

## BOOK REVIEWS

**The Simple Science of Flight/From Insects to Jumbo Jets.**—Henk Tennekes. 1995. The MIT Press. Cambridge, Massachusetts. x + 152 pp., 80 text figures. ISBN 0-262-20105-4. \$20.00 (cloth).

From the tiniest insects to the largest aircraft, all things that fly obey the same aerodynamic principles. Regardless of size, structure, or energy source, they must all find ways to generate lift and minimize drag. Mechanics of flight and means by which various flying creatures, devices, and aircraft comply with those physical laws are the subject of this book.

The author is a professor of aeronautical engineering with an interest in flying animals, and is not a zoologist. He takes delight in showing us that the basic physics of flight is not formidable and that it explains a lot about how animals and machines fly as they do. He begins by setting forth the fundamental factors that govern flight and explaining relations between them. This opens the way for a comprehensive diagram that plots various flying animals and aircraft ranging from a fruit fly to a jumbo jet according to weight, cruising speed, and wing loading. The chart presents a lot of data in a form that allows ready comparisons and study. A crane fly and a House Wren (*Troglodytes aedon*), for example, turn out to have the same weight/wing loading relationship as a 747 jet airplane, and many other fliers are close to the trend line. It is worthwhile to see which other animals and aircraft deviate from it (e.g., pteranodon, Ruby-throated Hummingbird, *Archilochus colubris*) and ponder why.

Tennekes next takes up the energy cost of flying for birds and airplanes in different modes of flight. This leads him to examine energy values of various fuels and foodstuffs and efficiencies of different energy conversion processes. As before, reducing entities to basic physical units yields some surprising comparisons. Whole milk, for instance, is more than twice as expensive as peanut butter in terms of cost per unit of work (megajoules), five times as expensive as vegetable oil, and more than thirty times as expensive as kerosene or diesel oil. A discussion of the food required by migrating birds links costs of flight with sources of energy. Since fat yields twice as much energy as sugar, most migrants eat heavily before and during their trip to build up their fat deposits.

The next chapters examine effects of wind and weather on flying, physics of gliding and soaring, dynamics of taking off and landing, and balance of forces and their relation to speed in flapping and gliding flight. The relationships between physical factors explain a great deal about why different birds fly as they do. Alcids, for example, fly much faster and less maneuverably than gulls because they must flap their relatively smaller wings more rapidly to generate enough lift. Another intriguing diagram compares gliding performance of various butterflies, birds, and aircraft.

Lastly, Tennekes draws lessons from paper airplanes, ultralight aircraft, and jumbo jets. He leads the reader through the basic calculations of flight parameters to show how the design construction of the first

ultralights was arrived at. Turning to the 747, he repeats the exercise, adding fuel consumption and economics of transportation to the design considerations. The author champions this airplane as one of the great engineering wonders of the world. Because it is the only jetliner that conforms to strict engineering logic, it is more productive and economical than any other means of transportation.

The book is aimed at lay readers and it succeeds. While instructive and mildly technical, it is not a textbook of aeronautics. The writing is clear and inviting, enlivened with personal asides and anecdotes. Physical concepts are defined and freely referred to, but in such a way as not to scare off non-engineers. The numerous simple equations and diagrams are understandable with no more than high school math. One is led through them with explanations as to how the values are derived. (Even this mathematically-challenged reviewer was able to follow them.) It would have been helpful to have repeated all definitions and symbols in a glossary at the end.

Several other books are comparable in giving the fundamentals of aeronautics. This one stands out, however, in showing some of the similar and different ways in which animals and machines solve the problems of flight. Its approach of reducing these problems to basic physical units (e.g., weight, wing area, energy, speed) makes it possible to compare diverse fliers over a wide size range, giving fresh insights into their design and performance.

One weakness is that causes of lift and drag are never explained and there are no diagrams of airflow around a wing. The surface/volume ratio and the effects of scale are inadequately discussed. The writing is anthropomorphic in places, e.g., "courageous" little migrant passerines. Differences in the modes of soaring of albatrosses, vultures, and gulls are ignored, and generalizations about "the hummingbird" and migrant passerines result in some questionable statements.

