffer & Bascompte, 2010).

Studies show that the results from trophic modules are not scalable to larger food webs, and the stability behavior based on the form of the modules changes from what measured in local models (Stouffer & Bascompte, 2010). It is also shown that network modularity has positive effects on the stability of food webs. In this matter, it is shown that in empirical food webs having subsets of species that interact more frequently among themselves than with other species in the community, increases the persistence of multitrophic food webs (Stouffer & Bascompte, 2011). Also, contrary to what it might be expected, the stability of complex food webs can be modeled and studied by simple functions of variables easily measurable in nature, (Berlow, Dunne, Martinez, Stark, Williams, & Brose, 2009).

Considering all the research on food web stability, which a few of them were mentioned, the research on realistic food webs which are made of spatially diverse local webs, interacting with each other in the form of network of networks remains a topic for more research; using the methods and models used in network science. In another word, the goal for this project is to bridge the two sets of local food web networks and regional spatial networks of simplified communities to investigate the stability of natural food web systems

Questions & Goals

Theory suggests that food web complexity results in instability, while this is not true in the real-world models which are complex while stable. At local scales, an attempt to address this issue was to consider the network modularity and compartmentalization in promoting stability (Stouffer & Bascompte, 2011). Also, it is shown that small-scale dispersal promotes stability at local and regional scale (Gouhier, Guichard, & Gonzalez, 2010).

The question to be investigated by this project is to understand how these different factors interact to maintain the stability of complex and interconnected food web networks.

Methodological Approach

The analysis will be based on the implications of network science and topological properties of the complex networks. The local and regional networks will be studied by modeling the interconnected networks, or the network of networks. In the proposed model nodes are the species which create the trophic modules, and the links between them maintains predator/ prey relationships, creating directed networks. The connections between local networks will represent the movement of organisms between them. Then the stability of the model is studied by deleting different nodes (species) from the model, and to do robustness analysis for the network.

Different network topologies will be considered to model the food web, containing scale-free networks, small-world networks, and niche networks. The data are will be provided from the Web of life, ecological networks database (www.web-of-life.es).

Expected Results & Implications

Using the implications of network science will help in explaining the reason beyond different behaviors among the trophic isolated models and the whole food-webs in their stability, and to make realistic models containing connected local and regional food webs. Different network models can provide the opportunity to better compare and justify the models to the real world, and resulting in more accurate models.

Resources:

Berlow, E. L., Dunne, J. A., Martinez, N. D., Stark, P. B., Williams, J. R., & Brose, U. (2009). Simple prediction of interaction strengths in complex food webs. *PNAS*, 187-191.

Gouhier, T. C., Guichard, F., & Gonzalez, A. (2010). Synchrony and Stability of Food Webs in Metacommunities. *The American Naturalist*, E16-E34.

Stouffer, B. D., & Bascompte, J. (2010). Understanding food-web persistence from local to global scales. *Ecology Letters*, 154-161.

Stouffer, D. B., & Bascompte, J. (2011). Compartmentalization increases food-web persistence. *PNAS*, 3648-3652.