

**Title:** Transient dynamics and ecological systems

**Abstract:** Analyses of both models and data in ecology are still focused on equilibrium or long-term dynamics, with some notable exceptions. Although recent work on tipping points does include approaches based both on underlying changing environments and dynamics on different time scales, the possible situations where dynamics on different time scales are important are much more general. Using new mathematical ideas one can address questions of dynamics on ecological time scales, rather than longer times, and include other kinds of underlying environmental change. The importance of this way of analyzing ecological systems is clear in consideration of changing environments due to anthropogenic influences. The analyses demonstrate that there are wide ranges of ecological situations where standard analyses based on assuming asymptotic behavior are misleading. Additional cases where explicit time dependence is included in dynamics shows further complications. Different kinds of situations where long transient behavior is expected can be identified. In particular, adding space, which essentially makes systems very high dimensional, is often likely to lead to long transient dynamics. This work also, unfortunately, points out challenges in trying to identify systems where future sudden shifts in system state due to transients are going to occur, since transient behavior of a system with long transients will be asymptotic or long-term behavior of a corresponding system without transients. Examples of ecological systems illustrating the conclusions, including coral-algal-grazer systems will be discussed in light of the general theoretical results.