Where the Wild Things Were

Beyond Conservation. A Wildland Strategy. Taylor, P. 2005. Earthscan Publications Limited, London. 296 pp. (278 + xviii). £19.99 (approximately US$34.66). ISBN 1-84407-198-7.

In Maurice Sendak's popular children's book, *Where the Wild Things Are*, written more than 40 years ago, the hero, Max, who has been sent to his bedroom for a series of misdemeanors, watches in his wolf suit as the bare walls and ceiling sprout leaves and turn into a jungle overlooked by a silvery moon. He sails across an ocean, in and out of weeks, and over a year to a land where the wild things are. They gnash their terrible teeth and show their terrible claws, but he says, "be still," and tames them with a stare. They become frightened and, perceptively, call him the wildest thing of all. After being crowned king of all wild things, the fun begins. But as time passes, he eventually becomes homesick. Leaving the wild things, which gnash their terrible teeth in dismay, he sails back home to his bedroom and finds his hot supper waiting for him.

Although we have lived with wild things for most of human history, many are now extinct. Early hominids shared Europe with the auroch, giant Irish elk, woolly mammoth, scimitar-toothed cat, woolly rhinoceros, hyena, and hippopotamus. As agriculture and human settlements expanded and forests and other wild lands were converted, species gradually disappeared. In Britain the brown bear survived certainly until AD 750 and possibly to the time of the *Domesday Book*. The last beavers were recorded in the 1300s, wild boar were common to the late middle ages but then disappeared, and the last wolf died in the 1600s. Today, we are left with 44 species of land-breeding mammals, the most common of which are voles, shrews, rabbits, rats, mice, and moles. In North America, the losses of species have been more dramatic. Since the seventeenth-century arrival of Europeans, some 500 species of animals, fish, and plants have disappeared, a rate of between one and two species a year.

Bringing back some of these lost animals is now part of an emerging conservation agenda that seeks to be more proactive than in the past. In this welcomed book, *Beyond Conservation*, Peter Taylor says we have been too defensive in the past and that conservation is still not relevant to the mainstream economy. Here he seeks to set out a strategy to "rewild" our industrialized landscapes and so bring us closer to nature. Is such integration possible, or is it all a bit too late? It would be easy to make the mistake of thinking that the division between agriculture and nature began when the first seeds were sown 10,000 years ago. In truth, though, this separation was never complete until this industrial age had taken full effect. Thus, there are three levels of possible integration: biodiversity in the field that contributes a service to food production; whole-farm integration with mosaics of different land uses; and whole landscapes in which ecological restoration can occur. All have been a focus of recent efforts to make agriculture more sustainable.

What prospects are there, then, to bringing back some of the more iconic wild animals of industrialized landscapes? Rewilding is described by Peter Taylor as "putting a new soul in the landscape." It aims to retrieve something lost and perhaps even to create something quite new. Three chapters in the book detail the potential for large-scale landscape change for Coed Eyri in Snowdon National Park, for the reestablishment of the Caledonian forest in Scotland, and for a rewilding of Dartmoor in Devon. A further chapter usefully summarizes efforts to create new networks and corridors, including woodlands, wetlands, coastal marshes, and wild rivers. Then follow chapters on the requirements for restoring the herbivore and carnivore guilds, again mainly with a focus on the U.K. landscape. All of this will require some coordinated policy for both agriculture and conservation and some big shifts in public thinking. Are we ready for this, he wonders?

Many of the animals and birds being proposed as possible reintroductions have long since disappeared from our memories. Bringing them back would change the land and change the people too. Some reintroductions have been relatively uncontroversial. The White-tailed Eagle was eradicated in 1916, reintroductions attempted from 1959, and breeding successful in the Western Isles of Scotland from 1986. Forty-five years of effort have led to a population of 11 pairs. The Great Bustard has been reintroduced from Hungary to Salisbury Plain and has so far survived foxes and motor cars. Tarpan

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and Konik horses have been brought in to help in the managed grazing of coastal marshes and reed beds, and Chillingham cattle, relatives of ancient aurochs, have been put back into some forests.

But it is the next cohort of introductions that will excite controversy. Beavers have been proposed for release into habitats in Kent and Scotland, but hitherto rejected for fear that their escape would lead to habitat destruction. Others are talking about elk—could they be introduced as part of the Wicken Fen project to the northeast of Cambridge? Wild boar are already present in four or five herds across southern England, and the policy question centers on whether they should be permitted to remain or be hunted out. But the greatest of all controversy would come with predator introductions, particularly wolves, bear, and lynx. Bear get better press than wolves but are unlikely to be seriously proposed. Lynx do not carry so much public concern and might be permitted. Wolves, though, would be an extraordinary attraction if introduced into a landscape large enough to support active packs. I suspect many would love to see them in the wild, while at the same time feeling the visceral fear that wolves seem to provoke.

Taylor also touches on one of the enduring mysteries of U.K. landscapes. This is the phenomenon of alien big cats. About 1000 reports of sightings per year are reported. Individual testimonies seem convincing, even though some people may be mistaken. As with the Loch Ness monster, the photos mostly are blurred and confusing. Could there really be such wild animals out there in our crowded land? And, if so, are they escapees from zoos or circuses or deliberate releases by pet owners or welfare activists. If they are present, are they breeding? Once there have been a number of sightings in one location, the animals inevitably receive a popular moniker—the Beast of Bodmin, the Fen Tiger, the Surrey Puma. In this way, they enter popular mythology and increase the likelihood of people seeing something that may not really be present. We are, however, still left with sheep kills and horse mutilations that seem to point only to big cats, yet officials have searched at some locations for weeks with little success. The lack of hard evidence is strange. Is it because they genuinely do not exist, or are they really so elusive that we cannot locate them in the landscape?