An appendix tabulates weight, wing area, wingspan, and cruising speed for many birds, compiled from the literature. These data are valuable because they enable readers to do their own calculations and comparisons. The species are listed in order of ascending weight, which makes sense to an engineer but not to an ornithologist. Regrettably, many of the scientific names are obsolete or misspelled.

The layout is attractive, thanks to generous use of space. In addition to charts and diagrams, the book is illustrated with simple black-and-white drawings of seeds, insects, birds, and aircraft in flight. Although the drawings are captioned with flight data from the appendix, they are largely decorative because most of them are not referred to in the text.

The bibliography is short but adequate for steering interested readers into the literature. C. J. Pennycuick's name is misspelled, as it is in the text.

This book is a good, readable primer on the basics of how things fly. Readers who want to learn the operation of the wings in insects and birds, the different

kinds of flight in birds, and the suite of adaptations for avian flight will have to seek elsewhere, such as Georg Ruppell's *Bird Flight* (1977, Van Nostrand Reinhold). The present book's strength lies in its approach to evaluating flight performance and the resulting comparisons between insects, birds, and aircraft. One can find here ideas for teaching and thinking about the evolution of animal flight.—PETER STETTENHEIM, HC 64, Box 255, Lebanon, NH 03766-7607, e-mail: peter.stettenheim@valley.net

**The Minds of Birds.**—Alexander F. Skutch. 1996. Texas A&M University Press. College Station, Texas. xvi + 183 pp., 42 illustrations. ISBN 0-89096-671-0 \$29.95 (cloth).

Natural history and ecology provide vital information for all ornithologists. While this is most obviously true for those working in the field, it also is true for those working in the laboratory. The best laboratory research is informed by knowledge of lives of animals outside the laboratory. This is particularly true in the case of behavioral research. One of the areas in which that connection may be particularly important is the study of the cognitive abilities of animals. Field workers often observe behaviors that imply impressive cognitive abilities, and those observations have served as the source of important hypotheses about animal cognition which have, in turn, stimulated experimental research.

In this book, Alexander Skutch presents a large number of informal observations, most from his many years of watching birds, supplemented with observations by others. Those personal observations also are combined with some examples from the extensive experimental literature on avian cognition. Taken together, Skutch suggests that these data bear on the possibility that birds have a rich psychic life. However, the most valuable parts of the book are those based on Skutch's own observations. Skutch uses his many years as a keen observer of birds to assemble this book, in which he relates many observations that he feels are potentially informative about the mental lives of birds.

The book is organized into 17 chapters, with titles such as "Emotions," "Play," "Aesthetic Sense," "Dissimulation," and "Freedom and Altruism." As these chapter titles suggest, the organization of the book is somewhat scattered and the incidents described vary widely in their nature. Some incidents that Skutch relates are interesting, but most qualify as little more than anecdotes. It is difficult, if not impossible, to interpret the importance or meaning of most of them.

It could be argued that this is inherent in the anecdotal nature of this kind of evidence, and there is some truth to that argument. But for anecdotes to make maximal contributions, they must be interpreted in terms of relevant scientific information. Unfortunately, although Skutch attempts to integrate some anecdotal information with the more formal literature on animal cognition, he is not very successful.

In summary, this book is occasionally fun to read, with some interesting anecdotes. But it is poorly organized and very uncritical in its interpretation of the evidence. It would be of little value for the profes-

sional. And it could be seriously misleading to the beginning student in its suggestion that complex issues can be resolved through the collection of anecdotes.—ALAN C. KAMIL, School of Biological Sciences, University of Nebraska, Lincoln NE 68588-0118, kamil@niko.unl.edu

**Birds of Tropical America: A Watcher's Introduction to Behavior, Breeding and Diversity.**—Steven Hilty. 1994. Chapters Publishing Ltd. Shelburne, Vermont. 304 pp., 12 black-and-white illustrations and color cover illustration by Mimi Hoppe Wolf. ISBN 1-881527-56-5. \$12.95 (paper).

Tropical bird ecology is a fascinating and complex subject that ornithologists are just beginning to unravel. Differences between tropical and temperate zone bird communities are numerous and striking, and much of our North American experience regarding avian community structure, spatial distribution, degree of habitat specialization, social interactions, mating strategies, and breeding ecology is not applicable when attempting to understand patterns in tropical bird communities. The study of birds in the New World Tropics primarily has spanned the last 60 years, beginning with the works of Alexander Skutch and Alexander Wetmore, and picking up speed through the 1970's and 1980's. Excellent field guides now exist for birds of most regions in the Neotropics. However, apart from those field guides, few books have provided a synthesis of information gathered on ecology and behavior of tropical birds. With this book, Hilty continues in the footsteps of Skutch and artfully summarizes the current knowledge about birds of the Neotropics.

