

# Book Reviews

*Ecology*, 93(12), 2012, pp. 2769–2770  
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## The world of insects and scientists who study them

Cardé, Ring T., and Vincent H. Resh, editors. 2012. **A world of insects: the Harvard University Press reader**. Harvard University Press, Cambridge, Massachusetts. vi + 404 p. \$19.95, ISBN: 978-0-674-04619-1 (alk. paper).

*Key words:* entomologists; Harvard University Press; insect behavior; natural science; social insects.

Given that insects are among the most diverse and abundant organisms on the globe, it is not surprising that they also exhibit some of the most unusual behaviors, reproductive patterns, and physiological traits known to biologists. Add to that their widespread recognition among nonscientists as things of beauty, things that annoy, or simply small things that somehow find their way into our lives... and there is perfect opportunity for a “meeting of the minds” between the passionate scientists who have devoted decades to the study of their organisms and a generation of appreciative, curious readers.

*A world of insects: the Harvard University Press reader* is a collection of essays written by some of the most brilliant and inspiring biologists of our day who excel not only in scientific investigation but also in their ability to write beautiful and entertaining prose. Edited by two distinguished, veteran entomologists with decades of university teaching experience, this collection of writings is intended for readers interested in insects but not necessarily in “a career in entomology or even science.” As an insect enthusiast and instructor of several entomology courses (one for nonbiologists) at a mid-sized university, I immediately began considering how these essays might fit into my own teaching repertoire.

The 20 or so essays are relatively short, quick reads, averaging 10–15 pages each. All are previously published works from such gifted writers as Bert Hölldobler, Edward O. Wilson, Gilbert Waldbauer, Mark Winston, Bernd Heinrich, and Thomas Eisner, to name a few. They are loosely organized such that essays dealing with insects as pests are found in the first third of the book. Those that focus on the organism (social insects, foraging, energetics, physiology reproduction, and predator avoidance) make up the remainder.

While many of the organismal-based essays are decades old (the collection spans the 1970s–1990s), in many respects they are timeless. The discoveries described have been elaborated on in more recent years, but the original insights are as clear and elegant as always. Among my favorites are writings that illustrate the process of science: how simple observations by a curious investigator lead to questions of “how?” or “why?” and then the creative and sometimes painstaking experimental work to answer each question. For example, “The foraging abilities of a colony” by Thomas Seeley describes experiments begun in the 1970s that revealed how far honeybees travel per day and how foraging patterns within the hive change with nectar quality and the needs of the colony. The essay is filled with diagrams of experimental tests, bee flight paths, the resulting data, and clear explanations of how each result supported or refuted the hypothesis at hand, thus revealing much of what we know of bee perception and colony dynamics today. Kenneth Roeder presents a very readable account of the use of transducers, amplifiers, and other paraphernalia to record nerve impulses

and evasive behavior in startled cockroaches. The chapter by Vince Dethier, first published in *The hungry fly* (1976. Harvard University Press, Cambridge, Massachusetts), introduces the key determinants of blowfly behavior (energetics, circadian rhythms, and visual stimuli), followed by intricate descriptions of the early experiments that determined how insects orient to odor plumes. Detailed diagrams illustrate patterns of the flies’ footsteps as they follow different patterns of sugar painted on test surfaces. The highly stylized circling patterns of a fly trying to relocate a spot of sugar on a tabletop bear an uncanny resemblance to the more sophisticated waggle dance that honeybees use to convey the location and quality of nectar sources to fellow colony members. This essay in particular illustrates the precision and patience needed to characterize the behavior of individual flies and reminds the reader that science often progresses in equally small, but important steps.

