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Biodiversity Conservation

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Biodiversity conservation is the coordinated effort to sustain the diversity of life, at the genetic, species, and ecosystem levels, through the integration of scientific knowledge, philosophical understanding, economic and institutional policies, and management practices. It builds upon earlier historical stages in natural resource protection and management, but has as its primary focus not the sustained yield of particular biological resources, nor the preservation of particular parts of the landscape, but the protection, restoration, and maintenance of diversity and functionality in living systems at all levels of the biological hierarchy.

As knowledge of life’s diversity—its evolutionary basis, its historical and contemporary distribution, its accelerated loss due to human activity—has grown, the concept of biodiversity has reshaped the aims, assumptions, and methods of conservation. At the same time, conservationists have come to emphasize both the intrinsic and the instrumental value of biodiversity (for example, for human health, economic well-being, and ecosystem resilience). These shifts in the foundations of the conservation and environmental movements have recalibrated bioethical perspectives over the last century and a half. An examination of biodiversity conservation illustrates the significance of bioethics as a field that reaches beyond questions of human health and well-being to

embrace the full context of the living world in which humans have evolved and now exist.

### The Background of Conservation

Only since the 1980s have the value and significance of biological diversity become critical to the goals and practice of conservation. As a focus of concerted citizen action, public policy, scientific research, applied management, and professional endeavor, conservation first gained definition in the early 1900s. Over the decades, the conservation movement has evolved in response to varied forces: emerging scientific information, shifts in philosophical premises and aesthetic standards, new environmental threats, novel technologies, changing legal mandates, and constantly shifting social, economic, and political conditions. The interplay of these forces has produced a movement that remains in flux and whose goals continue to evolve as the world's ecosystems face increasing challenges to their diversity and integrity.

The Evolving Idea of Conservation. The term *conservation* acquired its modern meaning in the early twentieth century with the rise of the Progressive Era conservation crusade in the United States. However, as an expression of cultural commitment to an enduring and resilient relationship with the natural world, conservation has much deeper prehistoric and historic roots. Prehistoric peoples did not live in a simple or constant state of peaceful coexistence with and within their natural surroundings. Converging lines of evidence from paleontology, paleoecology, archaeology, and anthropology suggest in fact a

sobering picture of the human past: that the dispersal of the human population out of Africa over the past 70,000 years has been accompanied by spasms of continental and insular extinction (among other forms of environmental degradation).

In contrast to this record of prehistoric anthropogenic extinction, however, there are countervailing examples of many cultures having achieved relatively sustainable ways of life. Native peoples in landscapes throughout the world developed sophisticated belief systems and resource-use traditions that recognized their connections to and dependence on nonhuman nature. Some of these traditions have survived into the modern era, though they now contend with increasing pressures from population growth, diminished resources, altered land tenure systems, climate change, and rapid economic and technological change. In the past, these traditions allowed people to adapt to and sustain themselves in even extreme environments throughout the world. The conservation movement might be characterized as modern society's conscious effort to develop and exercise analogous social practices and restraints to guide its relations with the nonhuman world.

Contemporary environmental dilemmas have prompted modern scholars to reexamine conservation traditions in texts and stories from animist, Native American, Buddhist, Hindu, Judeo-Christian, Islamic, and other faith traditions. In the Judeo-Christian tradition, for example, the biblical injunction to "fill the earth and subdue it, and have dominion over every living thing that moves upon the earth" (Genesis 1:28) has often been cited as providing the justification and rationale for centuries of environmental exploitation in the Western experience. More recently, scholars have reinterpreted such textual sources, identifying alternative traditions of stewardship and respect for creation.

Early Western Approaches. Since ancient times, observers have recorded instances of environmental deterioration due to human action. Plato, for example, compared the deforested mountains of Attica to the “bones of a wasted body . . . the richer and softer parts of the soil having fallen away, and the mere skeleton being left” (Dubos 1980, 3). Evidence of early conservation practices can be found in the history of both Western and non-Western cultures. These include efforts to protect particular species and special lands, to maintain populations of wild plants and animals, and to sustain the productivity of agroecosystems.

