Chapter III
LIVESTOCK GRAZING: ENVIRONMENTAL EFFECTS

Domestic livestock grazing has been the greatest environmental calamity ever to befall the Western United States.
--George Wuerthner, author and ecologist (Wuerthner 1989)

The effects of ranching on the Western landscape are pervasive, shaping the look of the West and causing more environmental damage than any other single agent.
--Dave Foreman, **Confessions of an Eco-warrior** (Foreman 1991)

No force in modern civilization has changed the Western lands as much as livestock grazing.
--Steve Johnson, Southwestern Representative, Defenders of Wildlife (Johnson 1985a)

Why no hue and cry to aid the range? The persistent myth of the cowboy retains its power, of course, so that to catalog his sins is to risk seeming un-American. But it's also true that the threats rangelands face seem soporifically benign at first glance. Old Bossy's dewy-eyed stare fails to stir the same measure of fear and anger as a chainsaw, a bulldozer, or John Sununu. Moved to confusion (or boredom) by a litany of rangeland ills, the general reader turns the page; the activist turns her or his energies to saving something more "majestic."
--The editors of *Sierra* magazine (Sierra 1990)

So, just how do "harmless" cattle and sheep harm the land? This simple question has no simple answer. Ask someone to explain Nature itself -- the virtually infinite number of complex interactions between myriad components of biologic, geologic, hydrologic, and climatic systems in ecosystems throughout the West.

Maybe a better question is: what in Nature does livestock grazing *not* adversely affect? Its influence is all-pervasive, as limitless as the environmental interrelationships it disrupts. As will be seen, no other land use is so destructive in so many ways.

Unfortunately, livestock's destructive influences are mostly unrecognized and thus uncorrected. Their geographic remoteness and subtle, dispersed, and insidious nature combine with our society's blind love affair with cowboys and cows to make livestock grazing the most misunderstood and neglected major environmental problem facing the rural West.

For simplicity's sake I have assembled livestock grazing effects under 6 basic headings: *Plants*, *Soil*, *Water*, *Animals*, *Fire*, and *Air*. Please keep in mind that these headings are necessarily general and impose artificial boundaries. They merely serve as organizational aids to facilitate understanding. In the natural world there are no such delineations.

Seemeth it a small thing unto you to have eaten up the good pasture, but ye must tread down with your feet the residue of your pastures? and to have drunk of the deep waters, but ye must foul the residue with your feet?
--Ezekiel: 34:18

Plants

They are taking the skin off the land.
--from the movie *The Emerald Forest*

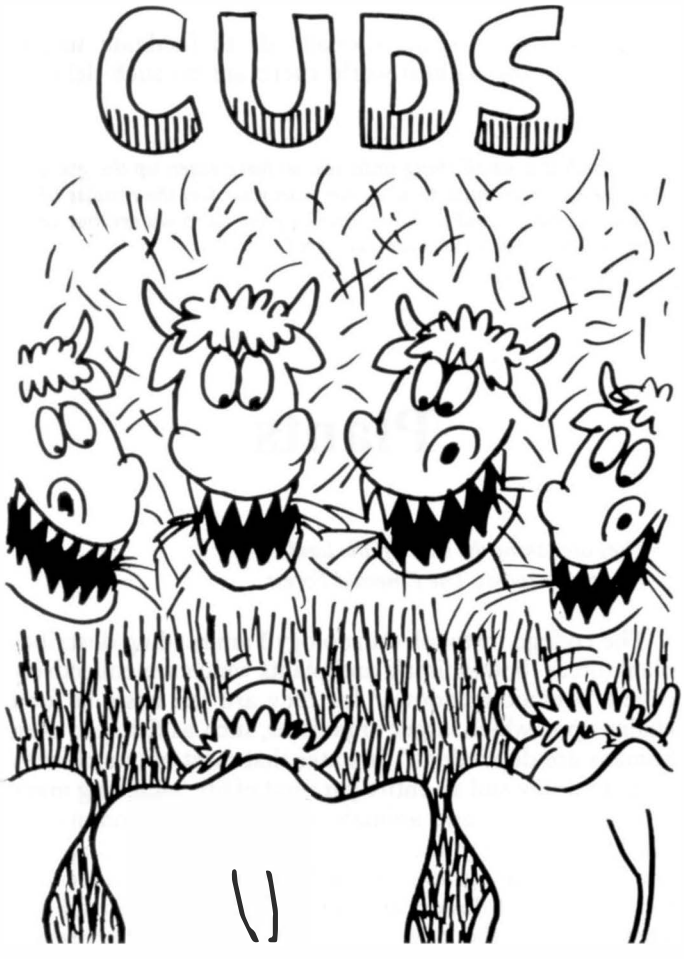
The college textbook on zoology I am reading describes plankton as "both animals and plants which are collectively called 'oceanic meadows,' for they are the basis of food chains upon which larger organisms, such as fish, and even humans are dependent." It states that most of this planet's oxygen supply and an entire pyramid of life, including many terrestrial plants and animals, is dependent upon marine plankton. Similarly, the ocean ecologist Jacques Cousteau and other oceanographers conclude that plankton are vital to the health of the oceans and dependent terrestrial life. They warn of the dire consequences of overharvesting, poisoning, or otherwise harming these countless trillions of tiny floating organisms.

Grass and small herbaceous plants, along with co-dependent micro-organisms and insects, are the "plankton of the land." These countless trillions of small plants and animals are the base of an extensive, complex food web -- an almost infinite interdependency of life. As with ocean plankton, they are vital to the health of most terrestrial ecosystems. Like plankton, they provide oxygen to the atmosphere and, ultimately, nourishment to larger animals and necessities to humans. Additionally, they maintain soil, water, fire, and atmospheric dynamics.

Livestock grazing has destroyed the plankton of the land in the Western United States -- and around the globe -- more extensively than has any other human pursuit.

Consider that on the Western range today cattle and sheep outweigh all large native herbivores combined roughly 10 times over. It takes more than 20 pounds of herbage to produce a pound of beef (Zaslowsky 1989). A cow eats

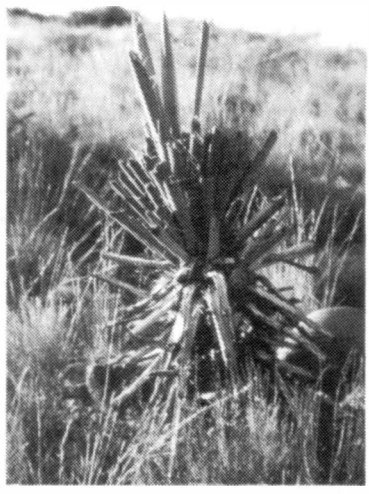
for about 8 hours a day to keep its 4 stomachs full, and an average cow consumes 700-800 pounds of vegetation per month. (Again, mature cattle average 800-1000 pounds -- 1 AUM -- monthly.) An average range steer eats 12,000 pounds of range plant material and 2850 pounds of feedlot food by slaughter time (Ferguson 1983). Sheep eat roughly 1/5 as much as cattle, and goats eat roughly 3/4 as much as sheep. Generally, a stock animal will eat approximately its weight in herbage per month.



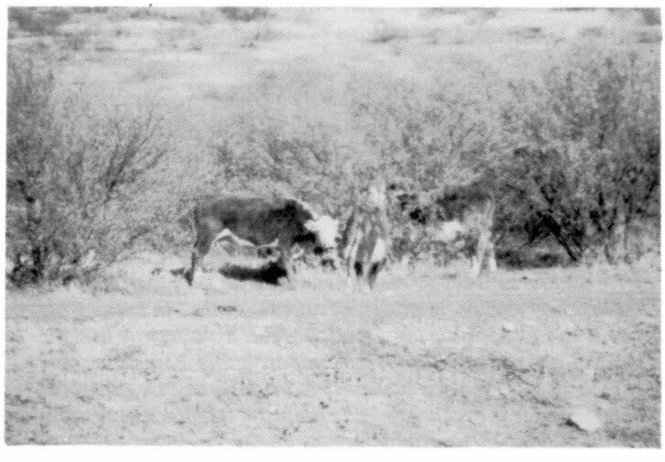
(Greg Pentkowski)

Thus, on most Western rangeland domestic livestock eat *most* of the forage (grass, herbs, and other non-woody plants) and much of the browse (leaves and twigs on shrubs and trees). Indeed, they eat not only preferred grasses, but willow shoots, wild celery, young agave stalks, rosehips, lupine, honeysuckle, miner's lettuce, cottonwood saplings, wild tobacco, desert marigolds, clover, watercress, saltbush, mesquite pods, wild oats, mountain mahogany leaves, morning glories, reeds, wild strawberries, monkey flowers, vetch, mulberry leaves, bracken ferns, sunflowers, small aspens, dandelions, marijuana, apple leaves, cacti, acorns, peppermint, maple stems, *ad infinitum*. Government grazing management plans specifically call for heavy "utilization" of many of these and scores of other species.

If preferred vegetation is not available, as is often the case in the overgrazed West, cattle, sheep, and goats resort to eating decreasingly palatable species, such as sagebrush, scrub oak, bear grass, manzanita, yucca, tumbleweed, and cheatgrass, eventually eating nearly anything organic, including tree bark and, according to one eyewitness, old newspapers. This plasticity of diet allows ranchers to "mine" the public's range vegetation with their livestock year after year, eventually right down to the bare dirt, and is a key to range degradation.



Cattle-eaten yucca.



Cattle eating mesquite.

Cattle even eat cattails.

This stripping of the vegetation cover is livestock's most obvious impact. Many plants are simply ripped out of the ground roots and all and swallowed; sheep are especially destructive in this respect. However, most plants are damaged by being heavily cropped or browsed. ("Cropped"

refers to the refers to the leaves and stems of non-woody vegetation being eaten off; "browsed" refers to the leaves and twigs of woody plants being eaten off.) When too much of a plant is removed or taken at the wrong time of year, its future growth is retarded. In fact, livestock usually remove more than half of the above-ground portions of most non-woody plants in their grazing areas and often graze during the weeks most critical to plant growth and development. When a plant is cropped or browsed too often in a single season or too heavily year after year, it dies. With the extreme grazing prevalent throughout the West, livestock stunt or kill *most* rangeland plants in these ways.

Cropping and browsing also destroy vegetation by preventing plants from seeding properly. Many plants are eaten before they are able to flower or produce seedheads or seed pods. As reserves in roots are depleted, other plants are so stunted in growth that they produce infertile or reduced numbers of seeds. The seeds that are produced may be eaten by livestock and rendered useless for reproduction (although seeds of several species pass through unharmed and may be spread through livestock feces). Due to reduced ground cover and other factors, many of the seeds that do fall to the ground are rendered sterile or caused to sprout at the wrong time of year by increased cold, heat, light or unfavorable moisture levels. On some soils, seeds of certain species may even be physically damaged by livestock hooves.

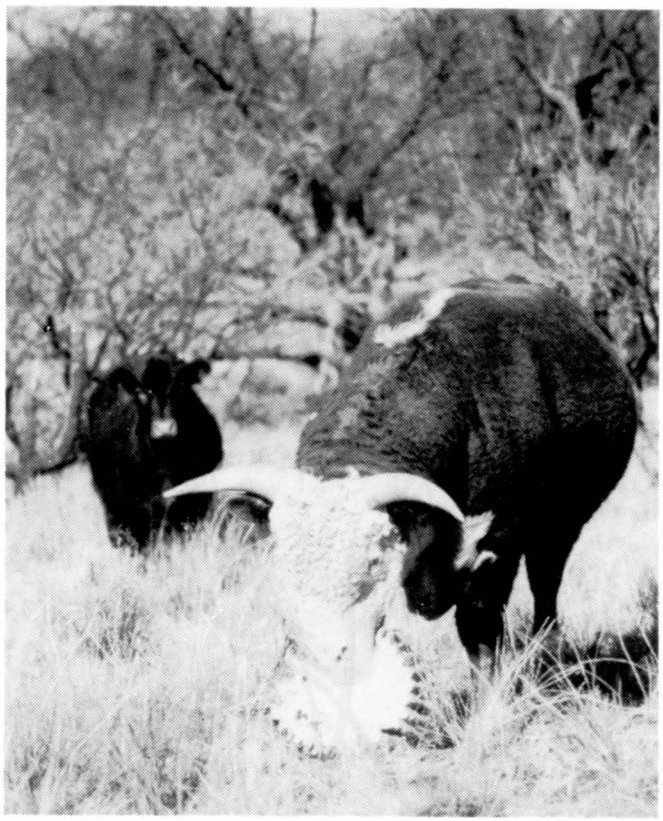
Indeed, perhaps even more destructive to vegetation than the actual grazing and browsing is the trampling that accompanies them. Most Western native plants -- those of the arid to semi-arid regions (most of the West) especially -- are ill-equipped to survive frequent, intense pounding from the cloven hooves of unnaturally managed, heavy, non-native ungulates. Small plants and seedlings are easily killed, and larger plants suffer physical disruption, injuries to root systems, exposure, and other damages. Vegetation has regularly been broken, beaten down, cut off, and crushed for over 100 years on hundreds of millions of Western acres.

Thus, livestock have transformed much of the West's relatively lush natural vegetation to wasteland. This biotic change is manifested in 4 basic ways:

- 1. *Decreasers:*

Most vegetation communities are a combination of many different plant species living together in competitive, yet mutually supportive, generally stable relationships. Though livestock are for the most part less selective than native herbivores, they nonetheless generally feed upon their favorite plants first -- the most palatable, succulent, and nutritious species, sometimes called "ice cream" species. On Western rangeland these include many of the important native grass and herbaceous perennials, and even several woody species such as whitesage, budsage, and bitterbrush. Livestock graze the tender tops first, then the coarser leaves, and finally the stems. Often these preferred plants are eaten to the ground before others are utilized. If they continue to be eaten year after year, these species are significantly reduced in number and range, and are thus termed "decreasers."

Because livestock spend more time in areas where these decreaser species occur, trampling and other detrimental effects are concentrated there, compounding damage from the grazing itself. As these desirable plants dwindle, they are sought more and more fervently by hungry livestock, creating a vicious circle of species extirpation.



This bull seems to prefer barrel cacti to grass and mesquite.

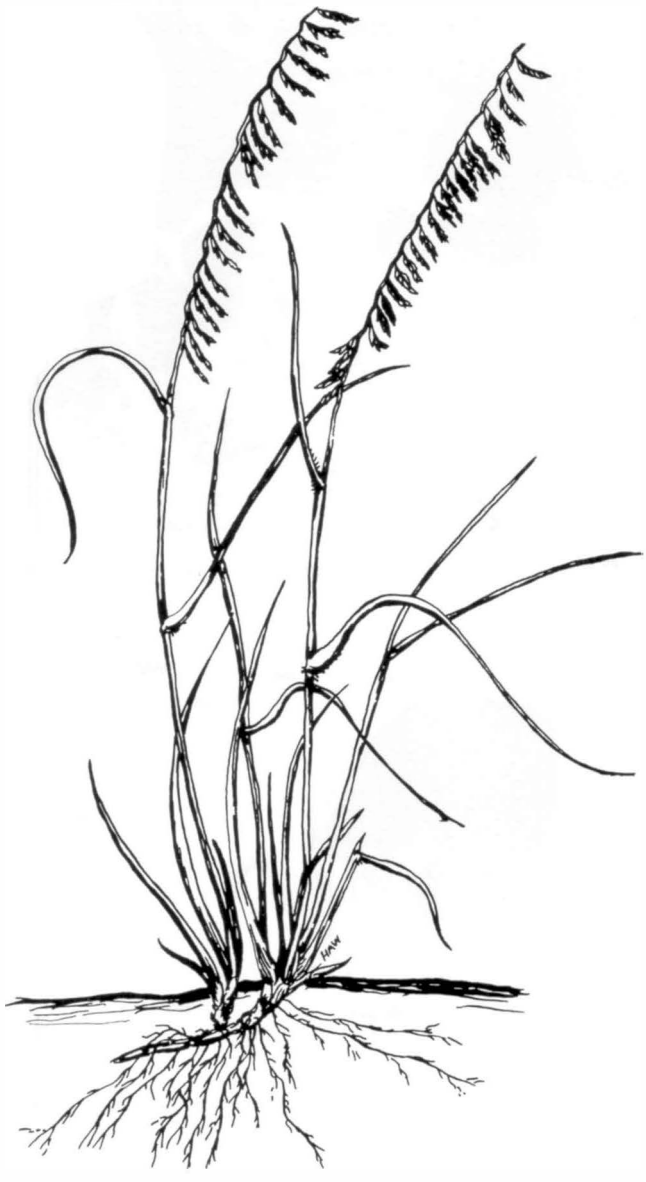
Stockmen "mine" vegetation with livestock, often right down to bare dirt. *(Richard Ginser)*

As a result, the plants we see least on the range today are generally those livestock (and native animals) prefer most. The result of more than 100 years of livestock grazing has been virtual eradication of many of the most biotically productive native plant communities in the West.

- 2. *Increasers:*

Conversely, livestock graze less on the less nutritious, more fibrous, thorny, poisonous, and otherwise unpalatable

plant species. Some species are protected from livestock by virtue of long taproots or extremely bitter taste, or because they hug the ground, possess stolons (runners) or rhizomes (underground stems), or are otherwise equipped to resist heavy grazing. These qualities, along with reduced competition for space, sunlight, water, and nutrients from decreasers, often allow these "undesirable" plant species to expand their numbers and territories. In other words, these "increaser" species fill the void left by the decreasers.



A livestock favorite, the distinctive sideoats grama was once a common resident of the West but, as a livestock decreaser, now survives as only a small fraction of its aboriginal population. *(Helen Wilson)*

An apparent increaser is not necessarily an increaser, however. Many areas are so denuded by livestock that certain plant species only *seem* to be increasers by simple virtue of being the only ones to survive in significant numbers. They have actually decreased in number and area, and only appear to be increasers in comparison to the ravaged decreaser species around them.

Nonetheless, many true increasers have indeed become dominant over large areas. Though these species were integral parts of original climax communities, they usually represented much smaller percentages of the total vegetation. Big sagebrush is a prime example. It originally composed 1/4 or less of the vegetation cover in bunchgrass communities throughout much of the Intermountain West. Today, on tens of millions of these same acres, big sagebrush forms essentially pure stands, interspersed not with grasses and forbs but with bare dirt. Depending on circumstances, prickly pear cactus may also be an increaser, and in some grazed areas prickly pear now grow so closely together that they are nearly impenetrable. Skunk cabbage and even wild iris can be increasers in heavily grazed wet meadows. Other prominent increasers include yarrow, tarbush, snakeweed, shadscale, rabbitbrush, mesquite, catclaw, and creosote.

Lakeview Cemetery in Montana's Red Rock Lakes Wildlife Refuge has not been grazed by livestock for 100 years. As a result of a century of livestock use, the thick native grasses and herbaceous plants on the left were replaced by the scraggly sage and other increasers on the right. *(George Wuerthner)*

- 3. ***Invaders***:

Increasers do not encroach from without, but merely fill the empty niches within their own ranges left by ravaged decreaser species. If heavy grazing continues, even increasers are eventually killed out and their places taken by the true grazing "invaders" -- exotic herbaceous or woody plants, or opportunists native to that region but not to that site. These invader species may appear at the first sign of ecological stress, but do not become dominant until overgrazing is so severe that increasers decline.

Among the many notable invader plants are cheatgrass, tumbleweed, knapweed (all exotic to the US), halogeton, leafy spurge (native), a few species of mustards, filaree, thistles, and some shallow-rooted annuals and forbs (many of which are exotics). Most invader species are very hardy and resistant to drought, grazing, trampling, and other disturbances. Most are also unpalatable to livestock, provide less soil holding and building ability, are highly inflammable, and are of lesser value to wildlife. Many are thorny or poisonous to livestock. Annuals are prominent among invaders largely because they grow an entirely new generation

of plants from seeds each year and are therefore less susceptible to cumulative damage from trampling and other impacts. Some invader infestations create conditions which cause populations of "pest" animals to explode, further favoring invaders over natural vegetation (discussed later).

> *The exotic plants saved the newly bared topsoil from water and wind erosion and from baking in the sun. And the weeds often became essential feed for exotic livestock, as these in turn were for their masters. The colonizing Europeans who cursed their colonizing plants were wretched ingrates.*
> --Alfred W. Crosby, **Ecological Imperialism** (Crosby 1988)

Ironically, invaders and increasers may play an important role in the restoration of overgrazed land. Without them there would often be little or no vegetation to hold soil, provide cover for wildlife, and so forth. Though not as valuable as native species, invaders and increasers are much preferable to bare dirt. They are all that keeps much of the Western range from becoming absolute wasteland. Invaders may pave the way for future restoration; if the land is protected from further overgrazing, most invaders and increasers will gradually be replaced by native vegetation. (Feral animals sometimes play a similar role.)

On the other hand, depending on the unique circumstances of each area, some exotic invaders may colonize overgrazed areas and remain dominant long after livestock are removed. In some areas these species show little obvious sign of yielding to the natives even after decades of nongrazing. Because of the long timeframes involved it may thus seem that these vegetation changes are permanent. However, close inspection of these livestock-excluded areas reveals that on most a very gradual, steady recovery of native vegetation is indeed taking place. While some invaders -- Bermuda grass and tamarisk, for example -- may be there to stay, most have begun to yield to the natives in areas given an extended reprieve from livestock.

Mostly because of livestock grazing, scores of increasers and invaders have become dominant on more than 150 million acres of Western range, or more than 1/5 of the West. Specific examples are plentiful. Indeed, most of the increaser and invader species listed above have replaced native flora on millions of overgrazed acres apiece.

Yellow star thistle.

Yellow star thistle, for example, is a spiny, 3' tall plant that produces numerous needle-sharp seedheads and which may be toxic to cows and horses if eaten in quantity. It is thought to have first arrived on this continent in California in the mid 1800s in shipments of contaminated alfalfa from southern Europe. The livestock explosion soon thereafter opened the way for star thistle to spread throughout the West. A recent *San Francisco Examiner* article explains:

> *Cattle ranchers, major victims of the thistle, have contributed significantly to its spread. Without cattle and sheep, whose hoofs break down the delicate fungal mat that once covered most western soils, the star thistle's seeds probably wouldn't have outcompeted the West's native perennial grasses.*

Overgrazing has helped spread yellow star thistle across tens of millions of acres throughout the West, 8 million in California alone. (Bashin 1990)

Cheatgrass, *Bromus tectorum*, is a prime example of a grazing invader. Originally from the Eurasian steppes, it spread quickly across the West with livestock in the late 1800s and early 1900s. Many stockmen initially welcomed the spread of cheatgrass (as they did tumbleweed), but soon discovered that as a forage plant it was much inferior to the natives it replaced, that the awned (barb-like) seeds lodged in the mouths and eyes of livestock and caused injury, and that it was explosively flammable. Today, cheatgrass covers tens of millions of arid to semi-arid acres throughout the West, often in single-species stands such as the one above.

- 4. *Bare dirt*:

Bare dirt is desirable only where it occurs naturally. Except for drier regions, this generally includes only small percentages of the ground area. *Overgrazing has probably resulted in more actual ground area in the West being converted to bare dirt, sand, and gravel than to a vegetation cover of increasers or invaders.* Yet, range literature invariably focuses on *changes* in species rather than overall *reductions* in plant cover. This obscures the severity of the problem.

> *Cows and sheep are everywhere on public lands, wandering into most every available nook and cranny with something edible on it.*
> --Letter to the editor, *High Country News*

In describing these changes in Western vegetation, we speak of what scientists call "biotic succession," or the

tendency of plant and animal communities to succeed or replace one another over a period of time in response to environmental or human influences. Biotic succession is influenced in two ways.

One influence is related to sudden changes in existing conditions. For example, extremely high winds in an area of dense coniferous forest may cause a "blowdown" of nearly all the trees. Soon thereafter a new community of plants begins to occupy the area, usually hardier "weeds" and forbs. These plants are gradually replaced by grasses and flowering perennials. Over the years this community is overgrown by a mixture of shrubs and bushes, which in turn is overgrown by a grove of aspens. Finally, the original conifers begin poking through and overshadowing the aspens, and eventually reclaim the area as a conifer forest vegetative community.

Quick changes in the environment, such as those induced by windstorm, fire, flood, drought, landslide, or insect outbreaks, are periodic natural occurrences to which biotic communities have been subject for millennia. Each "disaster" may cause dramatic changes. But because these disturbances occur infrequently and affect only limited areas, biotic communities reestablish and maintain their essential character. In the conifer forest, abrupt changes occur infrequently enough that most of the trees have time to reach maturity before the next disturbance hits. Although there are always some portions of the forest at earlier stages of succession, the forest as a whole maintains its coniferous character.

A second type of change in biotic communities occurs very slowly, usually in response to long-term climatic or geologic changes. For example, a long-term change in the storm track could cause a drying trend in climate and gradually move a conifer forest back through succession, finally resulting in some type of plant community adapted to a drier climate -- perhaps, again, the grasses and flowering perennials. Or, colliding crustal plates may create a new mountain range, with a "rain shadow" effect on the range's interior side and eventually producing a biotic community more adapted to aridity. These kinds of changes usually occur so slowly as to be imperceptible to humans.

Succession is a sliding scale, but to humans appears to occur in steps. Each change in the essential character of a a biome [particular biotic area] is termed a "stage of succession." All biotic communities are constantly changing, moving from one stage to another on the scale of succession, in response to both short- and long-term fluctuations in the environment. Changes may occur very quickly, as with the forest blowdown, or extremely slowly, over thousands or even millions of years, as with the drying climate. We humans see the sudden changes as "disasters" and rarely recognize the slow changes.

This is not to say that succession proceeds as a smooth, predictable pattern. It is more like a general trend with numerous variables. The natural environment provides succession many diverse influences, once again complementing biodiversity.

Generally, the more complex a biosystem, the more stages of succession it is subject to. The conifer forest discussed above went through at least 5 stages. Most grasslands have several stages. The simplest and least productive biosystems may have only 2 or 3. For example, removing the vegetation from a creosote flat in the Mojave Desert usually results in a slight, temporary increase in a few native and/or exotic desert annuals and, eventually, the regrowth of most of the original creosote or a continuance of bare dirt.

A "climax community" is the final stage of succession -- a relatively stable biotic community natural to each unique physical environment, able to replace and regenerate itself and maintain its essential character over long periods of time. Every place on Earth with plant or animal life has a climax community. Each is determined by the area's unique set of long-term environmental influences, including climate, soil, and landform. Though the overall biotic character of each climax community is relatively stable, integral to each is a complex mosaic of areas in different stages of succession. This diversity strengthens systems dynamics and the climax community as a whole.

There are no "bad" climax communities; each is the one best suited to given conditions, and as such the most beneficial to the environment as a whole. Scraggly, scattered creosote with its few small companion plants is "good" on hot, dry desert flats because it is the most biologically productive stable community possible under such conditions. Nor are the earlier stages of succession "bad," for each has an important role in augmenting biodiversity and reestablishing the climax community after it has been disturbed. Even the most hated "weed" has an important place in succession.

The radical disturbances caused by overgrazing would have only minimally affected the essential character of the Western range if it had occurred as infrequently as natural disturbances -- say 15 or 20 years apart, and for only a few days at a time. But heavy grazing usually occurs every year, for weeks, months, or even year-round. Chronically overgrazed land cannot progress along the stages of succession back to its natural state. Hence, natural systems progressively deteriorate, and plants and animals populations simply never recover.

On the other hand, when long-term changes constitute a permanent change in the environment, succession gradually provides an area with a new climax community. This type of change usually requires centuries, and isn't the type of change we've seen in the West. Before European intervention, grama-buffalo grass, tule marsh, scrub oak, sagebunchgrass, and scores of other major Western vegetative climax communities had existed relatively unchanged, aside from usual natural, periodic, localized disturbances, for many thousands of years.

What should be remembered is that Nature has already advanced each area's climax community as far toward the biologically productive side of the succession scale as possible for the given physical environment. Humans can temporarily increase the productivity of a given ecosystem only by artificially releasing energy stored in the ecosystem's biomass and soil, or by importing energy from other ecosystems. As a rule, drastic disturbances move succession toward the biologically less-productive side of the scale. The greater the disturbance, generally the less diverse and abundant the resulting biotic community. Continued livestock grazing leads to the replacement of climax vegetation with less and less productive plant communities and, finally, bare dirt, sand, and gravel. Recovery of the original climax

community is hampered because the foundation of the ecosystem is damaged. The resulting degraded biotic community does not represent merely a step down in succession or change in the climax community but a breakdown of the whole process.

> *More US plant species are wiped out or endangered by livestock grazing than by any other single factor. Of the five plant species placed on the national endangered species list in August and September of 1989, for instance, three were victims of grazing.*
> --George Wuerthner, "The Price Is Wrong" (Wuerthner 1990b)

As a result of livestock grazing, numerous plant species throughout the West have been locally extirpated. In fact, hundreds of species likely were completely eliminated from many areas at the onset of heavy grazing in the late 1800s, even before knowledge of their existence could be documented. We will never know what has been lost. Because damage from overgrazing is often such a slow, insidious process, the gradual decline of many other species has not been properly linked to livestock.

For example, mushrooms and other fungi of scores of species grow in ranching areas of the West. But a century of overgrazing has so reduced the soil moisture, humus, host plants, and shading vegetation they depend on that many mushrooms are now rare in these areas. While some note that mushrooms grow prolifically on cowpies, these represent only a very small number of species, and some of these formerly grew on the dung of wild animals as well.

Livestock so drastically reduced many Western plant species in range and number that those species are now listed as Rare, Threatened, or Endangered. The following are a few examples:

The autumn buttercup is a species endemic to the upper Sevier River Valley in Garfield County, Utah. The *Endangered Species Technical Bulletin* reports:

> *Approximately 11 individuals survive on less than 0.01 acre of privately owned land that is highly vulnerable to continued grazing and habitat modification. Believing the species in imminent danger of extinction, the* [government] *has proposed to list it as Endangered.*

Even so, the *Bulletin* reports that the rancher landowner wants to increase grazing in the area by building a new stock watering pond, although he "may be willing to allow construction of a protective fence."

Grama grass cactus is a little-known cactus that often grows within the fairy rings formed by grama grass or ring muhly grass. It grows long, papery spines which look remarkably like the curled, pale blades of old grama and muhly grass. "Hiding" in the dead layers of these grasses helps grama grass cactus escape predation by rodents and other herbivores. Overgrazing of its only habitat in parts of New Mexico and Arizona has drastically reduced the cover formerly provided by these grasses, while trampling livestock have killed many. Consequently, the grama grass cactus is listed as "rare."

Golden buckwheat (*Eriogonum chrysops*) is a distant relative of cultivated buckwheat. According to the Center for Plant Conservation, though thought extinct and last seen in 1901, it was rediscovered in 1988 in Malheur County, Oregon, on 3 barren, volcanic hilltops -- among the few places in its habitat not accessible to livestock.

The Tiburon Mariposa lily (*Calochortus tiburonensis*) grows only on the rocky upper slopes of Ring Mountain on the Marin Peninsula, north of San Francisco. Here, a remnant population finds shelter from the livestock grazing that has ravaged the remainder of its habitat for more than two centuries.

The Arizona agave was federally listed as Endangered in 1984. A report by Rick DeLamater and Wendy Hodgson of the Desert Botanical Garden in Phoenix states that "agave stalks provide an irresistible food for cattle" and that the agave's habitat, "including what we thought to be the most inaccessible areas, shows severe degradation by overgrazing." Studies show that less than 1/3 of the stalks of 3 types of agaves in the area reached maturity undamaged. The report concludes:

> *Cattle, overgrazing on lands administered by the U.S. Forest Service, are cited as the major threat to* [the Arizona agave's] *survival as well as to the population dynamics of* [other agaves in the area]. (DeLamater 1986)

Golden draba is a small member of the mustard family that grows in the spruce and alpine belts of California's high Sierra Nevada, where it has been relentlessly diminished by sheep and cattle grazing for more than 100 years. Golden draba is now listed as Rare in the state.

Clay phacelia is one of Utah's 190 globally Endangered species, many of which fell to livestock grazing. The world's only known population of this purple wild flower clings tenuously to a steep, shale-strewn hillside in central Utah. For years botanists have watched clay phacelia decline under the hooves of domestic sheep and have finally secured an agreement to erect a fence around the plants . . . rather than remove the sheep.

Colorado butterfly plant, Gila groundsel, Knowlton's cactus, Cusick's camas, Bitterroot milk vetch, solano grass . . . the list of livestock plant victims goes on and on. The Nature Conservancy reports that in California alone (which has nearly as many endemic plant species -- 1517 -- as all other states, except Hawaii, combined), more than 600 species are threatened with extinction. If nothing is done the state could lose 12% of its native plant species. Further, livestock grazing has been identified as a major factor in this threat. In Hawaii, livestock grazing, land clearing for pasture, development, and introductions of exotic species have caused a tenth of the estimated 1250 species of flowering plants that were present 200 years ago to become extinct. Probably half of the remainder has become Threatened or Endangered. The Center for Plant Conservation, in its *Endangerment Survey Summary* of December 9, 1988, offered a grim assessment:

> *3,000 of the approximately 25,000* [about 14,000 are in the 11 Western states] *species, subspecies, or varieties of plants native to the United States are at risk of extinction in the wild. For an estimated 200 species, we are too late; they are already extinct!*

The Center estimates that 680 of the species at risk will be extinct in the US by the year 2000. While many Endangered plants are indigenous to comparatively small areas and have succumbed mostly to intensive development, livestock grazing has forced more Western species to become Rare, Threatened, or Endangered than any other factor.

However, grazing's greatest impact on native vegetation has been -- far more than any other human influence -- **the depletion and extirpation of species over large areas.** Though they may not have been reduced to the point of imminent extinction, hundreds of native plant species have been reduced to only fractions of original populations over vast expanses, and have been eliminated entirely from many areas. Livestock grazing continues to be by far the most prevalent, insidious, and destructive force affecting native Western vegetation.

Soil Conservation Service range agronomists have for years conducted research with native plants and grasses, the object being to nurture them and eventually to reintroduce them into areas of degraded rangeland. The difficulty is that few native plants exist -- they have been trampled or eaten by livestock, and displaced by non-native species.
--David L. McWilliams, Rock Springs, CO, letter to the editor, 3-2-88 *Casper Star-Tribune*

Under many Western state laws it is illegal for a person to collect, kill, or otherwise harm certain rare plant species. You may even be cited for picking a wild flower. Yet, cattle and sheep are allowed to eat and trample these same plants by the thousands.

While grazing and trampling have wiped out much Western vegetation directly, livestock have also damaged native biotic systems in countless subtle and complex ways. For example, livestock negatively affect the *composition*, *range*, *distribution*, *density*, *size*, *health*, *diversity*, and *vertical stratification* of Western vegetation:

- *Composition* refers to the arrangement or mixture of the different plant species within a vegetative community. Vegetation composition determines relationships and interactions, and is crucial to animal, soil, water, fire, and air dynamics. For example, livestock grazing in a small Western canyon causes grasses and forbs to be replaced by rabbit brush and tumbleweeds. This new plant composition is less efficient at holding soil, so subsequent floods yield more soil erosion than before the replacement. The degraded soil, in turn, is even less able to support the original grasses and forbs, and the cycle repeats.
- *Range* refers to the general geographic area occupied by a plant species, while *distribution* refers to the placement of the species within its range. Although the two are often used interchangeably, they are not precisely synonymous. Range and distribution of plant species determine animal populations and also affect soil, water, fire, and air dynamics. For example, by shrinking the range and distribution of Indian ricegrass in portions of the West, livestock have likewise shrunk the range and distribution of some dependent seed-eating birds. (Range is also a generic term for open country; this second meaning is the more common usage in this book and can be determined by context.)
- *Density* refers to the number of individual plants of a given species within a given area, or how closely spaced individuals of a plant species are. The term also refers to the spacing of vegetation in general. Density usually indicates the importance or dominance of a particular species in a plant community; but, since density values indicate nothing about size, health, or how widespread a species is, this is not always so. Generally, livestock grazing has decreased the density of beneficial natives and increased the density of harmful exotics, with a significant decrease in overall combined plant density on most Western range (an increase in bare dirt). When livestock reduce or increase plant density, they once again negatively impact ecosystem dynamics. For example, overgrazing on bunchgrass/sagebrush rangeland in much of the Great Basin has so reduced the density of bunchgrasses that individual grass plants are no longer spaced closely enough to carry wildfires. The resultant loss of wildfire has given sagebrush a further advantage over grass because natural fire generally restricts the spread of sagebrush while actually stimulating the growth of many grasses.
- When assessing range conditions, range professionals generally survey the composition, range, and density of vegetation, but give little consideration to the *size* and *health* of individual plants. While composition, range, and density are important, individual plants must also be full-sized and healthy for ecosystems to function properly. For example, a full-sized, healthy buckthorn bush in a natural, non-livestock area may produce 2 or 3 times more leaves, flowers, seeds, stems, and other organic materials than one in an overgrazed area. This superior bush will provide much more food, nesting, and shelter for wildlife. It will also supply more organic litter, better wind resistance, more shade producing branches, more soil holding roots, and so on.

  Through the many influences described elsewhere in this chapter, livestock have caused most rangeland plants to be stunted and less vigorous today than in pre-livestock times. Wild sunflower plants in overgrazed areas are often only half the size of those in adjacent ungrazed areas. Sagebrush plants in grazed areas are typically short and misshapen, sparsely leafed, with many broken branches and little underlying organic litter. Cacti in livestock areas are often stunted, broken, and diseased.

  Additionally, because range plants are heavily grazed or browsed, size relative to plants in ungrazed areas is reduced even further. For example, on most Western range grass plant density, health, and size has been decreased, but since livestock also keep most individual grass plants cropped to less than half their normal height, their *size* has been decreased relatively even more.
- Plant *diversity* refers to the number of different species as well as to the variety of plant types in a given area. Natural diversity is essential to ecological health and stability. In affecting all of the above negative changes in Western vegetation, livestock have greatly lowered plant diversity in most of the West. Heavily grazed areas commonly support less than half as many species and much less diversity of plant types. In Idaho an ungrazed stand of big sagebrush supported 31 species of plants, while a comparable grazed stand supported only 9 species (Ferguson 1983). Overgraz-

ing nearly always simplifies ecosystems, further increasing their susceptibility to disturbances, including continued overgrazing.

- Livestock likewise damage what is known as *vertical stratification*. Most natural plant communities are stratified, having a vertical arrangement of plants in several layers instead of an even distribution throughout all heights from the ground to the tops of the tallest plants. In the forest vertical stratification may be obvious as a surface layer of mosses and lichens, a low herb layer, a grass and tall herb layer, a shrub layer, a subcanopy tree layer, and a canopy tree layer. In grasslands, shrublands, and deserts, vertical stratification may not be as well-defined, but is nearly always present nonetheless. All grasslands have at least 3 stratification levels, and some have 4 or even 5.

Each layer provides food, shelter, nesting, and other necessities critical to certain animals at certain times, and certain combinations of layers are likewise necessary to the survival of many animals. Each layer also contributes its unique benefits to soil, water, fire, and air systems and other interrelationships. Livestock grazing depletes or fragments ground surface and lower vegetation layers, and may over time also significantly impact upper woody vegetation layers.

Natural diversity is a key to ecosystem health and stability. Ungrazed in the Sonoran Desert.

Inaccessible to cattle, this luxuriant mixture of vegetation assures high environmental quality.

One little-appreciated factor in rangeland dynamics is the role of dead plant material. As old leaves, stalks, stems, flowers, and other plant parts wither and die they are acted upon in various ways and their nutrients are recycled throughout the biotic system. This dead organic material is essential to vegetation, soil, water, animal, and fire dynamics. In most ecosystems, 1/5 to 1/2 of all biomass (overall amount of organic matter) consists of dead plant material.

Accumulation of plant litter on the soil's surface is an ongoing process, and litter on the dry Western range depleted may require decades to replenish. Livestock inhibit or destroy the old growth vegetation needed as source material for organic litter. Particularly, they eat much of it and trample plants, damage soil, reduce available water, and cause other changes that ultimately deplete the amount of dead plant material. They break apart and scatter remaining organic litter. Additionally, much of the biomass that would otherwise eventually become dead plant material is removed from the ecosystem entirely when the domestic animal is moved off the range for eventual slaughter. Reduction of the organic litter layer has been extreme on most grazed land. On Nebraska's Sandhills Prairie, for example, removal of cattle for 4 years yielded a 300+% increase in litter cover (Potvin 1984). Even in many forests, livestock are the main cause of organic litter depletion.

The importance of organic litter to plant growth is graphically demonstrated here. I threw 2 small piles of a neighbor's cut brush down in a bare spot. Several months later plants growing in the area covered by the litter had twice the height and several times more biomass per unit of area than the plants in the surrounding area.

Livestock grazing damages vegetation in many other ways that are little understood or appreciated. For example, the leaves and branches of many plants in arid to semi-arid climates possess patterns or structures that gather rainfall and run it in toward the center of the plant, thus increasing the amount of water available to its roots. When livestock remove leaves or break branches, or otherwise alter plant patterns and structures, they reduce water-trapping capabilities. Conversely, water-stressed plants become more brittle and susceptible to physical damage from livestock.

Another example concerns plant reproduction. When livestock strip off the vegetation cover and deplete and displace the organic litter layer, they expose seeds on or immediately under the ground surface. Pecking and scratching birds and other foraging animals may then consume the seeds, leading to sparse regeneration. If you have ever had the bare ground of your garden de-seeded by foraging animals, you will appreciate this factor.

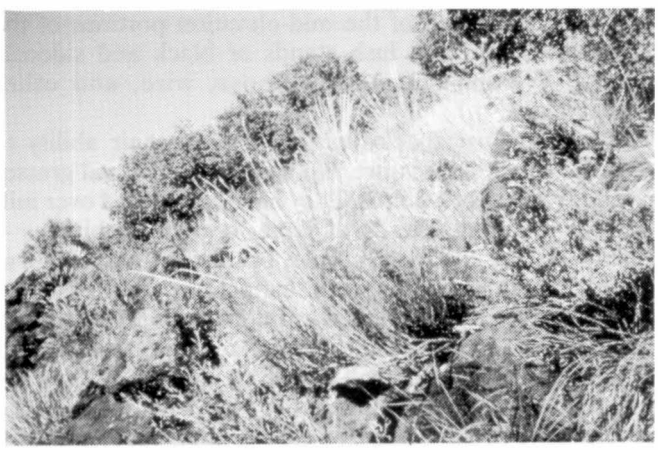
Moreover, many plants depend on lateral growth or rooting of broken segments for their spread. Others send runners out across the ground's surface that put down roots at certain intervals, creating new plants. Some have branches that sag as they mature, make contact with the ground, and send down roots at those points. Others, such as most cacti, possess segmented branches that break off easily, fall to the ground, and send down roots from points of contact.

Success for plants that spread in such ways depends primarily on (1) the health of the parent plant and spreading portion, (2) the condition of the soil and amount of ground moisture, and (3) how well and how long the spreading portion of the plant makes contact with the ground. Consequently, livestock prevent the establishment of new plants by (1) damaging or killing the parent plant and spreading portion, (2) damaging the soil and causing it to dry out, (3) trampling and shuffling, thereby preventing the spreading portion from "seating" properly onto the ground and making prolonged, close contact. Further, trampling livestock often pull out or break off the small roots that have established themselves. Even where livestock aid in the spread of plant reproductive segments, such as cholla cactus, their other harmful effects usually result in reduced net reproduction. I have seen this in some deserts, where in ungrazed areas cholla sections fall off and reproduce successfully around their parent plants, while in nearby grazed areas where cattle have scattered cholla "balls" randomly across the landscape (to the great discomfort of my ankles), so few of the segments have rooted that their overall reproduction rate is far lower.

In most natural biotic communities, plants shade and protect each other. A closely spaced arrangement of undamaged plants provides "nursery protection" for seedlings and ground-level plants, shading them from the sun and helping protect them from foraging animals, wind, hail, frost, etc. To a lesser degree, it does the same for mature plants. It also conserves essential soil moisture by protecting the ground from the drying effects of sun and wind. In the soil, close spacing creates an interlocking network of roots which helps stabilize both the plants and the soil that anchors them. Tall, closely spaced, fully vegetated plants are even less susceptible to damage from trampling because, together, they form a thick mat which disperses hoof impact on each individual, including its roots.

An obscure indirect effect of livestock: According to the photographer, a botanist for the National Park Service, on overgrazed ranges hungry rodents may eat patches from saguaros and other cacti. *(Charles Conner)*

A grazed hillslope in a BLM Wilderness Study Area offers mostly cactus, snakeweed, rocks, and bare dirt. *(Dale Turner)*



A comparable ungrazed hillslope in the same area is covered with a lush diversity of grasses, flowering plants, shrubs, soil surface microflora, etc., as well as cactus and snakeweed. *(Dale Turner)*

In sum, to the great harm of the environment, livestock have converted huge areas of the West to unpalatable, poisonous, thorny, unnatural, and comparatively unproductive vegetation or bare ground.

> *But, of all man's activities, grazing by livestock has been the most widespread and prolonged use and has had the most profound effect upon the Nation's ranges.*
> --US Forest Service, "An Assessment of the Forest and Range Land Situation in the United States" (USDA, FS 1980)

The Forest Service defines *range* as "land that provides or is capable of providing forage for grazing or browsing animals [read: 'livestock']." By this definition more than 80% of the West qualifies as range, including a complex array of more than 40 major ecosystem types, all of which have been significantly degraded by ranching. We may divide these into 4 basic categories:

Grassland

Rough Approximation of Major Grasslands
(Source: Vankat 1979)

Livestock have obliterated almost all of the West's original grasslands.
--Florence Williams, "The West's Time Capsules" (Williams 1990)

Grass is a relatively recent botanic lifeform, having first appeared "only" about 60 million years ago. Prairie grassland developed around 15 million years ago, large herds of herbivores evolving along with it.

When settlers migrated west they found more than 1/3 of what was to become the 11 Western states covered primarily with grass. The extensive interior basins, valleys, plains, plateaus, hills, and even mountains supported a great assortment of climax grassland and grassland/shrubland combinations. But this new grassland was quite different from the more familiar lush, soggy pastures of the eastern US and northern Europe.

Prairie grasses are chiefly *sod-forming*, meaning they form a dense mat of stems and roots. Most have rhizomes, while a few have stolons. These structures produce a series of new shoots as they spread away from the parent plant. Sod grasses and most other prairie plants are *perennials*, coming up year after year from the same underground root system. Once established, they depend much less upon seeds than new buds for their spread. They rely on summer rainfall, and their growing season extends well into summer. Therefore, in the West sod grasses generally are limited to

the Great Plains and portions of adjacent inter-Rocky Mountain plains, riparian areas, moist valley bottoms, the wet Pacific Northwest, and some high elevations.

Precipitation over most of the West is low during the summer months (and low overall), most of it ending by June. The grasslands there are dominated by *bunchgrass*, plants that grow in groups of upright stems, each tuft appearing as if held in a bunch. Single plants may form a hundred or more shoots, but these do not spread laterally as mats; they instead form dense clumps of aerial stems. Bunchgrasses generally rely on lingering winter moisture and spring precipitation. They mature and set seeds by mid-July, and become dormant in the dry summer. The plants may put on a new burst of growth during wet periods in the fall, especially in warmer climes.

A third category of Western grasses is the *annuals*, which live through the growing season, produce seeds, and then die. Each year a completely new generation is produced from seeds. Annual grasses normally inhabit mainly the dryer portions of the West, where precipitation is infrequent and erratic. Because their growing period is limited, most are smaller and less nutritious than bunch and sod grasses. Western annual grasses include wild oat, many of the bromes (foxtails, cheatgrasses), and some of the fescues and lovegrasses. Many are exotics.

Native annuals have been greatly depleted and even extipated from many areas by overgrazing. Over even greater areas, however, ranching's "desertifying" effects have eliminated perennial ground cover and created conditions favorable to annuals. In most of these areas, exotic annuals have outcompeted the native annuals and perennials, replacing them on tens of millions of Western public acres. Due primarily to livestock grazing *most* of the West's annual grass cover is now composed of increasers and invaders, including many exotics.

Some Western grasses may vary in their growth-form, developing as sod, bunch, annual, or some composite form of these, depending on conditions. Thus, livestock grazing tends to transform sod grasses into bunchgrasses and bunchgrasses into annuals.

Hundreds of different grasses are native to the West. Originally, much of the Midwest and intermountain prairie was carpeted with the rhizomatous grasses big and little bluestem, needle and thread grass, blue and hairy grama, and western wheatgrass; the stoloniferous buffalo grass; and the usually bunching wire grass. Large portions of Idaho and eastern Washington and Oregon were covered with Sandberg bluegrass, Idaho fescue, and the chiefly bunching, though sometimes rhizomatous, bluebunch wheatgrass. Scattered across many parts of the Great Basin were bunchgrasses such as bluebunch and western wheatgrass, bottlebrush squirreltail, sheep fescue, and Indian ricegrass. At least 23 million acres of California's valleys and hills (about 1/4 of the state) were spread with a great diversity of short and tall perennial bunchgrasses, including purple and nodding needlegrasses, with some sod grasses in moister areas. Finally, much of the mid-elevation portions of the Southwest supported lush stands of black and sideoats grama, Arizona cottontop, tobosa, wire, and other bunchgrasses.

The individual species vary greatly in their ability to withstand grazing pressure, but as a group the sod grasses generally fare much better. They have co-evolved over millions of years with herds of large, hooved herbivores -- mainly buffalo, but also elk, deer, pronghorn, and bighorns -- and, before the Pleistocene extinctions, with others -- camels, horses, mammoths, mastodons, ground sloths, etc. These grasses are adapted to occasional heavy grazing, and if not grazed too often will usually rejuvenate, even after being cropped to the ground. They have a high percentage of vegetative to flowering stems, so grazing has less impact on reproduction. Their new stems emerge horizontally, and their growth points are low to the ground, helping protect them from grazing damage. As mentioned, once estab-

Generalized depiction of the 3 major grass forms: annual (left), rhyzomatous (center), and bunch (right). *(Helen Wilson)*

lished, sod-forming grasses depend much less on seeds than on new buds for their spread. Their root systems are rugged and extensive, able to withstand tremendous trampling. A dislodged piece of root sod, thrown on bare ground nearby, may even reroot!

Semi-wild buffalo on a healthy prairie range in Badlands National Park, western South Dakota.

Depleted prairie grassland in Montana. *(USFS)*

All this is not to suggest that livestock have not been very destructive to the sod grasslands of the West, for they surely have. Where not under the plow, these grasslands have been seriously degraded by domestic grazing animals. Sod grasses are much more resistant to heavy foraging by large herbivores. However, they have been *far more heavily grazed* by livestock than have bunchgrass communities. To the untrained eye, the moist, uniform green of a sod grassland may look to be in much better condition than the scruffy tan, grey, and green of a bunchgrass community, but relative environmental damage may be similar.

Even the most pro-ranching of sources acknowledge the serious damage that livestock grazing has done to the prairie grasses of the West. For example, in the contemporary textbook **Range Management**, the authors have listed the results of 20 range studies done on short- and mixed-grass prairies in 7 Western plains states. Their table compares herbage production measured on moderately grazed sites to that measured on comparable sites ungrazed for 5 to 60 years. Of the 20 studies, 19 showed greater herbage production on the nongrazed sites, with an average of *68%* more on the nongrazed sites. (Holechek 1989)

Jared Smith in 1895 described the aboriginal great Western grasslands:

> *The prairies in their wild state were covered with the richest possible grass flora. There was no similar region that had so many useful species and so few poisonous or injurious ones. Almost any square mile of the whole extent of territory could furnish in one season 50 kinds of grasses and native forage plants, grasses that would make from one and a half to two tons of hay per acre as rich as that from an Old World meadow.* (Smith 1895)

In 1899 Smith reported:

> *It is the common testimony of the older stockmen that in the early eighties the grass was often as high as a cow's back, not only along the river bottoms, but also on the uplands far from the creeks and rivers. . . . The grazing capacity of large bodies of land has been reduced within a period of twenty years from one head to 2 to 5 acres, to one head to 20 to 25 acres.* (Smith 1899)

In 1940 grazing professional Kling L. Anderson reported in "Deferred Grazing of Bluestem Pastures":

> *Old grazing records show that prior to 1900 most of the bluestem pastures could be stocked at the rate of two acres for one mature cow or steer for a grazing season of six months beginning May 1. . . . At the present time the average grazing capacity is about seven acres per animal.*

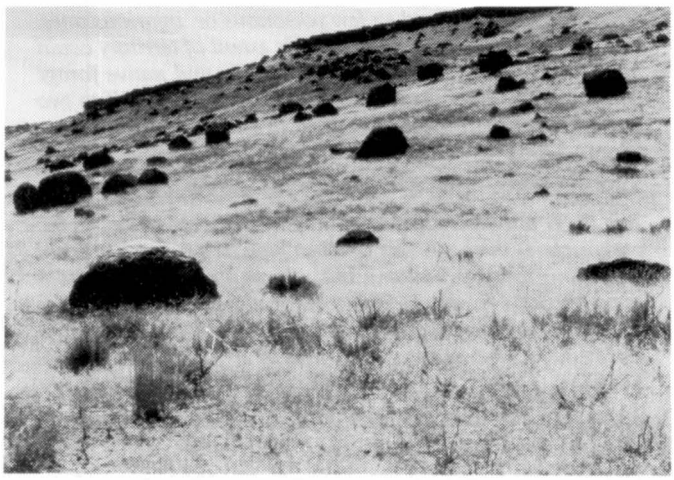
Similar references abound. Today, these once-lush prairie grasslands have recovered little, and in many ways continue to deteriorate. Many experts estimate that they have lost 50% or more of their productive potential to a century of livestock grazing.

Further east, ranching and, later, farming combined to devastate the comparatively well-watered tallgrass prairie. Tallgrass prairie is the world's most damaged ecosystem, in terms of percentage of land corrupted. According to The Nature Conservancy: "Once blanketing 142 million acres, tallgrass is considered extinct as a fully functioning natural ecosystem."

> *A study of historical accounts and the ecological research indicates that the vegetation of the sagebrush/grassland communities of the Intermountain West is distinct from the grassland vegetation of the Great Plains. Based solely on morphological characteristics, it is apparent that the vegetation of those two geographic areas evolved in response to different environmental factors. The vegetation of the Intermountain West did not coevolve with, and is therefore not adapted to, large grazing mammals.*
>
> --Katey Palmer, biologist (Palmer 1988)

Unlike sod grasses in the prairies of the central region of the US, Western bunchgrasses generally did not co-evolve with great herds of buffalo and other large, hooved herbivores. This different evolutionary history, combined with less precipitation, less dependable precipitation, and other factors, leave them ill-adapted to intensive grazing or trampling. To varying degrees, most bunchgrasses are severely damaged by livestock. Bunchgrasses generally show less ability than sod-forming grasses to adequately restore leaf area lost to grazing. Their ratio of flowering to vegetative stems is high, so their ability to reproduce after being grazed is low. Their new stems emerge vertically, with growing

points elevated and exposed to grazers. Regrowth from trampled stems is unlikely, and tufts of even partially uprooted bunchgrass often die, even under moist conditions.