Several articles stand out for making complex subjects easy to comprehend: Hölldobler and Wilson provide a wonderfully succinct yet conversational explanation of how haplodiploidy (a quirky mechanism of sex inheritance) explains the underlying benefit for ants to behave in seemingly altruistic behavior. After describing how ant colonies behave as “superorganisms,” the authors reveal why even the tiniest details, such as the optimal size and number of workers produced by a founding queen ant, or how worker ants recognize that a fellow ant is dead (and should be discarded), are important for the survival of the colony. Similarly, Mark Winston’s fast-paced article about the arrival and spread of Africanized bees in the New World reads like good investigative journalism. He concludes with an unashamedly rigorous biological explanation of the nuances of genetic introgression and why Africanized bees have retained their genetic identity in spite of the opportunities to hybridize with the more docile European honeybee.

For the readers who are more reluctant to enter the world of science, there are essays that draw upon unusual events and practices in the history of humans and insects. Throughout the 1400s through 1866, there are records of legal or church “trials” being conducted in response to outbreaks of insects in the community. Basically, priests or judges would hold a “trial,” declare the insect pests “guilty,” and banish them from the area... presumably in the hopes that this would cause the outbreak to end. My favorite phrase was a church leader proclaiming that all lower arthropods are “satellites of Satan!” Can’t wait to use that in my entomology lecture! Gilbert Waldbauer’s flowing account of the unusual mating habits of aquatic insects touches on dragonfly courtship, mayfly mating behavior (who knew that mayflies are equipped with two penises and two vaginas?), and why male giant waterbugs are such good fathers. In a separate essay, readers learn of bizarre uses of cantharidin (Spanish fly), both accidental and by humans hopeful to experience its purported aphrodisiac properties.

Other works in the book weave details from several different biological disciplines or perspectives to illustrate “how things work” and why interdisciplinary approaches are valuable. The chapter by Heinrich about night-flying moths remaining active at low temperature is a wonderful integration of behavior, morphology, thermal biology, energetics, and electrophysiology of muscle and nerve activity. Descriptions of heat production by shivering of flight muscles are augmented with electrophysiological tracings from nerves and flight muscles of two groups of

moths to illustrate the relationships between nerve impulses and muscle responses in moths with different wing sizes and warm-up strategies. Nonbiologists will find explanations of the tracings in the text and figure captions easy to understand. Similarly, Eisner reveals the fascinating story of reflex bleeding, alkaloid sequestration, predator avoidance, and the influence of chemical defense on pheromone production and ultimately mate selection in the moth, *Utetheisa ornatrix*. Understanding the ecological and evolutionary significance of chemical defense in this small moth has taken decades of careful work by teams of chemists, behavioralists, entomologists, and population biologists.

To be fair, not all of the 20 essays would find their way into a list of required readings in my courses. Some are interesting but a bit too elementary. Several are perhaps too advanced. For example, the semi-autobiographical account of the careers of Hölldobler and Wilson would resonate with advanced graduate students but might elicit mixed responses from undergraduates who may be less familiar with academic hierarchies and pedigrees. The collection is also somewhat artificially structured by the fact that all of the articles were originally published by Harvard University Press. This constraint introduces a bias in favor of topics that focus on the organism (behavior, thermal relations, physiology, and evolution of sociality) rather than “applied entomology” (pest control, disease transmission). Several of the more applied essays are outdated. For example, the articles describing codling moth control, efforts to slow the spread of gypsy moth, and the use of pheromones in pest control were originally published in 1997 and would need to be either supplemented or replaced by more contemporary accounts for classroom use.

I also found the two articles on the use of pheromone- and mating-based approaches to pest control (baits, traps, mating disruption, sterile insect release) to be surprisingly cynical in

that they contained a litany of failed attempts and concluded “pheromones in pest control will remain a fringe player in the pest control industry.” While this might be true, these articles are perhaps too policy-oriented for many of my students who do not yet appreciate the many reasons that broad agency-supported initiatives often fail.

