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BOOK REVIEWS

Hof, John & Bevers, Michael. 1998. **Spatial optimization for managed ecosystems**. 258 pp. Columbia University Press, New York, NY. ISBN 0-231-10636-X (hardcover). Price: USD 75.-.

Spatial ecology can be maddeningly vague. The general principles may be obvious, but converting these principles into specific management recommendations can be difficult. For example, edge habitat is important to many wildlife species; interior habitat is important to others. If a forest is harvested in clear-cut blocks, the spatial arrangement of the blocks determines the amount of edge habitat. How should the forest be cut to maximize benefits to wildlife? The answer is rarely obvious. This book illustrates how linear programming and related mathematical techniques can answer these sorts of questions.

Linear programming and its extensions (integer programming, non-linear programming) are mathematical techniques to optimize some objective function, subject to constraints. In the cutting and edge habitat example, the function could be the total value of all wildlife species. The abundance of a species, which depends on the amounts of edge and interior area, is multiplied by a predetermined value per individual for that species, then all species are summed. The cutting decision for each block of the forest is represented by one variable, with values of 0 = no cut and 1 = cut. These variables and their spatial arrangement determine the amounts of cut, uncut, and edge habitat. The mathematical problem is to find the set of cutting decisions (yes or no for each block) that maximizes the wildlife value.

The solution to an optimization problem must often satisfy certain constraints. For example, there may be a minimum amount of cut area (so that the necessary amount of timber is cut) and a minimum amount of uncut habitat. When all the relationships between variables are linear, the constrained optimum can be found by linear programming. Most spatial problems are more difficult because of non-linear relationships between variables (e.g. the amount of edge is a non-linear function of the cutting decisions) or because variables are not continuous (e.g. each block is either cut or not, intermediate values are not allowed). Hof & Bevers show how this cutting problem and many other spatial resource management problems can be rewritten or approximated as linear programming problems.

The book contains 4 parts, each addressing a major class of spatial problems that can be solved by constrained optimization. Each part starts with a general introduction to the mathematical and computational techniques followed by 2 or 3 chapter-length examples. The first part treats problems like the cutting example, where spatial effects are known. The second part includes spatial uncertainty and spatial autocorrelation into the analysis. One of the examples in this part assumes that timber yield per cutting block is uncertain. The problem is to minimize harvest cost while being 95% confident that the total yield exceeds a specified level. The third part describes models for movement in a landscape. The examples here include management of the black-footed ferret, control of a pest outbreak, and reducing maximum storm water flow. The final part considers community properties like species richness and diversity that require more complicated objective functions. Some of the examples are ‘toy’ illustrations, but many have sufficient biological and spatial detail to be useful for guiding real decisions. There is a strong emphasis on forestry and wildlife management

Large parts of the book are adapted from previously published material. Many of the chapters are adapted from journal papers published in the mid-1990s. Still, linear programming is not part of the training of most vegetation scientists. Most textbooks on linear programming emphasize the mathematics, with applications to business problems. A real strength here is the forestry and wildlife management examples.

There is little in this book that concerns vegetation science, *sensu strictu*. In their foreword, Tim Allen & David Roberts, argue that phytosociologists could benefit from these techniques. I partially agree. The ideas in this book will be a new way of thinking for most vegetation scientists. But, if you are interested in resource management applications of linear programming and related methods, this book provides a convenient introduction.

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Noss, R.F. (ed.) 2000. **The redwood forest: history, ecology, and conservation of the Coast Redwoods**. 339 pp. Island Press, Washington, D.C. ISBN 1-55963-726-9 (paperback). Price: USD 30.-.

This edited volume covers a rich diversity of timely subject matter on coast redwood forests. The contributing authors are experts in their respective scientific fields, but the book is more than just a compilation of scientific information. It is a well-organized account of biological management and conservation based on sound science. The book is best suited to students and professionals in ecology and conservation biology. Nonetheless, an effort has clearly been made to make the presentation accessible to ambitious non-scientists.

In a concise opening chapter Reed Noss lays out the objectives of the book. First and foremost, the aim is to present a scientific basis for protection, restoration and sustainable management of coast redwood forests. In doing so, the book’s contributing authors cover broad territory from history to ecology, management, and conservation.

John Sawyer and 7 co-authors discuss the prehistory and history of redwoods (Chapter 2). An extensive account of redwood paleo-ecology is provided. The redwood family (or *Taxodiaceae*) appeared in the Triassic Period. The genus *Sequoia*, to which coast redwood belongs, was represented as early as the Jurassic or Cretaceous Periods. In western North America, the range of *Sequoia* became restricted to the Pacific Coast by the Miocene epoch. The coast redwood (*Sequoia sempervirens*) is regarded as a paleo-endemic species, showing few morphological differences from its prehistoric counterparts. For at least the last 1000 yr, human activities have impacted the coast redwood forest. The effects of land use by pre-European and European peoples are outlined. Historic events in the conservation of coast redwood and giant sequoia (*Sequoiadendron giganteum*) forests are noted. Accounts of numerous conservation milestones from 1864, when Abraham Lincoln signed congressional legislation protecting a Sierran grove of giant sequoia, to acquisition of the Headwaters Forest in 1998 provide encouragement for conservation-minded readers.

