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A new approach for rapid detection of nearby thresholds in ecosystem time series

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Massive changes to ecosystems sometimes cross thresholds from which recovery can be difficult, expensive and slow. These thresholds are usually discovered in post hoc analyses long after the event occurred. Anticipating these changes prior to their occurrence could give managers a chance to intervene. Here we present a novel approach for anticipating ecosystem thresholds that combines resilience indicators with Quickest detection of change points. Unlike existing methods, the Quickest detection method is updated every time a data point arrives, and minimizes the time to detect an approaching threshold given the users' tolerance for false alarms. The procedure accurately detected an impending regime shift in an experimentally manipulated ecosystem. An ecosystem model was used to determine if the method can detect an approaching threshold soon enough to prevent a regime shift. When the monitored variable was directly involved in the interaction that caused the regime shift, detection was quick enough to avert collapse. When the monitored variable was only indirectly linked to the critical transition, detection came too late. The procedure is useful for assessing changes in resilience as ecosystems approach thresholds. However some thresholds cannot be detected in time to prevent regime shifts, and surprises will be inevitable in ecosystem management.