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Modeling in ecology

Mathematical Modeling in Ecology. A Workbook for Students. Clark Jeffries. 1989, Boston, Birkhauser; pp. 203; size 160 × 240 mm.

According to Immanuel Kant, the eighteen century philosopher, there is as much science as mathematics in human cognition. Although probably few bioscientists share this conviction, one must acknowledge that there are some biosciences where the role of mathematics is important. An example is ecology, where mathematical models not only predict the behavior of ecosystems and help to understand some aspects of their functioning, but also give a framework organizing ecological scientific thought.

The book of C. Jeffries was intended by the author to provide a student of ecology with some background in mathematical ecology. It was aimed to teach the student how to express the concept of ecosystem in terms of systems, compartments, energy and biomass flows; and how to evaluate system stability qualitatively and quantitatively.

The book introduces the reader into the basic terms used in mathematical modeling. Difference equation dynamical systems are presented using simple Lotka–Volterra model and a simple stochastic difference equation dynamical system. Then differential equation dynamical systems are demonstrated together with simple ecosystem models. Limit cycles, Lyapunov theory of stability, and Hurwitz stability tests are introduced. An interesting part of the book presents qualitative stability tests using signed digraphs. Another one is on chaotic dynamics of ecosystems. The author introduces then holistic ecosystem models based on energy flow and presents his own theorems which may be used to evaluate their stability. In the last chapter, which seems to be isolated from previous parts of the book, there is a realistic model of prairie ecosystem.

The author claims that only a background in the elements of calculus and linear algebra as normally taught in introductory university courses is needed to understand the main ideas of the book. Generally this is true, although some mathematical terms happen to be used before being defined, and some sections of the book (problems and proofs of theorems) require quite a good competence in using simple mathematical techniques.

The book is written in easy language, rich in examples and illustrated with drawings. Several short and simple computer programs in Basic, Lotus 1-2-3 and HP-41 programming language listed in the book enable to trace the behavior of some modeled ecosystems. Another advantage of the book are its numerous exercises and problems, so the reader may practice mathematical tools just learned.

A good idea, to some extent implemented in the book, is to combine the mathematical analysis of ecosystem model with computer simulation. For readers oriented on applications of mathematical modeling such an approach is of great didactic value. However, Lotus 1-2-3 and HP-41 languages are not appropriate for educational purposes because the programs are confused and enigmatic. The use of Pascal or in the worst case Basic would make the programs understandable.

The camera-ready copies of the book were prepared by the author himself. Unfortunately, this did not exclude many typing errors, most of them in mathematical formulas and expressions. Especially the last chapter, where the model of prairie ecosystem is presented, swarms with errors. Errors may be found in Basic and Lotus 1-2-3 program listings, as well.

Despite all the drawbacks the book may be recommended to students and to ecologists wishing to be introduced into mathematical modeling, particularly if they had no strong mathematical background.

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