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Weighting, scale dependence and indirect effects in ecological networks: A comparative study

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ABSTRACT

We studied the importance of weighting in ecological interaction networks. Fifty-three weighted interaction networks were analyzed and compared to their unweighted alternatives, based on data taken from two standard databases. We used five network indices, each with weighting and unweighting options, to characterize the positional importance of nodes in these networks. For every network, we ranked the nodes according to their importance values, based on direct and indirect indices and then we compared the rank order of coefficients to reveal potential differences between network types and between indices. We found that (1) weighting affects node ordering very seriously, (2) food webs fundamentally differ from other network types in this respect, (3) direct and indirect indices provide fairly different results but indirect effects are similar if longer than two steps, and (4) the effect of weighting depends on the number of network nodes in case of direct interactions only. We concluded that the importance of interaction weights may depend on the evolutionary stability of interaction types.

1. Introduction

Conservation biology is being shifted from protecting species to protecting interspecific interactions and communities. In order to better understand the nature of interaction networks, we need comparative analyses of different interaction types. Ecological complexity comprises the diversity of both species and interspecific interactions. Different types of interactions, such as prey–predator or plant–pollinator interactions are of different character in their ecology and evolution (Thompson, 1991). Since the majority of ecological networks studied so far are food webs (or trophic networks), we should re-examine many classical questions for other network types as well. These basic problems include the importance of weighting, the relevance of indirect interactions and the scale dependence of network properties.

The systematic analysis of ecological networks involves three steps: (1) data collection, (2) network construction and (3) network analysis *sensu stricto*. A number of problems are relevant only to one of these steps, while others bridge over the whole process. The mostly practical question whether and how to consider weights on links (Ulanowicz, 1986; Baird and Ulanowicz, 1989; Paine, 1980) concerns step 1. The problems of aggregation, network resolution and scale dependence (Martinez, 1991; Allesina and Bodini, 2005; Allesina et al., 2005) concern step 2. Finally, a possibly more technical question whether to neglect or explicitly study indirect interactions spreading over these networks (Menge, 1995; Wootton, 1994) concerns step 3. Each problem has a long history and has been

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