Exposition on Skepticism

The Skeptical Environmentalist: Measuring the Real State of the World. Bjørn Lomborg. Cambridge University Press, New York, 2001. 540 pp., $28.00 (ISBN 0-521-010683 paper).

Bjørn Lomborg discusses a wide range of topics in his book and implies, through the book's title, that he will inform readers exactly what the real state of world is. In this effort, he criticizes countless world economists, agriculturists, water specialists, and environmentalists, accusing them of misquoting or organizing published data to mislead the public concerning the status of world population, food supplies, malnutrition, disease, and pollution. Lomborg bases his more optimistic opinions on his own selective use of data. This review examines some of Lomborg's assertions and offers other information—extensively documented—that belies his assessment of the state of the world.

Lomborg reports that "we now have more food per person than we used to" (p. 61). Yet the Food and Agricultural Organization (FAO) of the United Nations reports that food per capita has been declining since 1984, based on available cereal grains (FAO 1961–1999). Cereal grains make up about 80 percent of the world's food. Although grain yields per hectare (ha) in both developed and developing countries are still increasing, these gains are slowing while the world population continues to escalate (FAO 1961–1999, PRB 2000). Specifically, from 1950 to 1980, US grain yields increased by about 3 percent per year, but since 1980 the annual rate of increase for corn and other grains has declined to only about 1 percent.

Obviously, fertile cropland is an essential resource for the production of foods, and Lomborg has chosen not to address this subject directly. Currently, the United States has available nearly 0.5 ha of prime cropland per capita, but that figure will drop if the population continues to grow at its current rapid rate (USBC 2000). Worldwide, the average cropland available for food production is only 0.25 ha per person (WRI 1994, PRB 2000). Each person added to the US population requires nearly 0.4 ha (1 acre) of land for urbanization and transportation (Vesterby and Krupa 2001). One example of the impact of population growth and development is found in California, where an average of 156,000 ha of agricultural land is being lost each year (USBC 2000). At that rate, California soon will cease to be the No. 1 state in US agricultural production.

In addition to the quantity of agricultural land, the quality and fertility of the soil are vital for food production. The productivity of soil is reduced when it is eroded by rainfall and wind (Lal and Stewart 1990, Troeh et al. 1991). Lomborg argues that this is not a problem, especially in the United States, where soil erosion has declined during the past decade. Indeed, as Lomborg states, instead of losing an annual average of 17 tons per hectare, US cropland is now losing an average of 13 $t \cdot ha^{-1} \cdot yr^{-1}$ (USDA 1994). However, this average loss is 13 times the sustainability rate of soil replacement (Pimentel and Kounang 1998). Exceptions occur, as when, during the 1995–1996 winter in Kansas, it was relatively dry and windy, causing some agricultural lands to lose as much as 65 $t \cdot ha^{-1} \cdot yr^{-1}$ of productive soil. This loss is 65 times the rate of natural soil replacement in agriculture (Lal and Stewart 1990, Troeh et al. 1991).

Soil erosion elsewhere is even more serious than in the United States. For instance, in India, soil is being lost at 30 to 40 times its sustainability rate (Koshoo and Tejwani 1993). The rate of soil loss in Africa is increasing not only because of livestock overgrazing but also because shortages of wood fuel make the burning of crop residues essential (Tolba 1989). During the summer of 2000, NASA photographed a cloud of African soil being blown across the Atlantic Ocean, further attesting to the massive soil erosion problem in Africa. Worldwide evidence of soil loss is substantial, and it is difficult to ignore its effect on sustainable agricultural production.

Contrary to Lomborg's belief, crop yields cannot continue to grow in response to increased applications of fertilizers and pesticides. In fact, field tests have demonstrated that applying excessive amounts of nitrogen fertilizer stresses crop plants and results in declining yields (Romanova et al. 1987). The optimum amount of nitrogen for corn, one of the crops that require heavy use of nitrogen, is approximately 120 kilograms per hectare (Troeh and Thompson 1993). Although US farmers frequently apply significantly more nitrogen fertilizer than 120 kilograms per ha, the extra is a waste and a pollutant. The corn crop can utilize only about one-third of the nitrogen applied, and the remainder leaches into either ground or surface waters or is denitrified and released to the atmosphere, or both (Robertson 2000). Such pollution of aquatic ecosystems in agricultural areas results in the high levels of nitrogen and pesticides found in many US water bodies (Mapp 1999, Gentry et al. 2000, Robertson 2000). For example, nitrogen fertilizer has found its way into 97 percent of the well-water supplies in some regions, including North Carolina (Smith et al. 1999). Concentrations of nitrate that are above the US drinking water standard of 10 milligrams per liter (nitrogen) may be a toxic threat to young children and young livestock (Smith et al. 1999). In the last 30 years, nitrate content has tripled in the Gulf of Mexico (Goolsby et al. 2000), where it is reducing fish yields (NAS 2000a).

