Statement of Steven H. Rich

Hearing on Increasing Carbon Soil Sequestration on Public Lands

House Natural Resources Subcommittee on Public Lands and Environmental Regulation

June 25, 2014

Mr. Chairman, I wish to thank the committee for this opportunity to share some of the best possible news those who care about federal public lands, our nation, and the future could receive. I wish especially to thank you, Mr. Chairman, for recognizing the potential of soil-carbon-based ecological restoration principles to the future of federal lands and that of the world.

While I will refer in this statement to the work of the Rangeland Restoration Academy, which I serve as president, I want to make it clear that I am testifying here as an individual, not representing the academy. As you will see, I think instituting various aspects of the policies which will increase atmospheric carbon sequestration on the public lands will require legislative action by Congress and the academy does not engage in lobbying or political activities.

We have described atmospheric CO2 sequestration in soils as a “Win-Win Solution” because it genuinely bridges the wide, divisive sometimes shrill divide over climate change and its causes. For those who feel that rising atmospheric CO2 levels are a lethal threat to humanity and nature—it should be truly wonderful news that the clear, scientifically-established potential to actually solve the problem—planet-wide—really exists. This is done simply by using a few optimal management changes—which are proven to create genuine ecological and biodiversity restoration and vastly increase carbon-sequestration! It has the added advantage that, in my opinion, this is the only political, economically proven solution that can be instituted within the timeframe that those concerned about climate change say must be met.

The fact is that some agriculturists have for many years been doing things that greatly accelerate the rate of the land-based carbon sink’s photosynthesis-sourced soil storage on rangelands, farm lands and grazable woodlands! This can be ramped up to the point of securely sequestering *all human-sourced carbon emissions from the beginning of the Industrial Age to the present day*.* This should be met with universal rejoicing—not least because soil carbon is the basis of ecosystem health. (*Dr. Christine Jones and others make this statistical projection of a near-term world-wide solution using various sequestration rates and assumptions, based on worldwide experience)

On the other hand, those who object to very painful economic damage imposed by an emissions-control based policy—which will most certainly be quickly overwhelmed and negated by emissions from India, China and elsewhere—should also be very happy. They can solve their “opponents” problem by healing nature. All people of good will love nature. Soil carbon sequestration genuinely and sustainably restores vast, long-lost biological and economic potentials—making positive differences of an order of magnitude and more. There is no rangeland or forest problem that is not improved by optimal soil relationships and more soil carbon. Public lands which can rapidly store carbon also make the difference between thriving rural economies in public land states and a series of dependent, impoverished economic basket cases whose young people must move away.

CO2 sequestration in soils is accomplished by the most ancient of plant processes—making sugar through photosynthesis. On land, “sugar-for-minerals and water” trading alliances between photosynthetic algae and fungi, such as in lichens, soon developed. Modern scientific discoveries about almost universal, win-win symbioses between complex plants and certain fungi—the “Liquid Carbon Pathway”—have allowed us to understand how leading livestock operators, farmers and researchers have managed to restore soil carbon levels from perhaps .5% to 5% (which represents a 1,000% increase in water-holding capacity) in a decade or less—vastly less time than anyone, including the “experts,” supposed.

Glucose (simple sugar)—made in a plant’s leaves from sunlight, water, and CO2—is routed in liquid form through the plant’s supporting tissues to its roots. Some of this is simply flooded out from root-hairs into surrounding soil for the support of nitrogen-fixing bacteria, etc. and other plants. Most plant’s roots allow fungi’s root-hair-like hyphae to enter them. The fungi have connections to myriads of further-specialized soil bacteria and other organisms which trade the mineral, etc. results of their specialties with the fungus. Since fungus-connected plants get much-increased mineral nutrition and water through the support of this complex, fungal-connected symbiosis, plants tied to such “fungal guilds” (again, trading alliances) are able to produce up to 40% more “photosynthate” (sugar) to support themselves and the rest of the soil community than are lone plants. The symbiosis often involves many thousands of plants exchanging nutrients through “fungal mats”, one of which may cover several acres. “Long Fallow Disorder” describes the puniness of crops grown in soils lacking proper fungi and other soil-symbionts—where the mats have died.