Or maybe there is something more subtle in all of this? Perhaps we simply would like to sustain some wild mysteries and stories that are not resolved to a final truth of presence or absence. Alien big cats continue to occupy a boundary between mythology and nature. What, then, does this rewilding agenda mean for conservation and agriculture? Some rewilding does mean the creation of completely separate habitats, but most implies an overlap, a sharing of the landscape for its various functions. It should be possible to have food-producing systems that complement and enhance nature. There is now growing confidence that we can indeed make the transition to sustainable agricultural and food systems that both protect and use nature. This will require some rethinking about the very idea of farming and its redefinition as a multifunctional activity rather than just focusing on food production. The new model farm produces wholesome food that people want to buy and eat, and it contributes to the production of a large number of environmental goods and services. It coexists with wildlife and links people to the land directly via the food they eat and places they know about and can visit. Perhaps we may indeed see a rewilding that reshapes our land, as well as ensures positive outcomes for both farming and conservation.

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Resurrection Ecology in the Service of America's Evolutionary Legacy

Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America. Martin, L. 2005. University of California Press, Berkeley, CA. 250 pp. $29.95 (hardcover). ISBN 0-520-2314-4.

Twilight of the Mammoths is an intriguing but not entirely effective combination of three disparate parts: memoir of scientific discovery, analysis of competing Late Pleistocene extinction hypotheses, and call for radical North American restoration. These various threads are united in falling within the broad interests of the author, who is justifiably well known for his overkill hypothesis (i.e., that human overhunting caused Late Pleistocene megafaunal extinctions) and for exploring the conservation biology implications of Pleistocene and Holocene extinctions. Although the book is inconsistent, the author's informed, passionate perspective remains worthy of consideration.

The first two chapters introduce overkill and provide an overview of prehuman Pleistocene faunas. Subsequent chapters address related topics. These include the importance of ground sloth dung and packrat midden analysis to Pleistocene studies; the paleobiology of ground sloths, which Martin considers the hallmark American megafaunal group; Grand Canyon ecology and paleoecology as an overkill test case; the global correlation between human arrival and extinctions; the question of when humans arrived in the Americas; the interpretation of archeological sites; and the particulars of competing extinction hypotheses. All of this sets the stage for a pair of concluding—and controversial—chapters on species restoration. Several short, free-standing essays are interspersed throughout the book. Most relate tangentially to the study's

main subjects, but one offers an exceptionally clear and very useful overview of carbon-dating techniques. Although Martin recounts several key research experiences, *Twilight of the Mammoths* is only secondarily a memoir. The book's main concerns are Late Pleistocene extinctions and ecological restoration. Accordingly, I also focus on those topics.

The section on extinctions is the stronger of the two. Martin provides a thorough overview of the species lost, although the book deals mainly with North American faunas. Debate about the cause(s) of the extinctions generally centers on the relative explanatory merits of climate shifts and human activities, including hunting, the introduction of destructive exotics (e.g., rats, dogs), and landscape alteration (e.g., as from burning), and all these topics are covered. Although not impartial, Martin's assessment of the debate is informed, fair, and civil. He accurately observes that no existing climate-change model explains the observed extinction pattern but remains willing to have his hypothesis tested. He notes that two lines of evidence would cast serious doubt on overkill: first, unique features of Late Pleistocene climate shifts that could explain the loss of large mammals and, second, evidence for long-term coexistence of humans and megafauna in the Americas or Australia.

The few minor problems with Martin's treatment of the extinctions will pose difficulties primarily for those unfamiliar with the subject. A clear, concise definition of overkill would have been helpful. As presented, the term could reasonably be interpreted as referring either to extinctions resulting solely from hunting or those resulting from a combination of human activities including hunting. Similarly, although Martin is careful to cite works that contradict his overall conclusion, he does not always point out the range of opinion bearing on the specific evidence he presents. For instance, on the subject of prey naiveté, the literature is nowhere near unanimous in accepting that an accurate parallel can be drawn between the North American megafauna that the first Paleoindian hunters encountered and the vulnerable island species that evolved isolated from predators and were easily eradicated by humans as a result.

The final two chapters represent an exchange in a broader dialog on the rewilding movement, which calls for a significant portion of North America to be restored to a wild condition, with core wilderness areas, corridors, and viable complements of native species. Here, Martin proposes a Pleistocene standard for American restoration efforts. The argument has much to recommend it. The ecosystems that European colonists encountered were shaped both by the first Americans and their sudden decimation by Old World disease. Consequently, it is difficult to differentiate between those aspects of early colonial ecosystems that are atypical and those that represent a "normal" condition toward which restoration should aspire. A Pleistocene restoration standard also involves difficulties—even leaving aside the problem of extinctions. Pleistocene floral and faunal assemblages frequently lack modern analogs, and it is unclear how well they can be approximated under current climatic conditions. Martin proposes a radical plan to address these difficulties.

