

A Practical To Ecological Modelling Using R As A Simulation Platform

Computerised Environmental Modelling A Practical Introduction Using Excel J. Hardisty, D. M. Taylor and S. E. Metcalfe
The University of Hull, UK The study of the environment is currently developing into a rigorous and demanding analytical science that requires the use of sophisticated environmental models. The increasing demand for graduates trained to deal with complex environmental issues gives rise to the problem of how environmental modelling should be taught.

Computerised Environmental Modelling, which is based upon an existing undergraduate course, addresses this problem by presenting a readable (and tested) introduction to the subject through an easy to use software environment. Simple numerical models taught through widely available spreadsheets do away with the need for language-specific training. Students now no longer need to program before they can model. Divided into three sections, the book first deals with the general principles of environmental systems modelling, then with a series of examples that familiarise the reader with the use of spreadsheets (in particular with Excel). Finally a set of new and topical environmental models are presented, including ocean, meteorological, hydrological, and extinction models. A supplementary disk, which holds all the programs discussed in the text, can be purchased upon request by returning the reply card at the back of the book. Both the disk and the text will greatly benefit all undergraduates who would like to acquire a comprehensive understanding of environmental modelling techniques.

Ecological Model Types brings an understanding on how to quantitatively analyze complex and dynamic ecosystems with the tools available today. Ecosystem studies widely use the notions of order, complexity, randomness, and organization, and are used interchangeably in literature, which causes much confusion. Better models synthesize our knowledge on ecosystems and their environmental problems, in contrast to statistical analysis, which only reveal the relationships between the data. This book brings together experts on ecological models to create a definitive work on how to understand our complex Earth. Bridges the gap between statistical analysis and synthesis of data, enhancing our understanding about ecosystems and their environmental problems Helps readers understand complex ecosystems by walking through the best modeling options to analyze and predict environmental effects Provides a detailed review of 14 model types, covering the breadth of options available for analysis at this time

Pollutants move into and through the three basic natural "media" (air, water, soil) in a variety of ways, and often move through one medium and into another. Integrated Environmental Modeling teaches environmental model development, implementation, and testing in a unified manner, applicable to all three natural media.

Addressing the basic concepts of ecological modelling, Jorgensen provides the user with a tool which can assist in the understanding of what various model types/network calculations can do, as well as outlining when to use which type as a tool to solve a specific problem.

Handbook of Environmental and Ecological Modeling

Practical Conservation Biology

Integrated Environmental Modeling

Model Selection and Multimodel Inference

Ecological Model Types

Modelling and Simulation

Quantitative models are crucial to almost every area of ecosystem science. They provide a logical structure that guides and informs empirical observations of ecosystem processes. They play a particularly crucial role in synthesizing and integrating our understanding of the immense diversity of ecosystem structure and function. Increasingly, models are being called on to predict the effects of human actions on natural ecosystems. Despite the widespread use of models, there exists intense debate within the field over a wide range of practical and philosophical issues pertaining to quantitative modeling. This book--which grew out of a gathering of leading experts at the ninth Cary

Conference--explores those issues. The book opens with an overview of the status and role of modeling in ecosystem science, including perspectives on the long-running debate over the appropriate level of complexity in models. This is followed by eight chapters that address the critical issue of evaluating ecosystem models, including methods of addressing uncertainty. Next come several case studies of the role of models in environmental policy and management. A section on the future of modeling in ecosystem science focuses on increasing the use of modeling in undergraduate education and the modeling skills of professionals within the field. The benefits and limitations of predictive (versus observational) models are also considered in detail. Written by stellar contributors, this book grants access to the state of the art and science of ecosystem modeling.

