Effects of global environmental changes on ecosystem synchrony

Chloé Vagnon*[1], Julian D. Olden[2], Stéphanie Bouletreau[1], Rosalie Bruel[3,4], Mathieu Chevalier[5], Flavien Garcia[1], Sophie Guillon[6], Gordon Holtgrieve[2], Michelle Jackson[7], Valentin Marin[1], Alexis Millot[8], Elisa Thebault[9], Pable A. Tedesco[1], and Julien Cucherousset[1]

[1]Centre de Recherche sur la Biodiversité et l'Environnement (CRBE) – Université Paul Sabatier-Toulouse III - UPS, CNRS : UMR5300, Institut de recherche pour le développement [IRD] : UMR5300, Institut National Polytechnique de Toulouse - INPT – France
[2]School of Aquatic and Fishery Sciences – États-Unis
[3]Office Française de la Biosiversité – OFB – France
[4]Pôle RD ECLA – OFB – France
[5]Institut Français de Recherche pour l'Exploitation de la Mer – Unité Dynamiques des Ecosystèmes Côtiers (DYNECO), Laboratory of coastal Benthic Ecology (LEBCO – France
[6]Centre de Géosciences – Mines Paris - PSL (École nationale supérieure des mines de Paris) – France
[7]Oxford University – Royaume-Uni
[8]CEREEP Ecotron IDF – CNRS : UMS3194, Ecole Normale Supérieure de Paris - ENS Paris – France
[9]Institut d'écologie et des sciences de l'environnement de Paris – Institut de Recherche pour le Développement, Sorbonne Universite, Université Paris-Est Créteil Val-de-Marne - Paris 12, Centre National de la Recherche Scientifique, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement – France

Résumé

The current biodiversity crisis is associated with important changes in ecosystem functioning that profoundly affect the services provided to humans. However, ecosystem responses to global change are challenging to apprehend comprehensively. Here, we first develop the concept of ecosystem synchrony – similarity in the temporal fluctuations of an ecosystem function among ecosystems within a meta-ecosystem – to quantify the spatio-temporal extents of global change impacts on ecosystem functioning. Second, we tested whether ecosystem synchrony could be used to assess the response of ecosystems to multiple global change factors and identify desynchronizing mechanisms using experimental and field data. Experimental results demonstrated that ecosystems submitted to eutrophication, warming and predator overexploitation displayed desynchronized dynamics of dissolved oxygen concentrations and changes in the frequency of oxygen variations within and between days, weeks and months. The combined effect of warming and eutrophication tended to buffer these impacts on ecosystem metabolism while warming and predator overexploitation led to additive effects. In addition, analyses of the dynamic of dissolved oxygen concentrations in lakes within a meta-ecosystem revealed that the level of ecosystem synchrony was driven by the level of heterotrophy, food web structure and functional diversity and depended on the season of

*Intervenant

productivity considered. These findings highlight the interacting effects of anthropogenic activities in driving ecosystem functioning and regime shifts. By integrating the effects of perturbations on biotic and abiotic dynamics, ecosystem synchrony is a novel and integrative approach that allows to understand the spatio-temporal extents of environmental changes on ecosystem dynamics and identify the mechanisms leading to the alteration of ecosystem functioning. This concept opens avenues for advances in ecosystem ecology and can ultimately serve to identify early warnings signals of ecosystem regime shifts in meta-ecosystems.

Mots-Clés: ecosystem dynamics, meta, ecosystem, global change, desynchronizing drivers, early warnings