"Resurrection ecology" would restart the evolution of some megafaunal lineages by reintroducing them to North America. The approach would involve a multigenerational commitment, caution, and considerable research. For these reasons it is important to avoid becoming mired in a premature debate about particulars. Martin's suggestions to introduce a host of species—from zebra and elephant to gemsbok and rhino—are tentative and should be read as such. The justifications for such a major enterprise, however, should be both clear and fully articulated, and in this respect the study falters. In addition to the presumed main justification of preserving evolutionary potential, Martin briefly offers a variety of arguments for the plan, but none are fully developed. Those rooted in ethics are the most fragmentary. For instance, it is difficult to determine in what context taxa could be considered to have an inherent right to evolve free of human interference. Martin also briefly offers a series of additional arguments: that resurrection ecology could save endangered Old World species, provide the conservation movement with much-needed optimism, and allow humans to develop deeper ecological understanding by creating a host of real-world experiments. Details are scarce, however. By predicating so ambitious a restoration plan on so fragmentary a series of arguments, *Twilight of the Mammoths* falls short of persuasiveness.

Martin explicitly states that his support of resurrection ecology is independent of his views on overkill. But he acknowledges that, if the hypothesis were validated, one controversial argument supporting his restoration plan would be that humans bear a moral responsibility to repair the ecological damage they have inflicted. Although Martin expresses reluctance to advance that argument, it nonetheless remains in the rhetorical background, as does a linkage between overkill and resurrection ecology. Martin writes that extinct megafauna are America's evolutionary legacy, commenting: "They are what is natural" (p. 201). But if megafaunal extinction proves not to have been a consequence of overkill or other human activities, the opposite argument—that megafaunal extinction is "natural"—would be more compelling. Certainly, there are many lineages whose evolutionary fortunes we might wish to reverse.

The main unanswered question here is "Absent compelling proof for overkill, why should these lineages receive so much attention?" The lack of a clear answer to that question leads to the book's major rhetorical shortcoming: the appearance it gives that proponents might favor resurrection ecology simply because they think it would be a fine and

pleasing thing to do. An esthetic hunch about how to work toward an attractive, newly configured American landscape is far too shaky a foundation for so large and uncertain an enterprise. In addition, some who might support the plan if its underlying logic were clearer might end up opposing it by misreading potential clues the book offers. For instance, Martin writes of the importance of a long-term perspective on Cenozoic mammal evolution, noting that it is vital to conceiving of how we might "design with nature" (p. 186). In context, comments like this one raise the possibility that a call for resurrection ecology might actually be a call for novel ecosystem design and construction—something many supporters of restoration would oppose.

In the absence of details, it is difficult to either accept or reject Martin's perspective. Individuals must decide for themselves whether or not it has a firm basis in ethics or science, a far shakier one in esthetics or whim, or, perhaps, something in between. Nonetheless, a long-term perspective on conservation biology and restoration is long overdue, as is a bolder, more proactive approach. Whatever the particulars of a more ambitious conservation agenda might turn out to be, the majority of conservation biologists would probably agree that while we go about formulating that plan, additional research and larger reserves with greater connectivity would be worthy medium-term goals. Long-term goals can come later. Martin offers his own views on the subject and invites us to consider them and to formulate our own. Although occasionally incompletely argued, the broad messages presented in *Twilight of the Mammoths* merit consideration—and in that regard Martin's study is a noteworthy success.

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A Masterful Underview

Biological Diversity and Function in Soils. Bardgett, R. D., M. B. Usher, and D. W. Hopkins, editors. Cambridge University Press, New York, NY. 425 pp. (411 + xiv). $65.00 (paperback). ISBN 0-521-60987-9.

Bardgett et al. present an impressive array of 20 chapters, authored by more than 40 researchers in the field of soil ecology, including topics of biological diversity and function in soils. The book takes a vigorous whole-systems approach, noting the many interlinkages between above- and belowground processes. The volume is the product of a symposium of the British Ecological Society held in the spring of 2003.

Biological Diversity and Function in Soils is the logical successor to a symposium held 19 years earlier on the topic of ecological interactions in soil, also sponsored by the British Ecological Society. That volume was almost entirely process oriented, mentioning aspects of biological diversity only briefly. So much of the biota was undescribed then (the situation is somewhat improved for some of the mesobiota and macrobiota), but even now the work of describing bacteria and fungi is in its infancy. Molecular tools provide insights into the wide array of microbes (over 25 phyla in the Eubacteria and the number is increasing) and fauna, many of which remain undescribed in temperate and tropical locales.

One generation ago, soil ecology was considered rather esoteric. It would have been difficult then to imagine a feature issue of *Science* (11 June 2004) with the theme "Soils, the Final Frontier." The articles in *Science* emphasized the emerging concept of soils as central organizing centers for terrestrial ecosystems. There have been additional issues of *Science* featuring the Mars explorers and their findings. Unfortunately, we know only a bit more about soils on planet Earth.

