Managing for Nature Conservation

From genes to ecosystems

Constance I. Millar and Lawrence D. Ford

At many universities nationwide, the new discipline of conservation biology has sparked broad interest. Recently developed courses, like the field of conservation biology itself, have successfully brought together biologists from many disciplines, not just in one classroom, but united by an urgent goal—nature conservation.

Three years ago, after participating in the first conservation biology course taught at the University of California at Berkeley (UCB), we were eager for more of the interdisciplinary discussion that had brought each of us different ways of thinking about conservation problems and given us additional tools for their solution. The first course had focused on biological foundations for conservation, but we were also interested in management of natural systems, with its matrix of social issues. We were aware that although the conservation biology movement is new in the effect it is creating and the widespread support it is attracting, it is not entirely new in substance. Biologists and natural resource scientists, as well as practicing land managers, have long wrestled with the problems, although not under a united banner, of conserving the remnants of biological diversity.

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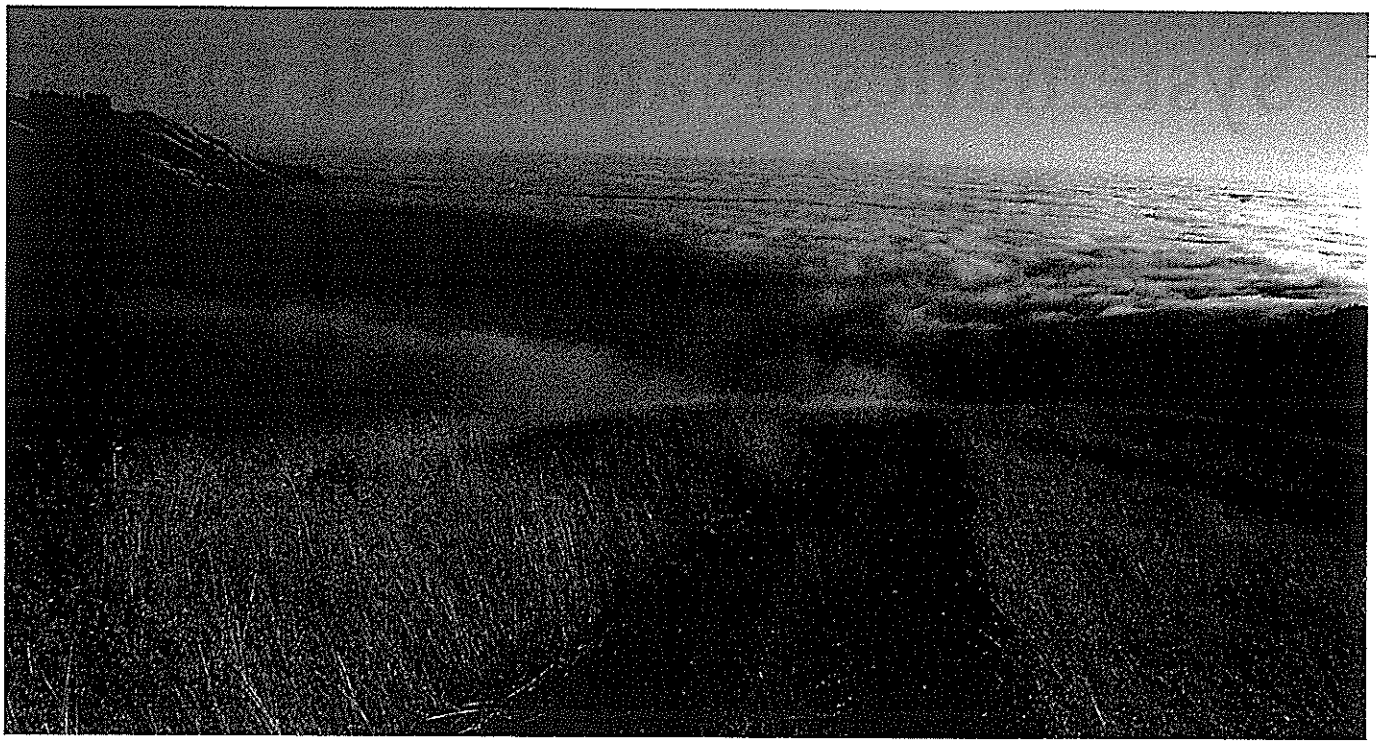
Thus, we have subsequently organized several guest lecture series and discussion groups within the UCB Department of Forestry and Resource Management (DFRM), where biology, wildland management, and biosocial analysis can comfortably coexist. The papers that follow in this *BioScience* special issue originated in a lecture series with the theme: "Managing for Nature Conservation: From Genes to Ecosystems." We here describe the elements of this theme.

