



John E. Ross

## KEEPER OF THE COGS

Aldo Leopold 50 years ago anticipated the present-day realization that mankind should conserve all parts of the Earth's life-systems

by Curt Meine

*A cup plant next to the Bradley  
Study Center pond on the Aldo Leopold farm.*

"For a long time the crowd has been more or less following (and sometimes objecting to) rules for wildlife management which you have prescribed. Now they are beginning to follow your philosophies, by and large without realizing whence they came. That is progress!"

—H. Albert Hochbaum to  
Aldo Leopold, 1947

**T**HE TIMES may finally be catching up to Aldo Leopold. Since *A Sand County Almanac* was first published a generation ago, Leopold's admirers have regularly noted that he was "ahead of his time." He has been called the "prophet" of the environmental movement, while *Sand County* is often cited as the movement's "scripture" or "bible." Leopold quotations adorn letterheads and calendars, posters and polemics. The tributes have secured Leopold's position in conservation's pantheon, but the question remains: how deeply have his words been absorbed? How much closer have we really moved in the 45 years since his death toward the goal that he championed—a more harmonious and mutually rewarding relationship between people and place?

There are now signs that both conservation professionals and the general public are beginning to act on the deeper implications of Leopold's land ethic. Perhaps the most important of these signs is the increased attention now being paid to the status and fate of biological diversity (or "biodiversity" for short).

When the complete saga of conservation in the 20th century comes finally to be told, its central storyline is likely to involve the path by which *Homo sapiens* came to—or failed to come to—a fuller appreciation of the diversity of life on Earth. Over the last two decades, the accelerated rate of species extinction because of human activities has become an object of global concern. At the same time, science has begun to fathom the full extent of biological diversity, revealing with greater clarity the role diversity plays in the structure and function of ecological systems, and reminding us of the myriad real and potential benefits to human well-being that biodiversity affords. Philosophy and religion, which Leopold in his day lamented "had not yet heard of"

conservation, have begun to explore the responsibilities of humanity within the larger community of life.

In the process, and in ways that are still difficult to comprehend, we have been gaining a new and broader context for conservation. Prior to the 1980s, conservationists seldom considered the totality of biological diversity as they carried out their practical efforts to protect and manage particular populations, species and places. Even modern biologists—with notable exceptions—shrank from the theme

as their science went increasingly cellular and molecular. Biodiversity as such was not an object of concern; it was the medium in which conservation and biology—in which life itself—took place. And like fish in water, we took our medium for granted.

By the end of the 1980s, the medium had become the message. A host of by-now-familiar environmental phenomena—accelerated rates of habitat loss, disruption and fragmentation in the temperate zones; desertification and deforestation in the trop-

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cused attention on biological diversity as a common denominator in all conservation work. The loss of diversity is seen as both the cause and effect of environmental decline. The impact of human-induced changes in the landscape on species interactions and survival is better (though far from adequately) understood. In short, biodiversity is now recognized for what in fact it has always been: a basic property of natural systems that must be considered in all efforts to protect, manage and restore those systems.

Aldo Leopold had just this consideration in mind when in the mid-1940s he nominated "the complexity of the land" as "the outstanding discovery of the 20th century." He was not engaging in hyperbole. After 35 years as a professional forester, field biologist and wildlife ecologist, he realized that "only those who know the most about [this complexity] can appreciate how little is known about it." In the face of this dilemma, he counseled a true conservatism: "The last word in ignorance is the man who says of an animal or plant: 'What good is it?' If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of eons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."

Over the last several years that passage has often been invoked by conservation biologists, agency officials and citizen activists. It represents as clear an expression of the importance of biological diversity as Leopold ever wrote. Its recent rise on the hit parade of quotable quotes can be taken as an indication that conservation as a whole is evolving and

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ics; degradation of soils and waters in agricultural systems; disruptive invasions of exotic species, especially in island habitats; pollution, mismanagement and overharvesting of aquatic systems around the world; the specter of global warming—has now fo-

finds itself at the point that Leopold himself reached 50 years ago.

