Land Health: A Language to Describe the Common Ground below Our Feet

by Courtney White

Land health is "the capacity of the land for self-renewal" and conservation is "our effort to understand and preserve this capacity." - Aldo Leopold [1]

"Until we understand what the land is, we are at odds with everything we touch."
- Wendell Berry [2]

Since my early teens, I have been fascinated with the skin of the Earth. It began when my parents briefly rented a dilapidated stable in what was then a remote spot in the desert east of Scottsdale, Arizona (a spot that's neither remote nor a desert anymore). They populated the little stable with an assortment of horses, mostly for trail-riding purposes. My favorite was Valentine, my Mother's huge quarter horse, on whose back I began to explore the desert which surrounded the stable like a sandy sea. As I rode, I began to watch the ground closely-- rattlesnakes were Valentine's one and only mortal fear--and as a result my urban eyes began to see, for the first time, the rocks, the plants, the hills, and the shape of the desert's horizon. Eventually, I developed an appreciation of the land's rhythms of sandy washes, flat expanses, palo verde forests, and magnificent, subtle hues that remain with me to this day.

At fourteen, my interest in the skin of the earth expanded to include dirt. Indulging my budding interest in prehistory, my parents allowed me to join the local amateur archaeological society, which meant my father spent many weekends driving me to a dig in another remote spot in the desert. There, I dug. Under professional supervision, my fellow enthusiasts and I systematically peeled back the layers of a 14th-century Hohokam village, ten centimeters at a time, which meant I became intimate with dirt, especially a layer called caliche which can be hard as cement. I kept digging. Over the years I participated in various excavations, including a

project in downtown Phoenix called *La Cuidad*, directed by archaeologists from Arizona State University. I dug in prehistoric rooms, profiled backhoe-cut trenches, excavated ancient hearths, canals, burials, trash pits and even helped to uncover a ball court. Dirt became my friend.

My interest in the skin of the Earth deepened again when I took the leap from excavation to archaeological surveying, which is the systematic sweep of land by a crew looking for undiscovered sites. For two memorable summers in my late teens, I served on four-person crews that surveyed parts of the desert outside Phoenix as part of an ASU-directed project to review potential dam sites for the city's unquenchable thirst for water and growth. Our job was to hike back and forth across the land in straight lines, no matter what the topography, often under a broiling July sun, while scrutinizing the land for signs of prehistoric activity. I was paid (what I thought was an extravagant $3.33 an hour), in other words, to be a liminalist--to analyze the fine line between nature and culture. Was a particular alignment of rocks natural or did it indicate a wall of a building? Sometimes it was hard to say, but in the process of asking this type of question hour after hour, day after day, mile after mile, I became sensitive to the subtleties of the Earth's skin.

This sensitivity largely explains why I eschewed the usual preoccupations with wildlife and wilderness when I became active in environmental causes during college. I liked birds and animals well enough and had backpacked in countless wilderness areas--I was particularly enamored of our national park system which I discovered during one glorious summer shortly before my 16th birthday--but my experience on horseback and on survey taught me that nature started below my feet, with the way water flowed across the land, with soil types, with the presence of grass and other plants, and the important way everything combined together to create an ecosystem.

Years later, my experience was confirmed when I met Jim Winder, a rancher near Deming, New Mexico, and Kirk Gadzia, a range expert and educator, who lives near Albuquerque. Both employed a language to describe the land that, though unfamiliar to me as an environmentalist, resonated with my youthful exposure to nature. They talked about *land health,* employing terms like water cycle, mineral cycle, and the original solar energy--photosynthesis. They used works like 'pedalsting' and 'capping' and 'bare soil.' Jim liked to talk about decomposers--termites, for instance--and how they assisted the cycling of nutrients in the soil, a cycling that is critical to the health of plants and, ultimately, the health of the land, they said. Curious, I kept listening.