Lomborg reports—without documentation—that pesticides cause very little cancer. Moreover, he does not explain how human and other nontarget species would avoid exposure to pesticides when crops are treated. However, abundant medical and scientific evidence confirms that pesticides do indeed cause significant numbers of cancer cases in the United States and throughout the world (WHO 1992, Ferguson 1999, NAS 2000b). Lomborg also fails to note that some herbicides stimulate in some plants the production of toxic chemicals that may be carcinogenic (Culliney et al. 1992).

In keeping with his view that agriculture and the food supply are improving, Lomborg states that "fewer people are starving" (p. 328). He questions the validity of two World Health Organization reports confirming that more than 3 billion people are malnourished (WHO 1996, 2000a). This is the largest number and proportion of malnourished people reported in history! Lomborg appears to reject the WHO data because they do not support his basic thesis. Instead, he argues that *only* people who suffer from calorie shortages are malnourished, ignoring the fact that humans die in great numbers because of deficiencies of protein, iron, iodine, and vitamins A, B, C, and D (Sommer and West 1996, Tomashek et al. 2001).

Further underscoring a decline in food supply, the FAO reports that there has been a threefold decline in the consumption of fish by humans over the past 7 years (FAO 1991, 1998). Fish numbers are decreasing because of overfishing and pollution, as well as a rapidly growing world population that must share the diminishing fish supply.

Lomborg is correct in stating that water supply and sanitation services improved in the developed world in the 19th century, but he ignores the available scientific data when he suggests that these trends have been "replicated in the developing world" in the 20th century. Countless reports confirm that developing countries discharge most of their untreated urban sewage directly into surface waters (WHO 1993, Wouters 1993, Biswas 1999). For example, of India's 3119 towns and cities, only 8 have full wastewater treatment facilities (WHO 1992). Furthermore, 114 Indian cities dump untreated sewage and partially cremated bodies directly into the Ganges River, where downstream people use the untreated water for drinking, bathing, and other domestic purposes (NGS 1995). It is no wonder that water-borne infectious diseases account for 80 percent of all infections worldwide and 90 percent of all infections in developing countries (WHO 1992).

Contrary to Lomborg's view, occurrences of most infectious diseases are increasing worldwide (WHO 1992), a rise attributable not only to population growth but also to increasing environmental pollution (Pimentel et al. 1998). Food-borne infections are increasing rapidly worldwide, even in the United States. For example, in 2000 there were 76 million human food-borne infections in the United States, with 5,000 associated deaths (Taylor and Hoffman 2001). Many of these infections were associated with contamination of food and water with livestock wastes (DeWall et al. 2000).

In addition, vast numbers of malnourished people are highly susceptible to infectious or opportunistic diseases such as tuberculosis (TB), malaria, schistosomiasis, and AIDS (Chandra 1979, Stephenson et al. 2000a, 2000b). For example, cases of tuberculosis are escalating worldwide and in the United States, in part because medicine has not kept up with the new forms of TB. According to the World Health Organization, more than 2 billion people have TB (WHO 2000b), and nearly 2 million people die from it each year (WHO 2001).

Consistent with Lomborg's thesis that natural resources are abundant, he reports that the US Energy Information Agency projected that oil prices would remain steady at about $22 per barrel over the period 2000–2020. This optimistic projection was refuted in late 2000, when oil rose to $30 or more per barrel (BP 2000). Reliable data project that world oil reserves will last approximately 50 years, based on current production rates (Youngquist 1997, Duncan 2001).