European traditions of forestry and gamekeeping date back to the Middle Ages and beyond. The establishment of royal game preserves and forests on the land estates of feudal Europe led to the development of customs and formalized laws regulating hunting and use of the forests—while also giving rise to a venerable tradition of local resentment over centralized resource management. On the continent, Germany and France in particular developed silvicultural systems and techniques that prevented wholesale destruction of the forest estate.

Europeans carried these “protoconservation” traditions to their expanding colonial empires. The change in jurisdiction over natural resources, from native peoples to colonial and state governments, had profound implications for social systems and ecosystems alike. Colonial domination, coupled with rising populations and industrialization, disrupted traditional patterns of land tenure and resource use. In many regions, native peoples became increasingly alienated from their landscapes, while Western conservation ideas and practices were slow to adapt to the new environments.

Efforts in North America. In the New World, European colonists encountered a landscape of abundance as Native American populations were decimated by disease and displacement. Unchecked resource exploitation was the norm as European settlement of North America proceeded. Despite this record, seeds of the later conservation movement were apparent in early efforts to protect wild game populations, forests, soils, waters, and special natural features. Through the 1800s, for example, the new American states intermittently passed laws establishing closed seasons, prohibiting hunting of nongame birds, and placing bounties on predators.

Despite such early resource conservation measures, exploitation of North America's extensive native forests—for conversion to agriculture, for construction and shipbuilding materials, for charcoal and domestic fuel supplies—drove economic development through much of the colonial and early American era. With the exhaustion of the eastern forests and the continuing settlement of interior North America, the focus of forest exploitation shifted to the Great Lakes region. The swift destruction of the Great Lakes pine forests in the latter decades of the 1800s in fact marked a turning point in forest conservation and in the emerging conservation movement generally.

A parallel pattern of resource degradation and early conservation response marked the process of agricultural development in North America. By 1776 the problem of soil erosion was evident to the new nation's leading statesmen. Over the next century, destructive agricultural techniques continued to take their toll on native plant and animal diversity in ecosystems across North America (and in other parts of the world as well).

At the same time, the preservation impulse in conservation found special expression in the North American setting, as European settlers encountered scenic

landscapes and natural features unlike any in their prior experience. Thomas Jefferson, for example, celebrated Virginia's Natural Bridge in his *Notes on the State of Virginia*. The artist George Catlin suggested after his first excursions in the West that portions of the continent's undeveloped lands were "worthy of our preservation and protection" (Nash 2001, 101). Such early expressions of concern were not aimed at conserving biological diversity in the modern sense, but sought primarily to protect economically and aesthetically important components of the landscape or ecosystem. Although limited in intent, these early protective measures provided the foundation on which a more coherent conservation movement began to take shape in the latter half of the nineteenth century.

### Modern Origins of Conservation

Exploration of the world's diverse ecosystems—from the earliest voyages of discovery through the New World scientific expeditions of Alexander von Humboldt, John and William Bartram, Meriwether Lewis and George Rogers Clark, John James Audubon, and others—contributed to a golden age of natural history studies in the eighteenth and nineteenth centuries. Establishment and adoption of the Linnean system of binomial nomenclature in the 1700s allowed for an unprecedented flourishing of taxonomic research. This, in turn, provided critical foundations for the development of evolutionary theory in the work of Alfred Russel Wallace and Charles Darwin. Although the biological sciences had not yet developed field methods for comprehending the full diversity of life,

they had begun to reveal the fundamental processes through which life diversifies and maintains itself.