Toxic chemicals can exert effects on all levels of the biological hierarchy, from cells to organs to organisms to populations to entire ecosystems. However, most risk assessment models express their results in terms of effects on individual organisms, without corresponding information on how populations, groups of species, or whole ecosystems may respond to chemical stressors. **Ecological Modeling in Risk Assessment: Chemical Effects on Populations, Ecosystems, and Landscapes** takes a new approach by compiling and evaluating models that can be used in assessing risk at the population, ecosystem, and landscape levels. The authors give an overview of the current process of ecological risk assessment for toxic chemicals and of how modeling of populations, ecosystems, and landscapes could improve the status quo. They present a classification of ecological models and explain the differences between population, ecosystem, landscape, and toxicity-extrapolation models. The authors describe the model evaluation process and define

evaluation criteria. Finally, the results of the model evaluations are presented in a concise format with recommendations on modeling approaches to use now and develop further. The authors present and evaluate various models on the basis of their realism and complexity, prediction of relevant assessment endpoints, treatment of uncertainty, regulatory acceptance, resource efficiency, and other criteria. They provide models that will improve the ecological relevance of risk assessments and make data collection more cost-effective. **Ecological Modeling in Risk Assessment** serves as a reference for selecting and applying the best models when performing a risk assessment.

The field of ecosystem health explores the interactions between natural systems, human health, and social organization. As decision makers require a sound, modular approach to environmental management and sustainable development, ecosystem health assessment indicators are increasingly used across any number of applications. **The Handbook of Ecologic**

Introduction to WinBUGS for Ecologists introduces applied Bayesian modeling to ecologists using the highly acclaimed, free WinBUGS software. It offers an understanding of statistical models as abstract representations of the various processes that give rise to a data set. Such an understanding is basic to the development of inference models tailored to specific sampling and ecological scenarios. The book begins by presenting the advantages of a Bayesian approach to statistics and introducing the WinBUGS software. It reviews the four most common statistical distributions: the normal, the uniform, the binomial, and the Poisson. It describes the two different kinds of analysis of variance (ANOVA): one-way and two- or multiway. It looks at the general linear model, or ANCOVA, in R and WinBUGS. It introduces generalized linear model (GLM), i.e., the extension of the normal linear model to allow error distributions other than the normal. The GLM is then extended contain additional sources of random variation to become a generalized linear mixed model (GLMM) for a Poisson example and for a binomial example. The final two chapters showcase two fairly novel and nonstandard versions of a GLMM. The first is the site-occupancy model for species distributions; the second is the binomial (or N-) mixture model for estimation and modeling of abundance. **Introduction to the essential theories of key models used by ecologists Complete juxtaposition of classical analyses in R and Bayesian analysis of the same models in WinBUGS Provides every detail of R and WinBUGS code required to conduct all analyses Companion Web Appendix that contains all code contained in the book and additional material (including more code and solutions to exercises)**

A Common-Sense Approach to Theory and Practice

Models in Ecosystem Science

A Climate Modelling Primer

Pollutant Transport, Fate, and Risk in the Environment

A practical approach

Bayesian Approach to Regression, ANOVA, Mixed Models and Related Analyses

Continuing in the tradition of its bestselling predecessor, the **Handbook of Ecological Indicators for Assessment of Ecosystem Health, Second Edition** brings together world-class editors and contributors who have been at the forefront of ecosystem health assessment research for decades, to provide a sound approach to environmental management and sust

Practical Conservation Biology covers the complete array of topics that are central to conservation biology and natural resource management, thus providing the essential framework for under-graduate and post-graduate courses in these subject areas.

Written by two of the world's leading environment experts, it is a "must have" reference for environment professionals in government, non-government and industry sectors. The book reflects the latest thinking on key topics such as extinction risks, losses of genetic variability, threatening processes, fire effects, landscape fragmentation, habitat loss and vegetation clearing, reserve design, sustainable harvesting of natural populations, population viability analysis, risk assessment, conservation biology policy, human population growth and its impacts on biodiversity. **Practical Conservation Biology** deals primarily with the Australian context but also includes many overseas case studies. The book is the most comprehensive assessment of conservation topics in Australia and one of the most comprehensive worldwide.