In conclusion, I found this book to be a good collection of writings for an economical price. The quality of editing is good but not without minor inconveniences. The editors’ short introductions to each essay and lists of supplementary readings are somewhat uneven in quality. Several of the titles were too vague (e.g., “War and insects” and “Insect terror”) and added to the already unwieldy number of three titles associated with each essay (the original article title, the title of the book it was first published in, and the title given by the editors of this volume). Another minor editing inconsistency was the absence of figure numbers, even though the original text refers to numbered figures. This generates a little confusion for the reader trying to match the correct figure to the text.

*A world of insects* could be equally categorized as an economically priced supplementary volume suitable for an undergraduate course with a strong insect biology theme or as an entertaining and inspiring evening read for the confirmed insect enthusiast.

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*Ecology*, 93(12), 2012, pp. 2770–2771  
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## From preservation to restoration: ecology for the 21st century

Galatowitsch, Susan M. 2012. **Ecological restoration**. Sinauer, Sunderland, Massachusetts. xvii + 630 p. \$89.95 (hardcover), ISBN: 978-0-87893-607-6; \$40.48 (eBook), ISBN: 978-0-87893-693-9.

*Key words:* adaptive management; habitat restoration; invasive species control; restoration ecology; species reintroduction.

In the preface of her new textbook, *Ecological restoration*, Susan Galatowitsch begins with a question: “To what extent can we reverse the damage caused by humans to Earth’s ecosystems and species?” As our scientific understanding of natural systems expanded, it led to the development of the field of ecology, and this paralleled the growth of the early conservation movement, which was initially focused on preservation of wilderness. Indeed, it was believed that ecology would be the integrating science that would be essential for preserving nature. However, with the rapid rise of technology and industry after World War II and an ever-growing human population, preservation of undisturbed wild places and wildlife became increasingly difficult. By the 1960s, there was a growing societal awareness of not only the extent of our diminishing natural resources, undisturbed spaces, and biodiversity, but also of the negative impacts of

pollution on soil, air, and water quality, and on our health. With this awareness, came a realization that humans needed to consider more sustainable practices and find ways to *fix* the environmental damage we had caused. By the 1980s, a new branch of science, restoration ecology, emerged in which ecosystems *under repair* were being studied.

The theory and methods from a wide range of disciplines are used in the practice of ecological restoration in which professionals work to remediate sites that have been disturbed or polluted to the point where the ecosystem is degraded or destroyed. Examples include reestablishing riparian zones and stream banks, reforestation, revegetating sites contaminated through mining and smelting operations, and reintroducing species that had been extirpated from an area or bolstering an endangered population. Galatowitsch notes that while the science, literature, professional practice, and teaching of restoration have all expanded over the past few decades, the availability of textbooks on the subject has not.

Galatowitsch begins by tracing the historical roots of ecological restoration, using examples not often included in books that discuss the history of ecology or the conservation and environmental movements. In the rest of Part I of the text, the author thoroughly describes how to diagnose ecological problems, set goals and desired outcomes, and carefully plan, monitor, and evaluate restoration projects. Restoration efforts must be ground-

ed in scientific principles (and indeed, students taking a course on restoration ecology that uses this text should have foundation courses in ecology and environmental science). The presumption is that, if we understand the science of the interactions in nature well enough, we should be able to repair damage in nature, whether caused by natural disturbances or human activities. In planning a restoration project, professionals must consult the scientific literature and review relevant ecological principles for a specific damaged site or a species reintroduction project. As goals are established, it is important to consider alternative scenarios and potential outcomes due to the many uncertainties associated with restoration projects and variables in nature that cannot always be controlled or even foreseen. The body of literature in this field is growing, but each site and project has its own unique history and conditions, so there is no guarantee that an approach that worked in one place can simply be replicated at another.

Ideally, restoration projects are monitored for several years or even decades to ensure that the predetermined goals are being achieved, both initially and maintained for the long-term. Galatowitsch notes, correctly, that follow-up monitoring, especially over the long-term, is too seldom done. It is important as the next cadre of restoration professionals are being trained that they understand the problems that can arise in the absence of monitoring—problems ranging from missed opportunities to enhance the limited scientific literature, to wasted resources of time and money for projects that do not lead to desired outcomes, to species reintroductions or biocontrol measures that go awry. If a well-planned monitoring program is implemented, and it is observed that the restoration is not occurring as hoped, then interventions and revisions of approaches and goals can be implemented in a timely fashion. Not only does the text contain an extensive discussion on project monitoring and evaluation, but sections on the use of data for decision making and how to manage large databases and project records are also included.