Chapter 3 covers coast redwood forest vegetation, flora, and environments. John Sawyer and 8 co-authors recognize 3 biogeographic sections with distinctive forest vegetation. These are the Northern Redwood Forest, the Central Redwood Forest, and the Southern Redwood Forest. Subsections are also recognized, but will not be summarized in this review. The Northern Redwood Forest is particularly distinctive with western hemlock (*Tsuga heterophylla*) as a component species that occurs primarily in sheltered drainages near the coast. Madrone (*Arbutus menziesii*) occurs inland and at higher elevations within this region. Redwood forms relatively pure stands on alluvial flats within the region. Douglas-fir (*Pseudotsuga menziesii*) is associated with redwood on upland slopes and ridges in all 3 sections. In the Central Redwood Forest, terraces along rivers are dominated by redwood, but Douglas-fir, tanoak (*Lithocarpus densiflorus*) and other hardwoods are upland associates. In the Southern Redwood Forest, north-facing raised terraces favor redwood. Upland associates include Douglas-fir and various hardwoods. Floristic information on understory plants, epiphytic plants, fungi, and lichens adds to the detailed description of redwood forest biology. Even exotic plant species are listed and discussed. Botanists will be aided by several species checklists in the appendices of this chapter.

Chapter 4, by John Sawyer and 10 co-authors, focuses on redwood trees, communities and ecosystems. The life history of redwood is characterized. Regeneration occurs by seed or sprouting. Data reveal that the vegetative regeneration can be prolific after death or damage to the parent. Tree architecture and the potential for rapid growth, large size, and great age are documented with extensive quantitative data. Speculation on how the fog environment characteristic of redwood forests may allow the trees to attain great heights is reinforced with scientific findings. Genetic studies reveal much variation among redwoods and a propensity for high genotype-environment interaction compared to other conifers. The successional status of this extremely long-lived species has puzzled foresters and vegetation scientists. Traditional reasoning holds that redwood cannot maintain dominance without major disturbances that favor the regeneration of redwood over other species. Emerging data on disturbance ecology reveals that disturbance agents such as fire, wind, floods, and animals can affect stand dynamics. The long-term dynamics of redwood communities and ecosystems under various conditions is not clear and requires further investigation.

In Chapter 5, attention shifts to the fauna of redwood forests. Allen Cooperrider and 7 co-authors surmise that the fauna of redwood forests is similar to that of temperate rainforests of the Pacific Coast of North America in general. Survey data indicate that no vertebrate species are restricted to redwood forests. Although data on invertebrates are scarce, endemism does not appear to be common. A discussion of the biogeographic prehistory of the northern Pacific Slope of North America (the Pacific Northwest hereafter) adds to our understanding of current distributional patterns. The plethodontid salamanders are noted for their particularly high abundance in coastal forests of the Pacific Northwest. Of these, the Del Norte salamander (*Plethodon elongatus*) may be associated with old, closed-canopy forests. Certain species of birds and bats may also favor old forests. However, the vertebrate fauna of homogeneous redwood forests is not species-rich. Its response to land use and management practices has been investigated with habitat relationships models based on vegetation type, seral stage, and other habitat elements. A need for more complex analyses considering landscape patch size, juxtaposition, and connectivity is stressed. Studies thus far suggest that certain vertebrates decline when mature forest is fragmented. A list of imperilled terrestrial vertebrates is provided. The chapter closes with a few case studies of animal conservation ecology in the Pacific Northwest. A general conclusion is that, although saving old redwood stands is helpful, landscape-level management is critical to the conservation of biota.

Chapter 6 covers stream biota and ecosystems. Hartwell Welsh and 2 co-authors review aquatic ecology in the redwood forest region. Much of their discussion draws on studies from across the Pacific Northwest. Fundamentals of stream ecology and the integrated management of riparian and aquatic ecosystems are covered. A key point has to do with the relatively large size of live and dead trees in old riparian redwood forests. Tall trees shade streams, keeping primary production low. The presence of large logs produces stream channel characteristics favourable for aquatic biota. High erosion and sedimentation occur in the redwood region. Road building and logging increase erosion, harming stream biota and riparian biota (including redwoods). Aquatic ecosystems have been altered. One example is the decline of salmonids. The effects of such declines on aquatic communities and ecosystems are poorly understood. Indicator species are suggested as a means of monitoring and assessing ecosystem changes. In addition, aquatic and riparian organism groups in the redwood region are outlined and selected groups are listed by species. The chapter closes with a call for work on the recovery of aquatic species and ecosystems.

