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*Principles of Conservation Biology*  
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## What Is Conservation Biology?

*Meffe + Carroll*

*When the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again.*

*William Beebe*

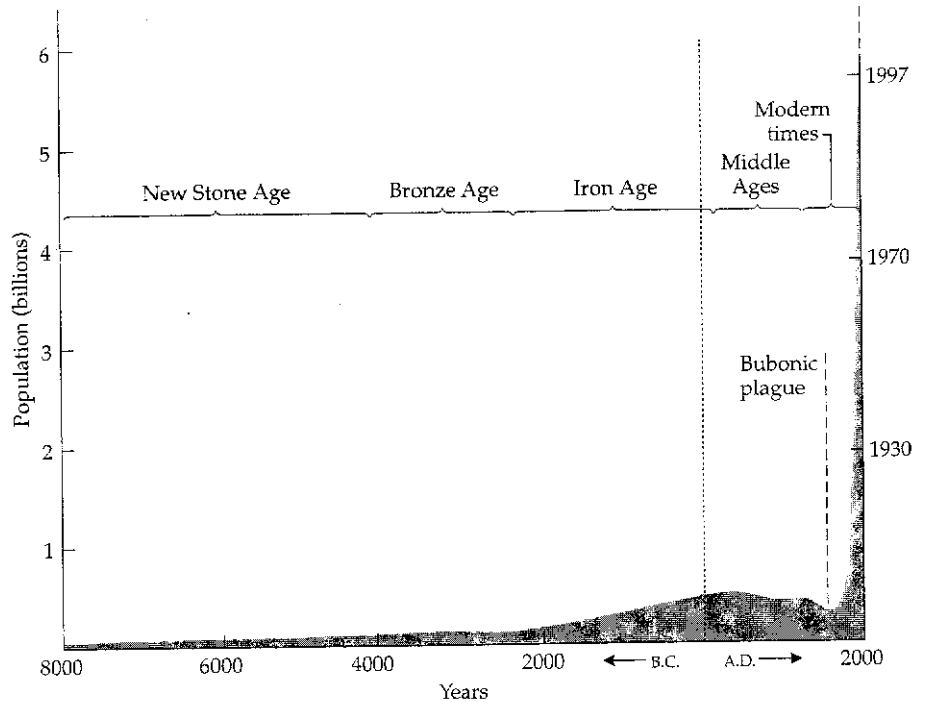
### Environmental Problems and Human Population Growth

The natural world is a far different place now than it was 10,000 years ago, or even 100 years ago. Every natural ecosystem on the planet has been altered by humanity, some to the point of collapse. Vast numbers of species have gone prematurely extinct, natural hydrologic and chemical cycles have been disrupted, billions of tons of topsoil have been lost, genetic diversity has eroded, and the very climate of the planet may have been disrupted. What is the cause of such vast environmental change? Very simply, the cumulative effects of 5.7 billion people (Figure 1.1), a number growing by 95 million each year (260,000 per day), have stressed the many ecological support systems of the planet, possibly beyond their powers of resilience. As a consequence, biological diversity (**biodiversity**, for short), the grand result of evolutionary processes and events tracing back several billion years, is itself at stake and rapidly declining. One of the many species suffering the consequences of ecological destruction is *Homo sapiens*, the perpetrator of it all.

The seeming inevitability of human population growth outstripping our planet's resources can easily lead to a feeling of helplessness and apathy in the face of so much destruction. However, there are three points that should provide reason for optimism. First, some countries have significantly lowered their population growth rates, and have done so in a short period of time. Examples include Costa Rica, Cuba, Mexico, Venezuela, and Thailand. Some, such as Hungary and West Germany, have even had periods of negative growth in the past few decades.

Second, the destruction of biodiversity today is due not so much to numbers of people per se, but to where they live and what they consume. In developing countries the expansion of highly commercialized agriculture and forestry has displaced the rural poor into city slums or onto steep hillsides and other ecologically fragile areas. In the industrialized world, the wealthy con-

**Figure 1.1** Estimated global human population size from the last Ice Age to the present, illustrating the exponential nature of human population growth since the Industrial Revolution. Note that the human population took hundreds of thousands of years to reach 2 billion, but then more than doubled in 40 years. (Modified from various sources.)



sume a disproportionate share of the global resources. These patterns are reversible.

Third—and this is the key—birth rates are high where family survival depends on being successful in an unskilled and uneducated labor pool; that is, where there are strong economic incentives for large families. The corollary is that education and the appropriate kinds of economic development can greatly reduce population growth rates.

The many ways that human population growth rates can be humanely reduced have several features in common: gender equity, access to education, equitable distribution of rural income, and rural economies based on something other than simple exploitation of natural resources. The take-home message is that we must think broadly about conservation. The **stewardship** of natural biodiversity requires that a strong link be forged between conservation biology and environmentally **sustainable development**.

The field of **conservation biology** is a response by the scientific community to the biodiversity crisis. It is a new, synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy, and other theoretically based disciplines to the maintenance of biological diversity throughout the world. It is new in that it is a product of the 1980s, although its roots go back centuries. It is synthetic in that it unites traditionally academic disciplines such as population biology and genetics with the applied traditions of game and forest management and allied fields. It is most of all challenging and imperative, in that it is motivated by human-caused global changes that have resulted in the greatest episode of mass extinction since the loss of the dinosaurs, 65 million years ago.

