Eye in the Sky

A holistic approach to rangeland monitoring

By Courtney White

Published by

The Western Landowners Alliance
PO Box 6278, Santa Fe, New Mexico 87502

The Quivira Coalition
1413 Second Street, Suite 1 Santa Fe, New Mexico 87505

education • innovation • restoration

Printed by Paper Tiger in Santa Fe, New Mexico

First edition, first printing, November 2016

Eye in the Sky

A holistic approach to rangeland monitoring

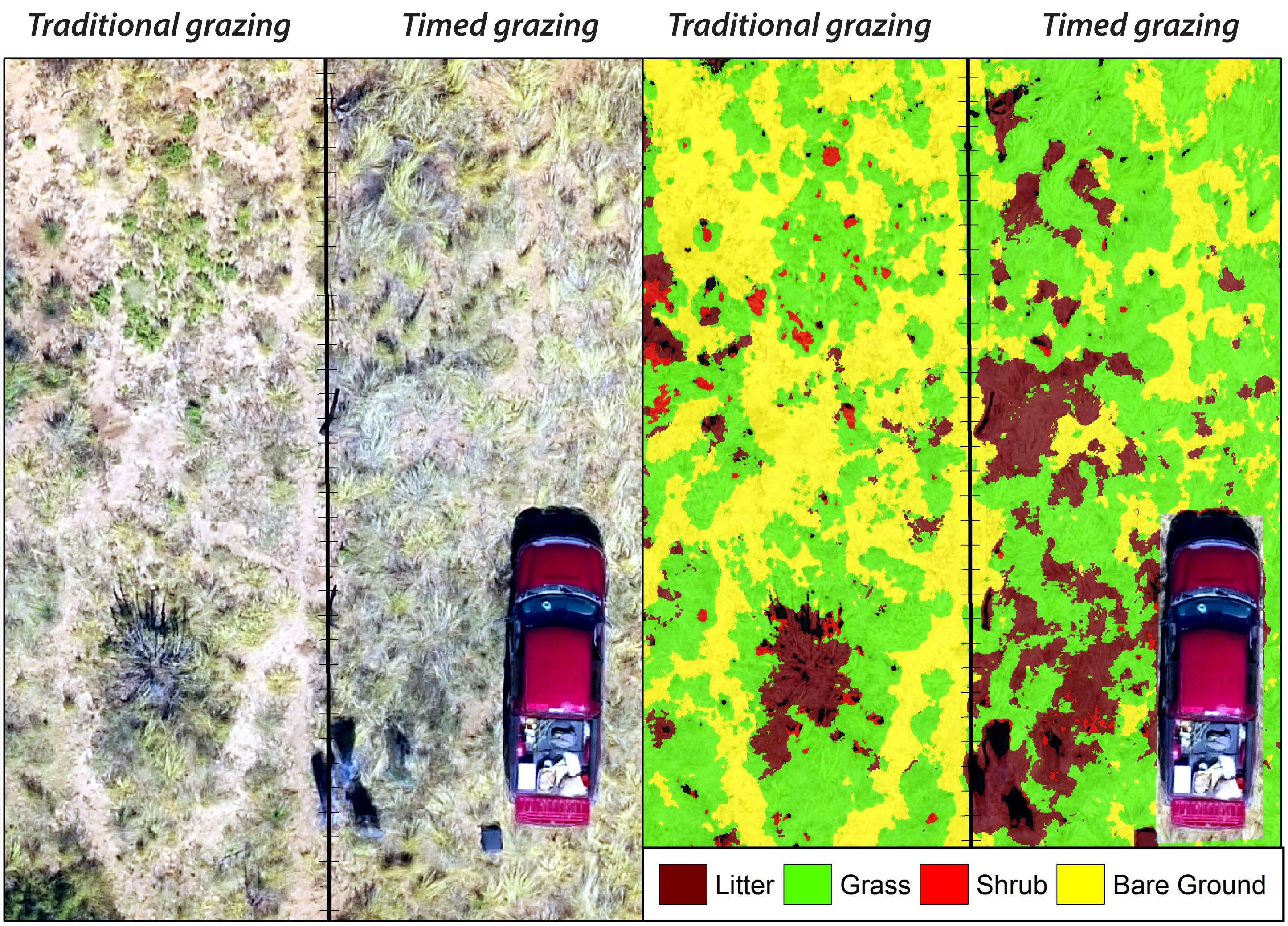
Written by Courtney White

Edited by Kathryn Brewer and Rick Danvir

Designed by Sarah Wentzel-Fisher

Western Landowners Alliance and The Quivira Coalition • Santa Fe, New Mexico

"If you can't measure it, you can't manage it."
~Gregg Simonds



Monitoring bare ground. From Open Range Consulting

Introduction

"If you can't measure it, you can't manage it." When Gregg Simonds said this to me years ago, expressing his land management philosophy, I wasn't sure I believed him. Of course, I *believed* him. Simonds had a well-earned reputation as one of the best ranch managers in the nation and a deep thinker on the ecology and economics of western rangelands, and so I assumed it to be true. Intellectually, I understood his point that hard numbers are required to substantiate scientific research, legal proceedings, and certain kinds of financial markets—and that to succeed in agriculture, a person must have some interest in these. But emotionally I couldn't fully embrace his argument.