Lomborg takes the World Wildlife Fund (WWF) to task for its estimates on the loss of world forests over the past decade and its emphasis on the ecological impacts and loss of biodiversity attributable to that loss. Whether, as Lomborg suggests, the loss of forests is slow or, as WWF reports, the loss is rapid, there is no question that forests are disappearing worldwide. Forests not only are a rich resource for valuable products; they harbor a vast diversity of species of plants, animals, and microbes. Progress in medicine, agriculture, genetic engineering, and environmental quality depends on maintaining Earth's species diversity (Myers 1996).

I take issue with Lomborg's underlying thesis that the size and growth of the human population is not a major problem. The difference between Lomborg's estimate that 76 million humans were added to the world population in 2000 and the 80 million reported by the Population Reference Bureau (PRB 2000) is not the issue, although the magnitude of either projection is of serious concern. Lomborg neglects to explain that the major problem with world population growth is the prevailing young age structure. Even if the world adopted a policy tomorrow that barred any couple from producing more than two children, the world population would continue to increase for more than 70 years before stabilizing at more than 12 billion people (Population Action International 1993).

As an agricultural scientist and ecologist, I wish I could share Lomborg's optimism, but my investigations and those of countless other scientists lead me to a more wary outlook. The supply of Earth's basic resources—namely, fertile cropland, water, energy, and unpolluted atmosphere—that support human life is declining rapidly as people—nearly a quarter million of them each day—are added to the planet. We all desire a high standard of living for all of the world's citizens, but with every person born, the available supply of resources must be further divided and shared. Current losses and degradation of natural resources are cause for deep concern and the need to plan for future generations of humans. Based on scientists' current understanding of the real state of the world and environment, we must, now and in the future, conserve and protect vital global resources.

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SEX, POLITICS, AND SUSTAINABILITY

Why Sex Matters: A Darwinian Look at Human Behavior. Bobbi S. Low. Princeton University Press, Princeton, NJ, 2001. 432 pp., illus. $18.95 (ISBN 0-691-08975-2 paper).

Evolutionary biologist and anthropologist Bobbi Low has written a compelling and comprehensive synthesis of what is known (and not known) about the evolutionary basis for complex sexual behaviors in humans and other species. Low clearly and convincingly explains at several different levels of causality why sex matters. Ultimately, sexual reproduction is a very effective way to ensure genetic diversity within a species, and genetic diversity is essential for the survival of the vast majority of species that are confronted with uncertain environments. For example, when organisms are faced with pathogens that can quickly zero in on genetically homogeneous populations, diversity is an essential survival strategy, which explains why almost all species of plants and animals on earth employ sexual reproduction. Given this, the wrongheadedness of the idea of mass cloning of higher organisms becomes apparent. Imagine how easy a target for pathogens herds of genetically identical sheep or cows would be. Any slight savings realized by cloning only the very best-producing animals would be far outweighed by the costs of protecting them from pathogens.

Once going down the road of sexual reproduction, the next question is, Why are there only two sexes? Why not 3 or 10 or 100? Although there are a few rare exceptions (a 13-sex slime mold, for example), most higher organisms have only two sexes. Low explains this as the natural outcome of the two competing tasks gametes must accomplish to form a successful zygote: They must find another gamete, and they must form a well-endowed and ultimately successful zygote. Small gametes perform the first task well, large gametes the second. Medium-size gametes do neither well. This leads to a bimodal distribution of gametes into small, abundant, low-cost ones (male sperm) and large, high-cost, scarce ones (female eggs).

Low then elaborates on how these competing tasks of producing a large number of small, inexpensive sperm and producing and nurturing a small number of large, expensive eggs are the basis for many male–female structural and behavioral differences across a broad range of species (including humans). Relative parental investment in offspring ultimately explains a lot of the "whys" behind male–female behavioral differences, including why males are usually the aggressors and risk takers (and shorter lived) while females are more nurturing (and live longer), why polygamy is such a common system and polyandry is so rare, why the division of labor along sexual lines is so common, why older men are still considered sexually attractive while older women generally are not, why large breasts and slim waists are considered attractive in women, whereas men with control over resources are considered attractive to women, and a host of other common sexual patterns that exist across a broad range of cultures.