Within the vast soil volumes occupied by these mats, one recently-discovered, sticky “glycoprotein” (made of protein and sugar) called glomalin, coats massive tonnages of the fast-growing, short-lived hyphae of VAM (Vesicular Abuscular Michorrhyzae) fungi. Glomalins from dead hyphae stick soil particles together in discrete globules—creating life-necessary “soil structure” which allows air and water to both penetrate and collect. They create the sweet smell from dark, rich soils. Glomalins make up a significant part of soil carbon. With the mineral-getting help of bacteria stimulated by liquid carbon, these and grazing-stimulated pulses of remains from dead plant roots and other soil life (78% 0f the total) are quickly “humified” in tough, plastic-like long-chain polymers (sort of like brown coal), in highly water-stabile forms that can last thousands of years. The deeper in the soil structure they lie, the more invulnerable they are.

Ranchers in tall-tree locations (perhaps 20” precipitation) report 2 to 15 tons and more of CO2 sequestered per acre annually, depending on several variables. The above sequestration figures, for example, come from recovering, once-degraded soils with an apparently *accelerating* deep-sequestration trend. This range is widely documented to be more than the animals respire, etc.

Less rainfall and shorter growing seasons do mean less photosynthesis—so, less carbon stored. But that’s where the soil carbon magic kicks in. Annual growth of a dry-climate (let’s say 8 to 10 inches precip.) short-grass like Blue Gramma or Sand Drop-seed can vary by 1,000% or more. With fungal-guild help—the growth varies less and has higher averages. Functionally, grazing animals are an indispensable, key part of fungal guilds, when properly managed. Simply stated, the greater soil symbiosis activity triggered by grazing animals that eat, dung and urinate on a site for a brief time—then leave until plants grow back grazed their tissues—make the plants and the soil community bigger and healthier.

The term “Pulse Grazing” (root pulses, above) describes grazing methods designed to optimize the natural deposition of tremendous tonnages of dead root hairs, etc. in soils—caused in nature by any removal of living, above-ground grass, etc. tissue (grazing, fire, insects, disease, etc.)—and by their death due to normal seasonal dormancy or drought. These root hairs, etc. are replaced during growing seasons. They grow back into improved, more carbon-rich soils, and are necessary to soil carbon storage and to feed decomposer organisms in the humification process.

Timing is critical, both in terms of length of the grazing event and the length and recovery effectiveness of the prolonged rest periods between grazings. The concept includes pulses of grazing and resulting dung, urine and animal hoof track deposition, etc., designed to both simulate natural effects of migrating herds and simultaneously cause great, cyclic increases (pulses) of bird, insect, fungal and other populations in response to these concentrated resources. Pulses of seedlings are also produced, supplying a steady stream of new plants to fill open or expanding niches.

These relationship dynamics, in time, allow the site to transcend progressively higher biological thresholds without more precipitation—progressing from bare ground and dry-country-adapted annuals, to struggling, weak perennial xerophytes (desert plants) to strong specimens of the same species groups, to a more complete xerophytic community with many species, located in less-productive sites—to taller xerophytes in better sites—then to the spread in favored locations of more mesic species (requiring damper soils—like western wheatgrass)— even to hydrophytes (water-loving, riparian species) as watersheds heal.

In wetter regions and higher-altitude areas, managing livestock by methods described below also create this entirely-natural, “no-cost”, very profitable, restoration of native plant, etc. biodiversity. In Missouri, for example, locally-extinct Tall Grass Prairie plant species have returned to played-out, eroding, carbon-poor farm soils by ranchers simply controlling timing, intensity and frequency of livestock grazing in response to weather, etc. (in pulses). These species typically have a 12 foot deep root zone and can sequester carbon at great depths in very high volumes. There are public lands in the East and other locations where these and other highly-productive plants are native (In the West, stands of Great Basin Wild Rye Grass, Giant Sacaton and other tall species reach up to 9 feet in height and have very deep roots).

Without planting a single seed, without using a tractor, any fertilizer, herbicide, etc. (all normally used when introducing Tall-Grass species) the ranchers simply let whatever weeds and grasses remain in the poor soils to grow—as high as 6 feet and more, let the highly concentrated livestock eat some and trample the rest, covering and protecting the soil from that time forward. This sets the stage for a series of other species—as above. As fungal mats and soil life communities and processes reestablished in the natural course of these scientifically guided, adaptive operations (guided primarily by the landowner) the Tall Grass species reappeared—by themselves! They grew from “hard seed”. Hard seeds are plants’ “species survival time capsules”, genetically programmed to remain long-dormant in soil seed banks, germinating only when highly favorable soil conditions reappear—in this case after a hundred years.

