



**STRUCTURED-POPULATION  
MODELS IN MARINE,  
TERRESTRIAL, AND  
FRESHWATER SYSTEMS**

**SHRIPAD TULJAPURKAR  
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**CHAPMAN & HALL**

# Structured Population Models

**Shripad Tuljapurkar, Hal Caswell**



## **Structured Population Models:**

Structured-Population Models in Marine, Terrestrial, and Freshwater Systems Shripad Tuljapurkar, Hal Caswell, 2012-12-06 In the summer of 1993 twenty six graduate and postdoctoral students and fourteen lecturers converged on Cornell University for a summer school devoted to structured population models This school was one of a series to address concepts cutting across the traditional boundaries separating terrestrial marine and freshwater ecology Earlier schools resulted in the books Patch Dynamics S A Levin T M Powell a book on food webs is in preparation Models of population structure differences among individuals due to age size developmental stage spatial location or genotype have an important place in studies of all three kinds of ecosystem In choosing the participants and lecturers for the school we selected for diversity biologists who knew some mathematics and mathematicians who knew some biology field biologists sobered by encounters with messy data and theoreticians intoxicated by the elegance of the underlying mathematics people concerned with long term evolutionary problems and people concerned with the acute crises of conservation biology For four weeks these perspectives swirled in discussions that started in the lecture hall and carried on into the sweltering Ithaca night Diversity may or may not increase stability but it surely makes things interesting

**Structured Population Models in Biology and Epidemiology**, 2008 Pierre Magal, Shigui Ruan, 2008-04-30 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

An Introduction to Structured Population Dynamics J. M. Cushing, 1998-01-01 This monograph introduces the theory of structured population dynamics and its applications focusing on the asymptotic dynamics of deterministic models

**Structured Population Models** Dylan Zachary Childs, University of London, 2003 **Gender-structured Population**

**Modeling** M. Iannelli, M. Martcheva, F. A. Milner, 2005-01-01 Gender Structured Population Modeling gives a unified presentation of and mathematical framework for modeling population growth by couple formation It provides an overview of both past and present modeling results The authors focus on pair formation marriage and two sex models with different forms of the marriage function the basis of couple formation and discuss which of these forms might make a better choice for a particular population the United States The book also provides results on model analysis gives an up to date review of mathematical demography discusses numerical methods and puts deterministic modeling of human populations into historical perspective *Stochastic Models for Structured Populations* Sylvie Meleard, Vincent Bansaye, 2015-09-03 In this contribution several probabilistic tools to study population dynamics are developed The focus is on scaling limits of qualitatively different stochastic individual based models and the long time behavior of some classes of limiting processes Structured population dynamics are modeled by measure valued processes describing the individual behaviors and taking into account the demographic and mutational parameters and possible interactions between individuals Many quantitative parameters appear in these models and several relevant normalizations are considered leading to infinite dimensional deterministic or stochastic large population approximations Biologically relevant questions are considered such as extinction criteria the effect of large birth events the impact of environmental catastrophes the mutation selection trade off recovery criteria in parasite infections genealogical properties of a sample of individuals These notes originated from a lecture series on Structured Population Dynamics at Ecole polytechnique France Vincent Bansaye and Sylvie Meleard are Professors at Ecole Polytechnique France They are a specialists of branching processes and random particle systems in biology Most of their research concerns the applications of probability to biodiversity ecology and evolution *Structured Population Models in the Biological and Social Sciences* Jeremy Thibodeaux, 2007 In chapter 3 we develop an impulsive differential equation model that describes the dynamics of college drinking We divide the student population into five drinking groups and then describe how students may move from one group to another Incorporated into the model is the idea of campus wetness or availability of alcohol We then experiment with several hypothetical campuses and explore the impact of wetness and intervention on the college student population *Nonlinear Size-structured Population Models* Xubo Wang, 2005

**Mathematical Modeling and Computational Methods for Structured Populations** Mingtao Xia, 2023 Structured population models are fundamental in the fields of biology ecology and social sciences as they provide both theoretical insights and practical applications Different structured population models range from modeling cellular population proliferation and population dynamics to simulating disease spread on social networks However there has been little work on modeling populations across different scales that could link individual behavior to population dynamics Additionally for existing mathematical models on structured populations several computational challenges arise as how to develop efficient numerical solvers to simulate those models and to control the dynamics of those models Overall my dissertation covers three