These gains in systematics, biogeography, and evolutionary theory occurred even as the Industrial Revolution and the expansion of market economies accelerated the progression in scale, pace, and character of human environmental impacts. Through the 1800s, the advent of more efficient technologies resulted in increasingly intensive exploitation of forests, game populations, fisheries, agricultural lands, and river systems. Traditional resource management practices and established land tenure systems were abandoned or changed to fit the emerging economies of scale. Industrial pollution and the global spread of invasive species became widespread problems for the first time. The concentration of carbon dioxide and other warming gases in the atmosphere began to increase with the shift to, and increasing reliance on, fossil fuel energy sources.

Philosophy and Literature. Coincident with these scientific, cultural, and environmental changes, the Enlightenment and romantic movements were altering Western conceptions of order, value, and beauty in the natural world. The natural philosophers of the Enlightenment stressed the smooth workings and stability of a mechanistic natural order. The romantic philosophers and poets emphasized the unity and wholeness to be found in a spontaneously creative organic nature. Although offering fundamentally different conceptions of nature, both encouraged human comprehension of natural objects and processes, and so laid the foundation for greater appreciation of human impacts upon the natural world. The writings of Thomas Malthus and other early economic philosophers provided the basic framework for considering the interwoven fate of the human population, human economies, and natural resources.

In Europe the romantic movement drew heavily upon the experiences of New World explorers and settlers, the encounters with native peoples there and elsewhere, and the exposure to wild landscapes. In turn, adaptation of the romantic impulse in the North American setting provided important literary and philosophical foundations for conservation. The strong American identification with wild nature found early expression in, for example, the essays of the transcendentalists Ralph Waldo Emerson and Henry David Thoreau, the poetry of William Cullen Bryant AND WALT WHITMAN, and the novels of James Fenimore Cooper.

George Perkins Marsh's *Man and Nature; or, Physical Geography as Modified by Human Action* (1864) is widely considered the first great landmark in modern conservation literature. A native Vermonter, Marsh saw in the destruction of New England's forests the latest expression of an ancient human tendency to "[derange] the original proportions between different orders of organic life" (103). Drawing on his extensive personal observations of long-term landscape change in New England and the Mediterranean, Marsh argued that human actions had caused widespread disruption of the "harmonies" of the natural world. Marsh's reasoning followed lines that would sound familiar to later generations of ecologists and biodiversity conservationists. "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" (109).

The publication of Marsh's book provided direction and definition to the nascent conservation movement through the remainder of the 1800s and the first decade of the 1900s. In North America, the dispossession of the Native American tribes, the enactment



of liberal land distribution policies, and the flow of settlers and capital into “virgin” landscapes resulted in an unprecedented wave of exploitation of natural resources.

Progress in Policy. This period also saw the first concerted efforts to address the causes and consequences of such massive ecological changes. At first these actions tended to focus on particular issues, species, problems, or landscapes. Sportsmen led campaigns to rein in market hunting and to institute stronger game laws at the state and local levels. Exploitation of plume-bearing egrets and other birds for the millinery trade mobilized sportsmen, scientists, and nature lovers to work together for reform. These moves culminated in the passage of the Lacey Act of 1900. The first important piece of modern national wildlife conservation legislation, it barred interstate shipment of wild animal species taken in violation of state laws, and soon succeeded in ending the plume trade.

Efforts to reform American land policy proved more difficult. Through the 1800s, the nation’s land allotment policies had encouraged rapid emigration, immigration, settlement, and land conversion, often accompanied by corruption and land speculation. The lands of the American West presented special challenges to settlement. The geologist and explorer John Wesley Powell attempted in the 1870s and 1880s to devise a more appropriate tenure system that would recognize the inherent environmental limitations and social requirements of the region’s arid and semi-arid landscape, but the speculative momentum proved intractable. Only decades later did the US government institute more careful land management policies on the nation’s remaining public domain. However, Powell’s innovations, especially his commitment to a strong role for science in land

management, laid important foundations for future private and public conservation planning.

