

Preface

The first edition of *Elements of Ecology* appeared in 1976 as a short version of Ecology and Field Biology. Since that time, *Elements of Ecology* has evolved into a textbook intended for use in a one-semester introduction to ecology course. Although the primary readership will be students majoring in the life sciences, in writing this text we were guided by our belief that ecology should be part of a liberal education. We believe that students who major in such diverse fields as economics, sociology, engineering, political science, law, history, English, languages, and the like should have some basic understanding of ecology for the simple reason that it impinges on their lives.

Structure and Content

The structure and context of the text is guided by our basic belief that: 1) the fundamental unit in the study of ecology is the individual organism, and 2) the concept of adaptation through natural selection provides the framework for unifying the study of ecology at higher levels of organization: populations, communities, and ecosystems. A central theme of the text is the concept of tradeoffs—that the set of adaptations (characteristics) that enable an organism to survive, grow, and reproduce under one set of environmental conditions inevitably impose constraints on its ability to function (survive, grow, and reproduce) equally well under different environmental conditions. These environmental conditions include both the physical environment, as well as the variety of organisms (both the same and different species) that occupy the same habitat. This basic framework provides a basis for understanding the dynamics of populations at both an evolutionary and demographic scale.

The text is divided into nine parts. *Part One* introduces the science of ecology and examines the unifying processes of natural selection and evolution. *Part Two* examines the constraints imposed on living organisms by the physical environment, both aquatic and terrestrial. *Part Three* explores the adaptations of organisms to the physical environment, considering both organisms that derive their energy from the sun (autotrophs), and those that derive their energy from the consumption and break-down of plant and animal tissues (heterotrophs).

Part Four examines the properties of populations, with an emphasis on how characteristics expressed at the level of the individual organisms (life history characteristics examined in *Part Three*) ultimately determine the collective dynamics of the population. *Part Five* expands our discussion from interactions among individuals of the same species to interactions among populations of different species (interspecific interactions). In these

chapters we expand our view of adaptations to the environment from one dominated by the physical environment, to the role of species interactions in the process of natural selection and on the dynamics of populations.

Part Six explores the topic of ecological communities. This discussion draws upon topics covered in *Parts Three to Five* to examine the factors that influence the distribution and abundance of species across environmental gradients, both spatial and temporal.

Part Seven combines the discussions of ecological communities (*Part Six*) and the physical environment (*Part Two*) to develop the concept of the ecosystem. Here the focus is on the flow of energy and matter through natural systems. *Part Eight* continues the discussion of communities and ecosystems in the context of biogeography, examining the broad-scale distribution of terrestrial and aquatic ecosystems, as well as regional and global patterns of biological diversity.

Part Nine focuses on the interactions between humans and ecological systems. It is here that we examine the important current environmental issues relating to population growth, sustainable resource use, declining biological diversity, and global climate change. The objective of these chapters is to explore the role of the science of ecology in both understanding and addressing these critical environmental issues.

Throughout the text we explore this range of topics by drawing upon current research in the various fields of ecology, providing examples that enable the reader to develop an understanding of species natural history, the ecology of place (specific ecosystems), and the basic process of science.

New for the Sixth Edition

For those familiar with the fifth edition of this text, you will notice a variety of changes in this new edition of *Elements of Ecology*. In addition to updating many of the examples and topics to reflect the most recent research and results in the field of ecology, we have made a number of changes in the organization and content of the text.

We have reorganized the sixth edition into nine parts, which reflect two major changes in the presentation of materials relating to community ecology and the application of ecology to current environmental issues. In the fifth edition, the discussion of populations (*Part Four: Populations*) was followed by *Part Five: Communities*, which included topics relating to interspecific interactions (competition, predation, parasitism, and mutualism). In the sixth edition, the discussion of interspecific interactions is presented in *Part Five: Species Interactions*. This new Part follows the discussion of populations

(*Part Four: Populations*) and precedes the discussion of community ecology (*Part Six: Communities*). The presentation of community ecology in *Part Six* has been reorganized into three chapters that address patterns of community structure (*Chapter 16: Community Structure*), factors influencing the structure of communities (*Chapter 17: Factors Influencing the Structure of Communities*), and community dynamics (*Chapter 18: Community Dynamics*). These three chapters are then followed by a discussion of landscapes (*Chapter 19: Landscape Ecology*).