Besides the relevant science, there are many other motivations, incentives, and barriers to restoration projects that should be considered. Galatowitsch thoroughly outlines the cultural, economic, demographic, sociopolitical, and technological factors to be considered if a restoration project is to be launched and *sustained*. Restoration professionals cannot ignore the historical and cultural contexts of the sites they work at, and the text discusses the complex intersections between restoration ecology and the public, economics, the legal system, and policy. In fact, an entire chapter is devoted to the social and institutional support needed. Unlike much work done in science and engineering, restoration projects often involve community-based organizations and volunteers in the process, and sites are sometimes used as demonstration projects for the public. Advice on project management when community members are involved is also included.

Part II of the text focuses on detailed theoretical scientific foundations, specific approaches, and best management practices for a wide range of disturbance scenarios, habitats, and restoration goals. Rather than focusing narrowly on specific examples such as riparian zones or Brownfield sites, there are separate chapters for landforms and hydrology, soil and water quality, plants and revegetation, invertebrates, and vertebrates. Galatowitsch discusses the abiotic and biotic components of a healthy, functioning ecosystem and the importance of understanding ecological interactions in nature. For instance, she notes the importance of restoring microbial mutualists (nitrogen-fixing bacteria and mycorrhizal fungi) in order to improve the chance of success in revegetation efforts. These chapters clearly illustrate the interdisciplinary nature of this field and describe both technologically based restoration approaches and cases where nature-based remedies can be implemented.

Instead of inserting specific case studies into the chapters, 19 varied examples from six continents are included as Part III of the

text. For each case study, the background, approach, and project progress and outcomes are provided, along with an extensive list of references. These cases are referenced in sidebars within earlier chapters as illustrations of a particular principle being discussed—without breaking up the flow of reading the chapter concepts.

One deficiency in the text is the nominal discussion on the links between global climate change and developing ecological restoration strategies and goals. Restoration debates have previously centered on the question of “restore to what” in terms of a desired outcome; there is often little agreement on what historical condition prior to disturbance should be used as a target. However, if predictions based on climate modeling come to fruition, these arguments will be meaningless. In many places, it will become impossible to look to predisturbance conditions due to changing regional climate, desertification, ocean acidification, or sea level rise, and new species assemblages as compared to what once characterized a location in the past. Galatowitsch does discuss the importance of restoring functioning ecosystems and ecosystem services but does not describe how these can impact biological resilience and adaptability—factors that are of critical importance as nature responds to a changing climate. The ongoing international discussions on how ecological restoration should be considered a strategy for mitigating climate change are not mentioned.

The text contains several high quality photographs that clearly illustrate disturbed sites and restoration projects and methods. There are also several schematics of conceptual models and flowcharts that provide useful summaries of the details in the dense text and show the complexities of issues considered in restoration projects. A few of these illustrations are likely to be confusing to students without explanation by the course instructor. Early in the book, some schematics are difficult to read because they contain faded text and colors. The author has included extensive references for each chapter and case study. These references further illustrate how recently this field developed (since the 1980s). Useful for students will be the thorough index and glossary. In addition, the “apply what you’ve learned” exercises and discussion questions at the end of each chapter help reinforce important concepts and enable students to analyze the case studies in terms of the information learned in a given chapter.