A cover of grass does not necessarily mean all is well. This slope in the Jackass Mountains of eastern Oregon is covered with cheatgrass, a livestock-spread exotic that replaced the much more beneficial native bunchgrasses and other plants. *(George Wuerthner)*

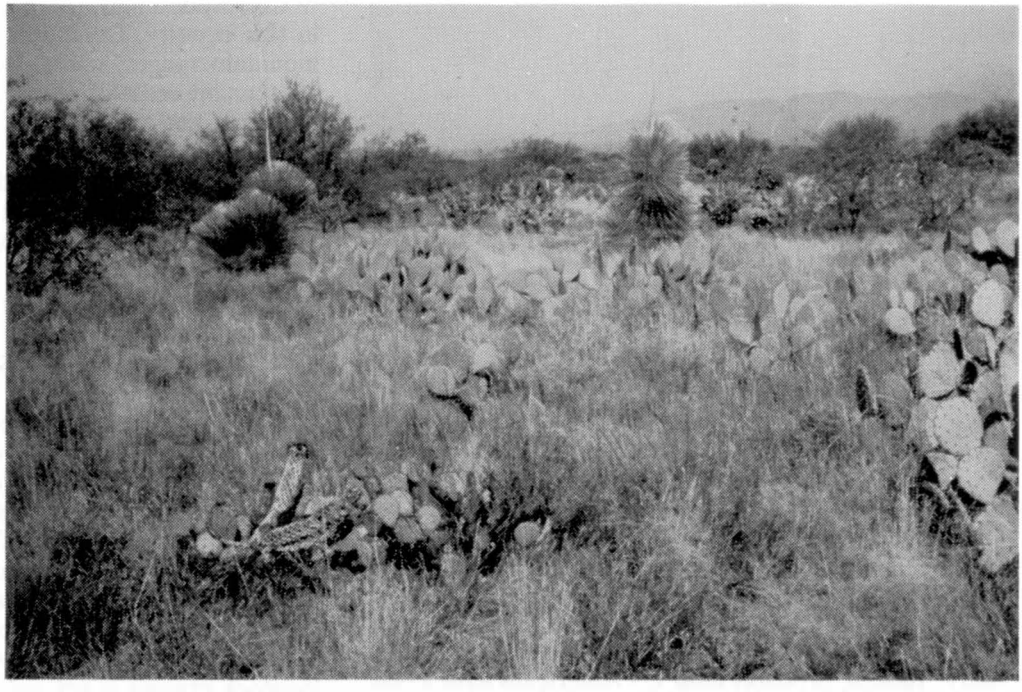
Pronghorn, bighorns, elk, mule and white-tailed deer were often present in the bunchgrass communities, but their smaller numbers and herd sizes, different behavior, and, importantly, their lower body weight prevented them from having as great an impact as did buffalo. Buffalo did occur west of the Great Plains, but in much smaller numbers and limited distribution. As evidence of this, scientists report that in the Intermountain West there are no native species of *Onthophagus*, a genus of dung beetle which occurs in association with dense herds of large mammals. In contrast, there are 34 species of the genus native to the Great Plains.

Native Western bunchgrasses have probably suffered as much at the hands of the grazing industry as any other plant group. For example, bluebunch wheatgrass is native to semi-arid land throughout Idaho, western Montana, eastern Oregon, and eastern Washington. It grows in 2-foot-high clumps, primarily at lower elevations. Individual plants can live 50-100 years. A cool-season grass, most of its growth occurs in spring; in the typical hot, dry summers it goes dormant. During wet periods in autumn it may break dormancy and grow until early winter.

Light grazing of bluebunch wheatgrass during summer dormancy, when most carbohydrate reserves are stored in roots, usually causes minimal damage to the plant. In fact, before the advent of fire suppression, wildfires burned these grasslands frequently with no long-term ill effect. But truly light livestock grazing is almost unheard of. As traditionally

Sign amidst lush grass in Badlands National Park, SD. Livestock have been banned from about half of the roughly 100,000-acre Park, making the ungrazed portion one of the largest ungrazed -- and healthiest -- grasslands in the West.

practiced, livestock grazing depleted the bunchgrasses repeatedly during one season, every year. In contrast, fires burned them at irregular but periodic intervals of perhaps 5 to 20 years. Cattle ate the grasses, converted them to energy, heat, body weight, and manure, then left the range completely, whereas fires left many more nutrients on the range in the form of ashes. And livestock trampled heavily. Over many thousands of years, the grasses adapted to influences of native animals and fire, but they have not adapted to the intensive grazing, trampling, and other impacts of exotic livestock.



A healthy bunchgrass community, ungrazed by livestock, is a biotic Shangri-la.

Bluebunch wheatgrass at one time grew tall and abundantly throughout much of its range. Today, after a century of overgrazing, most of it has been replaced by cheatgrass, other exotics, and bare dirt.

As early as 1910, excessive grazing, as well as accidental and grazing industry-caused arson fires, reduced perennial bunchgrass on Idaho rangeland by 85%, diminishing the land's grazing capacity by 40%-75% (Ferguson 1983). Today, cheatgrass accounts for 75%-95% of southern Idaho's herbage production (Palmer 1988). Studying overgrazed Utah National Forests in 1918, range professional A.W. Sampson reported that "these and similar eroded lands would originally support a cow or the equivalent in sheep on from one-third to one-fifth the acreage required at the present time (Sampson 1918)." Conditions in Utah haven't changed much since.

In the hills and valleys of California, the native bunchgrasses and rhizomatous grasses were so incessantly grazed that today about 95% of the herbaceous cover in uncultivated areas is composed of non-native species, mostly cheatgrass and other weedy annuals from Europe (Holechek 1989). Exclusion of livestock for 16 years from a Southwestern semi-grassland site resulted in 45% more grass cover, a comparatively heterogeneous plant community, and 4 times more shrubs than adjacent grazed areas (Bock *et. al.* 1984). Concerning the Great Basin, Gleason & Cronquist state in **The Natural Geography of Plants**, "Heavy grazing has caused considerable diminution of the grasses over much of the area, until in some places there is no native grass left (Gleason 1964)." The story is similar all around the Western United States. One magazine article on livestock grazing concludes:

> *Unfortunately, the grasses were exhaustible. One can find them surviving in cracks between rocks, beneath clumps of sagebrush, clinging to the sides of cliffs; any place a cow can't reach.*

> *Overgrazing became a greater problem* [than farming] *with increasing numbers of cattle* [on the prairie]. . . . *In the Desert Grassland . . . many factors may have been involved* [in historic vegetation changes], *but cattle grazing is thought to have been the most important. . . . Livestock grazing is also considered the primary cause of vegetation changes in the Palouse Prairie* [northwest US] *and California Grassland associations.*
>
> --John L. Vankat, **The Natural Vegetation of North America** (Vankat 1979)

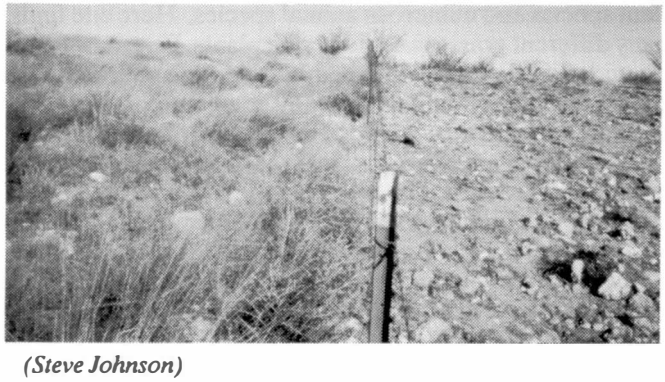
An intact, natural grassland is a wonderland of life and beauty. A healthy bunchgrass community may hold anywhere from a few to over 20 species of bunchgrass, a great variety of herbaceous, flowering plants, many brush and cactus species, trees along drainages and perhaps scattered around the landscape, yuccas, a carpet of soil lichen and mosses between the larger plants, even mushrooms -- in all, hundreds of species all growing together, along with an amazing variety of animals, as a complex yet harmonic intermingling of lifeforms.

Prairie-type grassland generally is not so rich in diversity of plant types, but usually contains an average of 125-150 plant species and numerous animal species. Here one finds many different grasses and flowering plants. Perennial forbs are widespread, especially members of the sunflower and legume families. Annuals typically comprise less than 5% of plant species. Thick stands of bushes and trees commonly line drainages, and woody plants, cacti and other "desert" vegetation may occur where the influences of soil, landform, fire, animal impact, and other factors create suitable habitat. While generally less biotically diverse than the bunchgrass community, prairie grassland usually has many more individuals and a much greater biomass per unit of area.

Grass
is
beautiful.

Unfortunately, grassland is not widely appreciated in this country. Indeed, probably most US Americans have a bias against grassland and other untimbered landscapes, assuming that trees are the natural and proper vegetation cover for the land. Charles A. White of the Iowa Geological Survey rightly challenged this assumption in 1870, saying, "There seems to be no good reason why we should regard the forest as any more a natural or normal condition of the surface than the prairies are (Malin 1956)." Indeed, grassland generally has the deepest, most fertile and productive soil, highest erosion resistance and water retention, and greatest biomass of animals of all the major bioregions.

Nevertheless, probably most people when traveling through a landscape of grass consider it with indifference. To them, grassland is monotonous and one-dimensional. Although literally thousands of kinds of plants and animals are found in the grass country, there is little conspicuous enough to excite their interest. No doubt much of the public's attitude toward grassland stems from the fact that most of the West's originally lush, productive ranges have been turned into scenes of desolation by a century of overgrazing. Exposed often to cross-fenced landscapes of closely cropped grass, bare dirt, and scattered cows, people simply don't have any idea what a healthy grassland would be like.



(Steve Johnson)

Correspondingly, there are few champions of grassland in this country. Defenders of the West's mighty forests, mountain ranges, rivers, lakes, canyons, and other such spectacular areas can be counted in the millions. Though grassland and semi-grassland probably cover more of the West than all of these areas combined, the vast majority of those interested in grass and grassland are connected with the ranching industry. With this in mind, it is no wonder that Western grassland continues to be abused.

Deterioration of forage is not always easy to detect. It can be a slow, insidious process.
--William Voigt, Jr., **Public Grazing Lands** (Voigt 1976)

When a plow rips into the earth, exposing the soil and uprooting native vegetation, even the most unobservant can see a big change. When a logging outfit cuts a forest, the results are painfully obvious. When a copper company scalps a hillside, leaving tailings in piles at the bottom, the destruction is immediate and evident.

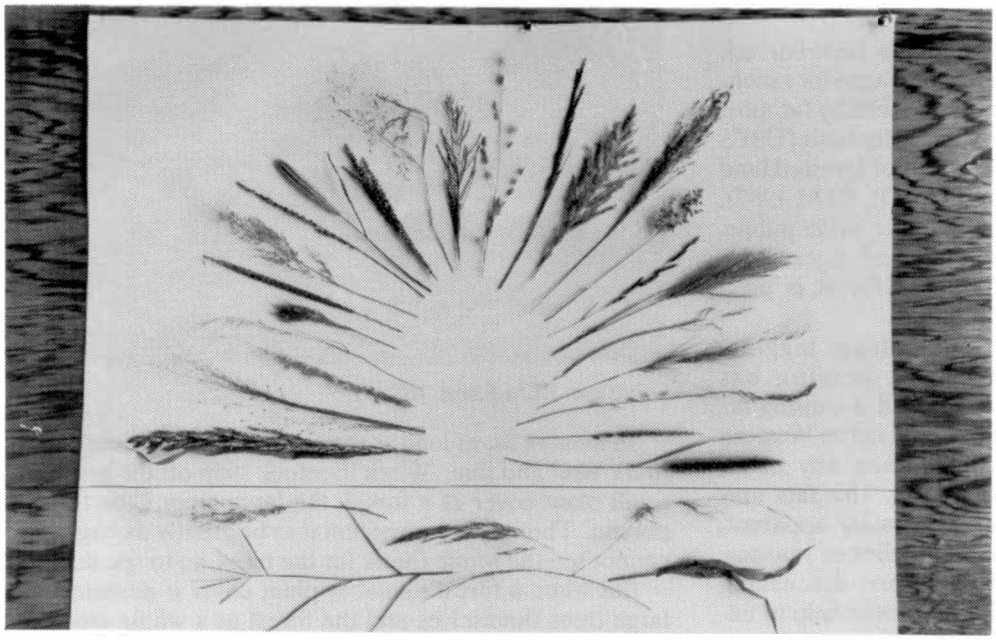
Not so with livestock. Grazing damage usually occurs in slow increments. Like the hour hand of a clock, changes are imperceptible, yet relentless. Of all the major land uses, livestock grazing is not only the most destructive but the most insidious.

Squirreltail.
(Helen Wilson)

USDA reports that 718 million acres of unforested grassland and semi-grassland in the US are grazed by livestock (Akers 1983). Unfortunately, healthy, intact native Western grassland has been almost totally eliminated by cow and plow, and, to a much lesser extent, development. On public land, its destruction has been caused almost exclusively by livestock grazing and ranching activities.

Though we usually think of rangeland as being grassland, this is just one of several major Western vegetation types grazed by livestock. All other major Western vegetation divisions have been severely affected as well.

Knee- and thigh-high grasses of several varieties and river grass 8' tall (top right) blanket this ungrazed bottomland along a remote stretch of the Green River in northeast Utah.



On an area of Arizona grassland fenced from livestock for 40 years, we picked the 24 seedheads of different grass species above the line. On an adjacent comparable area outside the exclosure, we found only the 6 species below the line.

Forest

At the beginning the mountains and heavily timbered areas were used but little [for livestock], *but as the situation grew more acute in the more accessible regions, the use of these areas became general and in course of time conditions within them were even more grave than elsewhere, for experience had demonstrated that they were in strong demand. The mountains were denuded of their vegetation cover, forest reproduction was damaged or destroyed, the slopes were seamed with deep erosion gullies, and the water-conserving power of the drainage basins became seriously impaired.*

--Albert F. Potter, sheepman, principal founder of the US Forest Service and its first Chief of Grazing, in "The National Forests and the Livestock Industry," 1912

When Europeans arrived in the West they found much of it -- 25% according to *Forestry Almanac* -- timbered, especially along the Pacific Coast and at higher elevations in the interior. There was a wondrous variety of forested areas, from immense stands of the world's largest trees in the Pacific Northwest to tiny forests of pigmy pinyon-juniper on rocky slopes in the Great Basin to impressive cottonwood and mesquite bosques in riparian areas of Southwest.

Over the years more than 90% of the West's commercially exploitable old-growth forest has been logged, and though most of this has regrown with trees, little of it attains aboriginal forest health and integrity. (In the US as a whole, less than 5% of pre-European old-growth remains intact.) Since the Western deforestation of the 1800s and early 1900s, many areas have been cut again, some 2 or 3 or more times, with tremendous environmental impact. Today this plunder continues at an accelerating pace.

Though few people realize it, Western forests are also heavily grazed, generally with higher livestock densities than on open landscapes. For a century, near-

ly every forest in the West, even in the soggy Northwest, has been degraded by livestock. (On a recent stay in Mountain Home State Forest in California, we found cattle damage even in a densely vegetated sequoia grove amid the world's largest trees.) Indeed, as mentioned, in the early years of exploitation ranching was of much greater consequence than was logging in National Forests, and the US Forest Service was largely an outgrowth of the grazing industry (Foss 1960, Roberts 1963, Voigt 1976).

Rough Approximation of Major Forests
(Source: Vankat 1979)

About 70% of the total area of Western National Forests, or roughly 100 million acres, is currently managed for ranching -- essentially all that "feasibly" can be -- with by far most of this land grazed by livestock on some regular basis (USFS 1988). BLM reports about 25 million acres of forested land in the West, the vast bulk of it grazed (USDI, BLM 1987). And there are millions of acres of grazed state, other public, and private forest. The US Department of Agriculture reports that 246 million acres, or 63% of US forest, is "used for pasture" for livestock (Akers 1983).

Aside from logging, livestock grazing has caused and is causing far more damage to Western forests than any other forest use. This fact may not be readily apparent, for a number of reasons. But before discussing these it would help to understand just what a forest is.

A forest is more than just trees. According to ecologist George Wuerthner, a forest includes "the interrelationships between trees, soils, water, insects, fungi, fire, wildlife and a host of other influences most of us don't even know exist, much less understand." As with grasslands, healthy forests are a rich mixture of species, natural processes, and complex interrelationships. Through the millennia the right balance has been achieved for each unique geographic area. Though trees are the dominant plant type in a forest, there usually is an understory of brush and a ground cover of mixed grasses, forbs, and flowering plants, many able to subsist on scant sunlight. These plants serve many purposes to the trees and the forest as a whole, including holding and building soil, retaining water, moderating temperature, providing beneficial insect habitat, and so forth.

The natural forest is usually a jigsaw puzzle of different vegetation communities at different stages of growth. This mosaic provides diversity for overall health and biologic regeneration in case of fire or other disturbance. Likewise, the trees in healthy forests are of varying ages and sizes, from tiny seedlings to centuries-old giants, dispersed fairly randomly to assure maximum regeneration and distribution. Natural disturbance and fallen dead trees allow sunlight to reach lower levels, and through natural processes the larger forest trees usually are spaced far enough apart so that lower branches and some young trees receive adequate sunlight. This also allows smaller plant species to prosper between the larger trees, in turn helping sustain the forest as a whole. Directly underneath each tree, within its "fall line," is found a thick duff of fallen needles or leaves, twigs, bark, catkins or cones, and other tree parts. In this way each tree provides itself a rich compost that supplies nutrients, conserves moisture, builds topsoil, moderates soil temperature, and benefits the tree in many other ways.

Cattle in BLM forest. *(BLM)*

To most of us, as long as there are trees everything seems "park-like" and fine. When livestock strip off the grass and small plant cover of a forest, the large trees ("the forest") remain. Though the ecosystem may be greatly damaged, we cannot see the *whole* forest for the trees, so to speak.

But when a forest's smaller plant cover is denuded, the large trees themselves and the forest as a whole are eventually affected. Soil erosion intensifies; soil moisture decreases; air and soil temperatures reach greater extremes; localized, low-level air movement increases;

humidity decreases; beneficial animal habitat is destroyed; seed beds are damaged. Thus, in the long run large trees may become stunted, experience reproductive failures, be damaged by disease or insects, and so on. New trees cannot replace those that die since seedlings cannot establish in the overgrazed dry, hard ground.

Trees are likewise harmed when their underlying compost layer is disturbed. Normally, this organic litter layer is loosely matted together, cool, moist, aerated, and full of nutrients and beneficial microorganisms. Cattle in particular drag their feet as they walk, and all livestock tear apart and scatter this fertile overlayer, exposing it to light, cold, and heat, while at the same time compacting the underlying duff and soil, preventing aeration and, indirectly, killing microorganisms. As a result, trees suffer from a lack of moisture and nutrients that causes them to shed leaves, grow meager foliage, produce fewer and less fertile seeds, and be more vulnerable to insects and disease.

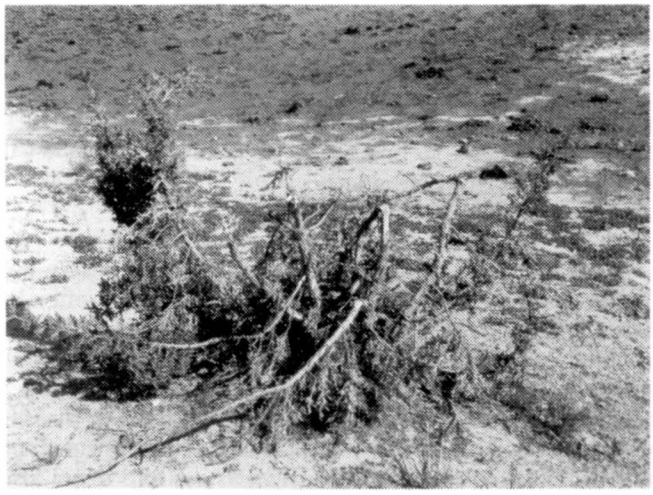
Dead trees and branches fall to the forest floor, where they may take longer to decompose than they did to grow. On the ground they are gradually reduced to humus by bacteria, fungi, and small insects. Like huge time-release vitamin capsules, they slowly release their nutrients into the soil and to plant roots.

These logs and branches may be periodically burned off by fires, without which they might accumulate to levels where they provide excessive fuel that results in highly destructive conflagrations. Where overgrazing depletes too much combustible organic ground cover, it prevents the spread of fire, or fire hot enough, to ignite these large branches and logs. In some sparsely forested areas where accumulation of duff alone isn't sufficient to carry fire, depletion of ground cover by livestock has reduced or eliminated forest fires altogether, to the forests' overall detriment (see Fire section of this chapter).

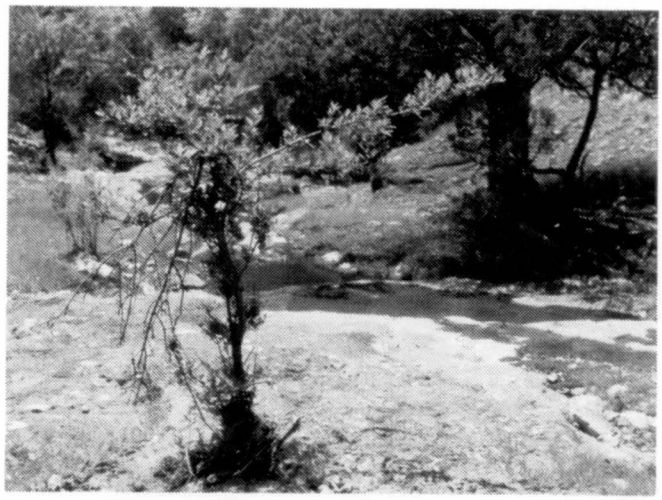
(GilaTrout)

Many people have a hard time believing that cows and sheep eat trees. Nevertheless, trees are a significant part of the diet of both in many areas. Trees preferred by livestock include oak, ash, walnut, willow, birch, aspen, alder, and cottonwood, though if need be they will eat almost any tree. Many times I have seen cattle eating pine, even pinyon pine!

Ponderosa pine, eaten, stunted, and distorted by cattle -- one of the few survivors in a tree plantation in Prescott NF, AZ. *(Rod Mondt)*



This juniper, eaten and broken, stunted by general environmental degradation caused by livestock, probably will not survive.



This ash is likewise damaged and stunted.

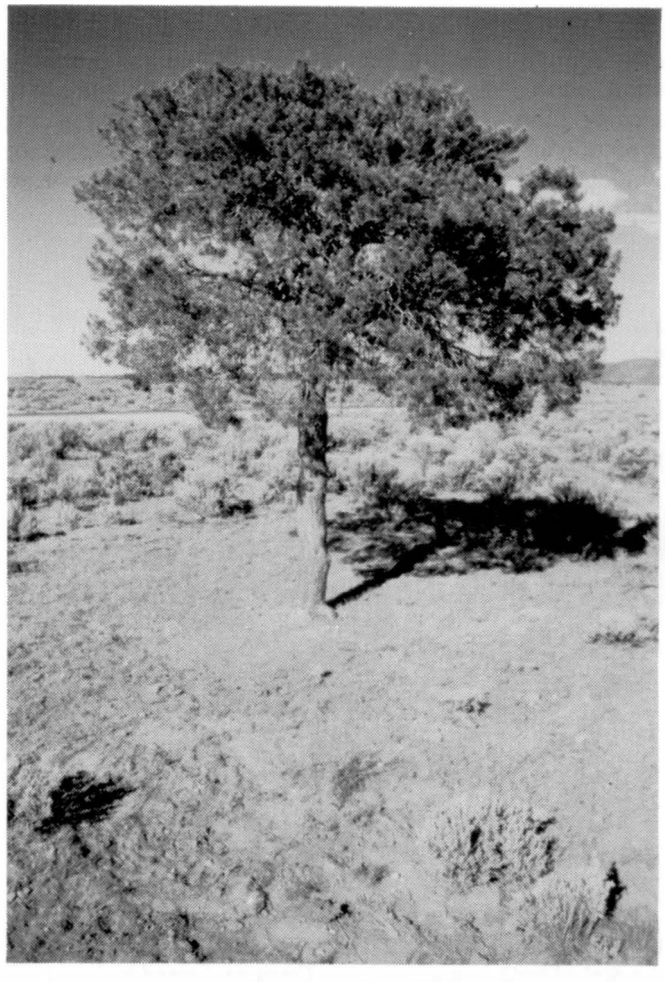
Livestock eat the leaves and twigs from branches as far up the tree as they can reach (about 5 feet with cows), leading to the familiar "browse line" common in pictures of the African savanna. Livestock also eat tree saplings, and in winter leafless saplings; in some areas these compose a significant portion of their diet. According to the Forest Service, "Proper utilization of ash, walnut, etc. is 40% to 60% of available twigs." Many public land grazing allotment management plans expressly call for 30%-70% or so annual "utilization" of tree seedlings, and often more is taken. Thus, again, as large trees die from old age or the effects of overgrazing and small trees are eaten by livestock, the forest declines. Very sparse or even-aged stands of trees often indicate a history of heavy livestock use.

Trees are dying on this deteriorating BLM range. They are stunted; lower branches are gone; soil beneath is barren and damaged; saplings are eaten. This bottomland may have been covered with trees 150 years ago.

While cattle browse trees and damage forest ecosystems, they may also physically injure trees more directly, often by crashing through them and snapping off lower branches or breaking off small trees completely. Cattle also scratch against trees, breaking branches and rubbing off bark. They gouge trunks with their horns, opening the trees to disease and parasites. And they gnaw on bark to the point of girdling and killing trees. Wild animals such as elk and bears also injure trees, but they usually do so in more heavily forested areas where the damage usually adds to forest diversity and stability. Conversely, damage done by cattle is worst in the least forested areas.

In the drier parts of the West, mainly the Great Basin and Southwest where most forests are small and sparsely treed to begin with, livestock have been particularly destructive.

Cattle-grazed oak grove. Note lack of lower branches, ground cover, small trees. When old trees die, none will take their place. Santa Barbara Co., CA.



Lone pinyon pine shade tree begets cattle "sacrifice area."

In fact, most forests in these areas show more overall damage from ranching than from logging or any other activity. Due to aridity, ecosystems here are especially vulnerable to most of the livestock influences discussed.

In the summer, cattle often congregate under the largest, shadiest trees in these forests to spend the hottest part of the day. Here, they rut about, chew their cud (which they do about 8 hours a day), digest their food, and generally rest from eating (another 8 hours a day). The cattle shade tree is a common sight throughout the drier West: lower branches eaten or broken away; bark stripped from the trunk; bare, pounded dirt for many yards around; and piles of dusty manure scattered everywhere.

> *Many streams throughout the West are littered with the remains of what were once vigorous aspen groves. Aspen reproduce by sending up shoots from roots. If these young plants are constantly grazed off, eventually the parent trees will die of old age and aspen will disappear from the site.*
> *--Livestock Grazing on Western Riparian Areas* (Chaney 1990)

Though livestock affect all Western forest types in many ways, generally broadleaf woodlands experience more harm than do coniferous, largely because the former's saplings are more succulent and palatable. Among the most heavily damaged, for example, have been the West's shimmering aspen groves. Most are ravaged by livestock that eat and trample aspen sprouts and seedlings and other low-level vegetation, damage soil and bare it to the elements, and in many cases allow brush to take over.

The grassy oak woodland of Mediterranean California has for more than 2 centuries been experiencing a steady decline in oak trees, mostly due to cattle and sheep eating saplings. Five years after the University of California fenced 40 acres of its 4550-acre San Joaquin Experimental Range from livestock, the fenced plot supported 345 oak saplings per acre -- many times more than adjacent grazed land. According to The Nature Conservancy, an estimated 94% of California's interior broadleaf woodland has been significantly damaged or destroyed, largely by the livestock that use the vast bulk of it.

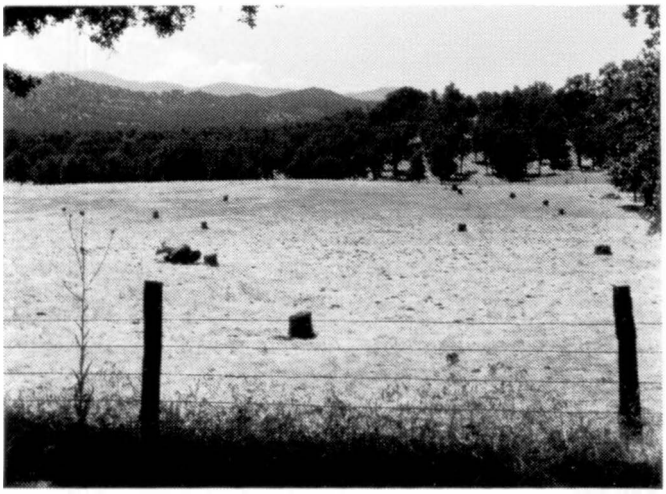
California's beautiful oak woodlands are disappearing. Trees die or are cut, and few young ones take their place. The only small oak in this scene survives behind the protective barbs of the roadside fence.

Ungrazed by livestock, a mountain meadow in summer vibrates with life.

This meadow in a Wyoming National Forest is a pretty scene, but the grazing sheep do extensive damage. *(George Robbins Photo, Jackson, WY)*

Forest meadows are among of the most forage-productive areas in the West, so ranchers historically have made a concerted effort to concentrate their animals there. Large numbers of cattle are still driven into meadows to graze through the summer, and vast flocks of sheep are herded slowly through them, leaving devastation in their wake. The beautiful mountain meadows of the West have thus been especially hard-hit by overgrazing. Because they usually remain moist and green even when overgrazed, few people understand the magnitude of the damage.

Additionally, *most* of the overgrazed "meadows" found today on flats and valley bottoms in Western forests are actually artificial pastures. They were created by (or for) early stockmen who cut down trees to maximize forage for their livestock. Because of their prime growing locations, these "meadows" once contained some of the largest trees and most productive portions of the forest. Even where timber harvesting was the original reason for cutting, ranchers have prevented the forest from growing back by continuing to cut young trees and allowing their livestock to damage the land and eat and trample saplings.



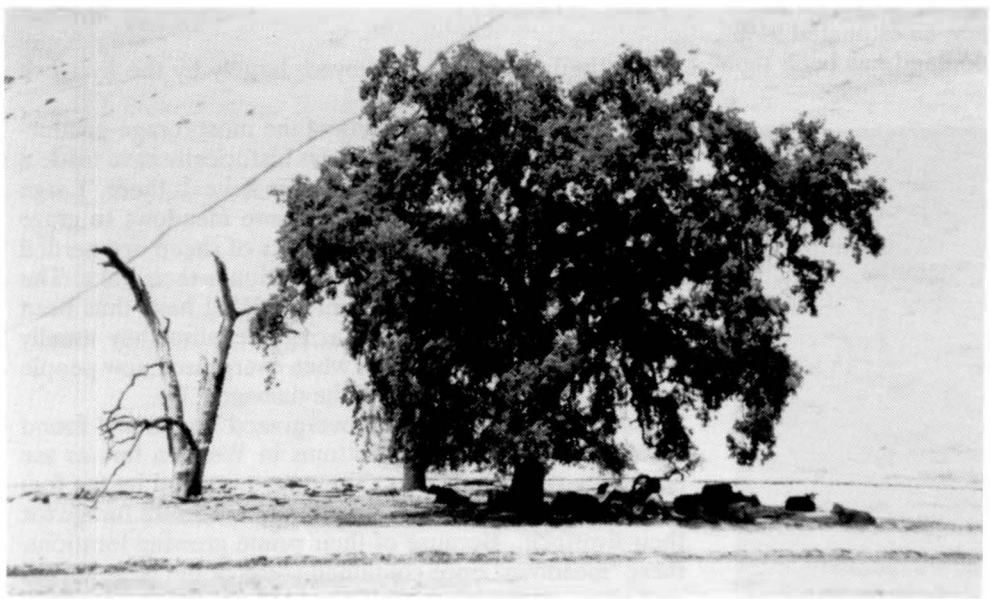
A "meadow" (cleared livestock pasture) in a central California forest. Note stumps, lush vegetation on fenced roadside.

On a seven-day backpack trip in the rugged Blue Range Primitive Area in eastern Arizona, I came upon a fence crossing the Blue River. Upstream, where cattle grazed, there were no tree seedlings at all on the gravel bars, mudflats and terraces along the river. Downstream, where cattle had been removed for several years, young cottonwoods, willows, and sycamores were lush.

--Dave Foreman, **Confessions of an Eco-warrior** (Foreman 1991)

The West's riparian groves have suffered more overall from livestock than have any other timbered lands. Situated on bottomlands along perennially flowing or moist drainages, these luxuriant stands of huge trees included various combinations of cottonwood, sycamore, alder, elder, boxelder, maple, willow, walnut, hackberry, mesquite, and others. Most covered hundreds or even thousands of acres and harbored an amazing variety and abundance of plants and animals. Riparian areas were the center of life in the West.

On public land *most* riparian groves have been virtually eliminated by overgrazing and grazing-induced flooding, and to a lesser extent by flooding caused by logging and unnatural fires, woodcutting, dams, and development (much of all this also a result of ranching). Overgrazing in watersheds caused drastic flooding that swept away the very bottomland these magnificent groves used to inhabit. Where large trees do remain, they may give the impression of riparian health; however, often all that survive are "historic" trees -- large individuals that were established before intensive livestock use began, or that established at some point in history when livestock grazing slacked off for a period. When these historic trees die they aren't replaced as long as heavy livestock use continues because saplings are eaten before they grow large enough to withstand intensive browsing. This appears to be the case along the Wild and Scenic Missouri River in Montana, where University of Montana researchers have discovered that livestock grazing is a major factor in the decline of the plains cottonwood; the deterioration has been masked to most observers because the remaining large historic trees give a false impression of riparian health (Wuerthner 1991).



Remaining live oak awaits its fate while shading its destroyers. When it dies there will be none. According to D.A. Duncan and W.J. Clawson in a presentation titled *Livestock Utilization of California's Oak Woodlands*, a study at the Hopland Station in the northern California foothills showed that after 5 years of protection from livestock an ungrazed study plot had 554 oak saplings per acre, compared to 0 saplings per acre on a plot grazed by sheep.

Hardest hit have been the verdant cottonwood and mesquite bosques of the Southwest; by far most of them have been destroyed. The Fremont cottonwood/Gooding willow community, for example, is the rarest of the 104 major plant communities in North America. Although it never covered more than 1%-2% of the Southwest, livestock grazing led the way in reducing its area to (according to The Nature Conservancy) less than 1/1000 of 1% of Arizona and less than 1/100 of 1% of New Mexico. The most sensitive riparian areas succumbed first to the initial grazing frenzy of the late 1800s, but modern ranching prevents

recovery and continues to cause new damage to riparian areas throughout the West (see Riparian Areas in this chapter).

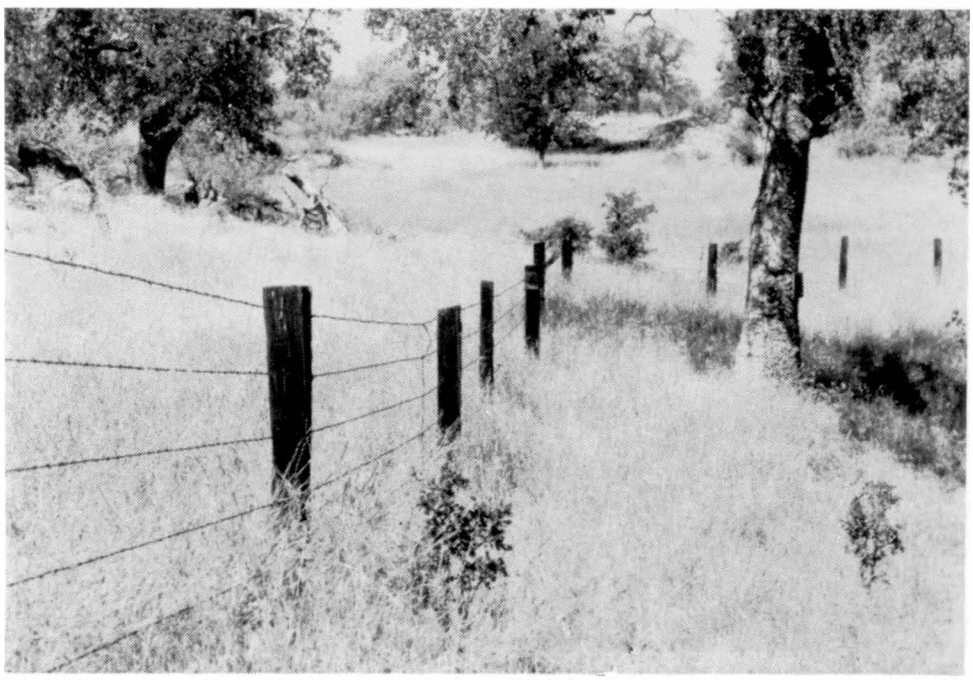
Generally, livestock grazing diminishes tree cover. However, under certain conditions overgrazing may increase the range and density of several kinds of trees.

Pinyon pine and juniper are the primary examples. These trees, often in mixed stands termed "P-J," currently cover about 75 million acres, about 1/10 of the semi-arid West. To justify destroying them to increase livestock forage, ranching advocates have greatly exaggerated the extent of their spread, but there is little doubt that pinyon and juniper have expanded their territory since the 1800s, "taking over" perhaps 20 million acres previously dominated by grass and grass/shrub combinations.

The exact reasons for this have not been determined, but it is no coincidence that overgrazing and P-J spread have occurred almost simultaneously. Overgrazing in P-J and potential P-J areas is very common, and the thin soils normally associated with this vegetation type make it highly sensitive to livestock influences. We know that livestock disperse juniper seeds through feces and their trampling tends to favor P-J seedlings over competing vegetation. And obviously livestock would rather eat grasses and most other herbaceous plants than pinyon and juniper. By stripping off this organic understory, however, livestock have precluded the natural fires that used to kill tree seedlings and revitalize forbs and grasses. This, in combination with the ranching industry's intentional war against natural fire, has eliminated most natural fire from *most* Western rangeland. Subsequent lack of fire, more than overgrazing directly, appears responsible for the spread of pinyon-juniper.

Whatever the cause, the new P-J "forests" are comparatively dry, eroded, and devoid of plant and animal life -- as overgrazed as the grassland and semi-grassland they replaced. They are a human creation, like golf courses, and wherever they have been artificially produced by livestock the livestock, rather than the trees, should be removed.

As young trees are eaten or succumb to other ranching impacts and old trees die, remaining trees (often used as shade) become foci for environmental damage, intensifying their extirpation.



A fenceline ungrazed on both sides. Note small oaks on both sides.

Most Western forest is grazed by livestock.

Because Western forests became fully stocked somewhat later than open rangelands, their greatest overall rate of livestock degradation probably occurred in the early 1900s (particularly during World War I). Forest conditions at that time have been described with terms like "devastation" and "holocaust"; indeed, many areas resembled barren deserts scattered with trees.

Thus, the forests were divested of their natural productivity, and those forests we think we know today are operating at much less productive levels. Livestock grazing may now seem less intense, especially compared to the historic past or to the more obvious damage of current open range grazing. Be that as it may, most Western forests are still stocked many times beyond their true carrying capacity, and this pressure perpetuates the dynamic state of degradation begun a century ago. Destructive modern range development (next chapter) has augmented this state, and in some ways cumulative damage continues to mount.

Brushland

Rough Approximation of Major Brushlands and Woodlands
(Source: Vankat 1979)

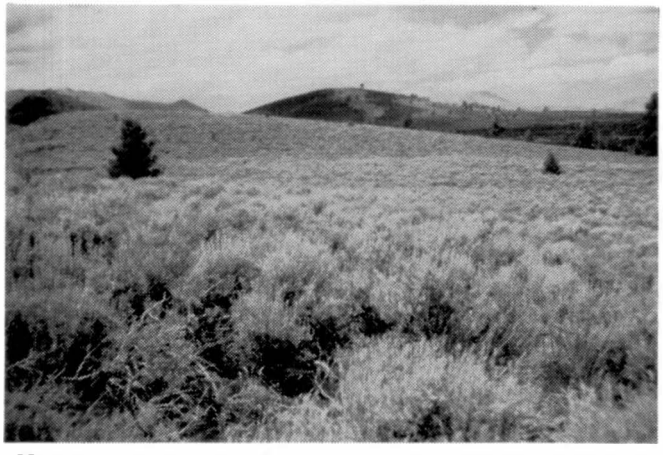
Decades of differences in livestock grazing have apparently resulted in more juniper and less mesquite on the far side of the fence, vice versa on the near side. Gila NF, NM.

Primarily because woody plants block sunlight and occupy space that could be used by forage grasses, brushland/shrubland is the most maligned major biotic community in the West. The ranching establishment considers it a hindrance to profits and has waged unrelenting war against woody plants (see Plant Enemies in next chapter).

Unfortunately, few people of any persuasion have much good to say about brush. Perhaps this is because brush is not conveniently open to human access; you cannot walk over it as with grass or under it as with trees. Maybe it is because brush provides few apparent benefits to humans; it is not easily conquered and molded to our will. Or maybe it is because a thick stand of brush is hidden, mysterious, and even a little scary. Certainly it has much to do with the grazing industry's vilification of it for over 100 years.

Brush (bushes) and *shrubs* are woody plants, with brush generally being larger and more tree-like, while shrubs are low to the ground. Scrub oak, greasewood, laurel, locust, sumac, winterfat, rabbitbrush, saltbush, tarbush, cliffrose, mountain mahogany, hawthorn, snakeweed, manzanita, acacia, chokecherry, ceanothus, creosote, serviceberry, Mormon tea, jojoba, soapberry, bur sage, burro brush, bitterbrush, blackbrush, buckbrush, buckthorn -- hundreds of varieties of brush and shrubs inhabit the West. Brushland and shrubland are areas where these woody plants are the predominant vegetation.

Though occasionally growing as dense, single-species stands, woody plants usually grow in mutually beneficial combinations of species. As with forests and grasslands, the natural brushland association is most often composed of a rich array of plant types and species.



Healthy, ungrazed sagebrush range also supports abundant grasses, flowering plants, cryptogams (see Deserts in this chapter), and animal life. Commonly, less than 10% of the ground is bare. This brushland in Craters of the Moon National Monument, ID gets only 10" annual precipitation.

Brushland performs all the essential functions of any other plant community. It builds and maintains soil, absorbs and retains water, blocks the elements, and all the rest. Even where brush forms tight, closed stands, it performs these jobs admirably. The ground beneath these stands is blanketed with a rich cover of organic litter dropped by the brush above. Pull back this thick layer and you'll find the soil beneath moist and dark, as it is well protected from sunlight, heat, cold, rain, wind. And, despite misconceptions, brush and shrubs provide habitat for the many and varied animals adapted to them.

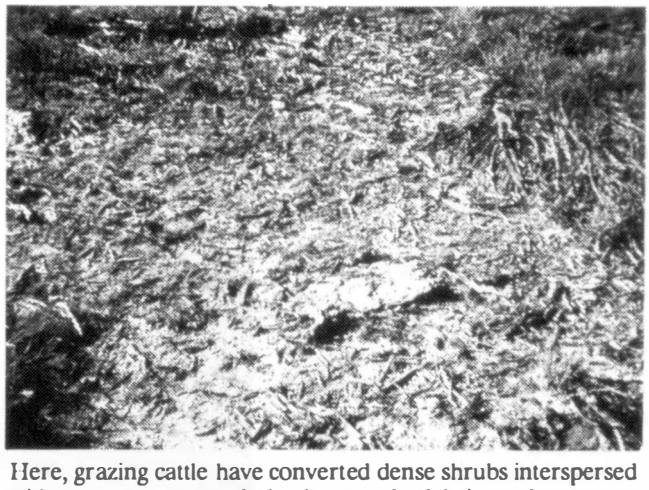
While it is true that in some respects brushland has a lower capacity to perform these functions than does grassland or forest, as with any natural plant cover brushland is the most productive, stable biotic community for the given environment. The key here is *health*. Neither grassland nor brushland nor any other vegetation type perform natural functions well if abused by livestock.

Forget ranching industry "information"! Bushes and shrubs are not merely "transitional" plants or "disturbance species" occupying space until some other kind of vegetation takes their place, though they sometimes do play that role. Rather, they are part of the climax community throughout large areas of the West. This is well-documented by the journals of early explorers and by scientific study.

Indeed, when Europeans arrived in the West they found much of it cloaked with brush and shrubs. Nearly every Western ecosystem supported woody vegetation, and even the grasses of the prairie were often interspersed with shrubs, such as buckbrush. There was a great diversity of woody plant communities, from widely spaced, low-growing, mixed desert shrubs in the lower Sonoran Desert, to vast sagebrush/grass-covered plains in western Wyoming, to huge stands of dense chaparral in California's hills and mountains, to tiny thickets of mixed shrubs in rocky outcroppings in eastern new Mexico to . . . The US Geological Survey identifies 15 major shrubland and grass-shrubland divisions in the West, with scores of subdivisions.

Today, most original brushland survives, though most has been damaged and much has been altered beyond recognition. Public lands ranching has played the major role in its deterioration. According to USDA, in the US (mostly in the West) shrubland range is in even worse condition than grassland range, with 55% and 53%, respectively, producing at less than 40% biotic potential and 85% of both producing at less than 60% potential (USDA, USFS 1980).

Brushland is affected by overgrazing in most of the same ways as grassland and forest. Brush and shrub seedlings are eaten and trampled. Mature plants are overbrowsed, giving them an excessively "hedged" appearance; many brush species, mountain mahogany for example, are highly desired as browse. Branches are broken and trampled. Plants eventually lose vigor, roots and branches die back, centers die out, and reproduction fails. Livestock strip off the ground cover of grasses and other small, herbaceous plants. They trample, displace, and destroy the organic litter layer and soil cryptogamic layer common to many brushlands (see Deserts in this chapter). Rain runs off instead of in, soil erodes . . . The whole familiar series of harmful effects proceeds.



Here, grazing cattle have converted dense shrubs interspersed with grass to scattered shrubs, woody debris, and no grass. Northern Nevada BLM.

As with pinyon-juniper, some brush and shrub species -- particularly catclaw, sage, snakeweed, and mesquite -- are resistant to grazing. As with P-J, they have in some areas become increasers or invaders at the expense of grass; thus, the grazing industry's "brush invasion." Overgrazing can

indeed increase the range and density of brush, *but only some species under certain conditions*.

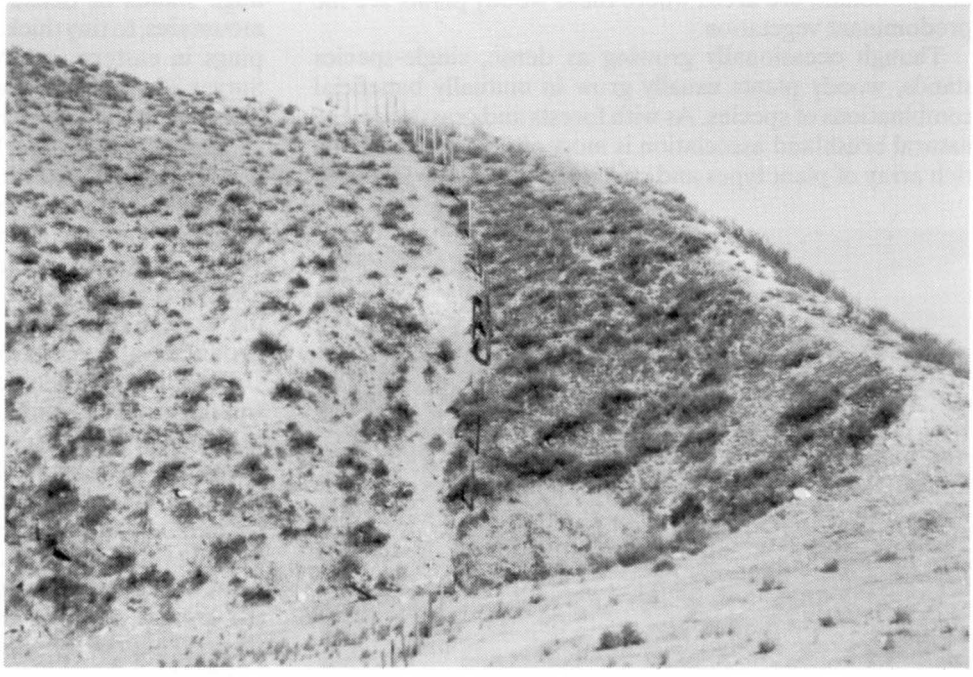
According to many range professionals, grazing's indirect effects, more than grazing *per se*, are responsible for the spread of these woody plants. For example, in his study of vegetational changes on Southwestern grassland and semi-grassland, **The Desert Grassland**, Robert R. Humphrey concludes:

> *The principal environmental factors that may have been modified are* [1] *climate,* [2] *grazing by domestic livestock,* [3] *plant composition,* [4] *rodents and rabbits, and* [5] *fire. Each of these appears to have aided in the spread of shrubs. The effect of some, as for example, climate, appears slight; that of others, such as grazing and fire, is of considerable importance.* (Humphrey 1967)

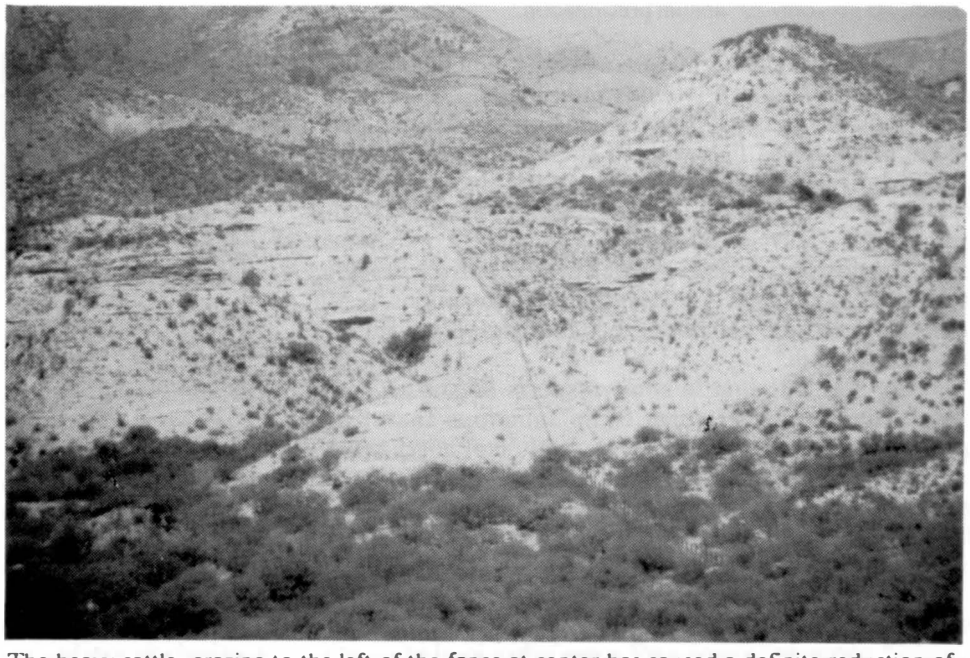
These 5 factors are most commonly cited as leading to the spread of brush throughout the West. Though Humphrey and most other range pros seem reluctant to state the obvious connection between livestock grazing and these other factors, I will do so here:

- (1) *Climate*, Humphrey agrees, has been a minor factor; in fact, there has been insignificant change in climate (see Air section of this chapter).
- (2) *Grazing by livestock* is listed as 1 of the 2 major factors, along with lack of fire, for the spread of woody plants. There are many influences involved, including: spread of seeds through fecal droppings (probably important to the spread of mesquite, for example); selective grazing (livestock eating the most palatable species and leaving the woody plants); trampling of smaller plants; reduced competition (removal of plant species that formerly served to limit other plant species' growth); damage to soil and water systems, which may favor woody plants over grasses; and removal of combustible plant matter which previously served to carry range fires.
- (3) *Plant composition* changes, including the increase in woody vegetation around the West, as previously explained, has been caused largely by overgrazing.
- (4) *Rodent and rabbit* population increases have also contributed to the increase in woody plants in some areas. These animals have accomplished this primarily by eating the more palatable species, spreading seeds in their droppings, and storing seeds underground, where they later germinate.

Increases in rabbits and other rodents are caused by the livestock industry in 2 basic ways: First, predator slaughter



Cattle on this New Mexico state range have decreased nearly all plant life, including brush by perhaps 50%. Roadside at right. Foreground was bladed.



The heavy cattle grazing to the left of the fence at center has caused a definite reduction of shrub and brush cover on this steep, rocky, semi-arid BLM range in central Arizona. Probably unbeknownst to the viewer, however, the lighter grazing to the right of the fence has caused a significant vegetation decline as well.

has allowed rodent populations to fluctuate wildly in many areas, causing them to periodically overuse smaller vegetation, favoring brush. Second, livestock grazing and certain ranching management techniques (next chapter) favor the spread of weedy species on which some rodents may thrive.

- (5) *Lack of fire* is, according to Humphrey, the major cause of the invasion of woody vegetation into Southwestern grassland and semi-grassland. Unfortunately, Humphrey failed to make the connection between the grazing industry and the lack of natural fire during the past 100+ years. Perhaps this is because range professional circles frown upon directly blaming ranching for anything more than the most obviously deleterious.

At any rate, by eating and trampling and causing other changes that radically decrease the amount of combustible material, livestock have eliminated natural fire from much of the range. Without periodic fire to rejuvenate grasses, destroy bush seedlings, and burn back small bushes, woody plants often have the advantage. This and the grazing industry's fire suppression campaign have been the 2 main elements snuffing out natural range fire in the West (see Fire in this chapter and Fire Management in Chapter IV).

Humphrey has changed his thinking somewhat. His recent book, **90 Years and 535 Miles**, compares photographs made in 1892-1893 in 205 locations along 535 miles of the US-Mexican border between El Paso and Yuma with recent photographs of the same locations. Conclusions on these comparisons were difficult because the 1892-1893 photos were made *after* many years of devastating overgrazing, and directly following a period of severe drought in which thousands of cattle in the area died of thirst and starvation. Even so, the photos and Humphrey's on-the-ground comments document a nearly universal reduction in grass and perennial herb cover, often accompanied by an increase in brush and annual forbs. A great many of his comparisons identify the impact from livestock as the probable main cause of change. Humphrey now concludes that climate "may be in part responsible for this change," that grazing is "in large part responsible for the change," and that "in many areas close grazing reduced the potential fuel; in others, fires would have been extinguished because they were seen as consuming valuable forage." (Humphrey 1987)

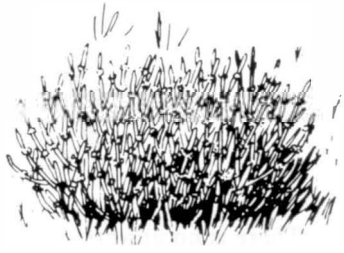
As a rule, increases in woody species from overgrazing are most pronounced in semi-arid regions. Livestock grazing in deserts usually decreases *all* vegetation, while grazing in moist regions generally causes native herbaceous perennials to be replaced by herbaceous increasers and invaders rather than woody vegetation. Large increases in bare dirt are common with livestock grazing everywhere.

While it is generally accepted that overgrazing has resulted in major changes to Western brushland vegetation, the nature and extent of these changes typically have been misinterpreted by those with vested interests in eliminating any and all brush. True to style, the grazing industry has blown "the brush invasion" totally out of proportion. For example, an article, "Man vs. Mesquite," in *Life* magazine, August 18, 1952, claims:

> *A century and a half ago, there was hardly any in this country . . . Mesquite march during the last 100 years has taken it from small riverside areas in which it grew in 1850 to the 75 million acres it now covers* [in the US].

