*Spreadsheet Exercises in*
*Conservation Biology and Landscape Ecology*

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# Conservation Biology and Landscape Ecology

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*For my parents, Tom and Earline (T.M.D.)*

*To my students, whose steadfast refusal to take my word for anything has forced me to learn (C.W.W.)*

# Contents

# Preface

This book is about using a spreadsheet program to build biological models. Spreadsheet programs have many uses, such as entering and organizing data, tracking expenses, managing budgets, and graphing. In this book, we use a spreadsheet program to create models to help you learn some basic and advanced concepts in ecology, evolution, conservation biology, landscape ecology, and statistics.

Why build your own models when so many specific, prewritten models are widely available? Because when you program a model from scratch, you learn all aspects of modeling—what parameters are important, how the parameters relate to each other, and how changes in the model affect outcomes. In other words, you not only learn about **models**, you also learn about **modeling**.

Why use a spreadsheet program rather than a dedicated modeling package or general-purpose programming language? In part, because most colleges and universities have a spreadsheet program readily available for their students, and many students are already familiar with basic spreadsheet operations. Using a spreadsheet thus reduces expense and learning time. In addition, using a spreadsheet allows more flexibility than is possible with most prewritten models. Students can easily modify or elaborate a model, once they have mastered the basic versions presented here. Finally, the spreadsheet takes care of much of the tedium of carrying out repeated calculations and creating graphs.

Why do modeling at all? Because modeling is a powerful learning tool. By building and manipulating models, you can achieve a deeper understanding of concepts. Models allow you to explore concepts, examine them from various angles, extend them in various directions, and ask "what if" all in rigorous and objective ways. Many models generate a clear set of predictions that can be tested in a natural or laboratory setting. Models offer a check on your understanding. When you plug values into a model and get unexpected results, you have to ask, "Why?" Answering that "why" leads to deeper understanding.

## Acknowledgments

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It takes many people to produce a book, and we have been very fortunate to work with Andy Sinauer and his associates. We are indebted to Carol Wigg and David McIntyre for the extraordinary energy and enthusiasm that they brought to the project, and to Susan McGlew, Roberta Lewis, and Joan Gemme. Finally, our families have been a consistent source of support and encouragement.

TERRI DONOVAN
CHARLES WELDEN
DECEMBER, 2001

# *How to Approach These Exercises*

This book is intended to be a supplement to the primary text in an undergraduate or a beginning graduate course in ecology, evolution, or conservation biology. Although there are many excellent texts on the market, two primers were instrumental in helping us develop many of the spreadsheet exercises in this book: Nick Gotelli's *Primer of Ecology* (2001) and Dan Hartl's *Primer of Population Genetics* (2000). Both are extremely well written and helped us fully understand the basic mathematics behind many ecology and evolution models.

Each exercise was written with the notion that an instructor would introduce the basic material, and that the spreadsheet exercises would reinforce the concepts and allow further exploration. **We will assume that you have read the Introduction, "Spreadsheet Hints and Tips," and that you have mastered Exercises 1 and 2, "Mathematical Functions and Graphs" and "Spreadsheet Functions and Macros," before attempting other exercises in the book.**

Each exercise consists of an Introduction, followed by Instructions and Annotations that guide you through the model development, and then by a series of Questions. In the introduction to each exercise, we have tried to include enough background material for you to understand the context and purpose of the exercise, but we have also tried to keep these commentaries relatively brief. The Instructions give rather generic directions for how to set up the spreadsheet, such as "Sum the total number of individuals in the population." The accompanying Annotations provide the actual spreadsheet formulae that we used to accomplish each step, with a complete explanation of the logic behind each formula. Because our formulae are provided for you, you may be tempted to leap to the Annotations section before attempting to work through the problem on your own. Don't. You will learn more about the process of thinking through a model if you struggle through it on your own, and you may come up with a better way of doing things than we did. As much as possible, use the Annotations as a cross-check.

The last portion of each chapter consists of a set of questions that will challenge you to "exercise" your model and explore it more deeply. Some of the questions ask you to change your spreadsheets in various ways. You may want to save your original spreadsheet, and use a copy of the spreadsheet model when answering questions to preserve your original entries. The answers to the questions are posted on the Web site **www.sinauer.com/spreadsheet-cble/**. Although you can double-check your results with those posted on the Web, in reality scientists don't have the luxury of an answer section when developing a new model. If your results look odd to you, an assumption of the model may have been violated, you may have made a mistake in your programming, or the result may be, in fact, correct. Learn to critically interpret your own results—that is what scientists do.

The Web site also contains all of the spreadsheets used in the book. Students have access to "shell" versions, containing only titles, labels, headings, etc. Downloading these before class can save class time. Instructors have access to complete spreadsheet models, which they can use for exploration, modification, or verification. The Web site is also a clearinghouse for errata, instructors' comments, ideas for modifications, and links to related Web sites.

The process of entering formulae, making graphs, and answering questions in each exercise is just the beginning. We have attempted to build models that are very open-ended and encourage you to play with the models and take them beyond the questions posed. Don't be shy about changing parameter values, initial variable values, and modifying formulae. Observe how the model responds, and think about why it does whatever it does. Question, modify, and question again. Think about how you might make the model more realistic, how you might include other processes in it, or how the same model might be applied to a different system. All these ways of thinking will help you understand the models that you encounter in your texts and in the scientific literature.

T.M.D. AND C.W.W.