In the preface, Hilty immediately draws the reader into the exhilaration, exasperation, and adventure of the tropics. Anyone who has birded, explored, or conducted research in tropical countries will identify instantly with the experiences that Hilty conveys in this introduction. The 20 chapters provide excellent coverage of the primary issues in tropical bird ecology, ranging from why tropical communities are so diverse, to evolutionary and ecological bases for different social systems, to elevational migrations and other intratropical movements, to ecology of different trophic guilds. In addition, Hilty delves into ecology and behavior of particularly interesting or well-studied avian groups, including army ant followers and communities on dynamic river islands.

Each chapter provides a stand-alone treatment of a particular issue, but related topics tend to appear in adjacent chapters providing a logical, if fairly loose, flow in presentation. The first four chapters address issues of community structure, diversity, biogeography, and phylogeny. Next are several chapters covering issues of migration and flocking, followed by chapters on plumage coloration, frugivory, and frugivore ecology. Manakins, hummingbirds, flycatchers, vultures, and caciques all receive special attention in separate chapters, and the final chapters examine questions of communication and breeding ecology. In each chapter, Hilty provides thorough coverage of the subject in a concise, yet readable way. The result is both informative and entertaining. Mimi Hoppe Wolf's black-and-white illustrations are excellent. Birds and

plants depicted are realistic and the scenes are so richly detailed that the absence of color is not noticed. Captions could have been arranged in a more aesthetically pleasing manner, but overall the illustrations are a considerable asset to the volume.

Written as part of The Curious Naturalist Series of Chapters Publishing Ltd., the book is geared largely toward a lay audience of advanced bird enthusiasts or weekend explorers. However, perhaps most impressive is that Hilty has skillfully bridged the gap between scientific and popular writing. Information usually is presented as a synopsis of one or several landmark research projects that have shed the most light on the subject of interest. Although the stories are told in a tidy, simplified manner, they are not so oversimplified as to be too pat or inaccurate. Hilty points out complexities of most issues as well as indicating areas where we simply need more information. The bibliography offers a few key references for each chapter, sufficient at least to point a graduate student or other scientifically-oriented reader in the right direction.

The geographic focus is primarily southern Central America and South America, with some examples from the Caribbean. Within this region, the representation of research projects is relatively well-balanced; roughly equal numbers of researchers from Central and South America are mentioned. Occasionally the glorifying praise of individual researchers seemed a bit excessive. In addition, it may have been worthwhile to point out that although past research on tropical birds was conducted mostly by North American and European scientists, that torch has been passed to many excellent Latin American researchers—those who ultimately may have the most personal stake in the study and preservation of tropical birds.

One disappointment may be in the abrupt, somewhat anticlimactic ending of the book. The final chapter on breeding ecology, although interesting, neither opened new possibilities nor gave particular meaning to previous chapters. It simply was the last chapter. The end. Just as the preface opened up the world of tropical birds, a short epilogue or general concluding section might have reaffirmed a broader context for the study of tropical birds, whether it be simply to gain further understanding of these fascinating and complex communities, or as a necessary step toward the preservation of fragile and threatened tropical ecosystems.

The book does not specifically address conservation of tropical birds except for a few references to the sensitivity of some species to habitat change. On one hand, this sets the volume apart from the profusion of scientific and popular articles that focus on conservation issues. Certainly the lack of a specific conservation theme does not lower the value of the volume. Yet, it would seem to be a missed opportunity to highlight the severity of threats to tropical birds and the urgency with which we must learn about these fascinating animals to know how best to mitigate the impending danger to their survival. Perhaps this could have served as the epilogue suggested above.

Apart from these relatively minor considerations, *Birds of Tropical America* offers a comprehensive look into the lives of some of the most fascinating birds in the world. The book will entertain and educate the

amateur birder and professional ornithologist alike, and would be a valuable addition to libraries at home and university.—LISA J. PETIT, Smithsonian Migratory Bird Center, National Zoological Park, Washington, DC 20008.

