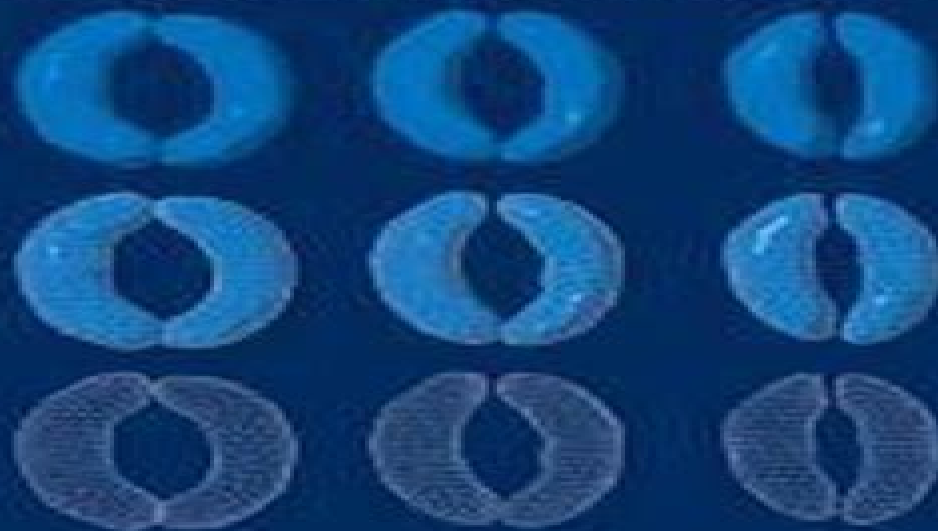


JAMES W. HAEFNER

MODELING BIOLOGICAL SYSTEMS

Principles and Applications



 Springer



Modeling Biological Systems Principles And Application

**Daniel Wallach, David Makowski, James
W. Jones, Francois Brun**



Modeling Biological Systems Principles And Application:

Modeling Biological Systems: James W. Haefner, 2005-12-05 I Principles 1 1 Models of Systems 3 1 1 Systems Models and Modeling 3 1 2 Uses of Scientific Models 4 1 3 Example Island Biogeography 6 1 4 Classifications of Models 10 1 5 Constraints on Model Structure 12 1 6 Some Terminology 12 1 7 Misuses of Models The Dark Side 13 1 8 Exercises 15 2 The Modeling Process 17 2 1 Models Are Problems 17 2 2 Two Alternative Approaches 18 2 3 An Example Population Doubling Time 24 2 4 Model Objectives 28 2 5 Exercises 30 3 Qualitative Model Formulation 32 3 1 How to Eat an Elephant 32 3 2 Forrester Diagrams 33 3 3 Examples 36 3 4 Errors in Forrester Diagrams 44 3 5 Advantages and Disadvantages of Forrester Diagrams 44 3 6 Principles of Qualitative Formulation 45 3 7 Model Simplification 47 3 8 Other Modeling Problems 49 viii Contents 3 9 Exercises 53 4 Quantitative Model Formulation I 4 1 From Qualitative to Quantitative Finite Difference Equations and Differential Equations 4 2 4 3 Biological Feedback in Quantitative Models 4 4 Example Model 4 5 Exercises 5 Quantitative Model Formulation II 81 5 1 Physical Processes 81 5 2 Using the Toolbox of Biological Processes 89 5 3 Useful Functions 96 5 4 Examples 102 5 5 Exercises 104 6 Numerical Techniques 107 6 1 Mistakes Computers Make 107 6 2 Numerical Integration 110 6 3 Numerical Instability and Stiff Equations 115 **Modeling Biological Systems** James W. Haefner, 1996-07-01