*Ecological restoration* is a thorough introduction to the field that is appropriate for a graduate-level course or for undergraduate students who have had a significant background in ecology and environmental science. In the preface to the text, the author states that ecological restoration courses are now commonplace. This may not be the case at colleges and smaller universities (predominantly undergraduate institutions). However, with the ever-increasing environmental challenges, especially the stress on ecosystems that global climate change will bring, it is likely that in the near future, ecological restoration will become even more critical, and the demand for graduates with exposure to the principles and practices in this book will be high. *Ecological Restoration* (the discipline and the text) illustrates how life science theory and data are being applied to real-world problems caused by human activities and provides an important and hopeful set of stories.

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*Ecology*, 93(12), 2012, pp. 2772–2773  
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## Ecological and environmental physiology of insects

Harrison, Jon F., H. Arthur Woods, and Stephen P. Roberts. 2012. **Ecological and environmental physiology of insects.** Ecological and Environmental Physiology Series, Volume 3. Oxford University Press, New York. viii + 378 p. \$117.00 (cloth), ISBN: 978-0-19-922594-1; \$62.99 (paper), ISBN: 978-0-19-922595-8.

*Key words:* environmental physiology; insect ecology; insect physiology; physiological ecology; physiological systems.

This book is volume three in the multi-volume “Ecological and environmental physiology series” (EEPS), published by Oxford University Press. The first volume focused on amphibians, the second on birds. A fourth volume on fishes is scheduled for release this year and will be followed in the near future by a volume on crustaceans. There are also plans for volumes on reptiles, mammals, humans, arachnids, molluscs, annelids, plants, and microorganisms. The aim of each volume is to provide a state-of-the-art review, synthesis, and consideration of future topics “that are relevant to how organisms have evolved and coped with the environmental features of their habitats.”

Insect physiology is a field with a broad and rich history—writing a book on this topic, even when the focus is on interactions between physiological systems and the environment, is a daunting task. The authors, to their credit, recognize this challenge and have structured the book in a highly effective way which will keep readers engaged, regardless of their level of expertise as insect physiologists. The first chapter lays the groundwork by explaining the structure of the book and the main topics covered in subsequent chapters. It then explains the ecological importance of insects, and why insects are good models for physiological ecology studies. It also provides a brief overview of insect evolutionary history and phylogenetic diversity, which is necessary if insect physiology is to be explored within a comparative context. The chapter concludes by laying out the broad physiological themes covered throughout the book.

The second chapter is clearly aimed at those with a limited entomological or insect physiology background—it covers the basics of insect functional anatomy and physiological principles. Topics include the insect life cycle, cuticle, and muscle, plus general reviews of how insect respiratory, circulatory, digestive, renal, and nervous systems function. The authors provide general introductions on two additional topics—metabolic systems in active and resting insects, including those undergoing diapause, and how insects transport nutrients and water across epithelia. Some of these general topics are covered in more detail than others, but where coverage is shallow, the authors generally highlight the key physiological processes that are most likely to be affected by changing environmental conditions. The authors also do a nice job of providing up-to-date review articles on each topic, so that readers have guidance for where to go when greater depth on a given topic is desired. I think that readers with a strong insect physiology background will find that this chapter provides a good refresher on topics that lie peripheral to their current research interests. It may even stimulate them to consider branching into new research areas within a physiological ecology context.

The meat of the book lies in Chapters 3 through 6, which cover how insects regulate temperature, water balance, nutrient intake, and oxygen requirements in a variable world. These are broad topics, but the authors have done the readers a tremendous favor by starting each chapter with a section entitled “defining the problem.” These sections provide a context that prepares the reader for the direction each chapter will take and also sets the boundaries that keep the discussion of each topic at a manageable level.