Then during a workshop led by Kirk in 1998, my interest in the skin of the Earth and my curiosity about this new language fused together. Kirk took us to the Black Ranch in the high desert west of Albuquerque (now gone to subdivision) where he pointed to two adjacent patches of ground--one grazed recently by cattle and one ungrazed--and asked, not-so-rhetorically, which was healthier from an ecological perspective? As an environmentalist I should have known the answer, right? I hadn't a clue. But in my cluelessness I suddenly saw an opportunity to intervene in the bitter conflict between ranchers and environmentalists that was being waged at the time. The issue wasn't wolves, wilderness, bovines, or property rights, I saw. Those issues came later. What mattered first was the health of the land, which could also be the foundation of peace-making. Not only was the skin of the Earth the common ground below our feet, there was a common vocabulary to describe it. We could start over--from the ground up.

Aldo Leopold and Land Health

The term 'land health' was coined in the 1930s by the great conservationist Aldo Leopold, though he frequently used the term 'land mechanism' as well. In both cases he was

referring to the ecological processes that perpetuate life--the processes of regeneration and self-renewal that ensure fertility among communities of plants and animals, including the proper cycling of water and nutrients in the soil. He likened land health to a self-perpetuating engine whose parts--soil, water, plants, animals, and other elements of the ecosystem--when unimpaired and functioning smoothly would endlessly renew itself. He frequently employed words such as 'stability,' 'integrity,' and 'order' to describe the land mechanism engine, drawing an image of nature that when healthy was perfectly tuned and in top shape.

By contrast, land became 'sick' when its basic parts fell into disorder or broke down. This wasn't just a scientific theory. Leopold began to recognize signs of land illness almost from the start of his career as a U.S. Forest Service ranger in 1909. They included: elevated soil erosion, loss of plant fertility, the effects of excessive floods and droughts, the spread of plant and animal pests, the replacement of useful by useless vegetation, and the endangerment of key animal species. These examples of disassembly of the land mechanism, as he put it, whether caused by natural catastrophe or by human interference, often led to adverse consequences for wildlife and human populations alike. That's because when nature's ability to regenerate itself over time is damaged--what Leopold called the 'derangement' of nature's health--its ability to provide plants for wildlife or food for humans breaks down as well. In other words, when the land mechanism isn't functioning properly, what we value from the land, whether food, fuel, or recreation, will be jeopardized.

To make his point, Leopold employed a different metaphor: land is like a bank account, he observed, "If you draw more than the interest, the principal dwindles." [3] Keep it up and bankruptcy happens.

During his lifetime, Leopold observed what happens to human communities when nature's principle dwindles to the point of ruin, the most dramatic, and tragic, example of which was the Dust Bowl. The plowing up of the prairie topsoil by tractor and drill for wheat farming in the 1920s, followed by an intense drought in the early 1930s, created a disordering of natural and human communities on a scale so vast that historian Donald Worster called it "the most severe environmental catastrophe in the entire history of the white man on this continent." [4]

Over the course of his life, Leopold saw numerous other examples of the ecological and economic costs of nature's derangement. During his work for the United States Forest Service in the Southwest during the 1920s, for instance, he drew the connection between overgrazing by livestock in the region's arid landscapes and the widespread evidence of soil erosion, particularly in riverine systems, causing him to raise an alarm with his superiors (to little effect). The loss of plant cover due to overgrazing, he observed, exposed the soil to the erosive power of wind and rain, which quickly resulted in the 'disordering' of fragile communities of plants and animals--the consequences of which we are still feeling today. The human cost of this disordering, he noted, ranged from lost forage productivity, thus reducing the economic viability of ranchers, to the displacement of human communities.

Leopold's response to these in-the-field insights about land health and sickness motivated his work for the remainder of his life. They included: deep thoughts on the "oldest task in human history," how to live on land without ruining it; his belief that the mission of conservation is to achieve "harmony between men and land" by keeping the land mechanism in working order; his economic assertion that "healthy land is the only permanently profitable land;" his belief that wildlife populations and habitat could be restored with the tools that "hithertofore destroyed it: ax, cow, plow, fire, and gun" by employing these tools with land health objectives; that

landscapes could be “read” and understood by their signs, which he challenged his students to do during frequent field trips; and, ultimately, in his formulation of his ‘land ethic’ thesis, in which he argued for a cultural disposition that protected, restored, and maintained the land’s health.

