CHAPTER 1

Conservation biology: past and present[1]

Curt Meine

Our job is to harmonize the increasing kit of scientific tools and the increasing recklessness in using them with the shrinking biotas to which they are applied. In the nature of things we are mediators and moderators, and unless we can help rewrite the objectives of science we are predestined to failure.

—Aldo Leopold (1940; 1991)

Conservation in the old sense, of this or that resource in isolation from all other resources, is not enough. Environmental conservation based on ecological knowledge and social understanding is required.

—Raymond Dasmann (1959)

Conservation biology is a mission-driven discipline comprising both pure and applied science. . . . We feel that conservation biology is a new field, or at least a new rallying point for biologists wishing to pool their knowledge and techniques to solve problems.

—Michael E. Soulé and Bruce A. Wilcox (1980)

Conservation biology, though rooted in older scientific, professional, and philosophical traditions, gained its contemporary definition only in the mid-1980s. Anyone seeking to understand the history and growth of conservation biology thus faces inherent challenges. The field has formed too recently to be viewed with historical detachment, and the trends shaping it are still too fluid to be easily traced. Conservation biology's practitioners remain embedded within a process of change that has challenged conservation "in the old sense," even while extending conservation's core commitment to the future of life, human and non-human, on Earth.

There is as yet no comprehensive history of conservation that allows us to understand the causes and context of conservation biology's emergence. Environmental ethicists and historians have provided essential studies of particular conservation ideas, disciplines, institutions, individuals, ecosystems, landscapes, and resources. Yet we still lack a broad, fully integrated account of the dynamic coevolution of conservation science, philosophy, policy, and practice (Meine 2004). The rise of conservation biology marked a new "rallying point" at the intersection of these domains; exactly how, when, and why it did so are still questions awaiting exploration.

1.1 Historical foundations of conservation biology

Since conservation biology's emergence, commentary on (and in) the field has rightly emphasized its departure from prior conservation science and practice. However, the main "thread" of the field—the description, explanation, appreciation, protection, and perpetuation of *biological diversity* can be traced much further back through the historical tapestry of the biological sciences and the conservation movement (Mayr 1982;

[1] Adapted from Meine, C., Soulé, M., and Noss, R. F. (2006). "A mission-driven discipline": the growth of conservation biology. *Conservation Biology*, **20**, 631–651.

McIntosh 1985; Grumbine 1996; Quammen 1996). That thread weaves through related themes and concepts in conservation, including wilderness protection, sustained yield, wildlife protection and management, the diversity-stability hypothesis, ecological restoration, sustainability, and ecosystem health. By focusing on the thread itself, conservation biology brought the theme of biological diversity to the fore.

In so doing, conservation biology has reconnected conservation to deep sources in Western natural history and science, and to cultural traditions of respect for the natural world both within and beyond the Western experience (see Box 1.1 and Chapter 14). Long before environmentalism began to reshape "conservation in the old sense" in the 1960s—prior even to the Progressive Era conservation movement of the early 1900s—the foundations of conservation biology were being laid over the course of biology's epic advances over the last four centuries. The "discovery of diversity" (to use Ernst Mayr's phrase) was the driving force behind the growth of biological thought. "Hardly any aspect of life is more

Box 1.1 Traditional ecological knowledge and biodiversity conservation
Fikret Berkes

Conservation biology is a discipline of Western science, but there are other traditions of conservation in various parts of the world (see also Chapter 14). These traditions are based on local and indigenous knowledge and practice. Traditional ecological knowledge may be defined as a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission. It is experiential knowledge closely related to a way of life, multi-generational, based on oral transmission rather than book learning, and hence different from science in a number of ways.

Traditional knowledge does not always result in conservation, just as science does not always result in conservation. But there are a number of ways in which traditional knowledge and practice may lead to conservation outcomes. First, sacred groves and other sacred areas are protected through religious practice and enforced by social rules. UNESCO's (the United Nations Educational, Scientific and Cultural Organization) World Heritage Sites network includes many sacred sites, such as Machu Picchu in Peru. Second, many national parks have been established at the sites of former sacred areas, and are based on the legacy of traditional conservation. Alto Fragua Indiwasi National Park in Colombia and Kaz Daglari National Park in Turkey are examples. Third, new protected areas are being established at the request of indigenous peoples as a safeguard against development. One example is the Paakumshumwaau Biodiversity Reserve in James Bay, Quebec, Canada (see Box 1.1 Figure). In the Peruvian Andes, the centre of origin of the potato, the Quetchua people maintain a mosaic of agricultural and natural areas as a biocultural heritage site with some 1200 potato varieties, both cultivated and wild.

Box 1.1 Figure Paakumshumwaau Biodiversity Reserve in James Bay, Quebec, Canada, established at the request of the Cree Nation of Wemindji. Photograph by F. Berkes.

In some cases, high biodiversity is explainable in terms of traditional livelihood practices that maintain a diversity of varieties, species and landscapes. For example, Oaxaca State in Mexico exhibits high species richness despite the absence of official protected areas. This may be attributed to the diversity of local and indigenous practices resulting in multi-functional cultural landscapes. In many parts of the world, agroforestry systems that rely on the cultivation of a diversity of crops and trees together (as opposed to modern

continues

Box 1.1 (Continued)

monocultures), seem to harbor high species richness. There are at least three mechanisms that help conserve biodiversity in the use of agroforestry and other traditional practices:

- Land use regimes that maintain forest patches at different successional stages conserve biodiversity because each stage represents a unique community. At the same time, such land use contributes to continued ecosystem renewal.
- The creation of patches, gaps and mosaics enhance biodiversity in a given area. In the study of landscape ecology, the principle is that low and intermediate levels of disturbance often increase biodiversity, as compared to non-disturbed areas.
- Boundaries between ecological zones are characterized by high diversity, and the creation of new edges (ecotones) by disturbance enhances biodiversity, but mostly of "edge-loving" species. Overlaps and mixing of plant and animal species produce dynamic landscapes.

