

Why Math Modeling in Ecology?

- Historically important role of math in ecology
- Our group focuses on math applications in ecology
- Models of invasive species



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Mathematical Modeling In Ecology

Olcay Akman, Christopher Hay-Jahans



Mathematical Modeling In Ecology:

A Biologist's Guide to Mathematical Modeling in Ecology and Evolution Sarah P. Otto, Troy Day, 2007-03-12 Thirty years ago biologists could get by with a rudimentary grasp of mathematics and modeling Not so today In seeking to answer fundamental questions about how biological systems function and change over time the modern biologist is as likely to rely on sophisticated mathematical and computer based models as traditional fieldwork In this book Sarah Otto and Troy Day provide biology students with the tools necessary to both interpret models and to build their own The book starts at an elementary level of mathematical modeling assuming that the reader has had high school mathematics and first year calculus Otto and Day then gradually build in depth and complexity from classic models in ecology and evolution to more intricate class structured and probabilistic models The authors provide primers with instructive exercises to introduce readers to the more advanced subjects of linear algebra and probability theory Through examples they describe how models have been used to understand such topics as the spread of HIV chaos the age structure of a country speciation and extinction Ecologists and evolutionary biologists today need enough mathematical training to be able to assess the power and limits of biological models and to develop theories and models themselves This innovative book will be an indispensable guide to the world of mathematical models for the next generation of biologists A how to guide for developing new mathematical models in biology Provides step by step recipes for constructing and analyzing models Interesting biological applications Explores classical models in ecology and evolution Questions at the end of every chapter Primers cover important mathematical topics Exercises with answers Appendixes summarize useful rules Labs and advanced material available

Mathematical Modeling in Ecology C. Jeffries, 1989-01-01 [Mathematical Modeling in Ecology](#) Clark Jeffries, 1989-01-01 Mathematical ecology is the application of mathematics to describe and understand ecosystems There are two main approaches One is to describe natural communities and induce statistical patterns or relationships which should generally occur However this book is devoted entirely to introducing the student to the second approach to study deterministic mathematical models and on the basis of mathematical results on the models to look for the same patterns or relationships in nature This book is a compromise between three competing desiderata It seeks to maximize the generality of the models constrain the models to behave realistically that is to exhibit stability and other features and minimize the difficulty of presentations of the models The ultimate goal of the book is to introduce the reader to the general mathematical tools used in building realistic ecosystem models Just such a model is presented in Chapter Nine The book should also serve as a stepping stone both to advanced mathematical works like *Stability of Biological Communities* by Yu M Svirzhev and D O Logofet Mir Moscow 1983 and to advanced modeling texts like *Freshwater Ecosystems* by M Straskraba and A H Gnauch Elsevier Amsterdam 1985

Mathematical Modeling in Economics, Ecology and the Environment N.V. Hritonenko, Yuri P. Yatsenko, 2013-04-17 The problems of interrelation between human economics and natural environment include scientific technical economic

demographic social political and other aspects that are studied by scientists of many specialities One of the important aspects in scientific study of environmental and ecological problems is the development of mathematical and computer tools for rational management of economics and environment This book introduces a wide range of mathematical models in economics ecology and environmental sciences to a general mathematical audience with no in depth experience in this specific area Areas covered are controlled economic growth and technological development world dynamics environmental impact resource extraction air and water pollution propagation ecological population dynamics and exploitation A variety of known models are considered from classical ones Cobb Douglass production function Leontief input output analysis Solow models of economic dynamics Verhulst Pearl and Lotka Volterra models of population dynamics and others to the models of world dynamics and the models of water contamination propagation used after Chernobyl nuclear catastrophe Special attention is given to modelling of hierarchical regional economic ecological interaction and technological change in the context of environmental impact

