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BOOK REVIEWS

Conservation Biology: The Science of Scarcity and Diversity, Michael E.Soulé, editor. Sinauer Associates, Inc., Sunderland, Massachusetts. xii + 585p, (1986). Softcover, U.S.$27.00.

The realization that man will have exterminated half of all living species and destroyed most of the planet's natural vegetation within the next hundred years lends the field of conservation biology a great urgency. The political, societal and economic costs of this situation are only just becoming clear. In September 1986, a group of senior scientists calling themselves the Club of Earth, issued a statement that "the species extinction crisis is a threat to civilization second only to the threat of thermonuclear war". Their statement, released at the National Forum on Biodiversity held in Washington, D.C., was published in newspapers throughout the world and was the subject of commentary in leading scientific journals (see TANGLEY, L. 1986. Biological diversity goes public. *Bioscience* 36(11): 708-711, 715). A month later, in October 1986, one of the world's leading sponsors of conservation research (Wildlife Conservation International, a Division of the New York Zoological Society) held a major meeting aimed a setting an agenda for getting the biosphere to the year 2100. These two meetings were preceded, in 1985, by a conference on the present state of conservation biology which resulted in the volume under review here.

The rapidly developing field of conservation biology is still in its infancy; ecologists and evolutionary biologists are presently unable to meet societal needs to assist many species through the on-going extinction spasm, to predict the ability of various communities to survive or recover from human activities, or even to help estimate the ultimate costs of failing to protect nature. This important volume provides a timely overview of the present scientific foundation of biological diversity management in nature. Packed with exciting discussions of first-rate scientific and management problems, it is required reading for scientists, resource managers and others who might help develop this science of planetary survival.

This book emerged from the Second Conference on Conservation Biology sponsored by the School of Natural Resources, University of Michigan, in May 1985. Despite similarities in title, editor and publisher to a 1980 volume resulting from the preceeding meeting in San Diego this is a completely new book with different authors and little overlap in topic coverage. The 25 contributed chapters are by leading academic scientists and as the book contains much new information and over 1200 references it will be even more useful than its predecessor to both researchers, educators and managers.

Conservation biologists are now more circumspect than they were 10 years ago. Attempts to find magic numbers (e.g. 500 for minimum viable populations, *MVP)* have been replaced by attempts to identify evolutionary significant units and the demographic and genetic thresholds regulating their survival, and to identify critical links in community processes. Answers to questions about *MVP* sizes, minimum viable

densities (critical for tropical trees), reserve size (the SLOSS debate – single large or several small?), and reserve shape are now far more pragmatic – it depends. It depends because of the complexity of the problems and because conservation biology has become a mission-oriented crisis discipline. As putting off making decisions and endangering are often linked, "it depends" increasingly on who wants to know? and by when? and why?

The interrelated chapters are arranged in six sections to deal with increasingly complex issues: populations, species, communities and the "real" world. In a stimulating opening chapter Gilpin and Soulé discuss the concept of minimum viable populations and the processes of species extinction. They outline a systems-level approach to population vulnerability analysis based on the simultaneous consideration of demography, genetics, ecology and behavior. Populations are likely to go extinct as a result of demographic and genetic problems, range fragmentation or failure of ability to adapt to a changing environment when they fall below some threshold of population size, density or age structure. This represents a major change in thinking away from the search for critical magic numbers (e.g. effective population size, N_e = 50 or 500) which dominated academic discussions until recently. Although large is always better than small there are no magic numbers below which one can justify abandoning a species. It is clear that attempts to develop the population vulnerability analysis approach will receive a great deal of attention in the next few years. There are also excellent reviews of the relationship between genetic variability and fitness in plants and animals, and of the problems of inbreeding and outbreeding depression in nature. Nature abhors both close inbreeding and distant outbreeding and managers should also.

Ledig's chapter on heterozygosity, heterosis and fitness in out-breeding plants should interest foresters. Forest trees are highly variable genetically and this variation may ultimately be an evolutionary adaptation to the high frequency of deleterious recessive genes (genetic load) that accumulate by recurrent mutation in these large long-lived organisms. On-going decreases in population size and reduced gene flow between remaining population fragments will result in increased expression of this deleterious genetic load and a reduction of vigor and reproductive output. Populations will be harder to maintain and more susceptible to parasitic and climatic stress. The obvious management prescription is to reduce inbreeding and promote heterozygosity by maintaining the largest possible populations. Outcrossing and gene flow between patches can be achieved least expensively by attending to the needs of natural pollinators.