Prescient though he was, Leopold did not always place high value on keeping "every cog and wheel." When he began his career in forestry in 1909, biological diversity was not in

the profession's lexicon, much less in its curricula or operations manuals. By the end of his days, he would argue that the maintenance of diversity was key to the healthy functioning of all natural communities, and to the ultimate fate of human activities within them. The process by which he came to that awareness both foreshadowed and stimulated the same changes within the conservation movement as a whole.

The phrase "biological diversity" did not become widely used in its present sense until the 1970s. The contracted "biodiversity" did not appear until 1986, when the National Academy of Sciences and the Smithsonian Institution cosponsored a landmark National Forum on BioDiversity. Thus we would not expect to find these terms in the discussions of Leopold or his contemporaries. What we can find, however, is a record of gradual expansion of knowledge about and concern for other living things and the ecosystems that sustain them. Leopold was by no means alone in this awakening; however, he was unusually disciplined in exploring it and uniquely eloquent in documenting it.

As early as 1915, the germ of the idea can be found in Leopold's formal writings on wildlife conservation—or, to be more precise, on game management. As a young forester in Arizona and New Mexico, he urged his colleagues in the U.S. Forest Service to devote more attention to what had been a neglected responsibility: the active protection and management of wild game populations on Forest Service lands. In his *Game and Fish Handbook*, Leopold's (and the Forest Service's) first publication on the subject, he made the case: "The breeding stock must be increased. Rare species must be protected and restored. The value of game lies in its variety as well as its abundance."

Conservation of wild plants and

*Leopold inspects tamarack saplings he planted on his Wisconsin farm to recreate a native tamarack bog. Above, a bloodroot blooms on the farm, now part of the Leopold Memorial Reserve.*



Jim Brandenburg/Minden Pictures



animals had not yet advanced beyond a concern for species that people hunted, fished, logged or otherwise directly exploited. Yet even within the limited sphere of game animals, Leopold sensed instinctively that "variety" was a quality worth preserving. At the time, his goal was to convince his fellow foresters not only that the fate of game animals was worth considering but that "every indigenous species" of game in the Southwest was worth protecting. To this end, Leopold during these years organized the sportsmen of Arizona and New Mexico into local "game protective associations" to support more effective state conservation laws.

He realized, however, that long-term conservation required more than just restrictive legislation. The greatest threat to self-perpetuating game pop-

ulations was not simply indiscriminate hunting but the loss of suitable habitat. Accordingly, his own efforts turned toward the protection, study and restoration of wild game habitat as the key to effective management.

In advocating this new approach, he faced not only lack of interest on the part of his fellow foresters but competition from a group with far different notions of "game management": game farmers. In distinguishing his aims from those of the game farmers, he again stressed diversity. "The game farmer," he wrote in 1919, "seeks to produce merely something to shoot, while the Wild Lifer seeks to perpetuate at least a sample of all wild life, game and non-game." Leopold probably did not coin the term "nongame." His early use of the term, however, underscored the breadth of his outdoor interests. His commitment and that of many conservationists may have focused initially on the protection of game animals, but ever since his boyhood in Iowa the circle of his concern had included other creatures as well.

The circle, however, was far from all-encompassing. Nongame, as then reckoned, included mainly non-huntable songbirds and small mammals. The vast majority of organisms still lay beyond the average game protector's range of attention. And

"nongame" certainly did not apply to those large predators and other creatures generically deemed "vermin." Even while calling for the perpetuation of "a sample of all wild life," Leopold noted that "controlling vermin is plain common sense, which nobody will seriously question."

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As it happened, that "plain common sense" would be called into question beginning in the 1920s, and Aldo Leopold himself became one of the most astute of the questioners. For the time being, however, he continued to rail against "varmint," and particularly against the wolves, grizzly bears and mountain lions that still inhabited the forests of the Southwest. "It is going to take patience and money to catch the last wolf or lion in New Mexico," he declared in 1920. "But the last one must be caught before the job can be called fully successful."