This new edition of **Numerical Ecology with R** guides readers through an applied exploration of the major methods of multivariate data analysis, as seen through the eyes of three ecologists. It provides a bridge between a textbook of numerical ecology and the implementation of this discipline in the R language. The book begins by examining some exploratory approaches. It proceeds logically with the construction of the key building blocks of most methods, i.e. association measures and matrices, and then submits example data to three families of approaches: clustering, ordination and canonical ordination. The last two chapters make use of these methods to explore important and contemporary issues in ecology: the analysis of spatial structures and of community diversity. The aims of methods thus range from descriptive to explanatory and predictive and encompass a wide variety of approaches that should provide readers with an extensive toolbox that can address a wide palette of questions arising in contemporary multivariate ecological analysis. The second edition of this book features a complete revision to the R code and offers improved procedures and more diverse applications of the major methods. It also highlights important changes in the methods and expands upon topics such as multiple correspondence analysis, principal response curves and co-correspondence analysis. New features include the study of relationships between species traits and the environment, and community diversity

analysis. This book is aimed at professional researchers, practitioners, graduate students and teachers in ecology, environmental science and engineering, and in related fields such as oceanography, molecular ecology, agriculture and soil science, who already have a background in general and multivariate statistics and wish to apply this knowledge to their data using the R language, as well as people willing to accompany their disciplinary learning with practical applications. People from other fields (e.g. geology, geography, paleoecology, phylogenetics, anthropology, the social and education sciences, etc.) may also benefit from the materials presented in this book. Users are invited to use this book as a teaching companion at the computer. All the necessary data files, the scripts used in the chapters, as well as extra R functions and packages written by the authors of the book, are available online (URL: <http://adn.biol.umontreal.ca/numerica/ecology/numecolR/>).

As a consequence of recent increased awareness of the social and political dimensions of climate, many non-specialists discover a need for information about the variety of available climate models. A Climate Modelling Primer, Third Edition explains the basis and mechanisms of all types of current physically-based climate models. A thoroughly revised and updated edition, this book assists the reader in understanding the complexities and applicabilities of today ' s wide range of climate models. Topics covered include the latest techniques for modelling the coupled biosphere-ocean-atmosphere system, information on current practical aspects of climate modelling and ways to evaluate and exploit the results, discussion of Earth System Models of Intermediate Complexity (EMICs), and interactive exercises based on Energy Balance Model (EBM) and the Daisyworld model. Source codes and results from a range of model types allows readers to make their own climate simulations and to view the results of the latest high resolution models. The accompanying CD contains: A suite of resources for those wishing to learn more about climate modelling. A range of model visualisations. Data from climate models for use in the classroom. Windows and Macintosh programs for an Energy Balance Model. Selected figures from the book for inclusion in presentations and lectures. Suitable for 3rd/4th year undergraduates taking courses in climate modelling, economic forecasting, computer science, environmental science, geography and oceanography. Also of relevance to researchers and professionals working in related disciplines with climate models or who need accessible technical background to climate modelling predictions.

Handbook of Ecological Modelling and Informatics

GIS for Environmental Applications

Ecological Modeling in Risk Assessment

Using R as a Simulation Platform

Individual-based Modeling and Ecology

Environmental Modeling with Stakeholders

Worldwide demand for sand and gravel is increasing daily, as the need for these materials continues to rise, for example in the construction sector, in land filling and for transportation sector based infrastructural projects. This results in over-extraction of sand from channel beds, and hampers the natural renewal of sediment, geological setup and morphological processes of the riverine system. In India, illegal sand mining (of alluvial channels) and gravel mining (of perennial channels) are two anthropogenic issues that negatively affect the sustainable drainage system. Along the Kangsabati River in India, the consequences of sand mining are very serious. The construction of Mukutmonipur Dam (1958) on the river causes huge sediment deposition along the middle and downstream areas, these same areas are also intensely mined for sand (instream and on the flood plain). Geospatial models are applied in order to better understand the state and the resilience of stream hydraulics, morphological and river ecosystem variables during pre-mining and post-mining stages, using micro-level datasets of the Kangsabati River. The book also includes practicable measures to minimize the environmental consequences of instream mining in respect to optimum sand mining. It discusses the threshold limits of each variable in stream hydraulics, morphological and river ecological regime, and also discusses the most affected variables. Consequently, all outputs will be very useful for students, researchers, academicians, decision makers and practitioners and will facilitate applying these techniques to create models for other river basins.