Environmentally, we are at the most critical point in the history of humanity, and the current population of students and professionals has a unique place in that history: of the hundreds of thousands of human generations that ever existed, no previous generation has had to respond to possible annihilation by humans of a large percentage of the species diversity on the planet.

Unless humanity acts quickly and in a significant way, the next generation will not have this opportunity. We are "it," and conservation biology is, in every sense of the word, a "crisis discipline" (Soulé 1985, and discussed below). One of the major developments needed in conservation is a shift from a reactive analysis of each crisis to a proactive science that permits us to anticipate developing crises and to prepare scientifically grounded contingency plans.

Many would ask, "What's so new about conservation biology? People have been doing conservation for decades, even centuries." This is true, but the "new" conservation biology differs in at least three ways. First, it now includes, and has been partially led by, major contributions from theoretically oriented academicians, whose ecological and genetic models are being applied to real-world situations. The unfortunate and false dichotomy of "pure" and "applied" research is finally breaking down, as the academic researcher and the resource manager have joined intellects, professional experience, and perspectives to address local to global conservation problems.

Second, much of traditional conservation was rooted in an economic, **utilitarian** philosophy whose primary motivation was to maintain high yields of selected species for harvest. Nature was seen as providing benefits to people, mostly from Western nations, through highly visible, selected components such as deer, trout, minerals, or timber, and was managed for maximization of a single or a few species, a small subset of the huge diversity of nature. The "new" conservation biology views all of nature's diversity as important and having inherent value. With this perspective, management has been redirected toward stewardship of the world's biodiversity and natural ecosystems, rather than toward single species. Four detailed perspectives on the "new" conservation biology are offered in essays in this chapter from academic (Stanley A. Temple), government agency (Hal Salwasser), nongovernmental organization, or NGO (Kathryn S. Fuller), and private landowner (Bill McDonald) viewpoints.

## ESSAY 1A

### *An Academic Perspective*

## The Role of the University in Conservation Biology

Stanley A. Temple, University of Wisconsin

Conservation biology was largely conceived in academia, and academic scientists have continued to play a major role in guiding its development. The generally recognized vision for conservation biology features at least four characteristics that have encouraged an academic bias: a focus on biological diversity, an expectation of scientific rigor, a focus on multidisciplinary and interdisciplinary approaches, and innovative practical measures for dealing with the biodiversity crisis. Because conservation biology focuses on understanding and conserving biodiversity, rather than on selected utilitarian species, academic prevalence in the field seems inevitable. The scope of biodiversity topics is so broad that no other institution outside of academia en-

compasses a wide enough range of specialists to cover the territory. Only in universities does one find such a broad array of geneticists, population biologists, ecologists, social scientists, philosophers, resource economists, and other disciplinarians who share an interest in and concern for biodiversity.

In contrast, government conservation agencies and private conservation groups tend to harbor a narrower range of specialists among their ranks, and the collective diversity of their interests may be too limited to provide expertise in all aspects of conservation biology. Conservation agencies have typically targeted specific categories of biological resources for attention (forests, fisheries, wildlife, rangeland) rather than

biodiversity. Even the network of subjects that these government bureaus collectively cover leaves enormous gaps because they may provide minimal attention to elements of the biota that are "non-resources." Conservation organizations also specialize, though recently some have expanded their missions to encompass biodiversity. Still, their collective staffs are far smaller and more narrowly focused than academic departments.

Conservation biology has always regarded itself as a field in which the usual criteria of scientific rigor should be imposed. Search for new generalizations from theoretical models that explain widespread patterns, use of the scientific method to test hypotheses

generated from these models, and publication of findings in peer-reviewed journals where they can be critically evaluated by the scientific community are important traits of academic science. The credibility that attends this approach has allowed conservation biologists to gain a general level of respect within the scientific community that previously had not been extended to many scientists who worked in conservation fields.

How rigorous has conservation biology proven to be? The report card is mixed. Although the field emerged with a body of useful theory already in hand (such as the equilibrium theory of island biogeography and its various manifestations), there have been few new theoretical contributions, in contrast to many tests and validations of existing models. This has led some scientists to question whether conservation biology, as a synthetic field, has actually generated any principles of its own or instead just borrows extensively from other disciplines.

Conservation biology aims to encourage collaborative work among specialists from many disciplines who share an interest in biodiversity. Ideally, these collaborations result in interdisciplinary problem-solving, and most recognized centers of excellence in conservation biology have tried to foster an interdisciplinary approach. An academic bias again results because universities are the home of many of the potential collaborating disciplines.

When incorporating conservation biology into the academic bureaucracy, most institutions have opted to create

new administrative units in conservation biology rather than to introduce biodiversity as a conspicuous issue in many existing units. Because these units include individuals from a broad array of disciplines, one of the consequences of this approach will be a new generation of conservation biologists who are trained as broadly versed generalists, rather than as disciplinary specialists, who can think and work well in an interdisciplinary mode. This situation contrasts sharply with the training of the first generation of leaders in the field, who had no specific training in conservation biology but typically focused on a particular aspect of conservation. Although the next generation of conservation biologists may be well equipped to promote more interdisciplinary work, their educational backgrounds may also reduce the likelihood of new scientific breakthroughs.

Conservation biology stresses the importance of generating new scientifically sound approaches to solving the complex web of problems that have created the biodiversity crisis. Producing innovations is a central mission of university scientists, whereas applying such research is often the challenge for nonacademic scientists. Often self-described as a mission-oriented, crisis-driven group, conservation biologists in academia have a heavy responsibility to make their research applicable and to venture forth from the Ivory Tower environment and make their findings available to the decision makers and managers who will actually implement strategies for preserving biodiversity in the real world.