There were two reasons for this. First, as an activist in the environmental movement at the time, I had been trained to distrust the idea of managed land generally. Wilderness protection is one of the cherished ideals of conservation, and wild land by definition is unmanaged. This means that every other type of land—including national parks—exists on a descending scale of priority, with agricultural land—ranches and farms in particular—somewhere near the bottom.

Embedded in this leave-it-alone paradigm was the belief that humans always despoil nature by our activities, which is why activists in my day were skeptical of claims of good management, especially where livestock was concerned. Given a choice, they preferred as little management as possible, whatever it took to keep land in a natural state, even if it had been degraded by poor management in the past. As for scientifically measuring things, the goal was one and the same: keep it wild. This hands-off attitude persists to this day among many in the environmental and scientific communities. The world still needs less management, they insist, not more, and if human interference is required at all, they advocate for the light touch of indigenous peoples.

Which brings me to the second reason Simonds' words didn't click initially: the overwhelming evidence of the terrible job non-indigenous humans have done managing the Earth's land and oceans. I won't run down the lengthy list of our crimes against nature, which include extensive overgrazing by human-directed livestock. I'll just reiterate Aldo Leopold's famous declaration that acquiring an ecological education means becoming aware that we live "in a world of wounds." And that was back in the 1940s. The list of wounds has grown a lot longer, and it's no wonder that environmental activists take a dim view of management by humans—just look around!

But in the late 1990s my perspective began to change, when I met a group of progressive ranchers who worked within nature's model of regeneration and ecological health. They managed their land according to the principle that the natural processes that sustain wildlife habitat, biological diversity, and functioning watersheds are the same processes that make land productive for livestock. And this wasn't just talk—they got results: grasslands that were more productive and diverse, where erosion had diminished, where streams and springs that were once dry now flowed, and where wildlife was more abundant. Not coincidentally, these ranches were also more profitable for their owners.

Still, Simonds' words didn't quite resonate. Many of these progressive ranches, I noticed, relied on minimal ecological monitoring or measurement, and what they did was mostly qualitative, not quantitative, and therefore not very scientific. Perhaps they didn't require much data to manage their land because the proof was in the pudding. The land looked healthy and the cows were content. Maybe managing by "feel" and experience was enough to get the job done. After all, many environmentalists also lacked data to back up their arguments, including some, notoriously, who ignored credible evidence that contradicted their opinions about livestock grazing.

By the early 2000s, the question of appropriate land use had become an emotional tussle between advocates for progressive management and critics who insisted that our eyes were somehow deceiving us. Both camps leaned on a limited number of quantitative studies and reports that backed their position, including peer reviewed conclusions that often contradicted each other. The result generally was an unproductive, good-cow-versus-bad-cow debate or, more specifically, my school of grazing management versus yours. The endless arguing encouraged many to remain in their respective trenches, and I wasn't convinced that more measurement would resolve the impasse.

Two developments changed my mind. First, important advances in the science and technology of measuring land and its ecological parts meant that acquiring detailed data became more practical and affordable. This enabled landowners and managers to rely less on personal experience and guesswork—what Simonds calls "faith-based decision making"—and more on facts, particularly with regard to what was happening in the microbial universe below the soil surface. Better yet, these new facts largely supported the management style advocated by progressive farmers and ranchers, giving credence to their arguments and encouraging new allies in the cause of regenerative agriculture.

Second, the world had changed *a lot*. By now most of us are familiar with the litany of environmental challenges, including rising temperatures, accelerating habitat destruction, rapid rates of species extinction, and declining water quality and quantity. All of these critical issues require action on the part of humans, largely of the intervening variety. We need to correct our poor behavior, not walk away from it, which means we need more and better management of natural resources, not less. That requires more measurements. Fortunately, the toolbox of regenerative practices is diverse, practical, and thoroughly field tested. New monitoring technologies and software enable us potentially to implement the toolbox at scale and convince markets to pay for the services that good stewardship provides. Simonds was right, but now in light of our global predicament, his words should be reversed: *we must manage it, and therefore we must measure it.*

Land Health

In the early 1990s, the National Research Council (NRC), an arm of the National Academy of Sciences, decided to respond to a long-running dispute among range professionals, environmentalists, ranchers, and public agency personnel over the health of the nation's 770 million acres of rangeland. Not only was there a substantial lack of data on the condition of the land itself; there was also an important lack of agreement among 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? Were they well managed or poorly managed? Should livestock numbers be increased or decreased? Everyone had an opinion, which was precisely the problem.

In 1994, in an attempt to resolve this situation, the NRC published *Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands*, which included an important consensus definition: "Rangeland health is the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained." By *health* they meant a condition in which ecological processes function properly and can maintain their structure, organization, and activity over time. By *integrity* they meant vigorous energy flows, plant community dynamics, intact soil profiles, and stores of nutrients and water. This was a novel definition at the time because it eschewed both the traditional production-based view of land promoted by the ranching industry and the leave-it-alone philosophy of conservationists, which were based more on economics or emotion than science.

