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1-1-1982

Book Review: Populist Systems: A General Introduction

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Johnson, Douglas H., "Book Review: Populist Systems: A General Introduction" (1982). *USGS Northern Prairie Wildlife Research Center.* Paper 215.
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Population Systems: A General Introduction. By Alan A. Berryman. Plenum Press, New York, N.Y. and London, U.K. 1981. xv, 222pp. $16.95 (cloth).

The profession of wildlife management has had an incomplete evolution into wildlife ecology if we are to believe that names of university departments accurately reflect current status. This transition implies less emphasis on doing and greater emphasis on understanding. I term the evolution incomplete because wildlife biologists have not fully embraced all the tools of ecology. One such tool is population ecology. Certainly we have studied wildlife population dynamics, but often with a narrow focus, viewing as unique a particular group of animals in a certain area at some specified time. Less often have we endeavored to draw together our knowledge into a comprehensive theory of more general applicability. Alan A. Berryman, a forest entomologist with a background in population dynamics, has successfully organized a theory of population ecology based on the mathematical theory of systems analysis.

Berryman's book will not solve all problems in wildlife biology, but it provides a perspective on population dynamics different from our norm, and one that may lead to fresh insights into our problems. It should be useful for undergraduate and graduate courses in population dynamics as well as for the practicing ecologist with a mathematical inclination.

The book contains 6 chapters, the first of which briefly describes systems in general. Featured are such topics as dynamic systems, system diagraming conventions, feedback, feedforward, and control. It concludes by indicating the role in biology of systems analysis, a theory developed primarily by engineers.

An elementary model of a single population is constructed in Chapter 2. The derivation of the logistic model of population growth is well motivated and illustrates the richness of behaviors that can be obtained from a simple model.

Population regulation is developed more fully in Chapter 3, which considers competitive and cooperative processes in density-dependent systems. Of particular management importance is the notion of multiple equilibrium points for a population, a situation that can arise, for example, if cooperative processes dominate at 1 level of density and competitive processes at another. Such circumstances may be common in nature and might explain why some populations do not recover from severe depletion even though the habitat is favorable, and why certain populations occasionally increase sharply. It may also provide a rationale for reintroduction efforts; a population still persisting but at a low level might move to a higher equilibrium if it is augmented by a large number of individuals. I would enjoy seeing this theory applied to some of the situations faced by wildlife managers, such as protection of rare species, reintroduction of depleted populations, and control of abundant pest species.

Chapter 4 treats systems with 2 interacting species; the mathematical complexity grows in proportion to the biological complications. Despite its difficulty, this chapter contains much important material and is worthy of serious study. Among the topics are cooperative and competitive interactions between species, and predator-prey interactions, including predator functional responses and strategies of prey and predators. Hypotheses of potential value to wildlife and fishery managers are interspersed throughout the book. One in this chapter is the extension to 2 species of the possibility of multiple equilibrium points in animal communities; the relationship between overharvested sardine stocks and the subsequent rise of anchovy fisheries is cited as a possible example. Berryman cautions that such

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tales do not prove the theory, but my own opinion is that a theoretical framework is needed, for only theories can provide testable and refutable hypotheses which are necessary to advance our understanding.

Complications due to spatial interactions are discussed in Chapter 5. Berryman presents the spruce budworm as an example involving spatial as well as temporal dynamics; an important implication here is that an epidemic can be prevented by treating a relatively small area (the epicenter), an alternative to costly and environmentally hazardous large-scale treatments. Spatial aspects are also shown to afford stability to an otherwise unstable system.

Chapter 6 offers a brief introduction to ecological communities, a link between population dynamics and community ecology. Most attention is given to the stability of communities and to the long-standing question of whether or not complex communities are more stable than simple ones. Berryman introduces the technique of loop analysis to evaluate the stability of a feedback system. This topic makes for some rather rough going, but references to other literature will guide those with whetted appetites.

Each chapter concludes with some exercises which allow the reader to take pencil and paper to the theory and mathematics developed in the chapter. The exercises, in conjunction with answers given at the end of the book, facilitate understanding for the independent reader. I suspect, however, that the latter chapters will be difficult for most students without an instructor, and that lively classroom interplay would make the learning more enjoyable and permanent.

A short epilogue to the book applies some of the theory developed earlier to the problem of human population growth, which is treated as a cooperative process. The negative feedback controls of the system—disease, starvation, predators, etc.—have now been overwhelmed and the system is in a positive feedback loop which results in unstable growth. Berryman ascribes many of today's ecological problems to economic attitudes, particularly those evolved from ideas of David Ricardo, a proponent of economic growth and a contemporary and intellectual competitor of Thomas Malthus. Ricardo's economic theories were followed instead of Malthus', a choice now lamented.—**Douglas H. Johnson,** U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, ND 58401.