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Sociocybernetics Rudolf F. Geyer, Johannes van der Zouwen, 2001-01-30 In an effort to shed light on recent developments in sociocybernetic research this volume represents recent and advanced thinking in this rapidly developing field The authors address the core problems in social science caused by increasing societal complexity and analyze the inadequacy of many of the methodological tools still used for grappling with nonlinear self organizing systems Together the 18 contributors propose elements of a new methodology based on sociocybernetic principles aimed at describing and explaining the growth of societal complexity the contribution of autopoiesis of societal subunits to more societal complexity and the new simulation based methodology needed to observe complex social systems This unique volume contributes to a greater understanding of sociocybernetics and its uses as a method for researching modern problems of increasing complexity and interdependence The first part of the book deals with increasing societal complexity and contains chapters on its overall development the complexity of brain environment interaction loops organizational change the development of human values and the increasing interpenetration of societal subsystems The second part concentrates on a current issue in sociocybernetics autopoiesis or self production The chapters included in Part II concentrate on embodied cognition on the applicability of autopoiesis to business firms on its roots in Aristotelian philosophy and on the possibility of societal control and steering in democratic societies Part III more focused on methodology discusses the difficulties inherent in observing complex social systems The chapters deal with the problems of cross cultural comparative research simulation of the evolution of social systems longitudinal simulation of education systems and the methodological difficulties associated with analyzing the unexpected complexities of mutually interacting nonlinear systems

Modeling for All Scales Howard T. Odum, Elisabeth C. Odum, 2000-02-03 All manner of models are used to describe simulate extrapolate and ultimately understand the function of dynamic systems These sorts of models are usually based upon a mathematical foundation that can be difficult to manipulate especially for students Modeling for All Scales uses object oriented programming to erect and evaluate the efficacy of models of small intermediate and large scale systems Such models allow users to employ intuitively based symbols and a systems ecology approach The authors have been leaders in the systems ecology community and have originated much of the scientific vocabulary of the field After introducing modeling and its benefits there is a series of chapters detailing the more particular elements of successful simulation There follows another series of chapters each

devoted to models of different sorts of systems Small scale models of growth competition and evolution give way successively to larger and larger scale models such as international trade and the global geobiosphere Anyone interested in an easy to use approach to modeling complex systems authored by perhaps the most original systems ecologists of the century will want this book To further enhance the users ability to apply the lessons of this book there is included a CD ROM disc which provides the fundamental tools for modeling at all scales Key Features The book makes it possible to teach modeling and simulation without much prior knowledge of mathematics Reasons for modeling and simulation are discussed The book makes modeling and simulation fun by keeping focused on simplified overview minimodels that have important principles to science and society The steps in successive chapters are arranged so that readers can teach themselves modeling simulation and the programming necessary to simulate the systems they diagram The CD ROM has minimodel programs and versions of QuickBasic and EXTEND to run them

Modeling and Simulation in Ecotoxicology with Applications in MATLAB and Simulink Kenneth R. Dixon, 2011-08-24 Exploring roles critical to environmental toxicology Modeling and Simulation in Ecotoxicology with Applications in MATLAB and Simulink covers the steps in modeling and simulation from problem conception to validation and simulation analysis Using the MATLAB and Simulink programming languages the book presents examples of mathematical functions and simulations with special emphasis on how to develop mathematical models and run computer simulations of ecotoxicological processes Designed for students and professionals with little or no experience in modeling the book includes General principles of modeling and simulation and an introduction to MATLAB and Simulink Stochastic modeling where variability and uncertainty are acknowledged by making parameters random variables Toxicological processes from the level of the individual organism with worked examples of process models in either MATLAB or Simulink Toxicological processes at the level of populations communities and ecosystems Parameter estimation using least squares regression methods The design of simulation experiments similar to the experimental design applied to laboratory or field experiments Methods of postsimulation analysis including stability analysis and sensitivity analysis Different levels of model validation and how they are related to the modeling purpose The book also provides three individual case studies The first involves a model developed to assess the relative risk of mortality following exposure to insecticides in different avian species The second explores the role of diving behavior on the inhalation and distribution of oil spill naphthalene in bottlenose dolphins The final case study looks at the dynamics of mercury in Daphnia that are exposed to simulated thermal plumes from a hypothetical power plant cooling system Presented in a rigorous yet accessible style the methodology is versatile enough to be readily applicable not only to environmental toxicology but a range of other biological fields