The forestry movement quickly gained momentum in the last decade of the nineteenth century. Forest advocates working through professional scientific and forestry organizations campaigned for national legislation to reform public land laws and prevent further forest destruction. These efforts culminated in 1891 with the adoption of legislation that included a provision allowing the US president to set aside public land forests as forest reserves, the germ of the nation's current system of national forests.

The movement to protect and preserve special scenic landscapes, natural features, and wild spaces likewise gained momentum in the decades following the American Civil War. In 1872 the US Congress established the world's first national park at Yellowstone. In 1885 New York created a state forest preserve in the Adirondack Mountains in order to protect its wild character as well as its watershed values. That same year Canada designated Banff National Park, its first. The impetus toward preservation drew heavily upon the enthusiasm of nature writers such as John Muir, who led the political effort that in 1890 resulted in the designation of an enlarged Yosemite National Park in California and who in 1892 founded the Sierra Club.

At the end of the nineteenth century, the varied strands of conservation concern—over depleted wildlife, widespread deforestation and watershed degradation, inappropriate land development, industrial pollution, and the loss of aesthetic quality—were connected only loosely. In the American experience, political corruption and inordinately concentrated wealth had typically accompanied these environmental changes. As the twentieth century began, these overlapping social, economic, political,

and environmental concerns brought forth a more consolidated movement that gave new meaning and power to the term *conservation*. However, the growing prominence of conservation also revealed inherent tensions in the emerging movement.

### Progressive Era Conservation

When Theodore Roosevelt assumed the American presidency in 1901, the stage was set for a revolution in conservation policy. Roosevelt's partner in political innovation was forester Gifford Pinchot. Pinchot, the first American to receive formal training in forestry, was a friend of Roosevelt who had been active in the complex politics of the American forestry movement through the 1890s. Their partnership during Roosevelt's presidency resulted in an increase in the total acreage of the forest reserves (renamed *national forests* in 1905) from 60 million to 151 million acres; the transfer of these lands to the Department of Agriculture under Pinchot's jurisdiction; and the creation, in 1905, of the US Forest Service to administer the new national forests.

The Utilitarian/Preservationist Split. Pinchot's Forest Service embodied the Progressive Era spirit and its approach to bureaucratic responsibilities. In contrast to Muir and others in the preservationist wing of the conservation movement, Pinchot conceived of the forest in utilitarian terms. The forests were not regarded as "reserves" to be "locked up," but as lands to be worked "for the greatest good of the greatest number for the longest time" (as Pinchot's formulation of the utilitarian credo put it) (Pinchot 1910, 48).

In practice, this meant that the forests were to be managed by a trained, professional workforce; that scientific principles were to guide the efficient exploitation

and processing of forest resources; and that the wealth derived from the forests was to be equitably distributed for the common good. Applied not only to forests but to natural resources in general, the resource conservation ethic provided the dominant paradigm of the early movement. Absent from many of the Progressive political initiatives were the voices of the increasingly influential preservationists and nature protectors. In contrast to the utilitarian view that Pinchot espoused, adherents of the romantic-transcendental preservation ethic emphasized wild nature's aesthetic and spiritual values and the need to safeguard those values for future generations through strict prohibitions on development and manipulation (Callicott 1990).

The tensions between the utilitarian and preservationist approaches intensified as conservation assumed center stage politically. The schism between the conservation factions came to a head in the bitter political struggle over plans to dam the Tuolumne River in Yosemite National Park's Hetch Hetchy Valley. Waged over a period of six years, the battle culminated in 1913 with the adoption of national legislation providing federal support for the dam. Although Muir and his colleagues lost the battle, they had aroused a national constituency in favor of protection. The growing popular and political acceptance of preservation led directly to the creation of the US National Park Service in 1916.

For all of the profound developments in conservation during the Progressive Era, scant attention was given to the state of the ecological processes and biological diversity characteristic of either wilder or more humanized landscapes. That attention would come only slowly, as conservation science, philosophy, policy, and practice coevolved through the twentieth century.