XIII Construction of Mathematical Models [An Introduction to Mathematical Models in Ecology and Evolution](#) Mike Gillman, 2009-04-08 Students often find it difficult to grasp fundamental ecological and evolutionary concepts because of their inherently mathematical nature Likewise the application of ecological and evolutionary theory often requires a high degree of mathematical competence This book is a first step to addressing these difficulties providing a broad introduction to the key methods and underlying concepts of mathematical models in ecology and evolution The book is intended to serve the needs of undergraduate and postgraduate ecology and evolution students who need to access the mathematical and statistical modelling literature essential to their subjects The book assumes minimal mathematics and statistics knowledge whilst covering a wide variety of methods many of which are at the fore front of ecological and evolutionary research The book also highlights the applications of modelling to practical problems such as sustainable harvesting and biological control Key features Written clearly and succinctly requiring minimal in depth knowledge of mathematics Introduces students to the use of computer models in both fields of ecology and evolutionary biology Market senior undergraduate students and beginning postgraduates in ecology and evolutionary biology [An Introduction to Mathematical Models in Ecology and Evolution](#) Mike Gillman, 2009-07-07 Students often find it difficult to grasp fundamental ecological and evolutionary concepts because of their inherently mathematical nature Likewise the application of ecological and evolutionary theory often requires a high degree of mathematical competence This book is a first step to addressing these difficulties providing a broad introduction to the key methods and underlying concepts of mathematical models in ecology and evolution The book is intended to serve the needs of undergraduate and postgraduate ecology and evolution students who need to access the mathematical and statistical modelling literature essential to their subjects The book assumes minimal mathematics and statistics knowledge whilst covering a wide variety of methods many of which are at the fore front of ecological and evolutionary research The book also highlights the applications of modelling to practical

problems such as sustainable harvesting and biological control Key features Written clearly and succinctly requiring minimal in depth knowledge of mathematics Introduces students to the use of computer models in both fields of ecology and evolutionary biology Market senior undergraduate students and beginning postgraduates in ecology and evolutionary biology

Mathematical Modeling in Economics, Ecology and the Environment Natali Hritonenko, Yuri Yatsenko, 2014-01-08 Updated to textbook form by popular demand this second edition discusses diverse mathematical models used in economics ecology and the environmental sciences with emphasis on control and optimization It is intended for graduate and upper undergraduate course use however applied mathematicians industry practitioners and a vast number of interdisciplinary academics will find the presentation highly useful Core topics of this text are Economic growth and technological development Population dynamics and human impact on the environment Resource extraction and scarcity Air and water contamination Rational management of the economy and environment Climate change and global dynamics The step by step approach taken is problem based and easy to follow The authors aptly demonstrate that the same models may be used to describe different economic and environmental processes and that similar investigation techniques are applicable to analyze various models Instructors will appreciate the substantial flexibility that this text allows while designing their own syllabus Chapters are essentially self contained and may be covered in full in part and in any order Appropriate one and two semester courses include but are not limited to Applied Mathematical Modeling Mathematical Methods in Economics and Environment Models of Biological Systems Applied Optimization Models and Environmental Models Prerequisites for the courses are Calculus and preferably Differential Equations

Mathematical Modeling for Epidemiology and Ecology Glenn Ledder, 2023-04-13 Mathematical Modeling for Epidemiology and Ecology provides readers with the mathematical tools needed to understand and use mathematical models and read advanced mathematical biology books It presents mathematics in biological contexts focusing on the central mathematical ideas and the biological implications with detailed explanations The author assumes no mathematics background beyond elementary differential calculus An introductory chapter on basic principles of mathematical modeling is followed by chapters on empirical modeling and mechanistic modeling These chapters contain a thorough treatment of key ideas and techniques that are often neglected in mathematics books such as the Akaike Information Criterion The second half of the book focuses on analysis of dynamical systems emphasizing tools to simplify analysis such as the Routh Hurwitz conditions and asymptotic analysis Courses can be focused on either half of the book or thematically chosen material from both halves such as a course on mathematical epidemiology The biological content is self contained and includes many topics in epidemiology and ecology Some of this material appears in case studies that focus on a single detailed example and some is based on recent research by the author on vaccination modeling and scenarios from the COVID 19 pandemic The problem sets feature linked problems where one biological setting appears in multi step problems that are sorted into the appropriate section allowing readers to gradually develop complete investigations of topics

such as HIV immunology and harvesting of natural resources Some problems use programs written by the author for Matlab or Octave these combine with more traditional mathematical exercises to give students a full set of tools for model analysis Each chapter contains additional case studies in the form of projects with detailed directions New appendices contain mathematical details on optimization numerical solution of differential equations scaling linearization and sophisticated use of elementary algebra to simplify problems

