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Mathematics in Population Biology

HORST R. THIEME

Mathematics In Population Biology

Saber N. Elaydi,Jim M. Cushing

Mathematics In Population Biology:

Population Biology Alan Hastings,1996-12-13 Population biology has been investigated quantitatively for many decades resulting in a rich body of scientific literature Ecologists often avoid this literature put off by its apparently formidable mathematics This textbook provides an introduction to the biology and ecology of populations by emphasizing the roles of simple mathematical models in explaining the growth and behavior of populations The author only assumes acquaintance with elementary calculus and provides tutorial explanations where needed to develop mathematical concepts Examples problems extensive marginal notes and numerous graphs enhance the book s value to students in classes ranging from population biology and population ecology to mathematical biology and mathematical ecology The book will also be useful as a supplement to introductory courses in ecology **Competition Models in Population Biology** Paul Waltman,1983-01-01 This book uses fundamental ideas in dynamical systems to answer questions of a biologic nature in particular questions about the behavior of populations given a relatively few hypotheses about the nature of their growth and interaction The principal subject treated is that of coexistence under certain parameter ranges while asymptotic methods are used to show competitive exclusion in other parameter ranges Finally some problems in genetics are posed and analyzed as problems in nonlinear ordinary differential equations *Mathematics in Population Biology* Horst R. Thieme,2018-06-05 The formulation analysis and re evaluation of mathematical models in population biology has become a valuable source of insight to mathematicians and biologists alike This book presents an overview and selected sample of these results and ideas organized by biological theme rather than mathematical concept with an emphasis on helping the reader develop appropriate modeling skills through use of well chosen and varied examples Part I starts with unstructured single species population models particularly in the framework of continuous time models then adding the most rudimentary stage structure with variable stage duration The theme of stage structure in an age dependent context is developed in Part II covering demographic concepts such as life expectation and variance of life length and their dynamic consequences In Part III the author considers the dynamic interplay of host and parasite populations i e the epidemics and endemics of infectious diseases The theme of stage structure continues here in the analysis of different stages of infection and of age structure that is instrumental in optimizing vaccination strategies Each section concludes with exercises some with solutions and suggestions for further study The level of mathematics is relatively modest a toolbox provides a summary of required results in differential equations integration and integral equations In addition a selection of Maple worksheets is provided The book provides an authoritative tour through a dazzling ensemble of topics and is both an ideal introduction to the subject and reference for researchers *Some Mathematical Questions in Biology* Alan Hastings,1989-12-31 Population biology has had a long history of mathematical modeling The 1920s and 1930s saw major strides with the work of Lotka and Volterra in ecology and Fisher Haldane and Wright in genetics In recent years much more sophisticated mathematical techniques have been brought to bear on

questions in population biology Simultaneously advances in experimental and field work have produced a wealth of new data While this growth has tended to fragment the field one unifying theme is that similar mathematical questions arise in a range of biological contexts This volume contains the proceedings of a symposium on Some Mathematical Questions in Biology held in Chicago in 1987 The papers all deal with different aspects of population biology but there are overlaps in the mathematical techniques used for example dynamics of nonlinear differential and difference equations form a common theme The topics covered are cultural evolution multilocus population genetics spatially structured population genetics chaos and the dynamics of epidemics and the dynamics of ecological communities *An Introduction to Mathematical Population Dynamics* Mimmo Iannelli,Andrea Pugliese,2015-01-23 This book is an introduction to mathematical biology for students with no experience in biology but who have some mathematical background The work is focused on population dynamics and ecology following a tradition that goes back to Lotka and Volterra and includes a part devoted to the spread of infectious diseases a field where mathematical modeling is extremely popular These themes are used as the area where to understand different types of mathematical modeling and the possible meaning of qualitative agreement of modeling with data The book also includes a collections of problems designed to approach more advanced questions This material has been used in the courses at the University of Trento directed at students in their fourth year of studies in Mathematics It can also be used as a reference as it provides up to date developments in several areas **Discrete Mathematical Models in Population Biology** Saber N. Elaydi,Jim M. Cushing,2025-01-03 This text lays the foundation for understanding the beauty and power of discrete time models It covers rich mathematical modeling landscapes each offering deep insights into the dynamics of biological systems A harmonious balance is achieved between theoretical principles mathematical rigor and practical applications Illustrative examples numerical simulations and empirical case studies are provided to enhance mastery of the subject and facilitate the translation of discrete time mathematical biology into real world challenges Mainly geared to upper undergraduates the text may also be used in graduate courses focusing on discrete time modeling Chapters 1 4 constitute the core of the text Instructors will find the dependence chart quite useful when designing their particular course This invaluable resource begins with an exploration of single species models where frameworks for discrete time modeling are established Competition models and Predator prey interactions are examined next followed by evolutionary models structured population models and models of infectious diseases The consequences of periodic variations seasonal changes and cyclic environmental factors on population dynamics and ecological interactions are investigated within the realm of periodically forced biological models This indispensable resource is structured to support educational settings A first course in biomathematics introducing students to the fundamental mathematical techniques essential for biological research A modeling course with a concentration on developing and analyzing mathematical models that encapsulate biological phenomena An advanced mathematical biology course that offers an in depth exploration of complex models and