The nature and significance of rarity is then examined in Section 2 in a series of analyses of plants and birds in Mediterranean climate communities, and plants in Britain, Panama, and South America. Species are rare for several quite different reasons with quite different conservation implications. Gentry argues that the very high species diversity in the tropics is a result of high rates of recent local speciation; this is in contrast to the widely held view of tropical species as relatively ancient – the great diversity

resulting from the accumulation of species over millions of years of habitat stability. In the Amazon basin he finds that the numerous local endemic tree species are edaphic specialists and that their conservation will not be achieved by Brazilian efforts to establish reserves in the hypothetical high-rainfall Pleistocene refugia. Similarly, in the case of the species-rich cloud forests of the tropical Andes he finds that the extraordinary local endemism of epiphytes, shrubs and herbs would require a large number of smaller reserves for even partial conservation.

Hubbell and Foster describe their monumental work on 50 hectares of old growth forest on Barro Colorado Island. Identifying all 238,000 free-standing woody plants with a stem diameter of 1 cm or more they found that one third of the 303 species present were rare (with less than 1 plant per hectare). All 111 rare species were represented by only 1419 individuals. Based on a detailed analysis of the reasons for rarity on their plot they make some general recommendations for the conservation and management of tropical forests. Although generalizations about the tropics are dangerous there is much to be learned from their work which is relevent to the forests of Asia. In particular, as about half of their rare plants were immigrants from nearby secondary growth forest, their site is very similar to many forest fragments elsewhere. Their recommendations include the usual exhortation that forest reserves should be large – preferably hundreds of square kilometers – should encompass a diversity of habitats and should be round or square in shape so as to reduce edge effects (see below). They emphasize the need for the conservation of mutualistic pollinators and seed dispersers whose own resource requirements may be more important in reserve design than the target tree species themselves.

The three chapters in Section 3 on effects of habitat fragmentation underscore the fact that the battle is not over when the land is saved. Lovejoy and Janzen draw on their remarkable studies of tropical forests to show cross-boundary effects can be just as detrimental as outright habitat destruction. What happens around a reserve is often more important than what happens inside. Lovejoy describes effects of isolation on 22 Amazonian forest fragments observed thus far in the 20-year Minimum Critical Size of Ecosystems Project. His group has documented generally negative edge and area effects for plant, primate, bird, butterfly, ant and bee (important pollinators) populations. The implications are that even larger reserves are required to preserve these ecosystems and that greater attention may have to be paid to connecting habitat fragments with "Corridors of life". Daniel Janzen draws on his intimate knowledge of Costa Rican forests to illustrate how edge effects from adjacent agricultural land can penetrate seemingly pristine forest for up to 5 km. He also describes the difficulties of conserving plants whose pollinators have much wider habitat requirements. For example, many species of large sphingid moths, important pollinators of more than 100 plants in the dry forests, migrate 15 – 50 km annually to the nearby rainforests. The conservation problems of the two contrasting types of forests are inextricably intertwined. Clearing the land between forests patches not only alters the local

climate but may also doom important elements of both communities dependent on migratory animals.

In Section 4 on community processes Pimm ably reviews the complex relationships between community structure and stability; finding both theory and practice have failed to identify populations about to collapse. Dobson and May show how recent theoretical developments should reduce the threat of parasites to endangered species. Terborgh emphasizes the role of keystone plant resources in maintaining community integrity. Keystone plants play disproportionately prominent roles in sustaining communities through periods of general food scarcity. His long-term studies in Manu National Park, Peru, revealed that less than 1% of the plant diversity (12 of 2000 species) sustained nearly all the frugivores for three critical months each year. The enormous significance of such species in conservation management is obvious. Furthermore, if such keystone species were adequately conserved then "a great deal of space in the forest could *potentially* be given over to timber production without reducing the carrying capacity for vertebrates". The word potentially is of course contingent on the development of lar more effective management skills for tropical forests than are presently available. Are keystone species important in the remaining Thai forests? Or, for that matter, in Asian forests? Figs are known to be critical in sustaining birds and mammals during long periods of relative scarcity in Kutai Reserve, West Kalimantan. Elsewhere there appears to be a suprising lack of information and T. C. WHITMORE makes no reference to the concept in *Tropical Rain Forests of the Far East* (Oxford, 1984, 2nd. ed.).