Reed Noss and 4 co-authors tackle the issue of redwood conservation planning (Chapter 7). Their focus is primarily on landscape management for biodiversity and ecosystem sustainability. They argue that the current reserve system cannot sustain all regional biota. Additional lands must be protected, and they assert that lands high in biodiversity, large in area, or suitable for ecological restoration should receive higher priority than others. General principles of conservation planning and of conservation biology are reviewed and discussed in the context of ecosystem management within the redwood region. Ecosystem management is advocated as an efficient alternative to species management. A conservation planning strategy is presented for the redwood region. The objective is to create a network of reserves connected by corridors. Many steps in selecting focal areas for land conservation in the region are discussed. This chapter easily stands alone as a case study in contemporary conservation planning.

Chapter 8 is devoted to redwood forest management practices. Dale Thornburg and 5 co-authors review past, present, and future forestry practices and their consequences. They begin by outlining 4 key points. The first point is that we must try to protect the old redwood forests that remain (ca. 5 - 7% of original historic land area). This may require more than just preservation. Periodic burning and removal of exotic plants is required to maintain a pre-European character. A second point is that structural legacies such as logs and snags should be retained after timber harvests. This improves ecosystem resiliency. Third, since the acquisition of all private lands is not feasible, decisions on which lands to protect, restore, or manage must be made carefully. A final point is that truly sustainable forestry practices must be developed. The authors argue that current practices are not working, especially in regard to aquatic and riparian ecosystems. The authors claim that new rules to improve the effectiveness of riparian forest buffers are essential. Old forestry practices include even-age and uneven-age systems. Even-age systems, characterized by clear-cutting, still prevail. Uneven-age systems, involving the removal of overstory trees in patches up to 1.2 ha in size, are also used. A potential drawback to this practice is that if patch sizes are too small, redwood regeneration is greatly diminished. New practices include: (1) a shifting mosaic of variable-size patch cuts; (2) single-tree selection with late-seral habitat; (3) short rotations with green-tree retention; and (4) structural retention cuts. All of these practices are designed to allow timber extraction while maintaining at least some structural aspects of old redwood stands. These approaches are in the experimental stage and in some cases they are highly controversial. For these reasons monitoring and adaptive management must be employed.

In the closing chapter Reed Noss states that the redwood forest ecosystem is endangered and requires more conservation work. Sound science will help guide the effort. Many of the major scientific findings and recommendations presented by the book's 33 contributing authors are summarized briefly for quick reference and review.

On the whole this is a very good book. Unlike many edited volumes, it is cohesive and well planned. A glossary (which unfortunately excludes several acronyms and technical terms), a species list with common and scientific names, and an extensive list of references help make it of value to a wide audience. The book is about much more than the redwood forest. It covers the latest scientific information on redwood forests quite well, but it is also a good account of ecosystem management in coniferous forests of the Pacific Northwest in general. Furthermore, it presents an educational example of how science can be an integral part of conservation planning.

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Beerling, D.J. & Woodward, F.I. 2001. **Vegetation and the terrestrial carbon cycle: Modelling the first 400 million years**. x + 405 pp. Cambridge University Press, Cambridge. ISBN 0-52-180196-6. Price: USD 150.-.

For some time now, many of us have been on a quest to find out how the world works as a global ecosystem. David Beerling & Ian Woodward share that vision, and with this book they take the reader on a long and rewarding journey toward that goal. Their approach of using mathematical models of photosynthetic production and general circulation computer models of global climate is now appearing in bits and pieces in many journals, each contribution easily dismissed for dubious or poorly stated assumptions. This book length treatment is thus welcome, presenting in detail a complex and intriguing mathematical jewel, with many glittering and attractive faces, but also some sides that remain rough and flawed. As equation followed equation and acronym followed acronym, I found myself longing for a simple box or glossary with all the fundamental units and their relationship laid out. This is not an easy read, but a performance demanding all of one's attention.

I was particularly surprised to find that global circulation models do not model land or ice separately, but treat them as modified ocean. Soil fertility is not included in the vegetation models, because nitrogen (not phosphorus or iron) is assumed to be the fundamental nutrient. Animals play little role in the models either, even though the results show that soil respiration is an important influence on climate. The reasons for this lack of attention to soil and animals are more historical than logical, because the circulation models have arisen from oceanographic and atmospheric sciences, rather than from soil, animal, and plant science. Beerling & Woodward counter this emphasis on geophysical approaches with a clear demonstration that plants are critical to world climate. In my opinion, the models have not yet gone far enough to include soil and animal parameters, and these rough faces will need considerable cutting and polishing in years to come.