The book is arranged in six parts, beginning with an insightful introduction by Wall, Fitter, and Paul (Part I), who provide an extensive overview of the field of soil biodiversity. After presenting a figure showing the major influences on research in soil biodiversity, the authors condense their message into 10 "take-home messages" as follows:

1. The terrestrial world is brown and black, not green, which emphasizes that soils contain twice the total carbon of vegetation and more ecology occurs below than above ground.
2. The world seems primarily microscopic. This is too mild; the world is primarily microbial dominated.
3. We do not know their names or what they do. Even now, no soils are known in which all species are described.
4. Food webs do not follow traditional rules. Many organisms are generalists and omnivory seems to be the rule. System behavioral traits follow from these facts.
5. Indirect effects can dominate, and are hard to quantify. The high species richness in soils results in multiple species interactions that are mostly indirect. Are species essentially interchangeable as a consequence?
6. Scale is a dividing issue between above- and belowground ecology. Spatial and temporal scales of above- and belowground organisms are markedly different. Many soil phenomena have been misinterpreted by applying aboveground macroscale viewpoints to the array of biota involved. Allowing that the biota involved span many scales in space and time and viewing them as "integrators" of phenomena is only gradually becoming appreciated.
7. Soil legac(ies) imprint soil biodiversity (and can override plant effects). This is a big factor that is little known or appreciated yet.

Thus, soil organic matter (SOM) at 50 cm depth in the field can be up to 1400 years older than the SOM at the surface but can decompose at similar rates to surface SOM when incubated in the laboratory.

8. Soils and their biota are not isolated in terrestrial ecosystems: they have multiple landscape connections. Humans and academic researchers tend to view soils and biota separately, but they do so at the peril of missing the big picture. Soils and sediments have many interconnections yet are often considered separately, unfortunately.
9. Small creatures have biogeography too. Latitudinal and landscape patterns of soil biodiversity are largely unknown, but information is starting to accumulate.
10. Decomposition is one of the two major life-generating processes. Decomposition is paired with photosynthesis as one of the two key ecosystem processes. The diversity of organisms involved in decomposition dwarfs that of photosynthetic organisms, and much of the remainder of the book hangs on that.

Part II, "The Soil Environment," contains chapters on "The Habitat of Soil Microbes," with innovative three-dimensional analyses of soil aggregates; "Twenty Years of Molecular Analysis of Bacterial Communities in Soil" (O'Donnell et al.), noting the exponential increase in information that is lagged yet by an equivalent amount understanding of all that the array of microbes do; and "Carbon as a Substrate for Soil Organisms" (Hopkins & Gregorich). This latter chapter takes a "soil metabolomic" approach to complex and composite substrates, noting the many benefits of stable-isotope probing to link organisms with their substrates.

Part III, "Patterns and Drivers of Soil Biodiversity," gets to the core of the subject. With an impressive array of synthesis papers, virtually any one would merit a full page of commentary in a review. I cover just a few high points. Bardgett, Yeates, and Anderson, in "Patterns and Determinants of Soil Biological Diversity," note the paucity of data, with little support for the notion that soil biodiversity at local scales conforms to either productivity-diversity or disturbance-diversity relationships. They note that belowground communities could differ from their aboveground counterparts in that soil biodiversity is not so strongly regulated by competition and competitive exclusion does not occur with increased resource availability in soil. This finds further support in a later article by Setälä et al., who discuss trophic structure and functional redundancy in soil systems. Bardgett et al. make the trenchant observation that although the results of numerous studies show that disturbances resulting from agricultural intensification can result in reduced soil biodiversity, they do not lend support for the notion that biological diversity in soil is optimized at intermediate levels of disturbance.

David Wardle, in "How Plant Communities Influence Decomposer Communities," presents two examples of aboveground, human-induced changes affecting the composition of the soil food web across several trophic levels, including key ecosystem functions carried out by the soil biota. These studies led Wardle to suggest that reductions in plant diversity do not cause predictable changes in drivers of soil biodiversity, such as microhabitat diversity or favorability of environmental conditions (soil fertility). De Ruiter, Neutel, and Moore in "The Balance between Productivity and Food Web Structure in Soil Ecosystems," follow up on earlier leads by noting several system-level properties of soil food webs. They note the key components in food web structure, namely the lengths and weights of trophic interaction loops (a pathway of interactions [not feeding rates] from a species through the web back to the same species without visiting the species more than once; hence a closed chain of trophic links). This synthetic construct enables ecologists to compare and contrast productivity, energy flow, and interaction strengths of microbes, microbivores, omnivores, and predators.

The role of redundancy in many of these groups is the subject of later chapters in the volume. Standing et al. consider "Rhizosphere Carbon Flow: a Driver of Soil Microbial Diversity?" and note the powerful tools of nucleic-acid-stable-isotope probing (SIP) with ^{13}C incorporated into microbial biomass. They comment that the techniques for linking microbial diversity to function can be extended further by application of SIP to mRNA gene probing. This approach will allow the activity associated with specific genes to be quantified.

Part IV, "Consequences of Soil Biodiversity," contains six chapters with a wealth of new information in impressive syntheses. Schimel, Bennett, and Fierer cover "Microbial Community Composition and Soil Nitrogen Cycling: Is there Really a Connection?" These authors note that some processes are physiologically "narrow" (e.g., fixation and denitrification) and should be sensitive to microbial community composition. In contrast, internal turnover processes, such as mineralization and immobilization, involve "aggregate" processes that have classically been considered insensitive to community composition. However, the latter can be broken into individual components that may be sensitive to microbial community composition, considering exoenzyme and microsite phenomena. The kinetics of exoenzymes may regulate microbial carbon and nitrogen limitation and hence community composition. Microsite phenomena in turn appear to regulate system-level nitrogen cycling in nitrogen-poor soils, with the effects scaling nonlinearly to the whole system. Thus, different organisms will live

and function in different types of microsites. Taking this more microsite-oriented approach will enable research linking microbial populations and the nitrogen cycling processes they carry out.