While endeavoring to lay the foundations of game management, Leopold became increasingly interested in other aspects of conservation in the Southwest. In the early 1920s his official duties as a Forest Service inspector led him to a lifelong interest in the broader processes of landscape change, and in particular the ecological cause-and-effect behind soil erosion in the Southwest mountains and rangelands. Simultaneously he began to push from within the Forest Service for the protection of wilderness areas, a campaign that resulted in 1924 in the designation of the Gila Wilderness, the nation's first, in southwestern New Mexico.

At the time, Leopold's rationale for wilderness protection stressed the recreational, cultural and historical value of wildlands. Implicit in the call, however, was his recognition of the opportunity, lost in the East and in much of the Old World, to provide large areas of undisturbed habitat for native "wild life." Importantly, this stimulated him to see the value of diversity not just at the species level, but in terms of whole landscapes. In one of the many advocacy pieces he penned during this period, he observed: "It is

often assumed that only mountain lands are suitable for wilderness areas. Why not swamps, lakelands, river routes and deserts also?"

In 1924, Leopold moved to Madison, Wisconsin, to assume the assistant directorship of the Forest Service's Forest Products Laboratory. He

remained in this rather sedate position for four years, devoting what spare hours he could afford to his dual causes of wilderness protection and game management. Finally, however, Leopold followed the pull of his true calling. In 1928, he left the Forest Service to devote himself to full-time work on game management.

Working under the auspices of a consortium of sporting arms and ammunition manufacturers, Leopold's new task was to ascertain the status of game species and habitat across the upper Midwest. There was no precedent for such a broad-scale, on-the-ground assessment, and his three years of field investigations provided his emerging theories of game management with a firm grounding in first-hand observation. The position also placed him in the precarious role of mediator between the hunting and nonhunting factions of the conservation movement, a role that in turn forced him to emphasize the common ground between them.

His diplomacy skills were soon put to the test. During these years, Leopold also served as chairman of the Committee on American Wild Life Policy of the American Game Conference. The committee was charged with preparing the first policy statement to guide wildlife conservation efforts across the United States. Through its work, Leopold was able to effect what amounted to a conceptual revolution within the movement. While still focused on game animals, the policy report succeeded for the first time in placing the management emphasis on the preservation and improvement of habitat. "The one and only thing we can do to raise a crop of game," an early version stated, "is to make the environment more favorable. This . . . holds true for all classes of game at



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all times and places. It is the fundamental truth which the conservation movement must learn." But in a concerted effort to expand its application, the report pointed out that "while this plan deals with game only, the actions necessary to produce a crop of game are in large part those which will conserve other valuable forms of wild life." The final version of the committee's report noted that "the public is (and the sportsman ought to be) just as much interested in conserving non-game species as in conserving game."

By this time, even the large predators had gained provisional admittance to the fold. The zealous efforts of federal predator control agents in the national parks and forests and on other public lands had been called into question by scientists and conservationists, most notably in the case of the Kaibab Plateau north of Grand Canyon. On the Kaibab, a combination of thorough predator eradication, tight hunting restrictions, and changes in the forest vegetation had

allowed the mule deer population to irrupt and subsequently to plummet, with devastating effects on range conditions.

The massive dieoff of Kaibab deer in the winters of 1924-25 and 1925-26 remains to this day one of the most important episodes in the history of wildlife conservation. Its lessons reverberated with Leopold for the rest of his life. The immediate effect was evident in the policy report's recommendation that "no predatory species should be exterminated over large areas." The report further stated that "rare predatory species, or species of narrow distribution and exceptional biological interest or aesthetic value, should not be subject to control." The circle of concern had expanded a further degree.

The culmination of this phase of Leopold's work came in 1933 with the publication of his book *Game Management*. The first text in an emerging field, *Game Management* provided students with a generalized approach, applicable to any species

in any environment. In contrast to the species-specific techniques that Leopold and his colleagues had been following up to that point, *Game Management* rested upon a more solid foundation of ecological theory. In this it reflected the important influence of Charles Elton, the eminent British ecologist. Elton's explication of food chains, food webs, trophic levels, population dynamics, the biotic pyramid and other basic ecological concepts in his 1927 book *Animal Ecology* had a permanent influence on Leopold's own scientific work. Their meeting at a conference in 1931 was in retrospect a critical juncture in the development of conservation biology, symbolizing as it did the marriage of ecological theory and management techniques in the interest of wildlife conservation.

