Fred Brauer
Carlos Castillo-Chavez

Mathematical Models in Population Biology and Epidemiology

Second Edition

Mathematical Models In Population Biology And Epidemiology

Lucas Jódar,Juan Carlos Cortés,Luis Acedo Rodríguez

Mathematical Models In Population Biology And Epidemiology:

    Mathematical Models in Population Biology and Epidemiology Fred Brauer,Carlos Castillo-Chavez,2001-03-30 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 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 Approaches for Emerging and Reemerging Infectious Diseases: An Introduction* Carlos Castillo-Chavez,2002-05-02 This book grew out of the discussions and presentations that began during the Workshop on Emerging and Reemerging Diseases May 17 21 1999 sponsored by the Institute for Mathematics and its Application IMA at the University of Minnesota with the support of NIH and NSF The workshop started with a two day tutorial session directed at ecologists epidemiologists immunologists mathematicians and scientists interested in the study of disease dynamics The core of this first volume Volume 125 covers tutorial and research contributions on the use of dynamical systems deterministic discrete delay PDEs and ODEs models and stochastic models in disease dynamics The volume includes the study of cancer HIV pertussis and tuberculosis Beginning graduate students in applied mathematics

scientists in the natural social or health sciences or mathematicians who want to enter the fields of mathematical and theoretical epidemiology will find this book useful **Mathematical Models in Population Biology** Maira Aguiar,2018-08-15 The aim of this book is to build a fundamental understanding in Mathematical Biology Epidemiology and Ecology Written for biologists mathematicians applied statisticians and physicists Mathematical Models in Population Biology Essential Concepts in Biomathematicsprovides a coverage of different topics in mathematical biology from vector borne diseases fractional calculus and stochastic differential equations to neuro dynamics illustrating some important models used for real data *Mathematical Models in Epidemiology* Fred Brauer,Carlos Castillo-Chavez,Zhilan Feng,2019-10-10 The book is a comprehensive self contained introduction to the mathematical modeling and analysis of disease transmission models It includes i an introduction to the main concepts of compartmental models including models with heterogeneous mixing of individuals and models for vector transmitted diseases ii a detailed analysis of models for important specific diseases including tuberculosis HIV AIDS influenza Ebola virus disease malaria dengue fever and the Zika virus iii an introduction to more advanced mathematical topics including age structure spatial structure and mobility and iv some challenges and opportunities for the future There are exercises of varying degrees of difficulty and projects leading to new research directions For the benefit of public health professionals whose contact with mathematics may not be recent there is an appendix covering the necessary mathematical background There are indications which sections require a strong mathematical background so that the book can be useful for both mathematical modelers and public health professionals

Mathematical Epidemiology of Infectious Diseases O. Diekmann,J. A. P. Heesterbeek,2000-04-07 Mathematical Epidemiology of Infectious Diseases Model Building Analysis and Interpretation O Diekmann University of Utrecht The Netherlands J A P Heesterbeek Centre for Biometry Wageningen The Netherlands The mathematical modelling of epidemics in populations is a vast and important area of study It is about translating biological assumptions into mathematics about mathematical analysis aided by interpretation and about obtaining insight into epidemic phenomena when translating mathematical results back into population biology Model assumptions are formulated in terms of usually stochastic behaviour of individuals and then the resulting phenomena at the population level are unravelled Conceptual clarity is attained assumptions are stated clearly hidden working hypotheses are attained and mechanistic links between different observables are exposed Features Model construction analysis and interpretation receive detailed attention Uniquely covers both deterministic and stochastic viewpoints Examples of applications given throughout Extensive coverage of the latest research into the mathematical modelling of epidemics of infectious diseases Provides a solid foundation of modelling skills The reader will learn to translate model analyse and interpret with the help of the numerous exercises In literally working through this text the reader acquires modelling skills that are also valuable outside of epidemiology certainly within population dynamics but even beyond that In addition the reader receives training in mathematical argumentation The text is aimed at applied

mathematicians with an interest in population biology and epidemiology at theoretical biologists and epidemiologists Previous exposure to epidemic concepts is not required as all background information is given The book is primarily aimed at self study and ideally suited for small discussion groups or for use as a course text *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 Mathematics in Population Biology Horst R. Thieme,2003 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 **Mathematical Models for Communicable Diseases** Fred Brauer,Carlos Castillo-Chavez,2013-02-07 A self contained and comprehensive guide to the mathematical modeling of disease transmission appropriate for graduate students *Structured Population Models in Biology and Epidemiology* Pierre Magal,Shigui Ruan,2008-04-30 In this new century mankind faces ever more challenging environmental and publichealthproblems

