

prevention, and use of market-based incentives to supplement conventional regulation will also reshape the policy agenda for the 1990s and the early twenty-first century. Perhaps of greatest importance the emergence of new global environmental threats such as climate change and the protection of biological diversity promises to redefine environmental policy ambitions in the decades ahead for the United States and all other nations.

Michael E. Kraft

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See also AIR POLLUTION: REGULATION (U.S.); BUSH, GEORGE; ENDANGERED SPECIES ACT (U.S.); ENVIRONMENTAL PROTECTION AGENCY; NATIONAL ENVIRONMENTAL POLICY ACT (U.S.); REAGAN, RONALD; RESOURCE CONSERVATION AND RECOVERY ACT; SUPERFUND; TOXIC SUBSTANCES CONTROL ACT

Leopold, Aldo

Over a forty-year career Aldo Leopold's contributions as a writer, forester, wildlife ecologist and manager, educator, philosopher, and activist established him as one of the central figures in twentieth-century conservation. Combining the sensibility of a poet, the discipline of a scientist, and the curiosity of a scholar, Leopold both stimulated and exemplified the evolution of conservation from a movement based on narrow utilitarian grounds to one based on a sound understanding of ecological processes and human impacts on ecological systems.

Leopold was born in Burlington, Iowa in 1887 and grew up along the banks of the Mississippi River. Introduced to hunting and fishing as a boy, he absorbed his father's deep-seated commitment to sportsmanship and outdoor ethics. These early lessons fed his decision as a teenager to become a forester. After graduating from Lawrenceville Preparatory School in New Jersey Leopold entered Yale

University, where in 1909 he received his Master's degree in forestry. He thus became a member of the first generation of Americans to be formally trained in the field.

After completing his studies Leopold joined the U.S. Forest Service (USFS) as a field officer in the national forests of the American Southwest. Over the next fifteen years he rose through the ranks of the USFS, gaining wide recognition among foresters as an innovative writer, thinker, and administrator, devoting himself in particular to the issues of game protection, soil erosion, rangeland degradation, and wilderness protection in the Southwest. His special concern over the loss of wilderness led him to advocate, beginning in 1921, the establishment of inviolate "wilderness areas" within the national forests. His work led to the designation in 1924 of the Gila Wilderness Area within New Mexico's Gila National Forest, the first such area to be so designated on the public lands of the United States.

In 1924 Leopold moved to Madison, Wisconsin, to assume the assistant directorship of the U.S. Forest Products Laboratory—the primary wood research facility of the USFS. Remaining in this position for four years, Leopold devoted increasing amounts of his time to the cause of wilderness protection and to what had always been his most fundamental interest: the conservation of wildlife (which at the time entailed mainly the protection of game animals). In 1928 Leopold left the USFS to dedicate himself wholly to the task of building wildlife management as a viable field.

Over the next three years Leopold conducted detailed field surveys of game populations and habitats in the north-central United States. This unprecedented effort resulted in a book-length report and, ultimately, the publication in 1933 of *Game Management*, the first text in the field. Combining his extensive field experience with new findings and concepts in animal ecology, Leopold's book contributed significantly to a fundamental shift within game conservation, away from artificial propagation and restrictive legislation and toward the protection and restoration of habitat. In 1933 Leopold accepted an appointment as professor of game management at the University of Wisconsin—the first academic position in the new field.

Up until this point much of Leopold's work in game management consisted of applying the principles of sustained-yield forestry to the management of game animals. But through the

1930s Leopold's thinking gradually evolved to reflect his deepening knowledge of ecology and his growing dissatisfaction with the limits of utilitarian conservation philosophy. This evolution had many stimuli: early experiments in ecological restoration at the University of Wisconsin Arboretum; the disastrous consequences of the Dust Bowl in the high plains; a trip to Germany in 1935 during which he studied the history of European forestry and game management; two trips into Mexico's wild Sierra Madre Occidental; and the expanded interest in wildlife (as opposed to "game") management in the United States in the late 1930s.

As a result of these and other factors Leopold's management philosophy began to stress increasingly the importance of what he termed "land health," or the functional integrity of the biotic community. "The land," he wrote in 1944, "consists of soil, water, plants, and animals, but health is more than a sufficiency of these components. It is a state of vigorous self-renewal in each of them, and in all collectively." In practice this entailed greater emphasis (whether in forestry, agriculture, fisheries management, wildlife management, range management, or other conservation subdisciplines) on ecological function, species diversity, rare and threatened species, and the integration of management efforts. It also gave added importance to wilderness lands, which could provide "a base-datum of normality, a picture of how healthy land maintains itself." In essence Leopold's emerging conservation philosophy superseded both the earlier utilitarian philosophy exemplified by forester Gifford Pinchot and the preservation-oriented school that John Muir represented. Leopold's signal contribution was to synthesize their views within an enlarged context of historical and ecological knowledge.

Another important stimulus to Leopold's thought was his purchase in 1935 of a run-down farm on the floodplain of the Wisconsin River north of Madison. As Leopold and his family worked to restore ecological health to this piece of land it became the focus of his scientific, literary, and philosophical innovations. During World War II Leopold began to write the lyrical essays that would eventually be compiled in his environmental classic, *A Sand County Almanac*. "On this sand farm in Wisconsin," he wrote in its introduction, "first worn out and then abandoned by our bigger-and-better society, we try to rebuild, with shovel and axe, what we are losing elsewhere."

The climax of *A Sand County Almanac* was its philosophical endpiece "The Land Ethic," in which Leopold argued for a broadened definition of community that would "enlarge the boundaries . . . to include soils, waters, plants, and animals, or collectively: the land." Such an expanded definition, it followed, would "[change] the role of *Homo sapiens* from conqueror of the land community to plain member and citizen of it." The Land Ethic would become, in the decades following its publication, an important cornerstone for sustained discussions in environmental ethics, and would establish Leopold as a seminal figure in not only the science and literature, but the philosophy, of conservation.

The manuscript of *A Sand County Almanac* was accepted for publication in April 1947. A week later, on April 21, 1947, Leopold died while fighting a brush fire on a neighbor's farm in Wisconsin.

Curt Meine

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See also CONSERVATION MOVEMENT; ENVIRONMENTAL ETHICS; FOREST SERVICE (U.S.); LAND ETHIC; MUIR, JOHN; PINCHOT, GIFFORD; WILDERNESS

Life-Cycle Analysis

An assessment of all direct and indirect environmental and other impacts of a given technology—whether a product, a system, or an entire sector in society—is called a life-cycle analysis (LCA). Not only are direct impacts from cradle to grave included, but also indirect effects from materials, energy, and other inputs to the manufacturing process and subsequent handling—from building the production facilities, to the transporting of related goods and services, use of the product, and, finally, disposal, whether