There was more. The NRC concluded that a "healthy rangeland has the sustained capacity to satisfy values and produce commodities." In other words, when land is ecologically healthy, the value we get from it can be sustained over time. It doesn't matter if that value is food production, wildlife habitat, recreation, or resource extraction, if the land isn't functioning at a basic ecological level, the particular value will decline over time. For example, overgrazing by livestock can cause erosion, which can cause rangeland to lose its ecological resilience to fire, flood, and other perturbations, which can reduce habitat integrity, which can cause wild turkey populations to decline, which reduces hunting opportunities, which reduces rural economies, and so on.

The key is land health. "The integrity of the soil and ecological processes," the authors 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."

Capped soil. By Courtney White

"The integrity of the soil and ecological processes determines the vegetation, habitat, aesthetics, and other commodities and values that rangelands can provide . . ." ~National Resource Council

A medical analogy is apt: when someone's physical health declines their quality of life declines as well. In land, the NRC authors identified a decline in health as the deterioration of the physical properties of soils through compaction, wind or water erosion, and loss of structure. Biological degradation occurs when there is a reduction in the organic matter in the soil, a decline in the amount of carbon stored as biomass, and a decrease in the activity and diversity of soil organisms. As a doctor would do with a patient, a range professional is able to diagnose signs of land sickness and prescribe remedies for its return to a healthy condition.

The NRC publication summarized healthy rangeland as a place where erosion is not accelerating; where rain infiltrates into the soil and is stored or used for plant growth; where the plant community takes advantage of the minerals, 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, such as drought, fire, or floods. This is important because, when policymakers, the public, ranchers, and range managers can be assured that rangeland health is being conserved or improved on a particular stretch of country, the general discussion can shift from litigation and finger-pointing to a constructive dialogue about appropriate uses for that land over the long-term. In other words, once the patient has recovered its health, it can decide whether it wants to go back to work, take a vacation, or run a marathon.

Following the publication of *Rangeland Health*, a collaborative effort was launched by a team of federal scientists to develop both qualitative and quantitative criteria for assessing and measuring the health of the land. A significant step in this process occurred in 2000 with a publication titled *Interpreting Indicators of Rangeland Health*, which identified seventeen indicators of land health 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 (a measurement of soil movement).
- ***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 (a measurement of vegetative health).
- ***Watershed function.*** The capacity of a 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 (a measurement of plant-soil-water relationships).

Sampling for soil carbon. By Courtney White.

One important land-health indicator is *bare soil*, defined as ground not covered by vegetation, rocks, or plant litter. "The amount and distribution of bare ground," write the authors, "is one of the most important contributors to site stability [and] therefore a direct indication of site susceptibility to accelerated wind or water erosion."

For example, given the same percentage of vegetation, a site with bare soil present in a few large patches will be less stable than a site at which bare soil is distributed in many small patches. Precisely measuring the patches of bare soil quantitatively, however, is time consuming and expensive, which makes it less attractive to landowners and managers with economic concerns. A simpler process is to measure the overall percentage of bare soil—derived from a digital image, say—and then compare it to an Ecological Site Description

(ESD) for the area to determine whether the amount is positive or negative. (More on this below.)

Other land-health indicators include rills and gullies, plant pedestaling, plant litter, wind scours, soil loss, soil compaction and capping, water infiltration versus runoff, plant vigor, and the presence of invasive species.

Sixty years ago, Aldo Leopold defined land health as "the capacity of the land for self-renewal" and described conservation as "our effort to understand and preserve this capacity." During his lifetime, Leopold saw firsthand what happens to human communities when their land becomes sick to the point of ruin, the most dramatic and tragic example being the Dust Bowl. Plowing up the prairie topsoil by tractor and drilling for wheat production 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."

As we move deeper into the twenty-first century, these words take on a renewed sense of urgency. If the Dust Bowl was the major alarm bell of Leopold's generation, so it will be with global warming and our generation. Both calamities share a common concern, the widespread disordering of land and people. They also share a common root, our mismanagement of nature. Leopold called this the "oldest task in human history"—how to live on a piece of land without ruining it.

Today, although this "piece of land" has scaled up from a 300-acre farm in the Oklahoma panhandle to the planet itself, the task remains essentially the same: how to live sustainably and economically within natural limitations. And the task remains just as complicated, just as vital, and just as daunting, though perhaps more imperative, as in years past. Fortunately, thanks to the diligent work of many researchers and practitioners we not only have a clearer picture of what land health is, we also have good, practical, and profitable models of what sustainable land use is. The big job now is to put this knowledge to wider use—and to do it quickly.

Aldo Leopold defined land health as "the capacity of the land for self-renewal" and described conservation as "our effort to understand and preserve this capacity."

Poor water cycling can cause gullying. By Courtney White

Monitoring workshop hosted by the Quivira Coalition. By Courtney White.

For decades, measuring the ecological health and condition of rangelands consisted largely of the qualitative assessment of a tiny fraction of land, which was then extrapolated to the whole landscape under consideration. Typical was the Parker 3-Step Method, developed in the 1950s, which employed permanent line transects on the ground, often 100 feet long, at locations considered to be representative samples of the land's grasses and soils. The first step of the assessment usually involved tossing a rope loop randomly along a transect, followed by a careful examination of everything inside the loop (grass types, bare soil, shrubs, etc.). The second step involved aggregating the data from multiple transects and loop tosses into a snapshot of the land's condition. The third step consisted of photographic documentation.