suchaspollution invasionbyexoticspecies theem gence of new diseases or the emergence of diseases into new regions West Nile virus SARS Anthrax etc andtheresurgenceofexistingdiseases in uenza malaria TB HIV AIDS etc Mathematical models have been successfully used to study many biological epidemiological and medical problems and nonlinear and complex dynamics have been observed in all of those contexts Mathematical studies have helped us not only to better understand these problems but also to nd solutions in some cases such as the prediction and control of SARS outbreaks understanding HIV infection and the investi tion of antibiotic resistant infections in hospitals Structuredpopulationmodelsdistinguishindividualsfromoneanother cording to characteristics such as age size location status and movement to determine the birth growth and death rates interaction with each other and with environment infectivity etc The goal of structured population models is to understand how these characteristics a ect the dynamics of these models and thus the outcomes and consequences of the biological and epidemiolo cal processes There is a very large and growing body of literature on these topics This book deals with the recent and important advances in the study of structured population models in biology and epidemiology There are six chapters in this book written by leading researchers in these 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 **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 **Mathematical Approaches for Emerging and Reemerging Infectious Diseases: Models, Methods, and Theory** Carlos Castillo-Chavez,Sally Blower,Pauline van den Driessche,Denise Kirschner,Abdul-Aziz Yakubu,2012-12-06 This IMA Volume in Mathematics and its Applications MATHEMATICAL APPROACHES FOR EMERGING AND REEMERGING INFECTIOUS DISEASES MODELS AND THEORY METHODS is based on the proceedings of a successful one week workshop The pro ceedings of the two day tutorial which preceded the workshop Introduction to Epidemiology and Immunology appears as IMA Volume 125 Math ematical Approaches for Emerging and Reemerging Infectious Diseases An Introduction The tutorial and the workshop are integral parts of the September 1998 to June 1999 IMA program on MATHEMATICS IN BI OLOGY I would like to thank Carlos Castillo Chavez Director of the Math ematical and Theoretical Biology Institute and a member of the Depart ments of Biometrics Statistics and Theoretical and Applied Mechanics Cornell University Sally M Blower Biomathematics UCLA School of Medicine Pauline van den Driessche Mathematics and Statistics Uni versity of Victoria and Denise Kirschner Microbiology and Immunology University of Michigan Medical School for their superb roles as organizers of the meetings and editors of the proceedings Carlos Castillo Chavez es pecially made a major contribution by spearheading the editing process I am also grateful to Kenneth L Cooke Mathematics Pomona College for being one of the workshop organizers and to Abdul Aziz Yakubu Mathe matics Howard University for serving as co editor of the proceedings I thank Simon A Levin Ecology and Evolutionary Biology Princeton Uni versity for providing an introduction Time Delayed Models in Population Biology and Epidemiology Isam Al-Darabsah,2018 In this dissertation we focus on the development and analysis of time delayed mathematical models to represent real world applications in biology and epidemiology especially population growth and disease spread Throughout five projects we establish then analyze the models using various theorems and methods in the literature such as the comparison principle and the method of fluctuations to study qualitative features of the models including existence and uniqueness of solutions boundedness steady states persistence local and global stability with respect to the adult basic reproduction number RA R0 which is a key threshold parameter Firstly we discuss ecological models in Chapters 2 4 In Chapter 2 we derive a single species fish model with three stages juveniles small adults and large adults with