**Bird Life of Woodland and Forest.**—Robert J. Fuller. 1995. Cambridge University Press, Cambridge, U.K. xiii + 244 pp. ISBN 0-521-33118-8. \$65.00 (cloth).

This is the third of a projected six-volume series on British habitat-specific bird life edited by Christopher Perrins. Like so many active researchers in avian ecology, Robert Fuller started as a young untutored "log-turner" curious about nature, in his case, in the Chiltern Hills of southern England. He now holds an influential place in matters relating to the function and conservation of British woodlands and their birds. Here, Fuller takes a step back from reporting his research in the primary technical literature and summarizes for the informed amateur the current state and future prospects of forests and woodlands in the U.K. and, to a lesser extent, mainland Europe. He first presents an introductory overview focused on historical effects of human activity from destruction of ancient broadleaf woodland beginning millennia ago to precipitous afforestation with exotic conifers during the mid-twentieth century. He then considers, in turn, bird populations in each of several woodland or forest types, and ends with a prospectus for the future of British woodlands and their conservation.

Chapter 1, Britain's Woodland Environment, leaves a North American with the overwhelming impression that little remains of natural woodland in the U.K. I read much of the book while being driven across Pennsylvania on I-80, a journey of several hundred km through the world's largest broadleaf deciduous forest. At any time I looked out the window, I could see thousands of downed logs and branches, virtually none of which exist in the heavily managed woodlands of Britain. Dead trees were ubiquitous in Pennsylvania, whereas virtually none occur in British forests, and I believe that at any one time I could see more broadleaved woodland than occurs in any county in England. So, it is hard for North Americans to appreciate how rare and precious are the remnants of native woodlands in Europe. (In southwest Sweden, a 20-ha woodlot of large broadleaved deciduous trees is so rare and valuable that it has been designated a national park. Twenty hectares!) Perhaps, the value of woodlands in Britain is better appreciated by the Midwesterners of North America who live in country only 5–10% forested, about the same percentage holding over much of England.

A major development prompted by the wood famines of the two World Wars has been the extensive introduction of conifer plantations. By 1980, about 1,400,000 ha of broadleaf woodland and heathland had been replaced with conifers in Britain, leaving only 500,000 ha remaining in broadleaved forest and 50,000 ha in coppice, the latter a type of woodland where forest is maintained in essentially a permanent shrub stage by continual cutting of stump sprouts.

The term, ancient woodland, is used to describe

broadleaf forest existing continuously since at least 1600 AD. Such woodlands have the greatest biodiversity and are therefore of most importance for conservation efforts. In addition to "high forest," formerly maintained primarily as royal hunting preserves, and the coppices just noted, broadleaf woodland is composed of "wood pasture," the product of a clever technique in which trees are cut, or "pollarded," about two meters from the ground every 20 years or so. The resulting "stump sprouting" to produce another crop of wood can then proceed out of reach of livestock grazing in the wood. Burnham Beeches, a public park on the outskirts of London, contains many huge old pollarded beeches, the remnants of such a woodpasturing system.

Chapter 2, *Historical and European Perspectives*, traces the history of forest in the western Palearctic from 7,800 years before present when Britain, newly separated from Europe, was essentially completely covered with forest until the 1950–1980 epoch, when forest cover reached its lowest extent, about 10%. Such fragmentation and destruction of woodland is discussed in relation to concurrent loss of woodland avifauna as well as increases in birds of more open habitats.

Chapter 3, *How Birds Use Woodland*, is a digression into population ecology, focusing in general terms on causes and demographic responses that lead to population change. Fuller then treats ways that avian species populations may interact via competition and predation to produce existing numbers of species and individuals in each type of woodland habitat. I found intriguing his postulate that natal dispersal will be greater in birds of successional stages than in those of climax woodland communities, an idea that he says has not yet been properly tested.

In Chapter 4, *Abundance and Distribution of Woodland Birds*, Fuller works through possible causal factors for where and in what numbers woodland birds are found. We are led from large scale latitudinal and altitudinal effects, through landscape-scale causes such as the isolation and connectedness of woodlands, to intra-woodland effects such as woodland size and vegetational composition. Fuller thinks that isolation will have little relevance to birds because of their extreme mobility, but suggests that such highly sedentary species as nuthatches and some tits could be exceptions. A recurring theme here and throughout the book is the call for demographic data. Whether a woodland is a source or a sink cannot be determined by censusing.

