Computer Exercise: Weeks 5 and 6
Zoology 535, Ecosystem Analysis

In this exercise we will compare different approaches for analyzing a compartment model of an ecosystem.

The particular model concerns flow of a contaminant in an agricultural ecosystem. A diagram of the model is presented in the file 'Contaminant_flow.gif'. Similar models have been used to study the effects of pesticides on vertebrate predators and biological control of insect pests in agriculture.

The box-and-arrow model can be converted to a difference equation. The key points can be seen in the file 'Contaminant_DiffEq.gif'. Harrison and Fekete (1980) present a nice summary of mathematical results for linear ecosystem models.

All programs for this exercise run in R.

Contaminant0.R computes equilibria, eigenvalues, and an example of time series output from the model.

Contaminant_LS_ML.R simulates time series with process error, and compares the parameter estimates from process-error fits using both least squares and maximum likelihood.

Contaminant_OE_PE.R simulates time series with process error and observation error. Parameters are estimated three ways: (1) by assuming process-error only, using least squares; (2) by assuming observation error only, using least-squares; and (3) by accounting for both process and observation error, using the Kalman Filter.

Exercises:

Compare the box-and-arrow diagram with the equations for the model. Write the equations as three separate equations, and as a matrix equation (see the matrix algebra handout if you need help). Are the diagram and the equations consistent?

Run Contaminant0.R. Is the model stable? Where does most of the pesticide end up? What are the implications for pest control?

Compare results of least-squares and maximum likelihood parameter estimates, using Contaminant_LS_ML.R. How well do least squares and maximum likelihood perform in estimating the parameters?

Using Contaminant_OE_PE.R, consider the consequences of ignoring, versus accounting for, observation error, when observation error is actually present. Try increasing the observation error. How do results change as observation error increases?

Reference

Harrison, G.W. and S. Fekete. 1980. Resistance of nutrient cycling systems to perturbations of flow rates. Ecological Modelling 10: 227-241.