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The Interconnectedness of Climate, Life, and Society

Climate Change: Biological and Human Aspects. Jonathan Cowie. Cambridge University Press, New York, 2007. 504 pp., illus. $52.00 (ISBN 9780521696197 paper).

Jonathan Cowie took on a monumental task in writing *Climate Change*—a book that covers climate science and the interactions of climate with the biosphere and geosphere from the inception of life to modern times. Given the book's vast scope, it is not surprising that the level of detail, the completeness of information, and the quality of writing vary considerably. Initially, I was somewhat ambivalent, but as I got deeper into this tome, I became more and more impressed by just how well Cowie tied together so many disciplines—all of which are relevant if one wants more than a superficial understanding of what human greenhouse emissions mean for our planet.

...[A]nyone who wants to understand climate change and its impacts, but who doesn't have time to earn a PhD on the topic, should buy this book.

There is so much to gain from Cowie's book that I can easily forgive its problems and limitations. *Climate Change* has flaws, and some chapters have an obvious European (particularly UK) bias, but those aspects should not deter readers. I know of no other source, including the Intergovernmental Panel on Climate Change (IPCC), that brings together the breadth and depth of material that this book does. There is sufficient repetition and cross-referencing so a reader may choose among topics and read only the ones of interest without losing a sense of completeness. This is one of the strongest points of the book. While I dutifully provide critique here, the bottom line is that anyone who wants to understand climate change and its impacts, but who doesn't have time to earn a PhD on the topic, should buy this book.

The title may be misinterpreted by people expecting a focus on modern-day species. While Cowie does a splendid job of summarizing modern-day impacts on wild species and on society, there is as much climate science, atmospheric science, oceanography, biochemistry, and biogeochemistry as there is organismal biology. Cowie does a brilliant job of weaving together the evolution of life with the evolution of Earth's climate. This topic occupies the first third of the book. Many of us know intellectually that the two are connected, but how many of us could explain the interconnections in any detail to another person, much less give a lecture on the topic? For those who would like to be able to do just that, Cowie provides the material.

As implied earlier, however, this is not a perfect work. The wording is rough in many sections, probably the result of a push to get the book published quickly. Speed is important, though, because the topic is timely and because the science is moving so rapidly that the content can quickly become outdated. I consider this an acceptable trade-off, given the very broad scope of the material Cowie covers. Further, the explicit aim of this book is to inform, not to serve as pleasurable bedtime reading.

Perhaps because of that haste, some sections are not clear. Unfortunately, a lack of critical information causes misrepresentation of the data in a few instances, the worst case of which concerns Cowie's treatment of the Holocene (chapters 4 and 5). He writes extensively about recent (Holocene) climate in relation to 20th-century climate, beautifully detailing extreme cold/warm and wet/dry periods in terms of temperatures, ice extent, and species' distributions. However, these trends are all derived from Northern Hemisphere data (principally from Europe, with some from Eurasia and even less from North America). The trends are far from consistent spatially, especially between the Northern and Southern Hemispheres. Although records are patchy, what evidence there is indicates that short-term climate extremes, such as the Medieval Warm Period and the Little Ice Age, were regional in nature, and that climatic fluctuations during the past 11,000 years tended to be asynchronous on a global scale. Thus, the general agreement among climate scientists is that in spite of some strong regional trends, global temperatures over the past 10,000 years are unlikely to have ever exceeded late 20th-century warming. This is an extremely important point when attempting to estimate the impacts of recent and near-future warming, and one that Cowie fails to identify in this discussion.

I was also disappointed with Cowie's treatment of recent and projected impacts for the United States. Cowie relied heavily on the US climate assessment produced by the US Global Change Research Program in 2000 rather than on more up-to-date primary literature. Not only was the US climate assessment weak on observed and projected impacts in natural systems, but its climate projections were quickly superceded, and for many regions, newer model projections conflict with the older ones used in the 2000 assessment. There were also some minor inaccuracies in descriptions and citations for some specific examples; these are not important to the overall messages, but they may matter to some readers.

Although I still recommend this book overall, if there is some particular information that is vital to the reader, it would be advisable to investigate key details by delving into the original studies. Fortunately, Cowie supplies ample references so that the reader can do just that. Indeed, part of the value of this book is

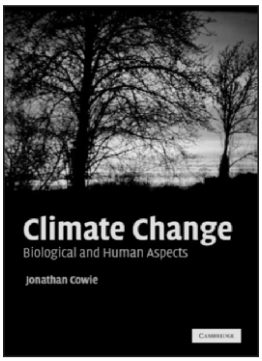
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as an inroad into the primary literature for each of the topics covered.