To Leopold, these were all parts of one question.

“The true problem of agriculture, and all other land-use, is to achieve both utility and beauty, and thus permanence,” Leopold wrote in an essay titled *The Land Health Concept and Conservation* (1946). “A farmer has the same obligation to help, within reason, to preserve the biotic integrity of his community as he has, within reason, to preserve the culture which rests on it. As a member of the community, he is the ultimate beneficiary of both.” [5]

Land Health in Today’s Conservation

It is testament to the originality and depth of Leopold’s thinking that the land health idea has undergone only two serious elaborations in the ensuing decades and today provides the foundation for a new approach to conservation and economic use of natural resources worldwide.

The first revision took place as a result of the rapid expansion of ecology as a scientific discipline after World War Two. Leopold’s mechanistic view of the natural world--the ‘engine’ metaphor, with its orderly arrangement of parts working in balance and harmony--was replaced with an organic, dynamic, even chaotic, vision of nature as ceaselessly changing, subject to bouts of disruption and stress. This revised idea of ecological health still focused on self-renewal and self-organization, but now scientists see nature as fluid, not static, complex, not reductionistic.

Ecologist Bryan Norton identified five axioms that define the natural world:

- Nature is more profoundly a set of processes than a collection of objects, all is in flux.
- All processes are related to all other processes.
- Processes are not related equally but unfold in systems within systems.

- The processes of nature are self-organizing, and all other forms of creativity depend on them; and that vehicle of creativity is energy flowing through systems that generates complexity of organization through repetition and duplication.
- Ecological systems vary in the extent to which they can absorb and equilibrate human-caused disruptions in their creative processes. [6]

In other words, the mid-century view of the 'balance of nature' was replaced by the 1980s with the 'flux of nature,' requiring, among other things, a new set of terms and concepts to describe this new vision, including 'resilience,' 'normal range of variability,' 'sustainability,' 'diversity,' 'stress,' and so forth. Moreover, this new vision cast human impact on ecological processes in a new light. Rather than simply upsetting the balance of nature through our blundering, our activities could now be evaluated according to their roles in the processes of stress and recovery. Those activities that encouraged resilience, for example, could be considered to be promoting land health, while those activities which reduced an ecosystem's ability to recover from a disturbance could be considered deleterious. This paradigmatic shift among ecologists, however, didn't reduce health as a useful metaphor, or as an important goal. "Health is a noun and may therefore suggest a static condition in both organisms and ecosystems," writes historian J. Baird Callicott. "But health, despite the grammar of its name, actually is very much a process, a process of self-maintenance and self-generation. Today, ecologists emphasize that ecosystems change over time, but, like healthy organisms, healthy ecosystems maintain a certain continuity and order in the midst of change." [7]

The second updating to Leopold's thinking was a filling in of the specific details of what constitutes land health. One particular effort began in 1994 with the publication by the National Research Council of *Rangeland Health: New Methods to Classify, Inventory, and Monitor*

Rangelands. This effort was a response to persistent disagreement among range scientists, environmentalists, ranchers, and public agency personnel about the health of the nation's 770 million acres of rangelands. Not only was there a substantial lack of data on the condition of the land itself, but there was also an important lack of agreement among range experts on *how and what* to monitor.

These voids contributed significantly to the acrimonious debate raging at the time about livestock grazing on the nation's public lands. Were rangelands improving or degrading? Everyone had an opinion, which was precisely the problem. There was a general feeling among most experts that significant portions of the nation's rangelands were to one degree or another degraded, but since there was no consensus on definitions or standards to objectively make such an evaluation the result was a shoving match between environmentalists, ranchers, and federal land managers.

In an attempt to resolve this situation, the book's authors wrote a definition of health: "Rangeland health is the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained." [8] Echoing Leopold, they used the word 'health' to indicate a condition in which ecological processes are functioning properly to maintain the structure, organization, and activity of the system over time. By 'integrity' they meant vigorous energy flows; plant community dynamics; intact soil profiles; and stores of nutrient and water.

