

Computer Exercise: Week 3
Zoology 535, Ecosystem Analysis

Mass budgets are a common tool in ecosystem research, and mass balance models are among the most common models in the ecosystem toolbox.

The different components of a budget are typically measured with different degrees of precision. When all terms of a budget are measured, the values provide a check on each other because the total budget should balance.

For example, suppose the calcium budget for a watershed at Hubbard Brook Experimental Forest is

$$\text{Change in Standing Stock} = \text{Aerial Input} + \text{Weathering} - \text{Stream Export}$$

Aerial input and stream export can be measured with fairly good precision, but weathering is difficult to measure. There are at least two ways to estimate weathering, (1) literature values for similar ecosystems or (2) by difference (Change in Standing Stock - Aerial Input - Stream Export). These two estimates could be combined using Bayes' formula.

This week's computer exercise tackles a similar problem for a lake phosphorus budget. The mass balance formula is

$$\text{Change in Standing Stock} = \text{Load} - \text{Export} - \text{Sedimentation}$$

or

$$\Delta P = L - X - S$$

We will focus on load, which is sometimes the most difficult number to estimate in a phosphorus budget. By difference, $L = \Delta P + X + S$. Load can also be measured directly, by gauging the surface water inputs and measuring their phosphorus concentration.

The WinBUGS program Budget1.odc estimates the load to a hypothetical lake by combining a direct estimate of phosphorus load (as the prior) with an estimate by difference (as the likelihood).

An important assumption of this analysis is that all of the budget terms can be computed from independent measurements. Therefore their errors are independent, and

$$\text{Var}(\Delta P + X + S) = \text{Var}(\Delta P) + \text{var}(X) + \text{var}(S).$$

Experiment with Budget1.odc. How does the posterior estimate of phosphorus load change as you change the prior precision? How does the posterior estimate change with the variances of ΔP , X and S ?