In a variation on the Parker method, loops were discarded for a point-by-point analysis of the entire 100-foot transect. In either case, subsequent decisions about livestock numbers and grazing management were based on these assessments, often with significant economic impacts on ranching operations and particularly on public lands often scrutinized by environmentalists.

While the Parker Three-Step approach gave managers a feel for the condition of the land, its limitations proved to be numerous: placement of transects was highly subjective; they were read irregularly and infrequently (maybe once every ten years); accurate reading depended on the expertise of the assessor, who could be a different person with a different skill set each time the line was read; throwing a loop was not a scientific way to take a random sample; extrapolation even a few inches away from the transect line was nearly impossible; and sites selected for monitoring could be degraded over time (by erosion, for example), losing their integrity for measurement.

The greatest shortcoming, however, was the method's inability to capture ecological change and variability at landscape scale. On-the-ground transects, even sophisticated ones, offered only a tiny window onto the land. Sometimes they got it all wrong. For example, a particular pasture might receive a lot more rain one year than a neighboring pasture, and if a monitoring transect was located in the dry pasture, then the overall picture of the land's health would be skewed downward, with serious implications for the rancher. This would be like a doctor making a diagnosis of disease after examining only a toe or a part of an arm once every ten years, declaring the patient to be grievously ill when the exact opposite was just as likely to be true.

Partly in response to these limitations, important new monitoring and measuring methodologies have been developed in recent years, including ones that examine the land at ranch-wide scales using "eye-in-the-sky" remote sensing technology involving orbiting satellites, such as Landsat, or increasingly sophisticated unmanned aerial vehicles (UAV), often called drones. In fact, it's safe to say that range management and monitoring is already being revolutionized by the employment of drones, which give managers a whole new perspective on a ranch.

"This method lets you know where you're at so you can figure out where you're going." ~Gregg Simonds

One such methodology has been developed by Gregg Simonds and Eric Sant of Open Range Consulting (ORC), based in Utah. I was first introduced to it through a presentation by Simonds. He started with the bare outline of a 400,000-acre ranch in Nevada. Clicking the mouse, he began to fill in the image here and there with little colored squares representing traditional monitoring sites. After a few more clicks, he asked if we could we tell what was going on ecologically across the ranch from these few squares. We couldn't.

More clicks followed and additional colored squares were added to the map. Could we tell now? No. More squares appeared, and I realized suddenly that we were watching as a puzzle was pieced together. Soon, the squares tipped into an image—of Homer Simpson! One final click filled in the entire ranch with Homer's bug-eyed mug. Simonds' point was clear: if we are going to base a ranch's management on what is actually on the ground, we have to measure it as a whole unit. Anything less will create an incomplete and possibly inaccurate picture.

This holistic approach to measurement dovetails nicely with a steady rise in the sophistication of holistic livestock management on western rangelands, a methodology pioneered by biologist Allan Savory in the 1980s in which the timing, intensity, and frequency of livestock grazing impacts on the land are carefully controlled.

"A good manager must continually adjust the number of livestock, the amount of time livestock are allowed to graze, and the location and season that grazing occurs," writes Simonds. "Understanding the relationship between these management practices and their effects on the land requires a feedback system that provides the information needed to make adjustments. A whole ranch view can also satisfy demands from the public for better stewardship of federal rangelands."

A bird's eye perspective on landscapes contextualizes the challenges of global warming, such as extended droughts and increased storm intensity. The new normal of anthropogenic climate change will increase variability—especially extremes—across whole regions, creating an urgent need for monitoring systems that measure changes in spatial and temporal conditions rapidly, accurately, and at scale.

To meet these demands, Simonds and Sant have developed a methodology that utilizes high-resolution, natural-color digital photography of representative ground samples to create a comprehensive, correlated, and highly accurate map of vegetative and soil components across whole landscapes. The digital image of the ground sample, typically a five-meter by seven-meter rectangle, generates more than eighteen million bits (pixels) of information in contrast to the 100 bits of information on a typical line transect. Multiple digital images across the ranch generate a huge amount of data.

Using advanced software, this information can subsequently be correlated with drone and satellite images and extrapolated across the entire landscape. Additionally, Landsat images extend back in time, often thirty years, which makes it possible to track historical changes in land condition, providing valuable data to managers and the public. As for rangeland health, Simonds points out that dryland ecosystems have distinct vegetation structures that are strongly linked to their function. Delineating these structures using his methodology allows a manager to make an accurate assessment of rangeland health.

"A picture is reputed to be worth a thousand words," Simonds wrote me in an email. "This picture is something experienced resource managers understand without being GIS specialists. It can be archived to be reviewed later by others and/or reanalyzed with new questions or technologies. Line transects can only be experienced by whoever was there at the time."

