Urban Ecosystems

Ecological Principles for the Built Environment

As humans have come to dominate the Earth's ecosystems, the ideal of studying and teaching ecology in pristine ecosystems has become impossible to achieve. Our planet is now a mosaic of ecosystems, ranging from the relatively undisturbed to the completely built, with the majority of people living in urban environments.

This accessible introduction to the principles of urban ecology provides students with the tools they need to understand these increasingly important urban ecosystems. It builds upon a set of key themes, including habitat modification and resource use, to demonstrate how multiple ecological processes interact in cities and how human activity leads to chains of unpredictable unintended ecological consequences.

Broad principles are supported throughout by detailed examples from around the world and a comprehensive list of further readings from the primary literature. Questions, exercises, and laboratories at the end of each chapter encourage discussion, hands-on study, active learning, and engagement with the world right outside the classroom window.

Answers to the questions and exercises, password-protected for instructors, are available at www.cambridge.org/9780521769846.

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Contents

Preface

This book describes the challenges and opportunities that urban environments present to the plants and animals that inhabit cities and the ways that those organisms and entire ecosystems respond. The broad outlines of life are always the same: the need to find resources, to avoid being eaten or being killed, and to reproduce successfully. Ecologists have long studied how these factors determine which species live in a particular place and how those species interact with each other and the ecosystem. Only recently, however, has the focus of ecological science turned to life in urban environments.

The science of ecology developed in the late nineteenth century through the integration of three advances: detailed natural history of species and their habits, Darwin's emphasis on species interactions and change over time, and improved understanding of the physiology of plants and animals. The new field struggled to define the very nature of its subject of study, the communities of plants and animals that coexist and interact in one place and time. Was each community a tightly knit whole or merely a loose assemblage? What key factors determine how communities function?

Faced by these fundamental questions, ecologists deferred thinking about the massive disruption that cities bring to natural processes until those processes themselves could be better understood. As that understanding emerged, ecologists began turning their attention to cities. The modern practice of urban ecology grew from several distinct sources. In nineteenth-century Europe, studies of the plants of urban gardens, cemeteries, and highly disturbed building sites established a foundation of natural history information. These studies were among the first to distinguish between introduced and native species, and show how urban climate and urban pollution determine which plant species persist.

Early studies in the United States focused on interactions between humans and nature. Contemporary with early studies on European plants, George Perkins Marsh emphasized the potentially catastrophic effects of humans on the environment. Faced by possible environmental collapse, the term urban ecology became linked with the ecological challenges underlying urban planning. A group of sociologists, often called the Chicago School, applied ecological ideas about communities, competition, and spatial spread to describe how humans and their institutions change over time. In her attack on traditional urban planning, Jane Jacobs stressed the ecological nature of cities, and the danger of ignoring how different elements interact.

The more purely ecological appreciation of urban plant and animal communities and the interplay between ecological thinking and social science have found a potential

synthesis in the establishment of two long-term ecological research sites in the cities of Phoenix and Baltimore in the United States. The sites will be monitored for decades to provide baseline data on ecological functioning to parallel studies in non-urban forests, grasslands, and wetlands. In addition to providing fundamental ecological data, these studies have spurred the effort to create a new synthesis that links human and non-human elements into a single framework.

Organization of the book

This book is structured like a play, in five acts, each with several scenes.

- Act 1 introduces the setting, the built environment, and the protagonists, the non-human residents of the urban world.
- Act 2 introduces the basic tension between intended and unintended consequences.
- Act 3 is the rising action, with development of the abiotic factors such as nutrients and weather that create the challenges faced by the protagonists.
- Act 4 is the climax, where we find out which protagonists fare well, which fare badly, and why.
- Act 5 is the resolution that looks at humans as urban organisms and challenges us to think where we go from here.

For some characters, such as the rock pigeon, we could see this as a comedy. All ends well, and the pigeons celebrate a new order. For others, such as the wood thrush, it is a tragedy as their world disappears. For urban humans, it is neither a comedy nor a tragedy, but an epic backyard drama. Nothing is resolved, for the story continues and indeed accelerates, but we hope to emerge wiser and more observant, and better able to see the world and ourselves.

How to use this book

This book is based on a one-semester course at the University of Utah. It is designed either to be read directly or used in the classroom. In the classroom, rather than presenting information in lecture format over a single semester or quarter, we recommend mixing lectures with discussion and choosing to give some topics less detailed classroom coverage. Centering class discussion around short papers based on the articles highlighted at the end of each chapter gives students a chance to focus and share their own ideas. Coupling classroom activities with field trips, based on the availability of local experts and sites, shows that the ecology discussed in this book is everywhere. For example, streams and reservoirs illustrate the transformation of urban water movement, parks or brownfields illuminate the factors that control urban biodiversity and the distribution of invasive species, and the college campus itself provides an overview of urban land types and their management.

Intellectually, the central goal of this book is to provide a framework of fundamental principles for thinking about ecological processes in urban environments. For this reason, we present only statistically significant results, and do not include error bars that of course can be found in the primary references. But more immediately, we seek to make readers aware that urban ecosystems are indeed ecosystems, and that fundamental life processes are happening all around us. For most people, a city consists of buildings, roads, and the humans that use them, ignoring the ways that urban residents interact with ecology. Urban residents, often unwittingly, shape the ecology around them, while that ecology shapes the lives of urban humans, again whether or not they are aware of it.

While working on this book, we returned to Salt Lake City by plane, and looked out the window as the plane flew low over the Salt Lake Valley, over suburbs planted with trees that would not have been there 100 years ago, over the straightened and polluted Jordan River bordered by a thin and threatened strip of green, over warehouses with their abandoned areas overgrown with weeds, and over playing fields planted with non-native grasses that can tolerate constant trampling, before descending into the paved expanse of the airport. These environments, so different from each other and so different from the sagebrush steppe on the surrounding foothills, were packed together in closely abutting contrast. How different this would be from the perspective of a bird or a floating plant seed! Filled though it is with charts and graphs very much of human origin, this book, we hope, is a path to seeing the urban world through different eyes.