The objective of formal protected areas is biodiversity conservation, whereas traditional conservation is often practiced for livelihood and cultural reasons. Making biodiversity conservation relevant to most of the world requires bridging this gap, with an emphasis on sustainability, equity and a diversity of approaches. There is international interest in community-conserved areas as a class of protected areas. Attention to time-tested practices of traditional conservation can help develop a pluralistic, more inclusive definition of conservation, and build more robust constituencies for conservation.

SUGGESTED READING

Berkes, F. (2008). *Sacred ecology*, 2nd edn. Routledge, New York, NY.

characteristic than its almost unlimited diversity," wrote Mayr (1982:133). "Indeed, there is hardly any biological process or phenomenon where diversity is not involved."

This "discovery" unfolded as colonialism, the Industrial Revolution, human population growth, expansion of capitalist and collectivist economies, and developing trade networks transformed human social, economic, political, and ecological relationships ever more quickly and profoundly (e.g. Crosby 1986; Grove 1995; Diamond 1997). Technological change accelerated humanity's capacity to reshape the world to meet human needs and desires. In so doing, it amplified tensions along basic philosophical fault lines: mechanistic/organic; utilitarian/reverential; imperialist/arcadian; reductionism/holism (Thomas *et al.* 1956; Worster 1985). As recognition of human environmental impacts grew, an array of 19th century philosophers, scientists, naturalists, theologians, artists, writers, and poets began to regard the natural world within an expanded sphere of moral concern (Nash 1989). For example, Alfred Russel Wallace (1863) warned against the "extinction of the numerous forms of life which the progress of cultivation invariably entails" and urged his scientific colleagues to assume the responsibility for stewardship that came with knowledge of diversity.

The first edition of George Perkins Marsh's *Man and Nature* appeared the following year. In his second chapter, "Transfer, Modification, and Extirpation of Vegetable and of Animal Species," Marsh examined the effect of humans on biotic diversity. Marsh described human beings as a "new geographical force" and surveyed human impacts on "minute organisms," plants, insects, fish, "aquatic animals," reptiles, birds, and "quadrupeds." "All nature," he wrote, "is linked together by invisible bonds, and every organic creature, however low, however feeble, however dependent, is necessary to the well-being of some other among the myriad forms of life with which the Creator has peopled the earth." He concluded his chapter with the hope that people might "learn to put a wiser estimate on the works of creation" (Marsh 1864). Through the veil of 19^{th} century language, modern conservation biologists may recognize Marsh, Wallace, and others as common intellectual ancestors.

Marsh's landmark volume appeared just as the post-Civil War era of rampant resource exploitation commenced in the United States. A generation later, Marsh's book undergirded the Progressive Era reforms that gave conservation in the United States its modern meaning and turned it into a national movement. That movement rode Theodore Roosevelt's presidency into public consciousness and across the American landscape. Conservationists in the Progressive Era were famously split along utilitarian-preservationist lines. The utilitarian Resource Conservation Ethic, realized within new federal conservation agencies, was committed to the efficient, scientifically informed management of natural resources, to provide "the greatest good to the greatest number for the longest time" (Pinchot 1910:48). By contrast, the Romantic-Transcendental Preservation Ethic, overshadowed but persistent through the Progressive Era, celebrated the aesthetic and spiritual value of contact with wild nature, and inspired campaigns for the protection of parklands, refuges, forests, and "wild life."

Callicott (1990) notes that both ethical camps were "essentially human-centered or 'anthropocentric'... (and) regarded human beings or human interests as the only legitimate ends and nonhuman natural entities and nature as a whole as means." Moreover, the science upon which both relied had not yet experienced its 20^{th} century revolutions. Ecology had not yet united the scientific understanding of the abiotic, plant, and animal components of living systems. Evolutionary biology had not yet synthesized knowledge of genetics, population biology, and evolutionary biology. Geology, paleontology, and biogeography were just beginning to provide a coherent narrative of the temporal dynamics and spatial distribution of life on Earth. Although explicitly informed by the natural sciences, conservation in the Progressive Era was primarily economic in its orientation, reductionist in its tendencies, and selective in its application.

New concepts from ecology and evolutionary biology began to filter into conservation and the resource management disciplines during the early 20^{th} century. "Proto-conservation biologists" from this period include Henry C. Cowles, whose pioneering studies of plant succession and the flora of the Indiana Dunes led him into active advocacy for their protection (Engel 1983); Victor Shelford, who prodded his fellow ecologists to become active in establishing biologically representative nature reserves (Croker 1991); Arthur Tansley, who similarly advocated establishment of nature reserves in Britain, and who in 1935 contributed the concept of the "ecosystem" to science (McIntosh 1985; Golley 1993); Charles Elton, whose text *Animal Ecology* (1927) provided the foundations for a more dynamic ecology through his definition of food chains, food webs, trophic levels, the niche, and other basic concepts; Joseph Grinnell, Paul Errington, Olaus Murie, and other field biologists who challenged prevailing notions on the ecological role and value of predators (Dunlap 1988); and biologists who sought to place national park management in the USA on a sound ecological footing (Sellars 1997; Shafer 2001). Importantly, the crisis of the Dust Bowl in North America invited similar ecological critiques of agricultural practices during the 1930s (Worster 1979; Beeman and Pritchard 2001).

By the late 1930s an array of conservation concerns—soil erosion, watershed degradation, urban pollution, deforestation, depletion of fisheries and wildlife populations—brought academic ecologists and resource managers closer together and generated a new awareness of conservation's ecological foundations, in particular the significance of biological diversity. In 1939 Aldo Leopold summarized the point in a speech to a symbolically appropriate joint meeting of the Ecological Society of America and the Society of American Foresters:

> The emergence of ecology has placed the economic biologist in a peculiar dilemma: with one hand he points out the accumulated findings of his search for utility, or lack of utility, in this or that species; with the other he lifts the veil from a biota

> so complex, so conditioned by interwoven cooperations and competitions, that no man can say where utility begins or ends. No species can be 'rated' without the tongue in the cheek; the old categories of 'useful' and 'harmful' have validity only as conditioned by time, place, and circumstance. The only sure conclusion is that the biota as a whole is useful, and (the) biota includes not only plants and animals, but soils and waters as well (Leopold 1991:266–67).