Robinson, Miller, and Deacon, in "Biodiversity of Saprotrophic Fungi in Relation to Their Function: Do Fungi Obey the Rules?" consider the conundrum of apparent fungal redundancy. They note that decomposition rate depends more on fungal species composition and its functional repertoire and less on species richness alone. Leake et al., in "Is Diversity of Mycorrhizal Fungi Important for Ecosystem Functioning?" tackle the problem of redundancy in mycorrhiza by noting that mycorrhizal associations are multifunctional, exhibiting complementarity. Because of the high specificity and dependency in many mycorrhizal associations, especially ones involving mycoheterotrophic plants, they suggest that the extent of functional "redundancy" is low. Setälä, Berg, and Jones, in "Trophic Structure and Functional Redundancy in Soil Communities," offer several examples of the extent of generalism, omnivory, and highly heterogeneous nature of soil organisms, all playing major roles in explaining the high degree of functional complementarity in decomposer communities.

Van der Putten, in "Plant–Soil Feedback and Soil Biodiversity Affect the Composition of Plant Communities," shows how different components of the soil subsystem, including plant pathogens, can have variable and even opposite effects on plant community composition depending on the productivity level considered. Spatial and temporal scales are ever important, and he demonstrates how central they are to soil ecological studies. McCarthy et al., in "Response of the Soil Bacterial Community to Perturbation," tackle the problem of myriads of bacterial species apparently coexisting by focusing on two measurable parameters: the total number of bacterial cells and the abundance of the most abundant species in a given microhabitat.

Part V, "Applications of Soil Biodiversity," addresses key problems of interest to land managers in tropical environments (Giller et al.). Also included are "Restoration Ecology and the Role of Soil Biodiversity" (Harris, Grogan, & Hobbs), "Soil Biodiversity: Stress and Change in Grasslands under Restoration Succession" (Brussaard et al.), and "Soil Biodiversity, Nature Conservation and Sustainability" (Usher). The main take-home lesson for the reader is that there is a wide range of useful techniques for land managers that can be employed now. Usher points out, rather poignantly, that there is no "charismatic fauna or microflora" with which the general public can resonate; hence, there is little pressure for conservation of soil organisms. That situation should be changed but will require further education of public and land managers alike.

Part VI, "Conclusion," is a masterful synthesis by Karl Ritz entitled "Underview: Origins and Consequences of Below-Ground Diversity." His main points are that we must be both wide ranging and far seeing in our dealings with soil diversity in terms of soil structure and the consequent community structure that is governed by many factors. He notes that soil biodiversity must be viewed in relation to the functional repertoire of the biota, potential and realized interactions between components, and functional redundancy. Biodiversity per se in most soils seems to be of little functional significance. The functional repertoire of the soil biota is much more pertinent. Although knowledge is growing apace, a unifying framework for soil biodiversity is not yet within reach, but he suggests that soil architecture, because it varies over space and time, may be the key to providing such a framework.

In its totality, this volume with its wide range of topics, is very thought provoking and a must-purchase reference for all terrestrial ecologists. It should be at the top of the list for all graduate students coming through ecology and natural resource advanced degree programs.

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Conservation beyond Community

Metacommunities. Spatial Dynamics and Ecological Communities. Holyoak, M., M. A. Leibold, and R. D. Holt. 2005. 524 (513 + xi) pp. $38.00 (paperback). ISBN 0-226-35064-9.

Years ago, when I first heard the word *metacommunity*, I resisted it. The basic idea was that community ecology needed a regional perspective. Space, after all, was ecology's last frontier (Kareiva 1994). But my gut reaction was to avoid the new "meta" expression. Did we really need a new term to add to the already rich metapopulation language? What would the concept contribute above and beyond traditional community ecology? Was it all just metaphysics envy? Since that time, my appreciation for the metacommunity concept has grown in reaction to an expanding and compelling body of theoretical and empirical work on the subject. The previously diffused and disconnected metacommunity research has now been synthesized into one book, *Metacommunities: Spatial Dynamics and Ecological Communities*, which provides a synthesis of past research, clarifies a nascent lexicon, and proposes new extensions and frontiers. Metacommunity ideas are still largely theoretical and as yet can deliver few practical conservation predictions. However, the metacommunity concept has substantial promise to spur a spatially integrated and more accurate perspective for conserving diversity in fragmented landscapes. In this respect, the book

presents a compelling case for adding the metacommunity concept to the ecological toolbox. I suggest that you add it to your bookshelf.

Metacommunities explores what happens when community ecology operates within an interconnected mosaic of habitat patches. In contrast to the more familiar metapopulation approach, local interspecific interactions determine each population's local extirpation risk. Hence, the metacommunity framework elevates community processes to a dominant role in determining local persistence. This assumption adds a layer of complexity to spatial ecology heretofore largely neglected. *Metacommunities* will engage community ecologists looking to broaden their erstwhile, limited spatial scope and metapopulation ecologists who cannot escape from the knotty complications that arise when multiple species interact. The hope is that the two will meet on amicable terms—an optimistic expectation by any measure. But through inclusiveness and sheer breadth, editors Marcel Holyoak, Mathew Leibold, and Robert Holt manage to unify these camps into a compelling framework. For the conservation biologist, many of the ideas are still early in their development and provide little in the way of hard and fast solutions. Practical applications await feedback from ongoing empirical assessments. That said, the metacommunity approach offers a useful theoretical construct that includes the biological realities of complex multispecies interactions over multiple spatial scales. This integrated perspective hints at the promise of improved future conservation recommendations.