Temperature is the first major topic covered, and the key questions addressed include the following. What are the consequences of variation in body temperature? What sensory and control systems allow insects to respond to thermal variation? What mechanisms do insects employ to regulate body temperature? How do insects protect themselves from extreme body temperatures? This chapter starts with non-pathological consequences of thermal variation and then transitions to pathologies associated with extreme temperatures. Next is a brief overview of neural systems involved in sensing and controlling temperature. Unfortunately insect physiology can at times be highly technical, including explanations of processes via formulas. The middle of this chapter provides great detail—including the underlying formulas—on heat exchange, conduction, convection, radiation, and evaporation. Collectively, these processes explain heat gain and loss in insects, but I imagine most readers will choose to skim this section because it is formula heavy. Things pick up again as the authors transition to thermotolerance mechanisms, and then the chapter ends with a brief evolutionary discussion of thermoregulation and thermotolerance. This chapter is highly relevant, and valuable, for researchers using insects as model systems to study climate change, especially the effects of increasing temperature. Insects cause many problems for humans (they destroy crops, vector disease, and can be highly invasive), and understanding the physiological effects of temperature on insects is essential if we are to understand shifts in behavior, phenology, and distribution patterns—including at the local, regional, and global scale.

Whole-insect water balance is the next topic and even though it is far from my main area of research, it was one of my favorite chapters. Insects, for a number of reasons, face a range of challenges with respect to maintaining water balance, and the authors do a very nice job in this chapter defining the problem of water balance, and then providing examples related to how an insect’s environment can impact physiological processes associated with maintaining water balance. The majority of the chapter focuses on water balance in terrestrial insects, including a section on the evolution of desiccation resistance in *Drosophila*. This discussion is followed by a thorough introduction to the hormones involved in the control of water balance and a section on how aquaporins (transmembrane channels) control water movement. The end of this chapter focuses on insects that live in water, including a section on why there are no marine insects. This terrestrial-aquatic contrast makes for fun reading—and makes the reader really appreciate the physiological challenge associated with transitioning from a terrestrial to aquatic habitat.

The biggest chapter, and deservedly so, deals with nutrition (disclaimer here: I’m an insect nutritional physiologist). The authors introduce the problem and effectively review the evolution of approaches used to study nutritional physiology (in a section called “Theoretical perspectives on insect feeding

and nutrition"). This section will be of real value to those interested in insect nutritional physiology, but who have a limited background, and even those more familiar with this area should find this section useful. A section on how the nervous system plays a role in finding and tasting food, and what happens to food after it has been digested, follows next. Throughout these two sections authors focus heavily on plant-feeding insects—perhaps because there is such a wealth of research. A bit more attention on predaceous insects would have provided some balance. The last two sections of this chapter focus on the regulation of growth and development and body size. Currently the best advances in these areas are being made at the molecular level, and the authors successfully introduce some of the key research. Regulation of growth, development, and body size really is the next frontier for nutritional physiology—and new insights related to this area will greatly expand as more insect genomes, representing diverse feeding biology, become available.

The final broad chapter covers oxygen requirements and the challenges insects face in different environments—ranging from low to high altitude, moving from a terrestrial to aquatic lifestyle, and transitioning between different life stages. This is a research area near and dear to all three authors, and much of their research is highlighted here. The first part of this chapter is formula driven and dense. Thereafter each section is more accessible—and the authors make the case for why thinking about the physiological effects of oxygen is important. I certainly appreciated this process more so after having read the entire chapter, and it made me contemplate the extent to which changing atmospheric conditions, over geological time scales, affected insect evolution.

The second-to-last chapter provides an introduction to techniques and applications, while the final chapter offers brief conclusions plus future directions. The techniques and applica-

tions chapter is aimed towards researchers who are interested in insect physiology but do not know where to start. This will give some direction, but unfortunately becoming comfortable using these techniques, let alone becoming an expert, requires a significant amount of time and dedication. But the rewards will be great. The final chapter outlines a series of big problems and questions in insect biology that the authors think deserve attention. Certainly there will be some disagreements about what has and has not made the list, but I think the authors have mostly gotten it right.

So what is my final evaluation, and do I think you should buy this book? If you are seriously interested in how the environment affects insects, and want to understand this process at a mechanistic level, you should own this book (and it is reasonably priced). I will certainly be recommending it to my graduate students and postdocs. I teach undergraduate insect physiology and am currently developing a graduate-level insect physiological ecology course. I will seriously consider this book for my graduate-level course and actually think it would be easily accessible to upper-level undergraduates who have some background in entomology.