With appreciation of "the biota as a whole" came greater appreciation of the functioning of ecological communities and systems (Golley 1993). For Leopold and others, this translated into a redefinition of conservation's aims: away from the narrow goal of sustaining outputs of discrete commodities, and toward the more complex goal of sustaining what we now call ecosystem health and resilience.

As conservation's aims were thus being redefined, its ethical foundations were being reconsidered. The accumulation of revolutionary biological insights, combined with a generation's experience of fragmented policy, short-term economics, and environmental decline, yielded Leopold's assertion of an Evolutionary-Ecological Land Ethic (Callicott 1990). A land ethic, Leopold wrote, "enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land"; it "changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it" (Leopold 1949:204). These ethical concepts only slowly gained ground in forestry, fisheries management, wildlife management, and other resource management disciplines; indeed, they are contentious still.

In the years following World War II, as consumer demands increased and technologies evolved, resource development pressures grew. Resource managers responded by expanding their efforts to increase the yields of their particular commodities. Meanwhile, the pace of scientific change accelerated in disciplines across the biological spectrum, from microbiology, genetics, systematics, and population biology to ecology, limnology, marine biology, and biogeography (Mayr 1982). As these advances accrued, maintaining healthy connections between the basic sciences and their application in resource management fields proved challenging. It fell to a diverse cohort of scientific researchers, interpreters, and advocates to enter the public policy fray (including such notable figures as Rachel Carson, Jacques-Yves Cousteau, Ray Dasmann, G. Evelyn Hutchinson, Julian Huxley, Eugene and Howard Odum, and Sir Peter Scott). Many of these had worldwide influence through their writings and students, their collaborations, and their ecological concepts and methodologies. Working from within traditional disciplines, government agencies, and academic seats, they stood at the complicated intersection of conservation science, policy, and practice—a place that would come to define conservation biology.

More pragmatically, new federal legislation in the USA and a growing body of international agreements expanded the role and responsibilities of biologists in conservation. In the USA the National Environmental Policy Act (1970) required analysis of environmental impacts in federal decision-making. The Endangered Species Act (1973) called for an unprecedented degree of scientific involvement in the identification, protection, and recovery of threatened species (see Chapter 12). Other laws that broadened the role of biologists in conservation and environmental protection include the Marine Mammal Protection Act (1972), the Clean Water Act (1972), the Forest and Rangeland Renewable Resources Planning Act (1974), the National Forest Management Act (1976), and the Federal Land Policy Management Act (1976).

At the international level, the responsibilities of biologists were also expanding in response to the adoption of bilateral treaties and multilateral agreements, including the UNESCO (United Nations Educational, Scientific and Cultural Organization) Man and the Biosphere Programme (1970), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975), and the Convention on Wetlands of International Importance (the "Ramsar Convention") (1975). In 1966 the International Union for the Conservation of Nature (IUCN) published it first "red list" inventories of threatened species. In short, the need for rigorous science input *into* conservation decision-making was increasing, even as the science *of* conservation was changing. This state of affairs challenged the traditional orientation of resource managers and research biologists alike.

1.2 Establishing a new interdisciplinary field

In the opening chapter of *Conservation Biology: An Evolutionary-Ecological Perspective*, editors Michael Soulé and Bruce Wilcox (1980) described conservation biology as "a mission-oriented discipline comprising both pure and applied science." The phrase *crisis-oriented* (or *crisis-driven*) was soon added to the list of modifiers describing the emerging field (Soulé 1985). This characterization of conservation biology as a *mission-oriented, crisis-driven, problem-solving* field resonates with echoes of the past. The history of conservation and environmental management demonstrates that the emergence of problem-solving fields (or new emphases within established fields) invariably involves new interdisciplinary connections, new institutions, new research programs, and new practices. Conservation biology would follow this pattern in the 1970s, 1980s, and 1990s.

In 1970 David Ehrenfeld published *Biological Conservation*, an early text in a series of publications that altered the scope, content, and direction of conservation science (e.g. MacArthur and Wilson 1963; MacArthur and Wilson 1967; MacArthur 1972; Soulé and Wilcox 1980; CEQ 1980; Frankel and Soulé 1981; Schonewald-Cox *et al.* 1983; Harris 1984; Caughley and Gunn 1986; Soulé 1986; Soulé 1987a) (The journal *Biological Conservation* had also begun publication a year earlier in England). In his preface Ehrenfeld stated, "Biologists are beginning to forge a discipline in that turbulent and vital area where biology meets the social sciences and humanities". Ehrenfeld recognized that the "acts of conservationists are often motivated by strongly humanistic principles," but cautioned that "the practice of conservation must also have a firm scientific basis or, plainly stated, it is not likely to work". Constructing that "firm scientific basis" required—and attracted—researchers and practitioners from varied disciplines (including Ehrenfeld himself, whose professional background was in medicine and physiological ecology). The common concern that transcended the disciplinary boundaries was *biological diversity*: its extent, role, value, and fate.

By the mid-1970s, the recurring debates within theoretical ecology over the relationship between species diversity and ecosystem stability were intensifying (Pimm 1991; Golley 1993; McCann 2000). Among conservationists the theme of diversity, in eclipse since Leopold's day, began to re-emerge. In 1951, renegade ecologists had created The Nature Conservancy for the purpose of protecting threatened sites of special biological and ecological value. In the 1960s voices for diversity began to be heard within the traditional conservation fields. Ray Dasmann, in *A Different Kind of Country* (1968: vii) lamented "the prevailing trend toward uniformity" and made the case "for the preservation of natural diversity" and for cultural diversity as well. Pimlott (1969) detected "a sudden stirring of interest in diversity . . . Not until this decade did the word diversity, as an ecological and genetic concept, begin to enter the vocabulary of the wildlife manager or land-use planner." Hickey (1974) argued that wildlife ecologists and managers should concern themselves with "all living things"; that "a scientifically sound wildlife conservation program" should "encompass the wide spectrum from one-celled plants and animals to the complex species we call birds and mammals." Conservation scientists and advocates of varied backgrounds increasingly framed the fundamental conservation problem in these new and broader terms (Farnham 2002).