Systems Science and Modeling for Ecological Economics Alexey A. Voinov, 2010-07-27 Modeling is a key component to sciences from mathematics to life science including environmental and ecological studies By looking at the underlying concepts of the software we can make sure that we build mathematically feasible models and that we get the most out of the

data and information that we have Systems Science and Modeling for Ecological Economics shows how models can be analyzed using simple math and software to generate meaningful qualitative descriptions of system dynamics This book shows that even without a full analytical mathematically rigorous analysis of the equations there may be ways to derive some qualitative understanding of the general behavior of a system By relating some of the modeling approaches and systems theory to real world examples the book illustrates how these approaches can help understand concepts such as sustainability peak oil adaptive management optimal harvest and other practical applications Relates modeling approaches and systems theory to real world examples Teaches students to build mathematically feasible models and get the most out of the data and information available Wide range of applications in hydrology population dynamics market cycles sustainability theory management and more

Individual-based Modeling and Ecology Volker Grimm, Steven F. Railsback, 2013-11-28 Individual based models are an exciting and widely used new tool for ecology These computational models allow scientists to explore the mechanisms through which population and ecosystem ecology arises from how individuals interact with each other and their environment This book provides the first in depth treatment of individual based modeling and its use to develop theoretical understanding of how ecological systems work an approach the authors call individual based ecology Grimm and Railsback start with a general primer on modeling how to design models that are as simple as possible while still allowing specific problems to be solved and how to move efficiently through a cycle of pattern oriented model design implementation and analysis Next they address the problems of theory and conceptual framework for individual based ecology What is theory That is how do we develop reusable models of how system dynamics arise from characteristics of individuals What conceptual framework do we use when the classical differential equation framework no longer applies An extensive review illustrates the ecological problems that have been addressed with individual based models The authors then identify how the mechanics of building and using individual based models differ from those of traditional science and provide guidance on formulating programming and analyzing models This book will be helpful to ecologists interested in modeling and to other scientists interested in agent based modeling

Working with Dynamic Crop Models Daniel Wallach, David Makowski, James W. Jones, Francois Brun, 2013-11-25 This second edition of Working with Dynamic Crop Models is meant for self learning by researchers or for use in graduate level courses devoted to methods for working with dynamic models in crop agricultural and related sciences Each chapter focuses on a particular topic and includes an introduction a detailed explanation of the available methods applications of the methods to one or two simple models that are followed throughout the book real life examples of the methods from literature and finally a section detailing implementation of the methods using the R programming language The consistent use of R makes this book immediately and directly applicable to scientists seeking to develop models quickly and effectively and the selected examples ensure broad appeal to scientists in various disciplines 50% new content 100% reviewed and updated Clearly explains practical application of the methods presented including R

language examples Presents real life examples of core crop modeling methods and ones that are translatable to dynamic system models in other fields

Introduction to Mathematical Modeling of Crop Growth Christopher B. S. Teh, 2006
 Learning mathematical modeling need not be difficult Unlike other books this book not only lists the equations one by one but explains in detail how they are each derived used and finally assembled into a computer program for model simulations This book shows how mathematics is applied in agriculture in particular to modeling the growth and yield of a generic crop Topics covered are agriculture meteorology solar radiation interception and absorption evapotranspiration energy and soil water balance soil water flow photosynthesis respiration and crop growth development Rather than covering many modeling approaches but in superficial detail this book selects one or two widely used modeling approaches and discusses about them in depth Principles learned from this book equips readers when they encounter other modeling approaches or when they develop their own crop models