This claim, provided to the article's author by ranching advocates and still alive today, is grossly inaccurate. Many early explorers, including Stephen Long, Lieutenant Abert, and R.B. Marcy, noted what surely totaled millions of acres of mesquite on the plains and valleys of the Southwest more than 150 years ago. In fact, evidence indicates that (1) mesquite has expanded its general geographic range only slightly, (2) mesquite has occupied most of its current territory for centuries, (3) mesquite formerly grew across plains and valleys, not only along drainages, and (4) the biggest change in the nature of the average mesquite landscape has been that formerly open, grassy savanna scattered with large mesquite trees has become scrubland of densely packed, scraggly mesquite (Malin 1956). (As livestock grazing tends to transform sod grasses into bunchgrasses into annual grasses, so it tends to convert trees into bushes into shrubs.)

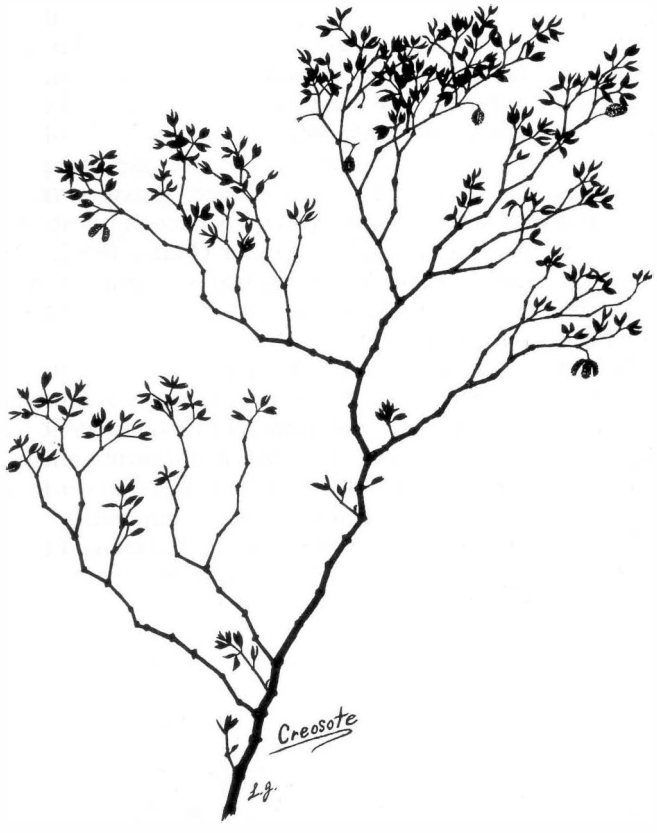
Numerous accounts by early Western explorers confirm that brush and shrubs have not increased nearly as much as claimed by the ranching establishment (Thwaites 1959, for example). Moreover, most of the brush and shrubs alleged to have "invaded" have actually been increasers, if even that. As natural components of mixed plant communities, they simply increased in density when livestock damaged their ecosystems. Or, in some cases, they only *seemed* to increase because they were the only plants left.



Whatever the case, most of today's brushlands and shrublands are generally incomplete, unhealthy, and unproductive as compared to those in pre-livestock times. Many have been turned into veritable biological wastelands. Frequently existing as stands of only 1 or 2 species, their stunted, broken plants are interspersed with little more than bare, trampled dirt. In such condition, who would have much good to say about them?

Deteriorated sage/grass range in northern Nevada. Note healthy vegetation on ungrazed side of fence.

Desert



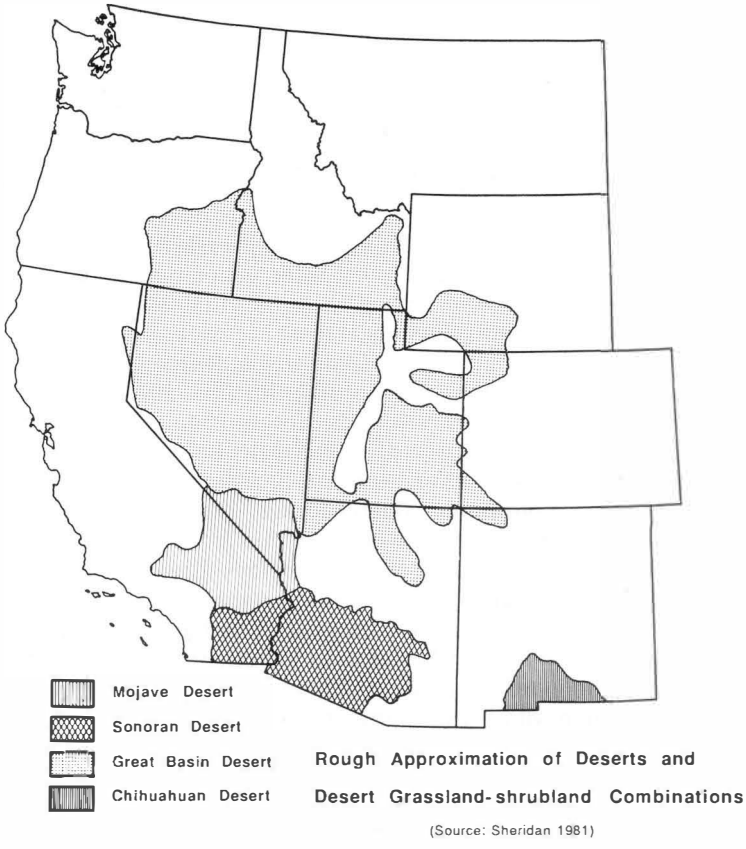
There is no universally accepted definition for the word "desert," but it is often considered to be a biotic region that receives 10" or less of precipitation per year. Under this interpretation, about 1/4 the area of the 11 Western states could be termed desert, including some portions of each of these states, even Montana.

The amount of vegetation cover should perhaps be as important a defining factor as the amount of rainfall. Many variables besides annual rainfall influence an area's amount of vegetation: type and season of precipitation; temperature; elevation; latitude; angle and lay of land; amount, speed, and direction of wind; soil color, texture, structure, and chemical composition; and so forth. There are areas receiving more than 10" annual rainfall that seem to be desert and areas receiving less than 10" that wouldn't be considered desert. When it comes down to it, each area is judged individually.

A true desert is not merely an area of sparse vegetation, but an area only capable of supporting sparse vegetation. There is an immense difference. Actual *desert* is not wasteland but simply another of the Earth's natural biotic regions. This helps explain why the Earth's human/livestock-created deserts, many of those in the "Old World" particularly, support a paucity of desert species compared to more natural deserts like those in North America.

Contrary to popular opinion, the "struggle for survival" in deserts is not necessarily harder than in other bioregions, just different. A healthy desert, like any natural bioregion, is a smoothly functioning group of ecosystems. Though deserts are capable of supporting only comparatively sparse vegetation, they produce the maximum abundance and diversity of plant and animal life possible *for existing climatic, geologic, and geographic conditions*. Having spent millions of years perfecting the art of using water to maximum benefit, deserts are the unsurpassed experts in conservation and effective use of water. Humans can only force deserts to produce more than what they would naturally on a transitory basis, and then only at the expense of the overall environment.

There are 4 main desert regions in the United States. The *Great Basin Desert* encompasses most of the high "sagebrush desert" that includes much of the area between the Rocky Mountains and the Sierra Nevada and southern Cascades. The *Mojave Desert* is the low-elevation, dry-summer desert covering most of southeastern California, southern Nevada, and northwestern Arizona. The *Sonoran Desert* of south and central Arizona is a warm, comparatively verdant desert with both winter and summer rainfall. And the *Chihuahuan Desert*, with a similar rainfall pattern to the Sonoran, is a somewhat higher and cooler desert covering much of southern New Mexico and western Texas. These 4 regions encompass the bulk of genuine desert in the West.



The morning sun lights an impoverished land: greasewood wide-spaced, dirt and sand between, a little grass, a low, prickly, gray-green matted cover only at river's edge -- woefully overgrazed land. . . . Somehow a true desert is less bleak than this vista; a desert seems at equilibrium within itself, while this is but the tattered remnant of something better.
--Ann Zwinger, **Run, River, Run**

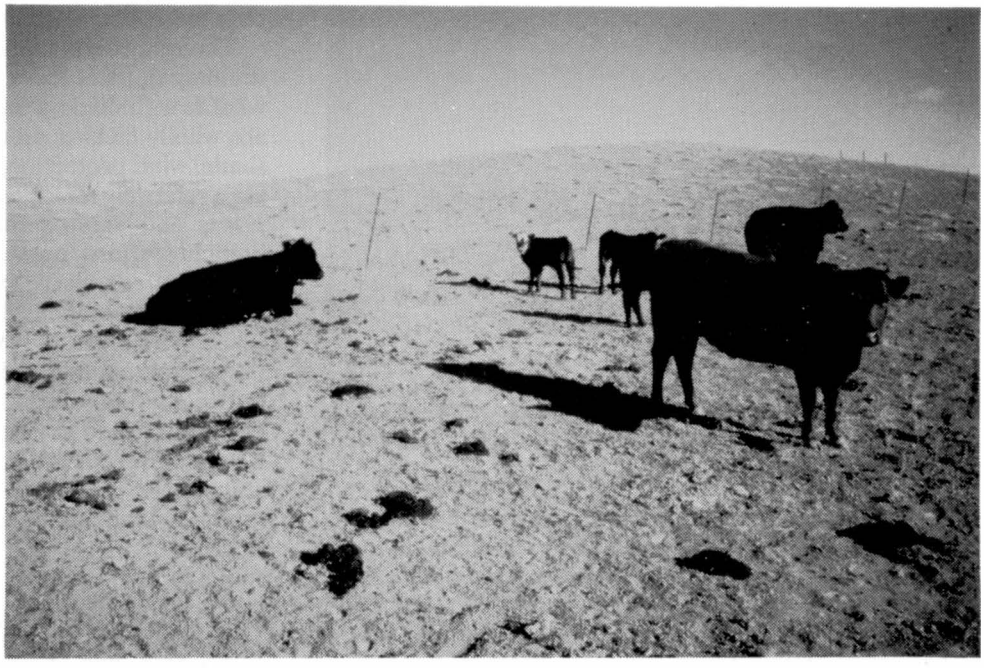
Much of today's West only superficially *appears* to be desert and would be more accurately described as "wasteland." Extensive overgrazing has caused what botanists term *desertification* (making desert-like -- something of a misnomer) throughout much of the West, including huge areas previously well-vegetated and still well-watered. Marginally arid areas generally are the first to succumb to desertification from overgrazing, but any place can be "wasted" or "cowburnt" and take on the outward appearance of desert. This is nicely demonstrated by former-grassland-now-wasteland areas in every Western state. While about 1/5 of the West could be termed true, natural desert, perhaps another 1/5 has been so thoroughly and incessantly grazed by livestock that it has taken on the superficial appearance of desert. The point is that this overgrazed land is *not* true desert and, further, that it does not function in the healthy, productive manner inherent in a natural desert.

Of course all this is not to say that the West's genuine desert has not been wasted as well. Indeed, it is the most vulnerable of all biotic regions to livestock damage. This is understandable when one considers that the last large native herbivore to occupy the arid West was the giant ground sloth, a browser extinct for more than 10,000 years. Additionally, desert experiences the greatest precipitation and temperature fluctuations of all biomes (biologic regions), which further augments its vulnerability. Already limited to a minimum of biomass, it is easily harmed by any kind or amount of livestock grazing. Once damaged, it usually does not recover for decades or even centuries.

For example, the Sonoran and Chihuahuan Deserts of the American Southwest are probably a million years old as deserts, and yet they have become perceptibly more barren during the past 100 years. . . . In short, these deserts have undergone desertification.

--Desertification in the United States by David Sheridan (Sheridan 1981)

Desert plants' relatively small stature, brittle nature, and slow growth rate make them highly susceptible to damage. And most desert vegetation is so scarce to begin with that it doesn't take much pressure from livestock to wipe it out completely. The few palatable plants that exist are quickly eaten. The combination of grazing, trampling, low rainfall, searing wind, and hot, glaring sun on exposed ground makes for conditions unfavorable to the establishment of seedlings.



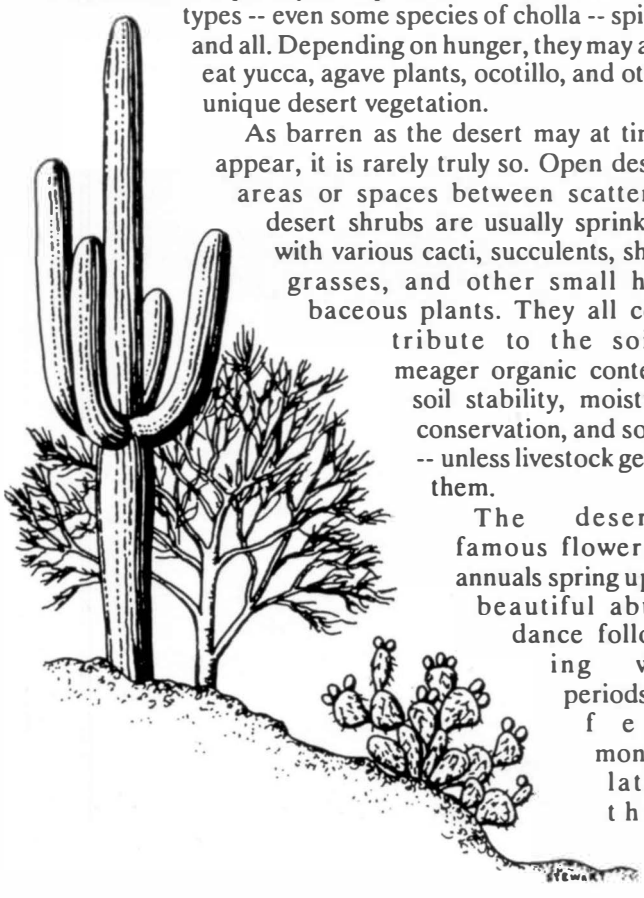
This arid region near the Paria River in southeastern Utah naturally supports only sparse vegetation, but a century of livestock has in many areas left it little or (in this case) no vegetation. *(George Wuerthner)*

This former grassland may now seem a desert, but it is more correctly a wasteland. BLM, Northern Nevada. *(BLM)*

Bare spaces left where vegetation was removed are likely to remain bare for long periods. Additionally, the combination of overgrazing and infrequent, torrential desert rains results in disastrous flooding and soil damage and erosion. These influences make it difficult even for desert annuals to survive and reproduce.

Stock tanks, corral, pens, and ramp at foot of Kelso Sand Dunes, Mojave Desert, CA, an area of 4" annual rainfall. Cattle wander the scorching sand, devouring the scant greenery; hoof prints and piles of mummified cow turds defile the graceful, otherwise beatiful dunes.

The great majority of desert plants are easily harmed by livestock. For example, studies show that cattle stepping on and eating young saguaros and some other cacti are a major cause of their decline in Western deserts (Vankat 1979). Indeed, cattle frequently trample and eat cacti of many types -- even some species of cholla -- spines and all. Depending on hunger, they may also eat yucca, agave plants, ocotillo, and other unique desert vegetation.



As barren as the desert may at times appear, it is rarely truly so. Open desert areas or spaces between scattered desert shrubs are usually sprinkled with various cacti, succulents, short grasses, and other small herbaceous plants. They all contribute to the soil's meager organic content, soil stability, moisture conservation, and so on -- unless livestock get to them.

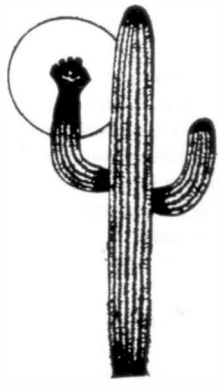
The desert's famous flowering annuals spring up in beautiful abundance following wet periods. A few months later, they may be dead and shriveled, but their dry tops and slowly decomposing roots help anchor and fertilize the soil. Over much of the desert West livestock eat *most* live annuals, thus precluding seeding, pulverizing dead tops and roots, and preventing the establishment of seedlings.

In the desert, moisture is usually inadequate to support woody increasers or invaders; when woody plants die back, a few annuals and bare ground take their place. Studies by Cook and Child show that desert plants even moderately devegetated in one season were significantly lower in vigor than those left intact, even after 7 years (Cook 1971).

Though deserts support few and small trees (mostly along drainages), these trees are vitally important. They provide wildlife with shade, shelter, food, and nesting sites that often are wholly lacking on the open desert. Underneath, their shade, wind protection, and dropped organic material create a relatively moist, cool micro-climate where many small plants and animals thrive. These, and the dense lower branches, afford "nursery" protection for small trees, immature saguaros, cacti, perennial herbs, leafy grasses, and other plants vulnerable to full desert exposure. Unfortunately, shade-seeking cattle often congregate under desert trees, killing and driving off wildlife, breaking lower branches, trampling underlying vegetation, depleting organic litter, and drying out and damaging the soil below. Because overgrazed deserts are devoid of preferred forage and browse, cattle and sheep also eat from these trees, even thorn-covered palo verde, hackberry, smoke tree, and ironwood.

Researchers studied the effects of traditional sheep grazing on 4 BLM sites in the western Mojave Desert in 1978. They found a 60%-90% reduction in the cover of annuals and a 16%-29% decrease in perennials. The sheep also caused significant soil compaction, which hampers plant growth (see Soil section of this chapter). The study concluded that "These changes indicate that the range quality of the Mojave Desert is deteriorating under sheep grazing pressures."

Studies by the US Geological Survey at the Desert Laboratory west of Tucson show that the 869-acre section of desert on and around Tumamoc Hill, fenced in 1907 to exclude cattle, has transformed from mostly creosote and a few other shrubs to a comparatively lush vegetative mosaic that includes bursage, ratney, palo verde, burro weed, prickly pear, cholla, ocotillo, grasses, saguaros, and "over 400 other species." *Even mesquite increased dramatically.* While saguaros in grazed areas of Arizona continue to decline, the 55 counted on a 100 acre study area on a flat below Tumamoc Hill in 1907 increased to 205 in 1989. Runoff and soil erosion have decreased, wild animals are provided more favorable habitat, and students at nearby Pima College are provided more beautiful scenery, though few of them realize why.



Cryptogams protect soil in an ungrazed portion of Behind the Rocks, a Wilderness Study Area near Moab, UT. *(George Wuerthner)*

. . . the Columbia Basin's unspoiled steppe has a thin layer of mosses and lichens that completely clothes the earth between the shrubs, grasses, and forbs. These minute, fragile plants dry during the summer heat and become extremely brittle. They are unable to survive trampling by sharp-hooved sheep, cattle, and horses.

--Andrew Kratz and James Kagen in "Grasslands Amid the Forests" (Kratz 1986)

Desert plants differ from those of other biotic regions in several significant ways, but perhaps the most noticeable difference is that they are spaced widely apart.. However, while the open space between plants might seem to be only bare dirt, this is rarely the case. In fact, the surprisingly fertile soil common to most arid lands is rarely directly exposed anywhere, being well-protected in several basic ways.

An important ground cover found primarily in drier regions are soil microphytic or cryptogamic crusts, better known as "soil lichen layers." These variously colored crusts are dominated by cyanobacteria (formerly known as blue-green algae), the oldest form of life known, and also may include lichens, mosses, green algae, liverworts, microfungi, and bacteria. These mutually supportive, numberless tiny plants form a "living skin" over much of the soil surface and are in essence the topsoil of much of the West. Any soil that contains a high concentration of cryptogams may be termed cryptogamic soil, but in some deserts cryptogamic crusts are extraordinarily well-developed and may represent 70%-80% of the living ground cover (Belnap 1990).

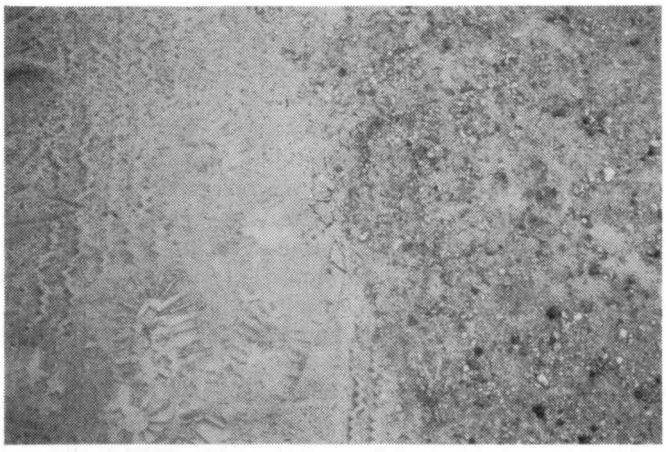
Cyanobacteria usually occur in the soil as filaments that compose an intricate webbing of minute fibers up to several inches deep which, along with other microflora, bind soil particles together and help prevent erosion. Cryptogamic carpets also infiltrate water, reduce evaporation, moderate soil temperature, trap wind-borne particles, physically and chemically create soil, bind important nutrients and keep them in upper soil horizons, fix nitrogen, contribute organic matter, provide a seed bed, and promote a wide variety of ground-dwelling animals.

Cryptogamic crusts are highly vulnerable to trampling and disappear rapidly whenever even moderate livestock grazing occurs. Thus, in most of the West, cryptogams and other small plants are found chiefly under the protective cover of larger plants and rocks, where livestock are unable to tread. Indeed, livestock grazing has destroyed more of the West's cryptogamic cover than all other human impacts combined! Where grazing is discontinued, cryptogams usually creep slowly out from their "hiding places" and recolonize exposed soil (Anderson 1982).

A loose pebblestone layer in the Sonoran Desert. Note seedlings and rabbit pellets.

In the more barren desert areas, soil is often protected by a tight surface layer of cobblestones, pebbles, or even coarse sand -- what is sometimes called "desert pavement." These inorganic protective layers are formed when smaller soil particles are blown or washed away from the desert surface over a period of time, leaving the heavier particles and/or stones as an overlayer. They serve to protect underlying soil and conserve water. With few large native animals to disturb them, these protective layers are a semi-permanent feature of many arid lands (and of some areas stripped of vegetation by livestock). Thousand-pound, trampling cattle quickly destroy them.

Even where desert soil is naturally open and exposed, Nature provides a protective covering. In these areas the soil surface itself hardens, forming a protective crust that shields it from the elements and keeps it from being displaced by wind, blowing objects, small animals, and so forth. When it rains, the crust immediately softens to allow water infiltration. This delicate soil crust is shattered by a half-ton, hooved beef as if it were pie crust.



Desert soil crust has been pulverized on left by tires and shoes, leaving a fine dust that is susceptible to the elements.

In the barren spaces between desert shrubs, the shrubs have created a spreading network of shallow roots to maximize their absorption of scant, infrequent rainfall. In many areas this web of roots just below the soil's surface is the desert's primary builder and stabilizer of soil. It is, of course, extremely vulnerable to the deeply cutting hooves of livestock.

Runoff flow is from right to left. Note smaller-grained sediments trapped behind the organic dike.

Sometimes open spaces of bare soil in the desert are sprinkled with a light covering of organic matter dropped from nearby plants. On the flat, gentle slopes common to many deserts, rainfall from intense cloudbursts runs in sheets, pushing this organic matter ahead of it, piling it into low, long, parallel "dikes." These dikes slow water runoff, enabling more water to infiltrate into the ground and minimizing sheet erosion. Later, the dikes may be gradually disassembled by gravity, wind, animals, etc. and redispersed over the soil's surface, ready to fulfill the same function once again. The larger and more sturdy of them remain to conserve water, build soil, and provide seed beds for the establishment of desert vegetation. Livestock deplete source materials and trample these dikes.

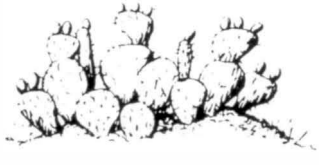
The above is just one example of the numerous unfamiliar but essential natural processes that keep desert ecosystems healthy. They go largely unnoticed, even by scientists, as do the ways in which livestock disrupt them.

(Bob Dixon)

In a nutshell, deserts are an absurd place to raise livestock. For example, on California's Mojave Desert, 108 ranchers graze livestock on 4,660,000 BLM acres of mid- to upper-elevation desert. This land -- about 5% of California -- produced 103,191 livestock AUMs in 1987, the equivalent of yearlong grazing for only 8599 cattle, or about *one cow per square mile*, about 1/600 of California's annual livestock production (while livestock production represents only 1/6000 of the state's economy). Permittees pay little more than a penny per acre per year; their livestock cause extensive damage; and taxpayers shell out more money for or because of ranching than the value of their cattle (see Chapter VII for economic details).

It takes *hundreds* of acres of desert to keep a cow alive for a year. Nonetheless, Western deserts are grazed almost anywhere there is enough forage or browse to keep a cow or sheep alive. About the only place they are not is where livestock grazing is virtually impossible -- the hottest, driest, most desolate parts of southeastern California and southwestern Arizona, and some barren dry lake beds and salt flats in the Great Basin.

Where there before existed beautiful, living desert, there now exists true *wasteland*. Grazing desertifies even the deserts.



The most widespread and cataclysmic change in the desert [of the United States] *in modern times has resulted from unrestricted grazing. . . . The desert in many places is one-tenth as productive for livestock as it was when white men first came on the scene.*

--David F. Costello, **The Desert World**

(Paul Hirt)

Conclusions: Plants

The principal cause of desertification in the U.S., as in the rest of the world, is overgrazing by livestock.

--R. Neil Sampson, **Farmland or Wasteland** (Sampson 1981)

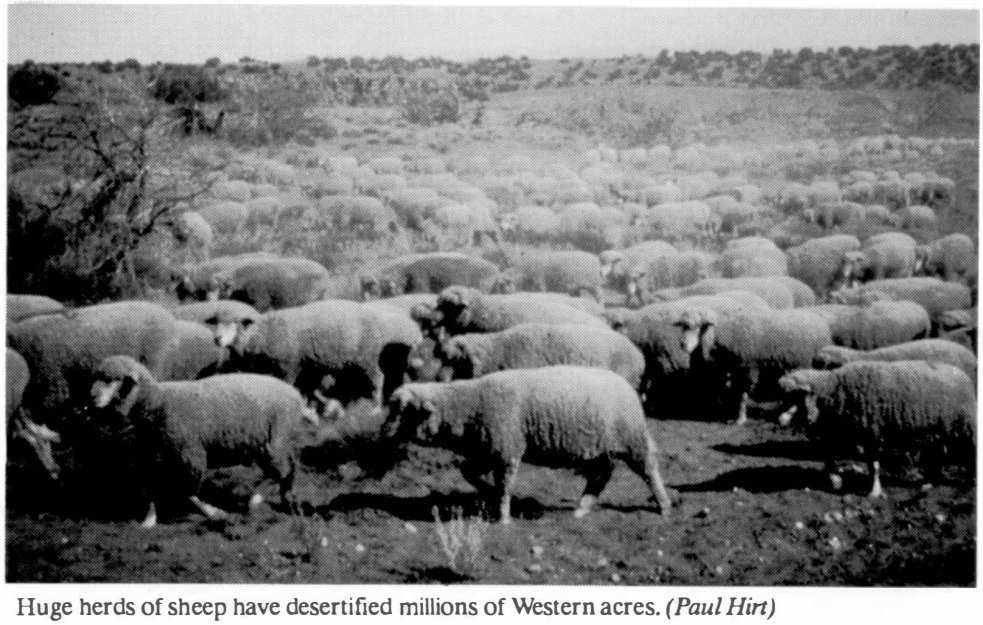
There is not an overgrazing problem, but a lack of rain problem.

--Northern Wyoming rancher

Livestock grazing has helped desertify more than 1/3 of the Earth's land surface. In the US West, it has helped desertify several hundred million acres -- *most* of the West -- converting well over 100 million acres of grassland and semi-grassland, brushland, and even forest to wasteland. Let's take a quick tour of the on-going destruction:

Only 130 years ago a great sea of grass stretched across western Texas, southern New Mexico, and southeastern Arizona. Today most of the area is basically "desert" in biological terms, often barren, and scrubby mesquite and catclaw have increased in density at the expense of other lifeforms on perhaps 20-30 million acres. The grassland and mixed grassland/shrubland of much of the Great Basin, once averaging about 80% bunchgrass and forbs to 20% shrubs and brush, has been converted into a wasteland of scraggly, broken sage, shadscale, snakeweed, cheatgrass, and tumbleweed, with a reversed ratio averaging about 20% grass (mostly exotic) and forbs to 80% woody vegetation (not including a much larger percentage of bare dirt, sand, and gravel). Most of California's once lush, grass- and flower-carpeted hills and valleys are now covered with sparse, overgrazed exotic grasses and "weeds" and bare dirt, transformed beyond recognition from their original state. The well-watered Pacific Northwest is still green, but much less so. In many areas its thick herbaceous cover has been cropped annually to near ground level, often replaced by exotics. The steppe-like grassy plains in portions of Idaho and eastern Oregon and Washington are now commonly barren and eroded. The Rockies, Sierra Nevada, and nearly all Western mountain ranges have been degraded by millions of sheep (the "hooved locusts" of which John Muir wrote) and cattle. Livestock have denuded and trampled the fragile deserts, canyons, and mountains of the fantastic Colorado Plateau of southern Utah and northern Arizona. Much of the marginally grazable true desert of the Southwest has been converted to wasteland. Likewise, the hot, barren, truly ungrazable low desert of southeastern California and southwestern Arizona is actually expanding its geographic boundaries as voracious cattle eat away at its fringes and higher elevations. And finally, the Great Plains of Montana, Wyoming, Colorado, and New Mexico today bears little resemblance to its former state in the times when great herds of buffalo, elk, and pronghorn roamed its vast, luxuriant spaces.

The grazing industry typically blames these changes on a drying climate (or sometimes plant evolution or development or road building or farmers using too much ground water or early beaver trappers eliminating beaver dams and lowering water tables or earthquakes [yes, earthquakes] or nearly anything but ranching). Climatic statistics, on the other hand, show no overall drying trend (see graphs in Air



Huge herds of sheep have desertified millions of Western acres. *(Paul Hirt)*

section of this chapter), and these other scapegoats are in truth relatively minor influences on overall Western vegetation.

Rain at the right time will make anyone look like a good rancher.
--Bill Brockman, Sawtooth NF, ID grazing permittee

As detailed elsewhere, experts in and out of the industry estimate that the Western range today is half or less as botanically productive as before the livestock invasion of the 1800s (some call it "the loss of the herbaceous component"!). For example, according to a 1990 report prepared for the US Environmental Protection Agency, "In 1980 the United States Department of Agriculture estimated that vegetation on more than half of all western rangelands was deteriorated to less than 40% of potential productivity, and to less than 60% of potential on more than 85% of rangeland" (Chaney 1990). This addresses *productivity* but does not take into account that most range plants are severely cropped down or browsed off and rarely allowed to attain full size. So the *actual* biomass of vegetation existing at any given time on today's Western range is undoubtedly far less than half that of 150 years ago.

To provide some veneer of justification and semblance of rationality for grazing public land, the ranching establishment alleges that livestock benefit Western plant communities by performing ecological functions similar to the native herbivores they replaced. This may sound good, but the influence of domestic livestock is vastly dissimilar to that of native grazers.

In natural situations wildlife are nomadic, bound by no fences or management schemes. Herds of grazing, trampling, wallowing, free-roaming buffalo and other ungulates create a complex mosaic of vegetation in varying states of recovery (though the bulk of the range remains old-growth). Periodic natural fires sweep through these plant communities, augmenting biodiversity and thus ecosystem

Plains lovegrass, a much diminshed native. *(Helen Wilson)*

Livestock desertification in northern Arizona. Adding insult to injury, the last juniper within miles has lost most of its branches for fence posts.

health and stability (see Fire section of this chapter). In contrast, managed livestock uniformly denude vegetation over vast areas, creating biotic monotones that are impoverished and prone to disease and pests. The resulting heavily grazed, homogeneous plant cover supports expansive, homogeneous fires, or more likely no fire at all.

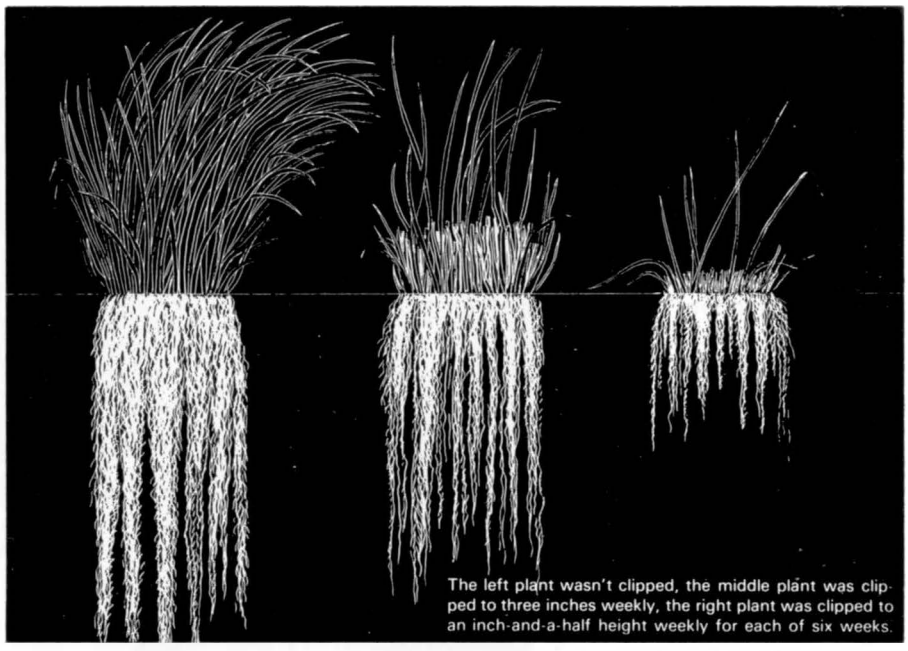
Ranchers declare that livestock are needed to trample seeds into the ground, as did native ungulates. In practice, plants frequently never make it to seeding time in the first place or are eaten before they can drop seeds if they do. Often the environment is so degraded that seeds won't sprout, and what seedlings do come up are eaten or trampled to death. Moreover, for millennia throughout most of the West trampling by large

Surrounded by unscalable cliffs, this lushly vegetated grassy area has not been grazed by large herbivores for at least centuries, indicating that grassland does not require animal impact to maintain health or essential character (trees also grow in the nearby lowlands). Badlands National Park, SD.

Bluebunch wheatgrass and scattered sagebrush on an isolated, cliff-sided plateau at the junction of the Deschutes and Crooked Rivers in central Oregon. Much of the northern part of the Great Basin probably looked a lot like this 150 years ago, before the competitive balance was shifted by livestock. *(USFS)*

ungulates was a relatively minor influence on plant regeneration.

It is true, as the industry claims, that light grazing or browsing of certain plant species at just the right time of year can sometimes cause plants to produce more overall biomass (what ranchers call *productivity*) during a growing season than if left uneaten. For example, under certain conditions gentle pruning of the older leaves of some grasses allows more sunlight to reach plants' basal growth cells, increasing photosynthesis and their overall growth. However, this relatively insignificant result is rarely achieved within contemporary livestock grazing. Rather than increasing overall plant growth, the grazing and browsing common to most of the Western range stunts or kills most plants. And the alleged increase in total production of plant fiber does not reflect higher environmental quality; indeed, livestock eat and trample many, many times more than this additional amount.



The left plant wasn't clipped, the middle plant was clipped to three inches weekly, the right plant was clipped to an inch-and-a-half height weekly for each of six weeks.

(SCS, USDA)

The industry similarly argues that without livestock to strip off a grass plant's old, dead leaves the green portion of the plant will fail to receive adequate sunlight and eventually die. While this sounds almost plausible, few plant species require the removal of old plant material to receive enough sunlight. Those that do significantly benefit from physical removal are adapted to having this procedure performed by *fire* more frequently and effectively than by native grazing animals. They are certainly not adapted to annual multiple denudations by domestic livestock.

In natural situations most wild herbivores move continuously and eat selectively, with each species specializing on a uniquely different set of plants. In comparison, domestic livestock -- bred to eat a lot and gain weight -- are lazy creatures that wander only far enough to eat and drink (or find shade or salt). Eating less selectively, they crop the plants nearest them (some say even past satisfying their own nutritional needs) beyond the plants' ability to replenish themselves. Livestock, cattle especially, concentrate in certain areas for long periods, denuding the same vegetation repeatedly in a single season. They "ambush" each new blade of grass, seedling, or leaf as it emerges or re-emerges. Eventually so little stored nutrients remain that plants cannot reach maturity, set seeds properly, or survive dormancy. The damaged plants suffer drought much more frequently because their shallow, weak roots are unable to extract sufficient moisture from the soil or compete with "weedy" species. Roots shrink to compensate for lost above-ground biomass and cause the plant to become stunted and unable to carry out essential processes; it finally dies.

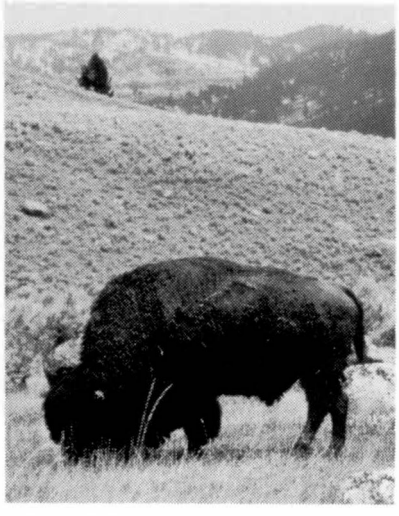
Ungrazed roadside at right is lush with vegetation and organic litter; heavily grazed plot at center supports roughly 10% as much biomass; and very heavily grazed pasture at left is nearly barren. NM BLM.

Consider for example that on most grazing allotments livestock remove 40%-90% of the above-ground biomass of most herbaceous plants at least once each year. After this drastic depletion of biomass, most native range plants require at least several years to

recover full size and health. Yet livestock defoliate them relentlessly.

For livestock to simulate the beneficial influence of wildlife, they would have to roam freely and unmanaged on an unfenced open range -- an inherent impossibility. Livestock are not American "common property" like wildlife; an unnaturally large percentage of livestock are culled each year; and most cattle and sheep would die quickly on the open range without extensive human intervention.

Cattle and sheep are ecological misfits. What worked well with isolated, drifting herds and small groups of buffalo, pronghorn, bighorns, deer, and elk on the Great Plains and other Western rangelands has not worked at all with cattle and sheep, either on the Great Plains, other grasslands, or anywhere else. The West was properly stocked with the appropriate animals 200 years ago.



(Steve Johnson)

Roughly 10% of all the land in the West has reached a state of severe desertification, meaning it has virtually lost its ability to support life. . . .

Florence Williams, "The West's Time Capsules" (Williams 1990)

Though we are led to believe otherwise, desertification continues to expand rapidly throughout most of the Western United States. In a 1981 report, the Council on Environmental Quality concluded:

Improvident grazing, or overgrazing, as it has come to be known, has been the most potent desertification force, in terms of total acreage affected, within the United States.

According to the report, about 225 million acres, mainly in the West (an area the size of the 13 original colonies) was undergoing severe or very severe desertification, while a similar sized area was threatened by desertification. An accompanying map by Professor Harold Dregne of Texas Tech University showed that overgrazing has helped increase desert-like conditions on 80% of the West, and that 36.8% of North America's dry land has suffered "severe" desertification. The report further stated that these figures probably *underestimate* the severity of loss and deterioration of soils. (Sheridan 1981, CEQ 1981) When the Reagan administration took power, distribution of the report was

LIVESTOCK GRAZING STUDY

In this century thousands of scientific (and pseudo-scientific) studies have been conducted to determine the effects of livestock grazing on Western vegetation (see bibliography). I could not begin to detail even a small percentage of these, but suffice it to say that -- even though most were conducted by ranching-oriented range professionals -- the great majority show grazing detrimental to most native plant species under most conditions, usually in direct proportion to the overall intensity of grazing. I offer the study report outlined below, "Effects of Grazing on the Vegetation of the Blackbrush Association" by Douglas L. Jeffries and Jeffrey M. Klopatek, as generally representative of many others, and more relevant than most for it includes as one of its comparison study sites an area *never* grazed by livestock:

Four communities or sites dominated by blackbrush were studied in the Kaiparowits Basin of southern Utah and northern Arizona. One site had been heavily grazed yearlong for about 100 years; the second had had 10 years of recovery from 100 years of heavy cattle grazing; the third had been lightly to moderately grazed in winter for 3 years (a new stock tank had opened it to livestock, whereas it was lightly grazed previously); and the fourth was a relict, ungrazed ecosystem -- an inaccessible mesa top (therefore, due to dryer soil and other conditions, probably inherently a less biotically productive site). Using traditional scientific methods the researchers measured the cover of different types of vegetation. Here are the results, the numbers indicating relative herbage cover:

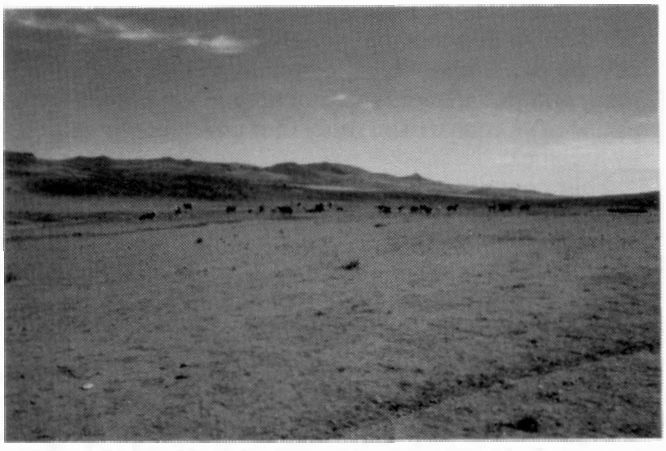
	Heavy grazing	Recov-ering	Light grazing	Ungrazed Relict
Shrub cover	**1405**	**1372**	**2874**	**3645**
Herbaceous cover	**102**	**127**	**256**	**1047**
Cryptogamic cover	**70**	**50**	**1196**	**2129**
Total cover	**1576**	**1549**	**4326**	**6821**

Jeffries and Klopatek summarized their findings: The data indicate that even light grazing may reduce the cryptogamic cover in this system, and heavy grazing almost completely eliminates it [30 times more in relict than heavily grazed]. This agrees with the findings of [many other researchers]. . . . Herbaceous vegetation cover was greatly reduced on the grazed sites as compared to the relict site [10 times less on heavily grazed than relict]. . . . The shrub cover is reduced by heavy grazing [over 2 1/2 times less on heavily grazed than relict]. . . . The relict site had significantly more total cover than all other sites [more than 4 times as much as heavily grazed], and the lightly grazed site had significantly more than the heavily grazed and recovery sites. (Jeffries 1987)

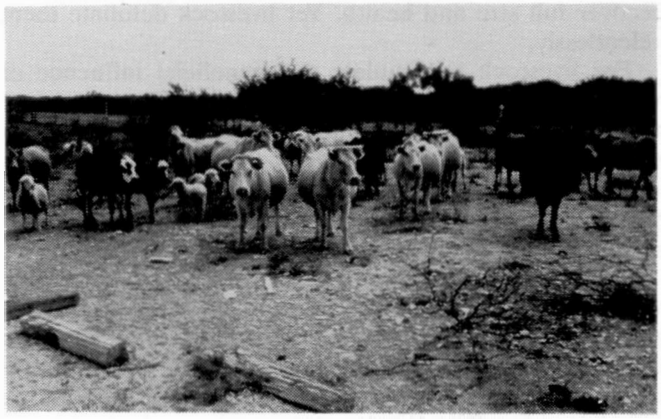
"stopped cold"; since 1982 the word "desertification" has not officially been used by the federal government in reference to US rangelands (Zaslowsky 1989).

Daniel Stiles of the United Nations Environment Programme writes, "The surest -- and perhaps only -- way to halt desertification is to stabilize human population and reduce livestock herd sizes."

Grazing and especially overgrazing [are] *still so widespread on the public lands that many say it looks as if the cows are being trained to eat rocks. . . .*
--Candace Crane, "In the Shadow of Livestock" (Crane 1989)



All-too-typical desertified range. Vale District, BLM, OR. *(George Wuerthner)*

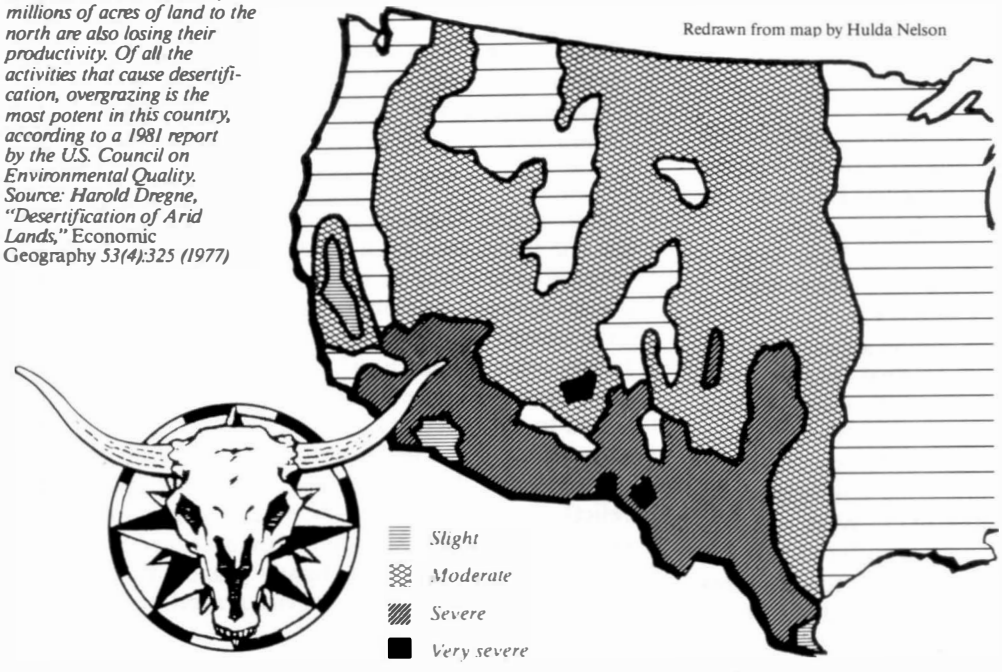


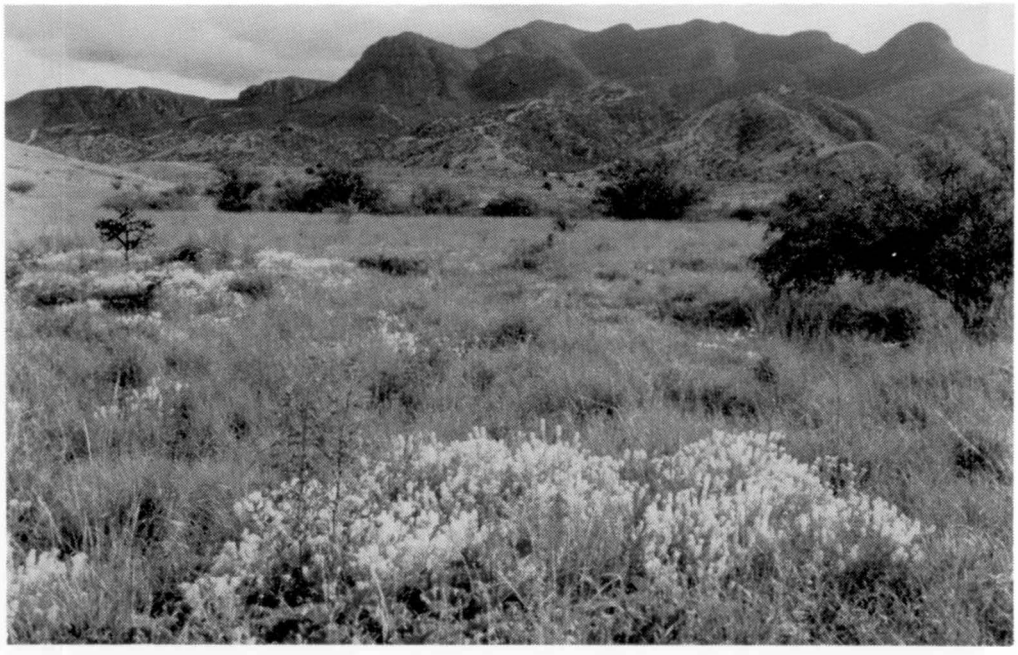
(Courtesy of Farm Animal Reform Movement)

(Courtesy of Farm Animal Reform Movement.)

The Status of Desertification in the United States

Overgrazing has helped put about 10 percent of the land in the United States, all in the West, in a state of severe or very severe desertification, according to Harold Dregne, head of the International Center for Arid and Semi-Arid Land Studies at Texas Tech University. While the most severely desertified areas are in the Southwest, millions of acres of land to the north are also losing their productivity. Of all the activities that cause desertification, overgrazing is the most potent in this country, according to a 1981 report by the U.S. Council on Environmental Quality. Source: Harold Dregne, "Desertification of Arid Lands," Economic Geography *53(4):325 (1977)*





Several decades after ranching was banned, 70,000-acre Fort Huachuca in southern Arizona can only be described as a plant wonderland -- one of the most botanically luxuriant and diverse areas in the Southwest. A short walk reveals scores of species and types of vegetation, many seldomly or never seen in nearby grazed areas.

matter is also depleted, and soil is bared to the elements -- raindrops, hail, wind, sunlight and other radiation, freeze and thaw, animal impact. Mechanically or chemically acted upon by these forces, broken apart by livestock hooves, loose soil particles succumb to gravity, or blow or wash away. (According to the US Soil Conservation Service, roughly 4/5 of US soil erosion is due to water and 1/5 to wind.)

Removal of protective vegetation and ground cover allows rain drops to hit the bare soil with great kinetic force, causing a physical displacement of soil particles termed "splash erosion." Damaged soil absorbs and retains less precipitation, leading to increases in both sheet erosion (displacement

Soil

. . . this nation and civilization is founded upon nine inches of topsoil and when that is gone there will no longer be any nation or any civilization.
--Dr. Hugh Bennett, US Soil Conservation Service

Soil is a collection of various-sized rock fragments, decaying organic matter, living organisms, atmospheric gases, and water solutions. Topsoil is the uppermost and generally most fertile soil horizon, and on the Western range is usually several inches thick.

Soil has been called "the soul of life itself." Without adequate and fertile soil, most terrestrial plant and animal life ceases. For over 100 years livestock grazing has been the major cause of both increased soil erosion and decreased soil fertility on Western public land. Most soil loss and damage is a result of livestock stripping off and trampling vegetation, though much loss and damage occurs even where vegetation remains intact.

As livestock injure and kill plants, fewer roots remain to hold soil particles together and masses of soil in place (some roots even excrete a substance that helps bind soil particles together). Consequently, surviving plants often are perched on little islands of self-protected soil/sod called *pedestals* (perhaps augmented by accumulated blowing particles captured by the plants). The scattered taproots of increasers and exotics and small, shallow roots of annual invaders do not hold the soil against the elements like the dense root masses of the natives they replace.

The soil's "living umbrella" of leaves and other plant

Wind and water erosion on overgrazed slopes in the Tehachapi Mtns., CA. *(USGS)*

of a fairly uniform layer of soil by water runoff) and gully erosion (dislocation of soil due to trenching). For example, studies by Weltz and Wood showed suspended sediment production (representing eroded soil) 30%- 950% higher on pastures under several common grazing systems than on comparable pastures where livestock were excluded (Weltz 1986).

Livestock grazing or other vegetation destruction on steep slopes can even result in "massive downslope soil displacement," as demonstrated by this short story: Several years ago my 2 young children and I lived in a rural area of central Arizona. Our little homestead was nestled at the bottom of a river valley, accessed from

Eroding hills on BLM cattle range in Campbell County, northeast Wyoming.

On the far side of the fence, within the exclosure ungrazed for 40 years, this drainage is a low, wide swale with no banks, filled with grass and other small plants. Exactly at the fenceline, where it emerges into grazed range, it becomes a barren, eroded gully.

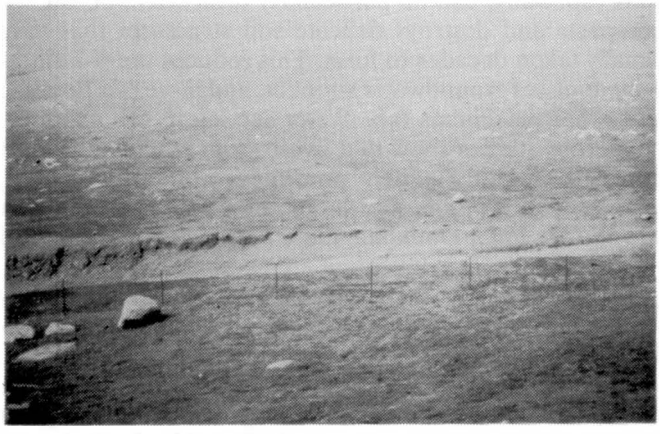
The topmost layer of soil is eroding as a broken crust from this grazed Arizona BLM range.

This expanding rim is actually the top soil layer eroding due to cattle trampling and removing protective vegetation.

above by a long dirt driveway. Not having been grazed by livestock for many years, the steep slope down which the driveway ran was well vegetated with bunchgrasses, flowering perennials, various shrubs, cacti, and many other plants.

One day the boys decided to play "slide down the hill on your butt." After an hour of this, a 5' x 10' strip had been denuded. When I found out about this, I told them that it "looked like a herd of cattle had stomped around there" and lectured them on the possible consequences. As if to prove the point, after a rainy period a couple of weeks later that section of the hill slipped right off the underlying bedrock, leaving part of our driveway under a ton of mud and rocks. Massive downslope soil displacement is caused by livestock in many areas; it is common, for example, in the overgrazed central California hills.

Trails form as cattle walk along easy and well-traveled routes, alongside fences, around obstacles, and to and from



This 1977 windstorm removed 25 million tons -- as much as 12" -- of soil from 373 square miles of overgrazed range in south-central California. *(Howard Wilshire)*

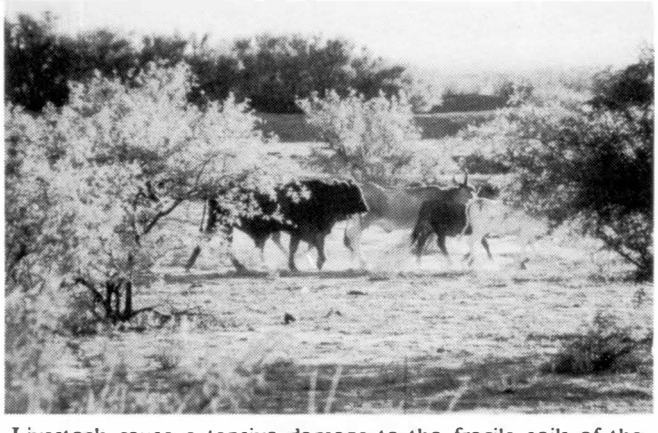
Erosion of cattle trail along fence at right has removed up to 2' of soil.

Cattle trails on degraded NM BLM range.

food, water, salt, and shade. Depending on terrain, cattle trails can be anywhere from 1 to 5 or more feet wide. On slopes they often become gullies. Cattle may then create parallel new trails, which may join together with the old to form larger gullies, and so on. Probably several hundred thousand miles of cattle trails criss-cross Western public land and comprise a barren area of well over 100,000 acres. As well as causing environmental damage directly, cattle trails provide humans and vehicles (with their harmful influences) easier access to many areas by providing avenues of travel through thick vegetation.