A historical feature of the *Elements of Ecology* text is our focus on applying the science of ecology to current environmental issues, providing students with a first-hand understanding of the importance of ecology in the relationship between the human population and the natural environment. In the fifth edition, topics relating to conservation, sustainability, and climate change were contained in a variety of chapters throughout the text. In the sixth edition, we have reorganized these materials into a new *Part Nine: Human Ecology*. This part consists of three chapters: *Chapter 26: Population Growth, Resource Use, and Sustainability*; *Chapter 27: Habitat Loss, Biodiversity, and Conservation*; and *Chapter 29: Global Climate Change*. This new part has incorporated materials previously contained in *Chapter 18: Human Interactions Within Communities* and *Chapter 23: Human Intrusions into Biogeochemical Cycles* in the fifth edition.

In addition to the broader reorganization of topics in community and applied ecology, we have made a number of changes and additions in the sixth edition. We have reorganized *Chapter 4: Abiotic Environment* and *Chapter 5: Soils* of the fifth edition to form two new chapters: *Chapter 4: The Aquatic Environment* and *Chapter 5: The Terrestrial Environment*.

We have eliminated *Chapter 7: Decomposers and Decomposition* of the fifth edition and have moved the materials to an expanded chapter covering decomposition and nutrient cycling (*Chapter 20: Decomposition and Nutrient Cycling*) in *Part Seven: Ecosystem Ecology*.

In the sixth edition, we have added a new chapter to *Part Four: Populations* that introduces students to the growing field of metapopulation ecology (*Chapter 12: Metapopulations*). This new chapter reviews the basic concepts and models that are central to the study of fragmented populations, a topic of growing importance in both landscape (*Chapter 19*) and conservation ecology (*Chapter 28*). The addition of this new topic, unique to this textbook, both complements and completes the presentation of the more traditional topics of population structure, growth, and regulation in *Chapters 9 through 11*.

In the sixth edition, we have reorganized and condensed the topic of biogeography, the discussion of the broad-scale distribution of ecosystems, and patterns of biological diversity. The materials in *Chapters 25–29* of the fifth edition are now addressed in three shorter chapters

within *Part Eight: Biogeographical Ecology*: *Chapter 23: Terrestrial Ecosystems*, *Chapter 24: Aquatic Ecosystems*, and *Chapter 25 Land–Water Margins* (coastal and wetland ecosystems). *Chapter 26: Large-Scale Patterns of Biological Diversity* covers the biodiversity materials that were addressed in *Chapter 24: Biogeography and Biodiversity* of the fifth edition.

In addition to the changes in the organization and content of the chapters, the sixth edition includes several new features. Each of the nine parts begins with a two-page introduction. The objective of these introductions is two-fold: (1) to set the framework for the chapters that follow and (2) to link the various levels at which ecologists view and study natural systems.

Another new feature to the sixth edition is the inclusion of fourteen **Researcher Profiles** that are associated with specific chapters. These Researcher Profiles serve two functions. First, they introduce students to the new generation of ecologists pursuing questions relating directly to concepts presented within the chapter. Secondly, they function as case studies, allowing a more detailed presentation of methods, analyses, and results. Each profile integrates the work from a number of research papers, which together address a broader research question. Although early in their careers, the work of the individuals included in these profiles represent the new frontiers of ecological research.

We have restructured and expanded **Quantifying Ecology**, which has been a feature of the text in previous editions. Although conceptually rich, ecology is a quantitative science. The Quantifying Ecology feature now functions to provide students with an understanding of how concepts introduced in the chapters are quantified. In many chapters, the Quantifying Ecology boxes focus on assisting the reader with the interpretation of graphs, mathematical models, or quantitative methods that we have introduced within the main body of the text. For additional help, students can try out our new interactive **QUANTIFY!** and **GRAPH!** activities on the website (www.ecologyplace.com).

In addition to the Quantifying Ecology feature, we have expanded our presentation of the basic mathematical models that are central to the understanding of population dynamics in *Chapter 10: Population Growth*, *Chapter 11: Intraspecific Population Regulation*, and *Chapter 14: Predation*. The previous treatments of exponential growth, carrying capacity, logistic growth, and the functional response of predators have been expanded to include the actual derivations of these models. Requiring only an understanding of basic algebra, the objective of the new materials is to de-mystify these models by walking the reader through the logical development of the equations, beginning with the basic concepts upon which the models are constructed.