Although Low's book also acknowledges the complex links between biological and cultural evolution, she does not take the next step of considering cultural reproduction itself as a distinct and parallel phenomenon. The ideas, norms, and rules that make up cultures can, like organisms, reproduce themselves, but without regard to the genetic relatedness of the individuals who carry those behaviors. If ideas and other aspects of culture reproduce and compete, there will be selection pressure for the most "successful" ideas, norms, and rules, where success is judged by the spread and reproduction of the idea, norm, or rule within the population. This type of reproduction is quite distinct from the physical reproduction of organisms. It allows culturally based evolution to occur at "light speed" relative to genetic evolution and in many cases to override genetically based behavior patterns (Ehrlich 2000). Of course, cultural and genetic evolution are intimately interconnected, but it is just this complex interconnection that has yet to be adequately explained and which represents a significant research challenge for evolutionary scientists.

Another important question has to do with the "reflexive" nature of cultural evolution: Because we are capable of at least some degree of conceptualization and foresight, we can exert at least partial control over our own selection environment (Arrow 1962). The process then becomes one of conscious design and tinkering with the cultural evolutionary process rather than passive response to externally determined biological criteria. How does this process work and what are its limits? Devising policy instruments and identifying incentives that can translate foresight into effective modifications of short-run cultural evolutionary dynamics is a key research challenge. In cultural evolution, we have the unique potential to first envision our goals and then modify the cultural selection criteria in order to achieve them (Costanza et al. 1993, 2000).

Low's book provides a solid basis for addressing these and countless other questions that are critical to understanding human sexual behaviors. But understanding how cultural evolution works and how it interacts with biological evolution in determining human behavior is still an elusive and increasingly important target.

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RADICAL SOLUTIONS TO OLD PROBLEMS

The Poverty of the Linnaean Hierarchy: A Philosophical Study of Biological Taxonomy. Marc Ereshefsky. Cambridge University Press, New York, 2001. 316 pp., illus. $65.00 (ISBN 0-521-781701 hard cover).

In his book, Ereshefsky's goals are both scientific and philosophical. The scientific goal is to provide a balanced and accurate discussion of biological systematics—the nature of species taxa, the species category, and the relationship between phylogeny and classification. His philosophical objective is to urge a temperate version of pluralism. He also makes two extremely radical proposals. In keeping with his pluralism, Ereshefsky suggests that systematists should not limit themselves to the construction of a single classification but should produce a half-dozen or so different classifications, each with its own theoretical foundation. In addition, he thinks the Linnaean hierarchy should be abandoned.

Ereshefsky's philosophical preference for pluralism motivates much of what he has to say on scientific issues. He thinks the world is constituted in such a way that it can be subdivided in several different ways, all of which can be equally legitimate. With respect to biological systematics, pluralists maintain that more than one legitimate species concept and way of classifying the resulting species exist, while monists keep striving for one—and only one—preferred classification and species concept. As things now stand, the literature on the species category supports Ereshefsky's pluralist inclinations. Systematists have set forth numerous different definitions of the species category—22 at last count!

A preference for monism does not require a blanket rejection of the multiplicity found in nature. For example, one might define the species category in terms of a single factor, such as cohesion, but acknowledge the existence of several mechanisms that contribute to this cohesion. Similarly, a preference for pluralism does not require a blanket tolerance for any and all explanations of natural phenomena. Ereshefsky spends a large part of his book distinguishing between promiscuous and discerning pluralism. Some species definitions are worth pursuing, but others are not.

Ereshefsky suggests four primary criteria for choosing among species definitions: empirical sensitivity, internal consistency, intratheoretic coherence, and intertheoretic coherence. Empirical sensitivity means merely that empirical data can affect the probability assigned to an hypothesis—not an overly stringent requirement—but the emphasis of the other three on the role of theories in classification is sure to be rejected by numerical pheneticists and pattern cladists, who want classifications to be as free of scientific theories as possible. A promiscuous pluralist might find theory-neutral classifications to be scientifically acceptable; Ereshefsky does not.

Ereshefsky provides an even more convincing case for biological taxa, species taxa in particular. There is no such thing as the essence of any one species—no essence of *Bos bos*, *Drosophila melanogaster*, or *Homo sapiens*. Prior to 1859 systematists were essentialists. They thought all taxa could be distinguished in terms of characteristics that are severally necessary and jointly sufficient for membership. If these characteristics are mapped onto some sort of character space, clear gaps between species should emerge, a few monsters notwithstanding. Even before the acceptance of evolution, systematists had to struggle to treat all taxa as if they had sharply defined boundaries in character space. After 1859, systematists could understand why the boundaries between so many species are so fuzzy. At any one time, species can be found in various stages of speciation. The more gradual this process is, the greater the problem.