In Section 5 there are six chapters on conservation problems associated with sensitive habitats. There are chapters on tropical marine inshore communities (the interaction of coral reefs, mangroves, sea grass communities in determining the productivity of traditional fisheries), tropical rivers (focusing on the Amazon but relevent to the Mekong), the processes of savannazation (on-going in Vietnam), desertification in Africa, and caves. Bats pollinate hundreds of genera of tropical trees and shrubs and even minor disturbances of their shelters and breeding caves can have a devastating effect on plant communities over a wide area. The impact of the population decline of the bat, *Eonycteris spelaea,* on durian production near Kuala Lumpur is a case in point. Especially valuable are Norman Myers' up-dated estimates of the threats to tropical forests and their rich biotas (globally, half have gone already, 8 million km^2 are left, and 2% are being destroyed or degraded annually). Myers identifies nonsustainable fuelwood gathering, shifting cattle ranching, commercial logging, and the small-scale "shifted cultivator" as the root causes. The latter, by-passed by conventional development planning and processes, is in Myers' opinion the key political issue. He regards the recent changes in World Bank policy as "the most hopeful piece of news to have emerged about the tropical forest scene in the past several decades" (See FITZGERALD, S. G. 1986. World Bank pledges to protect wildlands. *BioScience* 36(11) 712-715; TANGLEY, L. 1986. Saving tropical forests. *BioScience* 36(1) 4-8; and

WORLD RESOURCES INSTITUTE/ WORLD BANK/ UNITED NATIONS DEVELOPMENT PROGRAMME 1986. *Tropical Forests: A Call For Action.* WRI Publications, PO Box 620, Holmes, PA 19043 USA, US$12.50.).

The final three chapters (Section 6), dealing with the interactions between conservation biologists and the real world, comprise a discussion of the interplay of science, industry and regulation in damaged ecosystem restoration, a personal account by Jared Diamond on his involvement in the design of a nature reserve system for Irian Jaya (Indonesian New Guinea) where the government plans to devote about 20% of the area to reserves, and finally a philosophical examination of the formidable societal forces working against the movement to institute responsible, respectful treatment of nature. Diamond argues that doing practical conservation work is an obligation that "pure" scientists owe to tropical countries in return for the opportunity to do research there. I agree, and recommend the review by Daniel JANZEN on The Future of Tropical Ecology *(Annual, Review of Ecology and Systematics,* 17:305-324, 1986)... "the real future of tropical ecology lies in whether, within our generation, the academic, social and commercial sectors can collaboratively preserve even small sectors of tropical wildlands to be studied and used for understanding, for material gain, and for the intellectual development of the society in which the wildland is embedded. The tropical ecologist has clear mandate to be a prominent guide and glue in this collaboration."

This volume stands as testament that things are not hopeless and that the worst case scenarios of the Club of Earth and others might be avoided. Armed with *Conservation Biology* and Wildlife Conservation International's the soon to be published *Conservation 2100: Agenda for action,* the students to whom this book is dedicated will, in Soulé's words, "witness the worst and accomplish the most" We are indebted to the editor and his colleagues for the inspiration; hopefully they are right, and conservation biology is an applied science whose time has come.

But who in Thailand, or for that matter in most of the world, is in a position to understand and act on the advice of foreign academic conservation biologists? It is time that more effort be placed on the education and training of citizens and specialists in those nations that have the most to be gained from improved resource management. Unless environments are managed in a sustainable fashion, future generations are doomed to experience ever lower quality of life. Two hopeful signs involve upcoming meetings. The program of the first annual meeting of the new Society for Conservation Biology (Bozeman, Montana, June 1987) includes a symposium on training conservation biologists. (The Society may be reached c/o Blackwell Scientific Publications, 52 Beacon Street, Boston, Ma 02108, USA and the annual membership fee of U.S. $37 includes subscription to the new journal *Conservation Biology.*) Of greater local importance is the Workshop on Conservation Biology planned for July, 1987, by the Center for Wildlife Research, Mahidol University, to help disseminate the new information.

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