Chapters 5–8, respectively, detail the avian communities found in Fuller's four main woodland types, scrub, broadleaved high forest and coppice, upland woods and woodpasture, and coniferous woodland. Interestingly, enough scrub, or oldfield, habitat currently exists in Britain to be considered a separate class of woodland, a condition that has not existed in North America since the opening of the Erie Canal precipitated the collapse of eastern agriculture by flooding east coast markets with cheap midwestern grain.

Chapter 9, *Woodland in a Changing Countryside*, ends the main text by speculating on the future of British woodlands and woodland birds. (Two appendices present annotated lists of British, and then non-British

European, woodland birds.) Fuller relates that in The Netherlands, one of the world's two or three most densely populated countries, there is mounting evidence that the simple intensity of "noninvasive" human use is adversely affecting bird populations in the few wooded remnants scattered about the landscape. Evidence of such benign abuse is now being seen in Britain as well.

As I looked out across our magnificent eastern deciduous forest during my recent drive, I found it hard to imagine anything approaching the loss of European broadleaved woodland happening here. But then I realized what could happen if, after all the petroleum has been extracted and all the coal has been mined, we, like the British of the Middle Ages, must run our industrial plant on charcoal.

Greatly enriched by the sketches of Chris Rose, this book presents a fine nontechnical introduction to the ecology and conservation biology of British woodland birds. It deserves a place in undergraduate, community and personal libraries.—THOMAS C. GRUBB, JR., Behavioral Ecology Group, Department of Zoology, The Ohio State University, Columbus, Ohio 43210-1293, grubb.1@osu.edu

**Ruddy Ducks & Other Stiffetails: Their Behavior and Biology.**—Paul A. Johnsgard and Montserrat Carbonell. 1996. University of Oklahoma Press, Norman, Oklahoma. xiv + 291 pp., 15 tables, 33 figures including 16 color plates. ISBN-0-8061-2799-6. \$49.95 (cloth, hard cover).

Anyone who has had the opportunity to watch courting male Ruddy Ducks (*Oxyura jamaicensis*) perform their "bubbling display" should have no difficulty understanding the authors' fascination with oxyurines ("stiffetails"). Stiffetails truly are a fascinating group of birds exhibiting many features that are unique among waterfowl. For example, they are facultative to obligate nest parasites, lay large eggs relative to their body size, have polygynous mating systems, and have two simultaneous wing molts per plumage cycle. Motivation for writing this book also stems from the authors' concern about recent losses and degradation of stiffetail habitats and lack of information on distribution, population status, and life history characteristics of some species.

Six of eight stiffetail species are found in the Southern Hemisphere; consequently, we know very little about them compared to other waterfowl groups. *Ruddy Ducks & Other Stiffetails: Their Behavior and Biology* provides a very thorough review of published and unpublished information on stiffetails through about 1992. The book's title reflects the relative wealth of information on Ruddy Ducks and probably was selected to appeal to North American readers unfamiliar with other members of the group. The authors devote the first half of the book (Chapters 1–5) to reviews of stiffetail phylogeny, morphology, behavior, and breeding biology; the second half of the book (Chapters 6–13) consists of eight individual species accounts. The book also contains a glossary, identification key, list of references including some recent literature that was not used in the text, and a detailed index of authors and subjects. Clearly, the book's strong point is its de-

scription and comparison of stiff-tail behaviors supported by over 40 high quality illustrations. The authors' extensive, first-hand knowledge of waterfowl behavior is evident as they do an excellent job of framing various aspects of stiff-tail behavior in the context of closely related species and groups. The book also provides an informative account of the history of stiff-tail taxonomy and classification, ranging from pre-Darwinian classification to modern cladistic analyses. The authors carefully highlight the central issues and points of controversy surrounding stiff-tail phylogeny. Namely, are they descendants of an ancient lineage as immunological and molecular data suggest or have they evolved contemporaneously with sea ducks (Tribe Mergini)? How are *Biziura* and *Heteronetta* related to other group members? Are they properly included with the stiff-tails or do they represent transitional links to other groups? What are the relationships of various *Oxyura* species to each other? Does the Masked Duck (*O. dominica*) warrant generic separation? Throughout the book, the authors do a good job of identifying information needs for the group.