As the theme of biological diversity gained traction among conservationists in the 1970s, the key components of conservation biology began to coalesce around it:

- Within the sciences proper, the synthesis of knowledge from island biogeography and population biology greatly expanded understanding of the distribution of species diversity and the phenomena of speciation and extinction.

- The fate of threatened species (both *in situ* and *ex situ*) and the loss of rare breeds and plant germplasm stimulated interest in the heretofore neglected (and occasionally even denigrated) application of genetics in conservation.
- Driven in part by the IUCN red listing process, captive breeding programs grew; zoos, aquaria, and botanical gardens expanded and redefined their role as partners in conservation.
- Wildlife ecologists, community ecologists, and limnologists were gaining greater insight into the role of keystone species and top-down interactions in maintaining species diversity and ecosystem health.
- Within forestry, wildlife management, range management, fisheries management, and other applied disciplines, ecological approaches to resource management gained more advocates.
- Advances in ecosystem ecology, landscape ecology, and remote sensing provided increasingly sophisticated concepts and tools for land use and conservation planning at larger spatial scales.
- As awareness of conservation's social dimensions increased, discussion of the role of values in science became explicit. Interdisciplinary inquiry gave rise to environmental history, environmental ethics, ecological economics, and other hybrid fields.

As these trends unfolded, "keystone individuals" also had special impact. Peter Raven and Paul Ehrlich (to name two) made fundamental contributions to coevolution and population biology in the 1960s before becoming leading proponents of conservation biology. Michael Soulé, a central figure in the emergence of conservation biology, recalls that Ehrlich encouraged his students to speculate across disciplines, and had his students read Thomas Kuhn's *The Structure of Scientific Revolutions* (1962). The intellectual syntheses in *population biology* led Soulé to adopt (around 1976) the term *conservation biology* for his own synthesizing efforts.

For Soulé, that integration especially entailed the merging of genetics and conservation (Soulé 1980). In 1974 Soulé visited Sir Otto Frankel while on sabbatical in Australia. Frankel approached Soulé with the idea of collaborating on a volume on the theme (later published as *Conservation and Evolution*) (Frankel and Soulé 1981). Soulé's work on that volume led to the convening of the First International Conference on Conservation Biology in September 1978. The meeting brought together what looked from the outside like "an odd assortment of academics, zoo-keepers, and wildlife conservationists" (Gibbons 1992). Inside, however, the experience was more personal, among individuals who had come together through important, and often very personal, shifts in professional priorities. The proceedings of the 1978 conference were published as *Conservation Biology: An Evolutionary-Ecological Perspective* (Soulé and Wilcox 1980). The conference and the book initiated a series of meetings and proceedings that defined the field for its growing number of participants, as well as for those outside the immediate circle (Brussard 1985; Gibbons 1992).

Attention to the genetic dimension of conservation continued to gain momentum into the early 1980s (Schonewald-Cox *et al.* 1983). Meanwhile, awareness of threats to species diversity and causes of extinction was reaching a broader professional and public audience (e.g. Ziswiler 1967; Iltis 1972; Terborgh 1974; Ehrlich and Ehrlich 1981). In particular, the impact of international development policies on the world's species-rich, humid tropical forests was emerging as a global concern. Field biologists, ecologists, and taxonomists, alarmed by the rapid conversion of the rainforests—and witnesses themselves to the loss of research sites and study organisms—began to sound alarms (e.g. Gómez-Pompa *et al.* 1972; Janzen 1972). By the early 1980s, the issue of rainforest destruction was highlighted through a surge of books, articles, and scientific reports (e.g. Myers 1979, 1980; NAS 1980; NRC 1982; see also Chapter 4).

During these years, recognition of the needs of the world's poor and the developing world was prompting new approaches to integrating conservation and development. This movement was embodied in a series of international programs, meetings, and reports, including the Man and the Biosphere Programme (1970), the United Nations Conference on the Human Environment held in Stockholm (1972), and the World Conservation Strategy (IUCN 1980). These approaches eventually came together under the banner of *sustainable* *development*, especially as defined in the report of the World Commission on Environment and Development (the "Brundtland Report") (WCED 1987). The complex relationship between development and conservation created tensions within conservation biology from the outset, but also drove the search for deeper consensus and innovation (Meine 2004).

A Second International Conference on Conservation Biology convened at the University of Michigan in May 1985 (Soulé 1986). Prior to the meeting, the organizers formed two committees to consider establishing a new professional society and a new journal. A motion to organize the Society for Conservation Biology (SCB) was approved at the end of the meeting (Soulé 1987b). One of the Society's first acts was to appoint David Ehrenfeld editor of the new journal *Conservation Biology* (Ehrenfeld 2000).

The founding of SCB coincided with planning for the National Forum on BioDiversity, held September 21–24, 1986 in Washington, DC. The forum, broadcast via satellite to a national and international audience, was organized by the US National Academy of Sciences and the Smithsonian Institution. Although arranged independently of the process that led to SCB's creation, the forum represented a convergence of conservation concern, scientific expertise, and interdisciplinary commitment. In planning the event, Walter Rosen, a program officer with the National Research Council, began using a contracted form of the phrase *biological diversity*. The abridged form *biodiversity* began its etymological career.

The forum's proceedings were published as *Biodiversity* (Wilson and Peter 1988). The wide impact of the forum and the book assured that the landscape of conservation science, policy, and action would never be the same. For some, conservation biology appeared as a new, unproven, and unwelcome kid on the conservation block. Its adherents, however, saw it as the culmination of trends long latent within ecology and conservation, and as a necessary adaptation to new knowledge and a gathering crisis. Conservation biology quickly gained its footing within academia, zoos and botanical gardens, non-profit conservation groups, resource management agencies, and international development organizations (Soulé 1987b).