When combined with the Landsat imagery, the ORC methodology allows an investigator or manager to look back in time and measure big changes on the land, which can help determine whether the changes are the result of climate or management (or both). In a report about an ORC assessment of sage country in northern Utah, Simonds wrote:

> *This technique has great potential to place land cover [vegetation] change and rangeland health in a contextual perspective that has not been available before. In this way, past management practices can be evaluated for their effectiveness in altering basic cover components of rangelands. With this hindsight, improved management prescriptions can be developed, providing a valuable tool in assessing public land grazing allotments for renewal or habitat quality for sensitive wildlife species like the greater sage grouse.*

USDA's Natural Resources Conservation Service hired OCR to assess the rangeland condition in five large areas in Utah that are good habitat for the sage grouse, an at-risk species being considered for protection under the Endangered Species Act (a situation that has generated both litigation and on-the-ground collaborative efforts). Sage grouse have a variety of nutritional needs over the course of a year, including access to healthy riparian areas. When correlated to management practices, ORC's eye-in-the-sky assessment of riparian areas should help landowners improve management for habitat conservation. For example, if a stream has maintained its health over a stretch of time, evidenced by stable riparian vegetation, then the management practices that maintained its health can be implemented in other riparian areas.

By providing a ranch-wide view, ORC's methodology captures important variabilities on the land, including vegetative changes, amount of bare soil, trends in riparian health, and other indicators, and this can create the basis for trust and dialogue between ranchers, agency personnel, and the public. It takes the guesswork out of assessments and can provide timely feedback for landowners.

ORC's eye-in-the-sky methodology captures important variabilities on the land . . . and this can create the basis for trust and dialogue between ranchers, agency personnel, and the public.

Here's a quick summary of the benefits of high-resolution photography combined with remotely sensed imagery, and the whole-ranch perspective it allows:

- Provides highly accurate, quantified data at scale
- Can be frequently and easily updated
- Incorporates pre-existing monitoring data
- Can be used by ranchers and agencies to assess management decisions
- Combines easily with a rancher's experience and knowledge
- Promotes flexible, results-based grazing policies
- Incentivizes ranchers to implement best management practices
- Helps navigate unpredictable and variable conditions
- Helps manage for increasing climate variability
- Is easy to archive and retrieve for later use
- Satisfies public demand for information

Simonds summed it up this way at the presentation that I attended: "This method lets you know where you're at so you can figure out where you're going." Figuring out where we're going will be increasingly valuable in the twenty-first century.

ORC's digital monitoring vehicle on the JX Ranch. By Courtney White

Manage

In 2014, the Western Landowners Alliance (WLA), a nonprofit organization based in Santa Fe, New Mexico, contracted with Open Range Consulting to make a quantitative assessment of rangeland health on a select number of working ranches in New Mexico. The assessment would be used to help evaluate effective land management practices, which could then lead to the development of incentive-based strategies for the marketing of ecological goods and services, such as carbon sequestration and wildlife habitat improvement. Where possible, the monitoring extended to neighboring ranches where livestock had been managed differently on comparable soils and vegetation. A primary objective of this project was to identify grazing practices that work best in the diverse grasslands and shrublands of the American West.

Examining grass diversity. By Courtney White.

Five ranches in eastern and northeastern New Mexico were selected for inclusion in the assessment, including the JX and Pinon ranches (south of Tucumcari), the JT Ranch (near Santa Rosa), and the CS and Moore ranches (near Cimarron). Except for the Pinon, each of these ranches has managed their livestock according to planned grazing principles (sometimes called short duration or management-intensive grazing). These include bunching cattle into discrete herds and moving them on a flexible schedule through a series of paddocks, with the goal of allowing grasses and other plants sufficient time to recover between grazing events.

In contrast, the owners of the Pinon Ranch managed their cattle with continuous or season-long grazing rather than planned grazing. The Pinon contains two large paddocks, one which has been continuously grazed and one which has been rested for five years, due to the drought.

ORC conducted its fieldwork on all five ranches in September 2015, at the conclusion of what proved to be an atypical, highly productive growing season, the result of annual precipitation that in some places exceed 150 percent of normal. The abundance of grasses and forbs thus produced challenged the remote sensing methodology and the subsequent analysis of the data on a variety of levels, including the high degree of ecological productivity on ungrazed neighboring properties.

The land health indicator that stood out most prominently in the analysis of all five ranches was bare ground. This indicator can be closely correlated with rates of water infiltration into soil because higher infiltration rates of water into soil encourage plant vigor, increase the length of time plants stay green (and thus remain nutritious for grazing animals), and recharge riparian areas. In other words, reducing the amount of bare ground by increasing vegetative cover over time can increase the land's health, with benefits for wildlife and livestock operator alike.

However, before functional assessments or management decisions can be made, the site under consideration must be compared to its *ecological potential*, a scientifically derived classification based on soil type, native plant community, and other physical attributes, officially called an Ecological Site Description (ESD). For example, according to its ESD, in a mesquite-dominated site, a land manager might not expect to see a large amount of grama grass. Or, on a ranch in the drylands of southern Utah, a large amount of bare soil might be perfectly normal according to its ESD, while an equivalent amount in prairie country would indicate poor health. An inventory of ESDs has been completed for most of the nation and is available to landowners and managers through the web site of the USDA's Natural Resources Conservation Service (NRCS). Unfortunately, the detail provided by some ESDs is coarser than that provided by others and sometimes incorrect, as ORC has discovered.

In its analysis of the JT, JX, CS, and Moore ranches, ORC made comparisons with neighboring ranches by measuring a 100-meter strip on both sides of the fence at various locations.