My major criticisms of the book concern its organization and dependence on studies of captive birds. Organization of Chapter 3 (General Behavior and Ecology), Chapter 4 (Comparative Social and Sexual Behavior), and Chapter 5 (Reproductive and Population Biology) was somewhat confusing with extensive overlap in content among chapters. Likewise, species accounts could have been organized to improve reader access to information and more effectively highlight the group's unique features. Furthermore, given the authors' stated concerns about conservation of stiff-tails, a chapter or section within species accounts devoted to conservation biology would have been appropriate.

Because of the lack of information on free-ranging birds, there was a strong reliance in this book on captive studies. The authors generally were very candid about potential shortcomings of captive studies; nonetheless, they should have been more selective when reporting structural measurements, time-activity budgets, timing of annual cycle events, breeding chronology, molt and plumage descriptions, rates of nest parasitism, nest site characteristics, nutrition, or clutch size for captive birds. For example, Figure 10 showing timing of annual cycle events for six stiff-tail species held in captivity in Great Britain is of very limited value and potentially misleading. Similarly, molting patterns clearly differ for captive and free-ranging birds (e.g., prevalence of double wing molt; Hohman, 1996, *Southwest. Nat.* 41:195-198).

Other criticisms of the book include incomplete statistical summaries (e.g., no estimates of variance provided), inconsistent and sometimes inaccurate use of references, numerous typographical errors and omissions, incomplete descriptions of methods and data sources (e.g., captive vs. free-ranging birds, methods of quantifying behavior or food selection), and speculative treatments of some topics (e.g., competition, tail function). Although published in 1996, it is evident from the literature cited that the manuscript was actually completed much earlier, probably 3-4 years before publication date. Consequently, some recent publications on stiff-tails (e.g., nutrition, Alisaus-

kas and Ankney, 1994, *Condor* 96:11-18; molt, Hohman, 1993, *Can. J. Zool.* 71:2224-2228) were not included in the book. Understandably, publication delays of 3-4 years are common.

In spite of the above shortcomings, the book represents an important resource for information on stiff-tails and I recommend it for research libraries and professionals interested in stiff-tails or comparative behavior and evolution of life history traits in waterfowl. The book is probably too technical for most nonprofessionals, but use of the book by such readers will be facilitated by the glossary.—WILLIAM L. HOHMAN, USGS/BRD, National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA 70506-3152, e-mail: hohmanb@osprey.nwrc.gov

**A Primer of Conservation Biology.**—Richard B. Primack. 1995. Sinauer, Sunderland, Massachusetts. 277 pp. ISBN 0-87893-730-7. \$19.95 (paper).

**Conservation and Biodiversity.**—Andrew P. Dobson. 1996. A Scientific American Library Volume. W. H. Freeman, New York. vii + 264 pp. ISBN 0-7167-5057-0. \$32.95 (cloth).

**Conservation Biology (2nd ed.)**—George W. Cox. 1997. William C. Brown, Publishers, Dubuque, Iowa. xvi + 362 pp. ISBN 0-697-21814-7. \$32.00 (paper).

**Conservation Biology in Theory and Practice.**—Graeme Caughley and Anne Gunn. 1996. Blackwell Science, Cambridge, Massachusetts. xii + 459 pp. ISBN 0-86542-431-4. \$46.95 (paper).

**Essentials of Conservation Biology.**—Richard B. Primack. 1993 (new edition in Fall 1997). Sinauer, Sunderland, Massachusetts. xiv + 564 pp. ISBN 0-87893-722-6. \$41.95 (cloth).

**Fundamentals of Conservation Biology.**—Malcom L. Hunter, Jr. Blackwell Science, Cambridge, Massachusetts. xiv + 482 pp. ISBN 0-86542-371-7. \$46.95 (paper).

**Principles of Conservation Biology.**—Gary K. Meffe and C. Ronald Carroll. 1994 (new edition in Summer 1997). Sinauer, Sunderland, Massachusetts. 600 pp. ISBN 0-87893-519-3. \$51.95 (cloth).

