

# Conditional Heteroskedasticity Forecasts Regime Shift in a Whole-Ecosystem Experiment

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## ABSTRACT

Regime shifts in stochastic ecosystem models are often preceded by early warning signals such as increased variance and increased autocorrelation in time series. There is considerable theoretical support for early warning signals, but there is a critical lack of field observations to test the efficacy of early warning signals at spatial and temporal scales relevant for ecosystem management. Conditional heteroskedasticity is persistent periods of high and low variance that may be a powerful leading indicator of regime shift. We evaluated conditional heteroskedasticity as an early warning indicator by applying moving window conditional heteroskedasticity tests to time series of chlorophyll-*a* and

fish catches derived from a whole-lake experiment designed to create a regime shift. There was significant conditional heteroskedasticity at least a year prior to the regime shift in the manipulated lake but there was no significant conditional heteroskedasticity in an adjacent reference lake. Conditional heteroskedasticity was an effective leading indicator of regime shift for the ecosystem manipulation.

**Key words:** regime shift; conditional heteroskedasticity; Lagrange multiplier test; moving window analysis; leading indicator; early warning; ecosystem experiment.