The community’s biological processes move toward the optimal in response to “simulated native animal behavior”. This optimized, “naturalized livestock” grazing behavior—within many fungal guilds, is absolutely necessary in forming very large versions of what researchers Augustine, McNaughton and others call “grazing lawns”. This works best of all when stock are trained to eat a variety of “lessdesirable" plants—thus removing semi-toxic plant's competitive advantage versus grasses, etc. (Yes, livestock can indeed be trained to engage in certain grazing behaviors. 0

Overlapping grazing lawns represent an extremely valuable restoration opportunity for most adapted native organisms. Optimizing (generally, shortening) the time of plant's exposure to grazing pulses by domestic stock, limiting grazing to moderate levels, and evening out the grazing pressure per acre deeply minimizes risks to plant survival. It also periodically "jump-starts" the fungal guild and functionally joins separate grazing lawns into "grazing lawn areas" of hundreds to thousands of acres.

Grazing lawns have higher-carbon, high-nutrient-level soils, therefore—unlike dry-climate soils without grazers— they produce plants of high nutrient value for animals. These—though grazed, are not grazed so repeatedly as in unmanaged nature—so plant diversity is not limited—as it is in unmanaged sites— to species having the highest grazing tolerance.

These optimally-managed landscapes typically produce growing—even locally dominant—populations of species like high-value grasses, shrubs and forbs (flowers) which poorly tolerate repeated grazings without sufficient recovery time. These "progressively restored" landscapes are produced by grazer/plant/fungal-guild relationships which— very often—cannot occur at all without active, skilled, human-intelligence-directed grazing management. *Such management always includes adaptive, highly variable livestock herd sizes and other strategies to mitigate the effects of highly variable rainfall, etc.*

More soil carbon means bigger plants, more seed production and therefore more seedlings and closer plant spacings—cooling the soil and facilitating further sequestration. As a growing series of positive feedbacks continue to occur and strengthen, the site will be progressively colonized by larger grasses (etc.)—like the Sand Drop-deed's much larger cousins (3 to 4 feet tall), Tall Drop-seed or Spike Drop-seed. These have much deeper root systems, provide more leaf-litter when trampled and more shade when standing, cooling the soil further.

Cooler soil greatly benefits carbon storage and all other biology. Taller grasses and forbs can draw water and nutrients from deeper soil layers. So, then, can the fungus and the guild—and carbon-storage goes even deeper. When this happens, average production on the above 8" to 10" rainfall site—and all wetter ones—increases greatly. In dry lands this makes place for far more animals of far more kinds, such as insects, rodents, birds, deer, pronghorns, etc. This also means far less rainfall "runoff" (after a period of time almost none) and much more soil-water storage. Lands managed in this manner do not experience droughts as being as functional severe as lower-carbon lands and are far more resilient.

Fortunately there has been significant progress in remote sensing technology using satellite image data. This can even act as a "Time machine" documenting plant community changes since the 1970's. When known management changes result in huge meadow expansions into former sagebrush, for example, when such has not happened on adjacent ranches, this can be explained in terms of improved watershed conditions—which always means more soil carbon. Changes in density as well as growth or shrinkage of various plant species populations can be derived from the data and correlated to carbon levels under various plant communities through "ground truth" sampling. This should lead to effective soil carbon level carbon monitoring on public lands by averaging samples taken in similar communities on vary large acreages. It effectively and economically allows good monitoring of carbon sequestration rates on landscape scales.

Federal agencies are required to document the condition of the vast public lands. Those in "fair' condition and better are able to sequester soil carbon at varying rates. A tragically large percentage, however, that Is now in degraded states, actually lose soil carbon to the atmosphere due to erosion and other processes. By contrast, well-managed Aspen groves, for a positive example, can produce over 2,000 lbs. of herbaceous understory biomass per acre in addition to the tree tissue above and below ground. The combined sequestration potential is immense. Clearly, Aspens and herbaceous plants coexist as supportive symbionts.