In contrast to the section covering the United States, other sections are absolutely brilliant. The second third of the book focuses broadly on climate during human and societal evolution. I was particularly impressed by Cowie's discussion of the impacts that relatively small levels of climate change can have on society. His depictions of the famines and diseases that devastated Europe and China as these regions moved out of the Medieval Warm Period and into the Little Ice Age are as fascinating as they are horrifying. Cowie points out that these episodes demonstrate how vulnerable society is to relatively small changes in regional climate. With less genetic diversity in existence in modern agriculture than there was in medieval agriculture, society may be even more vulnerable now.

The last third of the book focuses directly on the human dimensions of climate change, including technological approaches to mitigation, energy policy and alternative energies, food production, sustainability, and human health. These topics are covered in enough detail to provide a well-rounded base of knowledge, and as with the earlier sections, references give the reader the option of learning more.

Cowie makes a bold transition from the earlier part of the book, which focuses on natural science, to the latter part, which focuses on society. He starts the societal discussion with a blunt yet thoughtful appraisal of the pivotal role that the sheer number of humans plays in producing climate change in the first place and in affecting our ability to both mitigate and adapt to future impacts. This is very much a late-night topic among conservation biologists and ecologists, but it is rarely brought to the forefront in public discourse on sustainability in general and on climate change in particular. Lowering the global population growth rate is perhaps the single most important action we could take to alleviate environmental degradation of many kinds and to promote a better quality of life and human well-being. I doubt it's coincidental that the IPCC emission scenario that results in the lowest average global warming (the B1 scenario) assumes not only the use of "green" energy but also a decline in the global population after 2050.



The failure of human population issues to rise to prominence in policy discussions is a result of political unviability, not scientific unimportance. Cowie himself puts it well: "If we are to comprehend and address climate change concerns and the implications for species, including our own, then this understanding needs to come from science.... If we fail...well, someone else can narrate doom and disaster, at least as far as human and many wildlife species are concerned. As for the rest of the biosphere, it will go on."

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THE WONDER AND DECLINE OF ANIMAL MIGRATIONS

No Way Home. David Wilcove. Island Press, Washington, DC, 2007. 256 pp., illus. $24.94 (ISBN 9781559639859 cloth).

Conservation strategies have struggled for decades to match the geographic scope of large-scale ecosystem processes, on which the survival of so many species depend. More than 20 years ago, growing awareness of habitat fragmentation sparked what is today an ambitious global agenda that aims to conserve ecosystem-level processes across vast landscapes. David Wilcove, a professor of ecology, evolutionary biology, and public affairs at Princeton University, has written a compelling book that brings our attention to a special suite of species for which even these large-scale conservation ambitions are not nearly large enough.

In separate sections on air, land, and water, Wilcove describes a diverse selection of bird, mammal, fish, and insect species that have two traits in common: they migrate vast distances, and they do so in colossal numbers. Migration is distinguished from other types of animal movement by back-and-forth passage, often performed on a seasonal basis, between sites that may be half a world apart. Migration has evolved separately in many species as an opportunistic survival strategy in which the rewards accruing to individuals from long-distance movement (say, abundant but ephemeral food) outweigh the penalties incurred (say, from energy expenditure). Wilcove's main theme is that, for many migratory species, humans have upset this fragile advantage—with disastrous consequences—by reducing the rewards and amplifying the penalties.

The trials and challenges of migration are detailed in case after case in *No Way Home,* and one marvels at how nature overcomes them. Tens of thousands of red knots (a small shorebird) migrate from the tip of South America to northern Canada each year, stopping along the way to refuel at a few key places. Delaware Bay is one of these, where resource-depleted birds descend at the end of May to gorge for a few weeks on the eggs of horseshoe crabs. The timing of their arrival is critical, because this feast is itself the product of a stunning annual migration by millions of horseshoe crabs, which move up from the continental shelf to the shores of the bay to spawn. Another migration involves millions of songbirds that arrive in the North American woods in spring, having overwintered in central and

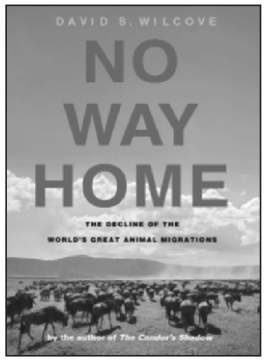
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southern regions of the hemisphere. How such delicate creatures achieve this arduous passage is fairly astonishing—the intricate vignettes describing these migrations amount to fascinating short stories.