In retrospect, the rapid growth of conservation biology reflected essential qualities that set it apart from predecessor and affiliated fields:

- Conservation biology rests upon a scientific foundation in systematics, genetics, ecology, and evolutionary biology. As the Modern Synthesis rearranged the building blocks of biology, and new insights emerged from population genetics, developmental genetics (heritability studies), and island biogeography in the 1960s, the application of biology in conservation was bound to shift as well. This found expression in conservation biology's primary focus on the conservation of genetic, species, and ecosystem diversity (rather than those ecosystem components with obvious or direct economic value).
- Conservation biology paid attention to the entire biota; to diversity at all levels of biological organization; to patterns of diversity at various temporal and spatial scales; and to the evolutionary and ecological processes that maintain diversity. In particular, emerging insights from ecosystem ecology, disturbance ecology, and landscape ecology in the 1980s shifted the perspective of ecologists and conservationists, placing greater emphasis on the dynamic nature of ecosystems and landscapes (e.g. Pickett and White 1985; Forman 1995).
- Conservation biology was an interdisciplinary, systems-oriented, and inclusive response to conservation dilemmas exacerbated by approaches that were too narrowly focused, fragmented, and exclusive (Soulé 1985; Noss and Cooperrider 1994). It provided an interdisciplinary home for those in established disciplines who sought new ways to organize and use scientific information, and who followed broader ethical imperatives. It also reached beyond its own core scientific disciplines to incorporate insights from the social sciences and humanities, from the empirical experience of resource managers, and from diverse cultural sources (Grumbine 1992; Knight and Bates 1995).
- Conservation biology acknowledged its status as an inherently "value-laden" field. Soulé (1985) asserted that "ethical norms are a genuine part of conservation biology." Noss (1999) regarded this as

a distinguishing characteristic, noting an "overarching normative assumption in conservation biology . . . that biodiversity is good and ought to be preserved." Leopold's land ethic and related appeals to intergenerational responsibilities and the intrinsic value of non-human life motivated growing numbers of conservation scientists and environmental ethicists (Ehrenfeld 1981; Samson and Knopf 1982; Devall and Sessions 1985; Nash 1989). This explicit recognition of conservation biology's ethical content stood in contrast to the usual avoidance of such considerations within the sciences historically (McIntosh 1980; Barbour 1995; Barry and Oelschlaeger 1996).

- Conservation biology recognized a "close linkage" between biodiversity conservation and economic development and sought new ways to improve that relationship. As *sustainability* became the catch-all term for development that sought to blend environmental, social, and economic goals, conservation biology provided a new venue at the intersection of ecology, ethics, and economics (Daly and Cobb 1989). To achieve its goals, conservation biology had to reach beyond the sciences and generate conversations with economists, advocates, policy-makers, ethicists, educators, the private sector, and community-based conservationists.

Conservation biology thus emerged in response to both increasing knowledge and expanding demands. In harnessing that knowledge and meeting those demands, it offered a new, integrative, and interdisciplinary approach to conservation science.

1.3 Consolidation: conservation biology secures its niche

In June 1987 more than 200 people attended the first annual meeting of the Society for Conservation Biology in Bozeman, Montana, USA. The rapid growth of the new organization's membership served as an index to the expansion of the field generally. SCB tapped into the burgeoning interest in interdisciplinary conservation science among younger students, faculty, and conservation practitioners. Universities established new courses, seminars, and graduate programs. Scientific organizations and foundations adjusted their funding priorities and encouraged those interested in the new field. A steady agenda of conferences on biodiversity conservation brought together academics, agency officials, resource managers, business representatives, international aid agencies, and non-governmental organizations. In remarkably rapid order, conservation biology gained legitimacy and secured a professional foothold.

Not, however, without resistance, skepticism, and occasional ridicule. As the field grew, complaints came from various quarters. Conservation biology was caricatured as a passing fad, a response to trendy environmental ideas (and momentarily available funds). Its detractors regarded it as too theoretical, amorphous, and eclectic; too promiscuously interdisciplinary; too enamored of models; and too technique-deficient and data-poor to have any practical application (Gibbons 1992). Conservation biologists in North America were accused of being indifferent to the conservation traditions of other nations and regions. Some saw conservation biology as merely putting "old wine in a new bottle" and dismissing the rich experience of foresters, wildlife managers, and other resource managers (Teer 1988; Jensen and Krausman 1993). *Biodiversity* itself was just too broad, or confusing, or "thorny" a term (Udall 1991; Takacs 1996).

Such complaints made headlines within the scientific journals and reflected real tensions within resource agencies, academic departments, and conservation organizations. Conservation biology had indeed challenged prevalent paradigms, and such responses were to be expected. Defending the new field, Ehrenfeld (1992: 1625) wrote, "Conservation biology is not defined by a discipline but by its goal—to halt or repair the undeniable, massive damage that is being done to ecosystems, species, and the relationships of humans to the environment. . . . Many specialists in a host of fields find it difficult, even hypocritical, to continue business as usual, blinders firmly in place, in a world that is falling apart."

Meanwhile, a spate of new and complex conservation issues were drawing increased attention to biodiversity conservation. In North America, the Northern Spotted Owl (*Strix occidentalis caurina*) became the poster creature in deeply contentious debates over the fate of remaining old-growth forests and alternative approaches to forest management; the Exxon Valdez oil spill and its aftermath put pollution threats and energy policies on the front page; the anti-environmental, anti-regulatory "Wise Use" movement gained in political power and influence; arguments over livestock grazing practices and federal rangeland policies pitted environmentalists against ranchers; perennial attempts to allow oil development within the Arctic National Wildlife Refuge continued; and moratoria were placed on commercial fishing of depleted stocks of northern cod (Alverson *et al.* 1994; Yaffee 1994; Myers *et al.* 1997; Knight *et al.* 2002; Jacobs 2003).

At the international level, attention focused on the discovery of the hole in the stratospheric ozone layer over Antarctica; the growing scientific consensus about the threat of global warming (the Intergovernmental Panel on Climate Change was formed in 1988 and issued its first assessment report in 1990); the environmental legacy of communism in the former Soviet bloc; and the environmental impacts of international aid and development programs. In 1992, 172 nations gathered in Rio de Janeiro at the United Nations Conference on Environment and Development (the "Earth Summit"). Among the products of the summit was the Convention on Biological Diversity. In a few short years, the scope of biodiversity conservation, science, and policy had expanded dramatically (e.g. McNeely *et al.* 1990; Lubchenco *et al.* 1991).