Managing. Although biological information is an essential ingredient for nature conservation, equally important are the tools for translating this information into management decisions. Allele frequencies, species richness, interspecies interaction, or community disturbance data are of little use without methods of effectively applying them to conservation problems, such as reserve placement, size, number, and compatibility with human uses. Furthermore, once reserves are designated or endangered species brought into captive propagation, they must be managed and sustained.

Nature conservation. It is the biological emphasis and concern for perpetuating biological diversity that distinguish the new discipline of conservation biology from traditional natural resource conservation and the environmental movement. Biological information is essential in all attempts to perpetuate functional natural ecosystems—whether doing inventories and monitoring diversity, justifying acquisition of lands, or guiding management of reserves and conservation programs. We use the term *nature conservation* as it is widely used in Europe and other parts of the world to describe perpetuation of the full range of naturally occurring biological phenomena in their native conditions.

Genes. The initial groundswell of interest in conservation biology focused primarily on ecological phenomena at the species level. Research on island biogeography, species diversity, and species extinction captured much of the early attention. Other biological levels, including genetic diversity below the species level, are equally important to effective nature conservation. Patterns of genetic diversity among and within individuals and populations of species (collectively called the genetic architecture of species) influence long-term health and survival of organisms. The genetic components of species are manipulated knowingly and unknowingly by a host of management actions. Methods of genetic conservation can be quite



An access road plunges into a thick bank of coastal fog on the slopes of the Landels-Hill Big Creek Reserve, part of the University of California Nature Reserve System. The reserves protect valuable biosphere research and teaching sites. Photo: Jeff Kennedy, courtesy UC Natural Reserve System, Oakland, CA 94612-3560.

different from other conservation practices, and they demand special consideration.

Ecosystems. Just as genetic elements represent one extreme of conservation biology, ecosystems represent the other. The challenge at this level is to perpetuate not just the individual parts—be they genes, individuals, or species—but the whole system. Interaction with the external environment, including human communities, becomes a central focus. Since much of the attention of conservation biology will focus on *in situ* reserves, the demand for understanding the joint behavior of individuals and species within their environment will be critical for long-term protection.

From. . .To. . . It should be obvious that the levels of biological organization between—and perhaps additional to—the genetic and ecosystem must also be the focus of conservation biologists. Each subdiscipline will add new meaning to the common goal. Each biologist can contribute a unique perspective to the overall task of understanding and protecting the earth's biotic riches.

The articles that follow are not meant to be a comprehensive representation of conservation biology, nor are they meant to provide a model conservation-biology curriculum. We offer these selections in the hope that they will provoke the same spirit of ecumenical and creative thinking about the complexities of nature conservation that we have enjoyed in our courses.

The articles. In the first article, Harry W. Greene and Jonathan B. Losos demonstrate the vital roles of systematics and natural history for nature conservation and urge all involved to promote discussion and support of the sciences behind the information. Lawrence D. Ford and Kenneth S. Norris review the evolution of the University of California's Natural Reserve System, and they argue that the system's role should be expanded to include research and training programs to benefit nature conservation worldwide. F. Thomas Ledig surveys genetic conservation strategies for western forests and recommends management by genetic-resource units. Next Christine Schonewald-Cox describes application of boundary models to problems of reserve management. Raymond F. Dasmann concludes by outlining management strategies to turn conflict between natural reserve managers and local human communities into mutual benefits.