In the last few decades, it has become increasingly evident that human consumption of natural resources has reached an unprecedented level. It is estimated that humans as a species appropriate as much as 40% of all energy fixed by photosynthesis. This astounding figure has no parallel in the history of life on this earth. Organismal biologists and ecologists are one of a small group of scientists in society that are faced with the challenge of documenting the impacts of this human consumption on the rest of the species that inhabit the earth. Along with this scientific challenge comes a responsibility to help society act appropriately to the impacts this consumption is having and will continue to have.

Among the myriad of needs that the increased concern with conservation places upon university scientists is the training of young scientists who have the tools to apply their knowledge of ecology and biology to conservation issues. An additional responsibility is the exposure of professionals in fields other than biology to the fundamental facts and issues that surround current conservation debates. Each of these teaching

responsibilities will require different approaches. The books reviewed herein each have strengths and weaknesses that make them more appropriate for one of the other of these activities.

It is not entirely clear what the span of conservation biology, as a discipline, should be. Is it a synthetic field of science with unique questions and theories that stands alone, or is it simply an interface between more established fields such as ecology, wildlife management, and biogeography? Perhaps the answer to this question is more of academic than practical interest. However, because conservation biology is a relatively young field of interest, the uncertainty associated with a lack of a fixed identity for the field shows up in the variation in coverage of topics among the texts reviewed here.

Given these uncertainties regarding what should and should not be part of conservation biology, I examine the books from the viewpoint of how they might best be used in teaching. The books listed above come in two general classes. The first are books appropriate for a general education class of nonbiological sciences majors in conservation biology. This group includes Primack's *Primer of Conservation Biology*, Dobson's *Conservation and Biodiversity*, and Cox's *Conservation Biology*. The four other texts are appropriately designed for students with some experience and background in biology and ecology.

Of the general education texts, perhaps the most basic is Dobson's. The production of this book is clearly intended for a general audience. There are abundant, colorful pictures and graphs, many of which are simplified to enhance their message. As is the style of the magazine *Scientific American*, figures and pictures are not numbered. A short bibliography is found at the end of the book, but sources are not directly quoted in the text. The writing avoids technical jargon and is conversational in its flow, making it a pleasant and easy read. The conservation focus of the text is evident from the Prologue, where Dobson suggests the thought experiment of sitting in a wheat field and then in a Peruvian rainforest. The taxonomic simplicity of the wheat field is contrasted with the taxonomic complexity of the rainforest. The comparison here is overly simplistic, perpetuating the assumption that agroecosystems are simple, monotonous, and uninteresting. This is unfortunate, because it is in these highly impacted ecosystems where conservation biology might have its greatest impact. Throughout the text Dobson is quick to point out how economic decisions often dominate and over-ride science when conservation decisions are made. Although this is probably true more often than not, Dobson's approach borders on being mildly polemic. Given that this book will find its home in academia primarily as a general education text, it might have been better to approach such controversies from a less emotional viewpoint. From the perspective of sympathetic students, Dobson's propensity not to pull punches when dealing with hard issues will endear the book to many. Critical students with certain political biases, however, might attempt to dismiss it as being motivated more by liberal environmentalism than scientific fact.

Primack's *Primer* is more of a textbook. It is based

on the more detailed *Essentials of Conservation Biology* discussed below. Most teachers of general education classes will feel more comfortable with its style. All artwork and photography is black and white, but figures are referenced throughout. Most of the text includes citations to primary literature, and each chapter ends with a list of suggestions for further reading. The level of detail in this text may turn off students from nonscientific disciplines, but the information is well organized and accessible. The writing is more formal and even handed. Nonbiologists will get a well-rounded view of conservation biology, although they might consider it a little stuffy.

*Conservation Biology* is a revision of Cox's earlier *Conservation Ecology*. The content of this revision is similar to other conservation biology texts with one major difference. In addition to discussing principles and ideas, Cox spends a major portion of the book (about 200 out of 350 pages) describing terrestrial and aquatic ecosystems and special problems encountered in managing and conserving these ecosystems and the biosphere. In these chapters he deals with topics often covered in environmental science texts (pollution and global climate change) and wildlife ecology texts (predator ecology and management). This makes this text broader than the other two that I consider candidates for nonmajors' courses in conservation biology. Teachers that want to provide nonmajor students with a broad exposure to specific kinds of ecological systems and their related conservation problems will be interested in using this text.