To some degree, conservation biology had defined its own niche by synthesizing scientific disciplines, proclaiming its special mission, and gathering together a core group of leading scientists, students, and conservation practitioners. However, the field was also filling a niche that was rapidly opening around it. It provided a meeting ground for those with converging interests in the conservation of biological diversity. It was not alone in gaining ground for interdisciplinary conservation research and practice. It joined restoration ecology, landscape ecology, agroecology, ecological economics, and other new fields in seeking solutions across traditional academic and intellectual boundaries.

Amid the flush of excitement in establishing conservation biology, it was sometimes easy to overlook the challenges inherent in the effort. Ehrenfeld (2000) noted that the nascent field was "controversy-rich." Friction was inherent not only in conservation biology's relationship to related fields, but within the field itself. Some of this was simply a result of high energy applied to a new endeavor. Often, however, this reflected deeper tensions in conservation: between sustainable use and protection; between public and private resources; between the immediate needs of people, and obligations to future generations and other life forms. Conservation biology would be the latest stage on which these long-standing tensions would express themselves.

Other tensions reflected the special role that conservation biology carved out for itself. Conservation biology was largely a product of American institutions and individuals, yet sought to address a problem of global proportions (Meffe 2002). Effective biodiversity conservation entailed work at scales from the global to the local, and on levels from the genetic to the species to the community; yet actions at these different scales and levels required different types of information, skills, and partnerships (Noss 1990). Professionals in the new field had to be firmly grounded within particular professional specialties, yet conversant across disciplines (Trombulak 1994; Noss 1997). Success in the *practice* of biodiversity conservation was measured by on-the-ground impact, yet the *science* of conservation biology was obliged (as are all sciences) to undertake rigorous research and to define uncertainty (Noss 2000). Conservation biology was a "value-laden" field adhering to explicit ethical norms, yet sought to advance conservation through careful scientific analysis (Barry and Oelschlager 1996). These tensions within conservation biology were present at birth. They continue to present important challenges to conservation biologists. They also give the field its creativity and vitality.

1.4 Years of growth and evolution

Although conservation biology has been an organized field only since the mid-1980s, it is possible to identify and summarize at least several salient trends that have shaped it since.

1.4.1 Implementation and transformation

Conservation biologists now work in a much more elaborate field than existed at the time of its founding. Much of the early energy—and debate—in conservation biology focused on questions of the genetics and demographics of small populations, population and habitat viability, landscape fragmentation, reserve design, and management of natural areas and endangered species. These topics remain close to the core of conservation biology, but the field has grown around them. Conservation biologists now tend to work more flexibly, at varied scales and in varied ways. In recent years, for example, more attention has focused on landscape permeability and connectivity, the role of strongly interacting species in top-down ecosystem regulation, and the impacts of global warming on biodiversity (Hudson 1991; Lovejoy and Peters 1994; Soulé and Terborgh 1999; Ripple and Beschta 2005; Pringle *et al.* 2007; Pringle 2008; see Chapters 5 and 8).

Innovative techniques and technologies (such as computer modeling and geographic information systems) have obviously played an important role in the growth of conservation biology. The most revolutionary changes, however, have involved the reconceptualizing of science's role in conservation. The principles of conservation biology have spawned creative applications among conservation visionaries, practitioners, planners, and policy-makers (Noss *et al.* 1997; Adams 2005). To safeguard biological diversity, larger-scale and longer-term thinking and planning had to take hold. It has done so under many rubrics, including: adaptation of the biosphere reserve concept (Batisse 1986); the development of gap analysis (Scott *et al.* 1993); the movement toward ecosystem management and adaptive management (Grumbine 1994b; Salafsky *et al.* 2001; Meffe *et al.* 2002); ecoregional planning and analogous efforts at other scales (Redford *et al.* 2003); and the establishment of marine protected areas and networks (Roberts *et al.* 2001).

Even as conservation biologists have honed tools for designing protected area networks and managing protected areas more effectively (see Chapter 11), they have looked beyond reserve boundary lines to the matrix of surrounding lands (Knight and Landres 1998). Conservation biologists play increasingly important roles in defining the biodiversity values of aquatic ecosystems, private lands, and agroecosystems. The result is much greater attention to private land conservation, more research and demonstration at the interface of agriculture and biodiversity conservation, and a growing watershed- and community-based conservation movement. Conservation biologists are now active across the entire landscape continuum, from wildlands to agricultural lands and from suburbs to cities, where conservation planning now meets urban design and green infrastructure mapping (e.g. Wang and Moskovits 2001; CNT and Openlands Project 2004).

1.4.2 Adoption and integration

Since the emergence of conservation biology, the conceptual boundaries between it and other fields have become increasingly porous. Researchers and practitioners from other fields have come into conservation biology's circle, adopting and applying its core concepts while contributing in turn to its further development. Botanists, ecosystem ecologists, marine biologists, and agricultural scientists (among other groups) were underrepresented in the field's early years. The role of the social sciences in conservation biology has also expanded within the field (Mascia *et al.* 2003). Meanwhile, conservation biology's concepts, approaches, and findings have filtered into other fields. This "permeation" (Noss 1999) is reflected in the number of biodiversity conservation-related articles appearing in the general science journals such as *Science* and *Nature*, and in more specialized ecological and resource management journals. Since 1986 several new journals with related content have appeared, including *Ecological Applications* (1991), the *Journal of Applied Ecology* (1998), the on-line journal *Conservation Ecology* (1997) (now called

Ecology and Society), *Frontiers in Ecology and the Environment* (2003), and *Conservation Letters* (2008).

The influence of conservation biology is even more broadly evident in environmental design, planning, and decision-making. Conservation biologists are now routinely involved in land-use and urban planning, ecological design, landscape architecture, and agriculture (e.g. Soulé 1991; Nassauer 1997; Babbitt 1999; Jackson and Jackson 2002; Miller and Hobbs 2002; Imhoff and Carra 2003; Orr 2004). Conservation biology has spurred activity within such emerging areas of interest as conservation psychology (Saunders 2003) and conservation medicine (Grifo and Rosenthal 1997; Pokras *et al.* 1997; Tabor *et al.* 2001; Aguirre *et al.* 2002). Lidicker (1998) noted that "conservation needs conservation biologists for sure, but it also needs conservation sociologists, conservation political scientists, conservation chemists, conservation economists, conservation psychologists, and conservation humanitarians." Conservation biology has helped to meet this need by catalyzing communication and action among colleagues across a wide spectrum of disciplines.