Metacommunities is divided into four parts. The first describes the assumptions and core concepts of metacommunity theory. These chapters introduce a prevailing focus of the book: comparing and contrasting four divergent ideas about metacommunity assembly. These ideas are termed the patch-dynamics, neutral, mass-effects, and species-sorting perspectives. Each perspective differs in its assumptions about the strength of spatial coupling among communities, the magnitude of environmental heterogeneity, and the effect of heterogeneity on species fitnesses. Together, these concepts provide a steady progression from community dynamics determined largely by dispersal to those that relegate dispersal to correcting the match between species traits and local conditions. That metacommunity variation can be explained along an organizational axis of interpatch migration and environmental heterogeneity suggests a compelling hypothesis—one of many to originate from the metacommunity vantage point. However, as noted in later chapters, these templates are not mutually exclusive and not all species in a region or even a local community can be expected to adhere to the assumptions underlying a single perspective.

The second section presents empirical examples detailing how local species interactions and dispersal jointly affect local and regional community patterns. The take-home message is that changes in communities cannot be predicted without understanding the role dispersal plays in counteracting local extirpation. Although empirical examples are compelling, the reader should not expect a polished understanding of real-life metacommunities. The rarity of empirical work on metacommunities renders synthetic conclusions impossible. Instead, book examples function as a feedback on emerging theory by highlighting current inadequacies. Of profound and apparently general relevance is the problem that each species can disperse over widely divergent scales. Yet most theory assumes equivalent dispersal rates among species. This result limits the applicability of current theory and highlights the chasm that must be crossed before conservation biologists are likely to use metacommunity models.

Both synthesized and novel theories on metacommunities are merged into the last two sections. The reviews of mass effects (a form of sink source dynamics for multiple species), competition colonization tradeoffs (Mouquet, Hoopes, & Amarasekare), and spatial-storage effects (Chesson, Donahue, Melbourne, & Sears) are impressive and accomplished with rare clarity. Anyone requiring a refresher or an introduction to these complex concepts will benefit from these chapters. Additional chapters break new ground. Although not as accessible as review chapters, new models of multispecies community assembly in space (Law & Leibold), neutral communities (Gomulkiewicz & McPeek), and the metaecosystem (Loreau, Mouquet, & Holt) are presented. This last concept proposes an integration of metacommunity and landscape ecology such that flows of energy and materials across boundaries inform predictions of community diversity and emergent ecosystem properties such as biomass production. A chapter by Resetarits and others illustrates how incorporating the behavior of habitat selection into a regional perspective leads to a more complex, yet realistic, portrayal of species movement. This spate of theoretical work offers a variety of novel ideas that will continue to push the theoretical envelope while we wait for empirical research to catch up.

The final chapters reveal an emergent theme of the book—that strong similarities exist between metacommunity and genetic theories of coexistence and diversity. The analogous changes that occur as genetic and species diversity are sorted among divergent environments provide both a call for integration and a bountiful pool of population genetic theories to adapt for ecological use. The retooling of neutral genetics for neutral metacommunity theory illustrates this latter approach. Here, McPeek and Gomulkiewicz argue that macroevolution often builds species so similar in form that they have comparable fitnesses. Therefore neutral metacommunity perspectives

co-opted from the genetic literature often may prove useful. In this same thread, Leibold, Holt, and Holyoak highlight similarities between evolution by natural selection and metacommunity dynamics. This chapter suggests that a more comprehensive view of biological diversity can be focused through the integrated lens of complex adaptive systems (Levin 1998).

The book ends with an assurance of more to come for the application minded. In this regard, readers hoping for a deeper examination of conservation implications may feel disappointed. However, the metacommunity approach does offer some general insights. One conservation outcome that materializes from metacommunity research is a "Goldilocks" principle for the effect of dispersal on species diversity. Dispersal that is too low precludes the ability of immigrants to rescue local populations declining due to unstable interspecific interactions. Dispersal that is too high synchronizes patch dynamics and precludes the possibility of rescue effects. Hence, the highest local diversity is predicted at moderate (just right) dispersal rates that counteract local extirpation threats and, depending on assumptions about patch heterogeneity, realign species with optimal habitats following patch disturbance or succession. But this outcome depends critically on the strength of local interactions and variation in dispersal rates. Hence, metacommunity theories make strong cases for understanding dispersal rates of threatened species and for applying adaptive management strategies that account for interconnections between remnant patches within the larger regional landscape. The hope remains that more robust, applied predictions will be forthcoming.

Overall, *Metacommunities* should be recognized as a substantial and successful synthesis of existing theoretical and empirical work. The book integrates a bevy of competing ideas into a coherent and expanding metacommunity ecology field. In the process, the reader will be convinced of both its possibilities and liabilities. Perhaps this is what I like most about the book: its editors and writers freely admit and accept the challenges provoked by a metacommunity view. I believe that one of the thorniest challenges for the concept is that it remains faithfully tethered to the strong interactions that tie it to traditional community ecology. In the absence of species interactions, the metacommunity reduces to a more tractable metapopulation of multiple species. Herein lies my strongest criticism of the book. I had hoped it would provide stronger guidance on the strength of interactions necessary to justify a metacommunity approach. The problem is that enterprising researchers may apply the metacommunity term to suggest a novelty where one does not exist. This threatens to muddy ecology's metaterminological waters. A corrective measure would place the weight of evidence on researchers to demonstrate the primacy of interspecific interactions in the local extirpation process.