sophisticated mathematical frameworks designed to tackle advanced problems in biology With its clear exposition and methodical approach this text educates and inspires students and professionals to apply mathematical biology to real world situations While minimal knowledge of calculus is required the reader should have a solid mathematical background in linear algebra Mathematical Models in Population Biology and Epidemiology Fred Brauer,Carlos Castillo-Chavez,2011-11-09 The goal of this book is to search for a balance between simple and analyzable models and unsolvable models which are capable of addressing important questions on population biology Part I focusses on single species simple models including those which have been used to predict the growth of human and animal population in the past Single population models are in some sense the building blocks of more realistic models the subject of Part II Their role is fundamental to the study of ecological and demographic processes including the role of population structure and spatial heterogeneity the subject of Part III This book which will include both examples and exercises is of use to practitioners graduate students and scientists working in the field **Mathematical Models in Population Biology and Epidemiology** Fred Brauer,Dawn BIes,2011-11-08 The goal of this book is to search for a balance between simple and analyzable models and unsolvable models which are capable of addressing important questions on population biology Part I focusses on single species simple models including those which have been used to predict the growth of human and animal population in the past Single population models are in some sense the building blocks of more realistic models the subject of Part II Their role is fundamental to the study of ecological and demographic processes including the role of population structure and spatial heterogeneity the subject of Part III This book which will include both examples and exercises is of use to practitioners graduate students and scientists working in the field **Mathematical Methods of Population Biology** Frank Charles Hoppensteadt,1982-02-26 An introduction to mathematical methods used in the study of population phenomena including models of total population and population age structure models of random population events presented in terms of Markov chains and methods used to uncover qualitative behavior of more complicated difference equations **A Short History of Mathematical Population Dynamics** Nicolas Bacaër,2011-02-01 As Eugene Wigner stressed mathematics has proven unreasonably effective in the physical sciences and their technological applications The role of mathematics in the biological medical and social sciences has been much more modest but has recently grown thanks to the simulation capacity offered by modern computers This book traces the history of population dynamics a theoretical subject closely connected to genetics ecology epidemiology and demography where mathematics has brought significant insights It presents an overview of the genesis of several important themes exponential growth from Euler and Malthus to the Chinese one child policy the development of stochastic models from Mendel s laws and the question of extinction of family names to percolation theory for the spread of epidemics and chaotic populations where determinism and randomness intertwine The reader of this book will see from a different perspective the problems that scientists face when governments ask for reliable predictions to help