*White-tailed deer skirt a duckweed-covered pond in Wisconsin. Leopold advocated reducing the state's large deer herds to provide habitat for other species. Facing page, a pine marten.*

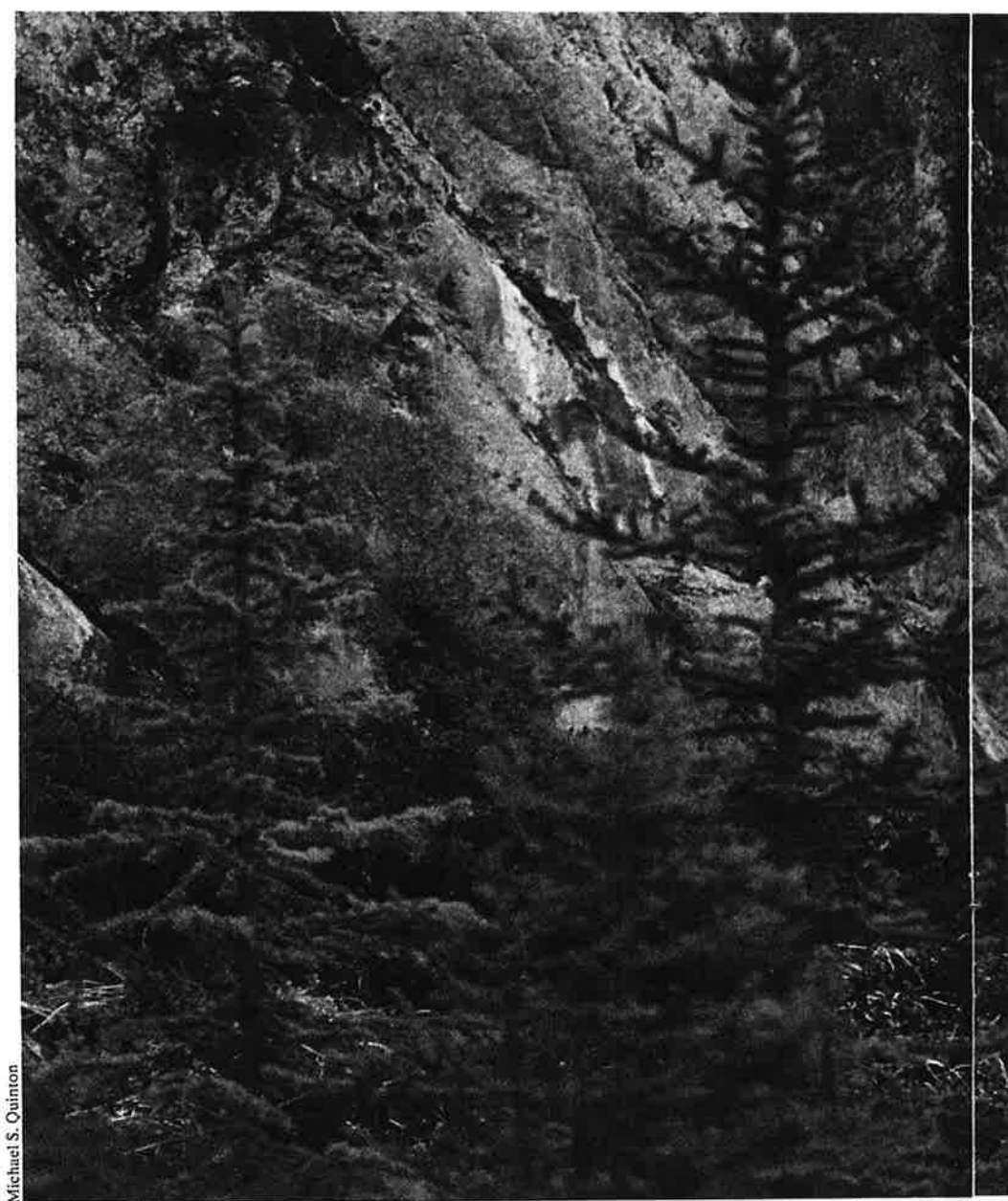


*Game Management*, as its title suggests, dealt primarily with management of game species. In its text, however, Leopold made it clear that game species were not his only concern and that simple production was not his only goal. "The objective of a conservation program for non-game wild life," he wrote, "should be . . . to retain for the average citizen the opportunity to see, admire, and enjoy, and the challenge to understand, the varied forms of birds and mammals indigenous to his state. It implies not only that these forms be kept in existence, but [that] the greatest possible variety of them exist in each community."

He made the same point more broadly in an important concurrent article, "The Conservation Ethic" (a forerunner to *A Sand County Almanac's* "The Land Ethic"): "[The] idea of controlled wild culture or 'management' can be applied not only to quail and trout but to *any living thing* from bloodroots to Bell's vireo. . . . A rare bird or flower need remain no rarer than the people willing to venture their skill in *building it a habitat*." For the first time, the plant kingdom and indeed all "living things" were explicitly included within Leopold's expanding circle. At a time when others were just beginning to grasp what Leopold meant by game management, he was rapidly moving beyond it.

Leopold joined the University of Wisconsin in 1933 as the nation's first professor of game management. The position gave him the opportunity not only to disseminate his management techniques and philosophy among his students, but to apply them to the land. Much of the early research in wildlife ecology was conducted by Leopold and his students in cooperation with farmers across southern Wisconsin. As director of research at the university's arboretum, Leopold worked with colleagues from the botany and horticulture departments (and with the newly mustered Civilian Conservation Corps) to restore tallgrass prairie and other plant communities on the arboretum lands—among the first experiments in the now burgeoning field of restoration ecology. And his own research interests found a home in 1935 when he acquired the worn-out bottomland farm that became the setting for the essays of *A Sand County Almanac*.

Meanwhile, the Dust Bowl and other



Michael S. Quinton