## Conservation through the Early Twentieth Century

As conservation in the United States became institutionalized, it tended to follow the tenets of Pinchot's resource conservation ethic. By the late 1930s, the basic principles of utilitarian resource conservation had been applied not only to forests but also to other "useful" components of the biota and the landscape: rangelands, game populations, sport and commercial fisheries, scenic lands and recreational areas, agricultural soils, river systems. New policies, laws, bureaucracies, academic disciplines, research and training programs, and professional societies arose to promote sustained yields of and from these various "resources."

Internationally, the years prior to World War II saw increasing recognition of the global scope of conservation challenges and halting moves to institutionalize a response to those challenges. The Western powers—particularly the United States, Britain, France, and Germany—continued to export forestry and national park programs to their colonies and protectorates. Intermittent steps were taken toward greater international cooperation: international conservation conferences in Europe in 1913 and 1923; the establishment in 1928 of an International Office for the Protection of Nature, in Brussels; an unprecedented international bird conservation conference in Paris in 1933; a Conference for the Protection of African Fauna and Flora in London, also in 1933; the first North American Wildlife Conference in 1936; and the establishment of the Pan-American Union, dedicated largely to conservation issues in the Western Hemisphere, in 1940.

These developments set the stage for the expanded international programs that emerged in the aftermath of World War II.

With the outbreak of World War II, conservation issues fell into the background of concerns, proving the difficulty of maintaining mindfulness of human-nature relationships when social crises erupt. As in no time since the Progressive Era, these years of crisis demonstrated the interwoven nature of social, economic, and environmental problems. However, conservation remained subject to the underlying philosophical rift between the utilitarian and preservationist approaches. Neither approach adequately addressed the increasingly extensive problems of soil erosion and exhaustion, disruption of hydrological cycles, endangerment and loss of species, and the degradation of biotic communities (both terrestrial and aquatic).

Scientific Advances. By the 1930s developments in ecology and evolutionary biology over the previous decades had begun to inform conservation issues, even as contemporary problems forced conservationists to reexamine their scientific assumptions. Ecology was revolutionizing scientific understanding of the functioning of biological communities, landscapes, and systems. Evolutionary biology provided new perspectives on, for example, the adaptations, roles, and interactions of all forest species (in contrast to the basic descriptive botany, dendrology, timber physics, and forest mensuration upon which silviculture and forestry had previously rested).

These scientific advances suggested the need to introduce ecological perspectives into the various fields of resource management in the effort to sustain not just the yields of particular commodities, but the healthy functioning of ecosystems generally. A key voice in this emerging approach was the American forester and wildlife ecologist Aldo

Leopold, who in the course of his career applied ecological principles first to the conservation of forests, then to soils, watersheds, game and wildlife species, agricultural lands, and then ultimately to the land “as a whole.”

Writing in 1939, Leopold noted that ecology provided “a new fusion point for all the natural sciences” and that its emergence

had 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. . . . 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. (727)

Leopold’s expanded conservation philosophy, as finally expressed in his landmark essay “The Land Ethic” in *A Sand County Almanac* (1949), emphasized the diversity, functional integrity, and beauty of what he called “the biotic community” and rejected the view of nature as merely a collection of disaggregated natural resources. It shifted the role of human beings “from conqueror of the land community to plain member and citizen of it” (204). Leopold’s evolutionary-ecological land ethic provided an alternative to the simple economic and utilitarian paradigm on the one hand, and the strict preservationist approach on the other (Callicott 1990). This provisional reconciliation would confront continuing challenges in the dramatically altered postwar environment. However, it would also provide those in the conservation movement with new conceptual tools with which to meet those challenges.