In general, there was less bare ground on the subject ranches, and their amount of bare ground was lower in all soil types. In contrast, the traditionally managed Pinon Ranch has the same amount of bare ground as its neighbors.

On the critical issue of stocking rate (number of acres per cow per year), which can be a make-or-break economic factor for a commercial operation, the four ranches had stocking rates that range from 28 to 173 acres/cow/year in 2015. This wide range strongly suggests that there is no correlation between bare ground and stocking rate. In fact, the ranch with the least bare ground (compared to its neighbors) had the highest stocking rate. In other words, the reduced amount of bare ground on a ranch is likely related to cattle management rather than acres per cow. As Simonds wrote in his report to WLA:

> *The common paradigm in managing rangeland to optimize long-term land health and animal production is to have moderate to moderately low stocking rates. In response, rangeland administrators have prescribed destocking to heal landscapes. However, ORC's key finding in the assessment of these five ranches in New Mexico is [that] bare ground, which is highly correlated to precipitation infiltration, carbon formation and sequestration, is not correlated to or predicted by stocking rate.*

The principle management practice on the JT, JX, CS, and Moore ranches, according to their owners, was time-controlled livestock grazing, primarily via the creation of new pastures and paddocks by cross-fencing larger paddocks into smaller ones. For example, after taking over the JT ranch in 1999, Jim and Carol Thorpe increased the number of paddocks from nineteen to thirty-three and the number of permanent water sources from eighteen to thirty-four (including tanks). They also reduced the amount of juniper, mesquite, and cacti on the property, which eventually yielded additional grass cover (after a period of bare ground and early successional weeds). "Our grazing infrastructure with cross-fencing, water developments, and brush control," wrote Jim Thorpe in an email, "coupled with flexibly adaptive rotational grazing and water-spreading structures, has over time resulted in increased landscape productivity, diversity, and overall resilience."

The situation on Mimi and Tom Sidwell's JX ranch is similar. When they purchased the property in 2003 there were eight paddocks on the property; today there are twenty-five. Additionally, the Sidwells manage time-controlled grazing with specific attention to bare ground, trying to improve bare areas by stirring up the soil with cattle hooves, primarily in winter during supplemental feeding. Tom Sidwell reports that he has seen the amount of bare soil decrease over time as a consequence of his management. He has also grubbed 1600 acres of trees and shrubs and chemically sprayed another 1500 acres.

Landsat imagery gathered by ORC show that for ten years prior to the management change there was no difference in the amount of bare ground on the JX and its neighbor. But after clearing mesquite and juniper and changing grazing management, there is six percent less bare ground on the JX. While this doesn't sound particularly dramatic, it is 20 to 30 percent less than the ESD for this area. Additionally, soil samples taken by ORC show that the JX has nearly 80 percent more soil carbon per acre than the neighboring ranch. The difference appears to be the Sidwells' removal of mesquite and juniper, coupled with planned grazing practices.

Alice Moore switched to planned grazing principles in the 1980s, cross-fencing much of the 29,000-acre Moore ranch, mostly with electric wire. Today, the ranch has fifteen paddocks for summer grazing, thirteen in mountainous country, and eleven for winter use. Grazing was the principle management tool (400-500 head of cattle for decades; 200 head today). There was very little tree or shrub removal; and as with all the other ranches in the study, there was no use of prescribed fire on the ranch.

Drone flying over the JX Ranch. By Courtney White.

The story of the CS Ranch is similar. Its 66,000 acres were continuously stocked from fall to spring; in summer cattle were moved to mountain pastures. A switch to planned grazing in the 1980s allowed the Davis family to increase the size of their cow-calf operation by as much as a third and bring in yearlings during wet years. According to Julia Davis Stafford, the number of new, smaller pastures doubled over time, which allowed the ranch to consolidate its cattle into fewer but larger herds, depending on forage conditions. The ecological effect was clear: the diversity of plant species grew from predominately one (blue grama) to more than twenty.

The Davises also tracked the amount of bare soil on their land with a qualitative monitoring system called Land EKG, developed by Charley Orchard of Ten Sleep, Wyoming. Orchard has collected monitoring data on ranches across the West for more than a decade. In his data, ranches such as the CS and Moore stand out as sites where plant productivity is increasing and bare ground is decreasing. The common factor is management that includes limiting grazing on each pasture to once a year, providing long intervals of rest for plants, and varying all pastures' season-of-use from year to year (another form of rest).

