

Preface to the Third Edition

When the second edition of this book was nearly exhausted, and orders were grinding to a halt, Springer urged me to do a third edition. At the age of 90 I said that was out of the question, but perhaps a co-author could be found. I spoke to several distinguished demographers, and the general drift of their replies was that the book was complete and well-rounded (my own opinion!) and there was nothing that could be usefully added.

We were monumentally wrong. We hadn't noticed the world of whales and birds and land animals, i.e., the world of biology. Hal Caswell has drastically broadened the perspective. Just as Alfred Lotka went far beyond the human species, so does Caswell. That wider perspective is fully incorporated in this third edition. It should not only be of interest to demographers, but to scholars of wide areas of biology. I can't thank Joel Cohen enough for realizing this and putting me on to Hal Caswell. His work on the third edition makes it a very different and much better book. Without Caswell, the book would have died with the second edition.

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The request from Nathan Keyfitz that I collaborate on a new edition of *Applied Mathematical Demography* came out of the blue. The prospect was daunting. After all, when I began to study demographic analysis, Keyfitz's *Introduction to the Mathematics of Population* (1968) was the book that I turned to first. As for *Applied Mathematical Demography*, it had always seemed to me to embody a level of analytical insight that I could only envy.

But I accepted the invitation. Keyfitz's suggestion that we incorporate some of my earlier work on matrix population models seemed like a good way to complement the methods presented in the book, and to expand the range of their applications.

I am a demographer of plants and nonhuman animals. Some would call this an oxymoron, since the Greek root *demos* refers to people, and that's us. But there are precedents for taking more inclusive definitions of the Greek. Ecology and economics, for example, both come from the root *oikos*, referring to the household. Interpreting *demos* as referring to individuals, whether they are persons or not, lets demography apply across species. There is a long tradition of such crossover. Alfred J. Lotka is acknowledged as a founding father of both demography and ecology. Raymond Pearl used demographic methods to analyze the effects of toxic substances and crowding on fruit flies. Lee (1987) compared the density-dependence of the vital rates of human and non-human animals. Today, in studies of senescence, reproduction, and individual heterogeneity, the boundaries between animal and human studies are becoming increasingly blurred (Wachter et al. 1997, Carey 2003, Wachter and Bulatao 2003, Carey and Tuljapurkar 2003).

Matrix population models were developed in the 1940s by Patrick Leslie, an animal ecologist (Leslie 1945, 1948). They lay fallow until the mid-1960s when ecologists (Lefkovich 1963, 1965) and human demographers (Keyfitz 1964, 1967, Rogers 1966) both rediscovered them. Both human demographers and ecologists needed to go beyond age-classified life table methods, because factors other than age affect the fates of individuals, regardless of species. In the 1970s this line of investigation was explored intensively by plant ecologists because the life cycles of plants, with their plasticity of development and multiple modes of reproduction, are particularly ill-suited to age-classified models. Now, stage-classified matrix population models are the most widely used framework for plant and animal demography, with applications in conservation biology, resource management, and pest control. All these ecological applications have parallels in human demography, in which the vital rates differ among individuals depending on age and other properties, and population dynamics depend on those vital rates and their variation in time and space. Modern mathematical software makes matrix methods not only theoretically appealing, but also practical tools for applied demographic analysis.

Much of the material on matrix population models in this book is extracted from the comprehensive treatment in *Matrix Population Models: Construction, Analysis, and Interpretation*, 2d edition (H. Caswell, 2001, Sinauer Associates, Sunderland, Massachusetts; www.sinauer.com). This book is referenced here as MPM.

We have made relatively few changes to the text of the second edition. Some topics have been rearranged, and we have added recent references, to permit a student access to current developments. We have purposely not removed many of the old references; they provide a valuable history of

the development of the ideas, and are interesting in their own right. We have tried to unify the mathematical notation, we hope without confusing readers, whether more familiar with human demography or ecology.

On data in Applied Mathematical Demography

Applied Mathematical Demography is not—nor was in its first two editions—a book about demographic trends and patterns. Instead, it is a book about the theory underlying, and applied to, population dynamics. The empirical data shown here must be recognized for what they are: examples of how to apply analyses and interpret the results. Do not take them for a description of the state of the world.

For example, Section 10.1 analyzes the age distribution, especially the percentages under 15 and over 65, in three countries (Taiwan, the United States, and France) in 1965. Even when the first edition was published in 1977, this tabulation would hardly have qualified as even a cursory summary of age distributions around the world. Certainly the demography of each of these countries has changed in the last four decades. How would the comparison look now? How would other countries fit into the picture in the twenty-first century? The only way to find out would be to repeat the analysis with contemporary data. The same is true of all the other data appearing as examples here.

Asking students to conduct such analyses would be an excellent teaching tool. The exercise would not only help to clarify the theory; it would also hone two skills that, while critically important, are beyond the scope of this book. One is obtaining and evaluating demographic data. The other is implementing the calculations on the computer. The latter task has changed so much since 1985 (to say nothing of 1977) as to be unrecognizable. Mathematical software, readily available for personal computers, makes even complicated analyses easy. One of the best, especially for matrix calculations, is MATLAB® (The Mathworks, 3 Apple Hill Drive, Natick, MA 01760-2098, USA; www.mathworks.com), which was used for the matrix calculations in this book.

Acknowledgments

I thank the many excellent collaborators with whom I have had the good fortune to work. Special thanks to Joel Cohen, Christine Hunter, and Michael Neubert. I am grateful for support from the National Science Foundation (grants DEB-9973518 and DEB-0235692), the National Oceanic and Atmospheric Administration (grant NA03NMF4720491), the Environmental Protection Agency (grant R-82908901), the David and Lucille Packard Foundation (grant 2000-01740), and the Robert W. Morse Chair at the Woods Hole Oceanographic Institution. The writing process was aided by support from a MacLaurin Fellowship of the New Zealand Institute of Mathematics and its Applications, and by the hospitality of the Statis-

tics Department at the University of Auckland. I owe a special thanks to Sinauer Associates for their permission to use material from *Matrix Population Models*, where a much more detailed treatment of these models may be found.

Finally, my deepest thanks go to Nathan Keyfitz, for his contributions to mathematical demography over a remarkably long and productive career, and for the privilege of working with him on this book.

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Applied Mathematical Demography

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2005, XXVI, 558 p. 74 illus., Hardcover

ISBN: 978-0-387-22537-1