1.4.3 Marine and freshwater conservation biology

Conservation biology's "permeation" has been especially notable with regard to aquatic ecosystems and marine environments. In response to long-standing concerns over "maximum sustained yield" fisheries management, protection of marine mammals, depletion of salmon stocks, degradation of coral reef systems, and other issues, marine conservation biology has emerged as a distinct focus area (Norse 1993; Boersma 1996; Bohnsack and Ault 1996; Safina 1998; Thorne-Miller 1998; Norse and Crowder 2005). The application of conservation biology in marine environments has been pursued by a number of non-governmental organizations, including SCB's Marine Section, the Ocean Conservancy, the Marine Conservation Biology Institute, the Center for Marine Biodiversity and Conservation at the Scripps Institution of Oceanography, the Blue Ocean Institute, and the Pew Institute for Ocean Science.

Interest in freshwater conservation biology has also increased as intensified human demands continue to affect water quality, quantity, distribution, and use. Conservationists have come to appreciate even more deeply the essential hydrological connections between groundwater, surface waters, and atmospheric waters, and the impact of human land use on the health and biological diversity of aquatic ecosystems (Leopold 1990; Baron *et al.* 2002; Glennon 2002; Hunt and Wilcox 2003; Postel and Richter 2003). Conservation biologists have become vital partners in interdisciplinary efforts, often at the watershed level, to steward freshwater as both an essential ecosystem component and a basic human need.

1.4.4 Building capacity

At the time of its founding, conservation biology was little known beyond the core group of scientists and conservationists who had created it. Now the field is broadly accepted and well represented as a distinct body of interdisciplinary knowledge worldwide. Several textbooks appeared soon after conservation biology gained its footing (Primack 1993; Meffe and Carroll 1994; Hunter 1996). These are now into their second and third editions. Additional textbooks have been published in more specialized subject areas, including insect conservation biology (Samways 1994), conservation of plant biodiversity (Frankel *et al.* 1995), forest biodiversity (Hunter and Seymour 1999), conservation genetics (Frankham *et al.* 2002), marine conservation biology (Norse and Crowder 2005), and tropical conservation biology (Sodhi *et al.* 2007).

Academic training programs in conservation biology have expanded and now exist around the world (Jacobson 1990; Jacobson *et al.* 1995; Rodríguez *et al.* 2005). The interdisciplinary skills of conservation biologists have found acceptance within universities, agencies, non-governmental organizations, and the private sector. Funders have likewise helped build conservation biology's capacity through support for students, academic programs, and basic research and field projects. Despite such growth, most conservation biologists would likely agree that the capacity does not nearly meet the need, given the urgent problems in biodiversity conservation. Even the existing support is highly vulnerable to budget cutbacks, changing priorities, and political pressures.

1.4.5 Internationalization

Conservation biology has greatly expanded its international reach (Meffe 2002; Meffe 2003). The scientific roots of biodiversity conservation are obviously not limited to one nation or continent (see Box 1.2). Although the international conservation movement dates back more than a century, the history of the science from an international perspective has been inadequately studied (Blandin 2004). This has occasionally led to healthy debate over the origins and development of conservation biology. Such debates, however, have not hindered the trend toward greater international collaboration and representation within the field (e.g. Medellín 1998).

Box 1.2 Conservation in the Philippines
Mary Rose C. Posa

Conservation biology has been referred to as a "discipline with a deadline" (Wilson 2000). As the rapid loss and degradation of ecosystems accelerates across the globe, some scientists suggest a strategy of triage—in effect, writing off countries that are beyond help (Terborgh 1999). But are there any truly lost causes in conservation?

The Philippines is a mega-biodiversity country with exceptionally high levels of endemism (~50% of terrestrial vertebrates and 45–60% of vascular plants; Heaney and Mittermeier 1997). However, centuries of exploitation and negligence have pushed its ecosystems to their limit, reducing primary forest cover [less than 3% remaining; FAO (Food and Agriculture Organization of the United Nations) 2005], decimating mangroves (>90% lost; Primavera 2000), and severely damaging coral reefs (~5% retaining 75–100% live cover; Gomez *et al.* 1994), leading to a high number of species at risk of extinction [~21% of vertebrates assessed; IUCN (International Union for Conservation of Nature and Natural Resources) 2006]. Environmental degradation has also brought the loss of soil fertility, pollution, and diminished fisheries productivity, affecting the livelihood of millions of rural inhabitants. Efforts to preserve biodiversity and implement sound environmental policies are hampered by entrenched corruption, weak governance and opposition by small but powerful interest groups. In addition, remaining natural resources are under tremendous pressure from a burgeoning human population. The Philippines has thus been pegged as a top conservation "hotspot" for terrestrial and marine ecosystems, and there are fears that it could be the site of the first major extinction spasm (Heaney and Mittermeier 1997; Myers *et al.* 2000; Roberts *et al.* 2002). Remarkably, and despite this precarious situation, there is evidence that hope exists for biodiversity conservation in the Philippines.

Indication of the growing valuation of biodiversity, sustainable development and environmental protection can be seen in different sectors of Philippine society. Stirrings of grassroots environmental consciousness began in the 1970s, when marginalized communities actively opposed unsustainable commercial developments, blocking logging trucks, and protesting the construction of large dams (Broad and Cavanagh 1993). After the 1986 overthrow of dictator Ferdinand Marcos, a revived democracy fostered the emergence of civil society groups focused on environmental issues. The devolution of authority over natural resources from central to local governments also empowered communities to create and enforce regulations on the use of local resources. There are now laudable examples where efforts by communities and non-governmental organizations (NGOs) have made direct impacts on conserving endangered species and habitats (Posa *et al.* 2008).

