Abiotic forcing in allometric trophic network models

Antti Eloranta[1], Tommi Perälä[1], and Anna Kuparinen[1]

[1]University of Jyvaskyla Faculty of Mathematics and Science

December 16, 2022

Abstract

Current ecological research and ecosystem management call for improved understanding of the abiotic drivers of community dynamics, including temperature effects on species interactions and biomass accumulation. Allometric trophic network (ATN) models provide an attractive framework to study consumer-resource interactions from organisms to ecosystems, but they rarely consider changes in some key abiotic drivers that affect e.g. consumer metabolism and producer growth. Here we investigate how seasonal changes in carrying capacity and light-dependent growth rate of producers and temperature-dependent mass-specific metabolic rate of consumers affect ATN model dynamics, namely seasonal biomass accumulation, productivity and standing stock biomass of different trophic guilds, including age-structured fish communities. Our simulations of the complex Lake Constance (LC) food web indicated marked effects of seasonal abiotic drivers on seasonal biomass accumulation of different guild groups, particularly among the lowest trophic levels (autotrophs and invertebrates). While the adjustment of irradiance level had minor effect, increasing metabolic rate associated with 1–2@C temperature increase lead to a marked decline of larval (0-year age) fish biomass, but to a substantial biomass increase of 2- and 3-year-old fish that were not predated by [?]4-year-old perch. A gradual temperature increase of 0.037@C year^{-1} observed in LC increased the productivity of highest trophic levels (i.e., juvenile and adult fish) by ca. 40–50% over the 100-year simulation period. However, when looking at biomass distribution and transfer between trophic guilds in the LC food web, inclusion of seasonal abiotic drivers caused only minor changes in average standing stock biomasses and productivity of different trophic guild groups. Our results demonstrate the potential of introducing seasonal variation in abiotic ATN model parameters to simulate within-year fluctuations in community dynamics, as well as to assess potential future community-level responses to ongoing environmental changes.

Hosted file

`OIK-08753-R1_Main-Document.docx` available at https://authorea.com/users/566952/articles/613517-abiotic-forcing-in-allometric-trophic-network-models