One response to this problem is to acknowledge vague boundaries by treating taxa names as cluster concepts. The goal is still to draw boundaries between taxa in character space. The only difference is that these boundaries are vague. An organism need not exhibit *all* of the characteristics of its species *fully* developed in order to belong to that species; it must exhibit only enough of the most important characteristics developed to a reasonable degree. The choice between taxa as essential natural kinds and as kinds with vague borders can be decided empirically. All one must do is map character distributions onto some sort of a grid. If sharp gaps between most species appear, then essentialism might just be appropriate for dealing with species. However, if in most cases species gradate into each other, then cluster analysis of some sort would be preferable. The latter alternative seems to be the case.

Ereshefsky rejects essentialism with respect to taxa for empirical reasons. Characters simply do not covary the way essentialists require. He also rejects species as gradually changing clusters, but for more theoretical reasons. If species are to be the things that evolve, then descent takes priority to character distributions, no matter what these distributions turn out to be. Advocates of "polythetic" taxa are right about how traits cluster in character space, but they are wrong in treating such traits as primary. What really matters is not character space but physical space. Species as evolving lineages are located in space and time. Hence, they are best construed as "individuals." Ereshefsky agrees with the preceding arguments but distinguishes between a weak and a strong sense of individuality. In a weak sense, species as lineages are located in space and time and therefore must be distinguished from other such lineages. However, they need not be internally cohesive. Many species exhibit such cohesiveness, and just as many lack it.

One of Ereshefsky's most radical suggestions is that systematists should produce a variety of alternative classifications —one systematically related to phylogenetic development, another that organizes organisms in ecologically meaningful ways, and so on. The response of most systematists to Ereshefsky's call for the construction of several alternative classifications is likely to be pragmatic. "We currently do not have enough systematists to produce a single, coherent, inclusive classification, let alone a half-dozen different classifications. And if things continue the way that they are going, we will have even fewer systematists in the future. The Natural History Museum in Washington will soon be nothing but another Disney World." The most that systematists can hope to do is to provide alternative classifications of very restricted bits of the natural world. More than one inclusive classification is simply not feasible.

Ereshefsky takes his second radical thesis to be so important that he entitles his book *The Poverty of the Linnaean Hierarchy*. Even though he views the "Linnaean system as the backbone of biological classification and much of biology" (p. 3), he thinks that it should be junked, a view shared by several highly respected systematists. When Darwin introduced his theory of evolution in 1859, he was met with opposition from a variety of quarters. His theory raised challenges to all sorts of deeply entrenched beliefs, but on one score, evolution fitted neatly into the received views at the time—the appropriateness of the Linnaean hierarchy for biological classification. All that was necessary was to substitute *splitting* for *subdivision* and *ancestors* for *archetypes*. The fundamental character of the Linnaean hierarchy is subdivide, subdivide, subdivide, whereas that of evolution is split, split, split. What could be easier than overlaying the traditional atemporal classifications of Aristotle and Linnaeus with phylogeny?

As long as the connection between classification and phylogeny was taken to be impressionistic at best, no conflicts arose. The integration of muck into gook is not likely to give rise to sharp conflicts. But as classifications were made more quantitative (a partial legacy of the numerical taxonomists) and the connections between phylogeny and classification more explicit (one effect of cladistic analysis), the conflicts between splitting and subdividing became clear. It is easy enough to draw a tree that depicts two species evolving from a third species, the common ancestor, but the conversion of that tree into a cladogram or a classification has proven to be extremely problematic. The same can be said for the depiction of other relationships, such as the representation of hybrid species.

Time and again, difficulties that have arisen with respect to representing phylogeny in a classification have been traced to the limitations of the Linnaean hierarchy. Hence, if systematists really want to produce classifications that exhibit some precise relationship to phylogeny, they must abandon the Linnaean hierarchy. Ereshefsky is well aware that systematists are not about to do that, but at the very least they need to realize how much discord results from the structure implicit in the Linnaean hierarchy.

Ereshefsky tries very hard to be clear and fair to all sides, and he succeeds to an amazing degree. If you want to understand the reasons for all the hubbub in systematics over the past 40 years or so with a minimum amount of labor, Ereshefsky's book is the place to begin. As I read this book, I was repeatedly taken aback by how straightforward so many of the issues seem in retrospect. All I can say is that they did not seem that way to me at the time. Could we have made them as clear back in the bad old days as Ereshefsky makes them appear today if only we had tried harder? I don't think so.