environmental dilemmas of the mid-1930s were raising profound questions among Leopold and his contemporaries in conservation. To a large degree, these questions centered on the intricate relationship between biological diversity and the ecological functions of land, and between the land and human society. Leopold did not mince his words. "Society has developed an unstable adjustment to its environment, from which both must eventually suffer damage or even ruin. Regarding society and land collectively as an organism, that organism has suddenly developed pathological symptoms rather than self-compensating departures from normal functioning."

The critical role that the loss of diversity played in this pattern of environmental decline came into sharp focus for Leopold under unexpected circumstances. In 1935, he was offered a three-month fellowship to study

the history and methods of forest and game management in Germany. What he saw in his travels was conservation—of a sort—carried to its self-destructive extreme. Over the centuries, intensive management of the German woodlands, primarily for timber and deer, had left little room for other species, even while undermining the long-term health of the forests and deer herds themselves. Among the results was an extreme loss of diversity, particularly among the preferred browse plants of the forest floor. It seemed to Leopold that the German forests were "deprived of a certain exuberance which arises from a rich variety of plants fighting with each other for a place in the sun. It is almost as if the geological clock had been set back to those dim ages when there were only pines and ferns." Leopold detected a similar dearth of mammalian predators, raptors and





*A grizzly ambles along a wash north of Yellowstone Park. Though initially he favored predator control, Leopold soon realized the importance of predators to their ecosystems. A great horned owl adult, below, prepares to take flight.*

needs of the grizzly, in each and every spot where he survives, and in each and every spot where he might be reintroduced, so that conservation projects in or near that spot may be judged in the light of whether they help or hinder the perpetuation of the noblest of American mammals."

While Leopold was in Germany, a subtle but significant shift was taking place within the American conservation establishment. Several of the leading conservation organizations had decided to adopt the one-word term "wildlife" to describe the objects of their attention.