A primer on modeling concepts and applications that is specifically geared toward the environmental field. Sections on modeling terminology, the uses of models, the model-building process, and the interpretation of output provide the foundation for detailed applications. After an introduction to the basics of dynamic modeling, the book leads students through an analysis of several environmental problems, including surface-water pollution, matter-cycling disruptions, and global warming. The scientific and technical context is provided for each problem, and the methods for analyzing and designing appropriate modeling approaches is provided. While the mathematical content does not exceed the level of a first-semester calculus course, the book gives students all of the background, examples, and practice exercises needed both to use and understand environmental modeling. It is suitable for upper-level undergraduate and beginning-graduate level environmental professionals seeking an introduction to modeling in their field.

Ecological modelling has developed rapidly in recent decades, with the focus primarily on the restoration of lakes and wetlands. Ecological Modelling and Engineering in Lakes and Wetlands presents the progress being made in modelling for a wealth of applications. It covers the older biogeochemical models still in use today, structurally dynamic models, 3D models, biophysical models, entire watershed models, and ecotoxicological models, as well as the expansion of modeling to the Arctic and Antarctic climate-zones. The book also addresses modelling the effect of climate change, including the development of ecological models for addressing storm water pond issues, which are increasingly important in urban regions where more concentrated rainfalls are a consequence of climate change. The ecological engineering topics covered in the book also emphasize the advancements being made in applying ecological engineering regimes for better environmental management of lakes and wetlands. Examines recent progress towards a better understanding of these two important ecosystems Presents new results and approaches that can be used to develop better

models Discusses how to increase the synergistic effect between ecosystems engineering and modelling
A unique and comprehensive text on the philosophy of model-based data analysis and strategy for the analysis of empirical data. The book introduces information theoretic approaches and focuses critical attention on a priori modeling and the selection of a good approximating model that best represents the inference supported by the data. It contains several new approaches to estimating model selection uncertainty and incorporating selection uncertainty into estimates of precision. An array of examples is given to illustrate various technical issues. The text has been written for biologists and statisticians using models for making inferences from empirical data.

Freshwater Ecosystems

Following nature's way

Environmental Modeling

An Introduction to the Art and Science of Modeling Ecological Systems

Ecological-Economic Modelling for Biodiversity Conservation

Finding Simplicity in Complexity

Introduction and background; Exploratory data analysis and graphics; Deterministic functions for ecological modeling; Probability and stochastic distributions for ecological modeling; Stochastic simulation and power analysis; Likelihood and all that; Optimization and all that; Likelihood examples; Standard statistics revisited; Modeling variance; Dynamic models.

