Q. Rev. Biol. 55(4)



COMPARTMENTAL ANALYSIS OF ECOSYSTEM MODELS. *Statistical Ecology Series, Volume 10. A Publication from the Satellite Program in Statistical Ecology, International Statistical Ecology Program.*

*Edited by James H. Matis, Bernard C. Patten, and Gary C. White; General Editor: G. P. Patil. International Co-operative Publishing House, Fairland (Maryland).* $40.00. xxxi + 368 p.; ill.; author and subject indexes. 1979.

In a compartmental model, some substance of interest moves among a set of compartments. The substance may be a drug, radioactive tracer, nutrient, a site for a tree in a forest, or people. The compartments, which partition the system being studied, may be part of an animal's body, species of fish or of trees, the status of being susceptible, infected, or immune, for instance.

In the models studied in this book, the substance is treated as continuous or particulate; the time scale may be continuous or discrete; the motion may be controlled by the concentration of the substance in the donor compartment, the recipient compartment, or both; the motion may be deterministic or stochastic with constant, time-varying, or even randomly determined rates; retention times in a compartment may be constant, negative exponential, or arbitrarily distributed; the system of compartments may be open or closed. Thus compartmental models cover a multitude of sins.

This volume contains 16 papers (nine of them worth reading — an unusually high success rate) contributed to a 1978 meeting in Parma. The papers emphasize the analysis of models, not the analysis of ecosystems. R. V. O'Neill reviews and evaluates the uses of the linear, constant coefficient deterministic compartment model. M. C. Barber, B. C. Patten, and J. T. Finn compare stochastic and deterministic input-output flow models. C. Cobelli, A. Lepschy, and G. Romanin Jacur review criteria for the identifiability of compartment models. G. C. White and G. M. Clark offer procedures for determining whether the variability in the behavior of a compartmental system is due to sampling fluctuations or to fluctuations in the flow rates of the system. R. E. Bargmann shows how to assess the reliability of future extrapolation based on a model fitted to observations made over a short time. J. H. Matis and T. E. Wehrly offer a useful taxonomy of stochastic and deterministic models, and show how stochastic models with identical average behavior can be distinguished on the basis of their covariance structure. A. H. Marcus describes how semi-Markov processes can simplify modeling, and applies them to forest succession and the body-burden of lead. M. E. Wise suggests that excretion and retention data that have been fitted by sums of negative exponentials are sometimes better described by power functions of time. K. B. Gerald and J. H. Matis compute the cumulants and study estimators for donor- and recipient-controlled stochastic models.

Compartment models are used in the management of biological resources like fisheries and in environmental impact assessment. Because these models are important practically, I find the methodological sophistication of these papers reassuring. The essays in this book, however, neglect three basic issues. First, how does one decide what are the compartments? To carve a chicken nicely, one must cut at the joints. How does one find the joints of an ecosystem? Second, is there any evidence to support, or any procedure to test, the memoryless or ahistorical assumption built into every compartmental model? The future flow of a particle is never assumed to depend on the compartments it has occupied prior to its present compartment, in these models. Is this assumption true? Third, by what criteria could one reject the dynamic predictions of a compartmental model? I look forward to the development of methods to answer the questions.

JOEL E. COHEN, *The Rockefeller University, New York*, and *International Institute for Applied Systems Analysis, Laxenburg, Austria*