My personal standard for a book is that it changes how I think about a subject. This book met this criterion. *Metacommunities* makes an excellent case that metacommunity theory is not just metapopulation theory for the 00s. Substantially different dynamics from those predicted in metapopulation models result when dispersal enmeshes the local dynamics of multiple interacting species. I believe the book will encourage readers to understand how regional linkages affect local ecological outcomes in their own systems. In the process, I expect that the metacommunity framework will increase the future rigor and accuracy of conservation biology.

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Literature Cited

Kareiva, P. 1994. Space—the final frontier for ecological theory. Ecology **75:**1.

Levin, S. A. 1998. Ecosystems and the biosphere as complex adaptive systems. Ecosystems **1:**.431–436.

A Tropical Rain Forest Gem

Tropical Rain Forests: an Ecological and Biogeographical Comparison. Primack, R., and R. Corlett. 2005. Blackwell Publishing, Malden, MA. 329 pp. (319 + x). $74.95 (hardcover). ISBN 0-632-04513-2.

Tropical rain forests continue to spawn numerous treatises, but this book may become the most influential of the decade. In contrast to the leading classics (e.g., Richards 1996; Whitmore 1998) on tropical forests, the authors of this new book take a very different tact by focusing on the ecological and biogeographical differences among the five principal ecoregions of tropical forests. The authors' thesis is that the dominant paradigm of the late twentieth century, that tropical rain forests are more similar than different, has led to the mistaken assumption we know more than we actually do, which has serious consequences for prioritizing research questions and meeting conservation objectives.

The book's chapter titles provide a good indication of coverage: Many Tropical Rain Forests; Plants—Building Blocks of the Rain Forest; Primate Communities—A Key to Understanding Biogeography and Ecology; Carnivores and Plant-Eaters; Birds—Linkages in the Rain Forest Community; Fruit Bats and Gliding Animals in the Tree Canopy; Insects—Diverse, Abundant, and Ecologically Important; and The Future of Rain Forests. Each chapter is appropriately introduced and ends with conclusions and further reading

citations. Young as well as older researchers will find several stimulating questions in the " . . . future research directions" (pp. v–vii) that close each major chapter.

The authors demonstrate great breadth of knowledge and a thorough command of the relevant literature. The book offers many thoughtful gems such as the following. "American [tropical] rain forests could reasonably be called 'bromeliad forests'" (p. 54). "The Sarcolaenaceae [endemic to Madagascar] is the sister group to the dipterocarps . . ." (p. 70). " . . . 90% of all primates are associated with tropical forests . . ." (p. 76). "The nearest ecological equivalent to the Old World colobines are not primates but [Neotropical] sloths . . ." (p. 84). " . . . the everwet forests of tropical Asia are truly 'fruit deserts' most of the time . . . ." (p. 89). "[T]he [Malagash] aye-aye, as a sort of primate woodpecker . . ." (p. 92). "Carnivores may be the least understood of rain forest animals, not only because of the difficulties of studying them, but also because their opportunistic and variable behavior makes it hard to interpret the limited data we have . . . ." (p. 130). "Understanding the role of past and present human hunters in rain forest ecology may be our biggest challenge" (p. 131). "Although fruit bats in the Old and New World are united by their consumption of fruits and nectar, they are evolutionarily and ecologically worlds apart" (p. 179). "After primates, some of the most striking differences among rain forest areas are found in the frugivorous bats . . ."(p. 195). " . . . the ant–homopteran partnership may be responsible for more consumption of plant biomass than all other invertebrates and vertebrates together . . . ." (p. 214). "It seems a curious coincidence that the fungus-growing leafcutter ants are confined to the New World and the fungus-growing termites to the Old World . . . ." (p. 222). "Unfortunately, the countries that are likely to see the greatest increase in demand for rain forest-associated products over the coming decades are also the ones least likely, on current evidence, to make environmental considerations a major factor in their decisions" (p. 260).

This is a delightfully informative and well-written book that keeps the reader engaged. It would be an excellent text for either an on-campus or field-based course in tropical ecology. In addition to excellent photos and figures illustrating the chapters, the book includes 16 pages of fine color photos. The book is reasonably free of errors; however, there are some mistakes such as using "complimentary" for complementary, "lead" for led, "poisonous" for venomous, "guar" for gaur; and the photograph (p. 145) of a Collared Aracari is identified as a Toucan. Nevertheless, the authors have met their objective and I highly recommend this excellent book to all those interested in the tropics.

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Literature Cited

Richards, P. W. 1996. The tropical rainforest: an ecological study. 2nd edition. Cambridge University Press, New York.

Whitmore, T. C. 1998. An introduction to tropical rain forests. 2nd edition. Oxford University Press, New York.

A Radical Science

The Science of Sustainable Development. Sayer, J. A., and B. M. Campbell. 2004. Cambridge University Press, Cambridge, United Kingdom. 288 pp. $50.00 (paperback). ISBN 0-521-53456-9.

Jeffrey Sayer and Bruce Campbell have a radical proposition: scientific research in the tropics should support the needs of local farmers and other resource users and managers. At the heart of this vision for integrating science with natural resource management is an effort to address the fundamental discord between the functioning of complex social ecological systems and the manner in which external technical support is provided to local managers. These systems are characterized by spatial and temporal variability, numerous scales of interaction, and nonlinear change. The challenge for rural communities and other managers in the tropics is to deal with this complexity and variability. Essential traits for doing this include flexibility, adaptability, and the ability to learn and innovate in the face of changing conditions. As Sayer and Campbell note, farmers living in these environments have always practiced "adaptive management" as a matter of basic survival.