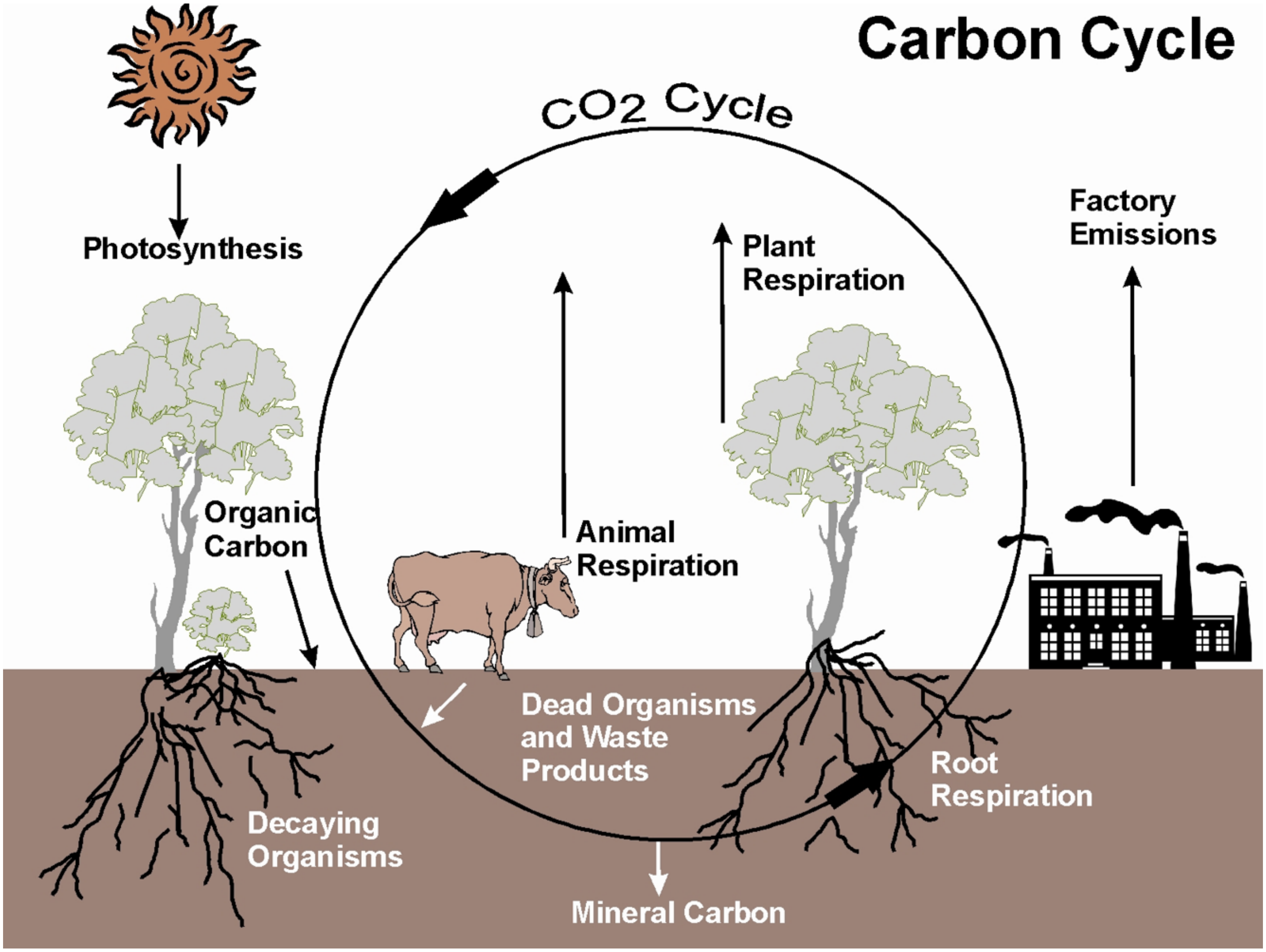
When Orchard began monitoring the Moore ranch more than a decade ago, he noticed that it had a healthy amount of litter and plant cover compared to sites of similar potential. In particular, Alice Moore's riparian habitats and swales with deeper soils were highly productive and had little bare ground. He attributes these conditions to Moore's grazing strategy and moderate stocking rate (50-70 acres per cow at that time). The CS ranch soon adopted a similar approach, he noted. In both cases, the grazing management includes long periods of rest in order to ensure adequate forage and litter in the pasture when the cattle leave. Orchard believes that by adhering to these principles, these ranches have not only maintained their production capability through the drought years but have also been able to respond rapidly when the rains finally come—all the while maintaining a positive cash flow.

In other words, Orchard's observations supported ORC's findings (and vice versa).

> *The traditionally managed Pinon ranch has the same average amount of bare ground and variation as its neighbors . . . This data would indicate that stocking rate has no relationship with bare ground but is likely related to their cattle being bunched and moved based on balancing plant use with appropriate rest for recovery.*

"This analysis shows that the JX, CS, Moore, and JT ranches have less bare ground overall and less variation in bare ground than their neighbors," Simonds wrote in the WLA report.

Tom Sidwell at the JX Ranch. By Courtney White.



From the Quivira Coaltion

From 2011 through 2014, eastern New Mexico endured a devastating drought, with annual precipitation levels dropping as low as five inches in some places. Many ranches destocked their land of cattle entirely as a consequence, incurring a sharp drop in economic vitality. The JT, JX, CS, and Moore ranches, however, did not destock, though all four did reduce their livestock numbers substantially. Owners of all four ranches credit their progressive livestock management for allowing them to stay in business during this difficult period, thanks to improved grass cover produced by planned grazing and a simultaneous reduction in unproductive bare ground. Their land, in other words, was healthier than their neighbors' land. The high level of their soil stability, biotic integrity, and watershed function meant they could ride out the drought by destocking while waiting for the rains to return.