In every non-wetland location, higher soil carbon means more soil water. In most ways, this is the functional equivalent of being in a higher rainfall zone. But, in Western federal lands which have degraded—often due to policy errors described by Dr. Teague, and others related to woody-species management (following), *this soil water rescue must now begin at the very-harsh, bare-soil-surface level before soil carbon sequestration can proceed again*. One source of documented degradation is massive, west-wide increases in the stem density and canopy cover of semi-toxic woody shrubs and tree species like conifers and sagebrush. When the least-healthy end of these burn, they degrade far further, still because of the negative effects on the soil.

These dense stand structures were triggered by several causes, among them pioneer-era, etc. overgrazing, followed by very active fire suppression after the mass-removal of most semi-toxic-woody-plant-eating sheep and goats, plus the simple competitive advantage of being taller and less-palatable-to-animals.

Fact: as these stands thicken beyond functional thresholds, they literally kill most other plants by hyper-competitive strategies. *This means the end of the most productive grass-mycorrhizae pathway to soil carbon sequestration in very large areas.* Springs dry up as a result. Entire perennial streams cease all but flood flows. Also, the animals that depend on these plants must leave or die. *This catastrophe, unknown to the public and media, leads to 90% and greater losses in overall site-adapted biodiversity and triggers a cascading loss of biological values.* Vast reaches of pinion/juniper woodland, sagebrush steppe, chaparral, etc. range sites are in such conditions. They are depauperate biological deserts.

Too-dense tall conifer (firs, spruces, etc.) stands also have no grass, etc. understories. Studies published in "Nature" in 2008 indicate that such thick, unmanaged (since 1930), "wilderness-type" conifer forests *actually store around 30% less tree-tissue carbon than do far less-dense forests restored to the fewer, healthier, faster-growing and vastly more fire-safe, mainly large trees of ancient Native American management practices.*

Reducing tree densities to pre-Euro-settlement levels has also been shown to end the bark beetle scourge that has killed tens of millions of too-dense conifers. The deaths of these un-harvested trees must now set off a series of events *leading to millions of acres of horrifyingly severe future ground fires burning in tens of millions of acres of then-fallen timber. Burning in perhaps hundreds of thousands of acres per fire event—most of these huge fuel loads of fallen, beetle-killed trees will certainly be completely consumed in close contact with soils—utterly sterilizing them —while killing any regrowth of conifers, aspens and other resprouters, as well as the herbaceous plants. This will, within hours, release <u>all</u> their combined carbon stores, including vast amounts of methane and nitrous oxides, into the atmosphere.*

Resulting from well documented deep soil sterilization and soil-carbon-vaporizing effects of severe fire, the hydrophobic (water-shedding) crusts they develop, with the massive 7 to 14 year flooding periods and huge soil erosion that develops as a result—it should be noted here that many hillslopes with southern and western exposures, for example, many never produce forests again. Mountain soils are often thin anyway. Severe losses may foreclose some potentials forever.

Present, rapidly-rising wildfire emissions in Western states now typically equal those of the transportation sector. Again, the emissions from burning live trees are a small ratio of the totals almost instantly released in the much more damaging future fires described above.

All resource management professionals know—and the Natural Resource Conservation Service, National Park Service, Forest Service and Bureau of Land Management acknowledge—that the loss of the grass-forb “herbaceous layer” means vast increases in bare ground, high, bare-ground soil temperatures between woody plants, much-increased erosion, rapid surface (runoff) and subsurface losses of soil moisture and terrible losses of critical biological potentials.

What some may not understand is this: “Soil Degradation in Place” also occurs. Simultaneous to the usual accelerated erosion common to bare ground between shrubs and trees; soil bacterial-consumption-caused losses of soil carbon continue in upper soil layers.

The Park Service has undertaken some much-needed restoration efforts, even in Bandelier Wilderness and elsewhere. They removed most small-diameter trees and scattered the saw-slash to intercept sheet and rill flows of water on this degraded pinyon/juniper woodland—thus reestablishing the remnant herbaceous layer and restoring this sequestration pathway. Such efforts should be undertaken West-wide. The opportunity exists to use scientifically-supplemented (nutrient suppliements) goats to accomplish these treatments. Within a NEPA or NEPA-like protection framework, suitable sites could be opened to (closely controlled) commercial goat operators, which should pay no grazing fees while providing such a valuable ecological service. Biomass burning electro-generation and other stand thinning opportunities also have been proven world-wide.