related topics modeling structured populations developing efficient numerical solvers to simulate these models and developing control algorithms to control population dynamics Specifically my dissertation focuses on modeling and devising algorithms for two types of structured populations i age size or added size structured cell population for describing cellular proliferation and ii the structured infected time or number of contact based human population for describing disease spread Regarding the structured cellular population we derive mathematical models at both the macroscopic population dynamics level and microscopic individual behavior level leading to structured partial differential equation PDE models for cellular proliferation with different structure variables such as cellular age size or added size Next we develop an efficient adaptive spectral method for numerically solving spatiotemporal PDEs which was inspired by simulating the blowup behavior in the unbounded domain PDE model for cellular populations In addition to the structured population models the adaptive spectral method proves efficient and accurate in solving a wide range of spatiotemporal PDEs in unbounded domains such as the Schrödinger equations in quantum mechanics Regarding the structured human population we introduce an infected time structured PDE model and a number of contact structured ODE model for simulating disease spread e.g. COVID-19 in the population Then for the number of contact structured ODE model we develop classic Pontryagin maximum principle based and reinforcement learning based optimal control algorithms These two algorithms can effectively mitigate the spread of disease by appropriately allocating limited test kits or vaccination resources

*The Basic Approach to Age-Structured Population Dynamics* Mimmo Iannelli, Fabio Milner, 2017-08-27 This book provides an introduction to age structured population modeling which emphasizes the connection between mathematical theory and underlying biological assumptions Through the rigorous development of the linear theory and the nonlinear theory alongside numerics the authors explore classical equations that describe the dynamics of certain ecological systems Modeling aspects are discussed to show how relevant problems in the fields of demography ecology and epidemiology can be formulated and treated within the theory In particular the book presents extensions of age structured modeling to the spread of diseases and epidemics while also addressing the issue of regularity of solutions the asymptotic behavior of solutions and numerical approximation With sections on transmission models non autonomous models and global dynamics this book fills a gap in the literature on theoretical population dynamics *The Basic Approach to Age Structured Population Dynamics* will appeal to graduate students and researchers in mathematical biology epidemiology and demography who are interested in the systematic presentation of relevant models and mathematical methods

**Age-structured Population Models with Applications** Min Gao, 2015

**Structured Population Models** Shuhua Hu, 2004

**Structured-Population Models in Marine, Terrestrial, and Freshwater Systems** Shripad Tuljapurkar, Hal Caswell, 1997-01-31 In the summer of 1993 twenty six graduate and postdoctoral students and fourteen lecturers converged on Cornell University for a summer school devoted to structured population models This school was one of a series to address concepts cutting across the traditional boundaries separating

terrestrial marine and freshwater ecology Earlier schools resulted in the books Patch Dynamics S A Levin T M Powell a book on food webs is in preparation Models of population structure differences among individuals due to age size developmental stage spatial location or genotype have an important place in studies of all three kinds of ecosystem In choosing the participants and lecturers for the school we selected for diversity biologists who knew some mathematics and mathematicians who knew some biology field biologists sobered by encounters with messy data and theoreticians intoxicated by the elegance of the underlying mathematics people concerned with long term evolutionary problems and people concerned with the acute crises of conservation biology For four weeks these perspectives swirled in discussions that started in the lecture hall and carried on into the sweltering Ithaca night Diversity may or may not increase stability but it surely makes things interesting

Discrete-time Age-structured Population Models Kenneth David Lane,1980 *Analysis and Numerical Schemes for Structured Population Models* Yi Wang,2013 On Some Quasilinear Structured Population Models Philipp Getto.,2005 **Deterministic and Stochastic Structured Population Models with Application to Green Tree Frogs** Qihua Huang,2011 **The 'cumulative' formulation of (physiologically) structured population models** Odo Diekmann,1992 *Continuous and Discrete Structured Population Models with Applications to Epidemiology and Marine Mammals* Tingting Tang,2017

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## **Table of Contents Structured Population Models**

1. Understanding the eBook Structured Population Models
  - The Rise of Digital Reading Structured Population Models
  - Advantages of eBooks Over Traditional Books
2. Identifying Structured Population Models
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Structured Population Models
  - User-Friendly Interface
4. Exploring eBook Recommendations from Structured Population Models
  - Personalized Recommendations
  - Structured Population Models User Reviews and Ratings
  - Structured Population Models and Bestseller Lists

5. Accessing Structured Population Models Free and Paid eBooks
  - Structured Population Models Public Domain eBooks
  - Structured Population Models eBook Subscription Services
  - Structured Population Models Budget-Friendly Options
6. Navigating Structured Population Models eBook Formats
  - ePub, PDF, MOBI, and More
  - Structured Population Models Compatibility with Devices
  - Structured Population Models Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Structured Population Models
  - Highlighting and Note-Taking Structured Population Models
  - Interactive Elements Structured Population Models
8. Staying Engaged with Structured Population Models
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Structured Population Models
9. Balancing eBooks and Physical Books Structured Population Models
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Structured Population Models
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Structured Population Models
  - Setting Reading Goals Structured Population Models
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Structured Population Models
  - Fact-Checking eBook Content of Structured Population Models
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- 
- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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