control epidemics AIDS SARS swine flu manage renewable resources fishing quotas spread of genetically modified organisms or anticipate demographic evolutions such as aging Mathematical Topics in Population Biology, Morphogenesis and Neurosciences Ei Teramoto,Masaya Yamaguti,2013-03-08 This volume represents the edited proceedings of the International Symposium on Mathematical Biology held in Kyoto November 10 15 1985 The symposium was or ganized by an international committee whose members are E Teramoto M Yamaguti S Amari S A Levin H Matsuda A Okubo L M Ricciardi R Rosen and L A Segel The symposium included technical sessions with a total of 11 invited papers 49 contributed papers and a poster session where 40 papers were displayed These Proceedings consist of selected papers from this symposium This symposium was the second Kyoto meeting on mathematical topics in biology The first was held in conjunction with the Sixth International Biophysics Congress in 1978 Since then this field of science has grown enormously and the number of scientists in the field has rapidly increased This is also the case in Japan About 80 young japanese scientists and graduate students participated this time The sessions were divided into 4 categories 1 Mathematical Ecology and Population Biology 2 Mathematical Theory of Developmental Biology and Morphogenesis 3 Theoretical Neurosciences and 4 Cell Kinetics and Other Topics In every session there were stimulating and active discussions among the participants We are convinced that the symposium was highly successful in transmitting scientific information across disciplines and in establishing fruitful contacts among the participants We owe this success to the cooperation of all participants *Some Mathematical Questions in Biology* Alan Hastings,1989 Population biology has had a long history of mathematical modeling The 1920s and 1930s saw major strides with the work of Lotka and Volterra in ecology and Fisher Haldane and Wright in genetics In recent years much more sophisticated mathematical techniques have been brought to bear on questions in population biology Simultaneously advances in experimental and field work have produced a wealth of new data While this growth has tended to fragment the field one unifying theme is that similar mathematical questions arise in a range of biological contexts This volume contains the proceedings of a symposium on Some Mathematical Questions in Biology held in Chicago in 1987 The papers all deal with different aspects of population biology but there are overlaps in the mathematical techniques used for example dynamics of nonlinear differential and difference equations form a common theme The topics covered are cultural evolution multilocus population genetics spatially structured population genetics chaos and the dynamics of epidemics and the dynamics of ecological communities **Mathematical Population Dynamics and Epidemiology in Temporal and Spatio-Temporal Domains** Harkaran Singh,Joydip Dhar,2018-12-07 Mankind now faces even more challenging environment and health related problems than ever before Readily available transportation systems facilitate the swift spread of diseases as large populations migrate from one part of the world to another Studies on the spread of the communicable diseases are very important This book Mathematical Population Dynamics and Epidemiology in Temporal and Spatio Temporal Domains provides a useful experimental tool for making practical predictions building and testing theories answering specific

questions determining sensitivities of the parameters forming control strategies and much more This volume focuses on the study of population dynamics with special emphasis on the migration of populations and the spreading of epidemics among human and animal populations It also provides the background needed to interpret construct and analyze a wide variety of mathematical models Most of the techniques presented in the book can be readily applied to model other phenomena in biology as well as in other disciplines **Population Biology** Simon A. Levin,American Mathematical Society,1984-12-31 The lecture notes contained in this volume were presented at the AMS Short Course on Population Biology held August 6 7 1983 in Albany New York in conjunction with the summer meeting of the American Mathematical Society These notes will acquaint the reader with the mathematical ideas that pervade almost every level of thinking in population biology and provide an introduction to the many applications of mathematics in the field Research mathematicians college teachers of mathematics and graduate students all should find this book of interest Population biology is probably the oldest area in mathematical biology but remains a constant source of new mathematical problems and the area of biology best integrated with mathematical theory The need for mathematical approaches has never been greater as evolutionary theory is challenged by new interpretations of the paleontological record and new discoveries at the molecular level as world resources for feeding populations become limiting as the problems of pollution increase and as both animal and plant epidemiological problems receive closer scrutiny A background of advanced calculus introduction to ordinary and partial differential equations and linear algebra will make the book accessible All of the papers included have high research value A list of the contents follows **Integrated Population Biology and Modeling, Part A** ,2018-09-26 Integrated Population Biology and Modeling Part A offers very complex and precise realities of quantifying modern and traditional methods of understanding populations and population dynamics Chapters cover emerging topics of note including Longevity dynamics Modeling human environment interactions Survival Probabilities from 5 Year Cumulative Life Table Survival Ratios Tx 5 Tx Some Innovative Methodological Investigations Cell migration Models Evolutionary Dynamics of Cancer Cells an Integrated approach for modeling of coastal lagoons A case for Chilka Lake India Population and metapopulation dynamics Mortality analysis measures and models Stationary Population Models Are there biological and social limits to human longevity Probability models in biology Stochastic Models in Population Biology and more Covers emerging topics of note in the subject matter Presents chapters on Longevity dynamics Modeling human environment interactions Survival Probabilities from 5 Year Cumulative Life Table Survival Ratios Tx 5 Tx and more **Dynamical Systems in Population Biology** Xiao-Qiang Zhao,2013-06-05 Population dynamics is an important subject in mathematical biology A cen tral problem is to study the long term behavior of modeling systems Most of these systems are governed by various evolutionary equations such as difference ordinary functional and partial differential equations see e g 165 142 218 119 55 As we know interactive populations often live in a fluctuating environment For example physical environmental conditions such as temperature and humidity and the