Ecosystem analysis and ecological modelling is a rapidly developing interdisciplinary branch of science used in theoretical developments in ecology and having practical applications in environmental protection. In this book, the authors introduce new holistic, particularly cybernetic, concepts into ecosystem theory and modelling, and provide a concise treatment of mathematical modelling of freshwater ecosystems which covers methods, subsystem models, applications and theoretical developments. Part I begins with a brief introduction to the principles of systems theory and their applications to ecosystems, and provides a summary of various methods of systems analysis. In Part II emphasis is laid on the pelagic processes in standing water, characterised by relatively uninvolved structures from which models can be readily developed. Part III describes applications of the technique of modelling to solutions of theoretical and practical problems, with different modelling methods and objectives being used in the various chapters. More recent developments in the methods and theory of ecosystem modelling are covered in Part IV which also includes a discussion of future trends. The book is addressed to practising ecologists and engineers in the fields of ecology, limnology, environmental protection, and water quality managements, as well as to graduate/post-graduate university students in science and engineering. Students and researchers involved in environmental applications of mathematics and cybernetics will also find the book of interest. GIS for Environmental Applications provides a practical introduction to the principles, methods, techniques and tools in GIS for spatial data management, analysis, modelling and visualisation, and their applications in environmental problem solving and decision making. It covers the fundamental concepts, principles and techniques in spatial data, spatial data management, spatial analysis and modelling, spatial visualisation, spatial interpolation, spatial statistics, and remote sensing data analysis, as well as demonstrates the typical environmental applications of GIS, including terrain analysis, hydrological modelling, land use analysis and modelling, ecological modelling, and ecosystem service valuation. Case studies are used in the text to contextualise these subjects in the real world, examples and detailed tutorials are provided in each chapter to show how the GIS techniques and tools introduced in the chapter can be implemented using ESRI ArcGIS (a popular GIS software system for environmental applications) and other third party extensions to ArcGIS to address. The emphasis is placed on how to apply or implement the concepts and techniques of GIS through illustrative examples with step-by-step instructions and numerous annotated screen shots. The features include: Over 350 figures and tables illustrating how to apply or implement the concepts and techniques of GIS Learning objectives along with the end-of-chapter review questions Authoritative references at the end of each chapter GIS data files for all examples as well as PowerPoint presentations for each chapter downloadable from the companion website. GIS for Environmental Applications weaves theory and practice together, assimilates the most current GIS knowledge and tools relevant to environmental research, management and planning, and provides step-by-step tutorials with practical applications. This volume will be an indispensable resource for any students taking a module on GIS for the environment.

Presents the state-of-the-art of model-based integration of ecology and economics in the field of biodiversity conservation.

An Introduction

Numerical Ecology with R

Flourishing Within Limits to Growth

Ecological Modelling and Ecophysics

Applications in Environmental Management and Research

Ecological Modeling

Given the importance of interdisciplinary work in sustainability, Simulation of Ecological and Environmental Models introduces the theory and practice of modeling and simulation as applied in a variety of disciplines that deal with earth systems, the environment, ecology, and human-nature interactions. Based on the author's many years of teaching g This is a thoroughly revised and updated edition of an authoritative introduction to ecological modelling. Sven Erik Jørgensen, Editor-in-Chief of the journal Ecological Modelling, and Giuseppe Bendricchio, Professor of Environmental Modelling at the University of Padova, Italy, offer compelling insights into the subject. This volume explains the concepts and processes involved in ecological modelling, presents the latest developments in the field and provides readers with the tools to construct their own models. The Third Edition features: • A detailed discussion and step-by-step outline of the modelling procedure. • An account of different model types including overview tables, examples and illustrations. • A comprehensive presentation of the submodels and unit processes used in modelling. • In-depth descriptions of the latest modelling techniques. • Structured exercises at the end of each chapter. • Three mathematical appendices and a subject index. This practical and proven book very effectively combines the theory, methodology and applications of ecological modelling. The new edition is an essential, up-to-date guide to a rapidly growing field.

This volume brings together, in a central text, chapters written by leading scholars working at the intersection of modeling, the natural and social sciences, and public participation. This book presents the current state of knowledge regarding the theory and practice of engaging stakeholders in environmental modeling for decision-making, and includes

basic theoretical considerations, an overview of methods and tools available, and case study examples of these principles and methods in practice. Although there has been a significant increase in research and development regarding participatory modeling, a unifying text that provides an overview of the different methodologies available to scholars and a systematic review of case study applications has been largely unavailable. This edited volume seeks to address a gap in the literature and provide a primer that addresses the growing demand to adopt and apply a range of modeling methods that includes the public in environmental assessment and management. The book is divided into two main sections. The first part of the book covers basic considerations for including stakeholders in the modeling process and its intersection with the theory and practice of public participation in environmental decision-making. The second part of the book is devoted to specific applications and products of the various methods available through case study examination. This second part of the book also provides insight from several international experts currently working in the field about their approaches, types of interactions with stakeholders, models produced, and the challenges they perceived based on their practical experiences.