Present federal policy as practiced tends to actively prevent what we are proposing today. Our proposed grazing strategies, for example, protect streamside riparian values and the health of uplands as a matter of their standard course. They make many standards and guidelines obsolete and destructive of the overall resource.

During the last 30 years, it has been increasingly become a career risk for federal employees to support such efforts or recognize scientific facts. Any land-related policy from any organization which ignores basic biological facts in favor of political or other philosophy is fatally flawed and therefore destructive in its first principles. This “Blind Rage Against Livestock”—or against any human activity—has led to an atmosphere where blatant falsehoods are spread by federal staff in NEPA and other documents.

There are far too many instances to share here, but federal scientists have claimed, for example, that cows eat several endangered fish species and their endangered fish eggs, step on the nests (redds) of endangered fish species that in fact do not make redds, claimed that dry washes were critical habitat for several endangered fish species, etc., etc.—all to hurt ranchers. The public, media and some environmental groups and by ignorant precedent, the courts, have inherited a belief that simply “leaving such areas alone” will lead to ecological recovery.

This is a false, vain hope—and all competent professionals know it. Our proposals are based on the most basic, elemental matters of land management. Only the role of these particular fungi in soil carbon sequestration and some microbiology is in any way new knowledge. Having lost the grasses and the ability to retain rainfall without high runoff percentages, the hold the dominant woody species, the abiotic forces and structures like incised erosion patterns have on such places cannot generally be broken without human intervention.

Earl McKinney (retired) and his BLM team, working with ranchers, famously restored perennial flow to a seasonally-dry Oregon trout stream that had succumbed to thickening woody populations—in a very brief period. They cut invading Juniper trees and threw them into erosion features and otherwise placed them as sediment traps. The stream soon attracted beavers, and their dams raised soil-water levels—soon restoring lost meadows.

Another laudable intervention practiced on the same principles described here is occurring in Marin County, California which is documented to be effective in soil carbon sequestration. We will hear extensive testimony about it in this hearing. Well-made compost is applied to rangelands grazed by well-managed cattle. This immediately cools the soil and provides nutrients for the soil food web (described in this piece). This can move the process forward by years. I am looking forward to hearing John Wick describe this project and the most recent developments.

As a matter of information, similar work is ongoing at Fort Collins, Colorado, using cost-effective biosolids applications. I have seen the progression on the Fort Collins ranch from xeric Blue Gramma to dry-meadow spacings of far-more-mesic Western Wheatgrass (stems perhaps 1/3rd” to ¾” inches apart) highly increased photosynthesis and plant biomass levels and a much longer green period, and completely shaded soils due to this treatment. It has also been used to similar experimental effect on the Rio Puerco drainage in New Mexico where native biodiversity and soil stability were also jump-started effectively, according to published reports. This has also been done on a very large scale at Sierra Blanca in West Texas, to similar effect. Doctors Dick and Pat Richardson of UT Austin were on the team monitoring the project. They reported years of positive results to me personally. Outlined by comparative barrenness of the surrounding areas, the green, carbon-storing, biodiverse project area can be actually be seen from space.

For “most resource recovery for the dollar” economic reasons, limiting most ranchers—once range sites have reached degraded, high-bare-ground-percentages—restoration of sequestration potential must proceed from hugely multiplying “microsites”. I have seen establishment of multi-thousand acre native dry-country perennial grass stands in a single wet year by this method. Microsites are small locations where water and/or organic matter are able to collect and ameliorate (make life-friendly) the deadly-to-seedlings and germination-preventing bare ground conditions. Making microsites works like a light application of compost or biosolids, but is not generally as continuous or as nutrient-laden.

On 105 degree F., fairly windless summer days—not uncommon in much of the West and Midwest—dark, dry, bare soils can reach 158 Fahrenheit degrees and more. That’s the temperature of well-done roast beef. No seedling can long survive such conditions. No seed will germinate without several days of moist soil.