availability of food water and other resources usually vary in time with seasonal or daily variations Therefore more realistic models should be nonautonomous systems In particular if the data in a model are periodic functions of time with commensurate period a periodic system arises if these periodic functions have different minimal periods we get an almost periodic system The existing reference books from the dynamical systems point of view mainly focus on autonomous biological systems The book of Hess 106J is an excellent reference for periodic parabolic boundary value problems with applications to population dynamics Since the publication of this book there have been extensive investigations on periodic asymptotically periodic almost periodic and even general nonautonomous biological systems which in turn have motivated further development of the theory of dynamical systems In order to explain the dynamical systems approach to periodic population problems let us consider as an illustration two species periodic competitive systems dUI dt I t Ul U2 0 Applied Mathematical Demography Nathan Keyfitz,Hal Caswell,2005-11-14 Focuses on applications of demographic models This book introduces the life table to describe age specific mortality and uses it to develop theory for stable populations and the rate of population increase This theory is then revisited in the context of matrix models for stage classified as well as age classified populations **Differential Equations and Applications in Ecology, Epidemics, and Population Problems** Stavros Busenberg,2012-12-02 Differential Equations and Applications in Ecology Epidemics and Population Problems is composed of papers and abstracts presented at the 1981 research conference on Differential Equations and Applications to Ecology Epidemics and Population Problems held at Harvey Mudd College The reported researches consist of mathematics that is either a direct outgrowth from questions in population biology and biomathematics or applicable to such questions The content of this volume are collected in four groups The first group addresses aspects of population dynamics that involve the interaction between spatial and temporal effects The second group covers other questions in population dynamics and some other areas of biomathematics The third group deals with topics in differential and functional differential equations that are continuing to find important applications in mathematical biology The last group comprises of work on various aspects of differential equations and dynamical systems not essentially motivated by biological applications This book is valuable to students and researchers in theoretical biology and biomathematics as well as to those interested in modern applications of differential equations **Network Models in Population Biology** E. R. Lewis,2012-12-06 This book is an outgrowth of one phase of an upper division course on quantitative ecology given each year for the past eight at Berkeley I am most grateful to the students in that course and to many graduate students in the Berkeley Department of Zoology and Colleges of Engineering and Natural Resources whose spirited discussions inspired much of the book s content I also am deeply grateful to those faculty colleagues with whom at one time or another I have shared courses or seminars in ecology or population biology D M Auslander L Demetrius G Oster O H Paris F A Pitelka A M Schultz Y Takahashi D B Tyler and P Vogelhut all of whom contributed substantially to the development of my thinking in those fields to my Depart mental colleagues E Polak and

A J Thomasian who guided me into the litera ture on numerical methods and stochastic processes and to the graduate students who at one time or another have worked with me on population biology projects L M Brodnax S P Chan A Elterman G C Ferrell D Green C Hayashi K L Lee W F Martin Jr D May J Stamnes G E Swanson and I Weeks who together undoubtedly provided me with the greatest inspiration I am indebted to the copy editing and production staff of Springer Verlag especially to Ms M Muzeniek for their diligence and skill and to Mrs Alice Peters biomathematics editor for her patience

Integrated Population Biology and Modeling Part B ,2019-02-05 Integrated Population Biology and Modeling Part B Volume 40 offers very delicately complex and precise realities of quantifying modern and traditional methods of understanding populations and population dynamics with this updated release focusing on Prey predator animal models Back projections Evolutionary Biology computations Population biology of collective behavior and bio patchiness Collective behavior Population biology through data science Mathematical modeling of multi species mutualism new insights remaining challenges and applications to ecology Population Dynamics of Manipur Stochastic Processes and Population Dynamics Models The Mechanisms for Extinction Persistence and Resonance Theories of Stationary Populations and association with life lived and life left and more Studies human and animal models that are studied both separately and throughout chapters Presents a comprehensive and timely update on integrated population biology

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