Noting this shift, Leopold specifically challenged them to attend to previously neglected members of the biota, namely predators, "rare plant associations" and "all wild native forms which fly at large or have only an esthetic or scientific value to man."

"The new organizations which have now assumed the name 'wildlife' instead of 'game,'" he wrote, "are I think obligated to focus a substantial part of their effort on these threatened forms." In one of many outward indications of his own commitment to the shift in focus, he soon switched his title from that of professor of game management to professor of wildlife management.

In contrast to Germany's grim lesson in land-management-gone-awry, two hunting trips to Mexico's Sierra Madre in 1936 and 1937 enabled Leopold to gain greater insight into what he had begun to call "land health." In Mexico he encountered a landscape in which human impacts were minimal. Most, if not all, of its native flora and fauna persisted, including the mountain lions and wolves. The land's ecological functions were unimpaired. "It was here," he later wrote, "that I first clearly realized that . . . all my life I had seen only sick land, whereas here was a biota still in perfect aboriginal health. The



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cavity-nesting birds in the neatly maintained conifer plantations.

The lesson for America was clear. "We Americans, in most states at least, have not yet experienced a bearless, wolfless, eagleless, catless woods," Leopold wrote. "We yearn for more deer and more pines, and we shall probably get them. But do we realize that to get them, as the Germans have, at the expense of their wild environment and their wild enemies, is to get very little indeed?"

In particular, Leopold's trip to Germany raised his level of anxiety about the future of rare and endangered

species. "The most pressing job in both Germany and the United States," he wrote soon after his return, "is to prevent the extermination of rare species." In a 1936 article entitled "Threatened Species," his first devoted exclusively to the topic, he warned that "the immediate needs of our threatened flora and fauna must be defined now or not at all." As an example, he chose the grizzly bear. In so doing, he revealed how far he had come in his concern over the survival of large predators as members of "our national fauna." "No one," he wrote, "has made a list of the specific

term 'unspoiled wilderness' took on new meaning."

And new importance. Leopold noted that the deer herds of the Sierra Madre provided an example of "an abundant game population thriving in the midst of its natural enemies," with none of the manifestations of

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," he concluded, "can be 'rated' without the tongue in the cheek; the old categories of 'useful'

tection of large mammalian predators was one of the most critical tests of society's commitment to the maintenance of native biological diversity. Leopold confronted the issue both personally and professionally. His calls for concerted action to protect predatory species came from a deep sense of regret over his own role in their extirpation in the Southwest. The essays "Thinking Like a Mountain" and "Escudilla" in *A Sand County Almanac* recorded both his contrition ("We . . . were the captains of an invasion too sure of its own righteousness") and his high regard for predators as the ultimate symbols of wildness ("Time built three things on the old mountain: a venerable aspect, a community of minor animals and plants, and a grizzly").

In this sense, the fate of the large predators was an important indicator of progress toward "a state of harmony between men and land"—Leopold's most comprehensive definition of conservation. "Harmony with land," he wrote, "is like harmony with a friend; you cannot cherish his right hand and chop off his left. That is to say, you cannot love game and hate predators; you cannot conserve the waters and waste the ranges; you cannot build the forest and mine the farm. The land is one organism. Its parts, like our own parts, compete with each other and cooperate with each other. The competitions are as much a part of the inner workings as the cooperations. You can regulate them—cautiously—but you cannot abolish them."

During the last decade of Leopold's life, his formal discussion of conservation science and policy stressed the ecological benefits of biological diversity—as controller of pests, preventer of irruptions, provider of fertility, conservator of soil, regulator of floods and defender against pathogens. He did not overlook, however, the economic and scientific benefits. And drawing on the work of geographer Carl Sauer, he also noted the value—now widely recognized and promoted—of biodiversity as a source of potentially important genetic material. "The domesticated plants and animals which we use now," he wrote in 1944, "are not necessarily those we will need a century hence. To the extent that the native community is extinguished the . . . source of new domesticated plants and animals is destroyed."