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A GOLDEN *ECONOMY OF NATURE*

The Economy of Nature, 5th ed. Robert E. Ricklefs. WH Freeman, New York, NY, 2000. 550 pp., illus. $92.30 (ISBN 0-716-73883X cloth).

In 1982, I purchased my first copy of a Ricklefs general ecology textbook, which I was advised was the single most complete reference book to have on one's shelf. *Ecology* (2nd ed., Chiron Press, 1979) was huge—966 pages in black and white, with 80 of those pages a detailed bibliography, and what seemed then to be an extravagant section on the biomes illustrated with large black-and-white photographs. In graduate school, I assisted in a general ecology course in which we used *The Economy of Nature* (2nd ed., also Chiron Press), the boiled-down version for undergraduates.

Since that time, many more textbooks on general ecology have been published, and the criteria for textbook selection in this competitive market have become much more complex. Instructors seek textbooks that will not only provide solid material and an even representation of topics but also appeal to today's students, with brilliant color photos and graphs, "sound bites" of the key ideas, connections to current events, and inexpensive paperback formats. In addition, professors want good support: test banks, innovative Web pages, and digital versions of the graphics to include with computerized presentations.

Suffice it to say that Ricklefs has moved with the times! Not only that, this text is, in my view, in a leadership position with respect to most of these criteria. Since I am immersed in teaching this course, I am very familiar with most of the competing texts. This fall, I read Ricklefs's book side by side with the one I was using as a text and three others.

The text is organized as many are, by beginning with an introduction to the field of ecology, then moving into the physical environment, a presentation of the biomes, and a progression through the subfields of ecology to end with global ecology. Interestingly, this is the only text that puts ecosystem ecology after the biomes and before population and community ecology. I found this organization to be quite effective. It built on the physical environment and biome descriptions beforehand, and provided the big picture for the ensuing chapters.

The text very successfully uses sound bites to convey the most important messages; headers in the text are full sentences that guide the reader to specific sections very quickly (e.g., "Early and late successional species have different adaptations"). These statements are listed in the table of contents as a nice guide to topics and the big ideas.

Economy of Nature does not rely only on sound bites, however, nor does it skimp on material. It provides a very high level of detail for almost every topic, and context that is rich in history as well as current perspectives. The introduction, for instance, not only presents ecology in the context of the scientific method but also describes the complexity that ecologists face in dealing with processes that vary across multiple temporal and spatial scales. The section ends by emphasizing the importance of understanding the increasing role of humans in the biosphere, which seems appropriate because it represents the direction of the field. There are some environmentalism values that develop here, which I will address more below.

The presentation of the physical environment and adaptations is very thorough. The biome description is rich with color photographs and diagrams, with excellent development of the geographic distributions of climate and biomes through the use of maps, Walter climate diagrams, and Whittaker's delineations. The biome descriptions are short, emphasizing an overview of vegetation and soils, with no description of faunal adaptations. However, given the length of a semester and thus the time generally available to cover the topic, this section is about the appropriate length for presenting in class.

Ricklefs's ecosystem section does an excellent job of linking energy flow and matter cycling. It places greater emphasis on the similarity among the element cycles than do most other texts, a concept that I think is important in enabling students to perceive the big picture (advanced ecology students claim to have memorized the separate nutrient cycles many times but never learn them). While I very much liked having the ecosystem-level foundation for energy, production, and nutrient cycling early in the text, I thought that more linkages back to this material could have been included in the following chapters. For instance, the interactions between community structure and nutrient cycling would have been an appropriate and important topic for the community or biodiversity sections later in the text; the book emphasizes only the response of plant competition to nutrient availability. It misses the opportunity to address the role of plant communities or invasive species in altering nutrient availability.