Old cattle trails at center eroded a large chasm; new trails are rerouted to the left and right.

With their enormous weight and cloven hooves, standing cattle exert an average pressure of 24 pounds per square inch upon the soil's surface, and this pressure increases greatly when other feet are lifted and the animal is in motion (Ferguson 1983). This, their inbred awkwardness and decreased intelligence, and their unnatural impacts make cattle (and to a lesser extent sheep and goats) ideal soil destroyers, especially on the fragile soils and steep slopes common to the West. Their many areas of congregation exhibit especially degraded soil conditions. In contrast, wild animals travel carefully and lightly over the land (in part so as not to attract predators), avoid trampling individual plants, and rarely concentrate in one place for long.



Livestock cause extensive damage to the fragile soils of the Western range. *(Steve Johnson)*

Livestock physically alter the soil itself, setting into motion destructive ecological chain reactions. They upend and scatter small rocks that would otherwise stabilize soil, conserve water, promote plant growth, and provide habitat for small animals. They overturn large rocks and send them crashing down hillsides. They churn up the topmost soil while simultaneously compacting the under layer to create a "hardpan." Soil structure -- the arrangement of soil particles -- helps determine soil productivity, susceptibility to erosion, and other characteristics. Intensive grazing, of wet soils especially, can be particularly destructive because it compacts and destroys delicate soil structures that have usually taken decades to form. This reduces water infiltration, depletes groundwater supplies, and increases flooding and other detriments (see Water section in this chapter). Numerous studies show that livestock grazing under most conditions significantly compacts soil underlayers, decreases infiltration, and increases runoff (see Laycock 1967a, Orr 1975, Dadkhah 1980, Abdel-Magid 1987, and Stephenson 1987).

Compacted soils increase water loss through capillary action. Spaces between soil particles are reduced, and capillary action pulls more water more rapidly to the surface. The increased surface evaporation from soil water solutions may leave mineral crusts on soil surfaces that harm plant life. Organic wastes from livestock also add salts to the soil and exacerbate this mineralization problem.

Intensive or protracted livestock use breaks apart and scatters the protective inorganic, cryptogamic, and organic litter layers and exposes underlying soil. Churned up and scattered organic matter, no longer matted together or interlinked with the soil below, washes or blows away, further decreasing soil fertility. Remaining organic material then decomposes faster than it is replaced, with a net loss to the soil.

Through these and other influences, and through consumption and damage of a large percentage of the rangeland vegetation that would otherwise contribute to the organic litter layer, livestock reduce soil humus. *Humus*, partially decomposed organic matter incorporated into soil, is vitally important for maintaining proper soil pH, binding soil particles together, providing nutrients to plant roots and soil microorganisms, aerating soil, increasing soil moisture-holding capacity, and limiting the topmost soil's susceptibility to heat and frost.

Soil stripped of organic matter and ground cover, trampled, compacted, and bared to the sun and wind, dries out and cannot support original plant life. The resultant

transition toward sparser, more desert-like vegetation is caused not only by an overall reduction in soil moisture but by greater *fluctuations* in soil moisture.

All these changes together kill off soil microorganisms -- bacteria, fungi, protozoa, algae, nematodes, etc. -- that would otherwise break down and recycle the chemical constituents of organic matter. Certain of these tiny organisms would also provide food for other small life, fix atmospheric nitrogen (alone or in conjunction with plant roots), form nitrates essential for plant growth, and even produce growth-stimulating substances necessary for vigorous plant growth. On healthy ranges microorganisms may occur by the billions in every cubic yard of soil; about 95% of them by weight live in the litter layer and top few inches of soil. No less important are the myriad other small soil creatures -- earthworms, mites, grubs, termites and other insects, etc. -- that would help infiltrate water; enrich, mix, and aerate soil; promote root penetration; and so on. As life-giving organic litter is depleted and topsoil is damaged and eroded, all these organisms decline.

The amount of organic material in the soil and the amount of organic litter also help determine the *color* of the soil and exposed ground surface. Livestock grazing's depletion of organic matter (sometimes in conjunction with increased mineralization, etc.) tends to cause the ground surface to lighten, intensifying reflected heat and glare (albedo), increasing aridity, killing soil microorganisms, and so forth. While darker ground may absorb more heat than lighter ground, the albedo effect, reduction of shade and protective organic cover, etc. of lighter colored grazed ground are together a much more potent aridifying influence.

Further, as livestock deplete low-level vegetation and the organic litter layer, they destroy the soil's protective, "shock absorbing" surface mat. Normally this mat functions to absorb and disperse the pressure from hooves as they thrust toward the soil and to physically shield the soil's surface from their abrasive action. When the mat is removed, pounding hooves hit the soil's surface with full force and compact subsurface layers, while their scuffling, scraping action tears apart and scatters the topmost soil.

By compacting the underlying soil, trampling also directly reduces soil aeration, slowing the flow of necessary oxygen to roots and soil organisms and of carbon dioxide back out to the soil surface. These exchange processes are imperative to a healthy biosystem, as is illustrated by the death of plants and soil organisms in waterlogged soil. Rainwater may accumulate on the surface of damaged soils, compounding these problems and causing others, including again increased surface mineralization.

Between storms, plant roots tend to deplete moisture in the topmost layers of soil, thereby increasing the soil's capacity to absorb and infiltrate storm water that would otherwise run off. Some ranching proponents maintain that heavy grazing thus reduces drying of the topsoil by reducing root biomass. In truth, overgrazing's other environmental detriments are far greater soil-drying influences.

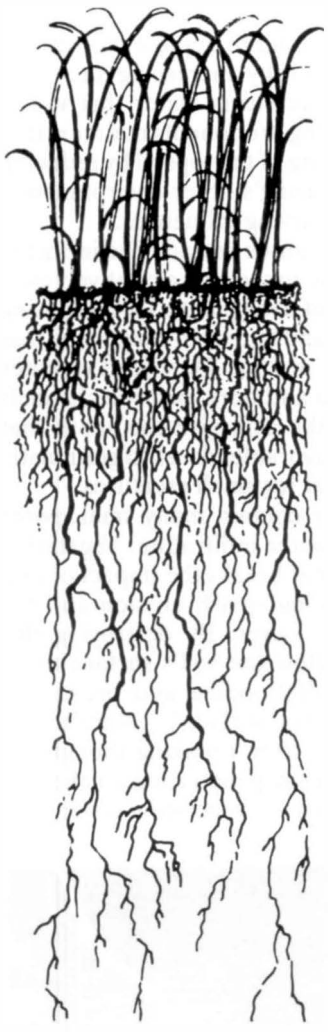
Continued livestock grazing causes a steady decline in the number and size of plants on the range, and a relatively even greater decline in the biomass of *dead* plants. Decomposing roots supply much soil humus, and humus to deeper soil that would otherwise lack organic matter. They feed termites and other soil-enhancing fauna and flora, provide channels for water infiltration, aerate the soil, give the seeds that settled into their empty holes favorable places to germinate, and create subterranean habitat for small creatures.

Most soil surfaces naturally contain many small pores that permit soil aeration and water infiltration. Vegetation provides a protective canopy that breaks the impact of rain on the ground, thereby retarding splash erosion and the clogging of these soil surface pores. By destroying this protective canopy, livestock allow the soil's surface to be "sealed," thus increasing runoff flooding and preventing aeration. When dry, this sealed soil surface becomes a hard crust which prevents seedlings from breaking though the soil's surface or their roots from penetrating to the soil below, which in turn further reduces vegetation cover.

Intact lower branches help trap organic matter that otherwise would wash or blow away, creating rows or piles of debris that serve important ecological functions. Livestock commonly break off and trample to pieces lower branches of trees and bushes.

Leaves, twigs, other fallen plant parts, and living plants themselves slow the velocity of low-level air flow and rainwater running over the soil's surface. This reduces wind erosion and allows water more time to infiltrate the soil and augment groundwater reservoirs. When livestock deplete vegetation and organic ground cover, few obstacles remain to slow wind and overland flow of water.

Similarly, as rainwater runs across the surface of the land it carries loose organic matter along with it. This debris accumulates against plants and other obstacles, forming low piles that act as small check dams to further slow runoff.

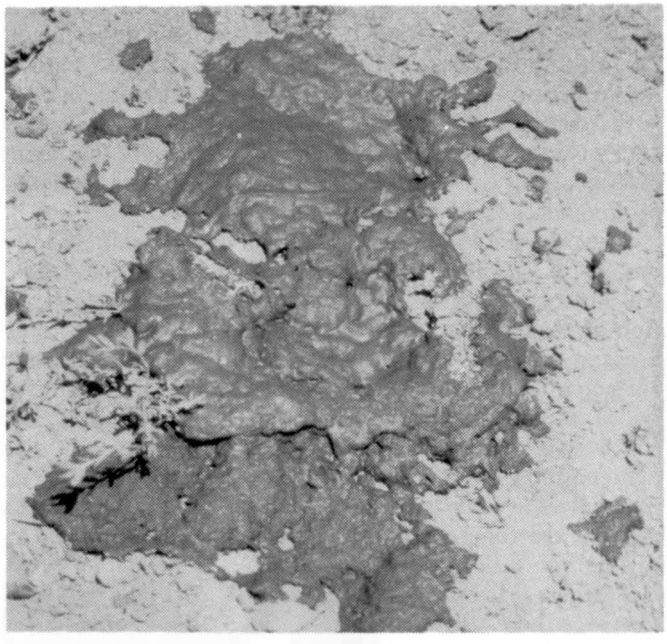


Later, they help build soil, conserve moisture, provide insect and small animal habitat, and so on. The loss of ground-level vegetation due to livestock grazing results in less organic debris, as well as more debris loss through flooding and erosion, leaving a greater percentage of exposed soil.

The above factors and others together may alter the soil's chemical and mineral composition, further decreasing fertility and once again affecting other interrelationships. Overgrazing-induced soil changes may also cause essential soil nutrients to be lost to the atmosphere as gaseous emissions. And in some areas increased runoff carries away nutrients important to plant growth (Schlesinger 1990).

According to ranching promoters, the manure left by livestock is an essential source of organic matter and soil fertility. What they invariably fail to mention is that *much more organic matter and nutrients are lost than returned*. The organic material left by livestock contributes many times less in organic weight and most soil nutrients than if it were left in herbaceous form. For example, less than 1/4 of the nitrogen consumed by range cattle is returned to the soil with manure (Hur 1985).

As livestock deplete vegetation and organic matter, they also retard soil formation. Less plant roots exist to break apart rock fragments. Decreased soil moisture impairs chemical and biological soil-forming processes. Reduced soil microorganisms mean slower breakdown of soil particles and less soil organic material.



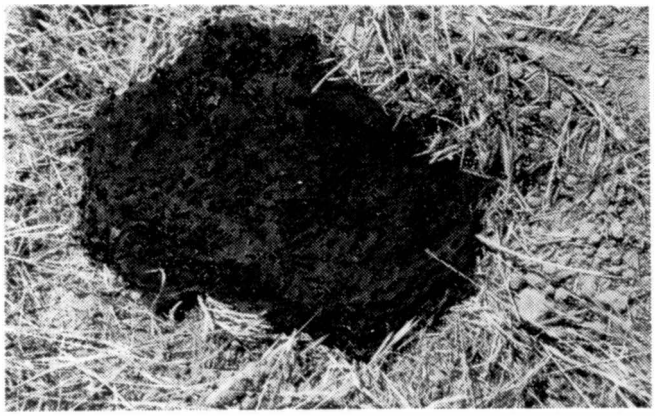
Cattle defecate about 12 times and 50 pounds per day. Their offerings vary greatly; due to disease, parasites, and other problems, many are liquid in form.

The luxuriant diversity of grasses and flowering plants in the livestock-ungrazed portion of Badlands National Park, SD, produces dark, moist, relatively fertile soil.

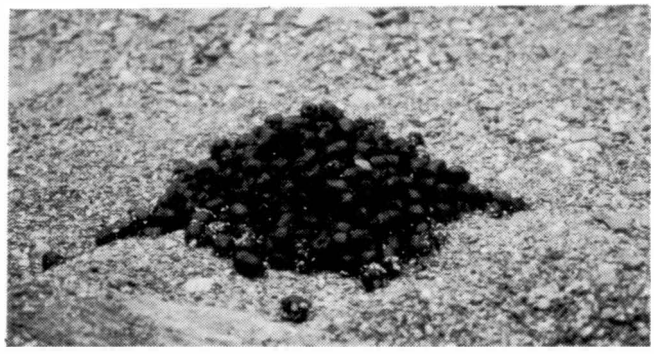
Cow flops, in contrast to nearly all other Western herbivore droppings, are produced moist (they are 85% water) and quickly lose ammonia (a gas containing nitrogen) to the atmosphere. In the arid to semi-arid conditions common to the overgrazed West, cowpies dry rapidly in the sun and heat up, killing the bacteria and fungi that would normally speed decomposition; they often remain intact for years. The large, flat, dry cowpie also kills the grass beneath it, whereas the fecal pellets of other dryland ungulates are smaller and roughly spherical. According to Paul Ehrlich's **The Machinery of Nature**, "Rather than tending to create a 'fecal pavement' as cattle droppings

do, the pellets are readily broken down by decomposers, returning the nutients to the soil" (Ehrlich 1986).

As with all mammals, much of the biomass eaten by livestock is lost because it is converted to heat (a cow produces about 3500 Btu/hr) and motion by the animals' bodies. However, most livestock bodies themselves are taken from the range after a year or two, rather than being left there to die, decompose, and be recycled. Nutrients such as nitrates and phosphates are often already scarce in rangeland soils but, according to B.K. Watt and A.L. Merrill in "Composition of Foods," for each kilogram of choice grade beef from a whole carcass with bone (raw), 7.9 grams of nitrogen, 1.1 grams of phosphorus, and 0.55 grams of potassium (among other nutrients) are lost to grassland ecosystems.



Flat, wet cowpies tend to smother vegetation.



Wildlife pellets are easily scattered and provide more available nutrients.

In most natural situations the surface of soil is *uneven*, that is, there are numerous protrusions and concavities (they differ from soil pores discussed above). These irregularities come in many forms and sizes. Many result from plants pushing up and building small mounds of soil around their bases and thereby in effect creating depressions in the spaces between. Other irregularities are animal burrows, worm and insect holes, and footprints, scratchings, diggings, wallows, dirt baths, mineral and salt licks, and other effects of animal activity. Live roots often push up the soil's surface and dead ones cause it to subside. Cracks appear in drying soil. Cobblestone, pebblestone, organic litter, and soil lichen layers provide irregularity. Running water, hail, lightning, chemical action, falling tree branches, rolling rocks -- many things can cause uneven soil surface. In addition, plants, rocks, branches, bones, and other objects are themselves a form of surface irregularity.

These irregularities serve important ecological functions. They slow water runoff and aid infiltration, help break ground-level wind, improve habitat for small animals, provide openings for seeds to enter the ground, and promote eco-diversity. In especially barren areas small depressions collect water, topsoil, and organic matter that would otherwise blow away, creating seedbeds for the seeds that also settle into them. These small mounds and ruts also function as "intakes" and "outlets" for water and air as part of the soil-air interface. During heavy rain, as water runs into depressions and sinks into the ground, displaced air within the soil moves to the tops of mounds and escapes into the atmosphere. Without protruding surface irregularities to release soil gases and equalize pressure, incoming water forms a uniform toplayer over these soil gases, decreasing infiltration while increasing runoff and soil erosion.

Though trampling by livestock may initially create an uneven soil surface, in the long run it has just the opposite effect. Soil structure collapses. Once the earth is stripped of vegetation and natural irregularities are reduced by trampling, then gravity, wind, and rain level the trampled dirt, usually within weeks or months. With fewer plants, animals, and healthy soil protective layers to form more *permanent* irregularities, soil simply flattens out over time, leaving the all-too-familiar "cowburnt" landscape. Extreme cases of overgrazing on clay soils have resulted in billiard table-flat and bare landscapes.

Some stockmen advocate intensive and frequent grazing, thinking that by maintaining a constantly disturbed soil surface they can offset the detrimental effects of heavy grazing. Scientific studies and actual grazing practice demonstrate that this simply does not work. Instead, the surface protrusions and concavities created by frequent livestock trampling are constantly destroyed and reformed, nullifying most of their potential benefits, while intensive grazing depletes vegetation, increases soil erosion, and all the rest.

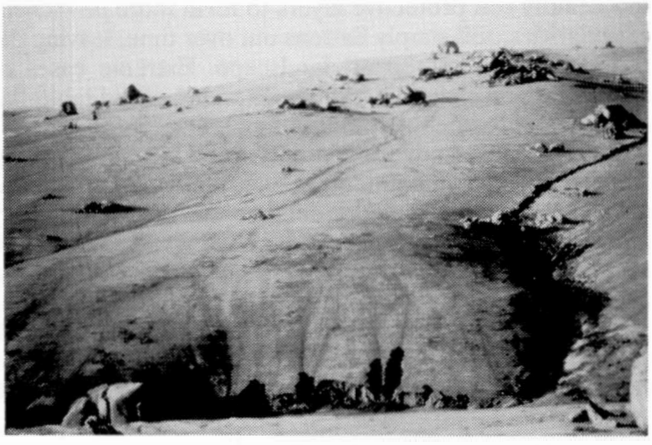
When overgrazed soil loses its ability to support vegetation, vicious circles ensue; one aspect involves accelerated soil erosion. Unprotected from the elements, topsoil experiences higher and lower temperatures than before, and its surface is loosened by daily expansion and nightly contraction, especially during hard freezes. This loosened soil is much more susceptible to wind and water erosion, and on steep gradients this topsoil seems to "melt off" in a rain. Beneath the soil surface, less organic matter and roots exist to form small air pockets and buffer underlying soil from temperature extremes, causing soil organisms to die and soil structure to decline. When root systems shrink or die, they provide fewer pathways for water infiltration, increasing runoff and erosion, baring more dirt. Hotter topsoil increases evaporation, which increases upward water movement via capillary action, which then increases evaporation.

More radical temperature fluctuations adversely affect surviving plants and animals. For example, denuded, sun-baked soil may become hot enough to "scorch" or stunt seedlings, vines, and other sensitive ground-level vegetation. More extreme soil temperatures kill or drive off moles, earthworms, termites, insect larvae, and other soil creatures

that would have served to mix and aerate soil, aid water infiltration, and break down organic matter for use by plants. Roots in the upper soil are likewise more susceptible to injury from temperature extremes. In most plants, roughly half of the "action" occurs below ground, and in many as much as half their overall weight is roots.

Topsoil humus helps to physically retain water, so less organic matter means less soil moisture. Less humus in the soil also means less space between soil particles, leading again to increased upward water capillary action, more evaporation, and drier soil. Dry soil is affected by the various forces of chemical decomposition at different rates than previously, causing detrimental changes in soil nutrient content and availability and negatively affecting dependent plants and animals. The resulting decrease in numbers of, say, burrowing animals leads to reduced water infiltration and organic matter to lower soil levels, causing plant roots to concentrate nearer the surface. Plant life, now stunted and more susceptible to drought, dies back, and soil erosion further intensifies.

This leads inexorably to other effects, which in turn lead to still others . . . *ad infinitum*. Government statistics and grazing industry disseminations obscure the seriousness of the problem.



Severe grazing and erosion in central California hills. *(Howard Wilshire)*

On July 21, 1915, when both areas [study areas in Utah's Manti National Forest] *had been protected from grazing since August, 1914, a heavy rainstorm occurred in which area B received approximately twice as much precipitation as area A; but only about one-twelfth as much run-off and one-ninth as much erosion was recorded from area B as from area A. On August 5, 1916, area B was grazed closely by sheep, area A being at that time ungrazed. Late in the day of August 5, a rainstorm occurred in which both of the selected areas received an average of 0.25 of an inch of rain. Practically the same amount of run-off was recorded from the two areas, and the erosion from area B was one- half that from area A. . . .*

Since grazing was the only factor changed as compared with all previous records, it appears safe to conclude that the change in the ratios of run-off and erosion showing a marked increase in erosion on area B was due to grazing.

--A.W. Sampson, "Range Preservation and Its Relation to Erosion Control on Western Grazing Lands" (Sampson 1918)

The overall rate of topsoil erosion on public land may have, as claimed, decreased over most of the West since the initial grazing mania of yesteryear. This is largely because the most susceptible topsoil eroded first. But topsoil erosion is still extreme, even by the government's own reckoning, and especially so considering that the US Soil Conservation Service (SCS) estimates that *less than half the West's original rangeland topsoil remains*. In other words, there is now less than half as much topsoil to erode *from*. It's like the difference between losing $1 when you have $6 compared to losing $0.75 when you have only $3.

A similar critical factor often overlooked is that erosion removes the most productive soil first. Generally, the closer to the ground's surface soil is, the more available nutrients, organic material, and living things it contains. The top few inches of soil contain the vast bulk of organic matter and much more available nutrients and living things than do layers below. Losing the topmost few inches of soil to erosion is like losing many inches of soil below it. After the best soil is depleted, soil erosion may continue at a high rate even without continued livestock grazing. Since the most fertile soil generally occurs in conjunction with and is produced by thick grass and herbaceous plants -- and these are the very plants most sought out and consumed by livestock -- the best soil has been the most abused, eroded, and prevented from regenerating. Livestock are like roving topsoil terminators!

Also, though the rate of soil erosion by weight per acre is generally higher in the East than West, and higher on farmland than on rangeland, there are several reasons why soil erosion is even more of a problem in the West than in the East. First, the East -- especially Eastern farmland, where soil erosion rates are the highest in the US (largely due to higher rainfall) -- has far more soil to lose. Even if it lost many times more soil than it already has, it would still be in generally better shape soil-wise than the West. For example, according to SCS, "Unlike cropland, which can bear an annual soil loss of up to 5 tons per acre, the more fragile rangeland soils can tolerate an erosion rate of no more than 2 tons per acre" (USDA, SCS 1981). The West, its public land in particular, is so thinly covered with soil that much of it is already down to sand, gravel, or bedrock. Additionally, since in most plants roughly half the "action" occurs below ground, the reduction in the actual *volume* of soil leaves less room for roots, thus limiting the size, species, and type of plants.

Second, because of all this, soil erosion on Western public land has a relatively greater impact on native wildlife*, community watersheds, recreational values, and the like. Third, soil is generally *created* much faster in the East than West -- perhaps an average of 2 or 3 times faster. Fourth, there is more than twice as much non-arable grazing land as there is cropland in the United States. In the West, 525 million acres are grazed, compared to only 66 million acres farmed (mostly for livestock feed) -- 8 times more rangeland than cropland (US Dept. of Com. 1986). And fifth, grazing land produces scores of times less food value per acre than does cropland, so grazing's "justification factor" is vastly lower. (All of this is in no way intended to belittle the serious soil erosion problem in the East.)

* "Wildlife" in this book may refer to native animals *and* plants.

Non-arable grazing land suffers even more acutely from soil erosion and degradation than cropland does. . . . Over 2/3 of the nation's non-arable grazing land is sparsely vegetated Western rangeland. Little of the remaining 1/3 has an extensive vegetational cover. Rangeland receives almost no fertilizer or irrigation water to enhance its vegetational cover. So, when cattle denude it of over 50% of its vegetation -- and many cattlemen allow their animals to consume 80%-90% -- the land becomes virtually defenseless against erosion.

--Robin Hur, "Six Inches from Starvation" (Hur 1985)

In the US, Nature creates topsoil at an average rate of roughly 1 inch per 100 years, or 1 1/2 tons/acre/year. Under ideal conditions (in warm, humid grassland for example), the rate may be as high as 1 inch per 30 years (5 tons/acre/year), while under poor conditions (most Western rangeland for example), it may take several hundred years or more to produce an inch of topsoil (less than 1/2 ton/acre/year). (Pimentel 1976)

On healthy forest and range, soil erosion is minimal -- usually less than 1 ton/acre/year -- and for millions of years soil creation and erosion generally kept an equilibrium. But now SCS reports an average US topsoil erosion rate of 4.2 tons/acre/year for grazed forest and 3.1 tons/acre/year for grazed rangeland. (USDA, SCS 1981) Considering that Western grazing land is generally the least productive topsoil producer in the US and is already heavily damaged, it is safe to assume that most of the Western range is producing topsoil at far less than 1 ton/acre/year. In other words, Western rangeland is losing topsoil, mostly due to ranching, at least 4 to 5 times faster than it's being replaced. This is a conservative estimate; reports by food production expert David Pimental suggest that range soil is actually eroding roughly 20 times faster than it is being replaced.

Additionally, the subsoil in some parts of the West is prehistoric; that is, it developed in large quantities thousands of years ago during long periods of humid climate and abundant vegetation. Likewise, the deep aboriginal soil in many Western valleys is the result of thousands of years of silt deposition by natural floodwaters. These deep ancient soils are vitally important to many ecosystems. When this "reservoir" of soil is depleted, it cannot be replaced until the climate changes again.

1. The soil levels indicated by alluvium remnants in thousands of canyons in southeastern Utah represent what the canyons looked like barely a century ago. All the cutting and soil removal has taken place since the relatively recent pioneer occupation of the region. 2. One century of domestic livestock grazing in southeastern Utah has largely destroyed 4,000 years of natural soil-building alluviation in the region.

--F.A. Barnes, naturalist and author, *High Country News* (2-29-88)

Gully erosion on cattle range.

Sediment loosened by livestock is carried steadily downward away from its origin.

A fenceline demonstrates how potent livestock grazing is as a cause of soil erosion. The right side of the fence has been very heavily grazed by cattle for many years, the left side "only" heavily grazed (it too has lost much topsoil). Note lush vegetation on fenced roadside in foreground. BLM/state land, Grant Co., NM.

In a fine example of livestock industry misinformation, an article in *American Cattle Grower* stated that increased soil displacement caused by cattle actually *benefits* the West by leveling out uneven terrain and depositing eroded sediments in lowland areas, thereby creating more usable flatland! (Ferguson 1983) As if things aren't bad enough, how many stockmen are out there actually *trying* to increase soil erosion!?

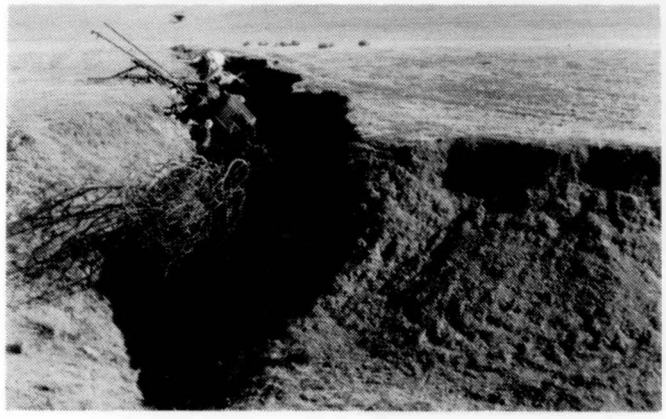
Experts estimate that in the past 200 years human activities have depleted **75%** of US topsoil, about **85%** of this to the feet of grazing livestock or to the production of livestock feed. This loss represents a steady decline in environmental potential with each passing year. In the US only farming, which *intentionally* manipulates soil, outranks grazing as a cause of soil erosion and damage. Ever since Europeans arrived, in most of the West livestock grazing has been the major cause of soil displacement, loss, and damage. Even the BLM states that 40% of its land is seriously eroded (likely an ultraconservative estimate). (Ferguson 1983) More than 5 billion tons of US topsoil erode each year, and half a billion tons blow and flow off public land, mostly due to ranching (Akers 1983; USDA, SCS 1981). In sacrificing 41% of the West thusly, the public receives an insignificant 3% of national cattle and sheep production.

What this all adds up to is bad news for public land. There is less soil now than for millennia past, and this loss is compounded by soil degradation. Some desert areas are now only *1/10* as productive for livestock as they were when stockmen arrived in the West (Sheridan 1981). Even the most well-watered Western rangelands have lost large percentages of topsoil and soil fertility to livestock grazing.

(Ginny Rosenberg)

The damage that began in the 1800s, and which continues to this day, has so changed the land that it should not be called grazing, but mining. Over vast areas of the West, the soil is gone. Viewed in the human scale by which we measure civilizations, such soil has become a non-renewable resource. It has been mined.

--Steve Johnson, SW Rep., Defenders of Wildlife (Johnson 1985a)

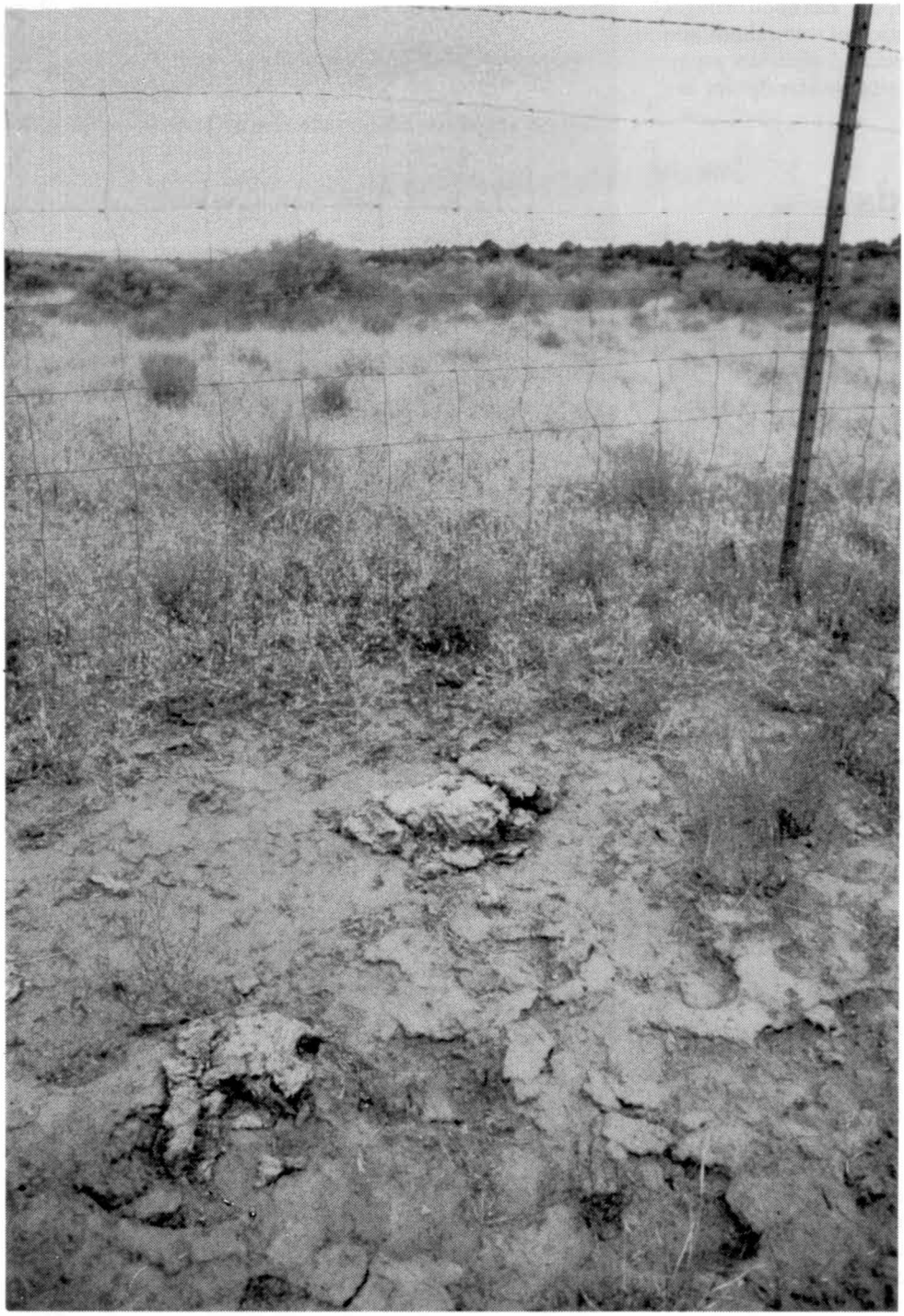


Ranchers dump junk into gullies to help stem erosion.

Ranching's geologic impact goes beyond soil, however. Soil is mostly decomposed rock. In the long run rock is not static and dead, but an inextricable part of life on Earth. Substantial evidence suggests that though rock life seems motionless on the human scale (avalanches, earthquakes, and volcanos excepted), over the millennia rocks exhibit many of life's properties, even a certain consciousness. If geologic processes were sped up millions of times, we could see rocks being created, changing, interacting with their environment, "dying," and reforming, all with a pattern and sense of purpose similar to biologic lifeforms.

Though modern humans may not understand, many of their activities are altering these geologic processes, to the short- and long-term harm of other environmental components. For example, by decreasing soil formation and increasing erosive flooding, livestock grazing has reduced or removed much of the fine-particled alluvial soil (bottomland) from most Western floodplains. Some of this soil would have eventually been deeply buried and over eons turned into fine-grained sedimentary rock. But where it has been replaced by sand, gravel, and rocks, sandstone and sedimentary conglomerates will form instead. Because these two classes of rock possess differing properties, when they finally reappear at the Earth's surface they will have differing effects on the biosphere and character of the land. Finer-grained sedimentary rock usually provides a more fertile parent material for new soil, for example.

These possible scenarios are of course speculative, but it is certain that the great changes wrought by livestock grazing on Western soil formation, erosion, deposition, composition, mineral content, and so forth over time represent a substantial influence on the inorganic Earth, and thus the organic Earth. Our actions today will affect the condition of the planet far into the future.



The soil of the Western range is being treated like dirt. Cattle exclosure on far side of fence.

Water

Along with vegetation and soil, livestock grazing has severely affected what many people call the West's most essential element -- water. Water quality has suffered greatly, but more serious harm has been done to the *amount* of water absorbed, retained, and released slowly as surface flow.

This vast reduction in "the water supply" has been brought about mainly in 2 ways -- (1) degradation of watersheds and (2) damage to waterways and associated riparian areas. Most important from a strictly quantitative standpoint are the watersheds.

Watersheds

Livestock grazing operations have severely damaged or destroyed more pristine watersheds in the West than all other uses of the land combined.
--Edwin G. Dimick, **Livestock Pillage of Our Western Public Lands**

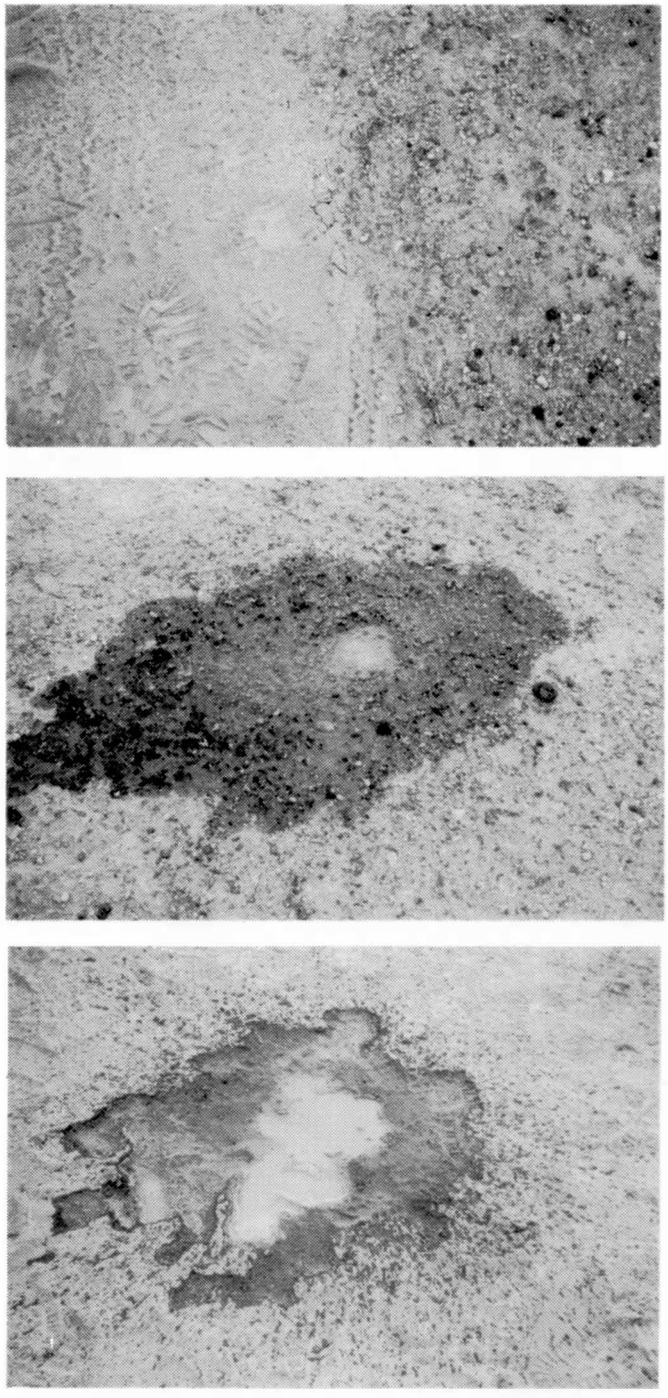
This here crick used to run, but it don't no more.
--Rangeland old-timer

To understand how watersheds affect surface water quantity, it is first necessary to understand the basic underground water system, which contains more than 99% of all unfrozen fresh water and is the source of most surface water. As water percolates down through soil layers, it enters permeable water-bearing strata of rock, gravel, or sand called *aquifers*. Some aquifers retain water in one place for long periods. But most aquifer water flows slowly diagonally downward roughly parallel to the slope of the land, eventually to appear as base flow for springs, streams, ponds, or lakes. Other aquifer water joins the large underground reservoirs of lowlands, where it may give rise to meadows or marshes, water deep-rooted plants, keep subsoil moist during dry seasons, and so on.

The *water table* of any area is the depth below which the ground is saturated with water. Water table levels depend on the amount of water absorbed into the soil and the amount of water allowed to escape back out through surface flow and/or evaporation. Nearly every place on Earth has ground water at some level below the surface.

A *watershed* is a particular area that drains into a creek, river, lake, other waterway or dry channel -- in other words, a drainage area. On a topographical map a typical watershed resembles the twigs, branches, and trunk of a tree, the trunk being the main drainage.

The three-dimensional watershed can be imagined as a funnel made from very thick, absorbent material. As sprinkled water hits the funnel's surface, most of it is absorbed quickly into the porous material and carried slowly downslope toward the neck of the funnel and gradually down the spout. Little water actually flows along the surface unless the sprinkle turns into a lengthy downpour. After the sprinkling stops, by far most of the water is retained within the absorbent material itself; gravity works it slowly toward the spout, while capillary action brings a lesser amount to the surface to evaporate. In watersheds, water that does flow



A photo (top) taken after a weekend camp-out on the range shows trampled dirt on left and undisturbed dirt on right. A quart of water poured onto the undisturbed ground had infiltrated into the soil several seconds later when the middle photo was taken. A quart poured onto the trampled ground was still largely puddled several seconds later when the bottom photo was taken; on sloping terrain, this water would have run off. Note soil displacement from splash erosion in bottom photo; on sloping terrain, much of this soil would join runoff.

along the surface and in waterways is slowed and infiltrated by organic litter, accumulated debris, fallen trees and branches, and living plants. Additional moisture is stored within all organic matter itself, and the soil's cover of dead plant material minimizes evaporation from the surface.

Livestock grazing is like throwing a sheet of plastic over a watershed. Organic matter that formerly slowed surface flow, stored moisture, and checked evaporation is eliminated. Studies show that depleted, damaged vegetation is less able to reduce runoff, shelter moist soil and snow from sun and wind, trap blowing snow, and in general preserve moisture. By damaging vegetation, drainages, soil protective layers, and the soil itself, livestock have destroyed the "sponge" that before soaked up and stored most of the West's precipitation.

Livestock damage watersheds, causing more runoff and flash floods. *(Bob Dixon)*

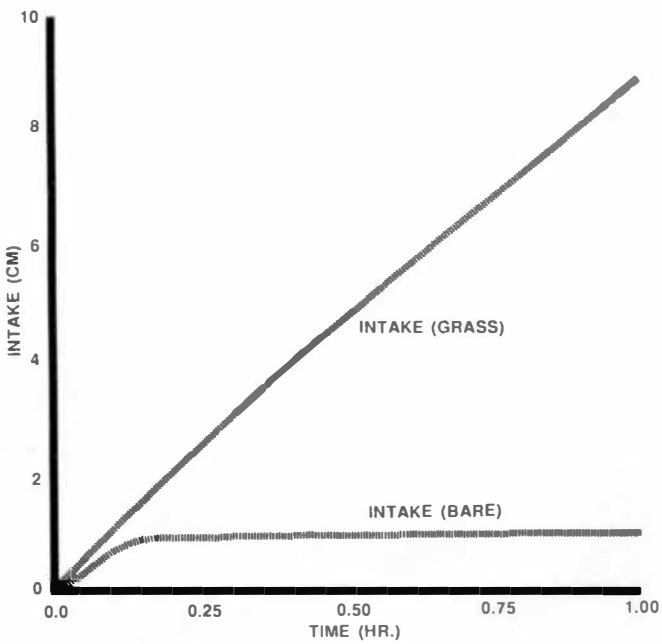
Thus, water that previously infiltrated into groundwater supplies to be released slowly as surface water throughout the year now runs quickly off watersheds, into and through waterways, and eventually into the oceans. As a result, the West's water storage capability has been tremendously reduced. Most watersheds have been rendered less productive, thousands of them greatly so.

> *We know that 150 years ago the area's* [southeastern Arizona's] *streams were all perennial, and the only thing that has caused the change is the destruction of the watershed by grazing.*
> --Grassland ecologist Carl Bock (Crane 1989)

When stockmen seized the West and livestock numbers skyrocketed in the late 1800s, water tables immediately began dropping in most grazed areas. Steadily since then *many thousands* of surface waters have vanished -- a greater relative percentage of them, of course, in drier areas where they were most needed. Thousands more now flow only intermittently, and so has every Western river been reduced in flow. All this is at the expense of environmental quality and agricultural, industrial, municipal, hydroelectric, recreational, and other human use.

Again, there has been no overall drying trend in Western climate during the past century to bring about these changes (see Air section of this chapter). While other factors -- notably groundwater pumping for agriculture (mostly for livestock production) and urban growth, irresponsible logging and mining activity -- have depleted Western water, by far the major force exhausting Western water sources has been and remains livestock grazing.

In 1600 B.C., Emperor Yu of China said, "To protect your rivers, protect your mountains." In the Western US, nearly all of the major waterways and 3/4 of the water supply for humans originates in National Forests -- generally the highest elevation lands in the West. But the grazing industry has not appreciated the importance of protecting these watersheds. To the contrary, ranchers manage most of these areas as livestock pastures, and some misguided or crafty stockmen actually promote heavy grazing in mountains, alleging that stripping off the ground cover will increase runoff to lower elevations, thereby increasing water available for human use.



Water infiltration at Santa Rita Experimental Range, Arizona, 1975. According to soil scientist Bob Dixon, "Grazing down to bare ground reduces infiltration to just 1/10 of what it was with a grass cover."
(Source: Dixon 1978)

> *In the 1930s, Trout Creek on the eastern slope of the Colorado Rockies disappeared. When I first saw it in 1937, a widening network of gullies fed into a dry streambed. On a return trip to the watershed in 1974, I noticed a striking difference: vegetation was filling the gullies, beaver dams stretched across a beautiful clear stream. What had happened? In the main, the Forest Service had removed several bands of domestic sheep that grazed the watershed.*
> --Noel Rosetta, "Herds, Herds on the Range" (Rosetta 1985)

Surface Waters

This awkward attempt to compare the value of healthy flowing streams alive with native trout and all their food chain, the welcome shade of the over-bending willow, and the smile of the buttercup; the scarlet gilia yielding under the soft foot of a furtive mule deer -- with the bawl of an auction-bound steer, shows what stratagems a land manager must adopt to justify restoring our native heritage.

--Janet O'Crowley, Chair, Board of Directors, Committee for Idaho's High Desert

A spring on BLM land in the mountains of White Pine County, north-central Nevada. How would you like a drink of the water?

As mentioned, livestock congregate around water, generally in greater concentrations, more frequently, and for longer periods than did native herbivores. Their excessive grazing and incessant trampling turn many riversides, creeks, springs, lakesides, marshes, wet meadows, sinkholes, bogs, bottoms, and otherwise moist areas into veritable quagmires. Ponds and small lakes are particularly susceptible, in large part because they usually have little flow to replenish them and dilute water-borne sediments, urine and manure.

Recently I visited Indian Spring southwest of Mono Lake. The willows had been trampled nearly to oblivion, and the spring itself was a muddy morass of hoof prints.

--The late David Gaines, Mono Lake Committee, Lee Vining, CA

Throughout the West livestock hooves annually churn springs, seeps, and other wet areas into mush, over time causing subsurface changes that physically block outflows. In many cases, trampling spreads water thinly into multitudes of hoof holes, dissipating flow and allowing water to become stagnant, reducing its availability and presenting health hazards to native animals.

Livestock's destruction of plant life around springs reduces or halts springflow. In a natural situation, plants help shelter springs, clean the water, and enrich, stabilize, and mechanically build up finely particled soil; through capillary action the plants draw underground water higher in relation to the levels of surrounding areas and increase outflows. Roots provide channels for water to rise to the surface. Unfortunately, vegetation around springs is typically eaten to nubs by livestock, beaten down and largely destroyed. Roots are mashed or scraped from the ground. Soil is often damaged and badly eroded, reducing plant biomass and lowering water retention capacities. Most livestock-impacted wet areas are trampled, barren mud, baked by the sun, and often highly mineralized.

Thus, in these ways, and especially through lowered water tables, over the years tens of thousands of Western springs have been depleted or eliminated. Although in most cases it is nearly impossible to conclusively document decades of livestock grazing as the cause, circumstantial evidence is overwhelming; indeed, livestock grazing has been the only significant human influence where most of these changes have occurred.

Unlike any other large native ungulates in the West, cattle stay around water indefinitely, or until the depletion of herbage forces them elsewhere. *(Bottom photo courtesy of Farm Animal Reform Movement)*

Tonto Creek was timbered with the local creek bottom type of timber from bluff to bluff, the water seeped rather than flowed down through a series of sloughs and fish over a foot in length could be caught with little trouble. Today this same creek bottom is little more than a gravel bar from bluff to bluff. The old trees are gone. Some were cut for fuel, many others were cut for cattle during droughts and for winter feed, and many were washed away during the floods that rushed down the stream nearly every year since the range started to deplete. The same condition applies to practically every stream in the Tonto.

--Fred Croxen, Senior Forest Ranger, Tonto National Forest, AZ, 1926 (Chaney 1990)

Livestock grazing's impact on Western creeks and streams is similarly overwhelming. As cattle walk along streamsides they cave in and disintegrate banks and kill the plants that formerly stabilized them (the banks, not the cattle!). Cattle also commonly lie on cool, moist banks and mash them down, killing vegetation. As they plod about in water, eating, drinking, and keeping cool, they kill aquatic vegetation that anchors streambeds. These and the other livestock impacts discussed below make streams wider and shallower. Grazed streams, where they still exist, are commonly 2 or 3 times as wide and 1/2 to 1/3 as deep as comparable ungrazed streams. For example, a study on Montana's Rock Creek found channel erosion 2 1/2 times greater on grazed portions than on an ungrazed portion

Cattle-ravaged warm spring in Nevada.

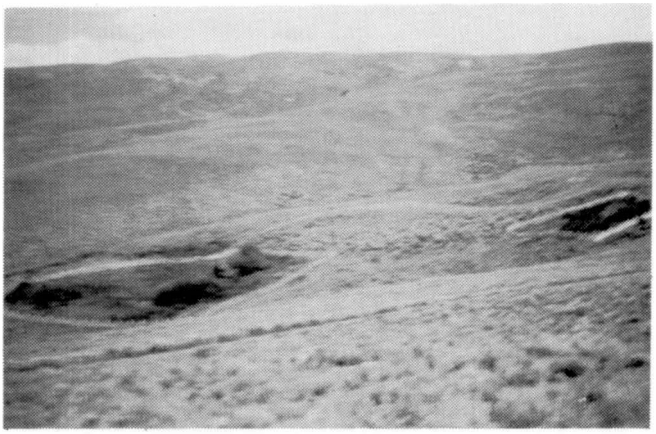
Small creek on BLM land near Cannonville, UT.

(Marcuson 1977). The resulting larger water surface area exposed to the sun and shallower water cause stream temperatures to rise.

As water warms, its oxygen and carbon dioxide-carrying capacities diminish, adversely affecting aquatic animals. An increase in water temperature of only 5 or 10 degrees can eliminate some species, fish particularly. Summer temperatures of many Western streams have been raised 10 degrees or more by livestock grazing, and now instead of 60s they often exceed 80 degrees F. Cold water fish such as trout

are gradually replaced by "rough fish" such as carp (an exotic), suckers, dace, chubs, and squawfish that can tolerate higher water temperatures and lower oxygen levels (though this is not to say that livestock grazing has not also ravaged warm water fish).

LaBarge Creek, Bridger-Teton NF, WY, is stripped of vegetation, trampled, depleted, wide, shallow, warm, sediment-laden, and polluted -- all due to cattle grazing. *(George Wuerthner)*



Relatively few springs in the rangeland West are fenced from livestock; these are, but the fences are obtrusive, hard to maintain, cost the taxpayer, harm wildlife, and drive cattle out onto the more fragile surrounding range. *(George Wuerthner)*

This former lushly vegetated bog is now a cattle quagmire. BLM, NV.

Higher water temperatures, along with copious livestock manure and urine, sometimes cause severe algal blooms, which give water that "pea soup" appearance common to Western creeks these days. The oversupply of nutrients in warm water causes algal populations to peak; the algae die and their decomposition uses up virtually all dissolved oxygen. This sometimes causes tremendous die-offs of fish and other aquatic animals. In addition, higher water temperatures cause changes in the type and amount of aquatic vegetation, likewise harming ecosystem dynamics.

Rising water temperatures and widened channels also increase water loss through evaporation. As livestock have doubled or tripled the width of streams, so have they doubled or tripled water surface exposed to air. Similarly, because vegetation on the surface of the water and overhanging streams has been depleted, more water surface is exposed to sunlight and wind, further increasing evaporation. In turn, depleted water volume caused by this and other livestock influences means increased salinity, turbidity, and concentrations of pollutants.

When cattle stomp around in wet areas, their hooves often sink deeply into the mud, sometimes a foot or more. This displaces or kills numerous mud-dwelling creatures, many in hibernation, as well as insects in pupal and larval stages. This subsurface zoological community is generally more diverse and complex than either the watery or terrestrial communities above it, yet its demise goes unnoticed. Aquatic plants, trampled and left to rot in waterways or along banks, slowly decay and release their nutrients into the water, augmenting eutrophication and aggravating algal bloom. Water-filled hoof ruts at waterside become stagnant and putrid, increasing the possibility of disease.

As cattle stomp and shuffle through the water, they also displace rocks on stream and lake bottoms. These rocks, until displaced, offer shelter to many different small animals, places to birth and rear young, feeding spots, and hibernation sites. Without them many small invertebrates -- various worms, insect larvae, fresh water clams, snails, etc. -- do not survive. Silt and organic matter also settle around rock bases, securing them to stream or lake beds and promoting plant growth. This vegetation, in turn, stabilizes these sediments and filters out other water-borne sediments. The plants and animals killed also add to water pollution.

By displacing rocks and stirring up stream bottoms, livestock release large amounts of sediment into the water, further increasing turbidity. This reduces light penetration, in turn reducing aquatic plant photosynthesis, which further reduces dissolved oxygen levels. Additionally, these water-borne sediments harm or kill aquatic animals and plants.

Most natural streams are an alternating succession of riffles and pools. The rapids are vital to water aeration, which is necessary for water purification and to provide oxygen to aquatic fauna. A high rate of aeration is a function of both high turbulence and rapid water speed, both factors in effect increasing surface area exposed to the air. The cascading of rapids helps cool water, further increasing water's oxygen-absorbing ability. Rapids also fulfill the habitat needs of many animals, including limpets, caddis fly larvae, various rock suckers, darters, and trout. And functioning as check-dams, the high points under rapids slow floodwaters.

Oak Creek, Arizona. A deep pool teeming with aquatic life (and some terrestrial life) (left) and cascading rapid just downstream (right) indicate a healthy, little-grazed watershed and waterway.

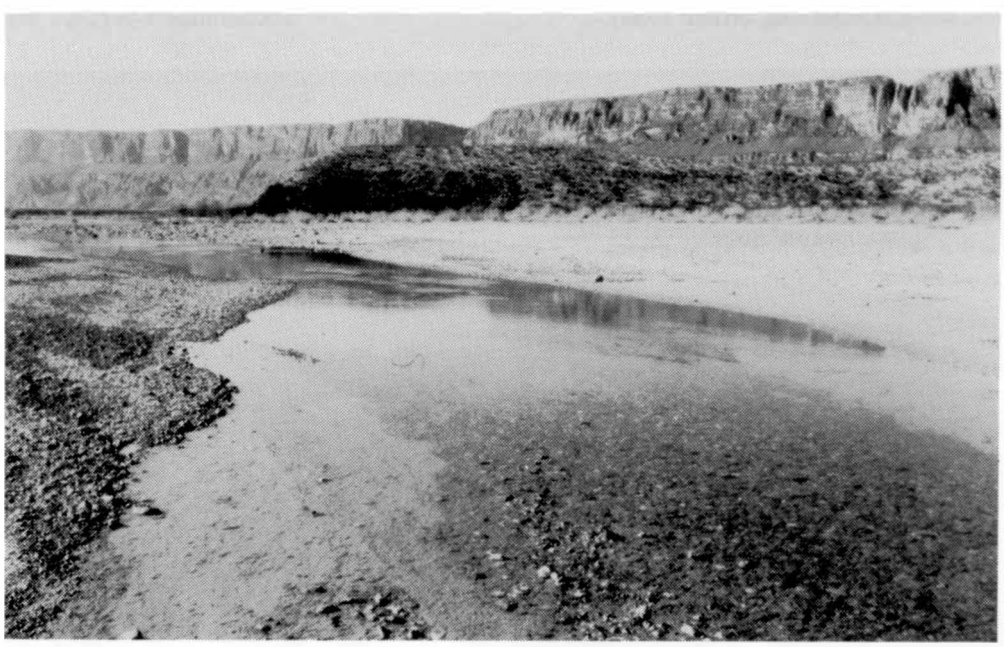
Pools are likewise vital to healthy waterways, in large part because they contain such great *volumes* of water in relation to their surface areas. Pools embrace a different set and greater abundance of animal inhabitants, including sunfish, catfish, minnows, crayfish, fresh water shrimp, many insects and insect larvae, frogs, turtles, muskrats, beaver, and many more. In the still water of pools, fine-particled sediments, instead of being washed away, sink to the bottoms, as does decomposing organic debris, where they combine to create extremely productive subsurface habitats -- so productive, in fact, that some bottom muds contain more organic than inorganic material! Pools, as "speed dips," also team up with rapids ("speed bumps") to decrease the erosive power of floods. Additionally, being deep and slow-flowing, pools release a constant flow of cooling water slowly into streams.