Descriptions of the research that led to the discovery and understanding of each migration are effortlessly woven into the narrative. The importance of research is underscored by the dearth of information we have about migrations that vanished before research could be done. Tens of millions of bison once roamed the Great Plains, but only sketchy impressions of where, why, and how these migrations operated can be gathered from the few brief anecdotes that exist.

Piecing together the details of ecological processes that span continents is not trivial. We learn that it took almost 50 years of perseverance to track down the monarch butterfly migration in North America by recording the flight directions of marked individuals at different stages. It turns out that monarchs reach as far north as the US-Canadian border, but then turn south and westward, eventually funneling into a few sites on the forested slopes of a volcano in south-central Mexico, where they spend the winter attached to trees in gigantic clusters. It also turns out that individuals do not make the entire journey; rather, it takes several generations of butterflies to complete the round trip each year. Exactly how this intergenerational feat is accomplished has yet to be discovered. Today, technological miracles allow tracking transmitters to be affixed to migrating birds and even to dragonflies, and Wilcove takes us to the cutting edge of this research.

His case studies are carefully selected to portray not only the wonder and diversity of migration strategies in nature but also the threats they face from modern humanity, and the full range of fates that have ensued: extinction (Rocky Mountain locust and bison in the American West), decline (new world songbirds, monarch butterflies, North Atlantic right whales), and recovery (gray whales). Declining numbers of migrating songbirds are partly due to loss and modification of habitats along the way, and increased exposure to nest predators and brood parasites. The overharvesting of horseshoe crabs to be used as bait for the fishing industry has drastically reduced numbers of knots.



Monarch butterflies are losing habitat to illegal logging in the Mexican forests where they overwinter. A barbed-wire fence may close off a migratory route that pronghorn antelopes have followed for millennia. At least 14 major dams impede salmon migration on the Columbia River. That any of these great migrations persist at all is testimony to the resilience of the species undertaking them.

Wilcove is as well-versed in conservation as in research, and he deftly explains the measures, policies, and tactics that have been crafted to halt the decline of migrating species. "Turtle-excluding devices" on fishing nets have helped some sea turtle populations. Whale watching and monarch ogling provide incentives for local communities to actively conserve these species. Securing sufficient staging habitats for birds along their entire migration routes entails complex collaborations and negotiations across local, state, and international boundaries, involving independent agencies bound by different policies and languages. This is possible—as attested by the successful conservation of migrating ducks and geese—but most migrations remain critically threatened.

Migration is a theme that would be well served by spectacular photography (which presumably was a victim of production costs in *No Way Home*). But Wilcove's descriptions succeed in conveying the sense of awe evoked by witnessing a mass migration by any species, for example, by tens of thousands of sandhill cranes taking off in unison from the Platte River lowlands in Nebraska. The emotions evoked by such spectacles are qualitatively different from those that arise from observing a few dozen or even a few hundred individuals, as this poignant comparison makes clear: 20 years after Wilcove had visited Delaware Bay, he returned with a group of students to observe the shorebird phenomenon. This was the students' first exposure to the congregation, and they were dazzled. But Wilcove was disappointed by the apparent reduction in species' numbers. This extraordinary book helps us to guard against such creeping intergenerational loss of awareness and experiences that enrich the human spirit.

With no conscious effort, one emerges with the impression of having become expansively informed about the natural history of migrations, the research that has defined them, and the solutions necessary to conserve them. Wilcove manages to describe the extreme perils that threaten these migrations, and still impart confidence that they can be conserved. Putting the book down, one ponders how best to make that happen.

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EVOLUTION EXTENDED

Evolution for Everyone: How Darwin's Theory Can Change the Way We Think about Our Lives. David Sloan Wilson. Delacorte Press, New York, 2007. 400 pp., illus. $15.00 (ISBN 9780385340922 paper).

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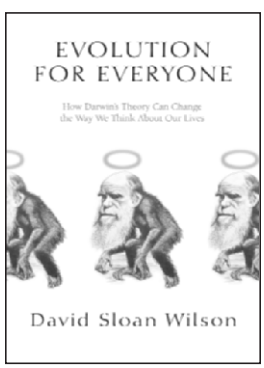
Undergraduate students are challenged when trying to understand the principles of evolution in science courses. Often they begin with deeply embedded yet flawed ideas about what evolution is and how it works, and it is difficult for them to correct these. Furthermore, for some, personal conflicts between evolution and religion can interfere with gaining meaningful understanding. Students may learn to pass exams, then when the course is over, revert to reluctance to accept—or even to denial of—evolution.

