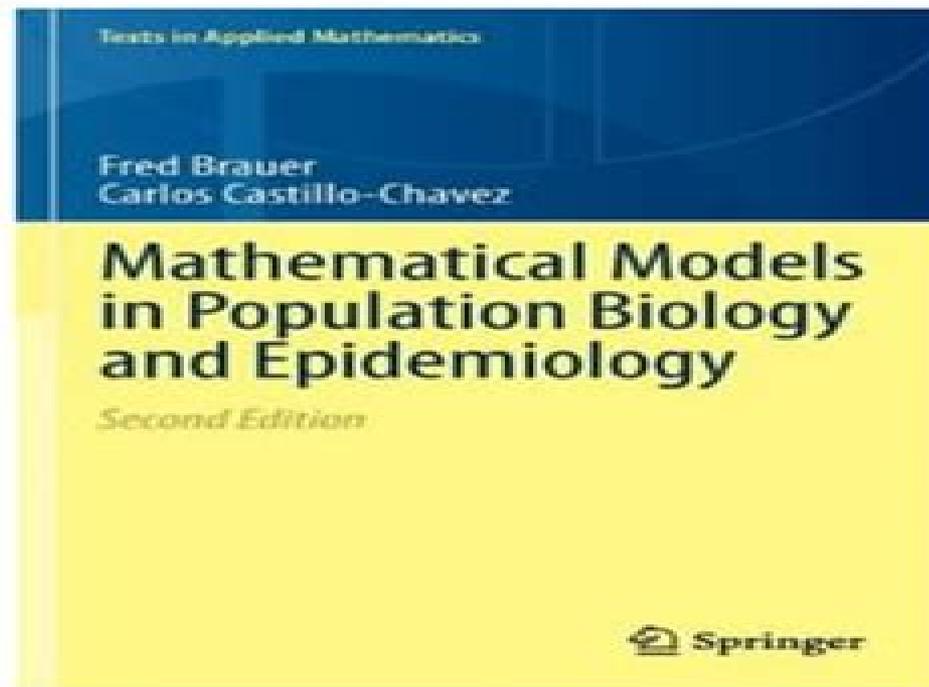


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# Mathematical Models In Population Biology And Epidemiology

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## **Mathematical Models In Population Biology And Epidemiology:**

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**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 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 Biomathematics provides 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 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 proceedings of the two day tutorial which preceded the workshop Introduction to Epidemiology and Immunology appears as IMA Volume 125 Mathematical 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 BIOLOGY I would like to thank Carlos Castillo Chavez Director of the Mathematical and Theoretical Biology Institute and a member of the Departments 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 University 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 especially 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 Mathematics Howard University for serving as co editor of the proceedings I thank Simon A Levin Ecology and Evolutionary Biology Princeton University for providing an introduction

**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

**Spatial Ecology** Stephen Cantrell, Chris Cosner, Shigui Ruan, 2009-08-05 Exploring the relationship between mathematics and ecology Spatial Ecology focuses on some important emerging challenges in the field These challenges consist of understanding the impact of space on community structure incorporating the scale and structure of landscapes into mathematical models and developing connections between spatial ecology *Math and Bio 2010* Lynn Arthur Steen, 2005 *Math and bio 2010* grew out of Meeting the Challenges Education across the Biological Mathematical and Computer Sciences a joint project of the Mathematical Association of America MAA the National Science Foundation Division

of Undergraduate Education NSF DUE the National Institute of General Medical Sciences NIGMS the American Association for the Advancement of Science AAAS and the American Society for Microbiology ASM Foreword p vi *Mathematical Models for Communicable Diseases* Fred Brauer, Carlos Castillo-Chavez, 2012-01-01 This graduate level textbook appeals to readers interested in the mathematical theory of disease transmission models It is self contained and accessible to readers who are comfortable with calculus elementary differential equations and linear algebra The book provides insight into modeling cross immunity between different disease strains such as influenza and the synergistic interactions between multiple diseases e g HIV and tuberculosis diseases transmitted by viral agents bacteria and vectors e g mosquitos transmitting malaria to humans and both epidemic and endemic disease occurrences 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 Modelling of Population Dynamics Ryszard Rudnicki, 2004 *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

**Development and Applications of Mathematical Tools in Models of Infectious Diseases and Biological Phenomenon** Stanca Mihaela Ciupe,2005 **Dynamical Epidemic Models and Their Applications** Baojun Song,2002 Structured Population Models in Biology and Epidemiology Pierre Magal,Shigui Ruan,2008-04-12

In this new century mankind faces ever more challenging environmental and public health problems such as pollution invasion by exotic species the emergence of new diseases or the emergence of diseases into new regions West Nile virus SARS Anthrax etc and the resurgence of existing diseases 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 find solutions in some cases such as the prediction and control of SARS outbreaks understanding HIV infection and the investment of antibiotic resistant infections in hospitals

Structured population models distinguish individuals from one another according 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 affect the dynamics of these models and thus the outcomes and consequences of the biological and epidemiological 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 **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.

**Research Grants Index** National Institutes of Health (U.S.). Division of Research Grants, 1967 **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  $R_A$  or  $R_0$ , 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  $R_A$  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  $R_s$  and the net reproductive number of cleaner fish  $R_f$ .

including the global stability of the trivial steady state when  $R_s < 1$  global attractivity of the predator free equilibrium point when  $R_s < 1$  and  $R_f < 1$  persistence and coexistence of a unique positive steady state when  $R_s < 1$  and  $R_f < 1$  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  $R_0$  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

### **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 *Discrete and Continuous Dynamical Systems* ,2004

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