## Biodiversity: Emergence of an Idea

In the postwar years, new tools in the earth sciences provided greater scientific understanding of the interrelations within and among terrestrial, aquatic, marine, and atmospheric systems. In the 1950s and 1960s, revolutions in fields ranging from genetics and evolutionary biology to atmospheric chemistry and geology began rapidly to reshape society's understanding of the global biosphere and the human place within it. The publication in 1962 of Rachel Carson's landmark book *Silent Spring*, examining the biological impacts of DDT and other pesticides, gave rise to the modern environmental movement, distinct from but still connected to the older conservation tradition.

Efforts to protect wildlands in the United States also intensified in the years following World War II. The Wilderness Act in 1964 provided for a strengthened national system of wilderness areas on the public lands of the United States. The Wilderness Act was only one of many laws adopted during this period of environmental awakening. Over the next decade the US Congress would enact a series of important environmental statutes, including the National Environmental Policy Act (1970), the Clean Air Act (1970), the Clean Water Act (1972), and the Endangered Species Act (1973). These far-reaching changes in environmental policy reflected a rising wave of popular support and organized political activism, symbolized by the observance of the first Earth Day on April 22, 1970.

The years following the inception of Earth Day saw increasing acceptance of environmental values. Those values, however, were not easily translated into effective



conservation action. Conservation programs tended still to focus on single species, or particular economic resources, or separate jurisdictions within a given landscape. At the international level, differences in perspective between the wealthier, developed countries of the North and the poorer, developing countries of the South likewise proved difficult to overcome. International conservation continued to make important gains through a series of conventions and treaties, including the Convention on Wetlands of International Importance (the “Ramsar Convention”) (1971), the Convention on International Trade in Endangered Species (CITES) (1975), the International Convention for the Conservation of Migratory Species of Wild Animals (the “Bonn Convention”) (1978), the United Nations Convention on the Law of the Sea (1982), and the United Nations Convention on Biological Diversity (1992). However, international development policies would incorporate stronger conservation and environmental provisions only gradually, as the need to connect economic development and long-term environmental security became increasingly evident.

Disciplinary Synthesis. As these broad patterns of change in the human dimensions of conservation unfolded in the 1970s and 1980s, the scientific foundations of conservation continued to shift. Taxonomy and systematics provided more robust estimates of the extent of species diversity and of its actual and potential loss. The field of island biogeography revealed principles governing the spatial distribution, relative abundance, persistence, and extinction of species, with important implications for land use and the establishment and management of protected areas. Genetics became an increasingly important component of conservation science as attention focused on the reproductive success of rare and endangered species and the viability of their populations,

both in captivity and in the wild. Ecology moved away from its “classical paradigm,” which emphasized discrete, stable, deterministic equilibria, and toward a view of ecosystems emphasizing flux, uncertainty, and contingency. The emerging field of restoration ecology sought to apply ecological principles to the remediation of species loss and ecosystem degradation. Increasingly, conservation strategies required the integration of knowledge from the many branches of biological and social science, involving various levels of biological organization.

The need to rethink conservation across disciplinary lines was driven not only by changes in the foundational sciences but by changes in the environment itself. By the late 1970s, scientists and conservationists were alarmed by the escalating loss of genetic, species, and ecosystem diversity at the global scale. Of special concern was the accelerated destruction of the species-rich forests of the humid tropics. The advances in island biogeography revealed that ecosystems of all types were being fragmented by human activity, while even the most effectively protected areas were at risk due to their inadequate size and their isolation. Wildland managers increasingly understood that preservation alone was an inadequate management strategy, and that the loss of diversity and the disruption of ecological functions were intimately associated. Agricultural scientists, foresters, and other resource managers, too, were increasingly concerned about environmental degradation, the breakdown of ecosystem processes, the loss of diversity in humanized landscapes, and the social and economic costs associated with these changes.

