

Preface

The accelerating pace of discovery makes the teaching of a dynamic scientific discipline such as ecology very challenging. The challenge to ecology instructors and their students is made greater by the relevance of ecology to the pressing environmental problems that threaten ecological systems at every level. As we attempt to educate students to understand and design solutions to those problems, every facet of ecology is relevant. Therefore, ideally, an introduction to ecology should include the foundations to all of its major subdisciplines. Including such breadth, and developing it to sufficient depth, is difficult. However, careful organization and a conceptual approach can ease the task.

Introductory Audience

I have written this book for students taking their first undergraduate course in ecology. I have assumed that students in this one-semester course have some knowledge of basic chemistry and mathematics and that they have had a course in general biology that included introductions to physiology, biological diversity, and evolution.

"I receive positive feedback about the text from my students. During or after the course, some students majoring in other fields have expressed an interest in switching to ecology as a major, and I believe the text contributes toward that interest."

—Carolyn Meyer
University of Wyoming

A Focused Approach

In an address at the 1991 meeting of the Ecological Society of America in San Antonio, Texas, eminent ecologist Paul Risser challenged ecology instructors to focus their attention on the major concepts of the field. If we subdivide a large and dynamic subject, such as ecology, too finely, we cannot cover it in one or two academic terms. Risser proposed that by focusing on major concepts, however, we may provide students with a robust framework of the discipline upon which they can build.

This book attempts to address Risser's challenge. **Each chapter is organized around two to five major concepts, presenting the student with a manageable and memorable synthesis of the subject.** I have found that while beginning ecology students can absorb a few central concepts

well, they can easily get lost in a sea of details. Each concept is supported by discussions that provide evidence for the concept and introduce students to the research approaches used in the various areas of ecology. Wherever possible, the original research and the scientists who did the research are presented. Allowing the scientists who created this field to emerge from the background and lead students through the discipline breathes life into the subject and helps students retain information.

"What primarily motivated me to adopt Ecology: Concepts and Applications is the way the author emphasizes a few key ecological concepts in each chapter and then uses relevant studies to demonstrate how scientists have 'discovered' these concepts. I find this emphasis on concepts and the science behind them to be a refreshing change from the typical textbook that tends to present the science of ecology as a rather dull collection of facts. I feel that the students who read this text will come away with a better understanding not only of ecology, but also of the method of doing science."

—Tim Maret
Shippensburg University

New to This Edition

All 23 chapters of the book have been revised following the suggestions of numerous reviewers. An attempt was made to address reviewers' concerns, to update material where needed, add missing perspectives, correct errors, and generally freshen and streamline the treatment. Suggested readings have been updated, drawing mainly from literature published since the publication of the fourth edition.

The introduction now links the historical foundations of ecology with developing frontiers. Emphasis is placed on how new tools, such as stable isotope analysis and canopy access cranes, provide more powerful ways of investigating ecological systems, as we explore and attempt to sustain biodiversity in the face of global climate change and other environmental pressures.

The evolutionary foundation for the book has been strengthened. The chapter on population genetics and natural selection has been moved from eighth position, in section III, to fourth, in section I. Section I is now titled *Natural History and Evolution*. Moving evolution to this point in the text sets all the material to follow in a stronger evolutionary

framework. This is particularly significant to section II, which is retitled as *Adaptations to the Environment*.

The overall conceptual foundation of the text has been enriched. New concepts presented include the principle of allocation, apparent competition, indirect mutualism, and the ecology of fear.

The treatment of nutrient cycling has been improved. The nutrient cycling presentation now appears under its own umbrella concept and is buttressed by the addition of central concepts, including nutrient sinks, sources, fluxes, and pools, which are critical for understanding contemporary issues related to the buildup of atmospheric carbon dioxide.

Lessons learned through the Investigating the Evidence boxes enrich the graphical presentation. Confidence intervals and standard error bars are added to selected graphs once the statistical concepts are introduced in section IV.

New supplementary materials have been placed online. Suggested readings, answers to Concept Review questions, and answers to Critiquing the Evidence questions are now online. In addition, examples cut from the fourth edition are also available online.

New chapter opener photos, related to chapter content, have been added to enrich the visual presentation of ecology.

Organized Around Key Concepts

An evolutionary perspective forms the foundation of the entire textbook, as it is needed to support understanding of major concepts. The textbook begins with a brief introduction to the nature and history of the discipline of ecology, followed by section I, which includes two chapters on natural history—life on land and life in water and a chapter on population genetics and natural selection. Sections II through VI build a hierarchical perspective through the traditional subdisciplines of ecology: section II concerns adaptations to the environment; section III focuses on population ecology; section IV presents the ecology of interactions; section V summarizes community and ecosystem ecology; and finally, section VI discusses large-scale ecology and includes chapters on landscape, geographic, and global ecology. These topics were first introduced in section I within a natural history context. In summary, the book begins with the natural history of the planet, considers portions of the whole in the middle chapters, and ends with another perspective of the entire planet in the concluding chapter.