Relations between academics and practitioners can be awkward, and there were early hints of disharmony in conservation biology. The new breed of conservation scientists in academia was initially perceived by some in the conservation establishment as arrogant, out-of-touch, and unwilling to work cooperatively with practitioners. Whether justified or not, this initial reaction hampered progress, and there are still old-guard conservationists who are threatened by the ascendancy of conservation biology and remain antagonistic to it. There are also some academics who do remain arrogant and out of touch. This unfortunate divisiveness may be one of the most serious handicaps associated with conservation biology's academic roots, and one that all conservation biologists should try hard to dispel. Fortunately, the barriers are crumbling and their dissolution should be encouraged by all parties.

The urgent and lofty goals of conservation biology can be achieved only if all members of the conservation community work together on biodiversity issues. As a university scientist who has been closely involved with conservation biology, I have fluctuated between enthusiasm for, and concern over, the academic bias in the field. Despite occasional apprehension, I continue to believe that conservation biology's development and ongoing evolution have been well served by its academic roots. Working closely with colleagues in conservation agencies and organizations, academic scientists will continue to have a vital role to play in preserving biological diversity.

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The "new" conservation biologist recognizes that diverse and functioning ecosystems are critical not only to maintenance of the few species we harvest, but also to perpetuation of the nearly limitless variety of life forms of which we know little or nothing. The conservationist realizes that intact and functioning ecosystems are also important as life-support systems for the planet, and are critical to our own continued survival and well-being as a species (Odum 1989; Daily 1997).

Third, conservation biology fully recognizes and embraces the contributions that need to be made by nonbiologists to conservation of biodiversity. In particular, the social sciences, economics, and political science may ultimately have more influence on real advances or losses in conservation than the biological sciences. Unless major changes can be made in the way that humanity does business with the natural world, and in humanity's destructive patterns of population growth and resource consumption, it would appear that much of our biological knowledge of conservation will be rendered useless under the sheer weight of the human presence.

A goal of conservation biology is to understand natural ecological systems well enough to maintain their diversity in the face of an exploding human

population that has fragmented, simplified, homogenized, and destroyed many ecosystems to the point that contemporary species extinction rates are estimated to be 1000 to 10,000 times higher than the normal **background extinction rate** expected in the absence of human influences (Wilson 1989). Thus, conservation biology tries to provide the basis for intelligent and informed management of highly disrupted ecosystems.

In 1965, the ecologist G. Evelyn Hutchinson described the natural world as an "ecological theater" serving as a stage for an "evolutionary play." Perhaps no better metaphor sums up the mission of conservation biology: *to retain the actors in that evolutionary play and the ecological stage on which it is performed.* Conservation biology strives to maintain the diversity of genes, populations, species, habitats, ecosystems, and landscapes, and the processes normally carried out by them, such as natural selection, biogeochemical cycling, photosynthesis, energy transfer, and hydrologic cycles. It is a dynamic play, with players and action on many different spatial and temporal scales, with old actors disappearing and new ones arriving. But the play ultimately comes down to one thing: dynamic evolutionary processes in a changing ecological background. Conservation biology attempts to keep those normal evolutionary processes working within a functioning ecological setting.

## A Brief History of Conservation Biology

The global effort to conserve and protect the natural environment is a recent phenomenon, though efforts to conserve economically important natural resources have a long history. Although we may think of environmental destruction as a product of recent times—and certainly the scale of contemporary destruction is unprecedented—significant environmental degradation has always accompanied humankind. Humans may have been responsible for the extinction of most of the large mammal fauna of North America, which occurred shortly after human colonization from Asia about 11,000 years ago (Martin and Klein 1984). According to what has been termed the "blitzkrieg" hypothesis (Martin 1973), mastodons, camels, tapirs, glyptodonts, giant ground sloths, and many other species may have been hunted to extinction shortly after human colonization of the continent.

In the classical Greek period, Aristotle commented on the widespread destruction of forests in the Baltic region. At the same time in southern Asia, forests were felled to meet the growing need for timber to build trading ships to serve expanding mercantile centers such as Constantinople (now Istanbul). The barren landscapes that we associate with much of Turkey, Syria, Iraq, and Iran are unnatural deserts resulting from massive exploitation of fragile woodlands. Indeed, this part of Asia had been known in earlier times as the "land of perpetual shade." The Mediterranean region of Italy and Greece was likewise heavily wooded before human settlement.

Diamond (1992) argues that virtually wherever humans have settled, environmental destruction has been the rule; he and others (e.g., Redford 1992) largely debunk the notion of the "noble savage," primitive but wise peoples who had great concern for natural resources. Many, if not most, societies have had some lasting, destructive impact on the natural world. However, some societies have certainly minimized their environmental influences and lived in a more sustainable fashion than most.

In the humid tropics, early agrarian societies dealt with declining resources by moving when yields began to drop and local game became scarce, an option no longer available in today's crowded world. Some of these shifting cultivators practiced, and some still practice, forms of conservation management. In many tropical regions, complex tree gardens helped stabilize land use

**Figure 1.2** Highly diverse agroforestry systems, such as the Dammar system from Indonesia, can be found in many tropical regions. This photograph shows a similar agroforestry system from southeastern Mexico. It is known locally as a “huerto,” or tree-garden. These traditional agroforestry systems of mixed, cultivated perennials may be structurally similar to old, second-growth natural forests and contain nearly as many tree species on a per-hectare basis. (Photograph by C. R. Carroll.)