Mathematical Modeling in Biology and Ecology Symposium on Mathematical Modelling in Biology and Ecology (1979 ; Pretoria), W M Getz (ed), 1980

Mathematics for Ecology and Environmental Sciences Yasuhiro Takeuchi, Yoh Iwasa, Kazunori Sato, 2007-01-19 Dynamical systems theory in mathematical biology has attracted much attention from many scientific directions The purpose of this volume is to discuss the many rich and interesting properties of dynamical systems that appear in ecology and environmental sciences The main topics include population dynamics with dispersal nonlinear discrete population dynamics structured population models mathematical models in evolutionary ecology stochastic spatial models in ecology game dynamics and the chemostat model Each chapter will serve to introduce students and scholars to the state of the art in an exciting area to present important new results and to inspire future contributions to mathematical modeling in ecology and environmental sciences

Introduction to Systems Analysis Dieter M. Imboden, Stefan Pfenninger, 2012-12-14 Systems and their mathematical description play an important role in all branches of science This book offers an introduction to mathematical modeling techniques It is intended for undergrad students in applied natural science in particular earth and environmental science environmental engineering as well as ecology environmental chemistry chemical engineering agronomy and forestry The focus is on developing the basic methods of modeling Students will learn how to build mathematical models of their own but also how to analyze the properties of existing models The book neither derives mathematical formulae nor does it describe modeling software instead focusing on the fundamental concepts behind mathematical models A formulary in the appendix summarizes the necessary mathematical knowledge To support independent learners numerous examples and problems from various scientific disciplines are provided throughout the book Thanks in no small part to the cartoons by Nikolas St rchler this introduction to the colorful world of modeling is both entertaining and rich in content

Mathematical Models in Ecology British Ecological Society, 1972

Mathematical Modeling of Biological Systems, Volume II Andreas Deutsch, Rafael Bravo de la Parra, Rob J. de Boer, Odo Diekmann, Peter Jagers, Eva Kisdi, Mirjam Kretzschmar, Petr Lansky, Hans Metz, 2007-10-12 Volume II of this two volume interdisciplinary work is a unified presentation of a broad range of state of the art topics in the rapidly growing field of mathematical modeling in the biological sciences Highlighted throughout are mathematical and computational approaches to examine central problems in the life sciences ranging from the organization principles of individual cells to the dynamics of large populations The chapters are thematically organized into the following main areas epidemiology evolution and ecology immunology neural systems and the brain and innovative mathematical methods and education The work will be an

excellent reference text for a broad audience of researchers practitioners and advanced students in this rapidly growing field at the intersection of applied mathematics experimental biology and medicine computational biology biochemistry computer science and physics

Relaxation Oscillations in Mathematical Models of Ecology A. I. Kolesov, I. S. Serafimovich Kolesov, 1995 This book presents for the first time a systematic exposition of techniques for constructing relaxation oscillations and methods for investigating stability properties of certain classes of systems with delay The authors bring out some of the distinctive features that have no analogues in relaxation systems of ordinary differential equations The exposition provides analysis of significant examples from biophysics mathematical ecology and quantum physics that elucidate important patterns Many unsolved problems are posed The book would appeal to researchers and specialists interested in the theory and applications of relaxation oscillations

Mathematical Modelling in Biology and Ecology W.M. Getz, 1980 This volume consists of a selection of papers presented at a Symposium on Mathematical Modelling in Biology and Ecology held at the Conference Centre of the Council for Scientific and Industrial Research CSIR Pretoria South Africa on July 5 and 6 1979 The Symposium was organized by the National Research Institute for Mathematical Sciences of the CSIR the National Institute of Virology the University of the Witwaters rand and the South African Journal of Science The primary reason for the symposium was to provide a forum for South African researchers in the fields of Mathematical Biology and Ecology at which to present or review their most recent work It was also hoped that such a symposium would stimulate further research in this field in South Africa and elsewhere Accordingly a number of South African Scientists working on a wide range of problems in Mathematical Biology and Ecology and three Scientists from North America were invited to present papers Although a somewhat wide spectrum of problems was covered by the Symposium a balance was maintained by ensuring that the papers were evenly distributed in the three categories Models of Physiological Processes Morphological Models and Ecological and Population Models