Encyclopedia of Biodiversity, 2013-02-05 The 7 volume Encyclopedia of Biodiversity Second Edition maintains the reputation of the highly regarded original presenting the most current information available in this globally crucial area of research and study It brings together the dimensions of biodiversity and examines both the services it provides and the measures to protect it Major themes of the work include the evolution of biodiversity systems for classifying and defining biodiversity ecological patterns and theories of biodiversity and an assessment of contemporary patterns and trends in biodiversity The science of biodiversity has become the science of our future It is an interdisciplinary field spanning areas of both physical and life sciences Our awareness of the loss of biodiversity has brought a long overdue appreciation of the magnitude of this loss and a determination to develop the tools to protect our future Second edition includes over 100 new articles and 226 updated articles covering this multidisciplinary field from evolution to habits to economics in 7 volumes The editors of this edition are all well respected instantly recognizable academics operating at the top of their respective fields in biodiversity research readers can be assured that they are reading material that has been meticulously checked and reviewed by experts Approximately 1 800 figures and 350 tables complement the text and more than 3 000 glossary entries explain key terms

Ecological Models for Regulatory Risk Assessments of Pesticides Pernille Thorbek, 2009-11-24 Bringing together more than thirty influential regulators academics and industry scientists Ecological Models for Regulatory Risk Assessments of Pesticides Developing a Strategy for the Future provides a coherent science based view on ecological modeling for regulatory risk assessments It discusses the benefits of modeling in the context of r

Learning Landscape Ecology Sarah E. Gergel, Monica G. Turner, 2017-03-30 This title meets a great demand for training in spatial analysis tools accessible to a wide audience Landscape ecology continues to grow as an exciting discipline with much to offer for solving pressing and emerging problems in environmental science Much of the strength of landscape ecology lies in its ability to address challenges over large areas over spatial and temporal scales at which decision making often occurs As the world tackles issues related to sustainability and global change the need for this

broad perspective has only increased Furthermore spatial data and spatial analysis core methods in landscape ecology are critical for analyzing land cover changes world wide While spatial dynamics have long been fundamental to terrestrial conservation strategies land management and reserve design mapping and spatial themes are increasingly recognized as important for ecosystem management in aquatic coastal and marine systems This second edition is purposefully more applied and international in its examples approaches perspectives and contributors It includes new advances in quantifying landscape structure and connectivity such as graph theory as well as labs that incorporate the latest scientific understanding of ecosystem services resilience social ecological landscapes and even seascapes Of course as before the exercises emphasize easy to use widely available software <http://sarahgergel.net/lel/> learning landscape ecology *Models in Ecosystem Science* Charles D. Canham, Jonathan J. Cole, William K. Lauenroth, 2021-04-13 Quantitative models are crucial to almost every area of ecosystem science They provide a logical structure that guides and informs empirical observations of ecosystem processes They play a particularly crucial role in synthesizing and integrating our understanding of the immense diversity of ecosystem structure and function Increasingly models are being called on to predict the effects of human actions on natural ecosystems Despite the widespread use of models there exists intense debate within the field over a wide range of practical and philosophical issues pertaining to quantitative modeling This book which grew out of a gathering of leading experts at the ninth Cary Conference explores those issues The book opens with an overview of the status and role of modeling in ecosystem science including perspectives on the long running debate over the appropriate level of complexity in models This is followed by eight chapters that address the critical issue of evaluating ecosystem models including methods of addressing uncertainty Next come several case studies of the role of models in environmental policy and management A section on the future of modeling in ecosystem science focuses on increasing the use of modeling in undergraduate education and the modeling skills of professionals within the field The benefits and limitations of predictive versus observational models are also considered in detail Written by stellar contributors this book grants access to the state of the art and science of ecosystem modeling