(see Carroll 1990 for examples), and some shifting cultivators practiced a kind of management of natural succession. Today, in “Dammar” agroforestry in Sumatra, for example, natural forest plots are converted over a period of 10–20 years into complex modified forests based primarily on dammar (*Shorea javanica*), a tree that is tapped for resins, and other economically important native trees (Mary and Michon 1987). The plots are structurally similar to natural successional plots and probably help support regional biodiversity. Although we may think of conservation management as a modern Western notion, there are many such examples of management of natural resources to be found in other cultures (Figure 1.2).

We would be remiss if we failed to point out the fragility of these traditional systems in the modern, interconnected global marketplace. To continue with the Dammar example, the practice is disappearing for two unexpected reasons. First, the establishment of Bukit National Park appropriated a major portion of Dammar forestry land and put severe constraints on the use of the remaining land. In particular, the long fallow period needed became increasingly difficult to accommodate. Second, a growing urban market created great demand for rice and, to a lesser extent, coffee and cloves. In response to these two factors, Dammar agroforestry has been replaced largely by dryland rice and coffee cultivation.

In Europe, conservation efforts were mainly devoted to private game management and maintenance of royal preserves and private manor lands. Until the 18th and 19th centuries, little notice was given to problems of the commons, the public lands. As a consequence, exploitation of these common-use resources led to the deforestation of most of Europe by the early 18th century. This occurred even earlier in Great Britain, where many of the native forests were destroyed by the 12th century (McKibben 1989); the demand for charcoal to supply home heating and industrial needs led to virtual elimination of the remaining public forests by the late 18th century. Similarly, in Asia, conservation efforts were game-oriented and largely restricted to the private lands of the privileged. An artist’s early rendition of a forest and pastoral scene in China, juxtaposed against a later photograph of the same place, which depicted an eroded and barren landscape, is said to have been the telling argument made to

President Theodore Roosevelt's administration by forester Gifford Pinchot in his successful campaign to establish the U.S. Forest Service in 1905.

### Conservation in the United States

Conservation in the continental United States has had a somewhat unusual history. Europeans colonizing America found a landscape that, by comparison

## ESSAY 1B

### *A Government Agency Perspective*

## Conservation Biology and the Management of Natural Resources

Hal Salwasser, University of Montana (formerly U.S. Forest Service)

In the closing decades of the 19th century, the concept of conservation was developed and promoted as an ethical relationship between people, land, and resources. It meant wise use of lands and resources so as not to destroy their capacity to serve future generations. Its champions were men such as William Hornaday, Theodore Roosevelt, George Bird Grinnell, and Gifford Pinchot. They were sportsmen, lovers of the outdoors, and political activists, the progressive thinkers of their time. The result of their zeal was the start of national conservation laws, government agencies to manage lands and resources in the public trust, and the great systems of national parks, forests, wildlife refuges, and public lands that now encompass about one-third of the land area of the United States.

The ideals of conservation can be traced back to Henry David Thoreau, George Perkins Marsh, and landscape artists of the mid-1800s. The philosophical roots go even further back to Native American beliefs and ancient cultures from other lands. What is significant about the period of the late 1800s in the United States is that the philosophy, ideals, and action to conserve natural resources came together in a set of government policies, public institutions, and social commitment.

Yet almost immediately, the conservation movement diverged along pragmatic utilitarian and romantic preservationist lines, a split in perspectives that to some extent continues to this day. Natural resource disciplines such as forestry, range management, wildlife management, and fisheries, along with their respective government agencies, arose from the utilitarian roots. Wilderness advocacy and its public agents arose from the preservationist roots.

Eventually, The Nature Conservancy, a nongovernmental conservation organization, emerged from the scientific discipline of ecology. The field of endeavor now called Conservation Biology shares common roots with these contemporary resource disciplines and their government agencies. It also shares with them a wide array of aims and methods.

One example of the common roots and shared aims of conservation biology and natural resource management comes from the opening sentence of the first article in the first issue of the first volume of the *Journal of Wildlife Management*: "In the new field of conservation biology, few life history phenomena have occasioned more comment than the heavy percentages of nest failures for many species of birds thus far studied" (Errington and Hamerstrom 1937). The discipline described is now known as Wildlife Management. From the start it recognized conservation biology as its scientific basis. As an aside, nest failures of birds are still a perplexing subject of both old and new traditions in conservation biology.

Some 40 years after Errington and Hamerstrom published their article, a new discipline was forming under the title of Conservation Biology. It confused a lot of people in government agencies and academia who thought all along that they were conservation biologists. But there must have been a need or the new field would not have emerged. The need was to compensate for a weakness in applied conservation disciplines that focused most of their attention on the continued productivity of already common or productive plants and animals. Conservation Biology has its current focus on population viability of all native plant and animal species, many of them uncommon, and on bio-

logical diversity in general. Beyond counterbalancing the weakness in applied conservation disciplines, however, Conservation Biology has more in common with traditional conservation fields than it has differences with them.

