

Title: From large to small and back to large again: embracing multiple scales to understand resilience and stability of reef assemblages

Author: Lisandro Bendetti-Cecchi

Affiliation: Department of Biology, University of Pisa, URL CoNISMa, Via Derna 1, Pisa, Italy

Email: [lbenedetti@biologia.unipi.it](mailto:lbenedetti@biologia.unipi.it)

Session: Pattern of changes in marine ecosystems (invited Keynote)

Scale in ecology is a multidimensional concept, referring both to the hierarchical levels of biological organization and to the spatial and temporal extent of observations. Many fundamental ecological patterns, such as the diversity-stability, species-area and biodiversity-ecosystem functioning relationships are scale-dependent, and biodiversity itself is a hierarchical concept. Along with ecological patterns, also the mechanisms driving changes in biodiversity are scale dependent and establishing the linkages between patterns and processes across scales is key to advance ecological understanding and to manage biodiversity more effectively. Although assessing progress towards national and international conservation goals requires focusing on global trends of biodiversity, there is now substantial evidence that patterns are context-dependent. Here, I discuss the needs and opportunities for a more nuanced view of how biodiversity changes across scales. By combining observations, models and experiments, I provide examples of how a multiscale approach can advance our understanding of stability and resilience across a range of reef assemblages, including rocky intertidal biofilm, subtidal macroalgal forests, seagrasses and fishes. A synthesis of this evidence indicates that asynchronous species fluctuations, driven by or associated with changes in temperature regimes, play a crucial role in linking stability across scales. A three-dimensional characterization of thermal environments in macroalgal forests reveals a large degree of temperature heterogeneity at previously unresolved spatial and temporal scales. Understanding how these local thermal mosaics scale-up to generate regional climate patterns and their influence on stability and resilience may help reconciling context-dependency with large-scale changes in biodiversity.