In livestock-trodden streams, large-particled sediments, sand, and gravel from crumbling banks and sediments washed down from degraded watersheds settle into holes where the currents are less forceful. The reduction of deep holes diminishes volume and quality of habitat. Without deep holes, floodwaters flow even faster and level out rapids. This in turn causes floodwater speeds to increase further, causing more cut-and-fill, tearing out aquatic and streamside vegetation, killing wildlife, and so on. Doubling the velocity of streamflow quadruples its erosive power and gives it 64 times more bedload and sediment carrying power (Chaney 1990). The end result to thousands of Western waterways has been wide, flat, barren, sun-baked, wind-blown, gravel-filled, scoured, flood-ravaged channels.

Increased quantities of water-borne sediments may also augment the amounts of dissolved minerals and change water pH. Changes in either of these factors can have deleterious effects on aquatic life.

Heavy sediment loads bury spawning gravels, fish eggs and embryos, and the essential foods of many fish. These effects (along with the aforementioned) have reduced or extirpated native trout, salmon, and other native fish around the West.

Water-borne sediments (along with livestock manure and urine) flow down degraded tributaries and enter ponds, lakes, and reservoirs, impairing their ecological health and limiting their lifetimes. They are likewise dumped into oceans, where they interfere with marine processes, harm sealife, and even dirty the sand on beaches. In winter sediment deposits loosed by livestock sometimes restrict stream and river channels, resulting in ice buildups and related problems.



In 1885 Terlingua Creek in southwest Texas was, according to the first homesteader in the area, ". . . a bold running stream, studded with cottonwood and alive with beaver." Today, it is wide, braided, and barely runs most of the year. There are few cottonwoods and no beaver. A century of livestock grazing was the only major variable in the watershed and drainage. *(George Wuerthner)*

Heavy sheep grazing in the Boise Mountains caused the flood damage and excessive sediment load seen here. Boise NF, ID. *(George Wuerthner)*

The role of aqueous and streamside vegetation in maintaining healthy waterways is too seldom acknowledged. Nevertheless, such vegetation is essential for many reasons.

Under natural conditions most lowland streams are deep and meander slowly in serpentine curves through dense stands of aquatic plants such as watercress, grasses, sedges, reeds, and cattail. This vegetation helps spread water out over bottoms of drainages, creating small pools and marshy areas. It maintains high water levels, shades and cools water, and provides important aquatic habitat, including large underwater areas hidden from predators. Livestock destroy this vegetation.

Aquatic plants filter out water-borne sediments, and also capture and break down nutrients and pollutants. Studies show that healthy aquatic plant systems filter out even extremely tiny particles -- a process important to water quality and natural functions. (Blum 1986).

Sediments trapped by plants on stream bottoms, for example, stabilize the bottoms and provide nutrients for growth. As these sediments build up slowly in the base of the vegetative mat, the plants grow taller at approximately the same rate. Even when buried suddenly under a thick layer of sediment, they have an amazing capacity to regrow quickly to their normal stature, ready to repeat the process. In this way, stream channels gradually rise and in turn raise water tables.

When livestock eat and trample aquatic plants, this process is reversed. Sediments are released into water, streambed stability declines, unprotected stream channels are cut by increased flooding, water tables drop, and so on. Water plants and streamside vegetation also serve the important function of slowing water. They minimize hydraulic action, especially at the water line, protecting streambanks from erosion and affording healthy habitat for plants and animals. Generally, sedges and grasses provide the best streambank protection; unfortunately, these are the plants most avidly consumed by cattle.

Aquatic plants produce oxygen and release it into the water, augmenting that taken through surface absorption, largely from rapids. As livestock kill this vegetation, the water's oxygen content is reduced accordingly, affecting water purity, aquatic animals, and even aquatic plants. Because small lakes and ponds, having very slow water movement and no rapids, are comparatively deficient in oxygen, aquatic plant life here is especially important as a source of oxygen.

When trees, branches, and other vegetative debris fall or wash into waterways, they provide many benefits to aquatic systems. This organic matter serves as food for midges, mayflies, snails, and crayfish, which then serve as food for fish, raccoons, birds, and so on. Much of the vegetative debris sinks to the bottom, where it enriches bottom muds and feeds aquatic organisms therein. Logs, branches, and accumulated organic matter in water provide cover and homes for numerous aquatic animals. A 1978 Oregon study by Swanson *et al.* found that large fallen trees provided 50% of fish habitat in small to medium-sized streams (Wuerthner 1989). Floating and above-water portions of logs and branches provide basking, perching, and foraging sites for turtles, various mammals, amphibians, birds, and insects.

Denuded, trampled stream channels harm surface waters. BLM land in Utah. *(BLM)*

Boulders, log jams, single logs, and/or accumulated debris often function as check dams to slow floodwaters. These obstructions block flowing water, causing eddies and backwaters -- important resting and nesting places for fish and other animals. Water cascading over these check dams digs pools into streambeds. These pools become

especially important to fish and other aqueous life during periods of low water. The cascading water is aerated and purified. Water above the dams is raised, increasing stream volume, creating more aquatic habitat, trapping sediments, lowering water temperature, and so on.

When washed into a river, old dead snags like this play a crucial role in stream ecology. Yet, in many areas of the West, such large trees are becoming a rarity due to livestock, which prevent regeneration and cause destruction by flooding. *(George Wuerthner)*

Look out! -- here come the cows again. By destroying riparian trees and other vegetation, they reduce the amount of vegetation that ends up in water. Sloshing through streams, they break apart and scatter logs, branches, and debris and destroy check dams. And by damaging watersheds, riparian zones, and waterways -- thereby increasing erosive flooding -- they cause waterways to be scoured of vegetation and check dams.

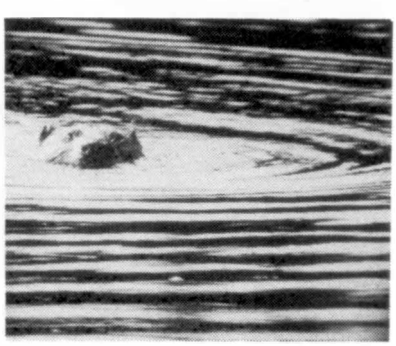
Streamside trees, willows, vines, berry bushes, cane, cattail, rushes, sedges, mints, grasses, and other moisture-loving plants provide habitat critical to a huge number and variety of animals. Many of the smaller animals -- beetles, ants, spiders, worms, flies, butterflies, moths, mosquitos, and so forth -- eventually fall into the water from overhanging vegetation, along with plant parts, to become food for fish and other aquatic animals (and to provide nutrients for plants). Researchers estimate that up to 99% of instream nutrients that produce the aquatic food web come from adjacent streamside plants (Blum 1986). Studies by William Platts and Rodger Nelson on Big Creek in northeastern Utah showed streamside vegetation overhang averaged 10 times greater in the protected portion than in the grazed portion of the stream, with 2 of the grazed study sites having no overhang at all (Platts 1989a).

Vegetation overhanging bodies of water not only provides food and shade to wildlife, but also moderates air temperature. Cooler summer and warmer winter temperatures benefit the entire ecosystem. Overhanging vegetation and plants on the water's surface insulate the water below from ice-forming cold, and thus protect it from damage due to expanding ice and melting, scouring ice. When livestock reduce streamside vegetation, stream banks are likewise more susceptible to frost. Repeated freezing and thawing of the soil composing stream banks causes it to be loosened, pushed outward, and dropped into streams, which widens channels and increases sediment pollution (Bohn 1989). Waterside vegetation also slows winds that blow across the water's surface, thus limiting evaporation.

Streambanks stripped of protective vegetation experience increased freeze and thaw; soil loosens, pushes outward, and crumbles into channels.

The extensive overhanging and submerged root tangles of natural streamside vegetation generally protect banks from erosion better than does wire and rock "riprap." These root tangles and the undercuts created by them provide shelter and nesting for birds, fish, beaver, muskrats, water snakes, frogs, turtles, and many other animals. Long-term livestock use usually results in destruction of this vegetation and the undercuts. When floods caused by overgrazed watersheds tear away at unprotected banks, the banks can melt and wash away as readily as cake in the rain.

Many of the aquatic animals that benefit by waterside vegetation play critical roles in maintaining the integrity of wet ecosystems. Beaver, for example, build check dams that slow streamflow, reduce flooding, raise water tables, promote riparian growth, create



(Steve Johnson)

deep pools of excellent animal and plant habitat (and swimming for humans), trap nutrients and water-borne particles, decrease water pollution, and maintain lower water temperatures. Old beaver ponds eventually fill with rich sediments, become lush meadows with meandering streams, and later provide a fertile base for large trees.

Cattle, sheep, and goats consume seedlings and small trees -- cottonwood, willow, and aspen are prominent ex-examples -- needed by beaver for food, lodging, and dam construction. Livestock grazing in watersheds causes violent flooding that destroys beaver dams. Trampling livestock also damage beaver dams, as well as the banks and protective root structures needed for homes by bank beaver; cattle impacts reduce streamflow, and spread giardia and other beaver diseases. Irrigation for ranching destroys habitat, and stockmen slaughter beaver as pests.

Beaver dam in Bannock Mountains, ID. Livestock grazing and stockmen have reduced or eliminated beaver from much of the West. *(George Wuerthner)*

The estimated 400 million beaver in North America before European settlement have been reduced to fewer than 9 million today -- about 2% their original population (Kay 1988). Once found in incredible numbers in waterways throughout the West, beaver have been decimated not only by trapping but in many areas by livestock. By hurting beaver, or any other native aquatic plant or animal, livestock hurt aquatic ecosystems.

Recall that streamside vegetation, acting something like a sponge, functions to regulate local streamflow. During periods of high water, vegetated, porous banks absorb water, recharging adjacent aquifers and expressing water as pools and seeps along floodplains. During dry seasons, these stored waters continue to be released into waterways, augmenting flows from water tables fed by watersheds. This continuing dry season flow can mean the difference between life and death to numerous plants and animals. Where livestock grazing persists, streamside vegetation is destroyed and the land's ability to store water is greatly diminished.

> *Locations that as little as 18 months ago were essentially devoid of vegetation with badly eroded streambanks and often only intermittent flow had been transformed* [by fencing out livestock and other restoration techniques] *into productive areas characterized by dense vegetation, stable streambanks, and deep perennial streams often providing excellent fish habitat.*
>
> *--Public Rangelands* (USGAO 1988)

Numerous scientific studies (see bibliography) demonstrate that simply fencing livestock out of waterways can restore damaged streams from ephemeral/intermittent to perennial flow -- ***even without reducing grazing in watersheds***. Most of these studies show dramatic increases in surface water quantities, and none that I am aware of have shown decreases. Some are nothing short of amazing.

Left photo shows the fenced boundary of Seedskadee National Wildlife Refuge in southwest Wyoming. The photographer took the center photo while standing at the fenceline looking at an ungrazed portion of the Refuge; the right photo was taken from the same spot looking at grazed land outside the Refuge. *(Kelly Cranston)*

One such study was done on Camp Creek in central Oregon (Winegar 1977). In 1875 the Oregon Surveyor General described the Camp Creek valley floor as an "ungullied meadow," with several marshes along its course and an abundance of bunchgrass on the uplands. After 28 years of heavy livestock grazing, the US Geological Survey described Camp Creek and its tributaries as they are today -- arroyos 15'-25' deep and 25'-100' wide, dominated by sagebrush and rabbitbrush. The previously perennial creek is now dry in late summer, and the once grass-covered uplands are mostly bare dirt with scattered juniper.

With a denuded watershed and without riparian vegetation to stabilize soil, Camp Creek became a conduit for enormous amounts of sediments. A downstream 531-acre-foot reservoir built in 1953 filled with about 1 million tons of eroded soil by 1970. Between 1965 and 1974, in an attempt to improve wildlife habitat and decrease turbidity, the Oregon Department of Fish and Wildlife and BLM fenced a 4-mile portion of the Camp Creek channel.

Before fencing, only 17 plant species, mostly "undesirables," were present within the area to be exclosed. In 1977, 45 species were identified, including willow and many rushes, sedges, and grasses. A wildlife inventory was conducted in July 1976. In 2.5 miles of unfenced creek channel only 75 members of 9 animal species were observed; 22 of these were sage grouse, which of course generally prefer sagebrush to riparian vegetation. In 2.5 miles within the exclosure 153 members of 27 species were observed. Today, beaver have re-established themselves and constructed many dams. Waterfowl and at least 12 mammals now use the protected area.

Camp Creek's sediment load was measured 3 times during run-off periods in 1972 and 1973. Water samples were taken from flows entering and leaving the fenced channel. Results of the 3 samplings showed that the non-grazed portion of the stream reduced sediment loads by 79%, 48%, and 69%. Turbid water taken from above the exclosure and left in a still bottle remained cloudy for several days. Samples taken from the outflow cleared and appeared to contain no suspended material within 3 hours.

Perhaps most impressive was the effect on Camp Creek's streamflow. Since the 1800s the creek has experienced only intermittent flow. A simple fence has restored perennial flow. Further, at times during dry periods water begins flowing 225 yards inside the upstream fence, flows at half a cubic foot per second through the fenced portion, and then disappears 30 yards outside the downstream fence.

In addition, due mainly to the protection of vegetation and the lack of streambed trampling, the level of the streambed within the exclosure is steadily rising. A measurement at one point in 1975 revealed 36" of soil deposition between the stream bottom's vegetative mat and the stony bed of 1966. Local water levels have risen accordingly. Lush vegetation covers the area; summer water temperatures have decreased; wildlife has re-established itself. In short, a simple fence has restored this 4-mile section of Camp Creek to its best condition in over 100 years.

Camp Creek is not unique. Most grazed Western streams could be fenced and show similar results -- as sections of many have. For example, a large portion of Big Creek in Rich County, northeast Utah, was fenced in the late 1970s. Studies there by Platts and Nelson showed that, compared to the fenced portion, the grazed portion of the creek had an average of less than 1/3 the bank stability (reflecting mostly vegetative cover), 64% steeper bank angle, 2 1/2 times less beneficial undercut, less than half the streamshore depth, 18 times less overhanging vegetation, far less sedge cover, less fine sediment deposition, far more streambank erosion, a wider channel, and a lower water table. (Platts 1989a)

Indeed, today dozens of riparian and stream restoration projects are being undertaken using livestock exclosures, often in combination with check dams, plantings and seedings, and/or the removal of competing non-riparian vegetation. Other waterways are being restored by default as they are fenced off by land owners and governments for various reasons.

These protected segments represent only a tiny fraction of waterways on the Western range; but they offer overwhelming evidence of the advantages of excluding livestock. Though few of these areas yet approach pre-livestock productivity, most evince remarkable improvement.

My experience in the Gila National Forest of southwest New Mexico helped open my eyes. The setting is an intermountain valley at 6000' elevation, a moderately wooded area of about 20" annual precipitation. A half mile section of Sapillo Creek and its valley has been fenced for many years, excluding the otherwise prevalent cattle.

Looking down from a hilltop near our home, the valley to the left of the fence is comparatively barren and lifeless. Here, the shallow, algae-infested creek runs quickly through a 100' wide, gravelly drainage devoid of plant life except for several small, broken willows. Steep banks enclose most of the stream channel, inexorably eating away at the bottomland along its margins, expanding the gravelly wash. The bottomland is nearly as lifeless as the scoured wash. Here, small semi-arid weeds and scattered, stunted brush provide 30% ground cover at best. Only a score or so tattered, dying "remnant" cottonwoods survive. In 3 years of living beside this wasteland, we've see little more than occasional birds and rodents.

The valley to the right of the fence is a different world, however. The stream soon disappears behind lush foliage. From walking the area, we know that here the stream slows considerably and contains many small holes and riffles. Its channel narrows to 20'-30' and is enclosed by dense vegetation rather than cutbanks. Silt and sand, rather than rocks and gravel, cover the stream bottom. Watercress and other aquatic plants grow in slower pools and in small marshy areas. The valley floor is 70% covered with abundant and diverse vegetation -- cottonwoods, walnuts, ash, alders, willows, many kinds of bushes, grass, and flowering plants. Here we see animals often -- except of course cattle.

> *In summer much of its* [Willow Creek's, in Central Oregon] *streambed is dry. . . . Between the years 1975 and 1980 fences were constructed to exclude livestock, permitting recovery in approximately 7 miles of its channel through Crooked River National Grassland. By 1978 flow had become continuous within this 7 miles except for about 100' within a cattle watering access point . . . almost the entire streambed, approximately 5 miles above and below the exclosure were dry and exposed to the summer sun.*
>
> *--Harold H. Winegar, "Streamflow Augmentation through Riparian Recovery" (Winegar 1982)*

Livestock exclosures have increased streamflow everywhere they have been built. In fact, as with Camp Creek and Willow Creek, many of these streams often flow only within, and not outside, exclosure fences (Winegar 1982).

According to riparian specialist Harold Winegar, usable water could be increased by about 190,000 acre feet on Oregon's Ochoco National Forest simply by removing cattle for 10 years. Similar increases could be expected for most Western National Forests and BLM lands. Winegar further states that with only 5 years of no grazing on the Ochoco, fishery production could be expected to increase 150%. Yet the proposed management plan for this National Forest -- like many recent FS and BLM management plans -- actually proposes *increasing* livestock grazing levels, from 76,000 to 83,000 AUMs. Even with overwhelming evidence of grazing's destructiveness to waterways, our land managing agencies continue servicing ranchers at the expense of the environment.

A recent study in Wyoming found that of 262 miles of streams, only 2% function now as they did in 1850. Eighty-three percent of the streams were lost or destroyed by overgrazing and accelerated erosion. The remaining 15% were in fair to good condition.

--Charles Kay, wildlife ecologist (Kay 1988)

On a much smaller scale -- but important nonetheless -- is the loss of water simply from livestock *drinking* it. Cattle consume about 10 gallons of water daily; on hot, dry days intake may exceed 15 gallons. Relatively speaking, this is more than any wild large herbivore; elk, for example, though weighing about half as much, consume only 2-3 gallons daily (USDA, SCS 1976). Just one steer drinking from a small spring, seep, pond, or waterpocket can quickly deplete available water. In drier areas this water is often crucial to plants and animals, and sometimes humans.

Wherever livestock have access to surface water, such as at this point on an Oregon stream, they destroy vegetation, destabilize banks, and foul water. *(BLM)*

Biologists know that an acre of streamside habitat is as valuable as an acre of redwoods.

--The editors of *Sierra* magazine (*Sierra* 1990)

This stream in the soggy Wind River Mountains, Wyoming, may seem pleasant enough, but it has been heavily degraded by livestock. *(Paul Hirt)*

Almost any water in the dry West seems nice, at least nicer than no water. Most visitors to public land seem happy with whatever surface water they encounter. I have heard the most terribly denuded, trampled, polluted, flood ravaged, cutbank-enclosed waterways described as "such a pretty little creek," "a nice camping spot," "a great place to enjoy the outdoors," and so forth. This pleasant attitude in the face of overwhelming degeneration may simply indicate a high degree of tolerance in some people. Most, however, simply seem unaware of what they are looking at.

While our Western waterways may *seem* nice, we should realize that most are depleted and degraded, often extremely so. As expressed by Stephanie Wood, a range technician for the Beaverhead National Forest in Montana: "This kind of damage is so widespread that most people, including most range managers, have never seen a healthy stream channel (Wuerthner 1991)." Moreover, we need to understand that throughout most of the West a large percentage of waterways no longer exist. Amazing what a few harmless cows and sheep can do.

[Note: For further documentation of this section see Winegar 1977; Blum 1986; USDI, BLM 1989; and other sources listed in the bibliography.]

(George Wuerthner)

According to hydrologists Wayne Elmore and Robert L. Beschta, "Many people have never seen a healthy rangeland riparian area, since degradation was widespread before many of us were born."

The photo at right is of Pole Creek in the Sawtooth National Recreation Area, central Idaho. The photographer, naturalist George Wuerthner, writes that "The creek looks lovely to the untrained eye. However, it is severely degraded. The channel is wide and shallow. There is little overhanging vegetation and few undercut banks. No willows or shrubs."

In this photo, Pole Creek flows under a fence onto the grounds of a Forest Service ranger station, where there has been no livestock grazing for nearly 100 years. Note that it narrows and becomes deeper.

This photo was taken within the ungrazed ranger station compound. Now the creek is barely visible. Rather than being several feet wide and 1' deep, as in the grazed area, it is a foot or two wide and *3' deep*! Vegetation is taller; overhanging vegetation is everywhere; and undercut banks are common. Willows and shrubs line the creek. Water flows more slowly; is cleaner, cooler, and better protected from the elements; and provides a more natural, superior habitat for wildlife.

Yes, the grazed portion of Pole Creek in the top photo is pleasant to look at. Indeed, it is probably in fairly good condition compared to most rangeland streams. Nonetheless, it *is*, as the photographer notes, **severely degraded.**

(Photos by George Wuerthner)

Riparian Areas

A riparian area in northeast Utah, ungrazed by livestock. *(Kelly Cranston)*

Even though wildlife riparian surveys are far from complete, the Arizona Game & Fish Department now identifies at least 137 species of fish, amphibians, reptiles, birds, and mammals that may face extinction if current habitat trends continue. About 80% of the above species (which does not include plants) are strongly affected by the destruction of riparian habitats. Since livestock grazing is by far the most common form of land use in Arizona and the other 11 Western states, it is not surprising that grazing abuse is a leading cause of riparian decline. Studies in every Western state have shown similar declines due to livestock grazing.

--Steve Johnson, Southwestern Representative, Defenders of Wildlife (Johnson 1987)

Scientifically, *riparian ecosystems* are defined as wetland ecosystems that have a high water table because of proximity to an aquatic system or to subsurface water. In other words, they are land surfaces that are close to water, but not under water. They derive a high amount of moisture from nearby surface and/or subsurface water, but aren't normally covered with surface water themselves.

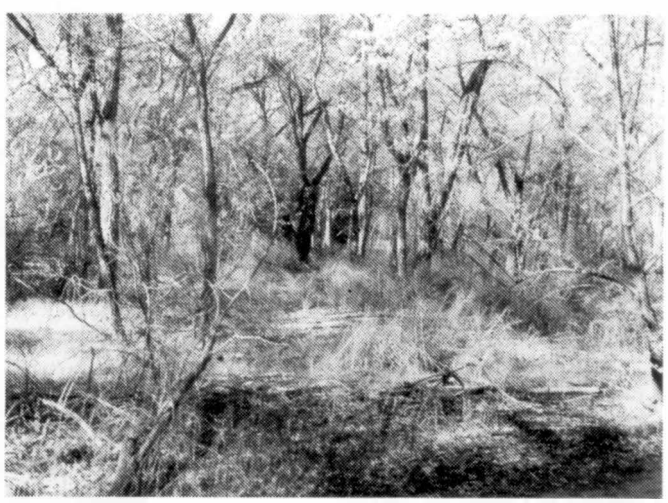
When talking about riparian systems, one usually thinks of springs, streams, rivers, lakes, and other surface waters. But these aquatic environments are not, strictly speaking, physically part of riparian areas; it may help to discuss them as separate but closely related entities.

Some riparian systems are supplied moisture from ground waters that never appear as surface water in the immediate area. In other words, riparian ecosystems can exist even where there is no regular surface water nearby.

The *riparian zone* is defined as the strip of land bordering surface waters whose vegetation depends on a high water table. These zones, particularly those along streams and rivers, constitute most riparian acreage in the West. The term *riparian area* is commonly used to describe any area with riparian qualities.

In the US, riparian areas encompass less than 5% of the land (Chaney 1990). Riparian areas and associated waterways together cover only about 3 million acres and represent less than 1% of the area of Western public lands (USGAO 1988). Yet riparian areas are the most biologically productive of all Western ecosystems. Their deep, rich soils, flat expanses of bottomland, and abundant moisture support the greatest abundance and diversity of vegetation in the West. Accordingly, they are, acre for acre, among the most significant animal habitats anywhere. In many parts of the arid and semi-arid West, the large trees and dense vegetation common to riparian areas provide the only cool, shady places and thick cover for miles around. Lush riparian vegetation moderates air temperatures and protects wildlife from weather extremes. Riparian areas provide avenues and cover for animal movements and migrations, assuring wide distribution, minimum species inbreeding, and refuge from humans and their developments. On Western ranges, which are often characterized by relative uniformity over vast spaces, riparian areas provide habitat diversity, thus abundance and stability. Riparian systems are transition zones between aquatic and terrestrial ecosystems -- land-water interfaces -- containing organisms from both overlapping ecosystems, as well as organisms endemic to riparian systems.

Throughout most of the West, most animal species rely at some time in their lives on riparian areas. For example, 75% of wildlife species in eastern Oregon utilize riparian zones (Ferguson 1983). In the Elko, Nevada, BLM Resource Area, 80% of approximately 300 terrestrial wildlife species "are directly dependent on riparian habitat, or use it more than any other habitat" (Luoma 1986). In



A healthy, ungrazed riparian area is alive with abundance and diversity.

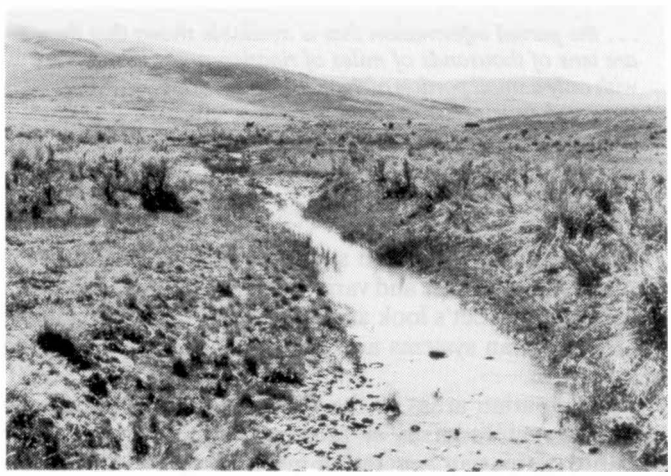
Arizona and New Mexico, 80% of all vertebrates depend on riparian areas for at least half of their life cycle; more than half of these are totally dependent on riparian areas. Riparian areas provide habitat for more species of birds than all other Western rangeland types combined, and in the Southwest more than half of bird species are completely dependent on them (Chaney 1990). Overall, 75% of all vertebrate species in the West in some way rely on riparian areas and associated waters (Williams 1990).

> *The extensive deterioration of western riparian areas began with severe overgrazing in the late nineteenth and early twentieth centuries.... Extensive field observations in the late 1980s suggest that riparian areas throughout the West were* (are now) *in the worst condition in history.*
>
> *--Livestock Grazing on Western Riparian Areas*, produced for the Environmental Protection Agency (Chaney 1990)

Unfortunately, cattle also find riparian zones immensely attractive. With lush, succulent vegetation, plentiful water, smooth, level ground, shade and shelter, riparian areas attract cattle like a magnet. Regardless of range conditions, riparian areas are their first target. Even a handful of cattle on a vast range will concentrate in riparian areas (Chaney 1990). Cattle are relatively lethargic, and once settled into this pleasant environment they stay indefinitely unless strongly induced to move. The BLM found that in the Great Basin all riparian land covers less than 2% of the area, yet receives 50% of the livestock pressure. Riparian meadows occupy only 1%-2% of the interior Northwest, but account for 81% of the forage removed by livestock. (Green 1989)

Therefore, riparian areas are exceedingly susceptible to damage from cattle grazing; generally, the narrower they are the more readily they are damaged. Until recent decades (and improved public relations) many range manuals referred to riparian areas as grazing "sacrifice areas."

Thus, riparian destruction is among the most environmentally disastrous aspects of public lands ranching, and many experts cite livestock grazing as the most harmful riparian influence on public lands. For example, a special report prepared for the US Environmental Protection Agency identifies livestock grazing as having "the most geographically extensive effects" on riparian areas Westwide, public and private land included (Chaney 1990). *Indeed, in the 70% of the West managed for ranching the vast majority of riparian areas have been and are being significantly damaged by livestock.* Of dubious consolation is that concentrating livestock on riparian areas in effect reduces pressure on neighboring countrysides .



"Cowed out" riparian zone on BLM land in Jordan Valley, Oregon. *(George Wuerthner)*

A riparian community impoverished by livestock is like a rainbow without color.

This is the same creek shown in the adjacent photo, as it flows onto a fenced, ungrazed roadside.

. . . the partial information that is available shows that there are tens of thousands of miles of riparian areas in the West, with only a small portion of them in good condition. . . . Poorly managed livestock grazing is the major cause of degraded riparian habitat on federal rangelands.

--US General Accounting Office, *Public Rangelands* (USGAO 1988)

Since riparian areas are such fruitful ecosystems, their functions are complex and varied, and so too are the impacts from livestock. Let's look at some of the basic functions of natural riparian systems and what effect livestock grazing has on them.

Most riparian areas in the West are situated alongside perennial watercourses or seasonal drainages. At higher elevations, riparian vegetation generally grows in narrow strips along fast flowing streams, around the perimeters of lakes, and in moist, boggy areas of seeps and springs. Cattle and sheep are usually brought into these places in late spring and remain until autumn, where they gobble down the luxuriant grasses and flowering plants and plod about in their self-made mire. In many areas, their destructive impacts can be easily seen right up to mountain headwaters, often above 10,000' elevation and occasionally as high as 12,000'. Harsh climatic conditions, thin soils, and low stream sediment levels make these high-elevation riparian areas quite susceptible to long-term damage from livestock.

This riparian area was once lushly vegetated and filled with wildlife. A century of livestock grazing has left it as you see it now. *(Steve Johnson)*

Most riparian zones at lower elevations occur within the valleys and canyons of rivers and streams. Riparian dynamics here are somewhat different and more complex. As streams descend from the highlands, they spread out and slow down as their drainages gradually become more shallow, wider, and more level. Eventually, streams join together to form rivers that flow slowly through wide, flat valleys toward the oceans.

When heavy rains or snowmelt send water rushing down from higher elevations, the water picks up particles of clay, silt, and fine sand along the way and carries them into streams. Upon reaching lower elevations, these flood-swollen waters spread out across the bottoms of canyons and valleys -- the *floodplains*. This dispersion causes the waters to lose speed and deposit their suspended sediments in a fairly even manner across canyon and valley floors. Each new flood drops another layer of these fine-particled sediments, over the years building up the wide strips of fertile floodplain soil called *bottomland*. This important process creates most riparian land in the West.

The combination of flat, deep, fertile soil with a constant supply of ground moisture provides riparian plant life an ideal medium. Most healthy riparian bottomlands support veritable jungles of vegetation usually consisting of at least 200 species of large and small trees, bushes, vines, grasses, flowering perennials, and other moisture-loving plants.

While these riparian plants owe their existence to the fertile soil and groundwater of the riparian system, conversely the soil and water owe their continued existence to these plants. Riparian vegetation and soil maintain a mutually beneficial equilibrium. As riparian plant life grows more profuse, it becomes better able to slow floodwaters and trap sediments, thereby adding to its base of rich topsoil. In turn, as more layers of topsoil are laid down, vegetation grows more profusely, enabling it to trap more soil, and so on. Additionally, the thicker the vegetation, the more able it is to filter out the finest waterborne particles -- generally the most fertile sediments.

When cattle deplete and destroy riparian vegetation, this cycle is reversed. Less plant cover means less soil trapped and deposited, reduced plant growth, even less topsoil. . . . With cattle depleting remaining vegetation at a quicker and quicker rate as it becomes scarcer, a downward spiral of botanic extermination ensues. Not only this, faster floodwater speeds due to depleted plant cover mean increased topsoil *erosion*, as well as decreased topsoil deposition -- a double whammy.

Under natural conditions, the topsoil composing most bottomlands is remarkably rich and fertile, due in large part to its high percentage of organic matter. Lush riparian growth, animal droppings and remains, and organic material washed down in floods and trapped among riparian plants are the main constituents of this organic matter. Without the physical obstructions created by riparian plants and debris, rising floodwaters simply wash these vital materials away, eventually to be caught under bridges or in logjams, buried under coarse sediments, or dumped into reservoirs and oceans.

Livestock destruction of riparian vegetation is accomplished in much the same way as in any other ecosystem. These moisture-loving plants, being more leafy, succulent, and palatable, are more eagerly sought out and consumed by greater numbers of cattle. Being generally more leafy and succulent, many are also more fragile. Thus, because cattle congregate and spend so much time in riparian zones, damage is, overall, acre for acre, comparatively even greater than in dry areas.

Loss of riparian vegetation exposes moist soils to the sun and wind, leading to increased groundwater loss through evaporation. In some areas, increased capillary action from the water table close below has brought inordinate amounts of dissolved salts and minerals to the soil's surface, forming a sterile crust, changing plant composition and killing vegetation.

Healthy riparian vegetation even acts as a filter for adjacent surface waters. It screens out pollutants, sediments, and harmful debris that would otherwise enter surface waters from surrounding rangeland. (Green 1989) The fine-particled sediments, organic matter, and beneficial chemicals also trapped by this vegetative filter make riparian areas nutrient repositories for surrounding watersheds. Livestock open passages through riparian vegetation, deplete it, or destroy it altogether.

Plants draw water up through roots and transpire it through leaves into the air. Because of this, some argue that riparian vegetation wastes water. In fact, riparian plants conserve more than they transpire. Their organic litter layer helps soil absorb rainwater and percolate it into underground storage. Likewise, the organic litter helps absorb and store the occasional shallow floodwaters that spread across bottomlands. Riparian vegetation blocks sun and wind, limiting evaporation. Of the water that is "lost" into the air through transpiration by leaves, much eventually forms clouds and returns to the earth as precipitation anyway (as opposed to water that mostly *runs off* denuded and degraded lands). We have already detailed many other ways in which vegetation, streamside vegetation in particular, conserves water.

Russian olive thicket along the Rio Grande River in central New Mexico. When the leafless cottonwood and willow saplings in foreground leaf out, cattle will eat and trample them, allowing the thorny exotic to dominate, as it does in the background.

As on rangeland, livestock in riparian areas reduce the amount and the diversity of vegetation. For example, tamarisk is a prolific riparian invader native to north Africa and southern Asia. The shaggy tree has replaced native species on tens of thousands of riparian acres in the West, much to the detriment of native animals. Livestock help spread tamarisk because they eat and trample cottonwoods, willows, walnut, sycamore, alder, etc. and thus give the unpalatable tamarisk the competitive advantage.

Similarly, damage and depletion of natural riparian vegetation reduces the diversity of animal habitat. Most Western wildlife depends on riparian vegetation for all or part of its needs, and much requires a combination of riparian and other biotic types to survive.

Thick -- ungrazed by livestock -- riparian vegetation traps flood debris. This debris is ecologically very important in many ways.

An important yet little-studied riparian process is the biogeochemical cycle that influences riparian and aquatic systems. Riparian areas are unique in that they contain large areas of water-saturated soil in conjunction with permanent, dense vegetation. The influence of both and the interaction between them helps keep riparian and aquatic systems in proper chemical balance. Livestock may upset this balance, with far-reaching but little understood consequences. (Green 1989)

Streams and rivers have a special relationship with the floodplains through which they flow. Over long periods, stream and river channels tend to meander from side to side

within the confines of their drainages -- a phenomenon called "sinuousity" -- from sweeping curves in narrow canyons at high elevations to great serpentine loops in wide lowland river valleys. If it were possible to look at a time lapse video of the movement of a stream or river channel within its canyon or valley, it might appear as a giant snake writhing back and forth from one side of the drainage to the other, now and then removing small portions of canyon and valley walls. In this way streams and rivers broaden their canyons and valleys over time, creating wide "overflow areas" -- floodplains -- that carry surplus floodwaters, dissipate destructive hydraulic action, and create fertile bottomland.

The increased speed and erosive power of livestock-caused floodwaters, in combination with other livestock impacts, has caused them to eat through stream and river meanders and eventually to widen and straighten water courses. Straighter courses, in turn, allow for even greater floodwater speed and erosive power. Streams are reduced in actual length, reducing overall water quantity as well as streamside and aquatic wildlife habitat.

Straighter courses also mean steeper stream slopes that further increase water speed and allow streams to carry coarser and larger amounts of sediments, which further erode channels and kill vegetation. These more erosive floods physically harm aquatic animals and displace channel bottoms, sweeping away and killing small aquatic animals that live in sand and gravel and under rocks, which in turn reduces the amount of food available for larger animals. Increased channel erosion, in conjunction with abnormally powerful and frequent floods eliminates sandbars that are essential for the establishment of some types of vegetation and that are important for animal habitat. Faster floodwaters racing through wider, straighter channels means the channels are able to contain much greater quantities of floodwater and that floodwaters are less likely to be spread out evenly over remaining bottomlands and deposit fine sediments.

As discussed, bottomland riparian vegetation extracts sediments, replenishes soil, provides organic litter, slows floodwaters, and thus replenishes groundwater supplies. Floodplains and their riparian vegetation, in turn, help maintain maximum water flows for the streams and rivers that helped create them.

Under natural conditions, streams and rivers meander very gradually. Sturdy masses of interwoven roots on channel banks allow only extremely slow bank erosion and lateral channel movement. Healthy watersheds rarely produce the violent, erosive floods necessary to tear apart these banks.

When cattle overpopulate a riparian ecosystem, bottomland vegetation is usually destroyed first, being generally less resistant to livestock use than the more luxuriant, well-watered, densely rooted, resilient streamside plant life. As a consequence, when streamside vegetation finally does succumb to livestock pressure and floodwaters break through its declining root masses, the denuded bottomlands behind them are suddenly laid open to massive erosion. Crumbling banks recede quickly, eating up precious bottomland as they go, often right up to canyon or valley walls. What is left is canyon and valley floors covered with sand and gravel, boulders, and massive corpses of uprooted trees -- now common scenes around the West.

Cattle-bombed riparian zone. Note erosion, absence of protective lower branches on trees, streamside depletion, and utter lack of ground cover, in contrast to fenced roadside in foreground.

> *Livestock overgrazing is the most pervasive cause of the deterioration of riparian ecosystems on public lands.*
>
> --Beverly I. Strassmann, "Cattle Grazing and Haying on Wildlife Refuges" (Strassmann 1983a)

> *The changes* [from livestock grazing] *are usually small from year to year and often go unnoticed. They are, however, cumulative, and eventually represent major alterations. Ironically, local residents will often declare that a stream hasn't changed since their grandparent's time; they may be correct because many of the major impacts occurred before the turn of the century. The consequences of riparian degradation for fish and wildlife are the same whether it occurs as a sudden catastrophic event, such as a washout from a tailing pond, or a long series of small, cumulative events.*
>
> --William S. Platts, "Fish, Wildlife and Livestock" (Platts 1990)

Consider these before-livestock descriptions of Southwestern riparian areas. From J.J. Thornber, an early botanist at the University of Arizona:

> *In moist valleys, cienegas* [marshy areas along drainages], *and occasionally canyons, tall sacaton grasses were the predominant plants. These valleys, examples of which are the Santa Cruz, San Pedro, San Simon, and Little Colorado, were veritable cienegas or flood plains over which the excess storm water spread from time to time in broad sheets,retarded by the accumulated vegetation of past years, and occasionally by groups of beavers' dams. . . .*

In **Desertification in the United States**, David Sheridan describes the Santa Cruz and San Pedro Rivers:

> *Water flowed through an unchanneled river that wound sluggishly across a flat, marshy area. Trout were abundant. Beavers built dams. There were giant cottonwood, mesquite, willow, sycamore, and paloverde, and grass -- grass tall enough to "brush a horse's belly," to shelter wild turkeys. Meandering, ungullied tributary creeks fed the river.* (Sheridan 1981)

These river valleys represent 4 of Arizona's major drainages. All 4 are now bone dry along most of their courses, as are their former tributaries. Their broad, sandy and rocky beds are enclosed in many places by cutbanks, some of which reach 50' in height and run for miles. These washes are scoured periodically by violent floodwawaters

that run off overgrazed rangeland. Most of the original bottomland and large trees were washed away long ago. There is very little grass of any kind, no beavers or trout, and little "accumulated vegetation." Few parts of them have any resemblance whatsoever to "cienegas." (Chapman 1948, Blum 1986, Hastings 1965)

Consider this excerpt from *Livestock Grazing on Western Riparian Areas*:

> *In 1976 the grazing permit for the allotment was relinquished by the permittee. The BLM used the opportunity to fence most of the creek and much of the watershed to exclude livestock.*
>
> *Riparian vegetation responded to rest from grazing and installation of a few instream structures to improve trout habitat by raising water levels and reducing erosion. Native perennial grasses increased throughout the fenced area. Previously decadent aspen groves expanded. Curlleaf mahogany began reproducing within the fenced area while outside the fence almost no seedlings survived grazing.*
>
> *Streambanks stabilized and erosion was reduced. The stream channel narrowed and deepened. Summer streamflow increased 400%, and depth of water increased 50%. Water temperatures and sediment load decreased.* (Chaney 1990)

As evidence of the diversity of problems caused by riparian livestock grazing, here are samples from a report by the General Accounting Office:

> *"The creek's riparian areas were in poor condition -- they had unstable banks and a declining trout population, which local BLM officials said stemmed from unrestricted grazing"; ". . . 118 streams* [in Nevada] *and found that over 80% of the 1,036 miles inventoried were in poor or fair condition"; ". . . the creek's riparian areas were overgrazed, causing the creek to dry up in the summer"; "The Audubon Society said overgrazing prohibited the regeneration of cottonwood trees critically needed as nesting sites for endangered bald eagles"; "The inventory showed that, primarily as a result of major floods and livestock overgrazing, the Burro Creek area had been devastated and stripped of vegetation"; "Degraded conditions were evidenced by eroded streambanks, shallow stream channel, and the elimination of a trout population"; "BLM said the area was eroding badly and producing excessive sediment"; ". . . the 2,000-acre allotment of the watershed has been reduced to bare ground, primarily through overgrazing by sheep and cattle."*

Little remains of this riparian area in the Challis National Forest, Idaho, except a stunted willow and an eroded gully. Note depleted range. *(George Wuerthner)*

Throughout the grazed 70% of the Western US, livestock grazing has been and continues to be the most widespread and potent force destroying riparian areas. For example, the Arizona Game & Fish Department reports that 97% of the state's original riparian habitat has been lost, with ranching the major factor (Wuerthner 1989a). According to the Arizona State Parks department, 90% of the original riparian ecosystems in New Mexico are gone. Assessments by BLM itself found that 80% of the 12,000 miles of streams and associated riparian zones on BLM land in Idaho are being damaged by poor management and 90% of 5300 miles surveyed in Colorado were rated in poor or fair condition due to livestock. (Wuerthner 1990b) California has lost an estimated 89% of its riparian woodland since 1848, largely to ranching, as well as farming, dams, placer mining, development, and other impacts. The Wyoming Game & Fish Department estimates a loss of 45% of the state's riparian area, again largely from ranching. In arid Nevada, a *BLM* report states, "Stream riparian habitat where livestock grazing is occurring [most of the state] has been grazed out of existence or is in a severely deteriorated condition" (Ferguson 1983); the Nature Conservancy reports that Nevada has lost more than 80% of its wetlands since the 1800s. In rangeland areas of every Western state, *most* riparian habitat has been seriously damaged or eliminated by livestock. (In the US overall, livestock grazing and other human influence has caused the loss of 70% of the original area of riparian vegetation [Joyce 1989].)

Under increasing public pressure to improve riparian areas, the Chair of the House Committee on Interior and Insular Affairs and the Chair of its Subcommittee on National Parks and Public Lands in 1986 asked the US General Accounting Office (GAO) to identify examples of successful riparian restoration efforts on public rangelands, to determine why they were successful and if those methods could be used on a widespread basis. In response, the GAO in 1988 released *Public Rangelands, Some Riparian Areas Restored but Widespread Improvement Will Be Slow*, which reviewed successful restoration efforts by the BLM and FS on selected riparian areas in 10 Western States. (USGAO 1988)

The report showcases these agencies' most successful restoration attempts. Failures were not included. According to the report, "We first requested lists of successful riparian management projects from the BLM and FS headquarters." In order to set the stage for continued heavy livestock grazing, these agencies seem to have made a special effort to provide the GAO with the most impressive examples of livestock *grazing* (as well as removal or reductions) being used as a restoration technique. The GAO selected 15 out of 35 example projects provided by the agencies, and later added 7 more, for a total of 22. Continued the GAO, "We selected projects . . . to illustrate several different techniques of riparian management."

In other words, due to both of the above factors, the report is subtly structured to promote the false impression that changing grazing systems has been much more successful in riparian restoration than it actually has been. In truth, as shown even in this report, by far the most numerous and successful restorations of riparian areas have been accomplished by *removal or drastic reductions* of livestock, not changes in grazing techniques. Regardless, the report

dramatically displays the ability of riparian areas to make significant recovery if given a chance.

Of the 22 examples in the GAO report, half involved fencing and complete removal of livestock. Without exception, each of these ungrazed study areas soon displayed impressive improvement of riparian health, *except where cattle had broken through exclosure fences*. Though in some cases developments such as rip-rap, in-stream structures, and vegetation planting were implemented in conjunction with livestock removal, in most tremendous riparian recovery occurred without these aids.

In the other 11 study areas discussed in the GAO report, riparian grazing was continued in some form, usually as an intensified "rest-rotation" system of grazing (basically, moving large groups of livestock about more quickly between smaller pastures). In most of these cases, livestock numbers were significantly reduced. Generally, riparian recovery increased in direct proportion to the degree that livestock populations decreased. Areas where efforts were made to keep livestock away from riparian zones and waterways experienced noticeably greater improvement than where grazing continued unabated. All but 1 of these studies involved concurrent riparian and/or range developments, *to a greater degree than on the ungrazed study areas*. This included fencing; rip-rapping; tree and shrub planting, grass seeding; in-stream structures of various kinds; bank protection; stabilizing eroded terraces and gullies in watersheds; water developments in uplands; transporting water to livestock away from riparian areas; and brush eradication, prescribed burning, and seeding in watersheds. In the single grazed study area where no developments were implemented, recovery was perhaps the least impressive of all 22 case studies. Some permittees indicated they didn't believe much more restoration could be accomplished in their grazed riparian areas without additional improvements, which was not the case with the ungrazed areas.

The GAO reported numerous difficulties in completing the studies, particularly with respect to cooperation from grazing permittees. While visiting a number of the study sites, GAO staff found trespassing cattle or evidence of trespassing. The report stated, "As we saw, failure to

When The Nature Conservancy purchased a 5-mile stretch of west-central Arizona's Hassayampa River in 1986, the riparian area was as stripped and beaten by cattle as most other Western wetlands. Several years of no cattle later, preserve managers report "phenomenal recovery." Clear, cool water meanders slowly through a jungle of grasses, sedges, reeds, and rushes. Small, quiet, vegetation-filled ponds and bogs shelter wildlife. Dense thickets of bush willows and small trees line the wet zone, and the floor of the surrounding riparian forest is covered with organic matter and vibrant with living things.

keep livestock out of recovery areas long enough for vegetation to establish itself can ruin the progress made by months of effort and effectively doom projects to failure." Trespassing on one riparian project was so bad that the report stated:

> *We observed the project with BLM officials in October 1987. . . . They considered the project essentially a "showcase" demonstration area for visitor tours, the most recent of which was given about 2 weeks prior to our visit. However, when we arrived at the site we found that a large number of cattle had broken the exclosure fence and grazed the previously protected area to a desert-like condition. Essentially all of the regenerated grass in the area was eaten or trampled and most of the area was reduced to dust. The BLM officials expressed their surprise and dismay with the trespass. They stated, however, that such trespass was not uncommon and they would try to work more closely with the permittee to gain assurance the incident would not be repeated.*

Many of the permittees involved in the study projects initially objected and provided little cooperation. According to the GAO report, "On most BLM projects, staff worked long and hard to convince the ranchers that healthy riparian zones would benefit their ranching operations and thereby obtain their voluntary cooperation." Most of those whose livestock numbers were not significantly reduced eventually began to support the projects, especially when they found the many taxpayer-sponsored developments starting to enhance their profit-making potential.

But most of those whose livestock numbers were reduced were not at all happy. Some exerted pressure on agency officials, forcing them to "modify" project plans to be more conducive to their ranching goals. Some demanded, and received, livestock developments in upland areas in compensation for reduced riparian grazing. In protest, some took to trespassing livestock in fenced study areas. Some cut fences and damaged non-grazing-related developments. Apparently one permittee, objecting to a riparian fence being built on "his" allotment without his approval, stole half the fence materials after the project was completed. The BLM "could not determine who was responsible for the theft."

The GAO report cited not only the permittees but the agencies themselves as obstacles to riparian restoration. Reportedly, many agency efforts to restore riparian areas are hampered by pro-grazing staff at both upper and lower levels. BLM employees trying to make management decisions protecting riparian areas apparently were pressured to back off. The report stated, "If the BLM is serious about more widespread riparian restoration, it will have to demonstrate its seriousness with concrete actions such as cutting AUMs or citing known trespass or other permit violations, when such actions are necessary."

In sum, these 22 projects (22 of the most successful projects on public land, remember) improved the condition of a total of less than 150 linear miles of Western waterways and adjacent riparian zones. The reported cost of 14 of these projects was (as of 1988) over $400,000 in government funds. Including the other 7 projects, as well as additional and indirect costs, total costs would undoubtedly run well over $1 million in taxes. The report concludes:

> *The successes of the projects to date need to be measured against the backdrop of work that remains to be done. . . . The available information is too incomplete for an estimate of how many miles of streams on BLM and Forest Service land are in less than satisfactory condition. It seems likely, however, from the partial estimates above, that the number of miles easily runs into* tens of thousands. *In addition, many other types of riparian areas, such as springs and meadows, may also need work.* (emphasis added)

But even if these hundreds of millions of dollars are spent, improvement is never permanent as long as ranching continues. Tragically, as soon as riparian areas begin to recover the land management agencies are pressured to increase livestock grazing once again -- in direct proportion to the extent of recovery. The lush green (read: *greenbacks*) and water of a healthy riparian area are almost unbearably desirable to the rancher. He does his utmost to make sure the government doesn't "waste" this livestock potential. Few riparian areas, therefore, are allowed to make full and lasting recovery.

A riparian area on Sheldon National Wildlife Refuge, northwest Nevada, was fenced from cattle. Soon thereafter, dense vegetation covered the bare ground, aquatic plants stabilized the stream bottom, and the water level rose significantly, soaking the roots of the sagebrush in the foreground and killing the dryland plants. *(George Wuerthner)*

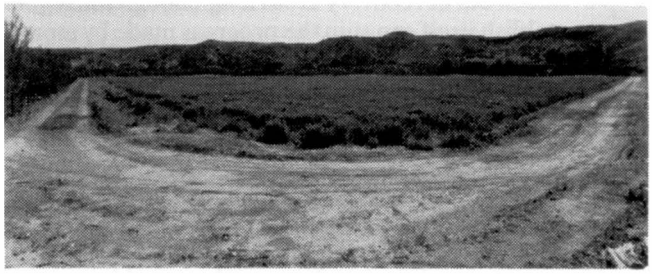
A number of reports similar to GAO's have been published in recent years (see bibliography). Prominent is a 1990 report produced for EPA titled *Livestock Grazing on Western Riparian Areas* (Chaney 1990). It essentially parallels GAO's report with before-and-after descriptions of grazed riparian areas and recovery efforts. As with the GAO report, only successful recovery efforts were showcased, this time in a dozen case studies in 8 Western states. Again, in general, the greater the degree of livestock reduction, the more dramatic the riparian recovery. And again, despite the admission of grazing devastation, a concerted effort was made to protect the grazing imperative:

> *Decreasing the number of livestock is commonly offered as the simple solution to degraded riparian conditions. But even under light stocking rates livestock tend to concentrate on riparian vegetation during various seasons of the year. Unless the reduction was extreme, it might not achieve the desired improvement in riparian conditions.*

So why not simply make the reduction extreme? Answer: The grazing imperative (a fusion of tradition, politics, bureaucracy, cowboy idolatry, etc.) mandates that ranching continue indefinitely. Thus, again we are instead advised to advocate and finance more ranching developments and administration to mitigate riparian impact, rather than use "the simple solution."

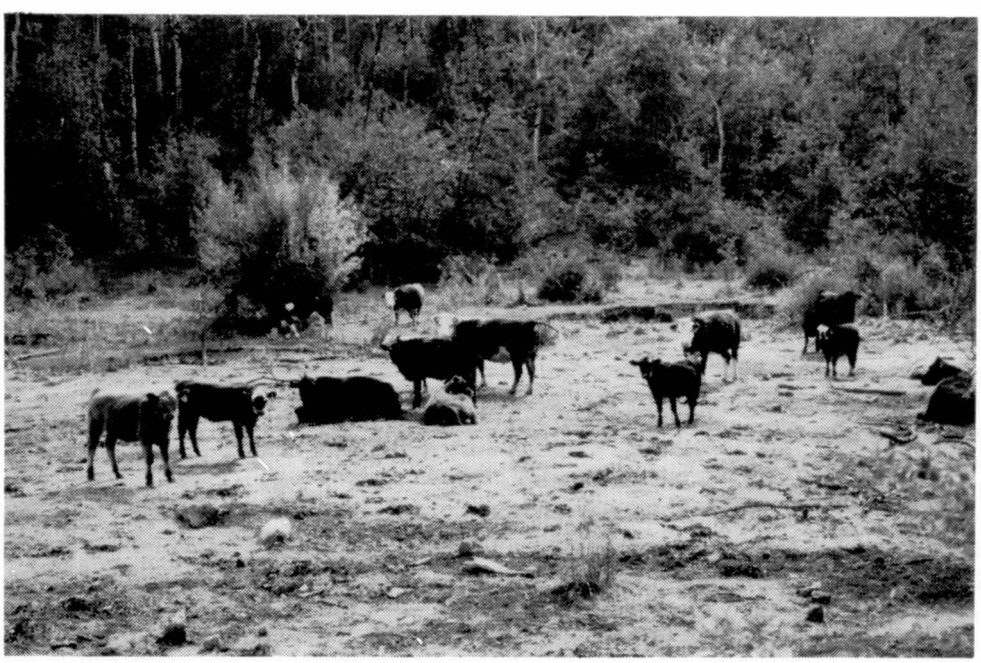
During the most severe drought in decades, thirsty cattle badly damaged riparian zones on public rangelands in southern Idaho [BLM says it made a "mistake" in management.]. . . . *An Idaho sports group, however, blamed the damage on pressure put on the BLM by ranchers and Idaho Sen. James McClure. R. Al Berry, a member of the Ada County Fish and Game League, told AP that cattlemen and McClure run the state, and if BLM officials tried to reduce grazing they'd lose their jobs.*

--*High Country News* (12-7-87)



Millions of acres of Western riparian bottomland have been devegetated and converted to livestock pasture and crops.

Luxuriant riparian vegetation turns to trampled, barren mud at fence. The cattle responsible for the contrast lie in the shade of a large oak at right. Note corral at left.



A National Forest riparian zone is now pummeled dirt. *(USFS)*

Though riparian areas on public land have suffered extensively from livestock, those on private land have fared even worse. In the 1800s ranchers took control of ***most*** of the fertile riparian flats in the rangeland West, along with associated surface waters. So the most productive riparian lands throughout most of the West have been in the hands of ranchers hands for over 100 years. To increase livestock production, they have cut down most riparian trees and brush on their lands and turned these bottomlands into cow, sheep, and horse pastures. **Thus have ranchers destroyed the most productive wildlife habitat in the rangeland West.**

Sadly typical to the contemporary Western scene is the once productive river valley, now stripped of nearly all native vegetation, fenced into small rectangles dotted with grazing cattle and sheep, barren of wildlife. The once free-flowing river trickles over gravel and rocks down the middle of the valley, narrowly restrained by parallel, rip-rapped rock dikes. A few large trees survive along the waterway and in places along the many irrigation ditches that dump most of the river's water onto the alfalfa fields and closely cropped livestock pastures that cover the valley.