ORC's eye-in-the-sky assessment supported the ranch owners' observations. By providing a ranch-wide analysis, the remote sensing technology, coupled with on-the-ground documentation, confirmed not only the ecological benefits of planned grazing principles but also demonstrated that a reduction of bare ground was possible, even during a severe drought. The exceptional precipitation in 2015 likely softened the contrasts between the progressively managed ranches and their neighbors but does not change the overall conclusion: *using bare ground as an indicator at ranch-wide scales demonstrates that planned grazing can benefit a landowner ecologically and economically.*

Using bare ground as an indicator at ranch-wide scales demonstrates that planned grazing can benefit a landowner ecologically and economically.

Glossary

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

infiltration. The process by which water soaks into soil. Soils in good condition, with developed structure and continuous pores to the surface, are able to absorb water from rainfall or snowmelt and store it for plant growth.

infiltration rate. The speed with which water enters a soil. Water evaporates or runs off of encrusted or compacted soils with slow infiltration rates. This reduces the amount of water stored for plant growth, which results in the reduction of organic matter. Over time, this weakens soil structure and can further decrease the rate of infiltration.

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.

landscape function. The degree to which a particular landscape is able to capture, store, and use valuable resources, such as water, minerals, and organic materials. Dysfunctional landscapes lose these resources to runoff and wind erosion.

litter. Any dead plant material that is in contact with the soil surface. Litter provides a major source of the organic material for onsite nutrient cycling. Litter movement is an indicator of the degree of wind and water erosion; less redistribution generally indicates less erosion, for example.

pedestals and terracettes. Pedestals are rocks or plants whose bases are elevated above ground level as a result of soil loss by wind or water erosion. Terracettes are benches of soil deposition behind obstacles caused by water movement (not by wind).

plant mortality. The proportion of dead plants to live ones, especially to juvenile plants, expected on a site under normal disturbance regimes; an indicator of population dynamics. When recruitment of new plants is not occurring and existing plants are dead or dying, the integrity of the site is expected to decline, and this will generally lead to increased erosion.

rangeland. Land on which the native vegetation is predominantly grasses, grasslike plants, forbs, or shrubs. Rangeland includes natural grasslands, savannas, shrub lands, most deserts, tundras, areas of alpine communities, coastal marshes, and wet meadows.

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.

runoff. Rainwater or snowmelt that flows downslope rather than infiltrating into soil. 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.

soil. A combination 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 the ways soil is managed.

soil quality. The capacity of a specific 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 water infiltration and runoff and thus the amount of water from rainfall and snowmelt that is available for plant growth; the availability of nutrients for plant growth; the conditions needed for germination, seedling establishment, vegetative reproduction, and root growth; and the potential for erosion.

soil stability. The ability of soil structures (groups of soil particles) to resist degradation. As organic matter, such as roots and litter, breaks down over time, it develops an adhesive quality that holds soil together. This 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.

vegetative cover. Total plants and plant litter on the ground at a particular site. 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 (adequate production of flowers and seeds) is crucial for maintaining good vegetative cover.

References

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

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

Pellant, M., P. Shaver, D. Pyke, and J. Herrick. ***Interpreting Indicators of Rangeland Health, Version 3. Technical Reference No. 1734-6.*** Denver: USDI Bureau of Land Management, 2000.

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

Acknowledgements

The Quivira Coalition and Western Landowners Alliance collaboratively produced this publication in an effort to make the research of Open Range Consulting in their assessement of New Mexico Rangeland Stewardship accessible to a broader audience.

We would like to thank Rick Danvir, Basin Wildlife Consulting, for guidance and project management.

The supplemental research document can be requested from Western Landowners Alliance.

This research and publication were made possible thanks to the generous support of the Thornburg Foundation.

We would like to thank Paper Tiger of Santa Fe, New Mexico for their support in publishing this book.

paper tiger

WWW.PTIG.COM

Published by

WESTERN LANDOWNERS ALLIANCE
STEWARDSHIP WITH VISION

QUIVIRA COALITION
education • innovation • restoration

Western Landowners Alliance (WLA) invites you to join us in advancing the ecological health and economic vitality of private and leased public lands in the West. Led by landowners, we work to advance policies and practices that sustain working lands, connected landscapes and native species.

Working lands encompass the most biologically diverse and productive portions of the Western landscape. They supply vital food and natural resources while sustaining our livelihoods, rural economies, communities and wildlife populations.

WLA provides a collective voice and knowledge sharing network for landowners and managers who steward these lands on a daily basis and who share a commitment to their long-term well being.

The Western Landowners Alliance
PO Box 6278, Santa Fe, New Mexico 87502
www.westernlandownersalliance.org

The Quivira Coalition builds resilience by fostering ecological, economic and social health on Western landscapes through education, innovation, collaboration and progressive public and private land stewardship.

In 1997, two conservationists and a rancher had a bold, new vision of land stewardship for the West—a new ranch operated on the principle that the natural processes that sustain wildlife, healthy soil, and living streams are the same that make land productive for livestock.

In its twentieth year, our coalition will expand the Radical Center and our reach to new corners of the rural West. We'll train more new ranchers, regenerate more acres of grazing lands, rebuild more miles of creeks and streams, and educate our community about the myriad innovations to foster land health in an increasingly uncertain climate.

The Quivira Coalition
1413 Second Street, Suite 1 Santa Fe, New Mexico 87505
www.quiviracoalition.org