If created in grazing operations like those advocated here, by far the most cost-effective, easily-placed and mass-producible microsites are livestock hoofprints. These, when in sufficient densities, roughen and pit the soil surface and function “riffle-fashion” to interdict the surface flow of water or air carrying the most valuable soil surface elements (like seeds) and force it to drop them. Herds easily break up and block erosion rills, can “round out” other erosion features and establish sediment-trapping grasses in their waterways. Tracks also force large percentages, often all, of moderate precipitation to stay in place in the germination and root zones. They are very effective seed-catchers. Without them there is little hope of reestablishing grasses, etc. in bare ground.

Significant rainfall events loosen and transport high-quality organics from the edges of leaf-fall deposited at the drip edge of shrubs and trees. I have personally run experiments using a heater and variable-speed fan to simulate a periodic hot, dry wind’s effects on native grass seeds in simulated bare-soil cow tracks and on bare, level, crusted soil. Equal amounts of water were applied at the same intervals. Equal amounts of chopped, dry grass and decomposed organics were applied upwind. The tracks retained most of the grass and other organics and caught nearly all of the water. The soil at the bottom of the tracks never dried. The seeds germinated. The grass blew off the flat soil surface. Much of the water ran off—carrying the decomposed organics. The trackless soil dried to the bottom of the deep trays. The seeds did not germinate.

If we are really serious about reducing atmospheric carbon we must find ways to restore the effectiveness of lands which effectively stored soil carbon in pre-settlement days. This certainly can and should include the public lands, some of which because of their degraded and deteriorating condition are actually contributing CO2 to the atmosphere. Thick, unhealthy forests now grow in formerly grassy Native American “Pine Savannahs”. They are rooted in soils which science has proven can only be produced under grass cover. On Arizona’s Mogollan Rim in the late 1800’s, General Crook reported moving cavalry in columns, “many troopers abreast” in grassy pine stands where thousands of trees per acre now shade the soils and exterminate grasses.

The Federal Government has known about the consequences of thickening tree stands since the “Light Burning Controversy” of the late 1800’s and early 1900’s. Some foresters argued then for retaining Native American forestry methods using frequent cool-season ground fires of low severity to keep fast-growing forest structures open, maintain biodiversity and watershed function, and prevent forest crown fires.

The “Light Burner’s” (many of whom were timber-stand owners) lost the policy argument—their ideas scorned as “Paiute Forestry”. Those favoring entirely mechanical European-forest-based methodology, using logging and direct thinning as the only management tools, actively prevented use of the centuries-proven Native methods. The forest densities got entirely beyond Government control. The Clinton Administration and environmentalist lawsuits effectively ended this period by driving most timber-harvest out of the public forests.

What they failed to realize is that after 100 years of building progressively greater fuel loads—so that there was far more live, standing dead and downed timber, etc. after logging ceased than before it began—their return to primarily fire-based management without transitional fuel load reductions would prove to be a horrendous calamity. Hugely destructive, hugely expensive mega-fires were triggered by exceeding forest-safety thresholds in the wave of enthusiasm. Contrary to the public’s (and many federal staffer’s) beliefs, Federal data shows peak flood flows from the *average* Southwestern wildfire to be 2,300% + greater than from a CLEARCUT where all trees are removed.

Fuel loads still grow by 11% a year. Restoration of the herbaceous soil-sequestration pathway can certainly be greatly accelerated by using a fraction of the Forest Service' budget-dominating fire costs to restore lower Native American-era tree densities in a biodiversity-sensitive, strategic system of treated-forest firebreaks as we restore the natural order. According to the 4-FRI (Four Forests Initiative) studies these efforts will create a net economic return.

Following several megafires threatening to exterminate regional forests, major Environmental groups in the Southwest have recognized the error of banishing timber harvest as a tool of management (the Southwest Center for Biodiversity and the Grand Canyon trust among them). They helped create the "4-FRI Plan" in Arizona. In a miracle of common sense and real science, a collaboratively crafted plan to thin 300,000 acres was adopted by the Forest Service. This would by its nature open the herbaceous sequestration pathway as restored, grazable woodland. The Environmental groups helped recruit a large industrial investor who would have paid essentially all costs (even millions for scientific monitoring) through proceeds from manufacturing OSB (oriented strand board) from the forests' small-diameter trees.