Domestic livestock have been and continue to be the principal destroyer of healthy riparian zones [on federal land].

--National Wildlife Federation, in 1990 letter to New Mexico State Game Commission

[Note: Studies on livestock's riparian and aquatic impacts are relatively numerous; see bibliography for many.]

Flooding

"I don't get it. . . . What do cows have to do with floods?" asked Rick.

"It's simple," answered his cousin. "When the cattle strip the land bare, the rain runs off it as if it were concrete. Instead of soaking into the ground, it rushes into the nearest stream and down through the canyons. Places that once were fairly safe can be hit by worse floods than ever before."

"Like here!" added Zelda knowingly.

"That's right," continued Roberto. "But's that's not all of it. The floods carry tons of soil with them. They cause some of the worst soil erosion. And when the soil is gone, you can kiss this country good-bye."

--Gerry Bishop, "Adventures of Ranger Rick," *Ranger Rick* (March 1985) (Bishop 1985)

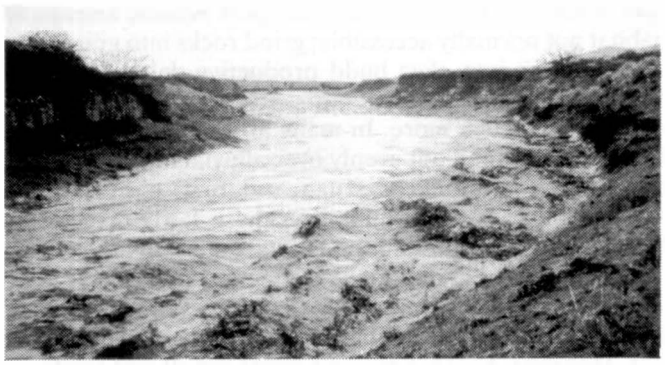
Floods can be defined as periodic dramatic rises in water flow within drainages, sometimes causing overflows onto land that is normally dry. Flooding is a natural and in many ways beneficial occurrence, serving many important functions. Floods periodically flush out and keep open waterways that might otherwise become choked with vegetation or blocked by detritus washed in from tributary drainages. As mentioned, flood overflow is essential to the building of fertile bottomland. Natural floods help spread seeds and root stocks; germinate seeds; transport aquatic animals to habitat not normally accessible; grind rocks into gravel into sand into silt into clay; build productive deltas; establish sandbars; maintain proper dissolved mineral levels in oceans; and much more. In many arid to semi-arid areas, flash floods spread out evenly over alluvial fans and plains, dispersing needed moisture and fertile sediments. Aboriginal peoples depended on these fairly predictable high waters and deposited sediments to support agriculture.

In the past, the greatest natural floods did, of course, have significant influences on local environments and occasionally may even have seemed disastrous from a human perspective. However, because massive water runoff was relatively infrequent, affected lands had plenty of time to reestablish. Indeed, in the long run, these natural highest waters were essential to the health and character of many ecosystems. Because the aboriginal environment was in near peak condition, resistance to the potentially destructive powers of floods was very high.

A heavy summer storm struck in the hills and gulches above town and what marched down Mt. Pleasant's [Utah] *main street was . . . a river of thick mud like concrete that, in a town of twenty-five hundred people, did half a million dollars' worth of damage in ten minutes. The range above town had been overgrazed and the storm waters which would have been retained by healthy land could not be retained by the sick, exhausted land.*

--Bernard DeVoto, **The Easy Chair** (DeVoto 1955)

Buenos Aires National Wildlife Refuge, ungrazed by livestock, is on the far side of the fence. *(Steve Johnson)*



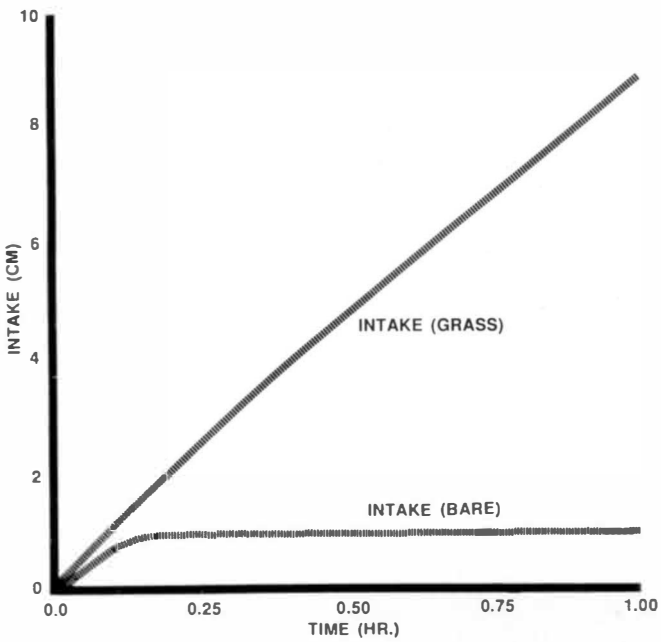
Watersheds degraded by livestock beget rampaging floods. *(Dave Foreman)*

Things changed with the introduction of livestock grazing in the 1800s. Violent flooding became commonplace throughout most of the West. Rather than mild flooding occasionally flushing out waterways, huge floods now ravaged stream and river channels. Rather than swollen streams and rivers gently overflowing their banks and moving slowly across bottomlands, massive floods turned whole canyon and valley floors into raging torrents, carrying away their topsoil and burying them under coarse sediments. Rather than moderate flash floods distributing moisture and sediments to alluvial outwashes, rampaging floodwaters cut deeply into the land and buried anything in the way downhill under tons of rock, sand, and gravel.

Intensified flooding due to livestock grazing triggered this massive landslide.

During the past 130 or so years, flood damage to the Western environment has been inestimably extreme. Billions of tons of topsoil, hundreds of thousands of acres of fertile bottomland and lush riparian land, billions of plants and animals, and millions of large trees have been swept away. Flooding, once a fairly reliable benefit to both environment and people, has become an uncertain and hated enemy.

Stockmen do not accept responsibility. And although ranching proponents offer 101 scapegoats, it is noteworthy that the peak in livestock numbers and commencement of greatly increased destructive flooding in each region occurred virtually simultaneously. For example, the period of 1875-1895 marked the beginning of this period in most of Arizona -- the same years livestock grazing reached its highest level. In most of California, where cattle numbers peaked at an estimated 1.4 million in 1860, destructive floods and drought in the 1860s caused extensive damage that brought cattle numbers down to around 670,000 by 1870 (Cleland 1941). In the vast Rio Puerco Basin of northwest New Mexico, serious flooding and arroyo cutting increased in direct proportion to the increase in livestock numbers in the 1880s to early 1900s. In most of Wyoming serious flooding and cutbank formation suddenly began at the same time huge numbers of livestock arrived from Texas and the far West in the 1870s and 1880s. Coincidence?



Water infiltration at Santa Rita Experimental Range, Arizona, 1975. Water not infiltrated = runoff; runoff = flood water quantity. (Source: Dixon 1978)

Livestock have caused this extreme increase in violent flooding mainly in 2 ways: (1) watershed degradation, and (2) damage to waterways and riparian areas themselves. The destructiveness of a particular flood depends on the amount of water it contains and the condition of the drainage through which it flows. In other words, because denuded and degraded watershed soils absorb much less water than previously, runoff is far greater and, thus, floods contain vastly greater volumes of water. These larger floods flow through degraded channels and riparian zones that are much more susceptible to flood damage.

Dense vegetation has an amazing capacity to hold water and percolate it into the soil and into aquifers, thereby limiting runoff and flooding. However, since livestock have for a century cut vegetative ground cover productivity by at least half on over half the West (livestock additionally eat and trample about half of surviving low-level vegetation annually), it is not surprising that rain and snowmelt runoff, and therefore major flooding, has increased dramatically during that period. Since plants eliminated by livestock were generally those most suited to conserving water, the increased runoff influence has been amplified.

As detailed, livestock have reduced the soil's water infiltration rate in many ways. However, the ground's ability to absorb and percolate water into aquifers also depends upon soil *quantity*. Soil holds water and releases it slowly into groundwater tables or surface flows. Where there is little or no soil, water runs quickly through underlying sand and gravel, hits bedrock, and flows off quickly into waterways. Topsoil likewise does a better job of holding and slowly releasing water than do underlying soil horizons. Since more than half of Western topsoil has been lost during the past 130 years, it is again not surprising that violent flooding has increased tremendously.

In "Land Erosion -- Normal and Accelerated -- in the Semiarid West," R.W. Bailey states that observations, measurements, and history ". . . amply justify the conclusions that many watersheds in the semi-arid West may develop a sufficiently complete plant-and-soil mantle to allow an infiltration rate equal to the greatest magnitude and intensity of storms." In other words, if undamaged, the plant and soil mantle of many watersheds in the semi-arid West will prevent serious flooding. As most of the rangeland West is in the semi-arid category, this means that before being grazed by livestock much of the West rarely experienced destructive floods.

This plant-and-soil mantle to storm equilibrium is verified by botanic, geologic, and hydrologic evidence from recent and prehistoric times. In their undamaged state watersheds have a far greater ability to absorb water and prevent flooding than is generally acknowledged. Unfortunately, undamaged watersheds are now extremely rare.

Both watersheds [along the Wasatch Front in Utah] *received equally heavy rain, yet the watershed of Parrish Canyon produced severe floods, whereas the adjacent Centerville Canyon produced little or no flooding. Investigation showed that the Parrish Canyon watershed was heavily overgrazed; whereas the Centerville Canyon watershed was protected from excessive grazing.*

--from **Environmental Conservation** by Raymond F. Dasmann (Dasmann 1972)

An arroyo on grazed range. *(Bob Dixon)*

If the West had a regional landscape, as states have state birds, it would be the gully and wash. Over the last century, millions of them have been cut into the vast landscape, carrying off cubic miles of dirt, causing water tables to drop, and helping to turn intact arid land into sterile desert.

--Ed Marston, "Rocks and Hard Places" (Marston 1991)

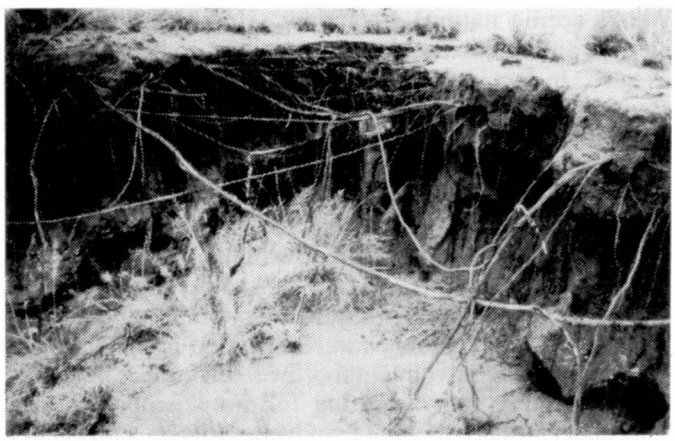
Most of us view the common eroded gulch as one of the West's scenic natural attractions. However, it is rarely natural, and scenic only because we have come to accept it as such. In fact, just 130 years ago it was unusual to encounter an arroyo (eroded drainage with flat floors and vertical banks) or cutbank, or even a scoured wash, in most of the Western US. In the Southwest, for example, the only stream for which significant pre-1850 arroyo trenching is well-documented is the Rio Puerco in New Mexico (where currently exist vastly larger arroyos than at that time).

Then in the late 1800s something radical happened. According to Ernst Antevs' study "Arroyo-Cutting and Filling," "The native grazing ranges were denuded in one to a few decades after the introduction of livestock in large numbers, and a general arroyo-cutting followed promptly." J.J. Thornber, an early botanist studying Arizona rangelands, agreed that "This overstocking [in the late 1800s] soon resulted in destructive overgrazing and trampling out of large areas of forage producing plants, often beyond recovery." As a consequence, rainwater rushed down watersheds and, "Once in the cienegas and rivers, these accumulated waters developed into the most destructive floods, cutting in the rich alluvial soils of these formerly well-watered valleys, within the space of a remarkably few years, permanent channels 5 to 30 feet deep and 50 to 300 feet wide."

Arroyos, though best represented in the Southwest, are now common to landscapes throughout the rangeland West. They come in all sizes, from small, eroded gullies to gigantic chasms up to 100' deep, hundreds of feet wide, and over 100 miles long. Arroyos are incised in unconsolidated materials consisting of clay, silt, sand, and gravel. These channels were formed primarily when accelerated water runoff from livestock-grazed watersheds caused violent floods that cut into the alluvium of the (usually) overgrazed bottoms of canyons and valleys.

Arroyos and cutbanks usually begin in the main drainages where floodwaters are most concentrated. After forming, they work their way back up main channels and tributary drainages, undercutting falls and eating away at cutbanks -- something like an army of Pac Men -- creating heavily eroded, miniature Grand Canyons. Because floodwater concentrates in these eroded channels rather than spreading out evenly over floodplains, downcutting, side cutting, and undercutting are exacerbated and deposition of bottomland is minimized.

Though arroyo formation was greatest during ranching's early years, it is still prevalent across most of the West. Moreover, the main reason that the rate of arroyo and cutbank formation has lessened during the latter part of this century is because the most arroyo-prone drainages have already been cut, not because grazing pressure and resultant flooding have significantly diminished.



Hanging roots indicate gully was recently cut; subsequent fencing from cattle has allowed new vegetation to begin recovery.

One of the simplest and cheapest ways to control small and medium gullies having small drainage areas is to fence them and exclude livestock . . .
--USDA, *Farmers' Bulletin #2171*

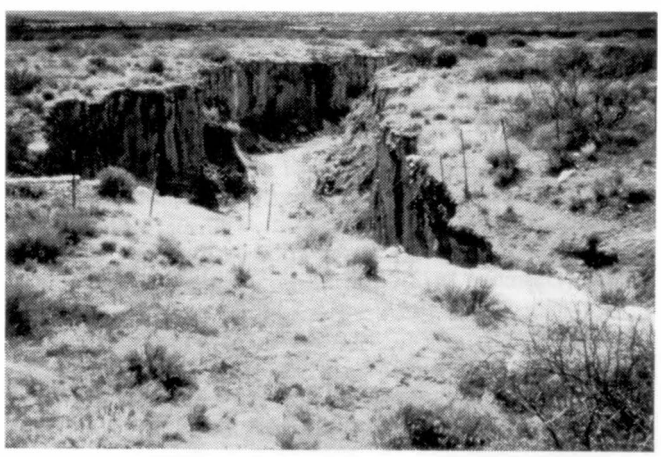
When a flood cuts into the drainage on the floor of a draw, canyon, or valley, long chains of destructive forces are unleashed. As channels cut lower into drainages, groundwater is drawn in laterally from adjacent bottoms and riparian zones and down to these lower levels. As a result, these bottoms and riparian zones dry out, stunting or killing vegetation and changing plant composition. Grasses, sedges, rushes, and other herbaceous perennials are replaced by annual forbs, cheatgrass, rabbitbrush, sagebrush, and bare dirt. Water levels drop below the roots of riparian trees, which then die.

For instance, the mesquite trees along the Santa Cruz River in southern Arizona originally grew to over 60' tall in huge riparian groves along much of this 100 mile long river valley. With the onset of heavy livestock grazing in the late 1800s, floods began cutting into the river bed and water tables began to drop. Mesquite roots, which can grow 300' or longer (the longest known roots of any plant) finally could no longer reach dependable moisture. Later, woodcutting and groundwater pumping augmented ranching's influence. Today, the river is gone and only a few stunted reminders of these once magnificent mesquite riparian forests survive.

Being barren and sun-baked, the walls of arroyos dry out quickly and effectively suck water from adjacent bottoms. In turn, when vegetation along drainages is depleted, violent floods are better able to rip into banks and expand cutbanks, causing further drying of adjacent land. In a similar manner, groundwater from surrounding uplands gravitates down and inward toward these incised channels, drying out the uplands as well.

One might imagine that surrounding groundwater draining down and in toward arroyo bottoms would increase streamflow there, but curiously just the opposite usually occurs. Arroyo beds, barren and composed of coarse sediments, are much less able to bring water to the surface than the well-vegetated, fine-soiled, fertile bottoms they replaced. Dried out, adjacent grazed land that once conserved water and released it gradually into drainages no longer does so.

Very active arroyo cutting on BLM land in the overgrazed Rio Puerco River drainage, NM. *(BLM)*



Large cutbanks on state land, Yavapai County, Arizona.

Across the West, cattle graze unchecked in stream bottoms, destroying riparian zones and causing serious erosion that in turn causes the deep-cut-bank streams that even old-timers think are natural conditions.
--Charles F. Wilkinson, professor, University of Colorado Law School

Ranchers commonly blame "the damnable weather" for all this. Many say that violent flooding, arroyos, and cutbanks have always been around. Of course, it does take a lot of rain or snowmelt to cause flooding anyplace, overgrazed or not. But blaming the weather for the flooding destruction of the past 130 years is like blaming the air or your lungs for your lung cancer after smoking 3 packs a day for 30 years.

Other ranching apologists promote the drying climate theory as the cause of the massive depletion of vegetation, water, and soil over the past century. Curiously, many of these same people concurrently push the violent weather theory to excuse the massive flooding and arroyo cutting of this same period. One well-known ranching proponent claims that "sudden violent showers" and "irregular occurrences of heavy storms" are what really caused the sudden appearance of arroyos, cutbanks, and tremendously destructive flooding in the West. Livestock were supposedly a minor influence, or at most merely a "trigger" that helped set off this deterioration.

If this were indeed true, wouldn't geologists and archaeologists have found much evidence of past periodic channel cutting and violent flooding in what is now the Western US? They haven't. Based on historical accounts and photographs, both K. Bryan and J.T. Duce, in separate studies, concluded that arroyo formation in the semi-arid West occurred at the time of livestock introduction and was not related to geomorphological processes (Palmer 1988). If livestock grazing is just a harmless "trigger," then what is the weapon, and why was it never detonated before?

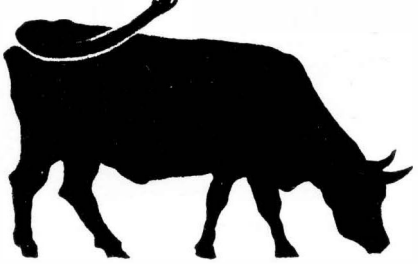
Today, many other human activities contribute to increased flooding, including logging, mining, ORV (off-road vehicle) use, road building, and development (much of all this by the ranching industry). Many stockmen lay the blame on one or more of these factors. But consider this: Throughout most of the West accelerated and violent flooding began long before any of these other activities had a substantial influence. Further, in many watersheds that have experienced increased and ruinous flooding, livestock grazing was and still is the only significant human use.

In 1933 a portion of Wickiup Creek in central Oregon -- at the time, a wide, barren, trampled, arroyo -- was fenced from cattle. Fifty years later, a 94% decrease in incised channel area had occurred, and the clear, flowing creek was "almost completely obscured by grasses and sedges, and willow thickets . . ." (Clifton 1989)

[Note: Consult Packer 1953, Lusby 1970, Busby 1981, Debano 1989, and other references in the bibliography for more information on watershed runoff and flooding.]

The greatest damage from erosion on range lands occurs where the areas have been overgrazed and the ground cover destroyed or seriously impaired. Before the ranges had been overstocked and the ground cover impaired, erratic run-off and erosion were practically unknown. After the breaking up of the vegetative cover in the early nineties, however, many streams originally of steady year-long flow and teeming with trout became treacherous channels with intermittent flow through which the water from rainstorms was plunged, or rose and fell according to the size and frequency of the storms and carried so much sediment in the water that fish and similar life could not exist.

--Range professional A.W. Sampson (Sampson 1918)



Water Quality

I can imagine the splendor of a not-so-distant past when Westerners could drink from streams without fear of giardia and other water-borne illnesses. But now, whether it be drinking from an alpine lake, a Rocky Mountain waterfall or a canyon creek, that opportunity has been lost due to indiscriminate cattle grazing. . . .

--Ken A. Rait, Tucson, AZ, *High Country News* (9-12-90)

Even as livestock grazing has depleted or eliminated most Western water sources, so has it lowered the *quality* of remaining water. Experts estimate that 90% of the surface water on public land is significantly polluted. In the West, sediments loosed by livestock, pollutants washed off the overgrazed land, manure, urine, and dead cattle are the main sources of water pollution in most ranching areas (which, again, compose 70% of the West), as well as many downstream waterways. The Arizona Department of Environmental Quality reports that 95% of the state's surface waters are polluted, with livestock being the leading cause. In Utah, more than half of the high-priority nonpoint source watersheds identified by the Utah Department of Health suffer from excess salts, organic and chemical wastes, and sediment due to grazing. The *New York Times* reports that cattle "represent the West's largest source of 'nonpoint' water pollution" (Royte 1990). Nearly all surface waters in the West are fouled with livestock-related contaminants (Suk 1986).

These plains rivers are depressing and rather sinister to look at, and they always have been helping carry the mountains to the sea. But one reads with amazement descriptions of them before the Civil War. They were comparatively clear streams, streams whose gradual, geological erosion of the land had not been accelerated -- as it was when the cattle business came to Wyoming and Montana.

--Bernard DeVoto, **The Easy Chair** (DeVoto 1955)

As water runs off the denuded, degraded, depleted soil of watersheds, it picks up sediments and carries them into surface waters. Other sediments are contributed by degraded riparian areas, crumbling banks, and trampled, stirred up stream and lake beds. Much of the finer-particled sediment remains in suspension for days, or indefinitely if water remains in motion, as in flowing water or where livestock stir it up. The sediment is harmful to fish and other aquatic life. Field studies reveal 37%-59% decreases in biological productivity as a result of increases in water-borne fine sediments.

In the West, rangeland contributes 28% of the total sediment load (as with soil erosion, most sediment is from farmland) (Ferguson 1983). In the US, over half of the suspended matter in water supplies consists of particles washed off grazing land and cropland used to grow livestock feed (Hur 1985a).

In 1929 the US Geological Survey estimated that the San Juan and Little Colorado River watersheds, which drain the Navajo Indian Reservation, where overgrazing was then at a peak, contributed 14% of the Colorado River's water but

more than half of its sediment. It called the Navajo Reservation "public enemy number 1 in causing the Colorado silt problem." Subsequent stock reductions brought corresponding reductions in siltation, though overgrazing remains the Navajos' most serious environmental problem (see Chapter IX).

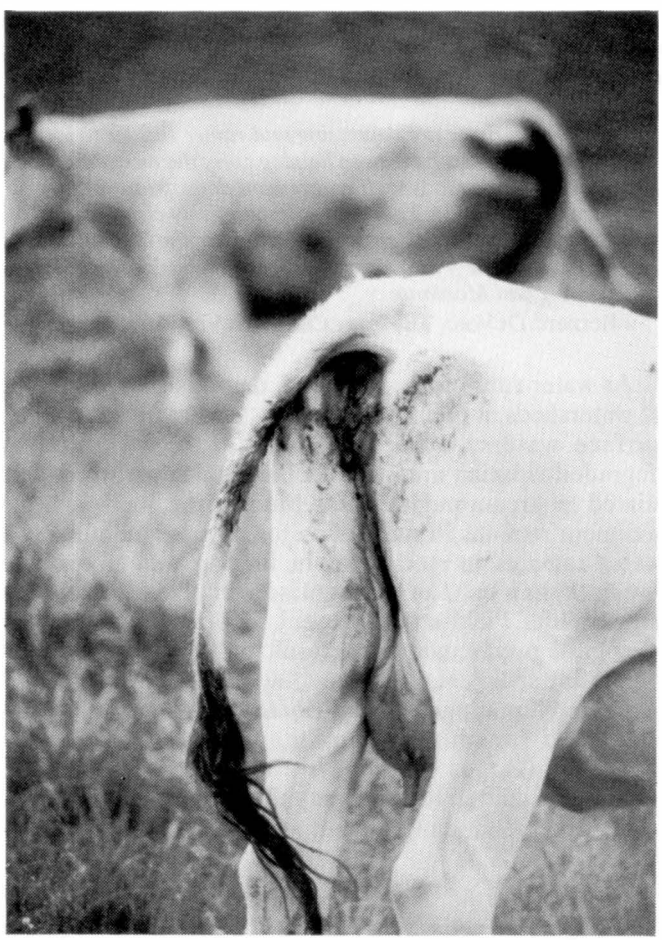
Airborne pollutants from vehicular exhaust, industrial emissions, radioactive discharges, and so forth are spread by winds through the atmosphere, a portion settling gradually onto downwind rangeland around the West. Various solid and liquid toxic wastes are dumped there, along with other banishments from civilization and ranching operations, such as old equipment, vehicles, appliances, trash, etc. Mining wastes make a heavy contribution. As rainwater and snowmelt run quickly off damaged watersheds, harmful particles from all these sources, rather than being filtered through soil or held on land until rendered less harmful, are picked up and carried into streams, lakes, and oceans. Once in water supplies, they may be consumed by animals and people, causing or contributing to a variety of health problems. Thus, ranching's overall contribution to water pollution is much greater than indicated by figures for its direct contribution.

Similarly, as mentioned, aquatic vegetation filters out and breaks down sediments and pollutants. On public land, livestock grazing has removed and destroyed far more aquatic vegetation than has any other influence.

Livestock also cause chemical water pollution directly. Cattle produce about 50 pounds of manure each day, which contains large amounts of ammonia, nitrates, sodium, phosphates, potassium, and other elements that -- in the amounts commonly found in livestock-impacted streams -- harm plants and animals; nitrates in drinking water, especially, have been shown to be hazardous to humans. Cattle urine, of which each cow donates about 20 pounds per day, contains much ammonia, which in heavy concentrations is toxic to fish and other aquatic animals. Excessive sediment and foreign substances washed off rangeland and dissolved into or chemically transformed in surface waters also add to chemical pollution, as do ranching activities such as herbicide and insecticide spraying.

Livestock grazing sometimes lowers water quality by lowering water tables. Much of groundwater is saline or highly mineralized, especially at lower levels. When good quality groundwater is depleted, adjacent lower-quality water may flow in and mix with what remains. This fouled water may then appear as surface flow or be pumped for human use.

Similarly, livestock have lowered water quality by reducing surface flows. Less flow means less aeration and filtering through inorganic sediments and aquatic vegetation, as well as less *volume* of water to dilute pollution. The stock tanks that partially replaced depleted surface waters exhibit essentially no flow and little cleansing action.



Compared to nearly all wildlife, cattle are filthy , disease-ridden animals. If not for modern medicine, many would not survive.

Ranching operations are the main cause of water pollution on Western public lands.

Almost always, government agencies advise against drinking from natural water sources. The traditional explanation has been, "There might be a dead animal just upstream from where you are drinking." Except in the case of dead cows, this is basically a fable, nurtured by the ranching establishment for a hundred years and generally accepted by the American public. Indigenous Americans drank solely from natural waters for millennia and rarely fell ill as a result. Many thousands of modern Americans have become sick and some have died from doing so. When hard pressed, government officials will usually confess that livestock are actually the main culprits. Most Western communities utilizing surface flow for domestic water seem to agree; they fence off their watersheds and water sources, from livestock more than from people. In the East's Appalachian Mountains, where there are no livestock but many humans, hikers are provided dippers at stream crossings and most are unafraid to drink the water.

Livestock grazing is the main reason we may no longer safely drink from natural water sources in the West (and, again, the main reason so many natural water sources no longer exist). Note cowpie at edge of creek. *(Bill Lewinson)*

Regardless, many ranchers contend that *people* -- backpackers especially -- are the real transgressors behind biological water pollution on Western public land. Undoubtedly people *are* mostly to blame in a few small, heavily used areas. But how many humans defecate directly into a stream or lake? Cattle do, perhaps a million of them each day, on *most* public land. If 1 million cows each release 1 quart (2 of 50 pounds) a day into water (a conservative estimate), this means that at least 1000 tons of bovine excrement are discharged into our public waters every day. Though human excrement generally is more dangerous from a disease standpoint (at least to humans), people produce an average of only 0.33 pounds per day, an infinitesimal percentage of which is released into public waters. Thus, the daily direct human contribution is *tens of thousands* of times less.

Many diseases and disorders are spread via water-borne livestock pollution to wild animals and humans. Most are bacterial or protozoan in nature.

Various *salmonella* bacteria, spread by livestock through surface waters, cause disease to humans and wildlife. *Dysentery* may be spread through feces or water. *Anthrax* bacteria live in the stagnant pools and hoof ruts created by trampling cattle or sheep and infest mice, rabbits, and other wild and domestic animals, usually killing them quickly. A similar bacteria-caused disease is *black leg*, which has killed many large herbivores over the years, though humans are immune. *Hoof rot* is also spread to ungulates through infected waters.

One disease of great concern is *giardiasis*, which is caused by giardia, a water-borne protozoan that parasitizes the intestinal tracts of humans and at least 40 wild and domestic animals, including cattle. More than 16 million Americans are currently thought to be infected with it, mostly from contaminated community water supplies in the East. Giardiasis can debilitate the body on a semi-permanent basis and cause acute abdominal pain, bloating, vomiting, and diarrhea, sometimes leading victims to seek hospitalization.

Countless thousands of people and wild animals have contacted giardia by drinking contaminated water from public land. Grazing industry apologists are currently busy trying to pin the blame for this giardia on beavers and humans. However, they ignore important facts. A main one is that giardia bacteria are often contracted from springs, streams, ponds, and lakes not inhabited by beaver and where human use is extremely light.

Consider, for example, that 20% of stock tanks tested in Arizona contained giardia. I have never seen any sign of beaver in a stock tank, and no other giardia-carrying mammals or humans use many of them either, so cattle are the only possible source. Many scientific questions about giardia remain, but overwhelming circumstantial evidence indicates that cattle are a major, and probably *the* major, purveyor of giardia to public waters.

This bloated carcass is actually *floating* downriver in at least 6' of water.

A dead cow is stranded on a gravel bar, unnoticed until downwind. The corpse lies like a beached hull, misted with flies. And more dead cows -- whether from infection, accident, or stupidity we can only guess. The aroma downriver of various states of decomposition ranges from unpleasant to pungent to nauseating.

--Ann Zwinger, **Run, River, Run**

Dead cattle are another source of biological water pollution. Seeing their bloated corpses floating down rivers, as I have many times, is not at all uncommon, especially during flooding. Other times, you will find them lying stiff-legged, half eaten by maggots, at the edge of a pond or stream, exuding foul fluids into the water. As you can imagine, a putrid, rotting, thousand-pound cow carcass can contribute to water pollution.

Also spread by livestock via surface waters are internal parasites. *Tapeworms*, various *roundworms*, and *pinworms* can be transmitted to wild animals and humans when affected cattle and sheep defecate into water.

Livestock's overall contribution to all the above-mentioned types of water pollution is vastly greater than that of all wildlife combined. Not only is there a far greater biomass of livestock, but livestock concentrate and spend much more time in and near surface waters. Being large, clumsy foot-shufflers, cattle keep sediments and waste products stirred up and in suspension. (Fecal *coliform* bacteria counts in these sediments may be 100 to 1000 times greater than in surface water itself.) And certainly, few other large animals evacuate their bowels and bladders directly into their own water sources.

Springs, creeks, ponds, and stock tanks are especially susceptible. Many are turned into virtual cesspools, heavily laden with manure, urine, rotting vegetation, and muck. Under these conditions, summertime fecal *streptococci* bacteria counts soar. On the other hand, *coliform* bacteria peak during spring runoff when large amounts of excrement are washed in from rangelands. Numerous studies show that prevailing livestock use increases stream bacteria levels as much as 1000%, and that levels may remain high for months after livestock are removed (Gary 1983, Blumm 1986, Tiedemann 1987, etc.).

Relative to all of the above, consider the State of Oregon's official definition of water pollution (similar to most states):

. . . such alteration of the physical and chemical or biological properties of any water of the state, including change in temperature, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into the waters of the state, which will or tends to, either by itself or in connection with any other substance, create a public nuisance or which will or tends to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life or the habitat thereof.

Obviously, under Oregon law (as under all other Western state water pollution laws) livestock are water polluters of the highest magnitude.

As the vast bulk of Western water is located on, flows through, or flows from public land, most surface waters in the West are affected by public lands livestock grazing. As mentioned, 75% of Western water for human use comes from National Forest land, most of it grazed by livestock.

(Ginny Rosenberg)

The drastic reduction in the amount of surface water in the West over the past century or so is a major adverse result of public lands ranching. If compressed into a single year, it would be declared a national disaster. The widespread pollution of what water remains adds insult to injury. The public and public land have a fundamental right to naturally occurring, clean water.

. . . grazing helps improve grass and crop production, control erosion, recharge aquifers, enhance riparian conditions, and provide water for recreational, agricultural, and other needs.

--Livestock Grazing Successes on Public Range, USFS, BLM, and Public Lands Council (USDA 1989)

They lie.

--Mike Roselle, progressive activist

Oman handed me a two-year-old photo that showed three cows wading in a mudhole embraced by bare, compacted dirt. I lifted my gaze from the photo to the pond, now rimmed with greenery and full of ducks and grassy nesting islands. We climbed over the fence and walked into the twenty-seven-acre oasis. Everywhere flax and aster were in blue and purple bloom, and thousands of willows, some waist high, were sprouting around the pond's perimeter. We pushed on toward the dike through Great Basin wild rye -- the native bunch grass that lapped the stirrups of the pioneers. A year ago the dike had been naked. Now it was filling in with western yarrow and small burnet, a good wildlife staple. Killdeer screamed, a marsh hawk wheeled and dipped, and redwings rustled through the cattails.

--Ted Williams, "He's Going to Have an Accident" (Williams 1991)

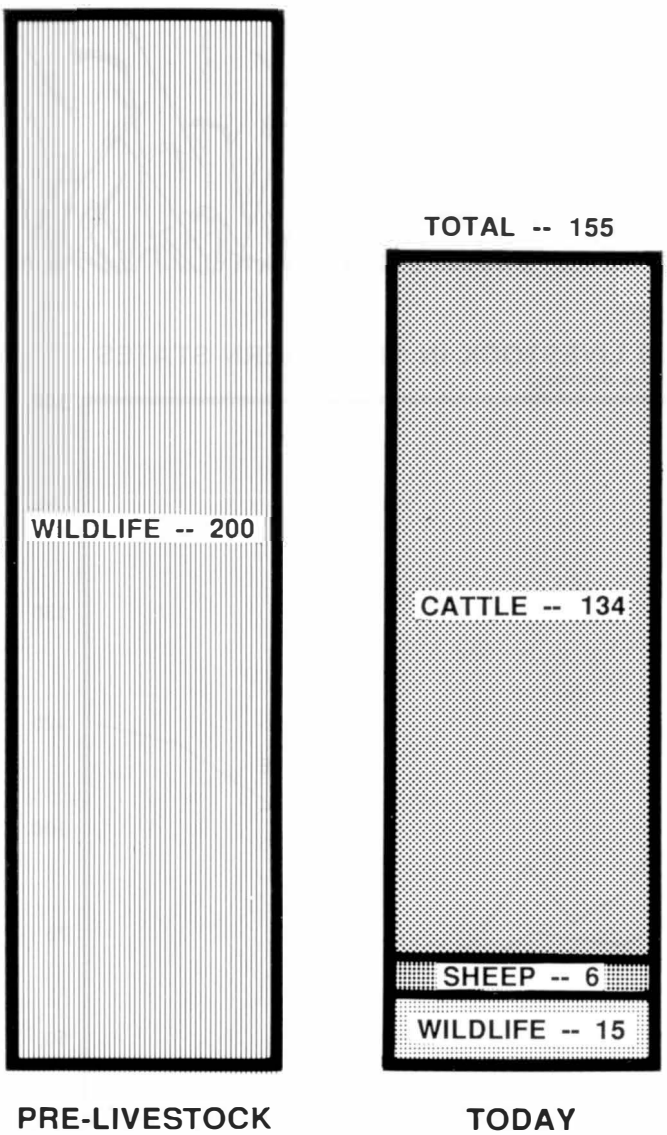
Animals

The grazing of domestic livestock on Western rangelands has probably had a greater adverse impact on wildlife populations than any other single factor.

--Steve Gallizioli, Research Chief, Arizona State Game and Fish Department (Ferguson 1983)

Do you realize that the small piece of plastic dropped along the way or left in camp is a thousand times more dangerous to wildlife (and livestock) than any cow?

--Jim Ellison, public lands rancher, Bond, Colorado, in a letter to the editor of *Colorado Outdoors* (Nov/Dec 1986)



RANGE AUMS CONSUMED: 11 WESTERN STATES

(In millions of AUMs annually. Livestock and large wild herbivores. Rough conjecture based on various sources.)

Practically speaking, *there are no empty niches in a healthy ecosystem*. Aside from any additional deleterious effects livestock may have, every cow, sheep, goat, or other domestic animal on the open land is *replacing* naturally occurring animals -- taking up their "living space," so to speak. No matter the number of livestock or grazing method used, there is no way around this actuality.

When livestock deplete natural resources and occupy space, wild animals have less available for food, cover, shelter, perching, mating, nesting, hibernating, and so forth. Additionally, the mere physical presence of domestic stock interferes with territorial boundaries and behavior, and forces wildlife to seek larger domains and infringe upon and deplete their neighbors' habitat. In short, wildlife has less of what it needs to survive. As a general rule, when livestock are placed in an area, they eliminate at least roughly their weight in elk, raccoons, spiders, pronghorn, worms, badgers, moles, mice, microbes, salamanders, robins, and other wild animals that inhabit the area.

However, livestock's negative impact on wildlife is far greater than this simple rule indicates. Mark Dimmitt, curator of plants at the Arizona-Sonora Desert Museum in Tucson, states that, "Anytime you damage a plant, you affect the health of an animal." Indeed, botanists estimate that the loss of 1 plant species affects the life processes of, on average, at least 15 animal species. On the Western range livestock grazing has depleted or extirpated more native plant species and biomass than any other factor. For each domestic animal added to an ecosystem there is a much greater corresponding decrease in total wildlife biomass, affecting a great number of species.

To repeat, Western rangeland today is probably less than half as productive biotically as before the livestock occupation. Disregarding other factors, it stands to reason that rangeland now supports less than half the biomass of wild animals that it once did. Further, on most rangeland today livestock have stripped off at least half of the forage and much of the browse; most public lands grazing plans call for 30% to 70% herbage "utilization," while actual removal (and destruction by trampling, etc.) is often even higher. With all this in mind, it is easy to understand why many native animals have been devastated.

Bighorns forage on heavily grazed BLM cattle range near Cody, Wyoming, but if snow piles too high they may starve -- while the cattle responsible for the lack of forage are fed hay. *(George Robbins Photo, Jackson, WY)*

Large Native Ungulates

We have let cattle displace at least 90% of native ungulates in the West. If loggers wanted to replace 90% of the trees in the West with even-aged European pines, would we let that happen too?

--George Wuerthner, naturalist/author

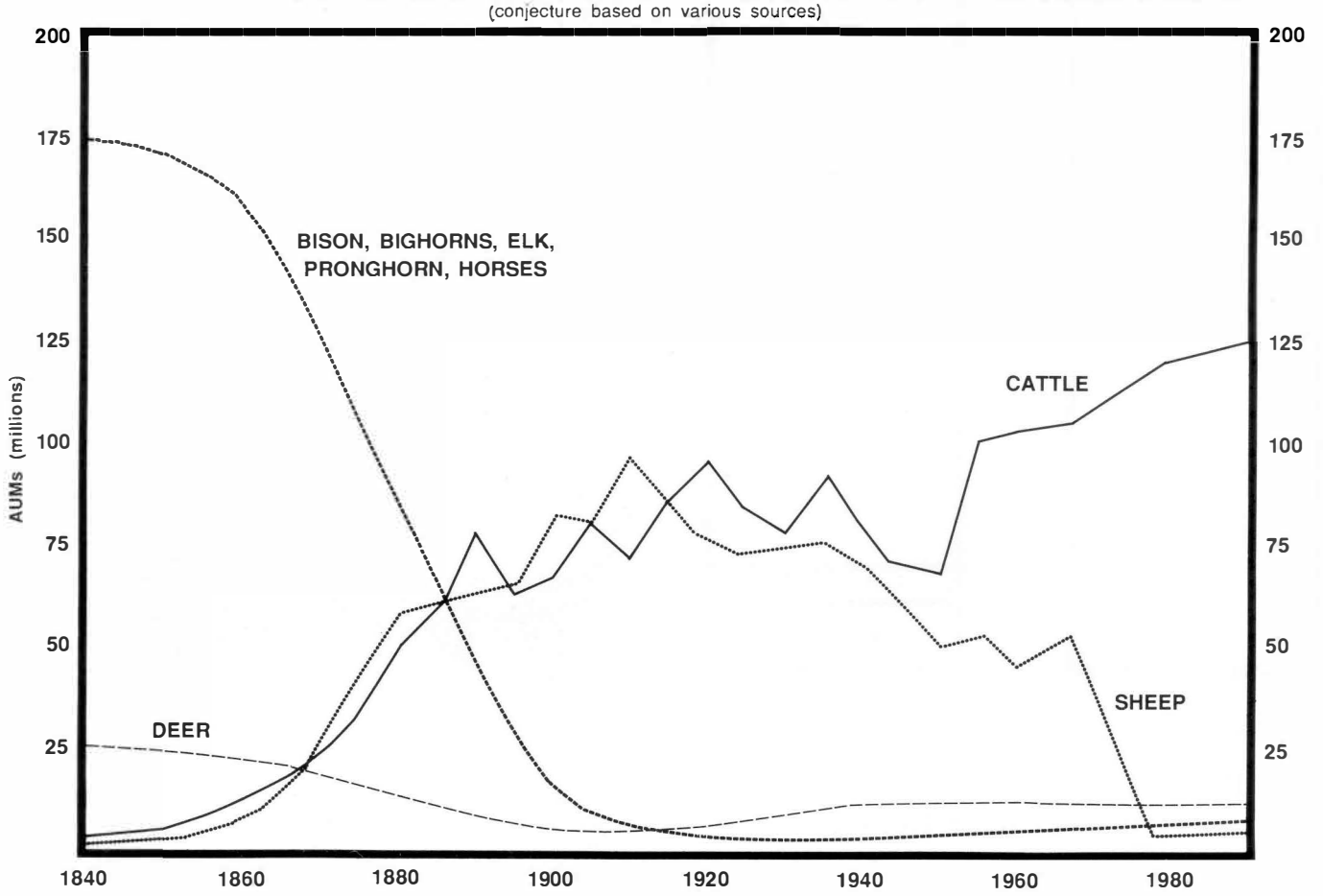
Cattle alone now eat a greater relative percentage of Western vegetation than did all native large ungulates combined when they roamed in great herds and scattered bands 150 years ago. According to reasonable estimates, at that time buffalo, elk, deer, pronghorn, bighorns, and free-roaming horses consumed roughly 150-250 million AUMs from the range in the region that would become the 11 Western states. Today, based on government wildlife estimates (which may be inflated), these species combined consume approximately 15 million AUMs from the Western range. Domestic sheep currently eat roughly half this amount, whereas cattle eat perhaps 7-10 times this amount, or between 100 and 150 million AUMs. (Variations in estimates are due largely to differences in what constitutes rangeland." For instance, some types of pasture may be considered rangeland and some may not. Ultimately, however, nearly all Western land now used to produce livestock was originally rangeland.)

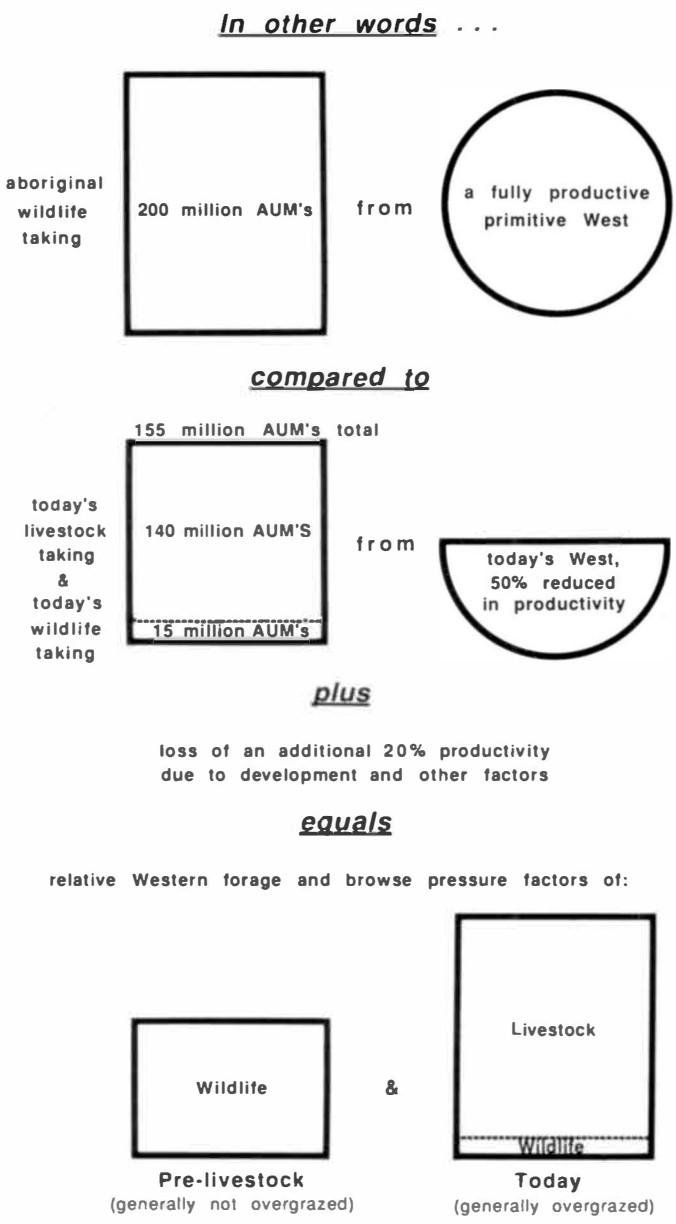
Therefore, the total amount of herbage eaten by all large herbivores, wild and domestic, on Western rangeland today is perhaps 130-170 million AUMs, compared to the 150-250 million eaten by wildlife 150 years ago. Of course, geographic use patterns are somewhat different now, so relative grazing pressures vary. For example, due to livestock water developments, some areas grazed by livestock now were never grazed by wild ungulates. Farmland now ungrazed was at one time prime wildlife range. And public and private range has experienced variations in management over the years. However, most of the West grazed by wildlife then supports relatively similar, corresponding -- *though lower* -- livestock levels now.

In a nutshell, this reaffirms that (1) today's rangland is far less productive, and far more degraded, than in pre-livestock times, and (2) livestock, unlike native herbivores, are destructive, and primarily caused this condition.

GRAZING AUMS CONSUMED BY WILDLIFE AND LIVESTOCK IN 11 WESTERN STATES

(conjecture based on various sources)





Further, there is an even greater relative loss to wildlife than the numbers of AUMs would indicate because livestock generally deplete and destroy the vegetation most beneficial to wild animals, largely because ranchers move their animals about to maximize consumption of preferred forage and browse in the most productive locations. Likewise, because so much of the West's preferred grasses, forbs, and browse are depleted, livestock frequently eat other types of vegetation, which accordingly leaves wildlife even less desirable vegetation in even less favorable habitat. There is therefore that much more competition between livestock and wildlife than commonly acknowledged by the grazing industry. For example, on many Great Basin sagebrush ranges, palatable browse, grasses, and forbs are so depleted by livestock that deer are forced to eat sagebrush, which they may survive on but not thrive on.

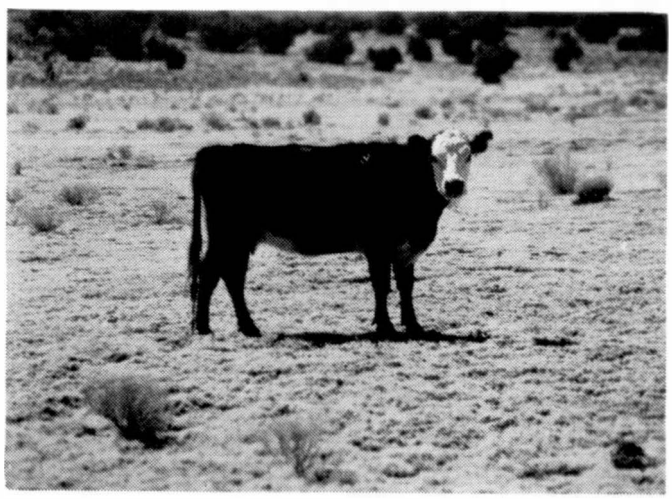
Additionally, since heavy grazing has depleted native forage and browse and degraded the range, poisonous increasers and exotics have become much more numerous and widespread. The great reduction in available food plants has forced wildlife to eat this toxic vegetation, causing a significant increase in the percentage of wild animals harmed or killed by this influence.

Finally, wild ungulates generally are more selective in their diet than are livestock, so they are more adversely affected by these radical vegetation changes. Much evidence indicates that livestock are better able than most wild herbivores to adjust their dietary needs to changing range conditions. Domestic cattle and sheep, spread over most of the globe, have adapted to and have been bred to eat whatever is available. Wild herbivores, on the other hand, have evolved slowly along with and so are adapted to certain plant species in certain habitats. In other words, though they may be selective within their forage area, livestock can survive on a greater variety of plants within a wider variety of conditions than most wild plant eaters (although within their own particular habitats most wildlife species would outcompete livestock without human intervention). In **Wildlife and America**, Frederic H. Wagner explains it somewhat differently:

> *Livestock, through centuries of selective breeding, appear more capable of shifting diets without so much detrimental effect on their nutrition. Consequently, as vegetation composition is altered through grazing, wild species may be affected detrimentally by slight or subtle changes while the range may still be in quite favorable condition for domestic animals.* (Wagner 1978)

All this doesn't take into account other negative factors such as introduced disease, loss of predators that normally keep wildlife populations healthy, hunting and trapping by ranchers, the effects of fences, human encroachment from ranching roads, and so on. No wonder populations of large herbivores -- and most wild animals -- plummeted when livestock grazing became intensive.

The decline of large herbivores on the Navajo Reservation in the late 1800s demonstrates ranching's impact. Navajoland visitors reported abundant game, including pronghorn, deer, and elk, in the early 1870s. Livestock numbers exploded soon thereafter and, as a result of overgrazing combined with hunting to eliminate livestock competition, by 1884 the Navajo Indian agent reported no game left. (White 1983)



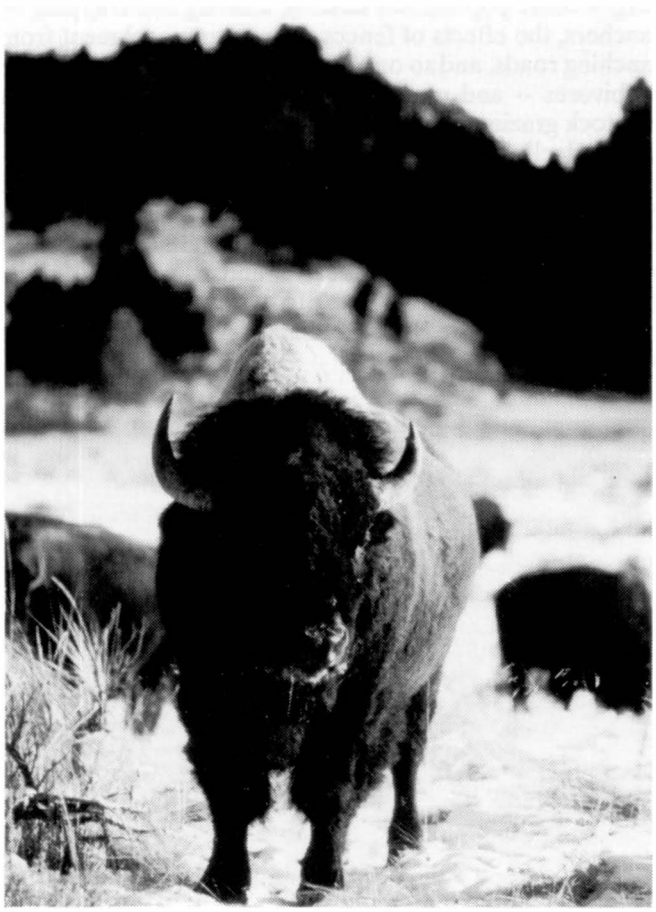
(Paul Hirt)

Contrary to the claims of some ranching advocates, compared to today large wild herbivores were numerous throughout the aboriginal West. Historical records and scientific study indicate that only the driest deserts and other waterless, barren, or inaccessible areas lacked some type of large herbivore. The mid- and short-grass prairies, in fact, supported megafauna numbers second only to that of Africa's Serengeti.

Aside from heavy use in the vicinity of strategic watering places and salt licks, however, native animals did not cause long-term depletion of native vegetation. Normal seasonal migrations permitted recovery of the range. The animals moved slowly across the land, herds of different species often side by side, grazing and browsing as they went, usually not returning to the same area until several years later -- perhaps even 10 or more years later. Moreover, for millions of years they and the vegetation they ate evolved together, to each other's overall benefit. There existed a symbiotic, dynamic equilibrium, a natural balance between plants and animals.

When livestock were introduced into the West, this coevolution mostly came to an end. As huge and wildly fluctuating numbers of domesticates were added to those of wildlife, the natural balance was quickly upset. Many species had to change habits and habitat to survive; in most areas populations significantly decreased or species disappeared altogether.

Native animals most noticeably affected by livestock have been the large, herding ungulates -- buffalo, elk, whitetail and mule deer, bighorns, pronghorn, and free-roaming horses (see Competitors in Chapter IV). Somewhat resembling cattle, sheep, and goats in size, herding tendency, and food requirements, these were the animals most perceptibly vulnerable to degradation of their habitats, to introduced disease, and to being replaced, displaced, and destroyed by livestock.



(George Wuerthner)

Just 150 years ago, incredibly huge herds of buffalo roamed the Great Plains and, in lesser numbers, the grassy portions of the Intermountain West, even in the mountains themselves. However, even then buffalo numbers had been reduced by Native Americans, chiefly because introduction of the free-ranging horse in the 1500s allowed for much more efficient buffalo hunting and eventual overkill. Estimates place the buffalo population in North America at that time at 40-75 million, and in the area to become the 11 Western states at 7-12 million, with the greatest concentrations on the plains of Montana, Wyoming, and Colorado. Single herds sometimes numbered in the millions and stretched 100 miles or more in length. It is thought that these herds were the greatest animal concentrations in terms of biomass that ever existed.

There were 2 subspecies of buffalo: the *plains*, which in 1900 dropped to a low of only about 500 individuals, and the *woods*, which is said to be genetically extinct as a species.

Directly or indirectly, buffalo provided necessities to a great number and variety of creatures, including wolves, coyotes, foxes, grizzly and black bears, eagles, wolverines, buffalo birds (now ironically known as *cow*birds), magpies, prairie dogs, dung beetles, and many others. For instance, the numerous buffalo bones once scattered across the plains were an important source of calcium to small gnawing mammals. These animals, in turn, dug extensive tunnels into the prairie soil, benefitting soil and water systems, and so on.

