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Slower recovery in space before collapse of connected populations
LEI DAI, KIRILL KOROLEV, JEFF GORE, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA. — Slower recovery from perturbations near a tipping point and its indirect signatures in fluctuation patterns have been suggested to alert catastrophes in a wide variety of systems. Recent studies of populations in the field and in the laboratory have used time-series data to confirm some of the theoretically predicted early warning indicators, such as an increase in recovery time or in the size and timescale of fluctuations. However, the performance of warning signals in spatially extended systems remains to be examined empirically. Here we use spatially extended yeast populations, an experimental system displaying a fold bifurcation, to evaluate early warning signals based on spatio-temporal fluctuations and to identify a novel warning indicator in space. We found that two leading indicators based on fluctuations increased before collapse of connected populations; however, the magnitude of increase was smaller than that observed in isolated populations, possibly because local variation is reduced by dispersal. Furthermore, we propose a generic indicator based on deterministic spatial patterns, "recovery length". As the spatial counterpart of recovery time, recovery length is defined as the distance for connected populations to recover from perturbations in space (e.g. a region of poor quality). In our experiments, recovery length increased substantially before population collapse, suggesting that the spatial scale of recovery can provide a superior warning signal before tipping points in spatially extended systems.

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