Clearly, these vigilant, major green groups see this principle as a big "Win" for nature. Unfortunately, the program was co-opted by giving the contract to a far-inferior bid from a weakly-financed biofuels operation, whose process, according to the SW Center for Biodiversity, had never worked at industrial scales and had failed miserably elsewhere. I expect that Gila County Supervisor Martin, who was directly involved in this innovative effort, will speak to this and related forest and rangeland sequestration issues. Little thinning has occurred.

After sad losses of ecosystem health and native biodiversity due to past *unmanaged* grazing, the centuries-old concept of using livestock as a restoration tool has been greeted with considerable skepticism. Sadly, too, the skeptics have generally not been competent (or for odd reasons not willing) to draw the very real distinction between managed and unmanaged grazing.

Research has been crafted (we believe for political/fundraising reasons) to challenge the specific principles of grazing advocated here. But, in fact, it's laughable stuff. The researchers refuse to understand reality: ecological restoration can be created most effectively at landscape scales, by the best ranchers, using these best practices, in an adaptive manner that changes to appropriately address changing circumstances. It's not uncommon for these inexperienced and uninformed, largely urban-researchers to create a completely rigid (therefore weather, etc. inappropriate) protocol, then confine an animal or two—which are in distress at their isolation—pacing the perimeters of tiny pastures looking for a way out—and expect such abstract, unscientific shambles to replicate real managed grazing and its effects. A few years ago, Dr. Jerry Holechek and others produced a paper, "Managed grazing versus grazing exclusion: what we have learned" the protocols of which rejected nearly all the anti-livestock activist's typical bibliography for poor study designs and bad data.

Soil Carbon Sequestration, Endangered Species and General Biodiversity: It is vain to suppose that most endangered species can ever be truly recovered without restoration of pre-contact soil carbon levels. High-carbon soils are self-replenishing reservoirs of stored potential energy, water and nutrients. By the Law of the Minimum, populations are limited by the energy available to them, especially at critical times. Example: if sufficient water to digest food and meet metabolic requirements is lacking, no amount of forage, however large, which lacks the necessary water, is actually available. Further, no amount of water, however large, is actually available to a Sage Grouse if a hungry coyote, fox, or hawk won't let them have it.

Noted bird expert Mark Stackhouse discussed Sage Grouse survival this way: In badly degraded ecosystems, the grouse must simply leave. If better habitat is not found, they die out. Why? Because, in poor habitat the distance between survival requirements is too great to justify the energy gained by the energy expended, in relationship to the risk posed by predators. Jackrabbits and some other prey items have lower-quality year-round forage requirements than do grouse—so while Jackrabbit populations continue—the grouse are exposed to higher predator numbers supported by the rabbits, etc.

Spring-hatched Sage Grouse chicks don't get milk. They require high-protein and high-energy, low-toxicity, fairly succulent plant material and abundant insects—and free water, in addition to escape cover and maternal attention (the species also need contiguous habitat options to maintain genetic diversity---like vast, over-lapping grazing lawns). The longer the distance between required items, the more total energy, etc. they need, and the more their high movement level and long scent trail will attract lethal attention.

Healthy, high-organic matter soils (as in continuous grazing lawns) mean much longer green periods, meadows, springs, plant and insect biodiversity and habitat health--which mean short travel distances at any age—so, higher survival. They also mean more eggs per mother, more chicks, and higher brood survival. The numbers back this up. Sage Grouse don't just need sagebrush (their main winter staple food) they need productive Sagebrush Steppe ecosystems.

The Utah ranch on which Stackhouse hosts birding tour has been designated as a World Wide Important Bird Area by Audubon—with over 300 bird species and a big percentage of the state's Sage Grouse. High species richness of birds is common to ranches managed in our proposed manner.

In my judgment, if any species is in danger in the West, the key to its recovery is, with high probability, found in rectifying the key relationships (so, higher soil carbon) described as leading to sustainable biodiversity in this testimony—not in simply protecting them from human activity.

Southwest Willow Flycatchers (SWF) are another example. Most western biologists know that around half of this subspecies lives on or surrounding a single ranch in the Gila-Cliff valley of New Mexico. The ranch is managed by the principles discussed here. Though the federal government maintains reserves containing the willows and gallery forest they believe the birds need—they were mainly unoccupied at my last information.