At present, most books on ecological modelling rely on very complex mathematics, resulting in students and researchers shying away from investigating the potential uses of ecological models and their methods of construction. This new book aims to open up this exciting area to a much wider audience. Assuming only basic mathematical knowledge, the text uses case studies to show how a relatively small set of techniques of model construction can be used in a wide range of important applications. Researchers will find it an invaluable guide to using ecological models in their work. Uses case studies to clearly demonstrate the applications of ecological models. Avoids complex mathematics. A practical how-to guide for ecological researchers. Sample ecological models available via this web site.

Thermodynamics and Ecological Modelling

A Practical Information-Theoretic Approach

The Kangsabati River, India

A Practical Guide to Ecological Modelling

Ecological Risk Assessment

Environmental Modelling

Ecological Modeling: An Introduction to the Art and Science of Modeling Ecological Systems, Volume 31, presents the skills needed to appropriately evaluate and use ecological models. Illustrated throughout with practical examples, the book discusses ecological modeling as both an art and a science, balancing the qualitative (artistic) side, with its foundations in common sense and modeling practice, against the quantitative (scientific) aspects of the modeling process. This book draws on the authors' extensive experience in both teaching and using these techniques to provide readers with a practical, user-friendly guide that supports and encourages the appropriate, effective use of these tools. Provides readers with a commonsense understanding of the systems perspective and its foundations in general system theory Highlights the importance of a solid understanding of the qualitative aspects of the modeling process Facilitates the ability to appropriately evaluate and use ecological models Supports learning with a variety of simple examples to instill the desire and confidence to embark upon the modeling experience

Decades of research and discussion have shown that the human population growth and our increased consumption of natural resources cannot continue – there are limits to growth. This volume demonstrates how we might modify and revise our economic systems using nature as a model. The book describes how nature uses three growth forms: biomass, information, and networks, resulting in improved overall ecosystem functioning and co-development. As biomass growth is limited by available resources, nature uses the two other growth forms to achieve higher resource use efficiency. Through a universal application of the three 'R's: reduce, reuse, and recycle, nature thus shows us a way forward towards better solutions. However, our current approach, dominated by short-term economic thinking, inhibits full utilization of the three 'R's and other successful approaches from nature. Building on ecological principles, the authors present a global model and futures scenario analyses which show that implementation of the proposed changes will lead to a win-win situation. In other words, we can learn from nature how to develop a society that can flourish within the limits to growth with better conditions for prosperity and well-being.

Increasingly used to represent climatic, biogeochemical, and ecological systems, computer modeling has become an important tool that should be in every environmental professional's toolbox. Environmental Modeling: A Practical Introduction is just what it purports to be, a practical introduction to the various methods, techniques, and skills required for computerized environmental modeling. Exploring the broad arena of environmental modeling, the book demonstrates how to represent an environmental problem in conceptual terms, formalize the conceptual model using mathematical expressions, convert the mathematical model into a program that can be run on a desktop or laptop computer, and examine the results produced by the computational model. Equally important, the book imparts skills that allow you to develop, implement, and experiment with a range of computerized environmental models. The emphasis is on active engagement in the modeling process rather than on passive learning about a suite of well-established models. The author takes a practical approach throughout, one that does not get bogged down in the details of the underlying mathematics and that encourages learning through "hands on" experimentation. He provides a set of software tools and data sets that you can use to work through the various examples and exercises presented in each chapter, as well as presentational material and handouts for course tutors. Comprehensive and up-to-date, the book discusses how computational models can be used to represent environmental systems and illustrates how such models improve understanding of the ways in which environmental systems function.