An Introduction to Structured Population Dynamics J. M. Cushing, 1998-01-01 Interest in the temporal fluctuations of biological populations can be traced to the dawn of civilization How can mathematics be used to gain an understanding of population dynamics This monograph introduces the theory of structured population dynamics and its applications focusing on the asymptotic dynamics of deterministic models This theory bridges the gap between the characteristics of individual organisms in a population and the dynamics of the total population as a whole In this monograph many applications that illustrate both the theory and a wide variety of biological issues are given along with an interdisciplinary case study that illustrates the connection of models with the data and the experimental documentation of model predictions The author also discusses the use of discrete and continuous models and presents a general modeling theory for structured population dynamics Cushing begins with an obvious point individuals in biological populations differ

with regard to their physical and behavioral characteristics and therefore in the way they interact with their environment Studying this point effectively requires the use of structured models Specific examples cited throughout support the valuable use of structured models Included among these are important applications chosen to illustrate both the mathematical theories and biological problems that have received attention in recent literature

A First Course in Systems Biology
 Eberhard Voit, 2017-09-05 A First Course in Systems Biology is an introduction for advanced undergraduate and graduate students to the growing field of systems biology Its main focus is the development of computational models and their applications to diverse biological systems The book begins with the fundamentals of modeling then reviews features of the molecular inventories that bring biological systems to life and discusses case studies that represent some of the frontiers in systems biology and synthetic biology In this way it provides the reader with a comprehensive background and access to methods for executing standard systems biology tasks understanding the modern literature and launching into specialized courses or projects that address biological questions using theoretical and computational means New topics in this edition include default modules for model design limit cycles and chaos parameter estimation in Excel model representations of gene regulation through transcription factors derivation of the Michaelis Menten rate law from the original conceptual model different types of inhibition hysteresis a model of differentiation system adaptation to persistent signals nonlinear nullclines PBPK models and elementary modes The format is a combination of instructional text and references to primary literature complemented by sets of small scale exercises that enable hands on experience and large scale often open ended questions for further reflection

Landscape Ecology in Theory and Practice Monica G. Turner, Robert H. Gardner, 2015-10-29 This work provides in depth analysis of the origins of landscape ecology and its close alignment with the understanding of scale the causes of landscape pattern and the interactions of spatial pattern with a variety of ecological processes The text covers the quantitative approaches that are applied widely in landscape studies with emphasis on their appropriate use and interpretation The field of landscape ecology has grown rapidly during this period its concepts and methods have matured and the published literature has increased exponentially Landscape research has enhanced understanding of the causes and consequences of spatial heterogeneity and how these vary with scale and they have influenced the management of natural and human dominated landscapes Landscape ecology is now considered mainstream and the approaches are widely used in many branches of ecology and are applied not only in terrestrial settings but also in aquatic and marine systems In response to these rapid developments an updated edition of Landscape Ecology in Theory and Practice provides a synthetic overview of landscape ecology including its development the methods and techniques that are employed the major questions addressed and the insights that have been gained

Flavour Development, Analysis and Perception in Food and Beverages J K Parker, Stephen Elmore, Lisa Methven, 2014-11-19 Flavour is a critical aspect of food production and processing requiring careful design monitoring and testing in order to create an appealing food product This book looks at

flavour generation flavour analysis and sensory perception of food flavour and how these techniques can be used in the food industry to create new and improve existing products Part one covers established and emerging methods of characterising and analysing taste and aroma compounds Part two looks at different factors in the generation of aroma Finally part three focuses on sensory analysis of food flavour Covers the analysis and characterisation of aromas and taste compounds Examines how aromas can be created and predicted Reviews how different flavours are perceived

The International Conference on Advanced Machine Learning Technologies and Applications (AMLTA2019) Aboul Ella Hassanien,Ahmad Taher Azar,Tarek Gaber,Roheet Bhatnagar,Mohamed F. Tolba,2019-03-16 This book presents the peer reviewed proceedings of the 4th International Conference on Advanced Machine Learning Technologies and Applications AMLTA 2019 held in Cairo Egypt on March 28 30 2019 and organized by the Scientific Research Group in Egypt SRGE The papers cover the latest research on machine learning deep learning biomedical engineering control and chaotic systems text mining summarization and language identification machine learning in image processing renewable energy cyber security and intelligence swarms and optimization

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Modeling Biological Systems Principles And Application Introduction

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