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*Ecology*, 93(12), 2012, pp. 2773–2774  
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## Knowledge of disturbance ecology must guide natural resource management and conservation

Walker, Lawrence R. 2012. **The biology of disturbed habitats**. The Biology of Habitats Series. Oxford University Press, New York. xiii + 319 p. \$117.00 (cloth), ISBN: 978-0-19-957529-9; \$59.95 (paper), ISBN: 978-0-19-957530-5.

*Key words:* biodiversity loss; habitat degradation; over-exploitation; over population.

Disturbances, small or large, natural or anthropogenic, are ubiquitous in natural and managed environments and shape biotic communities spatially and temporally. Disturbance and its effects on habitats and biota have been known to humans since the hunter-gatherer and pre-agricultural ages. Influential ecological theories and concepts (for example, succession, energy flow, material cycling, competition, ecosystem, biodiversity) were initially developed by studying natural systems relatively free from anthropogenic disturbance. Ecological textbooks describe these concepts and their application in resource management and conservation. Why then do we need this new book, *The biology of disturbed habitats*?

The author clearly justifies the need for this book in the introductory material. In the preface, Walker argues that even though all biota evolved in the presence of disturbance, our unprecedented resource exploitation to meet the ever-increasing demands of our increasing population size is disrupting the dynamic equilibrium of natural and anthropogenic disturbance and leading to habitat degradation. I cannot agree more with the author when he states that we need an expanded understanding of how humans directly disturb the environment and indirectly exacerbate natural disturbance.

Natural and anthropogenic disturbances now are so inextricably linked that the knowledge of just one type of disturbance gives an incomplete perspective of the conditions that the biotic communities are subjected to. Anthropogenic disturbances can increase both the extent and severity of natural disturbance. For example, control of the boreal forest insects by pesticides breaks the natural cyclical pattern of infestations of spruce budworm (*Choristoneura fumiferana*) in conifer and forest tent caterpillar (*Malacosoma disstria*) in deciduous forests. Wildfire is often a natural disturbance, but fire suppression constitutes an anthropogenic disturbance that often leads to less frequent but more devastating wildfires due to increased fuel buildup.

Disruption of natural fire frequency may cause loss of species that have evolved in the presence of wildfires for millennia. Fire-evolved plant communities of the boreal forest have been increasingly subjected to fire suppression, clearcut logging, soil scarification for planting tree seedlings, application of herbicides to remove competing plants and, in some cases, addition of soil nutrients and pre-commercial thinning. In the new anthropocene, the biotic communities are subjected to multiple disturbances almost simultaneously, the combined effects of which are just now being studied. The biotic response to the vast array of anthropogenic disturbance in combination with natural disturbance, which is often aggravated by anthropogenic disturbances, must be understood and considered for ecosystem management. This (disturbance ecology) is a new science for ecologists and natural resource managers, which must be understood and effectively communicated to the general public, politicians, and policy makers. We need disturbance ecology texts that cut across disciplinary boundaries of natural science, restoration ecology, ecological engineering, social science, public health, and public policy. From this perspective *The biology of disturbed habitats* is a much-needed text that makes a first attempt in this direction.

A book on disturbed habitats is long overdue and Walker has done a commendable job. Clarity and simplicity in defining ecological terms and concepts, logical flow of ideas, and evidence-based statements in describing patterns and processes in disturbed habitats are evident in all chapters. The author's own area of research is disturbance ecology. He is widely published, and he maintains worldwide research collaborations with colleagues working on disturbance ecology. In addition to his mastery of the subject area, Walker has shown exceptional talent in comprehending dispersed old and new information and presenting them concisely in a most readable form. This book is an essential read for ecologists, environmentalists, conservationists, and natural resource managers.