two harvesting strategies depending on the size and maturity We study the population extinction and persistence with respect to RA and find that the over harvesting of large matured fish after a certain age can lead to population extinction under certain circumstances Numerically we investigate the influence of harvesting functions and discuss the optimal harvesting rates In Chapter 3 we develop a model for the growth of sea lice with three stages such that the development age for non infectious larvae to develop into infectious larvae relates to the size of adult population size As a beginning we describe the nonlinear dynamics by a system of partial differential equations then we transformed it into a system of delay differential equation with constant delay by using the method of characteristics and an appropriate change of variables We address the system threshold dynamics for the established model with respect to the adult reproduction number including the global stability of the trivial steady state persistence and global attractivity of a coexistence unique positive steady state As a case study we provide some numerical simulation results using Lepeophtheirus salmonis growth parameters To explore the biological control of sea lice using one of their predators cleaner fish we propose a model with predator prey interaction at the adult level of sea lice in Chapter 4 Mathematically we address threshold dynamics with respect to the adult reproduction number for sea lice Rs and the net reproductive number of cleaner fish Rf including the global stability of the trivial steady state when Rs 1 global attractivity of the predator free equilibrium point when Rs 1 and Rf 1 persistence and coexistence of a unique positive steady state when Rs 1 and Rf 1 Furthermore we discuss the local stability of the positive equilibrium point and investigate the Hopf bifurcation Numerically we compare between two cleaner fish species goldsinny and ballan wrasse as a case study For epidemiological models in Chapter 5 we propose an SEIRD model for Ebola disease transmission that incorporates both the transmission of infection between the living humans and from the infected corpses to the living individuals with a constant latent period Through mathematical analysis we prove the globally stability of the disease free and a unique endemic equilibria with respect to R0 Moreover we find that the long latent period or low transmission rate from infectious corpses may reduce the spread of Ebola In Chapters 6 we consider the influence of seasonal fluctuations on disease transmission and develop a periodic infectious disease model where asymptomatic carriers are potential sources for disease transmission We consider a general nonlinear incidence rate function with the asymptomatic carriage and latent periods We implement a case study regarding the meningococcal meningitis disease transmission in Dori Burkina Faso Our numerical simulation indicates an irregular pattern of epidemics varying size and duration which is consistent with the reported data in Burkina Faso from 1940 to 2014 In summery in population growth models we find that the basic reproduction ration depends on maturation time indicating that this key parameter can play an important role in population extinction and persistence In disease transmission model we understand that latent period can play a positive role in eliminating or slowing a disease spread   **An Introduction to Mathematical Epidemiology** Maia Martcheva,2015-10-20 The book is a comprehensive self contained introduction to the mathematical modeling and analysis of

infectious diseases It includes model building fitting to data local and global analysis techniques Various types of deterministic dynamical models are considered ordinary differential equation models delay differential equation models difference equation models age structured PDE models and diffusion models It includes various techniques for the computation of the basic reproduction number as well as approaches to the epidemiological interpretation of the reproduction number MATLAB code is included to facilitate the data fitting and the simulation with age structured models

Mathematical Modeling in Physical Sciences Dimitrios Vlachos,2024-05-23 This volume gathers selected papers presented at the ICMSQUARE 2023 12th International Conference on Mathematical Modeling in Physical Sciences held in Belgrade Serbia from August 28 31 2023 This proceedings offers a compilation of cutting edge research which aims to advance the knowledge and development of high quality research in mathematical fields related to physics chemistry biology medicine economics environmental sciences and more Annually held since 2012 the ICMSQUARE conference serves as a platform for the exchange of ideas and discussions on the latest technological trends in these fields This book is an invaluable resource for researchers academicians and professionals in these areas seeking to stay up to date with the latest developments in mathematical modeling   Applications Of Epidemiological Models To Public Health Policymaking: The Role Of Heterogeneity In Model Predictions Zhilan Feng,2014-04-16 Mathematical models can be very helpful to understand the transmission dynamics of infectious diseases This book presents examples of epidemiological models and modeling tools that can assist policymakers to assess and evaluate disease control strategies   Mathematical Modelling in Engineering & Human Behaviour 2018 Lucas Jódar,Juan Carlos Cortés,Luis Acedo Rodríguez,2019-04-15 This book includes papers in cross disciplinary applications of mathematical modelling from medicine to linguistics social problems and more Based on cutting edge research each chapter is focused on a different problem of modelling human behaviour or engineering problems at different levels The reader would find this book to be a useful reference in identifying problems of interest in social medicine and engineering sciences and in developing mathematical models that could be used to successfully predict behaviours and obtain practical information for specialised practitioners This book is a must read for anyone interested in the new developments of applied mathematics in connection with epidemics medical modelling social issues random differential equations and numerical methods   **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 apporaches 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

The Enigmatic Realm of **Mathematical Models In Population Biology And Epidemiology**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing lacking extraordinary. Within the captivating pages of **Mathematical Models In Population Biology And Epidemiology** a literary masterpiece penned with a renowned author, readers set about a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book is core themes, assess its distinct writing style, and delve into its lasting effect on the hearts and minds of people who partake in its reading experience.

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