Preface

You are living in the Age of Ecology, and as a citizen you ought to learn something about this subject which forms the cutting edge of the major problem of climate change. There has been a revolution of human thinking in the last 60 years that has centered on the relationship between humans and their environment. The broader policy problems this revolution has brought forward are the focus of the "green" movement, the applied scientific problems of ecological pest management, conservation, and fishing, and the heart of environmental science and ecosystemhealth. The basic science behind it all is the science of ecology. Sustainability is the mantra of all our politicians, and environmental problems including conservation and climate change are now common subjects in the daily media.

Just as it is useful to know something about physics if you wish to be an engineer, it is useful to learn something about ecology if you wish to understand the problems humans face with sustaining their environment. This text is dedicated to presenting to you the outlines of the science of ecology. If you understand how the natural world works, you will be better poised to understand the Age of Ecology as it unfolds, and to think and vote with an ecological conscience.

Two dilemmas face the textbook writer. First, the writer must plot a course that will place the book serenely between the pitfalls of the past and the bandwagons of the present. We all recognize the pitfalls of the past, and any text has an obligation to point out some of these lest history repeat itself. We do not do as well at recognizing the pitfalls of the present—at recognizing which of the current bandwagons in ecology are enduring and which are ephemeral. Science, like most subjects of human endeavor, is subject to bandwagons, only some of which are useful for our long-term understanding. Second, the writer must create a textbook that pleases not only the students but also their instructors. I have strived to make this book readable, and the greatest compliment any text can get is that students think it is readable and interesting.

Each chapter in this book attempts to raise a question about how populations and communities operate in nature, and to give you enough information that you can think about it intelligently. If you need more information, a list of suggested readings is a good starting point. Each chapter also ends with a series of questions and problems that are devised to stimulate thought. I have not provided answers to these questions. For many of them the answer is not yet known. An overview question at the end of each chapter is a still more general question that may be the focus of a class discussion. Many overview questions are action-oriented. A key focus of much ecological thought ought to be "What are the practical consequences of this idea?"

In this edition I have consolidated the chapters on geographic distribution and expanded the section on community dynamics. I have added a chapter on ecosystem dynamics under changing climates, and updated all the material on ecosystem health and human impacts. I have tried to emphasize the historical development of ecology by adding profiles of famous ecologists. Science is a human activity and the scientists who have built ecology and are building it today are themselves interesting characters worthy of more recognition. I have extensively revised all of the chapters, particularly those on conservation biology, community organization, and primary production, and strengthened the integration of evolutionary and functional ecology. Conservation biology is a focus for practical problems that cry out for ecological understanding and is one of the strong growth points of ecological science. Many of the attempts to converse biodiversity hinge on concepts of community organization that need careful thought and analysis. Many chapters deal with ecological attributes and their evolutionary background. Ecologists can benefit by stepping back and looking at ecological systems in an evolutionary perspective, and students of evolution can benefit from knowing how ecological systems function, for they cannot otherwise understand natural selection. I have added essays in many chapters to illustrate some of the kinds of problems and questions ecologists deal with in their attempt to understand nature.

This book is my own attempt to present modern ecology as an interesting and dynamic subject. Beneath the variety of approaches that characterize modern ecology lie a few basic problems that I have attempted to sketch. I have placed special emphasis on problems and have illustrated them by examples chosen as diversely as possible from the plant and animal kingdoms. This book is not an encyclopedia of ecology but an introduction to its problems. It is not descriptive ecology and will not tell students about the ecology of the seashore or the ecology of the alpine tundra. It approaches ecology as a series of problems, problems confined neither to the

seashore nor to the alpine tundra but are sufficiently general to be studied in either area.

To understand the problems of ecology, students must have some background in biology and mathematics. Students will find that they can understand ecology without knowing any mathematics but that mathematics is necessary for those who wish to proceed beyond the simplest level of analysis. Ecology is not a haven for people who cannot do mathematics, and in this respect it is no different from chemistry and physics. Statistics and calculus are useful but not essential for an understanding of this book. I present mathematical analyses step by step and illustrate them with graphs. Students who cannot follow the mathematics should be able to get the essence of the arguments from the graphs.

The problems of ecology are "biological" problems and will be solved not by mathematicians but by biologists. Students will find that, contrary to the impression they get from other sources, the problems of ecology have not all been solved. A start has been made in solving many ecological problems, and I cannot give the "answer" to many of the problems I discuss. Controversies are common in ecology, and an important part of ecological training is appreciating the controversies and trying to understand why people may look at the same data and yet reach opposite conclusions.

Students can learn much about the science of ecology by analyzing one of its controversies. If you think that ecologists have the answer to most of our environmental questions, you will be surprised when you look into the variety of ecological controversies. Controversy is not a sign of weak science, and to appreciate controversies you should try to find out the scope of the controversy and what kinds of observations are needed to solve it. Many of the environmental controversies of our day, such as climate change, involve a mixture of scientific facts and policy decisions. Scientific facts alone do not determine policy, but policy without a solid scientific grounding is doomed. The relevant scientific facts are never completely known for many environmental problems, and we must decide what to do in the face of uncertainty. Interim policy decisions always point out the need for more scientific analysis, and there must be a continuous feedback loop between policy and all the environmental sciences, including ecology.

Good ecology is quantitative. At the end of many of the quantitative chapters, problems are included because no one can appreciate the quantitative aspects of ecology without going through some of the calculations. Most of the calculations are simple, but I have tried to leave some of them open-ended so that interested students can carry on under their own steam.

If there is a message in this book, it is a simple one: progress in answering ecological questions comes when experimental techniques are used. The habit of asking, "What experiment could answer this question?" is the most basic aspect of scientific method that students should learn to cultivate. When there is controversy, asking this question can cut to the heart of the matter.

Technical terms in this book are kept to a minimum; labeling with words should not be confused with understanding. The key words at the start of each chapter, the glossary of technical words, together with the indexes, should cover most technical ecological definitions.

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Charley Krebs