The book is completed in 10 chapters. Each starts with a concise introduction, followed by presentation of relevant concepts in a logical sequence. Each chapter then ends with conclusions, highlighting take-home messages. The introductory chapter justifies the need for this book and defines and describes disturbances of various kinds and concepts of community response to disturbance (such as resilience, stability, and intermediate disturbance hypothesis).

Chapters 2, 3, and 4 deal with disturbances in terrestrial, aquatic, and anthropogenic habitats, respectively, arranging the scale of disturbance topics in ascending order (from small-scale to large-scale). Although for academic reasons this might be a good arrangement, I would have preferred them in reverse order with more space for large-scale disturbances that affect vast areas just to emphasize the extensive damage they can cause. For example, a table in Chapter 2 shows that wildfires, droughts, floods, and cyclones affect >50, 30, 15, and 15% of terrestrial habitats, respectively, compared to volcanoes and earthquakes (only 1% each). The anthropogenic disturbances of agriculture and mining affect 45% and 1%, respectively, of terrestrial areas; fishing affects 40% aquatic areas. Discussion of the multifaceted disturbances caused by large-scale industrial agriculture (habitat homogenization, biodiversity loss, topsoil erosion, and agrochemical effects on soil structure, soil biota, and human health) and mechanized over-fishing causing drastic (in some cases irreversible) changes in aquatic community should be more prominent. Recent anthropogenic disturbances due to petroleum extraction from oil sands not only destroy vast areas of terrestrial habitats but also contaminate ground water systems far beyond the mining area. Some current statistics and images of such extensive anthropogenic disturbances would have been nice. For example, showing that 10

million ha cropland is lost each year from soil erosion drives home the extent of habitat damage caused by industrial agriculture.

The contents of Chapter 5, described as ecosystem processes, are in fact the environmental factors that affect ecosystems. I would have liked to see the contents of Chapter 5, 7, and 8 combined simply because the processes such as fragmentation, patch dynamics, and succession are all related to disturbance.

Other chapters in the book include biodiversity and invasive species (Chapter 6), management (Chapter 9), and global concerns and future scenarios (Chapter 10). In the concluding chapter, over-exploitation and over-consumption in the developed countries have been appropriately emphasized. However, I would have liked to see more targeted discussions of over-population, poverty, and lack of education (particularly female education) as drivers of ecosystem degradation. I would go so far as to suggest that all aids and loans from rich countries and organizations such as United Nations, World Bank, International Monetary Funds (IMF), and international NGOs to over-populated poor countries be conditional on developing effective national programs on population control, female education, and rural poverty alleviation.

In the second edition of the book I would strongly suggest developing a chapter on restoration ecology. Although the topic is discussed in various places in the book, it really deserves a chapter of its own. Here Walker could discuss solutions to the problems arising from natural and anthropogenic disturbances by examining how our conceptual knowledge in ecology and practical experience of land management can help restore damaged ecosystems. He could also describe steps that could prevent future habitat degradation.

In my view, environmental degradation in the world is caused by two factors: (1) rich countries' greed and abuse of modern technology in over-exploitation of natural resources worldwide and (2) over-population, poverty, and relaxed and ineffective environmental regulation in poor countries. For a sustainable future we must make progress on both fronts simultaneously, and so far we have failed on both. In the name of economic growth, environmental degradation remains unabated in rich countries and little has been achieved on population control and poverty alleviation in the poor countries. A clear understanding of disturbance ecology shows the links between resource exploitation and sustainability.

The book provides an excellent glossary of terms, and the index is very useful. I envy the author having a mother with such vigilant eyes for proofreading. I was able to find only one spelling error ("that" should be replaced by "than").

A much-needed asset, this book should be read and used by academics, researchers, environmentalists, social scientists, and graduate and undergraduate students specializing in disturbance ecology. All university and institutional libraries must have a copy. I have already adopted this book as a required text for an upper-level undergraduate course I teach called "Ecology of disturbed habitats." I encourage academic colleagues to do the same for similar courses.

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