These concerns prompted the emergence in the mid-1980s of a new synthetic interdisciplinary field, conservation biology, specifically devoted to the integration of

knowledge from the sciences and other disciplines in the effort to understand, maintain, and restore biological diversity (Meine et al. 2006). Conservation biology has sought to address conservation problems within an evolutionary and ecological context, and to stimulate the traditional conservation professions to reassess their management methods and goals accordingly. The compound term *biodiversity* itself was coined in 1986 and has since been widely adopted by conservationists. The concepts of *sustainability* and *sustainable development* came into general usage during the same period, reflecting the complex challenge of integrating long-term social, economic, and environmental factors in assessing human demands and impacts on ecosystems.

These concepts gained broader international footing in 1992 at the “Earth Summit” in Rio de Janeiro. Among the products of the summit was the Convention on Biological Diversity, which recognizes the conservation of biodiversity as “a common concern of humankind” (UN 1992, 1). The convention binds its signatories to undertake conservation efforts in concert with development; to address conservation needs at the genetic, species, and ecosystem levels; and to integrate traditional conservation approaches with the sustainable use of biological resources.

### Biodiversity and Bioethics

Since the 1980s the concept of biodiversity has changed the focus in conservation, highlighting the diversity and resilience of living systems and the human effects, positive and negative, on those systems. As such, it has reframed the ethical relationship of humans and nonhuman nature. It challenges the traditional utilitarian view of nature as a

collection of discrete, economically significant (or expendable) components. Likewise, it challenges the traditional preservationist view that humans can be separated from nature, and nature thereby protected from human impacts. By recasting the human role in nature and emphasizing the reality of economic relationships and transeconomic values within ecosystems, biodiversity conservation has inevitably entailed deeper consideration of ethical constructs.

Since the 1980s, the field of biodiversity conservation has matured together with the field of environmental ethics. As the former has sought to expand the purview of conservation to include the diversity of life, the latter has sought to enlarge the scope of ethical inquiry beyond the human sphere. However, the links between biodiversity and bioethics have still to be more fully explored. This has begun to occur more frequently as shared areas of concern have emerged: for example, biodiversity as a source of medicinal compounds; the phenomena of emerging diseases; climate change and human health; water, aquatic ecosystem health, and public health; exploration of the human microbiome; and the links between biodiversity and mental health.

In recognizing these connections to biodiversity, bioethicists are in a sense returning to the roots of their own field. Sass (2007) credits the German philosopher and educator Fritz Jahr with coining the term *bioethics* in a 1927 article entitled “Bio-Ethics: A Review of the Ethical Relationships of Humans to Animals and Plants.” Oncologist and biochemist Van Rensselaer Potter introduced the term more broadly in his 1971 book *Bioethics: Bridge to the Future*, which is dedicated to Aldo Leopold and in which Potter aimed to address issues at the intersection of biology, ecology, medicine, and ethics. In a later volume, *Global Bioethics: Building on the Leopold Legacy*, he sought explicitly to

reclaim the scope of the term from its more restricted meaning of biomedical ethics. The public may anticipate that connections between biodiversity conservation and bioethics will continue to proliferate as understanding grows of the dynamic relationships between levels of biological hierarchy, between humans and nonhuman nature, and between human health and ecosystem health.

## Conclusion

Although antecedents to conservation can be traced back over centuries, the conservation movement in the modern sense first emerged in the early twentieth century. Since then, conservation's aims have steadily evolved beyond the sustained exploitation of particular resources and the protection of particular natural features to address the sustainability and resilience of ecosystems and human communities within them. In the process, conservation has come to place greater emphasis on the diversity of life at all geographic scales and all levels of biological organization. In the late twentieth century this shift came to be reflected in the neologism *biodiversity* and in an expanding discourse regarding the ethical significance of biological diversity in human affairs—and, conversely, the significance of human affairs for the fate of biodiversity. As scientists and ethicists alike come to appreciate more fully the complexity and dynamism of human-nature relationships—physical, psychological, economic, and ecological—the boundaries between environmental ethics and bioethics are likely to dim, and the areas of convergence to emerge more clearly.

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