As understanding of complex systems dynamics and the challenges facing managers of these systems has grown (Ruitenbeek & Cartier 2001; Gunderson & Holling 2002), the inappropriateness of conventional aid delivery mechanisms has become more glaring. The traditional ways of providing scientific and technical support to rural resource users—briefly detailed by Sayer and Campbell in an aptly headed section on "dysfunctional development projects"—are built around relatively short project cycles, typically linear understandings of systems change, simplified causative interpretations, and rigid planning frameworks. Because these characteristics are so incongruent with those of the systems they are trying to support and influence, development projects in the tropics have a striking record of failure. Sayer and Campbell provide an excellent overview of these interventions and the dynamics of the systems they occur in, reviewing key theoretical elements and providing three instructive case examples from tropical Asia, Africa, and South America.

The authors' response is a call for reconceptualizing scientific research as an active component of locally driven adaptive management systems, a collaborative process between local users and outside

technical experts, with the former determining the agenda as much as the latter. Research conducted in this way cannot be done by foreign-based experts who visit their "study sites" from time to time, and it cannot be funded effectively through short-term project cycles. Sayer and Campbell's "science of sustainable development" is one where the division between research and management no longer exists because both become elements of a single integrated approach.

The challenge to affecting the authors' important and compelling vision lies in restructuring the organizational frameworks of management and incentives that determine how scientific research is conducted and funded. And as the authors note at the very end, the logic of their vision is no guarantee of its adoption. Although adaptive management is extolled in the literature, and has been for decades, the practice of natural resource management remains more often based on traditional command-and-control systems. Sayer and Campbell are hardly the first to assert the need for development agencies to move away from rigid planning frameworks, simplified analyses, and short-term investment patterns, and it is unlikely they will be the last. Major organizational and institutional barriers prevent reforming development aid's organizational structures in a way that will support the integration of science and natural resource management and enable adaptive management to move from theoretical acceptance to actual practice. It is by calling for such a broad reformation of scientific enquiry's norms, and perhaps spurring others to further develop ideas and strategies for attaining the requisite organizational reforms, that this becomes not only a visionary work but a truly radical one as well.

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Literature Cited

Gunderson, L. H. and C. S. Holling, editors. 2002. Panarchy: understanding transformations in human and natural systems. Island Press, Washington, D.C.

Ruitenbeek, J., and C. Cartier. 2001. The invisible wand: adaptive co-management as an emergent strategy in complex bioeconomic systems. Occasional paper 34. Center for International Forestry Research, Bogor, Indonesia.

Recently Received Books (February 2006—April 2006)

Brute Souls, Happy Beasts, and Evolution. The Historical Status of Animals. Preece, R. 2005. University of British Columbia Press, Vancouver, Canada. 448 pp. $85.00 (hardcover). ISBN 0-7748-1156-0.

California's Frontier Naturalists. Beidleman, R. G. 2006. University of California Press, Berkeley, California. 499 pp. (484 + xv). $39.95 (hardcover). ISBN 0-520-23010-8.

Earth Repair. A Translatlantic History of Environmental Restoration. Hall, M. 2005. University of Virginia Press, Charlottesville, Virginia. 352 pp. $35.00 (hardcover). ISBN 0-8139-2341-7.

Falcon. MacDonald, H. 2006. The University of Chicago Press, Chicago, Illinois. 208 pp. $19.95 (paperback). ISBN 1-86189-238-1.

A Field Guide to the Birds of the Gambia and Senegal. Barlow, C., and T. Wacher. 2005. Yale University Press, New Haven, Connecticut. 400 pp. $40.00 (paperback). ISBN 0-300-11574-1.

Fish for Life. Interactive Governance for Fisheries. Kooiman, J., M. Bavinck, S. Jentoft, and R. Pullin, editors. 2005. The University of Chicago Press, Chicago, Illinois. 427 pp. $52.50 (paperback). ISBN 90-5356-686-4.

Freshwater Fishes of Mexico. Miller, R. R., W. L. Minckley, and S. M. Norris. 2006. The University of Chicago Press, Chicago, Illinois. 652 pp., 96 color plates. $75.00 (hardcover). ISBN 0-226-52604-6.

Geography of British Columbia. 2nd edition**.** McGillivray, B. 2005. University of British Columbia Press, Vancouver, Canada. 2828 pp. $95.00 (hardcover). ISBN 0-7748-1253-2.

Global Biopiracy. Patents, Plants, and Indigenous Knowledge. Mgbeoji, I. 2005. University of British Columbia Press, Vancouver, Canada. 400 pp. $85.00 (hardcover). ISBN 0-7748-1152-8.

Vietnam: a Natural History. Sterling, E. J., M. M. Hurley, and L. D. Minh. 2006. Yale University Press, New Haven, Connecticut. 448 pp. $40.00 (hardcover). ISBN 0-300-10608-4.

Wave-Swept Shore. The Rigors of Life on a Rocky Coast. Koehl, M. 2006. University of California Press, Berkeley, California. 189 (179 + x) pp. 87 color illustrations. $39.95 (hardcover). ISBN 0-520238125.