The population and community sections of the book are rich with concepts as well as specific examples and seemed to present ecology in a modest way, in that each of the major lessons includes statements of uncertainty that leave the door open for more exploration. Essentially all the generalities include caveats, such as "predator and prey dynamics *often* increase and decrease," or "traits of competing populations *may* diverge" (italics added), which I think sets the tone for a field that continues to grow. It is important to note that these sections do not shy away from mathematical presentations, and to decrease the likelihood of scaring off the students, they provide qualitative descriptions for each equation. In addition, the book links to a Web site, "Living Graphs," which is an interactive presentation of the equations with graphs. This is probably the most effective linkage between a text and a Web page that I have yet seen. Students may explore the components of equations, see the consequences graphically, and participate in exercises that can be sent to the instructor. I have not yet tried this on students, but I think it will be a real hit.

The last section of the book, "Economic Development and Global Ecology," works to scale up to the globe and incorporate humans explicitly. This chapter worked least well for me, perhaps because the title led me to think that the focus would be global-scale issues. However, the topics seem to address all human impacts, varying from heavy metals and acid deposition to eutrophication and global change. Moreover, the coverage of global change was very shallow, including none of the good summary figures from IPCC (Intergovernmental Panel on Climate Change) and other sources of temperature correlations with carbon dioxide, or long-term perspectives of CO_2 variability and human impacts (some of these are presented much earlier, but not in the context of natural variability versus human influences). Carbon dioxide is the only greenhouse gas mentioned at all, and there is only passing reference to sources of greenhouse gases other than fossil fuel burning. Here, the text seems to lose the balance of presenting some uncertainty, with statements such as "warmer temperatures caused by the greenhouse effect will have mixed effects on productivity," making the assumption that the predictions are correct. There is no discussion of how scientists study these large-scale phenomena and incorporate our understanding into simulation models. My assessment is that it is much more engaging to present evidence, logic, scientific approaches to a system that can't be replicated or manipulated, and uncertainties. Given the very extensive coverage of global change in our daily dose of media, I think the text should present a more thorough summary. There are opportunities here as well for a discussion on connecting the scientific process and our uncertainties with policymakers' need for knowledge.

I think that this last chapter tips into values and environmentalism far too much for an ecology textbook. There are prescriptions for the future that are based on the author's values, for instance, "Energy consumption must be scaled back" and "we must use these abilities to impose self-regulation and self-restraint." Although I may share these opinions, one of the major messages our students should be getting is that scientists evaluate information based upon logic, and that our job as scientists is to present unbiased information and indicate very clearly where our values enter in. The term *ecology* for the most part has lost its meaning in our society, as the public confuses it with environmentalism. Authors of ecology texts, in my opinion, should be held to the highest of standards in making clear the distinction between science and editorializing.

The materials that accompany the text as supporting materials for instructors are superb. This is the only textbook I have seen that includes not only vivid color graphics but also all of the photographs in digital form (including .jpg, .gif, and PowerPoint files). The text comes with lecture outlines in PowerPoint, written by Tom Wentworth, to accompany this text. This is a terrific tool. Web content includes self-tests, flashcards, and additional resources on current events. The online tests can be used as exams, with the results e-mailed to the instructor.

Overall, I rate this text as the best of the five with which I am familiar. I very highly recommend it for its evenness and thoroughness of presentation and for the excellent resources for both instructors and students. My only reservations have to do with the last chapter, an outlier because its presentation is not up to the standard of the rest of the book.

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WOLF REINTRODUCTIONS: ARE MORE NEEDED?

Wolves and Human Communities: Biology, Politics, and Ethics. Virginia A. Sharpe, Bryan Norton, and Strachan Donnelley, editors. Island Press, Washington DC, 2001. 321 pp., $65.00 (ISBN 1-55963-828-1 cloth).

Pity the wolf and those who wish to expand the range of this apex predator. Consider the following:

- A handful of wolves can dramatically alter the structure of a community.
- Wolves are perceived by many as highly endangered, but in much of their current range, wolf populations are doing just fine.
- The main reason for the decline of wolves in North America was not habitat alteration but direct persecution. In the absence of persecution, wolf populations can expand dramatically wherever food is ample.
- Wolves are big predators—big enough to bring down bison, musk ox, and moose, and big enough to drive mountain lions away from a carcass.
- Wolves eat what humans eat, including deer and livestock. Many people see wolves as competitors, as an economic threat, and as a risk to personal safety.
- People will pay money to be near wolves, to see them, to hear their howls. Many equate the presence of wolves with a sense of wildness and may seek out areas with wolves. Because wolves can bring economic gains to a region, many people want the animals in areas where they no longer naturally exist.

