COMMUNITY INTERACTION WEBS AND ZOOPLANKTON RESPONSES TO PLANKTIVORY MANIPULATIONS

ANTHONY R. IVES,1,4 STEPHEN R. CARPENTER,1,3 AND BRIAN DENNIS1,5

1Department of Zoology, University of Wisconsin, Madison, Wisconsin 53706 USA
2Department of Fish and Wildlife Resources, and Division of Statistics, University of Idaho, Moscow, Idaho 83844 USA
3National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, Santa Barbara, CA 93101 USA

Abstract. The response of a species to an environmental perturbation depends on both the direct effect of the perturbation on the population growth rate of the species and the indirect effects operating through interactions among species in a community. To estimate the importance of indirect effects, we analyzed the population dynamics of nine zooplankton species or species groups in a lake subjected to experimental manipulations of the fish community. The manipulations included additions and removals of planktivorous and piscivorous fish over a period of seven years, thereby producing changes in planktivory rates on the zooplankton community. Applying autoregressive models to time-series data, collected during weekly samples, we estimated the direct interaction strengths between species, thereby constructing a quantitative interaction web for the zooplankton community. We then used this interaction web to explore the roles of direct and indirect interactions between species in determining the long-term changes in zooplankton biomasses that were observed over the course of the experimental manipulations. The analysis identified Daphnia pulex as a keystone species. This large herbivore had strong direct interactions with other zooplankton species and was strongly affected by changes in planktivory. Consequently, changes in the biomasses of other zooplankton species during the planktivory manipulations were influenced strongly by indirect interactions acting through changes in D. pulex biomass. In addition, we used the analysis to ask whether information about the response of species to planktivory manipulations could be used to anticipate species' responses to other types of perturbation. If the direct effects of a novel perturbation on each species in a community were known, then the interaction web would help to anticipate how a novel perturbation will affect each species via direct and indirect effects through the community.

Key words: autoregressive models; community ecology; Daphnia pulex; food webs; species interactions; time-series analysis; trophic cascade; zooplankton.