Researchers have identified several misconceptions about evolution that students commonly hold, including the following: (1) changes in a population occur through a gradual change in individual members of a population; (2) new traits in species are developed in response to need; (3) all members of a population are phenotypically similar; (4) all members of a population are genetically equivalent, so variation and fitness can be ignored; and (5) traits acquired during an individual's lifetime will be inherited by offspring.

Knowing what our students think about evolution is requisite to designing instruction to help them tackle their erroneous ideas and ultimately gain understanding, so I was delighted to have the opportunity to read David Sloan Wilson's thoughts on how to help everyone learn about evolution. My perception was that he wrote for a broad audience, including those with no previous background in science or evolution. I approached the volume from the perspective of a teacher who uses evolution as the thread that interconnects all the topics in an undergraduate introductory biology course. As I read, I imagined working with my students in a course with a large enrollment, using the scenarios and active learning activities Wilson presents. As I delved deeper into the book, however, I thought he began taking literary license with evolution that I would not use in an undergraduate course.

Wilson, a distinguished professor of biology and anthropology at Binghamton University in New York, considers himself an evolutionist who uses the principles of evolution to understand the world around him. He distinguishes "evolutionist" from the more familiar label "evolutionary biologist" on the grounds that evolutionary biologists typically restrict themselves to the conventional realm of biology. He, however, proposes a broader vision: that evolution is not only real but that it is relevant to all human affairs—indeed, to almost all aspects of life on Earth. His discussion of this nonconventional subject matter makes up a significant part of the book.

The chapters are short, with metaphors, applications, and analogies about evolution interwoven with personal anecdotes and biological facts. Wilson writes in the first person—a refreshing approach—and provides insight into his experiences and development of his way of thinking. I predict that his undergraduate evolution course will provide a novel learning experience in which students find themselves in a lively environment that connects and transcends the disciplinary boundaries of biology, psychology, anthropology, philosophy, and even the fine arts. Without doubt, students in Wilson's course are active participants rather than passive listeners.



Wilson begins the book with a discussion of the implications of evolutionary theory, not the facts of the theory. Why is evolution such a big deal? He skillfully leads the reader through a variety of scenarios—for example, brainstorming the advantages of infanticide in beetle populations, Wilson's area of research. This approach is intended to encourage people to set aside their personal biases and to consider evolution through real-life examples. Then he lays out the components of the theory. Students should by this point have a context for developing a conceptual framework for variation and its consequences, natural selection, adaptation, and the time it takes for natural selection to work.

Throughout the book, Wilson tries to show that evolution is essential to understanding everything that seems distinctively human, such as a sense of beauty and personality, and thus is deeply consonant with the rest of life. He argues the same point for morality and religion. In several places he seeks to demonstrate that morally laden terms such as "good" and "evil" have a simple biological explanation; traits associated with "good" cause groups to function well as units, while traits associated with "evil" favor individuals at the expense of their groups. Wilson's examples, inspired mostly by his ideas about the importance and generality of group selection, are woven throughout the narrative.

Wilson can apply the conceptual framework of evolutionist thinking to virtually any topic in biology, and his reflections about how evolution may have influenced human value systems are intriguing. He suggests that when students learn the conceptual framework, they gain confidence in their abilities to work with evolutionary theory to understand and improve their world. Readers will find the theory presented engagingly: Wilson fills his chapters with new ideas, vivid examples, and personal anecdotes in a witty, personable writing style. The approach Wilson takes and the ideas he presents in this book may stimulate some teachers to think outside the box as they design their evolution curriculum.

At the outset, I was intrigued by Wilson's novel notions. My enthusiasm waned, however, as chapter after chapter rolled out largely speculative ideas about the emergence of aesthetics, the origin of laughter, the vital arts of dancing and music, and cultural evolution. The presentations eventually seemed tendentious, especially given the paucity of hard evidence to support the posited explanations. His extraordinarily broad

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application of evolutionary principles is overly zealous and dangerously close to overstepping the boundaries of science. Although all readers will gain something from this book, I ended it feeling apprehensive that part of Wilson's intended readership may be misled by the number of ideas that, although tantalizing, are indeed just ideas, not established explanations.

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