



# Preface

This is the fourth edition of *Fundamentals of Ecological Modelling*, and we have given it a longer title: *Fundamentals of Ecological Modelling: Application in Environmental Management and Research*. This was done to emphasize that models, applied in environmental management and ecological research, are particularly considered in the model illustrations included in this book.

Giuseppe Bendoricchio, co-author of the third edition published in 2001, passed away in 2005. We would therefore like to dedicate this book to his memory and his considerable contributions in the 1980s and 1990s to the development of ecological modelling.

The first two editions of this book (published in 1986 and 1994) focused on the roots of the discipline — the four main model types that dominated the field 30-40 years ago: (1) dynamic biogeochemical models, (2) population dynamic models, (3) ecotoxicological models, and (4) steady-state biogeochemical and energy models. Those editions offered the first comprehensive textbook on the topic of ecological modelling. The third edition, with substantial input from Bendoricchio, focused on the mathematical formulations of ecological processes that are included in ecological models. In the third edition, the chapter called Ecological Processes encompasses 118 pages. The same coverage of this topic today would probably require 200 pages, and is better covered in the *Encyclopedia of Ecology*, which was published in the fall of 2008.

This fourth edition uses the four model types previously listed as the foundation and expands the latest model developments in spatial models, structural dynamic models, and individual-based models. As these seven types of models are very different and require different considerations in the model development phase, we found it important for an up-to-date textbook to devote a chapter to the development of each of the seven model types. Throughout the text, the examples given from the literature emphasize the application of models for environmental management and research. Therefore the book is laid out as follows:

Chapter 1: Introduction to Ecological Modelling provides an overview of the topic and sets the stage for the rest of the book.

Chapter 2: Concepts of Modelling covers the main modelling elements of compartments (state variables), connections (flows and the mathematical equations used to represent biological, chemical, and physical processes), controls (parameters, constants), and forcing functions that drive the systems. It

also describes the modelling procedure from conceptual diagram to verification, calibration, validation, and sensitivity analysis.

Chapter 3: An Overview of Different Model Types critiques when each type should or could be applied.

Chapter 4: Mediated or Institutionalized Modelling presents a short introduction to using the modelling process to guide research questions and facilitate stakeholder participation in integrated and interdisciplinary projects.

Chapter 5: Modelling Population Dynamics covers the growth of a population and the interaction of two or more populations using the Lotka-Volterra model, as well as other more realistic predator–prey and parasitism models. Examples include fishery and harvest models, metapopulation dynamics, and infection models.

Chapter 6: Steady-State Models discusses chemostat models, Ecopath software, and ecological network analysis.

Chapter 7: Dynamic Biogeochemical Models are used for many applications starting with the original Streeter-Phelps model up to the current complex eutrophication models.

Chapter 8: Ecotoxicological Models provides a thorough investigation of the various ecotoxicological models and their use in risk assessment and environmental management.

Chapter 9: Individual-based Models discusses the history and rise of individual-based models as a tool to capture the self-motivated and individualistic characteristics individuals have on their environment.

Chapter 10: Structurally Dynamic Models presents 21 examples of where model parameters are variable and adjustable to a higher order goal function (typically thermodynamic).

Chapter 11: Spatial Modelling covers the models that include spatial characteristics that are important to understanding and managing the system.

This fourth edition is maintained as a textbook with many concrete model illustrations and exercises included in each chapter. The previous editions have been widely used as textbooks for past courses in ecological modelling, and it is the hope of the authors that this edition will be an excellent basis for today's ecological modelling courses.

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