Deterministic Mathematical Models in Population Ecology Herbert I. Freedman, 1980 Single species growth Predation and parasitism Predator prey systems Lotka volterra systems for predator prey interactions Intermediate predator prey models Continuous models Discrete models The kolmogorov model Related topics and applications Related topics Applications competition and cooperation symbiosis Lotka volterra competition models Higher order competition models cooperation symbiosis Perturbation theory The implicit function theorem Existence and Uniqueness of solutions of ordinary differential equations Stability and periodicity The poincare bendixon theorem The hopf bifurcation theorem

Introduction to Mathematical Modeling and Chaotic Dynamics Ranjit Kumar Upadhyay, Satteluri R. K. Iyengar, 2013-07-23 Introduction to Mathematical Modeling and Chaotic Dynamics focuses on mathematical models in natural systems particularly ecological systems Most of the models presented are solved using MATLAB The book first covers the necessary mathematical preliminaries including testing of stability It then describes the modeling of systems from natural sci

Mathematical Modelling of Environmental and Ecological Systems J.B. Shukla, T.G.

Hallam, V. Capasso, 2012-12-02 This volume contains a cross section of the papers presented at the International Symposium on Mathematical Modelling of Ecological Environmental and Biological Systems held in Kanpur India in August 1985 The choice of topics emphasizes many aspects of ecological and environmental matters including air and water pollution ecotoxicology resource management epidemiology and population and community ecology It is intended that this volume will focus international attention upon some problems in the ecological and environmental sciences that can be impacted by mathematical modelling and analysis

Biomathematical Modeling Olcay Akman, Christopher Hay-Jahans, 2025-05-19

Welcome to the fascinating intersection of mathematics biology and ecology This book is intended primarily as a resource for teachers planning to teach their first introductory course on modeling in mathematical biology and or ecology This being said it can also be used by students preparing to embark on an independent studies project in one of these fields or by researchers unfamiliar with the methods or software introduced who are seeking an accessible and quick introduction to one of the methods and or software presented here or by curious biologists ecologists or mathematicians who may be unfamiliar with the other side or maybe by the perpetual learner who is intrigued by the dynamics of living ecosystems For each of the above this book is designed to be an accessible introduction to the captivating landscape of biomathematics The approach used in this book takes advantage of technology in leading readers on a journey that bridges seemingly distinct fields through introductions to three methods and software platforms Compartmental models with Berkeley Madonna agent based models with NetLogo and cluster analysis through selforganizing maps using an R Shiny app This is not intended to be a textbook though it may be used as one nor is it a purely mathematics book or one purely about deeper aspects of biology or ecology It focuses on three selected ways in which the intersection of mathematics and biology and mathematics and ecology can be explored with the help of software Moreover the manner in which the content is presented makes it possible to use this book to help prepare for an introductory course at a wide range of levels depending on the discipline within which the course is taught and the mathematical prerequisites for the course There are four chapters the first of which presents the reader with a bit of background information followed by suggestions on how to get the most out of this book The three core chapters introduce the three previously mentioned methods and software in a manner envisioned to be accessible to most

A Practical Guide to Ecological Modelling Karline Soetaert, Peter M. J. Herman, 2008-10-21 Mathematical modelling is an essential tool in present day ecological research Yet for many ecologists it is still problematic to apply modelling in their research In our experience the major problem is at the conceptual level proper understanding of what a model is how ecological relations can be translated consistently into mathematical equations how models are solved steady states calculated and interpreted Many textbooks jump over these conceptual hurdles to dive into detailed formulations or the mathematics of solution This book attempts to fill that gap It introduces essential concepts for mathematical modelling explains the mathematics behind the methods and helps readers to implement models and obtain hands on experience

Throughout the book emphasis is laid on how to translate ecological questions into interpretable models in a practical way. The book aims to be an introductory textbook at the undergraduate/graduate level but will also be useful to seduce experienced ecologists into the world of modelling. The range of ecological models treated is wide from Lotka-Volterra type of principle-seeking models to environmental or ecosystem models and including matrix models, lattice models and sequential decision models. All chapters contain a concise introduction into the theory, worked-out examples and exercises. All examples are implemented in the open-source package R, thus taking away problems of software availability for use of the book. All code used in the book is available on a dedicated website.

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