But for Leopold there was more to

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overabundance evident on the American side of the border. Leopold wondered "whether the presence of a normal complement of predators is not, at least in part, accountable for the absence of irruption? If so, would

not our rougher mountains be better off and might we not have more normalcy in our deer herds, if we let the wolves and lions come back in reasonable numbers?" Henceforth, he placed high priority on the value of wilderness for ecological study. Every region, he

subsequently argued, should retain "representative samples of its original wilderness condition," to serve science and the conservation professions. "Just as doctors must study healthy people to understand disease, so must the land sciences study the wilderness to understand disorders of the land mechanism."

By the end of the 1930s, Leopold's thoughts on the value of diversity and the quality of ecological stability had come together. He had come to appreciate that ecology was not simply a new science but "a new fusion point for all the natural sciences." Its far-reaching implications for conservation could not be ignored. Diversity lay four-square at the heart of the issue. In a 1939 address to a joint national meeting of foresters and ecologists, Leopold stressed the point. "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

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 biota includes not only plants and animals, but soils and waters as well." The circle of Leopold's concern now included not only the entire biological component of the natural world, but the physical components as well. This new view struck to the philosophical foundations of a conservation movement that for three decades had stressed the most direct and obvious utilitarian values above all others. If such values had provided the criteria by which conservation efforts were judged in the past, ecology suggested an expanded range of values that had to be weighed in, and for, the future.

Leopold's thoughts about "land health" played prominently in this reconsideration of conservation's means and ends. In one of many attempts over the last decade of his life to clarify and communicate these ideas, he defined conservation as "a state of health in the land. The land 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 short, the long-term health of the land and of the human communities that dwell thereupon depended on the retention of a diverse biota. This led to "the rule of thumb which is the basic premise of ecological conservation: the land should retain as much of its original membership as is compatible with human land-use. The land must of course be modified, but it should be modified as gently and as little as possible." Keep, in other words, the cogs and wheels.

In Leopold's day, as now, the pro-



Jim Brandenburg/Minden Pictures





*Leopold prepares his journal notes at "the shack," a cabin he renovated from a chicken coop. He built most of the furniture as well. Opposite, a dragonfly perches on a reed in Leopold's pond.*

be gained by the conservation of diversity than even the incalculable practical and material benefits. Land, he wrote in the foreword to *A Sand County Almanac*, also "yields a cultural harvest." His own reappings, finally gathered into the posthumously published *Almanac*, are ample evidence of the bounty. *Sand County* can be read in many ways, but not least as one human being's revelry amidst diversity. Canada goose and paper birch, white pine and trailing arbutus, bottle gentian and pileated woodpecker, pine weevil, ruffed grouse, tamarack, showy lady's slipper, larch saw-fly, cottonwood, winged elm, red dogwood, prickly ash, woodcock, hazelnut, bittersweet, shagbark hickory, hawthorn, basswood, bobwhite quail, poison ivy,

ragweed, raccoon, sugar maple, white oak, cottontail, chickadee, barred owl, crow, jay, wood duck, gray squirrel—and the memory of a prothonotary warbler. Those were the offerings just of November in Wisconsin's sand counties.

*A Sand County Almanac* has endured, not just because it so memorably documents the events of a year, but because it also records the journey of Leopold's life. That life was marked at every step by an expanding comprehension of the natural world and humanity's place within it. His was only one pathway, but the successive stages of work and thought through which he passed are in many respects the same stages that conservation has struggled through in its century-long march toward ecological enlightenment. The story tells itself in the succession of labels. Forests. Game. Varmint. Nongame. Threatened. Rare. Wildlife. Endangered. Biodiversity.

The land ethic that Leopold ulti-

mately proposed recognizes that within the biotic community, as within the human community, "the conqueror role is eventually self-defeating." While acknowledging the reality of human intervention in the natural order, the land ethic affirms the right of the other members of Earth's community of life "to continued existence, and, at least in spots, their continued existence in a natural state." The irony is that, in affirming that right, and in acquiring a deeper sense of humility toward and affection for the diverse life-forms that share this planet, the human community may also be taking the most important step toward assuring its own future health and stability. Therein lies the kind of progress that Leopold sought, and celebrated. □

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