For those intent on finding differences between the values and aims of Conservation Biology and Wildlife Management, a review of the preface in that 1937 issue of the *Journal of Wildlife Management* might be useful. The officers of The Wildlife Society stated their policy in unequivocal terms:

Management along sound biological lines means management according to the needs and capacities of the animals concerned, as related to the environmental complex in which they are managed. It does not include the sacrifice of any species for the benefit of others, though it may entail the reduction of competing forms where research shows this is necessary. It consists largely of enrichment of environment so that there shall be maximum production of the entire wildlife complex adapted to the managed areas. Wildlife management is not restricted to game management, though game management is recognized as an important branch of wildlife management. It embraces the practical ecology of all vertebrates and their plant and animal associates. While emphasis may be placed on species of special economic importance, wildlife management along sound biological lines is also part of the greater movement for conservation of our entire native fauna and flora. (Bennitt et al. 1937)

This statement, if extended to fisheries, forestry, recreation, and range management, would put conservation biology squarely in a role as the foundation science for resource management and the agencies that carry it out.

While conservation biology is not entirely new, Conservation Biology is. As an organized discipline, it is about 15 years old. But still it is not exactly clear what role the discipline will play in resource management and government programs. These are the perspectives of one who had a hand in the birthing of Conservation Biology out of a need to implement federal policies to better protect biological diversity and out of a desire to obtain a broader set of concepts, theories, and methods than traditional conservation disciplines had provided.

First, let's retreat to the dictionary for some help. For most speakers of the English language, *conservation* means the care and protection of resources so as to prevent loss or waste. It includes actions that government agencies call preservation, restoration, enhancement, recycling, extending useful life, and sustained-yield management. *Biology* is the body of scientific knowledge and methods that deals with the origin, history, physical characteristics, life processes, and habits of plants and animals. Thus a "common-folks" definition for conservation biology would be the application of biology to the care and protection of plants and animals to pre-

vent their loss or waste. This is a broad field for conservation biology, certainly broader than a focus on just the scarce elements of a flora and fauna.

This broad view of conservation biology is consistent with how I suspect Errington, Hamerstrom, and probably Aldo Leopold might have seen it: the basic biological sciences that underpin the applied conservation fields of forestry, wildlife management, fisheries, nature protection, and so on. These basic sciences would include genetics, physiology, population biology, natural history, and ecology. Because conservation entails more than biology, other sciences or disciplines are necessary complements to Conservation Biology, such as economics, geography, history, sociology, and philosophy.

The issue now facing Conservation Biology is this: will it become the foundation of biological sciences that supports conservation of plant and animal diversity and productivity? Or will it become another subspecialty that focuses on preservation of the scarcer parts and processes of biological diversity? Both would be legitimate outcomes. Both are needed. But the latter would leave it to another synthetic field to form the foundation needed by all the subdisciplines of biological conservation.

The polarized rhetoric swirling around Conservation Biology's role in issues such as endangered species, old-growth forests, landscape fragmenta-

tion, and biological diversity during the latter decades of the 20th century seems to indicate that Conservation Biology is destined for the rank of a new subspecialty. I hope this is not the case.

Conservation Biology sits on the horns of a dilemma. It can become the foundation of biological sciences that serves the broad spectrum of conservation in both public and private sectors. Or, it can become a special part of the framework of biological conservation, that part dealing with rare elements and processes. There are significant implications to how the practitioners of Conservation Biology decide to resolve this dilemma. The choice still exists, but it won't for much longer. I would like to see Conservation Biology become a foundation of biological sciences for conservation rather than just a subdiscipline for preservation of the rare elements of diversity. I would like to see it embrace the full spectrum of aims and methods in biological conservation, from preservation of natural systems and their diversity to sustainable management to produce the natural resources upon which all human life depends. But regardless of how the field evolves, the world of biological management programs is better off because Conservation Biology came into being in the 1980s. We needed the new perspectives and methods it brought to conservation, and they will continue to be useful for a long time to come.

with a highly exploited Europe, must have seemed pristine. Aboriginal peoples had exploited natural resources and driven some species to extinction, but their low population densities and lack of technologies for widespread devastation prevented wholesale destruction. American Indians apparently made extensive use of fire to manage lands for both agriculture and game. Some historians argue that Atlantic coastal lands cleared by Indians became important colonization sites for European settlers and helped them survive their first winters (Russell 1976).

During the colonial period, North American forests were extensively exploited for lumber, ship masts, naval stores (gum and turpentine), and charcoal for heating. Huge tracts were cleared for agriculture. Demand for forest products in Europe and domestic demand by a rapidly growing population were eagerly met by exploiting the seemingly endless forests. Later, forests were again called upon to provide lumber for vast railroad networks and building construction as the nation expanded westward. In coastal areas, salt marshes were harvested for salt hay (*Spartina*) to feed cattle before the opening of the prairies to grain farming.

The value of forests as an economic resource was not the only philosophical perspective held by the colonists, however. Religious attitudes of some groups, especially the Puritans, held that the forest was the abode of the devil. This is perhaps not an unfamiliar attitude even today, for many children's sto-



ries place witches, trolls, and goblins in deep, dark forests, and many otherwise reasonable adults are more frightened in a remote forest than in the heart of a large city with high murder rates.

Thus, the forests were beset by increasing economic demands and were perceived to be endless and vaguely evil—hardly a nourishing environment for conservation. Conservation did, of course, develop in North America, but it required several centuries after initial European colonization to become firmly established. Perhaps it was necessary first to develop a significant population whose livelihood was not intimately tied to forest exploitation.