Although we have consolidated the majority of topics relating to human interactions with the natural

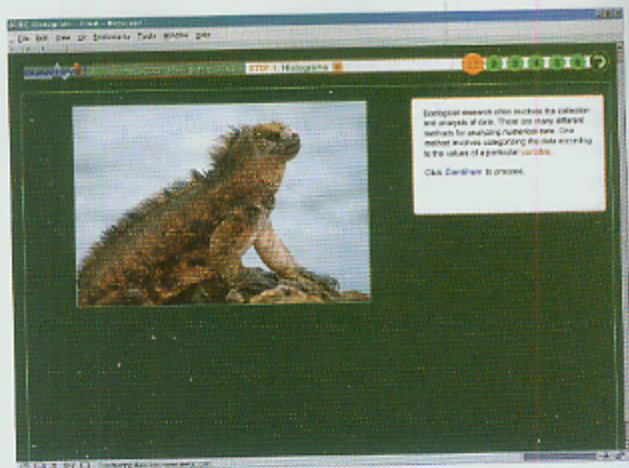
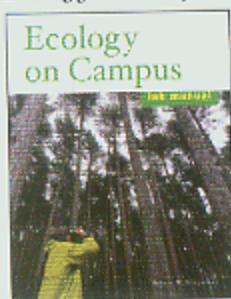
environment into the new *Part Nine: Human Ecology*, each chapter also contains short essays entitled Ecological Issues. Replacing the previous Focus on Ecology feature in the fifth edition, the objective of these short essays is to make the link between the basic ecological concepts that are being presented within the chapter and current ecological issues that depend upon an understanding of those basic concepts. At other times, we highlight the application of basic ecological concepts to the management and conservation of natural systems.

Note from Robert Leo Smith

Readers will note a change in the lead author of the 6th edition of *Elements of Ecology* from Robert Leo Smith to Thomas M. Smith, previously the second author. For over 40 years I have been immersed in two ecology texts: *Ecology and Field Biology* and *Elements of Ecology*. Although the basic foundation of the 6th edition of *Elements* remains the same as previous editions, ecology has changed considerably over the years. The time has come to “pass the torch” to my son, Tom. Even before becoming coauthor of the 5th edition, he had considerable input into earlier editions. He has literally grown up with the texts over the years. The major changes in content and organization in this edition, the development of Researcher Profiles, and new boxes on Quantitative Ecology reflect his fresh input into the text. His familiarity with current ecological research, his active research, years of international travel, and his experience in teaching ecology to both large undergraduate and small graduate classes provide him with valuable insights on how to make ecology stimulating to today's students.

Associated Materials (Web, Supplements, etc.)

- Media Manager (0-8053-4834-4)
- Instructor's Guide/Test Bank (0-8053-4831-X)
- Computerized Test Bank (0-8053-4833-6)
- Transparency Acetates (0-8053-4832-8)
- Ecology Place Companion Website (www.ecologyplace.com)
- *Ecology on Campus* Lab Manual (0-8053-8214-3)



- Course Management Options (All CourseCompass™ and Blackboard courses offer pre-loaded content including tests, quizzes, and more.)

Acknowledgments

No textbook is a product of the authors alone. The material this book covers represents the work of hundreds of ecological researchers who have spent lifetimes in the field and the laboratory. Their published experimental results, observations, and conceptual thinking provide the raw material out of which the textbook is fashioned. We particularly acknowledge and thank the fourteen ecologists that are featured in the Research Profiles. Their cooperation in providing artwork and photographs is greatly appreciated.

Revision of a textbook depends heavily on the input of users who point out mistakes and opportunities. We took these suggestions seriously and incorporated most of them. We are deeply grateful to the following reviewers for their helpful comments and suggestions on how to improve this edition:

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The publication of a modern textbook requires the work of many editors to handle the specialized tasks of development, photography, graphic design, illustration, copy editing, and production, to name only a few. Overseeing this team of specialists is one individual whose job it is to make it all come together. That individual was Alissa Anderson, Associate Editor. It was her effort, organization, and calming effect during the harried pace of production that ultimately made this project not only possible, but also enjoyable. Words cannot adequately express our appreciation and respect.

Through it all our families, especially our spouses Nancy and Alice, had to endure the throes of book production. Their love, understanding, and support provide the balanced environment that makes our work possible.

Thomas M. Smith
 Robert Leo Smith