Given that wolf reintroduction efforts in the continental United States have the potential for spectacular success (as in Yellowstone National Park, for example) or failure (Smoky Mountain National Park), and given that such efforts are expensive, the question becomes this: Is there a need for additional wolf reintroduction efforts?

There are currently no wolf populations in the northeastern United States, where robust populations once probably existed. Should a wolf reintroduction take place? A possible region for the effort might be the Adirondack State Park of northern New York, a huge and diverse mix of landscapes that is three times the size of the Greater Yellowstone ecosystem. Although wolves exist in eastern Canada, geographic and geopolitical barriers make it unlikely that they will reach the Adirondacks under their own power in the near future. If we want wolves in the Adirondacks, we will have to put them there.

Wolves and Human Communities is the result of a 1999 symposium held at the American Museum of Natural History to address a variety of basic questions:

- Should wolf reintroduction into the Adirondacks be a high priority?
- Is such an effort even feasible?
- Who makes the decision to commence the effort?
- What biological, economic, spiritual, philosophical, administrative, and political hurdles must be overcome to make any such introduction successful?

The volume brings together a fascinating mix of wolf biologists, politicians, representatives of nongovernmental organizations, local stakeholders, sociologists, wildlife agency personnel, lawyers, and ethicists with agendas as diverse as their backgrounds—those with pro- and anti-reintroduction positions, ostensibly skeptical independents, and those who simply lay out the cold facts of federal and state laws, jurisdictions, and funding priorities.

This book makes fascinating reading. Many of the authors have been involved in various aspects of carnivore conservation for decades, and having their thoughts in a single volume exploring the successes and limitations of wolf restoration will provide remarkable insights to those with little direct experience in dealing with carnivores. Other chapters, however, are written by authors who lack the carnivore expertise that should have gone into a volume like this. Indeed, even the editors are not known for their previous work with wolves, and their inexperience shows. Several chapters contain discussions of wolf biology and conservation that are distractingly vague and could have benefited immensely from a review by an expert on wolves.

And yet, if one can plow through the pages of fuzzy thoughts in some of these chapters, real insights can be unearthed. In the opening chapter, for instance, former Missoula mayor and Montana legislator Daniel Kemmis put forth the idea, echoed by others in this volume, that national opinion means little when it comes to species reintroductions. If local opinion is against something, said Kemmis, "there are and always will be endless opportunities for locals to undermine and sabotage any centrally devised and imposed recovery" (p. 12). This is an extremely important point, to which most conservation biologists and environmental activists have given insufficient thought.

This diversity of opinion, the conflicting information presented by different authors, and even the variable quality of each chapter serve to make this volume all the more significant. The opinions expressed by the various authors were occasionally at odds with one another and expressed so strongly as to give startling insights into how practitioners in different environmental fields prioritize reintroduction efforts and underscore the difficulty of reaching consensus on issues as contentious as wolf reintroductions. I am aware of no other volume quite like it—an edited work that so clearly displays the dramatically differing philosophical views, agendas, and even self-revealed naiveties of stakeholders. Nonetheless, two subtexts run through many of the chapters in the volume. One asks what we have learned from wolf conservation and reintroduction efforts elsewhere in the world. The other suggests that returning wolves to the Adirondacks will repair damage done by past generations and restore wildness to the region.

For those wondering if there is more to this book than simply wolves and human views of wolves, I would suggest that indeed there is. For instance, excellent chapters by Mech and by Clark and Gillesberg show how environmental organizations can compromise their own cause by obfuscating facts and failing to confront internal conflicts. Sax presents an overview of the difficulties that property rights law poses for environmental restoration efforts, including a fascinating discussion of the relevance to conservation biologists of US Supreme Court arguments over the landmark status of New York City's Grand Central Station. In addition, many of the chapters, though couched in terms of wolf reintroduction, have clear relevance to other reintroduction efforts in that they outline the biological, administrative, and ethical issues that must be resolved to ensure success.

As an ecologist studying carnivores in the Adirondacks, I have often wondered about the past influences of wolves in the region. Yet I have been unable to decide whether a wolf reintroduction effort is desirable. After reading this volume, I am no closer to an answer, and I suspect most readers will be left equally uncertain. But this is not necessarily a bad thing, and readers will come away with a greater appreciation of the complexity of seemingly simple issues.

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"I see we have a lot to learn on our first day of domestication...."