Effects of the loss of the buffalo reverberated throughout the environment. The thousands of large buffalo wallows that once pock-marked Western grassland became ponds to be used by numerous plants and animals. The wallows provided dust, dirt, and mud some animals used for various purposes; they also furnished an environment favorable to certain plant species with few other places to grow on the open prairie; and they provided for a diversity of habitat, not only for species that specialized in buffalo wallow habitat, but for those that depended on a combination of wallow and other types of habitat. Abandoned buffalo wallows, which contained copious manure and captured runoff, rich sediments, and organic material, eventually provided fertile, moist seedbeds for lush vegetation and habitat for many wild animals. Some of the depressions left by these wallows, and traces of their unique biologic community, can still be seen on the prairie today.

That the buffalo's demise was due mainly to the US campaign (led largely by stockmen) to subjugate the "Indians" by destroying their livelihood and to a relentless quest for meat, hides, and sport, is well-documented. But livestock, too, had a heavy hand in the buffalo's annihilation. Especially in the later years, cattle competed with buffalo, persistently overgrazing their forage plants, introducing disease and crowding them out. As buffalo declined, livestock occupied nearly all of their former range, effectively eliminating opportunities for re-establishment.

Recovery efforts by concerned groups and individuals in the early 1900s gradually increased buffalo numbers and saved them from extinction. The US government established token buffalo herds in some Western states; their low numbers are now carefully controlled, often with sport hunting. In recent years, as a growing appetite for buffalo meat has led to "buffalo ranching" (see Chapter XII), the total number of buffalo in North America has risen to approximately 90,000 -- still only roughly 1/600th their aboriginal number. Most are *raised* on small, carefully fenced lands that better resemble cattle ranches than open buffalo territory. There are no longer any truly wild, truly natural buffalo.

A time would come when those plains would be a grazing country, the buffalo give place to tame cattle, farmhouses be scattered along the water courses, and wolves, bears, and Indians be numbered among the things that were.
--Francis Parkman, in the preface to the 1872 edition of **The Oregon Trail**

We've been under Forest Service management since the 1930's, and we don't believe there's overgrazing by cattle. If there's any overgrazing, it's by elk. The cattle have been undergrazing. . .
--Jim Webb, President, Arizona Cattle Growers Association, in 1988

(Steve Johnson)

Before European settlement, elk lived in a wide diversity of habitats across North America: from coast to coast, from northern Canada to Mexico. Historically, 6 subspecies have been described, all of which lived somewhere within the 11 Western states. Two are now extinct due to human impact.

Herds of hundreds and even thousands of elk roamed the Great Plains, inter-Rocky Mountain valleys, semi-arid grasslands and adjacent mountains of the Great Basin, hills and valleys of California, forests of the Northwest, and mountains and mesas of the Southwest. Estimates put the number of elk in the West at that time variously at 2 to 5 million, with the higher figure probably more accurate.

Over the years, elk were overhunted and pushed out of their former range by ranching, farming, and development. The survivors were those able to subsist in rugged, remote, heavily forested areas; now elk occupy less than 15% of their former range. Since reaching a low point of about 70,000 in 1920, elk recovery and reintroduction efforts (mainly for hunting purposes) have brought the number in the West up to about half a million -- perhaps 10% of their original number. In contrast, there are about 20 million cattle and 5 million sheep in the 11 Western states, representing roughly 100 times elks' biomass (USDA 1987).

In the West today, elk are found mostly in National Forests, in dense mountain timber and adjacent open spaces where they can forage and browse. Primarily grazers, elk and cattle eat many of the same plants. Competition between the two is intense in much of the remaining elk habitat, not only for food, but for salt, minerals, and sometimes even water. For example, thousands of elk in Yellowstone National Park and elsewhere in the Northern Rockies starved to death in the winter of 1988-89, in large part because elk are no longer able to migrate to lower-elevation forage lands or, when they do, they are unable to find enough to eat. Disease spread by livestock also hurt elk.

Perhaps as harmful has been cattle's social and psychological influence on elk. Studies by Nelson and Burnell in 1976 conclude that elk left an area where cattle were introduced, and that elk would not use a study management unit except for those areas ungrazed by cattle. Studies by Jeffrey in 1963 and Mackie in 1970 showed similar results (Wagner 1978). A study by Jon Skovlin in 1968 also found that elk use was significantly lower on ranges cohabited by cattle than in those where cattle use was restricted (Skovlin 1968). Many people contend that, in addition to related factors, the mere *presence* of cattle is repellent psychologically to elk and many other wildlife species.

Livestock grazing continues to be a major threat to elk survival. Although elk do survive, most do so only with human help (e.g., winter feeding and vaccination against disease) and by assuming unnatural habits and living under unnatural conditions. As with the buffalo, the elk is no longer a truly wild animal able to adapt and evolve in a natural manner.

Before fencing this area was prime wintering ground for elk. Since sheep have grazed here almost no natural grasses grow between the sage, and without them, the wind worries the soil, producing it into the air in streaming funnels.
--Ann Zwinger, **Run, River, Run**

(Steve Johnson)

The 2 species of deer native to the West are the whitetail and mule, the latter recognized by its larger ears and black-tipped tail. A mule deer subspecies, the blacktail, lives in the damp, dense forests of the Pacific Northwest.

Ernest Seton, an early 1900s wildlife expert, estimated that a deer population of around 13 million existed in the West in pre-Columbian times (Seton 1929). Most current authorities place that number then at 1/3 to 1/2 that amount, but it should be noted that most of today's "authorities" are somehow professionally involved in deer management programs and may, consciously or otherwise, foster misinterpretation. Although no one knows for sure, extrapolation and numerous descriptions by Native Americans and early explorers suggest that the pre-European deer population was at least 5 million and perhaps as high as Seton's estimate.

Today's 3.6 million deer (according to state fish and wildlife agencies estimates) comprise *2/3* of all "big game" animals in the 11 Western states. This helps explain why professional wildlife managers consider deer their "big game success story."

For several reasons deer numbers remained high while those of all other large herbivores plummeted. First, deer, like elk, have semi-successfully abandoned their former habits and territory. Until the mid-1800s deer, often in large groups or herds numbering in the hundreds, roamed not only forest and brushland, but open rangeland as well. Unlike today, deer felt as much at home on the open landscape as in brush and trees. In his journal, Meriweather Lewis of the Lewis and Clark expedition notes, "when [mule deer] are met with in the woodlands or river bottoms and are pursued they invariably run to the hills or open country as the elk do" (Thwaites 1959). When ranching and hunting pressures increased, those deer that lived in or moved to wooded areas and lived singly or in small groups were better able to survive.

Second, deer eat forbs, grasses, and even mushrooms but, more than the other large herbivores, they can thrive on browse. For them, cattle and sheep competition has always been less severe. (Also, though cattle and especially sheep eat much browse, deer can reach higher into branches, and can even stand on their hind legs to do so.) Originally, huge herds of deer roamed Western grasslands, often eating grasses and forbs more than browse. However, after they abandoned most of the open range -- and when much of their new and former habitat was overgrazed by foraging cattle and sheep -- they were able to switch to a heavily browse diet. While overgrazing livestock may under certain conditions increase the amount of woody vegetation, this "benefit" is more than offset by their detriments -- depletion of woody vegetation and browse on most land, overgrazing of other vegetation, depletion of water sources, introduced disease, physical presence, and so on.

During the late 19th and early 20th centuries, as habitat was severely grazed and hunters and ranchers took an increasing toll, deer numbers reached a low point of perhaps 2 million. But then a curious thing happened. As the years passed, and as humans acquired a greater technological ability to exploit the forests of the West, extensive logging, woodcutting, and explosive, destructive fires (caused ironically by fire suppression) resulted in brush, forb, and grass increases in many previously heavily forested areas.

Additionally, as the West's human population increased, so did the demand for "big game." Consequently, in recent years governments have managed much of the land heavily for deer and deer hunting.

Mainly due to these factors, the overall area of prime habitat has not decreased nearly as much for deer as it has for other large herbivores. However, most deer habitat is currently grazed by livestock, so available *food per acre* averages far less than in pre-Columbian times. In many areas, deer are undernourished due to livestock pressures.

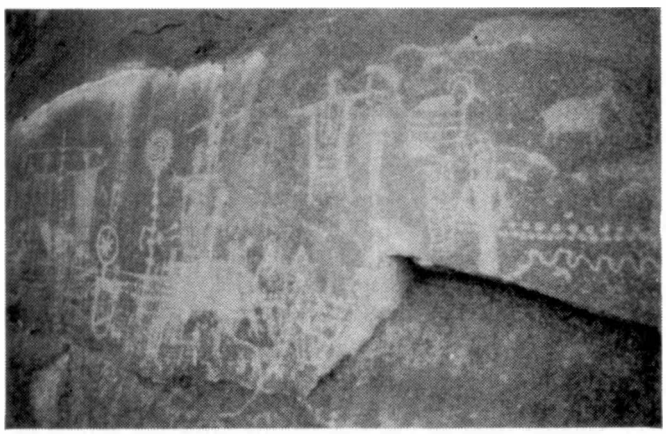
Studies show that livestock grazing exerts other detrimental influences on Western deer populations. As with elk, deer do not mix well with cattle or sheep; they are rarely found together. Livestock spread disease and reduce or eliminate cover that deer, especially young fawns, need for protection from predators. They also cause deer to abandon feeding grounds, feed more heavily in riparian areas, increase the size of their home range, and spend more time traveling and feeding, rather than resting or interacting socially. (Loft 1987)

[Bighorns] *could not support the competition of the domestic sheep imported into their terrains, and suffered seriously from scab and other diseases contacted from these stupid, stunted cousins.*

--from **Wildlife in America** by Peter Matthiessen (Matthiessen 1959)

At perhaps 1% of their aboriginal population due mostly to ranching, bighorns are still harmed by livestock grazing and persecuted as competitors by Western stockmen. *(Steve Johnson)*

Bighorn sheep have been extirpated from well over 90% of their former range. Once roaming in herds across plains, plateaus, mesas, and valleys as well as mountains throughout the West, the bighorn is now restricted chiefly to steep, rugged mountainsides and rocky escarpments -- about the only places inaccessible to cattle and sheep. Knowledgeable and open-minded estimates of the West's pre-European bighorn population range from 2 to 3 million or more. They were more common than deer in many areas. Lewis and Clark, who traversed the northern West from 1804-1806, frequently reported seeing "great numbers of the bighorned animals" (Thwaites 1959). Native American pictographs and petroglyphs commonly featured bighorns. Today, Western bighorns number 20 to 30 thousand -- perhaps 1% of their former population.



Representations of bighorns are common in aboriginal pictographs and petroglyphs throughout the West.

Bighorns fare very poorly if forced to associate with livestock, and often abandon an area when livestock are introduced. Wildlife workers had this to say about bighorns in Utah's Canyonlands National Park:

> *Prior to heavy livestock grazing pressure, bighorn sheep occupied much of the Park. Today* [they are] *restricted to canyons which were isolated from livestock grazing or to canyons where the physiography prohibited livestock from grazing the entire canyon.*

Overhunting and habitat encroachment (both often attributable to stockmen) were important factors in bighorn population declines, but problems caused by ranching have been more harmful. They include inability of bighorns to share space with livestock, depletion of forage and browse, loss of water sources, harmful range developments, and introduced disease. There are at least 4 bighorn subspecies, each with different food preferences, that eat similar percentages of forage and browse. Normal bighorn diet consists mostly of grass, and thus food competition with livestock is considerable in many areas where bighorns survive. Corresponding increases in brush caused by overgrazing augment this competition in some areas. Wildlife expert Frederic H. Wagner reports

> *There is a widespread view among wildlife specialists in the West that these kinds of changes were significant in exterminating bighorns from much of their former range and placing them in endangered status in the remnant areas still occupied.* (Wagner 1978)

Scores of scientific studies (see the bibliography for some) show that livestock are deadly to bighorns in all these ways and more.

In short, the bighorn's plight is due mostly to ranching; further, livestock now monopolize most of the bighorn's former habitat, effectively preventing its recovery. If not for its ability to survive in impossibly rugged terrain, and governments' expensive efforts to save the species, the bighorn might have vanished long ago.

(Steve Johnson)

An exclusively North American animal, the pronghorn "antelope" (not a true antelope) includes 5 subspecies -- 4 in the West, one of which, according to wildlife experts, is "gravely endangered," and 1 in Baja California, near extinction. When pronghorn wandered most of the West 150 years ago, probably at least 10-15 million individuals inhabited the area that later became the 11 Western states. On the grassy plains, plateaus, and valleys, their huge herds, often numbering in the thousands, rivaled the buffalo's in size, and the two often moved across the landscape together.

As with the species described above, pronghorn suffered a drastic reduction in numbers during the 1800s. But, unlike elk, deer, and bighorns, pronghorn stayed in open country; because they generally prefer forbs, browse, and wildflowers to grass, competition from cattle for food was less intense. Nevertheless, continual overgrazing, overhunting (largely by ranchers), farming, and habitat intrusion (largely by ranchers and their livestock) eventually took their toll, reducing pronghorn to an estimated low of about 26,600 individuals in 1924.

Because cattle are more closely related to buffalo than to any other native Western animal, and because pronghorn are well-adapted to living near buffalo, pronghorn experienced less harm from cattle. In some areas, extensive overgrazing by cattle also caused an increase in forbs or sagebrush, which pronghorn do enjoy. Overall, however, cattle have been highly detrimental to pronghorn. For instance, cattle overgrazing has nearly eliminated the tall grass in which pronghorn, deer, and other large ungulates hide newborns and fawns from predators. On large portions of the semi-arid intermountain West, cattle have so denuded the range that pronghorn cannot survive; many studies document cattle/pronghorn food competition (Wagner 1978). In many areas, livestock grazing has caused brush to become so thick that pronghorn, which prefer open grassland/shrubland, have moved elsewhere or died.

Domestic sheep, with a diet much like pronghorn, were especially harmful when their numbers peaked in the early 1900s. For example, research biologist Don Ness states bluntly that, "all of northern Arizona was marvelous antelope range. Then it was sheeped to hell." When sheep herding finally succumbed to cattle ranching in the early 1930s, domestic sheep numbers took a dramatic fall -- while pronghorn numbers made a closely corresponding rise.

Due greatly to this decline in sheep numbers -- and to government recovery efforts, largely for hunting purposes -- state fish and wildlife agencies today estimate that about 700,000 pronghorn inhabit the 11 Western states, half of them in Wyoming (this figure may be inflated for political purposes). Unfortunately, some experts think the pronghorn population may currently be at or near its maximum, considering continued ranching pressures and other factors (Yates 1988). Unbelievably, today's pronghorn, at perhaps 5% of its original number, extirpated from the vast bulk of its range, and roaming in small bands in scattered locations, is proclaimed "a spectacular success" by ranchers and government range managers.

Malnourished pronghorn on depleted New Mexico BLM cattle range.

Now, because of the excellent range conditions, we have an overabundance of big game in [Utah]. . .

--Gary Rose, President, Utah Cattlemen's Association, 5-15-89 *Salt Lake City Tribune* (Government statistics show that all Utah "big game" combined consumes roughly 0.7 million AUMs, while Utah cattle and sheep consume more than 10 million AUMs.)

(Steve Johnson)

The 3 other large ungulates native to the West are the moose, mountain goat, and woodland caribou. In the West, moose live in the northern Rocky Mountains, in forested areas with lakes, swamps, or streams. Because of their limited range and watery habitat, effects from livestock might seem negligible, but this is not the case. Although overhunting has been the main cause of moose decline, introduced disease, range developments, general degradation of habitat, and competition for food with livestock, especially sheep, have also been factors. A study shows that, except in winter, moose diet in Montana and Wyoming consists of 20% browse, 10% grass, and 70% forbs -- a diet similar to that preferred by the domestic sheep that graze much of their habitat. Other studies have shown that moose have a low tolerance for the physical presence of livestock. The current Western moose population of several thousand is a fraction of what it once was.

The mountain goat, living at or above timberline in the high mountains of the Northwest and northern Rockies, has been less affected by ranching. Nevertheless, large herds of domestic sheep invade portions of its summer range; mountain goats moving in winter to lower mountain elevations often find forage and browse depleted by cattle and sheep. Introduced disease and range developments have taken a toll, though overhunting has been the mountain goat's greatest enemy. It has been eliminated from much of its former range in the contiguous US (though in some areas it has been introduced as a "game animal").

The large native Western ungulate probably least affected by livestock is the woodland caribou. Larger than a deer, smaller than an elk, this chiefly browsing animal inhabits boreal coniferous forests, glacial bogs, and wet meadows. Records show that the woodland caribou once roamed the forests of Washington, Idaho, Montana, and east to Maine. It currently survives in the lower 48 only in small resident populations in the mountains of northern Idaho and northeast Washington, with small numbers occasionally wandering from Canada into northwest Montana and extreme northeast Minnesota. Caribou are harmed by logging, road-building, mining, hunting, and many of the same livestock impacts that harm moose and mountain goats. Ecologist Jasper Carlton identifies the woodland caribou as probably the rarest and most endangered indigenous mammal surviving in the wild in the lower 48 states.

Big game populations on public lands are increasing in the presence of regulated livestock grazing.

--Mosley, *et al., Seven Popular MYTHS About Livestock Grazing on Public Lands*

The grazing establishment counters that (1) "big game" numbers have increased since early this century and (2) ranching has continued during that period; therefore, (3) improved ranching management has caused or contributed to this increase (or, at least this proves that modern ranching is not harmful to these animals). In other words (or numbers), 1 +1 =3. As detailed elsewhere, decades of "big game" protection legislation and intensive reintroduction and restoration efforts (which ranchers have almost universally fought *against*) are actually responsible for these modest population increases. Regardless of increases or

decreases, ranching was and is the most destructive influence on large Western herbivores. Indeed, "big game" numbers generally have increased most where livestock grazing has been "regulated" -- that is, *reduced*.

Although livestock grazing has been disastrous to wildlife, public lands managers do little to correct the situation. In 1976 the BLM employed an average of 1 full-time wildlife biologist for each 3.36 million acres -- an area the size of Connecticut. That year, the Forest Service employed 1 biologist for each 1.9 million acres (Ferguson 1983). In contrast, the agencies employ several times as many ranching-related professionals. BLM and FS generally manage for less than 1% as many deer, elk, pronghorn, or bighorns as cattle and sheep on the public's land. In most Western states, livestock grazing accounts for 80%-95% of total forage allocations on BLM and FS land, while the percentage for state-owned land is even worse. And these figures don't take into account livestock trespass, which is common.

One example: According to a report by the Committee for Idaho's High Desert, all 6 BLM resource areas in southern Idaho, representing 13% of all land in the state, have released proposed management plans since 1982. Livestock are scheduled to receive 90.6% of the total allotted forage, while all wildlife gets the remaining 9.4%; this, again, does not take into consideration livestock trespass and other factors described below. Adding insult to injury, all 6 plans schedule increases in projected forage allocations to livestock, ranging from 13% to 66%, with lesser increases to wildlife. These BLM plans are unfortunately typical.

On top of all this, what little herbage is allotted to wildlife is usually located in areas undesirable to ranchers anyway -- dry, inaccessible, rugged, steep, brushy, otherwise unprofitable, and generally the least ungulate-productive habitat. Most wild ungulates would not inhabit these areas if given a choice, but under the grazing establishment's influence prime habitat is monopolized for livestock.

For example, bighorn sheep in New Mexico's Gila National Forest *may* get 1% of total forage allocations, according to the forest management plan. But bighorns in the Gila rarely leave their rugged cliff and rocky hillside homes, while cattle enjoy the comfortable, level, well-watered valley bottoms, grassy flats, and gentle slopes. That 1% forage and browse *may* be there, but in order to utilize it, the bighorns must expend much time and energy moving over rugged terrain. Just to drink, they may have to climb down 1000' of steep, rocky escarpment. Ironically, bighorns may not want to leave their rocky homes except to drink, for, being relatively unvisited by cattle, these rugged hide-outs often support more available forage per acre than the more gentle and potentially productive, yet overgrazed, cattle terrain below.

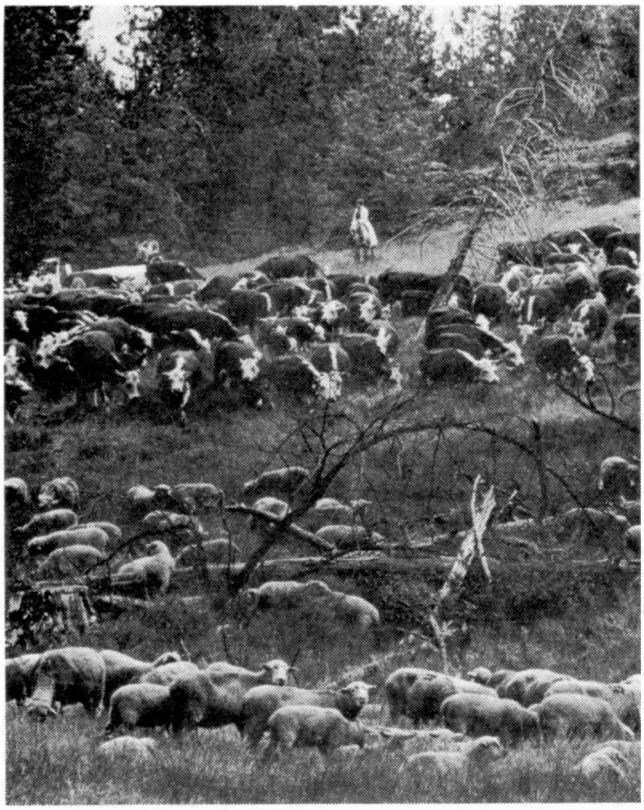
Further, at least 1 and usually more "big game" species have been reduced or extirpated from almost every public grazing allotment in the West. Yet, even though many allotments could still support these species, very few management plans seriously consider recovery or reintroduction.

The buffalo is an excellent example. More than half the area of the West used to support some buffalo, and perhaps half of the public grazing allotments in the West could still. Yet only a handful out of tens of thousands do. Why? Because the ranching industry simply will not allow it; buffalo aggressively compete for forage and break through ordinary livestock fences. Therefore, the agencies rarely even consider reintroducing them.

Thanks to their owners and our government, cattle and sheep have other unfair advantages over their wild competitors. Livestock often receive veterinary treatment and supplemental food, water, salt, and minerals, whereas wild animals usually do not (and when they do, it is to compensate for habitat degradation and fragmentation.) If they severely overgraze, livestock can be moved to greener pastures or be given supplemental feed. Domestic stock are usually moved off the public range altogether during seasons when grazing is less profitable, while wild animals must struggle through the lean seasons on what remains.

For example, during summer livestock heavily graze elk winter foraging areas. As winter approaches, livestock are moved to lower elevations where they subsist on pasturage and stored feed. As elk migrate from the highlands down to their traditional winter foraging areas, they find little to eat. Occasionally they starve, but even if they do not, insufficient food often leads to reduced body weight, lowered resistance to cold and disease, less energy to escape and fight predators, reproductive failures, and impairment of bodily functions. Some elk may eventually die as a result, and herds may experience genetic setbacks, or fail to produce offspring sufficient to maintain viable populations.

A bighorn in Gila NF. The river canyon bottom is overgrazed and occupied by cattle (note muddy river water), so bighorns here climb down from their steep, rocky uplands only to drink.



After several days of grazing in this heretofore little grazed area, the herbage cover will be reduced by more than 80%, leaving little for wildlife through fall, winter, and early spring. *(USFS)*

Further complicating matters for wildlife, ranching pressures are continually changing, often drastically from day to day, season to season, or year to year. Because range management varies according to perceived livestock needs, market trends, opinions, fickle whims, and greed, wild animals must constantly adjust to simply survive. For millions of years wildlife evolved to endure periodic *natural* hardships, such as storms, floods, fires, and to adapt to gradual, *natural* changes in the environment occurring over centuries or millennia. But expecting wildlife to adapt to the unnatural changes caused by ranching is like asking a leopard to change its spots to stripes quickly and frequently.

To demonstrate: Some livestock management plans call for grazing of allotments on alternating years, purportedly to allow the range to recover in between. During off years, livestock are moved elsewhere. Thus, one year wild animals have relatively abundant grass, forbs, and browse; the next -- stubbles, sticks, and stems. On, off, on, off. Wild animals generally cannot adapt to these conditions, and usually they have no good habitat left to retreat to. And, given human inconsistency and the transitory nature of human goals, any adaptations they do make cannot possibly benefit species evolution in the long run.

Bighorns overcome their fear of humans -- potentially fatal in and of itself -- while searching for winter forage on overgrazed range. *(George Robbins Photo, Jackson, WY)*

Large native herbivores lived in habitats to which they were naturally suited -- not where people put them. Over millions of years, each plant and animal in these habitats evolved to co-exist with these grazing and browsing animals. In an amazingly complex web of interrelationships benefiting all involved, each plant and animal was adapted to all other plants and animals. Cattle and sheep were not participants for these millions of years, and are thus not adapted to these countless unique interrelationships in these ecosystems.

Recently I received a letter from a woman in New Mexico who echoed ranchers' arguments in asking if perhaps cattle and sheep are now semi-native to the West because they have been here for so long. I answered that perhaps they would be if left completely unmanaged and genetically unaltered for several thousand years -- an inherent impossibility with any domestic animal, but especially with commercial livestock.

America's domestic cattle and sheep are native to lush, well-watered, level-to-rolling grassland and grassy woodland of the Old World (which also are mostly overgrazed by livestock) -- environments completely unlike most public land in the West. (Even if these environments were quite similar geographically and climatically, however, livestock

On extremely overgrazed BLM cattle range in northern Wyoming, winter may prove fatal to some of these mule deer. *(George Robbins Photo, Jackson, WY)*

would not be suited to the West's vastly different biosystem.) As such, livestock are invaders from a foreign land. Today's cow is a relatively dimwitted, ponderous, slow, gluttonous beast, unlike any native American animal except for a superficial similarity to the buffalo. Domestic sheep are similarly unlike native bighorns, much as domestic goats are unlike mountain goats.

Although large native herbivores exerted some outwardly similar influences on the land, because they were *natural* components of the Western range their overall impact was not harmful. The impact from intensively managed, domesticated livestock was, however. And, the most cattle-like native American animal -- the buffalo -- outside of the Great Plains, occurred only in relatively small numbers. Moreover, especially on the prairies, native herbivores grazed and trampled heavily, but only for short periods. After denuding the vegetation in an area -- commonly a matter of hours or days, not weeks or months -- they moved on to greener pastures, usually not to return until well after plants had rejuvenated. If wildlife had grazed like cattle -- unnaturally, intensively, for long periods every year, and for millennia -- there would be no prairie, or non-wasteland, anywhere in the West.

I cannot believe that grazing on public land endangers wildlife.

--Peter Decker, rancher, former director of the Colorado Agricultural Department

Disease and Parasites

Just like all other natural, living beings, disease organisms and parasitic creatures by right of evolution have a place and purpose in Earth's 5-billion-year old scheme of things. Human misunderstanding notwithstanding, disease and parasites are a natural and beneficial part of any ecosystem.

In much the same way as predators do, disease strikes and kills the very old, ill, deformed, crippled, wounded, and otherwise impaired much more frequently than it does the healthy; weak individuals are naturally culled. Other species members are thus spared the task of expending valuable food, time, and energy caring for disabled members, thus strengthening the species.

When overcrowding threatens to cause food or water shortages, detrimental social behavior, fertility problems, and harmful inter- and intra-species relations, disease reduces the population to a healthier level. Though death by disease is an unpleasant thought, it is usually far better than slow starvation, and it is better for other species than having an ecosystem gradually devastated and subjecting myriads to suffering. Additionally, those individuals that become sick from disease but don't die often temporarily experience much lower reproduction rates, further limiting population. Under *natural* conditions, however, disease rarely makes deadly rampages through populations.

In many ways, parasites are larger versions of disease organisms. (Some protozoans straddle the fine line between the two.) They play a similar role, and indeed often carry and transmit disease. Nevertheless, under natural conditions, parasites rarely infest hosts so seriously as to impair normal functioning.

All the foregoing applies to humans, as demonstrated by severe and frequent disease epidemics and die-offs in overpopulated areas of the "Old World," or in areas where humans lived under grossly unnatural conditions. Before the development of "modern man," the vast bulk of human history shows disease to be a relatively benign influence. When "Old World" humans first domesticated livestock and began farming in roughly 9000-5000 B.C., they became overpopulated and concentrated, and created conditions favorable to the development and spread of virulent diseases. Viral and bacterial oscillation/interplay between livestock and humans produced variants of old diseases and many new and deadly diseases hitherto unknown to either, yet deadly to one, the other, or both. (Crosby 1988)

When Europeans arrived in North America, they brought with them these new diseases, and their old ones as well, most of which they had over time developed at least partial immunities to. The indigenous peoples of this continent had not, however. Some of these diseases spread through native tribes like the Black Plague had through 14th century Europe. It is now widely accepted that more Native Americans were killed by introduced disease than by bullets, starvation, and exposure combined. The US Army's use of smallpox-contaminated blankets as gifts to subdue Native Americans is also well-known.

A contaminated blanket was given to the native wildlife of this hemisphere, in the form of domestic livestock. American animals were ill-prepared for the diseases and parasites common to the Europeans and their cattle, sheep, goats, and horses. Not having evolved with many of these viral and bacterial diseases or parasites, native species were highly susceptible to and greatly harmed by them. Though some resistance has been built up during the past century or two, Western wildlife is still more vulnerable to many of these disorders than are livestock, all things being equal.

But all things are not equal. Cattle and sheep pervade the West in large numbers in heavy, usually stationary concentrations -- exactly the conditions most conducive to spreading disease and parasites. Management activities exacerbate this situation. Immunizations, antibiotics, insecticides, and such generally keep problems in check. But when a disorder does spread through a livestock herd, it may be transmitted to wild animals not normally exposed to it. There are also a number of diseases and parasites that domestic stock can transmit to wild animals, but to which they are resistant.

Additionally, the unnatural situations forced upon wildlife by livestock grazing and related ranching activities often stress native animals, making them overly susceptible to disease and parasites. For example, the lack of herbage due to overgrazing causes nutritional stress in wildlife that results in greater susceptibility to disease. Experts believe that this is currently a significant influence on the desert tortoise, whose population has recently been diminished by an incurable respiratory disease.

When wildlife concentrates in small areas where food and water remain, stress and susceptibility to disease are further increased. For example, Wyoming Game and Fish Department officials think widespread ranching that forces elk to concentrate in localized areas is a main reason the number of elk calves born in the state has declined in recent years; the disease brucellosis is the major factor.

In short, domestic stock serve as a vector to spread disease and parasites, both native and exotic, to wild animals throughout the West. Bighorn sheep are a prominent example. Many experts think that livestock-spread disorders are the main cause of declines in bighorn sheep numbers in much of the West.

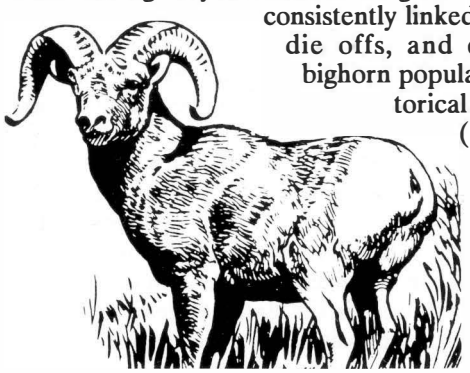
In California, for example, the bighorn is threatened by livestock competition, habitat loss, and human intrusion and poaching; but, in many areas the greatest hazard to its survival is *pasteurella*, an always lethal, highly contagious bacteria. The bacteria's transmission process is not fully understood, but nose to nose contact between livestock and wildlife is one suspected mode, and recent tests show that the viral agent can live 24 hours outside the host and be transmitted through grass. Entire herds can be decimated in weeks.

From the 1940s through the 1960s, California experienced many declines and local extinctions of bighorns due to livestock-spread afflictions. Since then, the California Department of Fish and Game has taken many measures to reintroduce and protect bighorns. Yet, both native and reintroduced herds continue to suffer from livestock competition and introduced disease.

In the Sierra Nevada, the Sierra race of bighorn is currently threatened by both habitat intrusion and a *pasteurella* parasite, carried and spread by domestic sheep which are themselves resistant to its effects. Reintroduced herds of 43 bighorns in Lava Beds National Monument and 50 in Modoc National Forest recently experienced 100% mortality from *pasteurella*. Both herds were adjacent to domestic sheep grazing allotments. Although many bighorn herds could be protected from introduced disease by a 5-mile buffer zone between sheep allotments and bighorns, few public lands managers are willing to confront powerful local ranchers and insist on the necessary changes in land management plans.

In the Challis National Forest in Idaho, a recent *pasteurella* outbreak has resulted in 7 known bighorn deaths so far -- immediately after a herd of 200 domestic sheep grazed the area for the first time in years. Bill Foreyt, an associate professor of veterinary medicine, microbiology, and pathology for Washington State University, said of the outbreak, "The results show the [strain of] *pasteurella hemolytica* is definitely of domestic sheep origin." A similar virus killed between 125 and 200 bighorns in Hells Canyon in 1983, and 75% of a 100 animal herd in northeast Oregon in 1985, including the largest recorded ram in the US.

In a report entitled "Effects of Domestic Sheep Grazing on Bighorn Sheep Populations," N.J. Goodson states that "Co-use of ranges by domestic and bighorn sheep has been consistently linked with declines, die offs, and extinctions of bighorn populations from historical to recent times" (Goodson 1982). (See Jessup 1985 in the bibliography for numerous other examples.)



Disease and parasites are spread to wild animals through infected water, vegetation, manure and soil, flies and other insect carriers, physical contact with livestock, feed, and salt licks. Most large mammals and many other animals are susceptible to these disorders. (Incidentally, there are 50 diseases that cattle can and sometimes do transmit to people -- more than are transmitted by any other animal except the lovable family dog.) Following is a general list of afflictions spread by range livestock:

Anthrax bacteria can be transmitted through stagnant water, soil, and dead animals. A relatively common and sometimes deadly disease, all warm-blooded animals are susceptible, including humans, but cattle are most vulnerable. Flesh eaters such as coyotes, ravens, and vultures may contact anthrax from eating infected dead cattle or sheep, and may also spread it to other wildlife.

Brucellosis is another bacterial disease, various strains of which affect many warm-blooded animals, especially cattle. It causes cattle fetuses to abort in late pregnancy; in humans it causes flu-like symptoms that may persist from 3 days to 3 months. Bovine brucellosis may be spread through livestock food, water, and salt licks, as well as through physical contact with live or dead stock, aborted fetuses and, for humans, through the handling of dead bodies in slaughterhouses. Brucellosis was once the most serious human/animal disease in the US, but in 1935 the US launched an intensive eradication program and brucellosis infection is now reported in only 0.17% of US cattle, while many states are certified brucellosis-free (Wuerthner 1990).

Circling disease is a widespread infectious bacterial disease affecting livestock, humans, and wildlife. Affected animal stagger, circle, and make strange, awkward movements.

Encephalitis, an infectious disease affecting cattle, sheep, and goats, can be spread to wild animals and humans. The mortality rate in untreated individuals is high.

The infamous and deadly *foot and mouth disease* has not been reported in the United States since 1929. Large sums of money were spent eradicating it, and much is still spent by the government keeping it away from US borders. At one time foot and mouth disease spread by livestock killed many thousands of deer in the West. Between 1925-1927 in the Stanislaus National Forest, California, 22,000 deer were slaughtered to eradicate the disease after it had been introduced by cattle.

According to the *Sacramento Bee*, cattle may even be linked to *leptospirosis*, a liver-kidney disease that has killed hundreds of *sea lions* along the West Coast. Spread mainly through urine, humans and other animals incur the disease by swimming in or drinking infected waters. Humans and predatory and scavenging animals can also contact it by consuming the meat of infected livestock. Surveys indicate widespread leptospirosis in the US cattle population.

Cattle are susceptible to all 3 forms of *tuberculosis* and can spread the disease to certain animals, including bighorns, elk, deer, and mountain goats.

Pneumonia caused by livestock-spread bacteria has been implicated in the deaths of many wild animals. One type of *pneumophilic* bacteria exacerbates existing disorders, thus producing fatal pneumonia, while another causes the progressively fatal disease independently.

Livestock help spread a viral disease called *bluetongue* to

deer, elk, pronghorn, bighorns, and other large mammals, sometimes with fatal results. A certain kind of gnat is also necessary for transmission; low elevation areas with stock tanks and high livestock densities are good gnat habitat.

The familiar bacterial disease *pinkeye* may strike humans as humorous, but it can be deadly to many wild animals because it causes blindness. Pinkeye is not a natural disease process in some wild animals. Spread by livestock, it is especially common to range and feedlot cattle, and affects 3% of all beef cattle.

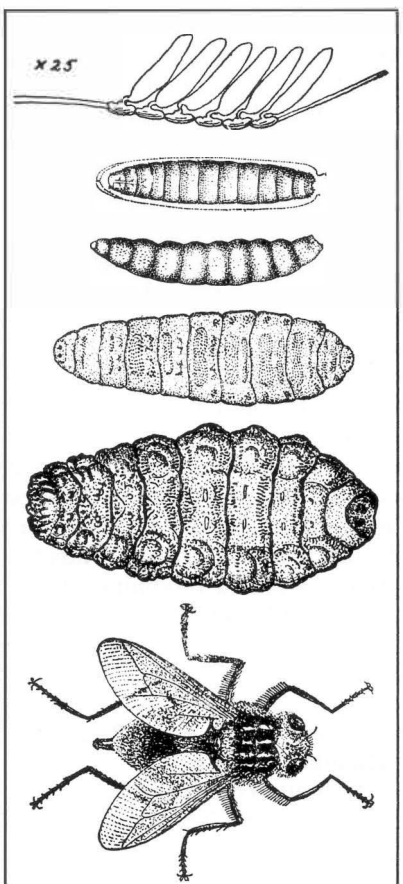
Soremouth, a pox virus common to domestic sheep, can be transmitted to bighorns and others through direct contact or through the infected animals' shed scabs, on which the virus can remain viable in soil for 10 years. The infection causes painful sores and scabs on the face and can either be lethal to an animal or retard its growth.

Scabies is a highly contagious and often deadly skin disease spread by a tiny mite carried by cattle, sheep, wildlife, and humans. Livestock frequently transmit this disease to wildlife, especially to bighorn sheep. According to a report by the California Department of Fish and Game, "The introduction of domestic livestock onto bighorn sheep ranges in the late 1800s and early 1900s was followed by severe and widespread die offs of bighorn sheep attributed to scabies." Domestic sheep were the main culprit; when their numbers declined, so did bighorn mortality rates.

And yes, cattle and sheep do get *rabies*, though less than 10 cases a year are reported. Infected livestock may be dangerous during the middle stages of the disease. In Canada and much of the US more humans are bitten by rabid cows than by rabid bats!

A number of *protozoan-based diseases* are also transmitted from livestock to wildlife, and sometimes to humans. Other diseases are too numerous to include here.

More than 100 species of external and internal parasites affect cattle and sheep, of which a score or so significantly affect Western wildlife. *Anaplasmosis* is a disorder caused by one of the tinier of these parasites. Transmitted by mosquitos, ticks, horseflies, and other biting insects, it spreads quickly and can kill wild animals.

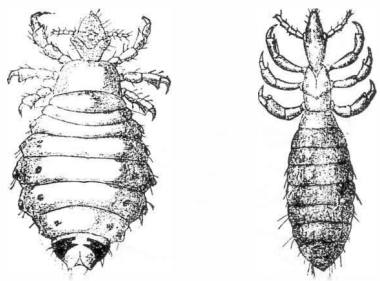


A common livestock parasite: the warble fly, from egg to adult

Several species of flies produce *parasitic larvae* that live within the bodies of cattle, sheep, and other domestic and wild animals. Many can make life miserable and some can be fatal. Among these are bot flies, blowflies, horn flies, warble flies, and screwworm flies. At one time, the screwworm fly, which arrived in this country with and was propagated by cattle, killed 60%-80% of all fawns throughout much of the southern United States, as well as many human babies. Their maggots consume living flesh inside wounds, increasing wound size sometimes until the victim is literally eaten to death. Blowflies are widespread on the range. Their maggots eat away at the skin surface of livestock and wildlife.

Livestock can also indirectly transmit disease to wild animals by spreading flies that carry disease. For example, there is strong evidence that a nose bot fly common to domestic sheep is a major cause of bighorn death from a disease syndrome called *chronic frontal sinusitis*.

Parasitic worms, spread to native animals and humans by livestock via shared ranges or water include stomach worms, bladder worms, tapeworms, lungworms, hookworms, pin worms, and various roundworms. (Some of these worms are also spread to people through inadequately cooked meat.) Victims die or suffer from malnutrition or internal hemorrhaging. *Liver flukes* kill livestock and wildlife in some areas of the West. Their life cycle takes them from animal feces, through certain species of snails, onto vegetation or into water, and back into large animals. Livestock help spread them. Cattle and sheep are also host to many different *ticks*, *lice*, and *mites*, a few of which can be transmitted to wild animals and humans.


Two lice of cattle.

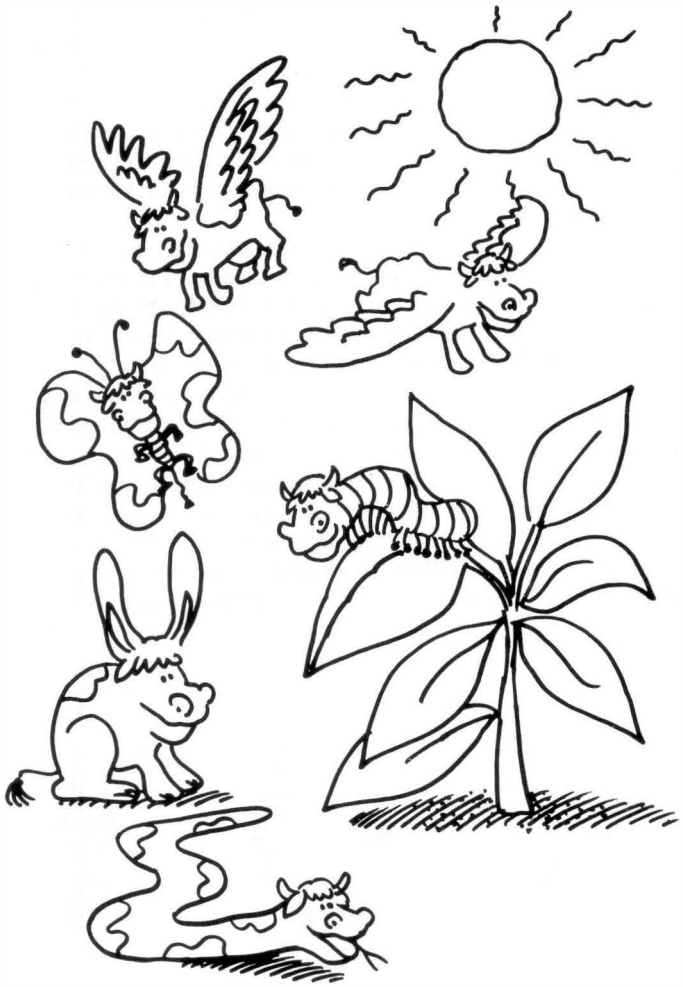
Ringworm, a contagious disease of the outer layers of skin caused by certain molds or fungi, creates round, scaly patches of skin almost devoid of hair. Able to live on most large animals and humans, it is sometimes spread by livestock.

Even *warts* can be spread from livestock to wildlife. Unbelievably, on cattle some of these ugly tumors become pendulous growths several pounds in size.

Various and numerous immunizations, antibiotics, medications and veterinary techniques have been employed over the years to protect livestock from the spread of disease and parasites -- some with success, most with tax money. In some cases, government efforts have stemmed outbreaks in wildlife. Usually, though, wild animals don't have the benefit of modern medicine when they become sick or infested.

As long as livestock remain nearly omnipresent in the West, we can expect disease and parasites to be spread to wild animals. Western wildlife is in a quandary, for the greater its concentrations, the more susceptible it becomes to livestock-spread disease and parasites. But it would be impractical to immunize and treat large numbers of wildlife without semi-domesticating them, thus destroying the essence of *wild* life.

Other Native Animals



(Greg Pentkowski)

Large native herbivores, though well below cattle and sheep on the rangeland totem pole, receive far more managerial benefit than other wildlife. Great government effort is expended to maintain sufficient numbers of "game" animals for hunters and fishers. But relatively little goes toward the tens of thousands of other species that inhabit (or formerly inhabited) public land. The Council on Environmental Quality observes that "$97 of every $100 spent by federal and state governments on wildlife management goes to less than three percent of the species; the ones used specifically for hunting, trapping or fishing." Much of what little the government spends on non-game species goes towards those already classified as Rare, Threatened, or Endangered.

The same influences that hurt pronghorn and elk hurt scaled quail, earthworms, garter snakes, and dragonflies. It would be impossible to list all the less-celebrated wild animals harmed by livestock grazing (or the many different ways they suffer), but here are a few: ant lions, armadillos, and alligator lizards; bass, bumblebees, and butterflies; cockroaches, coral snakes, and coatimundis; ducks, dippers, and daddy longlegs; earwigs, egrets, and earthworms; ferrets, finches, and freshwater crabs . . . . Indeed, of the thousands of species of mammals, birds, reptiles, fish, amphibians, and tens of thousands of species of smaller animals native to the rangeland West, **most** have been harmed by livestock grazing. Even the BLM's Division of Wildlife calls livestock grazing the primary cause of the "unsatisfactory" condition of major portions of wildlife habitat on public land (Natural Resources Defense Council 1973).

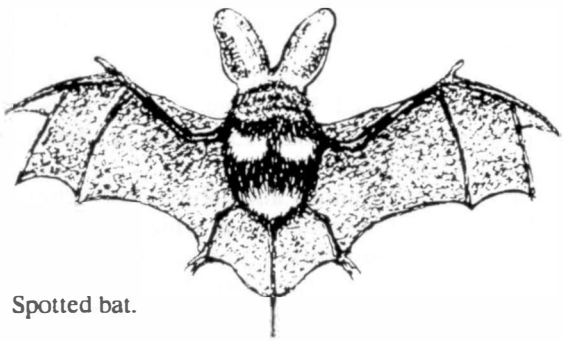
Consider a few examples: The tiger salamander is the world's largest land-dwelling salamander. Being a moisture-loving creature native to most of the Intermountain West, livestock grazing has seriously affected its habitat and reduced its numbers. Yet the tiger salamander remains one of the anonymous thousands not considered in land management plans.

The great plains toad is a large, grey to olive-brown, blotched amphibian native to grassland and shrubby/grassy areas of the Great Plains from Montana to southern New Mexico, southern Arizona, and the Colorado River Basin of the Southwest. Livestock grazing has eliminated much of the native vegetation in its habitat; correspondingly, its food supply of insects, cutworms, and other small animals has been depleted. The great plains toad depends on moist, loose soil for burrowing, but trampling and destruction of native plants have caused soils to dry and harden. It needs ponds and other slow, shallow waters in which to lay eggs, but livestock have depleted and polluted suitable waters. If eggs are laid, they may be stepped on or buried by drinking livestock. Adult toads may be trampled when on the ground's surface or burrowed into wet soil.

More than 2000 species of bee inhabit the West. Over the last 100 million or so years, they have become morphologically, physiologically, and behaviorally attuned to native flowers. Though many species can utilize non-native flowers, the natives are most beneficial and some bee species have become so specialized that they are wholly dependent on only one or a few flower species. Bees depend on the nectar and pollen of certain wild flowers being available through the growing season(s). Though overgrazing has increased the number of flowers in a some areas, in general it has diminished the number and variety of herbaceous flowering plants in the West and depleted or extirpated required native flowers over vast areas. In addition, because livestock grazing tends to decrease diversity, the variety of plants blooming at any given time has been reduced and some portions of blooming seasons may be devoid of flowers. Livestock have thus destroyed many of the bees and other flying and crawling creatures that helped pollinate flowering plants as they consumed or gathered pollen and nectar -- creatures that were a food base for much other wildlife.

The spotted bat is another unacknowledged victim of the grazing industry. This rare large-eared bat lives in arid to semi-arid areas in every Western state except Washington. But how could livestock hurt bats?? Much of their food source of small, flying insects has been wiped out through the effects of overgrazing. Livestock have a definite, destructive influence on these bats, but not many scientists

or range professionals make the connection. In the Southwest, the red bat, which is found primarily along riparian corridors, is listed as Threatened by the Arizona Game & Fish Department, due largely to livestock. Why? In Arizona the red bat roosts in the cavities of large riparian trees, primarily cottonwoods, most of which have been lost to the impact from livestock grazing.



Spotted bat.

Cottontail rabbits usually fare poorly on the common grazed range. Livestock remove cover needed for shelter, nesting, protection, and food. (Turkowski 1975)

Nor has the javelina escaped harm. The wild pig of the southern portions of Arizona, New Mexico, and Texas forages for grasses, cacti, beans, nuts, berries, fruits, grubs, and insects. Because grasses in these regions have been largely eliminated, cattle there draw heavily on other vegetation, especially the most palatable javelina food plants, thereby also reducing javelina grubs and insects that rely on these plants. For example, a 1942 University of California report titled "Mammals of the Big Bend Area of Texas" mentions the very small number of javelinas counted in a wildlife survey, and concludes that "heavy grazing by domestic stock has greatly reduced forage and shelter and probably has been an important factor in reducing the range and number of javelina."

Even such an unlikely creature as the northern bog lemming is violated by livestock grazing. This small vole-like mammal spends its life in cool, moderate- to high-elevation cirque bog basins and meadows in the mountains of extreme northern Washington, the Idaho panhandle, and northwestern Montana -- places you might not expect to find cattle. But as you may have guessed, the Forest Service does allow cattle grazing there, in the high wet meadows of all 5 National Forests in the area. Livestock, along with ORVs, snowmobiles, improper capturing techniques by biologists, and logging, have reduced the northern bog lemming's range and numbers so much that it is considered a "sensitive" species or "species of special concern" by various state and federal agencies.

Northern bog lemmings. *(Roger Candee)*

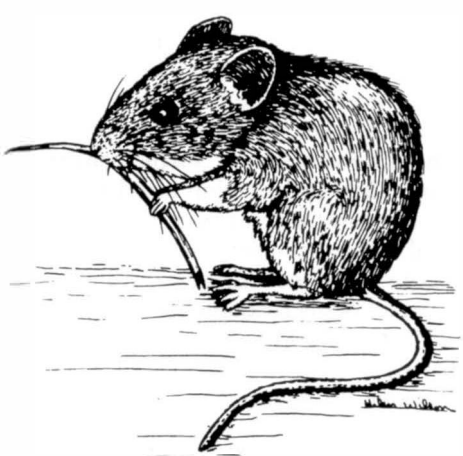
With the depletion of native grasses -- especially mature grasses with seedheads -- many seed-eating birds, rodents, and insects were devastated. With the removal of ground cover, a large percentage of small, moisture-loving, soil-dwelling creatures were killed off. With the loss of succulent low-level vegetation, many insects and their larvae, such as moths and butterflies and their caterpillars, bugs, and beetles (and the animals dependent upon them), were eliminated. These losses have had far-reaching, though largely unrecognized, impacts on Western ecosystems.

For example, a large percentage of insects that depend on low-level vegetation burrow into the top 1'-3' of soil for the winter, channelling and aerating the soil as they go. If they die there, their remains enrich the soil, but most emerge the following spring, further channelling and aerating the soil. Their loss has thus also lowered soil quality.

Similarly, a great many animals large and small live in the soil either permanently or at some stage of their lives, far more than we surface-dwellers realize. Thousands of species of microscopic creatures inhabit rangeland -- by the trillions, providing many essential, yet little-known, benefits to ecosystems. By far most of these animals utilize the topsoil. As mentioned, the SCS estimates that since the 1800s at least half of the West's original rangeland topsoil has been lost, mostly to ranching. In other words, these soil-dwellers have already lost half of their topsoil habitat.

The abundant, loose, moist, organic soil of ungrazed areas supports many more soil-dwelling creatures than does the soil of grazed areas. In this ungrazed scene, a colony of pocket gophers has pushed up numerous mounds of dirt, further promoting soil fertility.

By drastically depleting ground cover, trampling nests, and terrifying wildlife, livestock have reduced numbers of ground-nesting animals throughout much of the West and eliminated them from huge chunks of land. For example, a study by Thomas Overmire in 1964 showed that grazing reduced by 50% the breeding populations of Bell's vireos, birds which nest on or near ground level (Overmire 1964). When livestock numbers were increased dramatically at Oregon's Malheur Wildlife Refuge between 1940 and the 1970s, populations of ground-nesters such as mallards, Canada geese, and sandhill cranes plummeted correspondingly, largely because grazing livestock stripped off ground cover, leaving nests poorly concealed or in plain view for predators (Ferguson 1983). In southeastern Arizona, establishment of the San Pedro National Riparian Conservation Area and elimination of cattle grazing there several years ago has, according to preliminary results of a BLM study, increased the number of ground nesting song sparrows, yellow-breasted chats, and common yellowthroats by 100%-400%. Other animals that may be harmed by reduction of ground cover and associated impacts include ground doves, poorwills, horned larks, bobolinks, white-tailed ptarmigans, meadowlarks, some sparrows, many water birds, woodrats, some rabbits, a variety of shrews and mice, many reptiles and amphibians, and a huge number of invertebrates.



(Helen Wilson)

The wild turkey is another unrecognized livestock victim. Native mainly to open forest and brushy woodland, it was decimated in the West last century, not only by hunting but by gradual habitat deterioration from livestock grazing. Needing thick vegetation for cover and nesting sites, wild turkeys suffered greatly when livestock depleted tall grasses, flowering plants, and dense brush thickets in their range. Overgrazing also decreased their food supply of seeds, nuts, acorns, grass, forbs, tubers, and insects by depleting source plants, eliminating vegetation upon which their food insects relied, and drying up water sources. A comparison of young wild turkeys on heavily grazed and ungrazed lands revealed 580 young per 100 hens on ungrazed plots, compared to only 150 young per 100 hens on grazed plots (Gallizioli 1976).

Together with overhunting and habitat destruction (both largely by ranchers), commercial grazing helped reduce a pre-European US wild turkey population of roughly 10 million to about 20,000 by the 1930s. Intensive reintroduction and recovery efforts, mainly for hunting, have brought the wild turkey back to some areas in recent years, though generally in greatly diminished numbers. The "incredible restoration" of the wild turkey touted by vested interests has increased its numbers to an estimated (again, perhaps overestimated) 1-2 million today, or about 10%-20% of its original population.

Wild turkey.

Other upland "game" birds such as ruffed grouse, blue grouse, chukars (exotic), and lesser and greater prairie chickens have also suffered, as have gambel's quail (Gorsuch 1934), Mearn's quail (Bishop 1965), and scaled quail (Goodwin 1977). Livestock have destroyed their food sources, cover, and essential understory vegetation. Sharp-tailed grouse, which depend on seed-bearing perennial grasses, have been extirpated from several states and now occupy about 10% of their original habitat.