American conservation efforts can be traced to three philosophical movements, two of the 19th century and one of the 20th (Callicott 1990). The **Romantic-Transcendental Conservation Ethic** derived from the writings of Ralph Waldo Emerson and Henry David Thoreau in the East, and John Muir in the West. Emerson and Thoreau were the first prominent North American writers to argue, in the mid-1800s, that nature has uses other than human economic gain. Specifically, they spoke of nature in a quasi-religious sense, as a temple in which to commune with and appreciate the works of God. Nature was seen as a place to cleanse and refresh the human soul, away from the tarnishings of civilization. This was the philosophical and aesthetic position that Muir took as he argued for a national movement to preserve nature in its wild and pristine state, and condemned its destruction for material and economic gain. John Muir's movement flourishes today in the form of many citizen conservation groups; his direct organizational legacy is the Sierra Club.

This noneconomic view was countered by the so-called **Resource Conservation Ethic**, made popular by the forester Gifford Pinchot at the turn of the 20th century. His was an approach to nature based in the popular utilitarian philosophy of John Stuart Mill and his followers. Pinchot saw only "natural resources" in nature, and adopted the motto, "the greatest good of the greatest number for the longest time" (Pinchot 1947). Nature, to Pinchot, was an assortment of components that were either useful, useless, or noxious to people. Note the **anthropocentric** valuing of nature, not because it is part of "God's design" (as per the Romantic-Transcendentalists), but because natural resources feed the economic machine and contribute to the material quality of life. Pinchot (1947) once stated that "the first great fact about conservation is that it stands for development."

Pinchot's approach to conservation stressed equity—a fair distribution of resources among consumers, both present and future—and efficiency, or lack of waste. This led to adoption of the **multiple use concept** for the nation's lands and waters, which is the current mandate of the U.S. Forest Service and Bureau of Land Management. Under multiple use, many different uses of the land are attempted simultaneously, such as logging, grazing, wilderness preservation, recreation, and watershed protection. Because a market economy may or may not be efficient and has little to do with equity, governmental regulation or outright public ownership of resources was deemed necessary to develop and enforce conservation policy. An insightful perspective on multiple-use conflicts based on personal experience is offered by Edwin P. Pister in Essay 1C.

These two movements thus created a schism, with the Preservationists (Muir, Emerson, Thoreau) advocating pure wilderness and a spiritual appreciation for nature, and the Conservationists (Pinchot) adopting a resource-based, utilitarian view of the world. A third movement, born of the 20th century, emerged with the development of evolutionary ecology. This **Evolutionary-Ecological Land Ethic** was developed by Aldo Leopold in his classic essays, published shortly after his death as *A Sand County Almanac* (1949), and in other writings. Leopold was educated in the Pinchot tradition of resource-based conservation, but later saw it as inadequate and scientifically inaccurate. The

development of ecology and evolution as scholarly disciplines conclusively demonstrated that nature was not a simple collection of independent parts, some useful and others to be discarded, but a complicated and integrated sys-

## ESSAY 1C

### Agency Multiple-Use Conflicts

Edwin P. Pister, Bishop, California

Having conducted my 38-year career within the philosophical and practical insulation of an essentially unilateral California Department of Fish and Game, dichotomies inherent within federal land and resource management departments and their constituent agencies have intrigued and perplexed me. Early on I had naively assumed that such agencies, and the personnel staffing them, were all focused toward a common and righteous goal, and essentially comprised a team directed toward the long-term benefit of the natural resource (and, therefore, the people). I was sadly mistaken! The infighting and budgetary battles within "the system," largely directed by politically driven economic considerations and pushed by Administration priorities in Washington, D.C., were astounding.

My first significant encounter with bureaucratic dichotomies involved five agencies within the U.S. Department of the Interior in the early days of an effort to save the Devils Hole pupfish (*Cyprinodon diabolis*) in a remote portion of the Nevada desert. Devil's Hole (see Figure 5.2) is a disjunct portion of Death Valley National Monument, administered by the National Park Service, with the endangered fish primarily a responsibility of the U.S. Fish and Wildlife Service. Causing the fish's endangerment was deep well pumping on federal land administered by the Bureau of Land Management under lease to private farming interests, encouraged strongly by the Bureau of Reclamation, which was actively involved in drilling exploratory wells to allow more pumping. A fifth agency of Interior, the U.S. Geological Survey, was monitoring the venture, with its hydrologists confirming our worst fears that if the pumping were allowed to continue unabated, virtually every spring in the biological wonderland of Ash Meadows (Nye County, Nevada), along with its highly endemic biota, would be severely affected and ultimately destroyed (Deacon and

Williams 1991). It was only after a strong threat of legal action that Secretary of the Interior Walter Hickel called together a Washington-level task force representing all involved agencies, and progress was made to save the fish.

Often we are not so fortunate. Devil's Hole and Ash Meadows were the subject of dramatic events that came and went rather quickly, with the fish ultimately receiving protection by a unanimous decision of the U.S. Supreme Court. Much more cumbersome and damaging to the nation's biodiversity are chronic problems resulting from multiple-use management on public lands throughout the western United States, primarily for extractive activities such as timber harvest, mining, livestock grazing, and energy development. A representative situation, which began for me in 1965 and persists to this day, involves the Inyo National Forest and a series of livestock grazing permits within the Golden Trout Wilderness of the southern Sierra Nevada.