Significant Changes

In **chapter 2**, the maps of individual biomes are now supplemented by a global map of all the terrestrial biomes that appears on the inside back cover of the text.

In **chapter 4**, the treatment of evolution by natural selection is extended by presenting Darwin's conceptual connection of artificial selection to natural selection and discussing the significance of evolution to agriculture, including genetic engineering and genetically modified organisms.

In **chapter 5**, the principle of allocation and the concept of tradeoffs are elaborated, improving the foundation for all subsequent discussions of environmental adaptations.

In **chapter 7**, the trophic diversity of life is underscored by presenting the ecology of photosynthetic autotrophs, chemosynthetic autotrophs, and heterotrophs under separate concepts. Photorespiration is also presented and tied to the evolution of alternative photosynthetic pathways.

In **chapter 9**, the niche concept is moved up earlier in the text and tied to patterns of distribution.

In **chapter 13**, the niche concept is revisited and connected to the concept of competitive exclusion.

In **chapter 14**, the ecology of fear is discussed within the context of refuges and its significance presented within the context of wolf restoration in Yellowstone National Park. The discussion foreshadows trophic cascades, which appear in chapter 18.

In **chapter 15**, the material on mycorrhizae is updated and improved by presenting the functional equilibrium model for allocation of energy by plants.

In **chapter 16**, the discussion of disturbance is extended to include the extreme levels of disturbance wrought by humans and points out how these levels of disturbance tie into the predictions of the intermediate disturbance hypothesis. The sampling discussion in *Investigating the Evidence* is tied to the canopy crane research introduced in chapter 1.

In **chapter 17**, indirect interactions, including indirect commensalism and apparent competition, are introduced under a new concept and developed both with text and new art work.

In **chapter 18**, trophic cascades are presented under the conceptual umbrella of indirect interactions, which were introduced in the previous chapter.

In **chapter 19**, nutrient cycles are more carefully presented within an enriched conceptual context and tied to current environmental concerns about the buildup of atmospheric carbon dioxide.

In **chapter 21**, edge effects and ecotones are included to better define landscape structure for students and to prepare for material on habitat fragmentation in chapter 23.

Features Designed with the Student in Mind

The features of this textbook are unique and were carefully planned to enhance the students' comprehension of ecology. All chapters beyond the introductory chapter 1 are based on a distinctive learning system, featuring the following key components:

Introduction: The introduction to each chapter presents the student with the flavor of the subject and important background information. Some introductions include historical events related to the subject; others present an example of an ecological process. All attempt to engage students and draw them into the discussion that follows.

Concepts: The goal of this book is to build a foundation of ecological knowledge around key concepts. These key concepts are listed after the chapter introduction to alert the student to the major topics to follow, and to provide a place

where the student can find a list of the important points of each chapter. The sections in which concepts are discussed reinforce concepts with a focus on published studies. This case-study approach supports the concepts with evidence, and introduces students to the methods and people that have created the discipline of ecology.

Illustrations: A great deal of effort has been put into the development of illustrations, both photographs and line art. The goal has been to create more effective pedagogical tools through skillful design and use of color, and to rearrange the traditional presentation of information in figures and captions. Much explanatory material is located within the illustrations, providing students with key information where they need it most.

"I love the boxes in the illustrations! I think they facilitate both the reading and comprehension for the students. I think this style is the most helpful with the graphs and charts."

—Tatiana Roth
Coppin State College

Applications: Many undergraduate students want to know how abstract ideas and general relationships can be applied to the ecological problems facing us all. They are concerned with the practical side of ecology and want to know more about the tools of science. Including a few applications in each chapter motivates students to learn more of the underlying principles of ecology. In addition, it seems that

environmental problems are now so numerous and so pressing that they have erased a once easy distinction between general and applied ecology.

"The idea of Applications sections in the chapter is excellent."

—Frank S. Gilliam
Marshall University

“Investigating the Evidence” Boxes: These important readings offer “mini-lessons” on the scientific method, emphasizing statistics and study design. They are intended to present a broad outline of the process of science, while also providing step-by-step explanation. The series of boxes begins in chapter 1 with an overview of the scientific method, which provides a conceptual context for more specific material in the next 21 chapters. The last reading wraps up the series with a discussion on electronic literature searches.

"What I really like are the Investigating the Evidence (boxes) scattered through the chapters. This is an absolutely brilliant way to encourage quantification especially if there is no lab associated with the course."

—Peter E. Busher
Boston University

