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Cooperation, cheating, and collapse in biological populations

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Natural populations can collapse suddenly in response to small changes in environmental conditions, and recovery from such a collapse can be difficult. We have used laboratory microbial ecosystems to directly measure theoretically proposed early warning signals of impending population collapse. Yeast cooperatively break down the sugar sucrose, meaning that below a critical size the population cannot sustain itself. We have demonstrated experimentally that changes in the fluctuations of the population size can serve as an early warning signal that the population is close to collapse. The cooperative nature of yeast growth on sucrose suggests that the population may be susceptible to "cheater" cells, which do not contribute to the public good and instead merely take advantage of the cooperative cells. We confirm this possibility experimentally and find that such social parasitism decreases the resilience of the population.