Studies find that the ranch Flycatchers nest in certain branch configurations of Box Elder trees. They eat mostly bees. Why? Likely because well-managed, healthy meadows contain pollenating grasses and flowers, especially legumes with abundant blossoms. The use of bees (rather than flies) is easy to understand from an available energy standpoint: bees are bigger than flies, concentrate toward a certain location, and there are lots of them there.

The greatest threat to SWF's is identified as Cowbird parasitism (and by association, cows)—wherein Cowbirds chuck the SWF's eggs out of their nests, lay their own, and the SWF's raise their young for them. But, the ranch has the lowest level of Cowbird parasitism on record—despite high Cowbird numbers. Why? There is an available energy/soil richness explanation. It could be that when things are good—Cowbirds don't need to parasitize as much (there are lots of healthy cows to pick insects from and around). The ranch and valley are also the home of the highest and most species-diverse population of non-colonial riparian birds anywhere in North America—including endangered birds other than SWF's. There are also high numbers of upland species. Maybe massive bird numbers just spread the Cowbirds thinner.

The highest parasitism rate of Cowbirds on SWF's is in the Grand Canyon—where there are no cows. Though the fly, etc. numbers for SWF's are good next to the Colorado River—the upland available energy for non-riparian bird species is poor—as is the soil.

Management for soil carbon has tremendous implications for water dynamics, as we have said. Gabe Brown's ranch (same management principles) in North Dakota is documented by federal scientists (world-class sequestration researchers) to have recently absorbed a 13 inch, 24 hour rain event with no erosion and no runoff. Gabe has tripled his soil carbon in a few years. The neighbor's land was still waterlogged and partly under water 14 days later. It's reasonable to state that if all land in the Missouri Drainage and associated rivers was managed like Gabe's, the floods in this system would be greatly curtailed and the water stored in vast, regional soil reservoirs for steady release. Using these methods (including woody-species information, above), perennial stream flows have frequently been restored.

Waterfowl successfully raise up to 3 broods on never-dying potholes on Gabe's friend Gene Goven's Ranch and cropland at Turtle Lake in the water-fowl-critical Prairie Pothole area of North Dakota (same management principles). Most potholes dry up in summer. The birds struggle to raise one clutch. Gene's soils have much-elevated soil carbon due to grazing by our adaptive prescription. He documented a 6 inch rain with no runoff. The water entered the soil and started only raising the pothole levels a week later. Almost all species benefit from continual water availability. Ducks Unlimited of Canada subsidizes young rancher's education if they'll imitate Gene, Gabe and the others.

Also, Tallgrass Prairie species (Big Bluestem, etc.—no seeds planted—usually found far east of Gene in much higher precipitation) on what normally would be dry, blue Gramma etc.-occupied glacial-till hilltops on this ranch years ago. Short Blue Gramma to Tall Bluestem. Big jump. Frogs hunt insects on those hilltops now—a thing normally unheard-of.

Prescribed grazing on these principles started replacing non-native grasses and thistles on the Audubon National Wildlife Refuge within 2 years of Craig Hultberg's management changes. Prior to this, most of the job was spraying toxic defoliants.

In summary, Mr. Chairman, I hope it is clear that we know how to sequester vast amounts of CO2 in the soils of the public's grazing lands and forests. This is not a theoretical claim. It has and is being done on millions of acres around the world even as we speak. And by taking the steps to sequester carbon on these lands, all of the other economic and environmental benefits will follow as a result of natural laws.

There really is no downside to this approach and many, many upsides. It truly is not just "win/win" but win/win/win/win/win/win and so on.

We also recognize that as a policy matter, adopting this approach beyond in areas outside the public lands has major potential positive ramifications. While outside the scope of this hearing, if the controversial and divisive CO2/climate change issue were dealt with in this way, other potential benefits to the economy would follow. It could end the “war on coal.” It could allow us to depend more on domestic resources such as coal and export more natural gas to Europe, reducing their dependence on unreliable sources. It could avoid the costs and potential economic dislocations that many fear will follow from the regulatory approach the Obama Administration is pursuing.

But, let me also stress that to achieve these benefits on the public lands, and therefore put the U.S. in a position to demonstrate the value and potential of soil sequestration on landscape scales, will require the Congress to act. It will require changes in the federal management approach that, as we have pointed out, is currently not only preventing enhanced carbon sequestration but also preventing the wise and responsible management of all of the public’s lands and resources.