Other surprises abound in this thought provoking volume. Beerling & Woodward argue that carbon storage in Carboniferous soils and plants was low compared with the Jurassic. I would have thought it the other way around considering the abundant red paleosols of the Jurassic compared with the coals of the Carboniferous. Their quantification of moderate productivity, slow decomposition and high photorespiration in the Carboniferous, however, does make clear that counterintuitive results are possible in a complex multicomponent system.

Another surprise to some will be extensive deserts in models of Eocene time, when maps of paleovegetation based on paleobotanical data tend to show extensive rainforests. The dry regions are amply supported by evidence from evaporites, fossil mammals and paleosols. The global approach of the models is a useful antidote to simplistic climatic reconstructions showing little local variability.

In a final chapter, Beerling & Woodward apply their models to predict a future of plant productivity and carbon sequestration peaking in 50 - 100 yr time, after which human emissions of carbon dioxide have the potential to outrun other biotic controls. They are thus not fans of the Gaia hypothesis, arguing that dramatic Carboniferous atmospheric oxygenation also undermines the concept of biotic control of climate. However, even loose biotic control can still be effective.

Beerling & Woodward take us on an interesting and challenging journey with this book, and I suspect that they would be the first to admit that the destination of this research is still well over the horizon. This is not a book to read, glean a few ideas and return to the library. The fundamental equations and colour maps of paleoclimate and vegetation make this an important reference and guide to the burgeoning literature of climate and vegetation modeling.

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Podani, J. 2000. **Introduction to the exploration of multivariate biological data**. vi + 407 pp. Backhuys Publishers, Leiden. ISBN 90-5782-067-6 (softbound). Price: USD 52.50.

In the late 1960s, numerical methods in ecology were a fashionable area of study. Now they are much less fashionable, but we are well served with textbooks. Pre-eminent among these is the monumental *Numerical Ecology* (Legendre & Legendre 1998), whose 853 pages make Podani's book appear quite terse by comparison. Like the Legendres' book, Podani's is translated and revised from an earlier edition in another language. In both cases, the English is so good that this fact would not be noticeable if it had not been made apparent on the copyright page.

Both books have rather similar subject matter, with large parts devoted to similarity and dissimilarity coefficients, clustering methods and ordination. Podani deals not only with ecological data, but also with problems in cladistics and morphometrics. There is much mathematical detail on algorithms and comparison of methods. Relatively little attention is paid to problems that have recently been addressed by vegetation ecologists. Omissions that spring to mind are the analysis of plant traits in relation to species and environment, the scaling of species on pre-defined environmental gradients, the use of phylogenetically independent contrasts and the assignment of new data to existing classifications. These problems do not always require exploratory analysis, but are the practical problems that many vegetation scientists need to address. Other important but omitted multivariate problems are the use of species data to infer values of environmental variables (e.g. diatoms to measure pH and temperature), the analysis of remotely-sensed images, and the measurement of biodiversity.

For the most part, these problems are less abstract than the traditional problems of ordination and classification. To solve them, mathematicians must incorporate a relatively large amount of biological and environmental information. In particular, models of the response of species to environment, of patterns of environmental variation, and of the links between traits and phylogeny must be incorporated.

There is of course still a large requirement for the less specific methods that are presented by Podani in this book. It is a learned book, well researched, with detailed information on historical origins of methods and good clear explanations. The mathematical level is generally rather high, although in some cases such as the computational steps of correspondence analysis, the reader is invited to skip the mathematics.

An intriguing and unusual feature is that each chapter ends with a dialectic, in which the merits of methods are discussed by a sceptical reader and the (sometimes rather defensive) author. Such dialectic is normally more the method of philosophers such as Imre Lakatos (1976). This reviewer found it entertaining at first but less delightful after a few chapters. Nevertheless, it does provide an informal and often wise commentary on the text. Here is an example.

Q: "*Is there any method which will always produce unique results? Is it really important that the final result be unique?*"
A: "From a mathematical viewpoint, algorithmic uniqueness is an important criterion. In applied studies, however, this is not necessarily so. ..."

In summary, this is an attractive but rather limited book. Specialists in numerical methods will want to consult it, as will lecturers preparing courses. But for most readers of our journal, a textbook that directly addresses the problems of vegetation science would be preferable.

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Erratum

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The listing of species in the published tables 1 and 4 are incorrect due to a database error. A corrected version of both tables (in PDF format) is available at: http://www.opuluspress.se/pub/2271t14.pdf
A corrected PDF file of the entire article is available at: http://www.opuluspress.se/pub/12.553-566.pdf