Significantly, they concluded that a "healthy rangeland has the sustained capacity to satisfy values and produce commodities." This was important because it meant that the natural processes that sustain wildlife habitat, biological diversity and functioning watersheds are the same processes that make land productive for livestock. In other words, when the land was healthy, values--including commodity production--could be sustained.

Acknowledging the 'flux of nature' theory of modern ecology, the authors linked 'health' to resilience, which they defined as the capacity of a rangeland to recover from periodic perturbations, including floods, droughts, and overgrazing. "The integrity of the soil and ecological processes," they wrote, "determines the vegetation, habitat, aesthetics, and other commodities and values that rangelands can provide and determines how well rangelands are able to resist the destructive effects of mismanagement or natural disturbances."

They were also able to define land 'sickness' in a way that Leopold could not. Physical degradation, they observed, results in the deterioration of the physical properties of soils through compaction, wind or water erosion, deposition of sediments, and loss of soil structure. Biological degradation occurs when there is a reduction in the organic matter content of the soil, a decline in the amount of carbon stored as biomass, and a depression in the activity and diversity of the organisms living in the soil. "Soil degradation," they concluded, "primarily through accelerated wind and water erosion, causes the direct and often irreversible loss of rangeland health."

Their summary: a healthy rangeland is where erosion is not accelerating, where most precipitation infiltrates into the soil and is used onsite for plant growth or flows eventually to underground storage; where the plant community effectively takes advantage of the mineral nutrients and energy that occur on the site; where plant composition is dynamic, and where ecological functions can recover from natural or human-caused stress.

Components of Land Health

Following the publication of *Rangeland Health*, a collaborative effort was launched by an interagency team of scientists to develop both qualitative and quantitative criteria for assessing and measuring the health of the land. The first step was accomplished in 2000 with the

publication of *Interpreting Indicators of Rangeland Health* [9] which identified seventeen indicators of land health, which they grouped into three categories:

- **Soil stability**. The capacity of a site to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water. It is a measurement of soil movement.
- **Watershed function**. The capacity of the site to capture, store, and safely release water from rainfall and snow melt; to resist a reduction in this capacity; and to recover this capacity following degradation. It s a measurement of plant/soil/water relationships.
- **Biotic integrity**. The capacity of a site to support characteristic functional and structural communities in the context of normal variability; to resist the loss of this function and structure due to a disturbance; and to recover from such disturbance. It is a measurement of vegetative health.

Indicators include: rills, gullies, water flow patterns, pedestals, bare ground, litter movement, resistance to erosion, plant community composition, compaction, plant vigor, and invasive species (Table 1).

There was an important caveat to these definitions and terms, however: land health is not a substitute for a land ethic. A brown trout or a noxious weed might be perfectly *functional* in a particular landscape--filling an ecological niche in a stream or holding the soil together--but may not be acceptable from a cultural or biological perspective.

The language of land health is the proper starting point for nearly all discussions about the environment, natural resource use, restoration, recreation, and any of the other numerous issues that engage our daily interactions with nature. Sixty years ago, Aldo Leopold created the foundation for common vision of our relationship to the land. Through the very persistent work

of researchers and practitioners, the details of that vision have been filled out. Now it is up to all of us to put this language, and the physical elements they represent, into fruitful action.

From the ground up.

Table 1. A land-health glossary.

Soil: Consists of mineral particles of different sizes (sand, silt, and clay), organic matter, and numerous species of living organisms. Soil has biological, chemical, and physical properties, some of which change in response to how the soil is managed.

Soil quality: The capacity of a specific kind of soil to function within natural or managed ecosystem boundaries, sustain plant and animal productivity, maintain or enhance the quality of water and air, and support human health and habitation. Changes in soil quality affect the amount of water from rainfall and snowmelt that is available for plant growth, runoff, water infiltration, and the potential for erosion, the availability of nutrients for plant growth, the conditions needed for germination, seedling establishment, vegetative reproduction, and root growth.