During the 1860s, the meadows of the Kern River Plateau, 2500–3000 m in elevation and underlain by recently formed and very fragile granitic soils, were viewed by livestock operators as a source of quick wealth. Eyewitness accounts during the latter part of the 19th century told of invasions of hundreds of thousands of sheep and cattle that quickly removed the meadow grasses and began watershed degradation that has never fully healed (King 1935). Attempts by fish and wildlife biologists to effect significant reductions in livestock numbers were countered politically by the livestock operators, supported by a Forest Service range lobby eager to retain a budgetary status quo. When the Golden Trout Wilderness was created under the Endangered American Wilderness Act of 1978, Western congressmen made retention of the grazing leases part of the price to be paid to achieve "wilderness" status. Consequently, a wilderness dedicated to

California's state fish continually and needlessly suffers severe habitat degradation and riparian damage. Major eroded areas are widespread, riparian growth and undercut banks are virtually nonexistent, the best campsites near water have been reduced to dust bins fouled with cow manure, and one cannot drink safely from the South Fork Kern River (the evolutionary habitat of the golden trout, *Oncorhynchus aguabonita*) without prior filtering or boiling. The habitat change thus effected brought the added ecological problem of favoring an invasion of brown trout (*Salmo trutta*) which, in the early 1970s, nearly succeeded in extirpating the endemic goldens.

Other rare life forms have been similarly affected. A very rare species of sand verbenia, *Abronia alpina*, exists on only a few acres of the Plateau and must be fenced by the Forest Service to protect it from cattle. Only recently has some progress been made toward rectifying these problems, utilizing an ecosystem-wide approach involving major adjustments in the cattle operation, fencing of riparian areas, erection of fish barriers, eradication of brown trout, and very costly repair of headcuts and eroded areas (USDA Forest Service 1982a,b).

To make the situation even less acceptable, cattle operations on public lands are often subsidized by taxpayers. The costs of supporting such programs are several times greater than revenues derived from lease fees, and monetary returns to the Forest Service are so minimal that many readers could (and would, if permitted) easily pay them out of their own pockets. Resource abuse under multiple-use management is not restricted to livestock operations. Perhaps even more flagrant is energy development in key recreation areas.

The Inyo National Forest constitutes perhaps the most heavily used (and therefore most important) recreation

area in the United States. Located but a half day's drive away for more than 20 million people in metropolitan southern California, the Inyo presently supports more recreational use than Yellowstone, Grand Canyon, and Glacier National Parks combined. Yet, while geothermal features comprise major tourist attractions in Yellowstone, energy projects encouraged by multiple-use management have tapped the Inyo National Forest's geothermal resources (already very popular with tourists), which are gradually and inexorably being reduced, first to subsurface levels and eventually to nothing.

As Ellis (1975) points out in a classic paper describing geothermal development in New Zealand, "After major well production, the hot springs of Wairakei Geyser Valley and Broadlands no longer discharge, and what were once tourist attractions are now gray holes in the ground." When these fears were emphasized to federal decision makers during the environmental review process, they were almost totally ignored, and the plants were built, with accompanying press fanfare from Bureau of Land Management bureaucrats about how multiple-use management was playing a major role in freeing the nation from reliance upon foreign oil! (BLM administers all geothermal leases on federal lands). Absolutely no mention was made of the negative impacts. Probably nothing is more intransigent than bureaucracy at the policymaking level that takes comfort in the status quo.

At this writing, predictions are indeed proving to be accurate. We are already experiencing "gray holes in the

ground," a major trout hatchery operated on geothermally heated water since the 1930s is currently running at less than half capacity because of reduced flows and altered water temperatures, and the lawyers are sharpening their pencils. However, successful legal action would be but a hollow victory. It is unlikely that the geothermal resource will recover within several lifetimes. Considering the limited life expectancy of geothermal projects (30 years at best), even the most loyal, "system-dedicated" federal land manager would now find it difficult to defend such irresponsible development as achieving "the greatest good of the greatest number for the longest time." The underlying (but arguable) utilitarian principle of multiple-use management is a concept that badly needs to be redefined in light of modern ecological thought and understanding (Callicott 1989).

Similar threats are posed by hydroelectric development on the streams that form the basis and backbone of the roadside recreational resource. All this, of course, is simply because multiple-use management is expected, encouraged, and budgeted for on Forest Service and BLM lands, and valuable and irreplaceable resources located thereon are not afforded the protection required by law within the boundaries of a national park. Long-term destruction of publicly owned recreational resources is routinely sanctioned to accommodate private business interests.

What I have pointed out above constitutes only the most obvious of problems created by the monster frequently produced by a combination of politics

and multiple-use mandates. To livestock and energy development can be added other extractive uses such as mining and timber harvest. Even though local Forest Service and BLM officials may oppose particularly flagrant projects, they are required to fulfill the congressional mandates that direct their agencies, mandates that may be significantly skewed during pre-project evaluation and planning. Value judgments and resultant employee zeal basic to constructive change are seldom manifested and lie far outside of the training (or career aspirations) of most federal land managers. Many are keenly aware of the case involving John Mumma, Regional Forester from Missoula, Montana, who was fired from his job for refusing to implement timber harvest quotas assigned to him because doing so would have required violation of federal law (Wilkinson 1992).