Of the four texts that appear to be designed for a course in conservation biology appropriate for biology majors, perhaps the most specialized is Caughley and Gunn's *Conservation Biology in Theory and Practice*. This text deals nearly exclusively with the process of extinction. As such, it deals nearly exclusively with problems of small or declining populations from a demographic perspective. Starting with a chapter on the tools of science, Caughley and Gunn then spend two chapters on prehistoric and historic extinctions. A chapter examining case studies of small and declining populations follows. It is significant to note that with the exception of one butterfly, all of these case studies are of vertebrates. Of the 17 vertebrate case studies, only one is not a bird or mammal. Two chapters deal with demographic theory. Only a short section of 15 pages in this part of the book deals with genetics of small populations. Chapters on risk assessment, diagnosis, and treatment of declining populations provide some very well written detail on some essential tools needed by biologists in managing small or declining populations. A chapter on reserve theory and design rounds out the discussion of biological aspects of conservation biology. Curiously, this chapter is the only one to deal with issues of biological diversity. The last two chapters deal with economic and political aspects of conservation biology. The strength of this textbook is its focus on conservation of local populations, but in doing so, it fails to discuss other issues some instructors will find important.

*Essentials of Conservation Biology* by Primack, and Hunter's *Fundamentals of Conservation Biology* both share a similar design and framework. Both begin by

focusing on definitions of biological diversity and conservation biology. Hunter's treatment is a little more sophisticated, introducing the idea that biological diversity is a hierarchical concept. Hunter spends a chapter each discussing species, ecosystem, and genetic diversity, whereas Primack's discussion is more generic. Both texts then go into a discussion of threats to biological diversity, each drawing on both theory and examples. Each author emphasizes slightly different things, but both include discussions of extinction, habitat loss and degradation, and problems of exotic species and overharvesting. At this point, the texts diverge somewhat. Hunter devotes four chapters to the topic of maintaining biological diversity and covers the topic from both ecosystem and population perspectives, focusing on practical techniques of captive propagation and priority setting. Before dealing with practical issues, Primack devotes three chapters to the difficult topic of valuing biological diversity. He then discusses conservation of populations in two chapters before a full six chapters on applications. These six chapters provide perhaps the broadest discussion of the variety of issues related to applied conservation biology of all the texts I reviewed, but was less detailed than others. The tradeoff Primack's text makes is one of breadth of coverage for detailed discussion of specifics. Both Hunter and Primack end their texts by considering the relationship of human society to conservation biology. Hunter's discussion covers economics, politics, and sociological factors in each of three chapters, while Primack devotes four chapters to political issues, with an international focus. I would have preferred to see Primack's three chapters on the value of biological diversity included with these chapters, although there is no reason why an instructor need follow Primack's sequence of chapters.

The final text for biology majors is a compendium effort by Meffe and Carroll that includes chapters written by 12 other authors. *Principles of Conservation Biology* has the distinct advantage over the other texts

of introducing students to the ideas of a wide variety of authors. The organization of the book is similar to both Primack's and Hunter's texts, but the coverage is less broad in some areas. In addition to different authors, each chapter has several essays written by prominent scientists that bring up different viewpoints and issues regarding chapter topics. There is a little less coverage of biological topics in this book, but substantially more depth in social, economic, and political issues. Because of the diversity of viewpoints, this text is particularly well suited for a discussion-based course where class time is spent on student-generated discussion. Because of this, the text lends itself less successfully to a lecture based course. Hence, it may be most appropriate for upper-division undergraduate or first year graduate student courses.

In an emerging field like conservation biology, it is fortunate that there are a number of excellent textbooks available. Each text discussed above has its own niche, and I am certain each instructor will find a favorite. For what it's worth, here are my own choices. If I were teaching a general education course that would include a wide variety of disciplines, I would select Primack's *Primer* because of its coverage. If I was particularly concerned about maintaining student interest in the text, however, I might select Dobson's text because of its more attractive packaging. I would select Cox's text if I were interested in exposing nonmajors to a diversity of ecosystems and the problems faced in their conservation. For a course intended to be taken by biology majors, I would select Hunter's text because its focus is more biological. For a specialty course in conservation of populations, I would select Caughley and Gunn. Finally, if I wanted to teach a class as a discussion course rather than as a lecture course, then I would select Meffe and Carroll.—  
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