Soil Stability: The ability of soil structures (groups of soil particles) to resist degradation. When organic matter (roots, litter) breaks down over time it creates a 'glue' that holds soil structures together, which is critical for biological activity, root growth, and water percolation. Conversely, when soil structures become unstable due to disturbances such as raindrops, flowing water, trampling, earth moving, and other activities, structures can break apart, exposing organic material to decomposition and loss.

Landscape Function: How well a landscape captures, stores, and uses scarce resources, including water, minerals, and organic materials. Dysfunctional landscapes lose these resources to runoff and wind erosion.

Infiltration Rate: How fast water enters the soil. When restricted (soil crusts, compaction), water does not readily enter the soil and it moves downslope as runoff where it eventually evaporates. As a result, less water is stored for plant growth, resulting in less organic matter in the soil, which weakens soil structure and can further decrease the rate of infiltration.

Runoff: Can cause soil erosion and gully formation. It carries nutrients, organic matter and sediment offsite and generally reduces water quality. Excessive runoff can cause flooding, erode stream banks, and damage roads.

Vegetative Cover: A high percentage of plant cover and large amounts of root biomass generally increase infiltration. They also contribute to soil stability by contributing organic material to the soil which helps increase soil structure. Plant reproduction (seeds and flowers) is crucial for maintaining good vegetative cover.

Rills and Gullies: Rills are small erosional rivulets that do not necessarily follow micro-topography as normal water flow patterns do. Gullies are channels that have been cut into the soil by moving water. Both are generally caused by accelerated water flow and result in the down-cutting of soil.

Pedestals and Terracettes: Pedestals are rocks or plants that are elevated as a result of soil loss by wind or water erosion. Terracettes are benches of soil deposition behind obstacles caused by water movement (not wind).

Bare Ground: Exposed soil that is susceptible to raindrop splash erosion – the initial form of most water-related erosion. It is the opposite of ground (vegetative) cover. It is vulnerable to capping (soil crusting).

Litter: Any dead plant material that is in contact with the soil surface. It provides a major source of the organic material for onsite nutrient cycling. Also, the degree and amount of litter movement is an indicator of the degree of wind and water erosion.

Soil Surface Loss: In most sites, the soil at and near the surface has the highest organic matter and nutrient content. This generally controls the rate of infiltration and is essential for successful seedling establishment. Loss of this layer results in further degradation of soil structure.

Plant Mortality: The proportion of dead plants to live ones, especially to juvenile plants, expected on that site, under normal disturbance regimes, is an indicator of population health. If recruitment of new plants is not occurring and existing plants are dead or dying, the integrity of the site is expected to decline, generally leading to increased erosion.

Integrity: The capacity of a site to support characteristic functional and structural communities (soil and vegetation) in the context of normal variability and to resist the loss of this function caused by disturbance.

Notes

[1] Aldo Leopold. *Sand County Almanac: with Essays on Conservation*. Oxford University Press, New York., 1949.

[2] Wendell Berry. *The Art of the Commonplace: the Agrarian Essays of Wendell Berry.* Shoemaker and Hoard, Emeryville, CA., 2002.

[3] Leopold, Aldo. *For the Health of the Land: Previously Unpublished Essays and Other Writings.* Edited by J. Baird Callicott and Eric T. Freyfogle. Washington, D.C.: Island Press, D.C., 1999.

[4] Worster, Donald. *Dust Bowl: the Southern Plains in the 1930s*. Oxford University Press, Oxford, 1979.

[5] Ibid.

[6] *Ecosystem Health: Principles and Practice*. edited by D.J. Rapport, C.L. Gaudet, R. Constanza, R. Levins. Blackwell Science, Oxford, UK., 1998.

[7] Ibid.

[8] National Research Council. *Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands*. National Academy Press, Washington, D.C., 1994.

[9] M. Pellant, P. Shaver, D. Pyke, and J. Herrick. *Interpreting Indicators of Rangeland Health, version 3*. United States Department of the Interior, Bureau of Land Management, Technical Reference no. 1734-6, Denver, Co., 2000.