Ecological Modeling: A Commonsense Approach to Theory and Practice explores how simulation modeling and its new ecological applications can offer solutions to complex natural resource management problems. This is a practical guide for students, teachers, and professional ecologists. Examines four phases of the modeling process: conceptual model formulation, quantitative model specification, model evaluation,

and model use Provides useful building blocks for constructing systems simulation models Includes a format for reporting the development and use of simulation models Offers an integrated systems perspective for students, faculty, and professionals Features helpful insights from the author, gained over 30 years of university teaching "I can strongly recommend the book as textbook for all courses in population dynamic modeling particularly when the course is planned for the second or third year of a bachelor study in ecology, environmental science or ecological engineering. It uncovers very clearly for the readers the scientific idea and thinking behind modeling and all the necessary steps in the development of models." *Ecological Modeling Journal*, 2009

Agricultural and Environmental Applications

Fundamentals of Ecological Modelling

A Practical Introduction Using Excel

Computerised Environmental Modelling

River Sand Mining Modelling and Sustainable Practice

Chemical Effects on Populations, Ecosystems, and Landscapes

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.

Individual-based models are an exciting and widely used new tool for ecology. These computational models allow scientists to explore the mechanisms through which population and ecosystem ecology arises from how individuals interact with each other and their environment. This book provides the first in-depth treatment of individual-based modeling and its use to develop theoretical understanding of how ecological systems work, an approach the authors call "individual-based ecology." Grimm and Railsback start with a general primer on modeling: how to design models that are as simple as possible while still allowing specific problems to be solved, and how to move efficiently through a cycle of pattern-oriented model design, implementation, and analysis. Next, they address the problems of theory and conceptual framework for individual-based ecology: What is "theory"? That is, how do we develop reusable models of how system dynamics arise from characteristics of individuals? What conceptual framework do we use when the classical differential equation framework no longer applies? An extensive review illustrates the ecological problems that have been addressed with individual-based models. The authors then identify how the mechanics of building and using individual-based models differ from those of traditional science, and provide guidance on formulating, programming, and analyzing models. This book will be helpful to ecologists interested in modeling, and to other scientists interested in agent-based modeling.

Recently, environmental scientists have been required to perform a new type of assessment-ecological risk assessment. This is the first book that explains how to perform ecological risk assessments and gives assessors access to the full range of useful data, models, and conceptual approaches they need to perform an accurate assessment. It explains how ecological risk assessment relates to more familiar types of assessments. It also shows how to organize and conduct an ecological risk assessment, including defining the source, selecting endpoints, describing the relevant features of the receiving environment, estimating exposure, estimating effects, characterizing the risks, and interacting with the risk manager. Specific technical topics include finding and selecting toxicity data; statistical and mathematical models of effects on organisms, populations, and ecosystems; estimation of chemical fate parameters; modeling of chemical transport and fate; estimation of chemical uptake by organisms; and estimation, propagation, and presentation of uncertainty. *Ecological Risk Assessment* also covers conventional risk assessments, risk assessments for existing contamination, large scale problems, exotic organisms, and risk assessments based on environmental monitoring. Environmental assessors at regulatory agencies, consulting firms, industry, and government labs need this book for its approaches and methods for ecological risk assessment. Professors in ecology and other environmental sciences will find the book's practical preparation useful for classroom instruction. Environmental toxicologists and chemists will appreciate the discussion of the utility for risk assessment of particular toxicity tests and chemical determinations.

The book gives a comprehensive overview of all available types of ecological models. It is the first book of its kind that gives an overview of different model types and will be of interest to all those involved in

ecological and environmental modelling and ecological informatics.