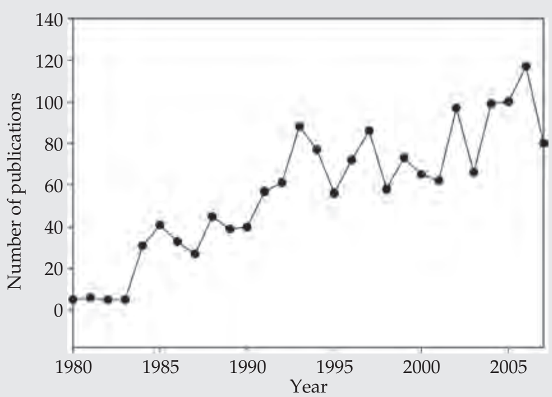
Driven in part by public advocacy, there has also been considerable progress in environmental legislation. In particular, the

continues

Box 1.2 (Continued)

National Integrated Protected Areas System Act provides for stakeholder involvement in protected area management, which has been a key element of success for various reserves. Perhaps the best examples of where people-centered resource use and conservation have come together are marine protected areas (MPAs) managed by coastal communities across the country—a survey of 156 MPAs reported that 44.2% had good to excellent management (Alcala and Russ 2006).

Last, but not least, there has been renewed interest in biodiversity research in academia, increasing the amount and quality of biodiversity information (see Box 1.2 Figure). Labors of field researchers result in hundreds of additional species yet to be described, and some rediscoveries of species thought to be extinct (e.g. Cebu flowerpecker *Dicaeum quadricolor*; Dutson *et al.* 1993). There are increasing synergies and networks among conservation workers, politicians, community leaders, park rangers, researchers, local people, and international NGOs, as seen from the growth of the Wildlife Conservation Society of the Philippines, which has a diverse membership from all these sectors.



Box 1.2 Figure Steady increase in the number of publications on Philippine biodiversity and conservation, obtained from searching three ISI Web of Knowledge databases for the period 1980–2007.

While many daunting challenges remain especially in the area of conservation of populations (Chapter 10) and ecosystems services (Chapter 3), and there is no room for complacency, that positive progress has been made in the Philippines—a conservation "worst case scenario"—suggests that there are grounds for optimism for biodiversity conservation in tropical countries worldwide.

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This growth is reflected in the expanding institutional and membership base of the Society for Conservation Biology. The need to reach across national boundaries was recognized by the founders of the SCB. From its initial issue *Conservation Biology* included Spanish translations of article abstracts. The Society has diversified its editorial board, recognized the accomplishments of leading conservation biologists from around the world, and regularly convened its meetings outside the USA. A significant move toward greater international participation in the SCB came when, in 2000, the SCB began to develop its regional sections.

1.4.6 Seeking a policy voice

Conservation biology has long sought to define an appropriate and effective role for itself in shaping public policy (Grumbine 1994a). Most who call themselves conservation biologists feel obligated to be advocates for biodiversity (Odenbaugh 2003). How that obligation ought to be fulfilled has been a source of continuing debate within the field. Some scientists are wary of playing an active advocacy or policy role, lest their objectivity be called into question. Conversely, biodiversity advocates have responded to the effect that "if you don't use your science to shape policy, we will."

Conservation biology's inherent mix of science and ethics all but invited such debate. Far from avoiding controversy, *Conservation Biology*'s founding editor David Ehrenfeld built dialogue on conservation issues and policy into the journal at the outset. *Conservation Biology* has regularly published letters and editorials on the question of values, advocacy, and the role of science in shaping policy. Conservation biologists have not achieved final resolution on the matter. Perhaps in the end it is irresolvable, a matter of personal judgment involving a mixture of scientific confidence levels, uncertainty, and individual conscience and responsibility. "Responsibility" is the key word, as all parties to the debate seem to agree that advocacy, to be responsible, must rest on a foundation of solid science and must be undertaken with honesty and integrity (Noss 1999).

1.5 Conservation biology: a work in progress

These trends (and no doubt others) raise important questions for the future. Conservation biology has grown quickly in a few brief decades, yet most conservation biologists would assert that growth for growth's sake is hardly justified. As disciplines and organizations become more structured, they are liable to equate mere expansion with progress in meeting their missions (Ehrenfeld 2000). Can conservation biology sustain its own creativity, freshness, and vision? In its collective research agenda, is the field asking, and answering, the appropriate questions? Is it performing its core function—providing reliable and useful scientific information on biological diversity and its conservation—in the most effective manner possible? Is that information making a difference? What "constituencies" need to be more fully involved and engaged?

While continuing to ponder such questions, conservation biologists cannot claim to have turned back the threats to life's diversity. Yet the field has contributed essential knowledge at a time when those threats have continued to mount. It has focused attention on the full spectrum of biological diversity, on the ecological processes that maintain it, on the ways we value it, and on steps that can be taken to conserve it. It has brought scientific knowledge, long-range perspectives, and a conservation ethic into the public and professional arenas in new ways. It has organized scientific information to inform decisions affecting biodiversity at all levels and scales. In so doing, it has helped to reframe fundamentally the relationship between conservation philosophy, science, and practice.

Summary

- Conservation biology emerged in the mid-1980s as a new field focused on understanding, protecting, and perpetuating biological diversity at all scales and all levels of biological organization.
- Conservation biology has deep roots in the growth of biology over several centuries, but its

emergence reflects more recent developments in an array of biological sciences (ecology, genetics, evolutionary biology, etc.) and natural resource management fields (forestry, wildlife and fisheries management, etc.).

- Conservation biology was conceived as a "mission-oriented" field based in the biological sciences, but with an explicit interdisciplinary approach that incorporated insights from the social sciences, humanities, and ethics.
- Since its founding, conservation biology has greatly elaborated its research agenda; built stronger connections with other fields and disciplines; extended its reach especially into aquatic and marine environments; developed its professional capacity for training, research, and field application; become an increasingly international field; and become increasingly active at the interface of conservation science and policy.

Suggested reading

- Farnham, T. J. (2007). *Saving Nature's Legacy: Origins of the Idea of Biological Diversity*. Yale University Press, New Haven.
- Quammen, D. (1996). *The Song of the Dodo: Island Biogeography in an Age of Extinctions*. Simon and Schuster, New York.
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Relevant website

- Society for Conservation Biology: http://www.conbio.org/

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