The public can benefit in the long run from multiple-use management, but much too often politics and blind bureaucracy take precedence over the long-term public interest. It is not multiple use per se that works against the public interest, but questionable management priorities that allow certain favored uses to proceed to the detriment of the overall resource. Williams and Rinne (1992) propose a solution to this long-standing problem by suggesting management for biodiversity within a broader, ecosystem management approach, a concept that offers much hope for federal land managers and, more importantly, the publicly owned resources under their stewardship.

tem of interdependent processes and components, something like a fine Swiss watch. There are really only a few parts of a watch that appear to be of direct utility to its owner, namely, the hour, second, and minute hands (back when watches had hands). However, proper functioning of those parts depends on dozens of unseen components that must all function well and together. Leopold saw ecosystems in this context, and this is the context in which modern ecology first developed. This **equilibrium** view was subsequently replaced by a dynamic, **nonequilibrium** ecological perspective, discussed below. Nevertheless, the Leopold land ethic remains as the philosophical foundation for conservation biology.

Although the Evolutionary-Ecological view of the world, updated by the nonequilibrium perspective, is the most biologically sensible and comprehensive approach to conservation, much of modern conservation is based on various mixtures of these three philosophies. The Resource Conservation Ethic of the late 19th century is still a dominant paradigm followed by public resource agencies such as the U.S. Forest Service, under which U.S. forest tracts are seen as economic resources to be managed for multiple human use

(Figure 1.3). The Romantic-Transcendental Conservation Ethic, though more typically without the overt religious rationale of its early proponents, is the basis for activism by many private conservation organizations throughout the world, whose goals are to save natural areas in a pristine state for their inherent value. This difference has resulted in repeated confrontations among so-called “special interest groups.”

Leopold’s Evolutionary-Ecological Land Ethic is the best informed and most firmly grounded of any approach to nature and should serve as the philosophical basis for most decisions affecting biodiversity. It is the only system that can provide even moderately useful predictions about our effects on the natural world, but it is still only part of the total decision-making process; the economic, spiritual, and social needs of people must also be met. It is curious that management decisions concerning natural areas can be made without recourse to evolutionary ecology, yet this still routinely happens in many resource agencies (such policy issues are thoroughly discussed in Chapter 17). Similarly, it would be a fruitless, counterproductive, and ethically suspect exercise to base comprehensive land use decisions solely on evolutionary ecology without regard to the people who will be affected.

Most natural areas today are remnant patches of formerly contiguous habitats in landscapes dominated by human economic endeavors (Figure 1.4). The biological activity within any one of these natural areas is strongly dependent on what happens outside its boundaries. Any long-term security for a natural area will come about only when it is accepted as an integral and contributing part of broader economic and development planning. Just as the Evolutionary-Ecological Land Ethic grew out of traditional disciplines to meet the emerging crises in biodiversity, so too are the traditional disciplines of resource economics and anthropology giving rise to new interdisciplinary views, sometimes called “ecological economics” and “ecological anthropology,” views that stress long-term environmental sustainability.

### Modern Conservation Biology: A Synthesis

The time is ripe to replace both the extreme preservationist and the exploitative utilitarian philosophies of the 19th century with a balanced approach that looks to an ethic of stewardship for philosophical guidance, and to a melding of natural and social sciences for theory and practice. This new context is necessary for conservation biology to flourish and make contributions to a sustainable biosphere.

**Figure 1.3** The deeply rooted multiple-use paradigm of the U.S. Forest Service is reflected in the irony of this sign in Aiken County, South Carolina, and the virtually clear-cut forest in the background. The Resource Conservation Ethic that has dominated most public resource agencies demands that forests and other natural areas be treated as economic resources to be managed for human gain. True “protection” for biodiversity often is not an option. (Photograph by G. K. Meffe.)





**Figure 1.4** An example of a mixed natural and human landscape in South Carolina. This aerial photograph shows patches of natural areas of various sizes interspersed with human-dominated activities such as agriculture and housing. (Photograph courtesy of Savannah River Ecology Laboratory.)

By the 1960s and 1970s, it was becoming painfully obvious to many ecologists that prime ecosystems throughout the world, including their favorite study sites, were disappearing rapidly. Biodiversity, the outcome of millions of years of the evolutionary process, was being carelessly discarded, and, in some cases, willfully destroyed. Previous conservation efforts, while focusing on important components of nature such as large vertebrates, soils, or water, still had not embraced the intricacies of complex ecosystem function and the importance of all the “minor,” less charismatic, biotic components such as insects, nematodes, fungi, and bacteria. It was time to change this attitude.

Early attempts at moving in this direction included Raymond Dasmann’s *Environmental Conservation* (1959) and David Ehrenfeld’s *Biological Conservation* (1970). These books helped to lay the groundwork for today’s conservation biology by melding good evolutionary ecology with human resource conservation, and by providing a vision of where modern conservation should go.

In 1980, Michael Soulé and Bruce Wilcox published a seminal work entitled *Conservation Biology: An Evolutionary-Ecological Perspective*, in which they presented conservation in this new light. This was quickly followed by Frankel and Soulé’s (1981) *Conservation and Evolution*, another attempt to draw attention to evolution as a basis for conservation decisions. The lesson was further driven home in 1983 with Schonewald-Cox et al.’s *Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations*, which specifically addressed the short- and long-term genetic (and thus evolutionary) health of managed populations. Shortly thereafter, in 1985, the Society for Conservation Biology was formed, a large membership rapidly grew, and a new journal, *Conservation Biology* (Figure 1.5), was developed to complement existing journals such as *Biological Conservation* and *The Journal of Wildlife Management*. Thus, in little more than a decade, the thrust and outlook of international conservation had dramatically changed, and it continues to change as conservation science matures.

Students of conservation biology today should be excited to know that they are still “getting in on the ground floor.” The science of conservation is still developing and needs many bright minds to determine its future direc-