Theory, Methods, and Applications

Ecological Modelling

Ecological Modelling and Engineering of Lakes and Wetlands

Simulation of Ecological and Environmental Models

Introduction to Ecological Modelling

Dynamic Modeling of Environmental Systems

Fundamentals of Ecological Modelling: Applications in Environmental Management and Research, Fourth Edition, provides a comprehensive discussion of the fundamental principles of ecological modeling. The first two editions of this book (published in 1986 and 1994) focused on the roots of the discipline the four main model types that dominated the field 30-40 years ago: (1) dynamic biogeochemical models; (2) population dynamic models; (3) ecotoxicological models; and (4) steady-state biogeochemical and energy models. The third edition focused on the mathematical formulations of ecological processes that are included in ecological models. This fourth edition uses the four model types previously listed as the foundation and expands the latest model developments in spatial models, structural dynamic models, and individual-based models. As these seven types of models are very different and require different considerations in the model development phase, a separate chapter is devoted to the development of each of the model types. Throughout the text, the examples given from the literature emphasize the application of models for environmental management and research. Presents the most commonly used model types with a step-by-step outline of the modeling procedure used for each Shows readers through an illustrated example of how to use each model in research and management settings New edition is revised to include only essential theory with a focus on applications Includes case studies, illustrations, and exercises (case study of an ecological problem with full illustration on how to solve the problem)

With descriptions of hundreds of the most important environmental and ecological models, this handbook is a unique and practical reference source. The Handbook of Environmental and Ecological Modeling is ideal for those working in environmental modeling, including regulators and managers who wish to understand the models used to make assessments. Overviews of more than 360 models are easily accessed in this handbook, allowing readers to quickly locate information they need about models available in a given ecosystem. The material in the Handbook of Environmental and Ecological Modeling is logically arranged according to ecosystem. Each of the sixteen chapters of the handbook covers a particular ecosystem, and includes not only the descriptions of the models, but also an overview of the state-of-the-art in modeling for that particular ecosystem. A summary of the spectrum of available models is also provided in each chapter. The extensive table of contents and the easy-to-use index put materials immediately at your fingertips.

The Routledge Handbook of Research Methods for Social-Ecological Systems provides a synthetic guide to the range of methods that can be employed in social-ecological systems (SES) research. The book is primarily targeted at graduate students, lecturers and researchers working on SES, and has been written in a style that is accessible to readers entering the field from a variety of different disciplinary backgrounds. Each chapter discusses the types of SES questions to which the particular methods are suited and the potential resources and skills required for their implementation, and provides practical examples of the application of the methods. In addition, the book contains a conceptual and practical introduction to SES research, a discussion of key gaps and frontiers in SES research methods, and a glossary of key terms in SES research. Contributions from 97 different authors, situated at SES research hubs in 16 countries around the world, including South Africa, Sweden, Germany and Australia, bring a wealth of expertise and experience to this book. The first book to provide a guide and introduction specifically focused on methods for studying SES, this book will be of great interest to students and scholars of sustainability science, environmental management, global environmental change studies and environmental governance. The book will also be of interest to upper-level undergraduates and professionals working at the science-policy interface in the environmental arena.

Thermodynamics is used increasingly in ecology to understand the system properties of ecosystems because it is a basic science that describes energy transformation from a holistic view. In the last decade, many contributions to ecosystem theory based on thermodynamics have been published, therefore an important step toward integrating these theories and encouraging a more wide spread use of them is to present them in one volume. An ecosystem consists of interdependent living organisms that are also interdependent with their environment, all of which are involved in a constant transfer of energy and mass within a general state of equilibrium or dis-equilibrium. Thermodynamics can quantify exactly how "organized" or "disorganized" a system is - an extremely useful to know when trying to understand how a dynamic ecosystem is behaving. A part of the Environmental and Ecological (Math) Modeling series, Thermodynamics and Ecology is a book-length study - the first of its kind - of the current thinking on how an ecosystem can be explained and predicted in terms of its thermodynamical behavior. After the introductory chapters on the fundamentals of thermodynamics, the book explains how thermodynamic theory can be specifically applied to the "measurement" of an ecosystem, including the assessment of its state of entropy and enthalpy. Additionally, it will show economists how to put these theories to use when trying to quantify the movement of goods and services through another type of complex living system - a human society.

Handbook of Ecological Indicators for Assessment of Ecosystem Health

Ecological Models and Data in R

The Routledge Handbook of Research Methods for Social-Ecological Systems

A Practical Introduction

Introduction to WinBUGS for Ecologists