Even the sage grouse has been decimated. One might imagine that the increase in sagebrush caused by livestock grazing would have boosted the numbers of this bird. Yet the sage grouse population today is only a tiny fraction of what it was before the livestock invasion (Wagner 1978). The main detriment is reportedly destruction of riparian areas, which contain vegetation and invertebrate foods essential for proper development of young sage grouse. Sage grouse also consume large amounts of forbs, perennial grasses, and nutritious shrubs on open sagebrush ranges -- foods that have been mostly eliminated by livestock. The Wyoming sage grouse population increased temporarily when stock-

ing levels were reduced from those levels around the turn of the century (Patterson 1952); however, continuing progressive habitat deterioration during this century augments long-term Wyoming sage grouse decline. The Wyoming Game and Fish Department estimates that 50% of the state's original sage grouse habitat has been destroyed, mostly by ranching. Hunting seasons on the bird in Oregon and Washington were eliminated in 1985, and if present trends continue, the sage grouse may be extirpated there by the end of the century.

(George Wuerthner)

Livestock harm many species of waterfowl by eating their food plants, depleting surface water through overgrazing watersheds, damaging riparian areas, and polluting water, reducing nesting success and the likelihood of nesting attempts through the removal and trampling of residual cover, killing chicks in their nests by trampling, and disturbing birds' normal activities. Some ranching advocates maintain that livestock "help out" waterfowl by "opening up" dense wetland vegetation and providing nesting sites. In "Waterfowl Production in Relation to Grazing," L.M. Kirsch concludes "In reviewing the literature I was unable to find a single example of where grazing or other cover removal activities increased waterfowl production" (Kirsch 1969). In 1978, the Conservation Committee for the Wilson Ornithological Society reported that of 56 scientific papers dealing with effects of grazing on waterfowl, all but 1 reported decreased production or other detrimental effects (Strassmann 1983a).

Studies at Oregon's Malheur National Wildlife Refuge showed passerine (perching bird and songbird) counts 5-7 times higher on an ungrazed area of the Refuge (Taylor 1986). Indeed, populations of nearly all bird species almost invariably decline under conventional livestock grazing. R.F. Buttery and P.W. Shields reviewed a number of papers reporting the results of studies in many parts of the country and found this to be so; they also determined that a lessening of grazing pressure resulted in an increase of more than 100% in the small bird population (Buttery 1975).

(Steve Johnson)

The overwhelming impact of livestock grazing on wildlife, birdlife especially, was impressively demonstrated to my family and me a few years ago. On this hot, humid summer afternoon we were driving slowly south through the Sand Hills country of western Nebraska. The asphalt of the old, narrow, unfenced road was full of potholes, much as the countryside was pockmarked with circular lakes.

As we drove, at intervals of a mile or so we'd bounce over cattleguards set perpendicularly through fences, bringing alternations of ungrazed and grazed areas. Each ungrazed mile was thick with medium-high prairie grasses, flowering plants, and widely scattered brush of various kinds. Butterflies and other insects were in the air everywhere, and small mammals were occasionally visible through the lush vegetation.

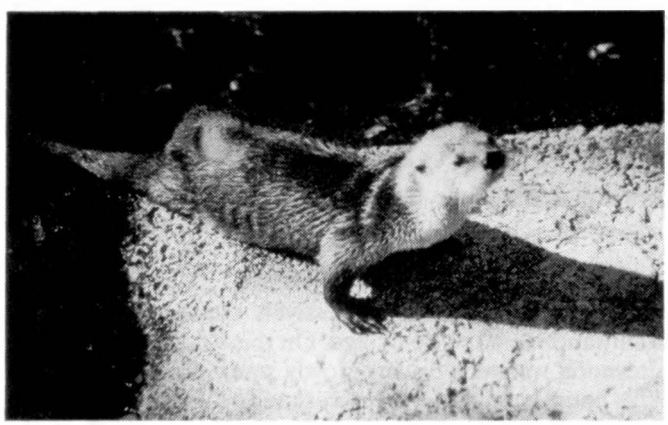
A bounce back into a grazed section brought much sparser grass cropped to a few inches, few native flowers, and patches of invader plants such as thistles and mustards. Flying insects were scarce, and a few rabbits were the only non-bovine mammals to be seen -- noticeable because the meager vegetation afforded so little cover.

But most amazing were the birds. In the grazed sections, we saw them only occasionally, representing only a few species. Upon entering an ungrazed section, we actually had to reduce our already slow speed to avoid hitting the numerous birds fluttering up out of the grass and over the road. There were large numbers of at least a dozen different species, including meadowlarks, buntings, goldfinches, sparrows, warblers, and hawks. Though grazing damage is considerable throughout the West, rarely is the power of livestock to alter the landscape so clearly demonstrated.

To repeat, in most of the West more than half of all animal species rely on riparian zones and associated waters --

precisely the areas hardest hit by livestock. Because most waterways have been depleted or eliminated by overgrazing, wildlife that depended on them has died off; because water volume is much reduced, remaining animals are more easily taken by predators. For example, in Arizona and New Mexico more than 100 riparian species are Threatened or Endangered, more due to livestock grazing than to any other influence (Wuerthner 1989a).

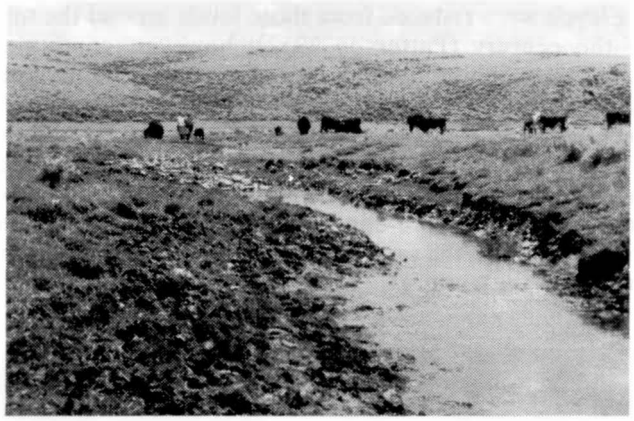
The river otter is a good example. Once found in rivers throughout the West, it is now extinct in most of its former range. Due to overgrazing (and water withdrawal for livestock purposes), many streams and small rivers no longer have adequate flow to support river otters. Because of damage to waterways and riparian systems, in many areas the river otter's food supply of fish, frogs, crayfish, and other aquatic animals has been diminished, while prime denning sites have been reduced. Also, because many riparian trees (and beaver dams and ponds) have been eliminated by livestock, prime river otter habitat has been reduced.



River otter.

The yellow-billed cuckoo is another victim. In the West, this bird is largely dependent upon riparian zones. Once numerous, it is now rare in much of its range. According to Robert Ohmart of Arizona State University, in the last decade alone 5000 acres of cuckoo habitat along the Colorado River valley on the California-Arizona border have been reduced to only 200 acres, chiefly by ranching and tamarisk invasion.

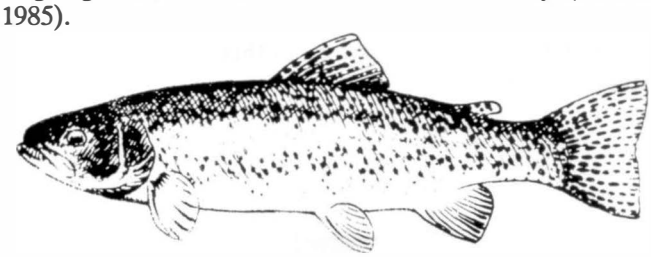
Other examples are bluebirds, flickers, woodpeckers, and other birds that depend on cavities in large riparian trees for nest sites. By eating tree saplings and young trees, damaging soil, causing increased flooding and lowered water tables, etc., livestock have eliminated many of the trees these birds formerly utilized. The story is the same for hawks, owls, flycatchers, orioles, warblers, egrets, herons, bald eagles, tree swallows, raccoons, skunks, squirrels, lizards, and other animals that nest, roost, den, or find shelter in riparian trees and snags. For example, the National Audubon Society put pressure on Arizona's Tonto National Forest to curtail grazing there because "improper grazing prevented regeneration of trees essential to nesting bald eagles (Chaney 1990)." The ferruginous pigmy owl, one of the world's smallest owls, is listed as Threatened in Arizona due largely to ranching's destruction of riparian zones with their snags, degradation of upland habitat, and withdrawal of groundwater for pasture irrigation.



A public stream somewhere in southwest Wyoming is testimony to the impact of a century of livestock grazing. Thousands of Western waterways are in such condition and can no longer support the abundant aquatic life they once did. *(Kelly Cranston)*

A study on the Little Deschutes River in Oregon found trout populations 350% higher on ungrazed than grazed portions of the river (Lorz 1974). An ungrazed segment of Montana's Rock Creek produced 268% more trout (336% by weight) than a grazed segment (Ferguson 1983). Studies by A.S. Leopold show deterioration of streams and loss of trout in California (Leopold 1951). A recent overview of 5 separate studies determined that trout populations averaged 184% higher in ungrazed than grazed segments of the same streams (Wuerthner 1990a).

Indeed, where streams still exist, trout populations are commonly 2-5 times higher on ungrazed than grazed streams. Livestock grazing is often cited as North America's foremost cause of the drastic decline in native trout populations and a leading cause of salmon decline since the 1800s -- not only in the West but in the central and eastern regions as well (White 1989). A recent study report released by the Forest Service documents how livestock have hastened the decline of salmon (Durbin 1991). The American Families Fisheries Society states that fishing opportunities have been reduced by 60% to 90% because of livestock overgrazing on 68,000 miles of streamside cover in National Forests. According to trout authority Robert Behnke, overgrazing is the single greatest menace to trout streams today (Rosetta 1985).



For example, in the Owyhee region of southwest Idaho, southeast Oregon, and northern Nevada, overgrazing has helped decimate the red-banded trout, a unique rainbow trout subspecies specially adapted to warmer water. Most red-banded trout that remain survive in small streams where grazing is restricted by rugged terrain. In the nearby Trout Creek Mountains of southeastern Oregon, the whitehorse trout, a subspecies of cutthroat, is a candidate

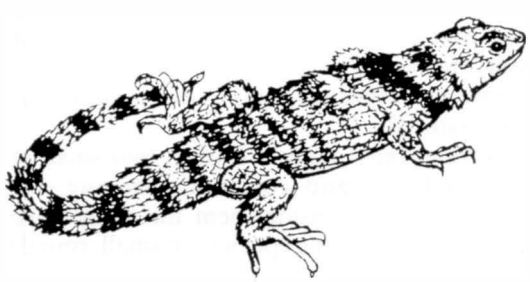
for federal listing as Endangered due basically to the same influences (Wuerthner 1990a). And in northern Nevada, livestock helped put the Lahontan cutthroat on the Threatened Species list.

The Gila trout is a colorful fish once abundant throughout the Gila River drainage and perhaps others in the Southwest. It began suffering from extensive habitat degradation due to livestock grazing about 100 years ago (Behnke 1976, Platts 1978). Along with competition from exotics, logging, fire suppression, and mining, overgrazing almost exterminated the species by the early 1900s. The Gila trout was placed on the Endangered Species list in 1966. Reintroduction efforts in recent years have been unusually successful, but the fish's future remains uncertain.

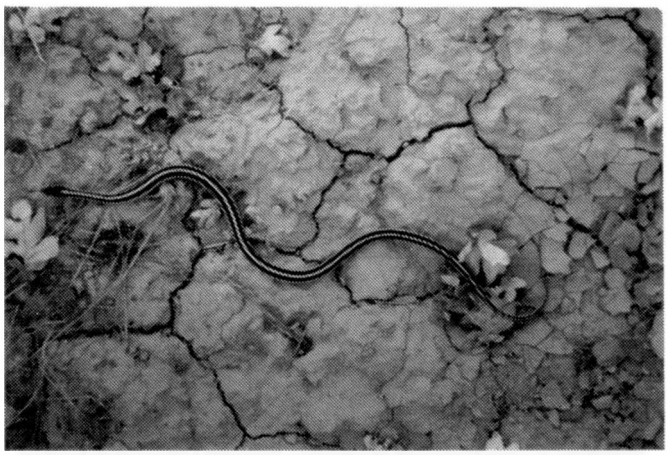
Similarly in the Southwest, loss of aquatic habitat, destruction of streamside vegetation, siltation and other water pollution, dams and water diversions for livestock production, and other ranching factors helped put the Arizona trout and Little Colorado spinedace on the Endangered list, and hampered recovery efforts (Behnke 1976, Gallizioli 1976, Meehan 1978, Platts 1978, Nowakowski 1982) In fact, of 32 fish species native to Arizona, 5 are extinct and 21 of the remaining 27 are officially listed as Threatened or Endangered or are being considered for listing -- all due largely to ranching (Wuerthner 1989a).

Though livestock grazing has raised summer temperatures of thousands of Western streams, thus giving warm water fish an advantage over cold water fish, grazing's depletion and pollution of surface waters, reduction of fish food, and many other impacts have caused declines of warm water fish as well. For example, the Zuni bluehead sucker, native to several waterways in western New Mexico, is currently under review for listing as Threatened or Endangered due mostly to habitat destruction by livestock and dams and water withdrawal to support livestock production.

It is reported that some undescribed species of fish were wiped out long ago from streams that are now nonexistent (Ferguson 1983). Though dams and overfishing commonly are blamed for the declines in Western fish populations, most dams were built (primarily for livestock production) and most intensive fishing began decades *after* fish populations plummeted in the late 1800s and early 1900s. Overgrazing was and probably still is the main force ravaging the finny multitudes that once swam freely Western waterways.



Researchers found twice as many lizards (3.7 times by weight) on ungrazed study plots than on grazed study plots (Ferguson 1983). Livestock may be implicated in declines of many frog species over much of the West, including the relict leopard, Rio Grande leopard, and Tarahumara frogs, canyon and mountain treefrogs, and the Las Vegas leopard frog, which is probably extinct (the city of Las Vegas has covered most of its habitat in recent years). Most snakes, toads, and salamanders likewise fare poorly under livestock grazing pressure.



Livestock grazing harms most snakes -- garter snakes, for example -- which utilize surface waters, abundant protective vegetation, and insects and other small prey.

Although countless creatures have been harmed, the destruction of species and their habitat by livestock is rarely a dramatic event. Rather, it is a slow, insidious *process* continually taking place throughout the West. As with moderate levels of toxics or radiation, it may take many years or even decades, but the damage is nonetheless severe. Steve Johnson of Defenders of Wildlife writes that "Grazing is a subtle agent of change, making inroads on wildlife and its habitat that are slow and cumulative."

The badger, for example, was once common throughout the rangeland West. It survives in small numbers, and is locally extinct in many areas. Its preferred habitat -- open grassland and semi-arid grassland abundant in small mammals and various animal and plant foods -- has been extensively and intensively grazed for over 100 years.

When livestock damage an area it is seldom immediately obvious the ways in which wild animals suffer. For example, many species require different foods or vegetation types at different times of the year. Black bears are omnivorous. At times during spring and summer they become grazers and over half their diet may consist of *grass*. Thus, in some areas livestock become direct competitors with bears for forage.

Likewise, because most allotments are not grazed year-long, lingering, harmful grazing effects may go unnoticed while livestock are elsewhere. As another random example, the hard-packed soil caused by trampling cattle may months later prevent burrowing animals from digging tunnels and dens.

The effects on wildlife are sometimes very obscure: Surveys at the San Pedro National Riparian Conservation Area (mentioned above) show a large increase in the number of yellow warblers since cattle were removed several years ago. Yellow warblers feed primarily on insects in the upper riparian tree canopy. BLM staff report that the amount of understory vegetation and number of saplings has increased tremendously since cattle were removed from the Conservation Area several years ago. But, how could this so immediately benefit a bird that depends on the upper canopy for survival? BLM says it may be because most of the upper canopy insects spend their larval, pupal, and/or younger stages in lower vegetation or topsoil, where they are vulnerable to cattle.

Typically livestock so eat and trample vegetation that little remains above winter snowpack for wildlife. *(George Robbins Photo, Jackson, WY)*

Where ground cover vegetation grows high and dense, it is much more available to foraging animals above the winter snowpack. In contrast, forage plants on the typical grazed range are so closely cropped by livestock that for months at a time little or no edible plant matter is above the snow's surface. As a result, most winter foraging animals have been harmed, especially those less able to dig deeply into the snow for forage.

Also, where vegetation grows high and dense, much more snow is trapped and protected from melting than on grazed ranges. This snow cover provides insulation, providing for higher below-snow and in-snow rodent populations, which in turn provide a greater prey base for predators like weasels, red foxes, coyotes, hawks, and owls.

By closely cropping vegetation, livestock harm wild animals in many other subtle ways. For example, without full-sized vegetation many invertebrates lack protection from sun, wind, and rain. Many crawling organisms likewise lack refuge from ground-level predators. Web-spinning spiders lack attachment points to build webs high enough and large enough to catch most flying insects (livestock also regularly destroy their webs). And without tall plants, whatever edible seeds, fruits, and greens do escape the jaws of cattle and sheep are trampled down (if not destroyed), to be eaten mostly by ground-level creatures -- to the deprivation of the herbaceous canopy-dwellers.

Fallen dead plants and loose organic litter combine to provide a cover of insulating material under which small plants escape frost or heat and keep moist; some species use this microclimate as a "greenhouse" to start seedlings. Many animals rely on this greenery during certain portions of the year. Livestock smash this canopy and deplete its source materials.

And, depletion of vegetation cover has unnaturally exposed numerous animals to the cross-hairs of human hunters, and to harassment, capture, and physical mistreatment.

This complex riparian interminglement of downed branches, litter, flood debris, and living plants is prime habitat for many animals. Ungrazed.

Logs, downed branches, and other plant parts such as yucca stalks, cactus skeletons, wild fruit and melon hulls, and pine cones, as well as leaf and organic litter, provide important cover, dwelling, hibernating, feeding, mating, and observation sites for thousands of species of small- to medium-sized animals. To many mammals, reptiles, amphibians, birds, arachnids, insects, and others, these ground-level organic objects are home. They give plants protective cover, provide a seed-bed, conserve water, enrich the soil, and so forth. Additionally, they give diversity and character to the land. Undisturbed rocks and stones serve similar purposes. (Turn over almost any fair-sized rock or other object and usually you'll find a surprising assortment of tiny creatures underneath.)

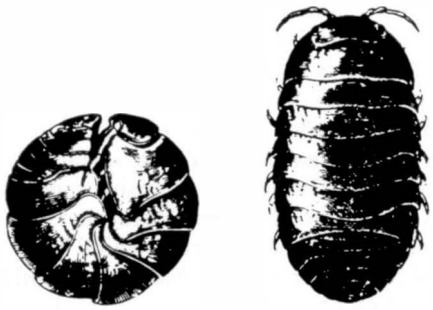
The bad news is, of course, that livestock spoil all this. They break apart and/or scatter logs, tree branches, rocks, and everything else on or near the ground, denying these objects fixed positions and prolonged contact with the ground, thereby impairing their usefulness to wild animals. Commonly, nothing remains but chaotic wasteyards. By desertifying the land, they make sure little new plant material grows and eventually falls to the ground to replace lost organic material.

Livestock keep these objects broken into small pieces, scattered, dried out, and constantly moving, thereby preventing wildlife from using them for many purposes. Consider bumble bees; some species cut small, round holes

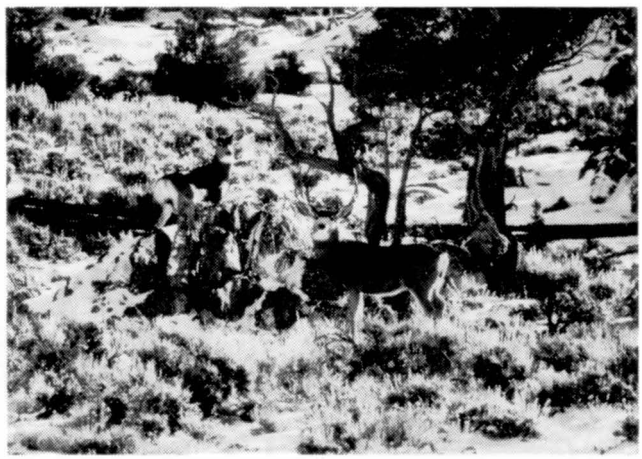
in old yucca stalks and hive in the hollow interiors. Overgrazing has reduced yuccas in many areas, but as important to bumble bees, cattle often knock over and trample apart yucca stalks. Consider lizards; most species find shelter in, under, and between ground-level objects and organic litter, so they are particularly harmed by its loss and rearrangement.

Ponder the lowly sowbug or "pillbug." Most of us recognize these as the miniature trilobite look-alikes that roll up into tiny, gray balls when disturbed. Sowbugs find refuge in perpetually humid surroundings, in the mat of litter beneath vegetation, below fallen logs, under rocks -- in conditions similar to those experienced by their ancestors hundreds of millions of years ago. Here, in sowbug comfort, they spend most of their time, avoiding deleterious weather, safe from most predators, producing young. Usually at night, they crawl out to feed, mostly upon decomposing plant material. In turn, they feed many other animals, including various birds, toads, lizards, and large insects.

Look at cows and sheep from the sowbug's point of view. They invade your habitat like a tornado. Thousands of gigantic shuffling and trampling hooves break apart and scatter logs, branches, rocks, and the organic litter layer, exposing you and your comrades to the blazing sun, to wind and cold, to predators, leaving you homeless. Many sowbugs are smashed. The ground is also exposed, causing a chain reaction of damaging effects; especially harmful from your viewpoint is the drying of the soil. As the livestock deplete vegetation and prevent new growth, sowbug habitat inexorably declines. Less plant life inevitably means less decaying vegetation for you to eat. You soon die.

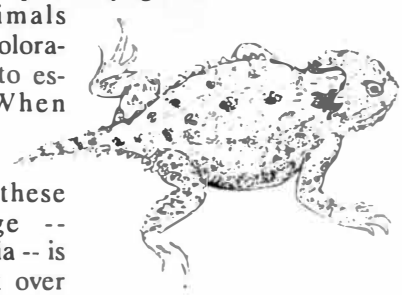


Some livestock effects may seem unimportant, but their cumulate impact may be significant. For example, as mentioned, overgrazing has caused a dramatic increase in the number of thorny and stickery plants on the Western range. This type of vegetation physically injures many wild animals, causing them to develop infections or lose the use of limbs or eyes. Some die from infection, and maimed animals are less able to fend for themselves and more susceptible to predation. Similarly, livestock have spread cheatgrass and foxtails across tens of millions of acres. As many dog owners will attest, the awned seeds of these plants often lodge in animals' eyes, ears, gums, or foot pads, from which they sometimes work their way into the animals' bodies, inflaming and infecting, sometimes causing blindness, hearing loss, or death.



On range ungrazed by livestock, healthy vegetation enhances the natural camouflage of these mule deer. *(George Robbins Photo, Jackson, WY)*

Again, many livestock effects are indirect and subtle, often poorly understood even by scientists. The link between livestock grazing and species decline is not recognized in many cases, purposefully ignored in others. For instance, many animals depend on specialized coloration and cryptic form to escape predation. When livestock change the character of the land, the effectiveness of these animals' camouflage -- developed over millennia -- is reduced. Suppose that over several decades overgrazing sheep cause changes in the composition, texture, and color of the soil's surface. As a result, horned lizards, which evolved irregular, colored blotches to resemble specific soil surfaces, are more visible to hawks and other predators.



Reptiles, being ectothermic ("cold-blooded") creatures, need adequate plant cover, rocks, or other objects to provide shade from the summer sun. Without shade, they must go underground or die. (In some grazed areas, the compacted, hardened soil may prevent them from burrowing.) Where livestock have eaten and beaten vegetation, shade is often inadequate and reptiles are limited in daytime movement and less able to carry out normal activities.

Many small animals suffer the effects of livestock in a more direct and immediate manner -- *they are stomped on*. Domestic cattle are huge, obese (if not undernourished), and awkward animals. Their large, cloven hooves crash down billions of times every day around the West. Large herds of domestic sheep or goats aren't much better. Many animals, including insects, spiders, snakes, lizards, tortoises, toads, and various amphibians, rodents, and small mammals

are maimed or killed. Ground-dwelling creatures are killed and injured as hooves crash into their burrows. Many animals cannot dig the burrows they use, and must rely instead on those dug by other animals. Thus, trampling livestock may leave them at the mercy of the elements. Baby animals are crushed in or thrown from their nests. In Old Spain, El Torro Ferdinando sat on a bee. In Idaho, a cow sat on and killed two baby Endangered whooping cranes.

(Greg Pentkowski)

If we get rid of the cattle that now infest our public lands in the American West we will then be making room for a much greater population of elk, pronghorn antelope, bighorn sheep, mule deer, black bear, grizzly bear, buffalo, mountain lion, javelina, jaguar, desert tortoise, moose . . .
--Late naturalist writer Edward Abbey

As habitats are degraded, the more livestock-sensitive species are reduced in numbers or extirpated from certain areas, a phenomenon called "localized extinction." The masked bobwhite is a good example. With the introduction of cattle in the late 1800s, the bobwhite's lush grassland habitat in New Mexico and southern Arizona was devoured and the bird declined rapidly (Brown 1977, Goodwin 1977). The last known bird in the US was killed in 1912, and within a few years it was also believed extinct in Mexico, its last stronghold. Unexpectedly, many years later a few masked bobwhites were found in a cage in Mexico. They were brought to the US and reared in captivity. Subsequent reintroduction efforts were unsuccessful until 1985, when the federal government bought a 112,500-acre ranch near Sasabe, Arizona, on the Mexican border, established it as the Buenos Aires National Wildlife Refuge, removed the cattle, and reintroduced the masked bobwhite. With tall grass and a comparatively healthy environment, the masked bobwhite is making a comeback on the Refuge and may already have reached a viable breeding population. There are still no other known wild populations of masked bobwhite in the United States and only a small number in a small area in the overgrazed Mexican state of Sonora.

Northern bobwhite, of which the Endangered masked bobwhite is a subspecies. *(USFWS)*

Ungrazed Buenos Aires National Wildlife Refuge. *(Paul Hirt)*

Wildlife in ecologically limited or simplified habitats may be particularly sensitive to livestock grazing. For example, the island night lizard is a large, darkly mottled, nocturnal, omnivorous reptile native only to the San Clemente, San Nicolas, and Santa Barbara Islands off the Southern California coast. Even its restricted habitat -- a few widely scattered islands 60 miles out in the Pacific Ocean -- has been ravaged by introduced livestock! Consequently, with no refuge the island night lizard is Endangered.

Similarly, species with naturally small ranges may be devastated by livestock. The black toad, for example, is native only to the area around Deep Springs Valley in east-central California. Decades of intensive ranching there led to the toad being placed on the California Endangered list. The Oregon silver spot butterfly, which lives in the lush meadows of coastal Oregon, probably never did have a large range or great numbers, but grazing sheep have so reduced its range and numbers that the insect is now a candidate for listing as Endangered.

When a species' population is reduced beyond a certain level, inbreeding and genetic drift gradually weaken the species. The gene pool dwindles and social structure collapses. The species eventually reaches the point where it cannot maintain a viable population and goes extinct locally or throughout its range. Such has been the case for numerous Western species.

(Eric Twachtman)

Dunes tiger beetle, Uncompahgre fritillary butterfly, Hualapai vole . . . As with plants, the list of animal victims forced onto the Threatened and Endangered list by livestock goes on and on. One example that has gained some media and scientific attention is the desert tortoise, a resident of the arid West for more than 3 million years, one that individually may live to 100 years of age. At home in the sparsely vegetated low-elevation deserts of California, Arizona, Nevada, and Utah, its diet consists mainly of grasses, forbs, and low shrubs. An average cow (or 5 sheep) eat as much of this vegetation in 1 day as a desert tortoise does in a year. Actually, the desert tortoise hibernates 9 or 10 months of the year and eats only about 23 pounds of vegetation during the other 2 or 3 months. So, strictly food-wise 1 cow equals about 500 tortoises. By far most tortoise habitat has been occupied by cattle and sheep for over 100 years. Ninety percent, mostly BLM land, is grazed now. Most native tortoise food plants have been wiped out, so it isn't hard to see why habitat once supporting 2000 desert tortoises per square mile now supports at most 200-400 per square mile, why the reptile has been extirpated completely from much of its former range, and why it is now listed as Threatened in California, Nevada, and Utah, and probably soon will be in Arizona.

(Steve Johnson)

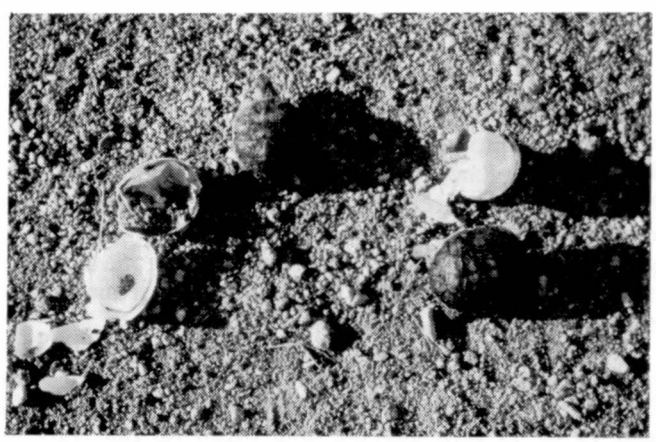
A 1983 study on BLM land in the Paiute Valley of southern Nevada showed that 109 desert tortoises had starved to death on a 1 mile square plot. Similar mass starvations of desert tortoises over large areas due chiefly to livestock competition are common during dry years. Tortoises may increase in numbers during wetter years, but the overall trend is downward.

An extensive study of desert tortoise mortality on BLM land in the Beaver Dam Slope area of Arizona and Utah (part of the longest-ever continuous study of a vertebrate) showed clearly that tortoises there were starving due to cattle grazing. (A friend writes that in a recent visit to this area she observed starving cattle "eating mesquite branches 3/4" in diameter.") Additionally, depletion of vegetation left tortoises without adequate shade from hot sun. Tortoises were also suffering a variety of malnutrition-related maladies and reproduction failures and being stepped on, overturned (which can kill them), and buried alive in burrows. Other ranching-related problems include compaction of soil needed for burrowing, harmful fires due to highly flammable exotic annuals, trampling of nest sites, and impacts from ranching activities. Nevertheless, BLM is considering *increasing* the number of cattle on the Beaver Dam Slope. (Jarchow 1987)

A 1990 FWS biological opinion documents numerous detrimental effects of ranching on the desert tortoise (USDI, FWS 1990). Even the Forest Service maintains, in *Run Wild: Wildlife/Habitat Relationships*, that, "Livestock have deleterious effects on tortoise populations and their habitat through trampling young, soft-shelled tortoises; damaging burrows and shrubs used by tortoises for shelter; and removing critically needed forage (Nowakowski 1982). Dr. Kristen H. Berry, the world's foremost authority on the desert tortoise, states that the animal could reach the brink of extinction by the end of the century:

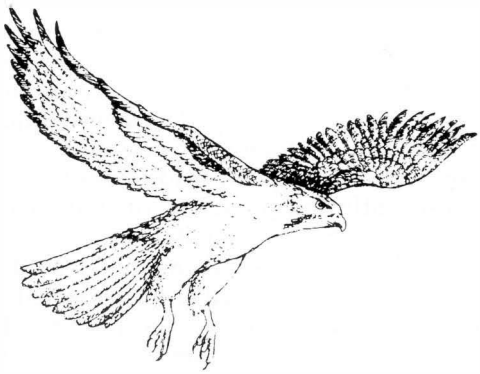
> *We're seeing extirpation of whole populations. Many of the island populations have already fallen below viable levels.*

Disease has recently taken a toll, probably due largely to increased susceptibility from stress caused by livestock pressures. Collectors have taken and killed millions, and development, mining, toxic dumping, and ORV use also harm tortoise habitat. But Berry cites livestock production as both the main historic cause of desert tortoise decline and the main threat to its future survival. (Berry 1978)



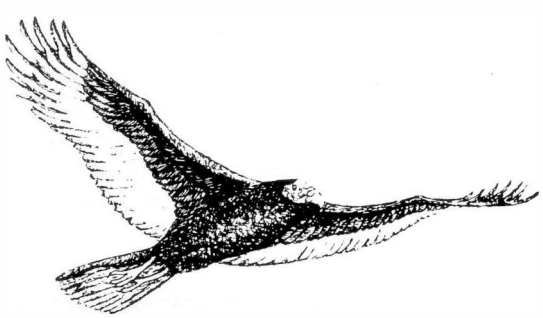
Desert tortoise hatchlings are easily killed by trampling livestock. *(Steve Johnson)*

> *The livestock users have always contended that there is no conflict between sheep and the desert tortoise.*
>
> --Frank Munoz, executive officer, Kern County [CA] Wool Growers Association (Hartshorn 1988)



The desert tortoise shows that the decline of one animal often leads to subsequent declines of others. The desert tortoise digs burrows up to 30' long and 15' deep. By a recent count, 362 species of commensal invertebrates and vertebrates utilize the tortoise's burrows, and many of them can live nowhere else or even dig burrows themselves (Carlton 1990). The drastic reduction in the tortoise population cannot help but lead to declines of dependent species.

Likewise, the general decline in wildlife caused by livestock means general decreases in prey and carrion and corresponding declines in populations of dependent predators and scavengers, such as hawks and turkey vultures.



As overgrazing progressively degrades an area, even livestock-tolerant species decline. For example, the Merriam's kangaroo rat generally maintains a fairly high population level on moderately grazed grassland (though not moderately grazed desert -- its chief habitat). But when grazing reaches the point where the grass is gone and little of the rat's food source of seeds and leafy ground cover remains, its numbers decline.

The Arizona Game and Fish Department reports that livestock grazing and associated activities are partially or fully responsible for the decline of 13 of 18 mammal species and 11 of 22 bird species now listed by the state as Threatened or Endangered (this not including impacts such as from ranching roads, etc.) (Wuerthner 1989a). Even BLM acknowledges a serious livestock/wildlife problem. In 1974 a BLM report stated that "uncontrolled, unregulated or unplanned livestock use is occurring in approximately 85% of the state [Nevada], and damage to wildlife habitat can only be expressed as extreme destruction." The next year a BLM study noted that 33 species officially designated as Endangered inhabited BLM land and that "public land management at existing levels may not insure the survival of these endangered species" (CEQ 1975). In its Fall 1986 issue, *Advocate* magazine reported:

> *There are currently 109 endangered species on BLM lands, but there are recovery plans for only 57. Of those 57, only 44 of the plans are being implemented. In fact, BLM has been trying to cut back on wildlife programs for 6 years, and this year requested a $2.16 million cut from their wildlife species program. ... The government touts a "multiple use" philosophy for public lands, but clearly, livestock are favored.*

Since the above was published, BLM has stated that it administers "habitat for over 3,000 wildlife species, including 127 Federally listed threatened or endangered plant and animal species and more than 800 species that are candidates for Federal listing" (USDI, BLM 1987). Similarly, the Forest Service reports that:

> *National Forests and Grasslands are home to 140 plant and animal species listed as threatened or endangered. The Fish & Wildlife Service has approved* [not implemented] *recovery plans for 80 of these species. ... An additional 761 species are considered sensitive ....* (USDA, USFS 1987)

If habitat is severely affected throughout an animal's entire range, eventual extinction is possible. The Wyoming subspecies of the Canadian toad is one example. General degradation of its southeastern Wyoming habitat by extensive livestock grazing and range management was a major factor in its recent extinction.

According to The Nature Conservancy, in California alone 220 animal species are threatened with extinction. Thus, 1/5 or more of California's native animals could become extinct in the near future. In 1988 Defenders of Wildlife identified 498 US animal and plant species listed under the Endangered Species Act, 940 species qualified for listing but not yet listed, 3010 species needing further study, and possibly 200-300 species already extinct. Ranching has been a major factor in the decline of many of these.

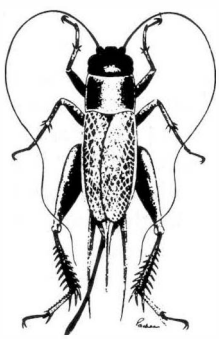
Jared Diamond, a physiologist at UCLA, thinks that nearly all of the world's modern animal extinctions were caused by human influence. He identifies 5 major causes of these extinctions (and drift toward extinction). Livestock ranching is the *only* human activity on Western public land (and much of the Earth) to include all 5 of these influences to a significant degree. They are: 1. *Overkill*. For more than a century, the grazing industry has killed great numbers of predators, competitors, and pests. 2. *Habitat destruction*. Overgrazing and range development have caused more damage to the ecosystems of Western public land than any other single agent. 3. *Impact of introduced species*. Livestock themselves are the most destructive introduced species on Earth; however, the Western grazing industry has also introduced feral horses, dogs, and cats; many insects and parasites; and numerous plant species over millions of acres. 4. *Pollutants*. The grazing industry has polluted Western public land and water more than any other user, with herbicides, insecticides, pesticides, predacides, petroleum products, various chemicals, sediments, urine, manure, and dead livestock. 5. *Secondary effects -- decline or extinction of one species leads to decline or extinction of another*. The decline of numerous Western species at the hands of the ranching industry -- elk, prairie dogs, and slugs, for instance -- has lead to the decline of numerous dependent species -- in this case, grizzlies, burrowing owls, and skunks.

The International Union for the Conservation of Nature and Natural Resources concludes that habitat destruction is the Earth's major cause of extinctions, accounting for twice as many extinctions as overexploitation, which in turn accounts for twice as many extinctions as introduction of exotic species (CEQ 1981). However you slice it, livestock production (including ranching) is Western public land's and the planet's greatest cause of drift toward extinction (see Chapter VI for global impacts of livestock production).

Further, both natural and anthropogenic reintroductions of many extirpated species are made more difficult by livestock. For example, by outcompeting large herbivores, overgrazing, predator-protected livestock have reduced the wild prey base needed by wolves wandering into the Western US from Canada and Mexico and potentially for wolves reintroduced by humans.

Respected scientists and learned others already are warning that natural vertebrate evolution on this planet is coming to a close as a result of unnatural influence. Invertebrate and plant evolution may not be far behind. Ranching is the major cause in the rural Western United States.

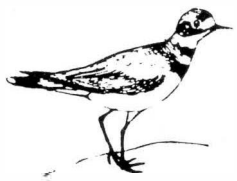
Because each species has different habitat requirements, livestock of course have varying effects on them. For example, where grazing has caused an increase in the brush-to-ground-level vegetation ratio, the ground cricket, which needs thick organic cover at ground level, may be harmed more than the bush cricket, which spends most of its time in bushes.



Because there is such a huge variety of animals with such a wide diversity of requirements, livestock grazing is bound to (temporarily) benefit some species in some areas in some ways. Carp, an exotic, can tolerate water temperatures in the 70s and 80s F., so in streams where grazing has caused higher summer water temperatures, carp have replaced native cold water fish. However, grazing has also reduced streamflow, eliminated protective shelter, ruined spawning beds, polluted water, and decreased available fish food, so undoubtedly even carp are much less abundant overall than they would have been without the livestock influence.

Some species gain numbers in some areas and lose in others. For instance, the blacktail jackrabbit prefers forbs as a food source to grasses. In areas where grazing of grasses has favored "weedy" vegetation, blacktail jackrabbit numbers may rise. However, where grazing is so heavy that even most weeds cannot survive and no cover from predators remains, jackrabbit numbers decline.

Similarly, certain kinds of grazing in certain places at certain times of the year may have certain beneficial influences on certain species, certainly. Killdeer prefer to nest in short grass, so moderate grazing of tall grass just prior to nesting season might be of benefit at that time, if not outweighed by other detrimental livestock factors. Yes, in theory, some livestock effects could occasionally benefit certain wild animals. But in practice this rarely occurs. The detrimental effects almost invariably outweigh the beneficial, especially if range management is considered with the other effects. Shorter grass at nesting time isn't much good to killdeer if the creek they depend upon is dried up and their food supply of water-oriented insects and crustaceans is destroyed.



Cowbirds (formerly buffalo birds) *seem* to do well on cattle ranges (but much more so on irrigated livestock pastures), where they sometimes feed on insects stirred up by grazing cattle. However, the 40-75 million buffalo and millions of other large grazers cattle replaced were of much greater benefit, and huge flocks of buffalo birds followed the great herds, eating the much greater numbers of insects that were flushed up from healthy ranges. The vast native herds supported more buffalo birds then than erratically managed, sporadically grazed groups of cattle do now.

Because native herds were nomadic, buffalo birds could not afford to be tied to nests, and they evolved *brood parasitism* -- that is, they laid their eggs in the nests of other birds at the expense of their hosts' eggs and offspring. However, all involved survived and thrived over the millennia in Nature's balance.

With the introduction of livestock grazing and farming, buffalo birds necessarily became cowbirds and spread into many areas not evolved to accommodate them. There, through their brood parasitism, they have caused the near-extinction of 3 songbirds and decline of many others. However, the main reason cowbird populations in these areas are so high is because millions of acres of cropland, particularly grain fields, provide them abundant food, not because cattle provide much benefit.

A few animal species even seem to thrive because of livestock grazing. The zebra-tailed lizard, for example, runs through sandy washes and open areas with hard-packed soil and scant vegetation cover. Because grazing has increased flooding, creating more sandy washes, and decreased vegetative cover, uncovering and compacting bare dirt over large areas, the overall area of zebra-tail habitat may have increased. Despite negative livestock influences on the zebra-tail (trampling of the lizards and/in their shelters, depletion of food species, reduction of hiding places, etc.), grazing may have caused an overall increase in zebra-tail numbers.

However, while some species appear to benefit from livestock grazing, we must bear in mind that the Western landscape we see today is little like it was before Euro-Americans and their livestock arrived. The environment is now functioning on a much less productive level. On a human-created landscape where much of the wildlife has been eliminated, those animals that survive stand out starkly. Though their numbers may actually be smaller than in pre-livestock times, we may imagine them higher.

For instance, here is a common experience: You are driving along a rural highway early one summer morning. Looking out over the sparse, overgrazed landscape, you see here and there a foraging cottontail rabbit. Since the cottontails are the largest and most prominent objects, and you can see many of them scattered across hundreds of barren acres, they might seem abundant. On a comparable ungrazed landscape, you may be able to see only a few cottontails here and there in the thicker, taller vegetation. Though there are actually many more cottontails and other animals on the ungrazed land, you simply cannot see them.

And some species *appear* to be doing well simply because they are doing better than the more severely harmed species. For example, when you take a week-long camping trip to the lava country of northeastern California and the only large animals you see are 8 deer, 3 coyotes, 2 skunks, a beaver, a few bighorns, and 287 cows, it might seem that deer are doing well there. How are you to know that on that same trip 150 years ago, you would have seen a dozen deer, plus 6 coyotes, 4 beaver, a couple of foxes, 2 herds of pronghorn, 3 black bears, 2 badgers, 3 herds of elk, a porcupine, a bobcat, a group of raccoons, a weasel, 3 mink, a pack of wolves, a ringtail, and no cows? How can we conceptualize accurate comparisons when we have only experienced one half of that to be compared?

> *Livestock grazing has been proven to be essential to proper management of wildlife and other natural resources.*
> --From statement adopted by Western state Farm Bureaus, Cattlemens Associations, and Wool Growers Associations

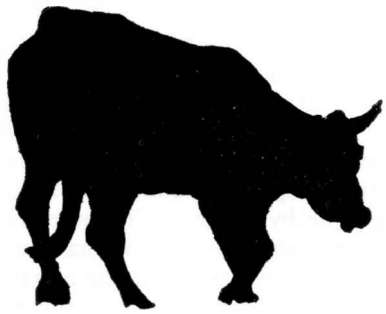
> *The old slogan that "good livestock management is good wildlife management" should be laid to rest by range managers as it has been by wildlife professionals.*
> --Maitland Sharpe, Director, Environmental Affairs, Izaak Walton League of America

Because of this illusory abundance of some wild animals on some grazed lands, some ranchers claim their hooved invaders benefit wildlife. As Denzel and Nancy Ferguson noted in **Sacred Cows**:

> *Today, we hear that ducks cannot take their newly hatched ducklings to water unless cows first trample a path through the dense vegetation. Big game animals would certainly starve if cows failed to eat old growth vegetation and expose the new. Grasses would become extinct if cattle weren't around to trample the seeds into the soil. And if it weren't for the magic stimulating agent in the saliva of cows, plants would probably cease growing altogether. Yes, indeed, American wildlife is certainly blessed to have enjoyed the fabulous benefits of cows as a wildlife management tool.* (Ferguson 1983)

Many if not most ranchers practically take personal credit for any wildlife that survives on "their" public land allotment, promulgating any living creature larger than a rabbit. As the Fergusons point out, however, wildlife is also seen on highways, but that doesn't mean highways are a favored or useful habitat. In an absurd twisting of the truth, it is as if these stockmen somehow manufactured these animals themselves through the wondrous effects of livestock grazing, that there would be some kind of void otherwise. I am reminded of an eloquent and succinct statement by Mike Roselle, a socio-enviro activist: "They lie."

Although they may talk like it, stockmen did not *create* the land or the animals on it, and what few large wild animals remain do so in spite of -- not because of -- ranching.



When a species increases to large enough numbers that it reduces livestock production, the grazing industry alleges it a "pest" -- the animal equivalent of a plant "invader." In damaging ecosystems and setting up conditions favorable for population explosions of certain species, overgrazing and range management (next chapter) are the principal causes of pest infestations in the rangeland West. Animals prone to becoming pests in this manner include grasshoppers, jackrabbits, various rodents, harvester ants, aphids, beetles, and crickets.

The grasshopper is perhaps the most renowned grazing industry pest. USDA calls it the most potent Western forage competitor. Grasshoppers rarely occur in large numbers on ungrazed range, plagues of them are signs of overgrazing. In fact, grazed land sometimes produces 50,000 or more grasshoppers per acre. Livestock grazing uncovers bare dirt in which hoppers lay their eggs, hastens egg development by permitting more sunlight to reach and warm the soil, eliminates vegetation needed by birds and other hopper predators, and causes other changes favorable to population explosions. Accordingly, many experts recommend a uniform grassy cover to reduce grasshoppers, and some suggest a barbed wire fence as the most effective method.

A curious personal experience exemplifies the livestock/grasshopper connection: On the plains of southeastern Montana, a fence separates grazed from ungrazed grassland. The grazed side, where "hooved locusts" have eaten most grass and uncovered much bare dirt, is crawling with hoppers. The ungrazed side, with a thick, tall grass, supports perhaps 1/4 as many. Most surprising is that (until no food remains) the hungry hordes stay on the wasted side of the fence -- not the side with the vastly greater amount of food!

Natural population cycles evolved as part of ecosystem dynamics. Unnatural pest infestations are generally very sporadic, fluctuate to much greater extremes, and do not fit into ecosystem dynamics. They reduce species' habitat, genetic viability, resistance to disease and parasites, and so on.

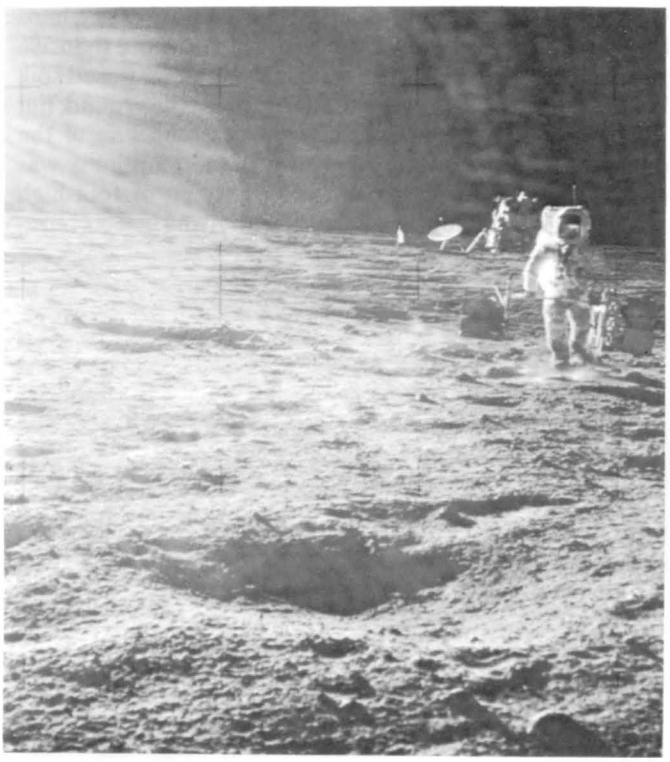
Pest infestations usually intensify the effects of overgrazing. When a large number of grasshoppers graze an already overgrazed range, an ecosystem can be devastated. At this point, either a massive grasshopper die-off occurs, leading to extremely low numbers of grasshoppers the following year(s), or the grasshoppers transform into winged "locusts" and fly off to greener pastures, where they may wreak havoc.

Sometimes so-called "pests" only seem to be pests or are misleadingly portrayed as such. For example, in some areas of California and the Southwest, kangaroo rats of several species are poisoned as pests when their numbers reach "unacceptable" levels. Their numbers may actually be no higher than normal for their habitat -- the high points of natural population cycles. Yet, they are considered pests merely because they reach higher numbers than other wild plant-eating animals in their range. Their comparative success guarantees them a deadly fate.

Similarly, wild animals often become "pests" by default. Pocket gophers, for example, are sometimes considered pests because at certain times they do more damage to livestock operations than any other wild animal. Though the decrease in profits may be slight, stockmen strike out at whatever animal reduces production most. In this way, the ranching industry always maintains at least 1 pest animal enemy, thus garnering subsidy and sympathy.

When grazing is extreme, and perhaps compounded by pests, the land may become so thoroughly degraded that even pests cannot survive. These areas become biological voids, barren wastelands. Millions of acres in every Western state fit this description.

I am reminded of one area in particular. Though no worse than many, at the time it struck me that walking across this stark BLM flatland south of Grants, New Mexico, must be a lot like walking across one of the Moon's desolate "seas."



The Moon. *(NASA)*

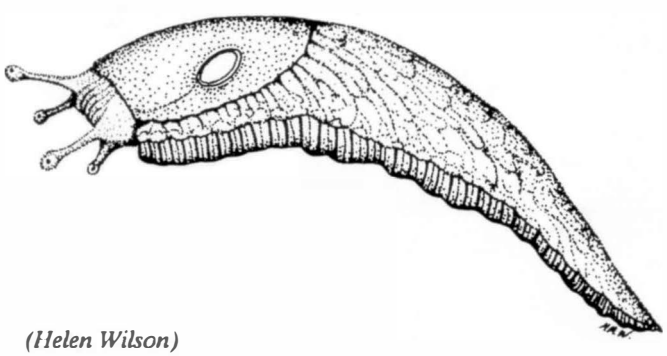
This BLM moonscape south of Grants, New Mexico, is virtually worthless as animal habitat. Ungrazed highway right-of-way on left.

Nothing broke the monotony of the vast expanse of dry, hard dirt. Tiny stubbles of brown, amounting to no more than 5% ground cover, provided little protection to the exposed soil. Perhaps a few ants or beetles crawled across the ground, but I don't recall any animal. Exactly at the fenceline of the nearby ungrazed highway right-of-way the emptiness was magically transformed into a thick covering of foot-high grasses, forbs, and flowering plants, with flying insects buzzing about.

An ungrazed portion of Bosque del Apache National Wildlife Refuge, New Mexico, supports relatively abundant wildlife.

A recurrent premise in this book is that *Nature knows best how to "manage" itself*. Teddy Roosevelt, selective Nature advocate, once said of the Grand Canyon, "Leave it as it is. The ages have been at work, and man can only mar it." Well, the ages have been at work on *all* natural entities and processes.

Here we come to a key juncture in our quest to understand what ranching has done to the West. Before Euro-American conquest, western wildlife existed in relative stability. Populations did fluctuate, but as part of natural cycles following irregular but relatively dependable patterns beneficial to species and ecosystems alike. For millions of years in most cases, individual species have evolved to thrive as parts of these cycles.



(Helen Wilson)

For example, during a series of wet years slugs naturally increase in number as more food becomes available and conditions remain moist. When dry years come, slug numbers drop. Slug species have experienced these irregularly alternating wet and dry periods for millions of generations. Each succeeding generation is given the most-fit genes of the preceding to adapt to environmental changes. In this way, slugs evolve to both survive under a wide range of environmental conditions and thrive under specialized conditions.

All animal and plant species exhibit this duality. On one hand, long-term adaptations to various changes in environments have caused them to evolve to survive as wide a diversity of situations as possible. Thus, within certain limits slugs can live in a multiformity of habitats, under a variety of changing conditions.

On the other hand, to varying degrees all species are also specialists. Each has evolved to take advantage of certain aspects of its environment more fully than other species. In this way, each species maintains some competitive advantage. Thus, slugs are favored in certain habitat in areas of prolonged frost-free periods and high moisture with succulent herbaceous plants for food.

But specialization has its price. Many species have over millennia become so highly specialized that they are harmed by only slight unnatural changes in their environment. Though adapted to survive natural long- and short-term changes, they often cannot tolerate the radically different artificial changes caused by livestock.

Natural cycles are the pulsebeat of all life. All living things have evolved to survive between cyclic extremes. These extremes define the parameters of species evolution. Without them, species become simplistic and limited in their ability to survive environmental changes. Like muscles that go unused, species atrophy without the stimulation provided by natural cycles, evolution stalemates, and species decline.

Nature's cycles are usually relatively gentle, occurring gradually enough so species have time to adjust. For example, as an extended period of dryness progresses, instinct -- the cumulative result of thousands of generations of natural experience -- tells slugs to leave open areas and concentrate along waterways and in low, moist areas. Here they stay until moister conditions return, whereupon they recolonize uplands.

Natural extremes rarely reach far beyond established limits. The periods of dryness that drive slugs and other animals to waterways and low spots almost never last long enough to extirpate populations completely. If a dry period lasts so long as to constitute a change in climate, it does so slowly enough that slugs and other animals and plants can move to moister climes or evolve accordingly.

However, when unnatural changes, such as those caused by livestock, hit an ecosystem, wildlife is caught unprepared and may suffer extirpation. When a herd of cattle moves onto slug habitat, it quickly strips off most low-level vegetation, destroys shelter, damages and dries the soil, smashes slugs, and so on. Slugs do not know what to do; they have not adapted to these changes over the millennia and, unless such a cattle herd invaded extremely infrequently, they could never evolve to survive such radical, unnatural changes. For example, many slugs are too far from waterways to make it there on such short notice. Those close enough to do so find the riparian zones have been similarly damaged. A massive die-off of slugs occurs, perhaps affecting slug predators and others as well.

When livestock alter the necessities of any species, that species suffers. Because almost every natural component has become a necessity to some species, the drastic unnatural influence wrought by livestock has hurt *most* rangeland species.

"Natural disasters," such as tornados, landslides, avalanches, and volcanic eruptions, are also radical influences on wildlife, but they occur relatively infrequently, and usually in small areas. Rejuvenation begins soon thereafter and continues until the previous circumstances re-occur. In areas where radical natural changes, such as those caused by floods and fire, are periodic occurrences, wildlife has evolved to withstand them with minimum hardship and no long-term decline.

The impact of livestock pushes environmental changes and cyclic extremes far beyond natural limits. When the lushly vegetated area that supported slugs for millennia is suddenly stripped of most vegetation, and soil is exposed to the drying rays of the sun on an annual basis for periods of time far exceeding those caused by native grazing animals, fire, or other natural disturbances, slugs and many other animals and plants cannot survive.

Even if they don't die immediately, long-term survival is doubtful. Genetic changes made gradually and under natural conditions do not apply to radically different or fluctuating human-manipulated surroundings. Those genetic changes wildlife does make in response to these human influences will not apply to future environments where conditions will either continue to be radically different and fluctuating or (if humans end livestock grazing or fail to survive), revert back to (whatever is left of) Nature.

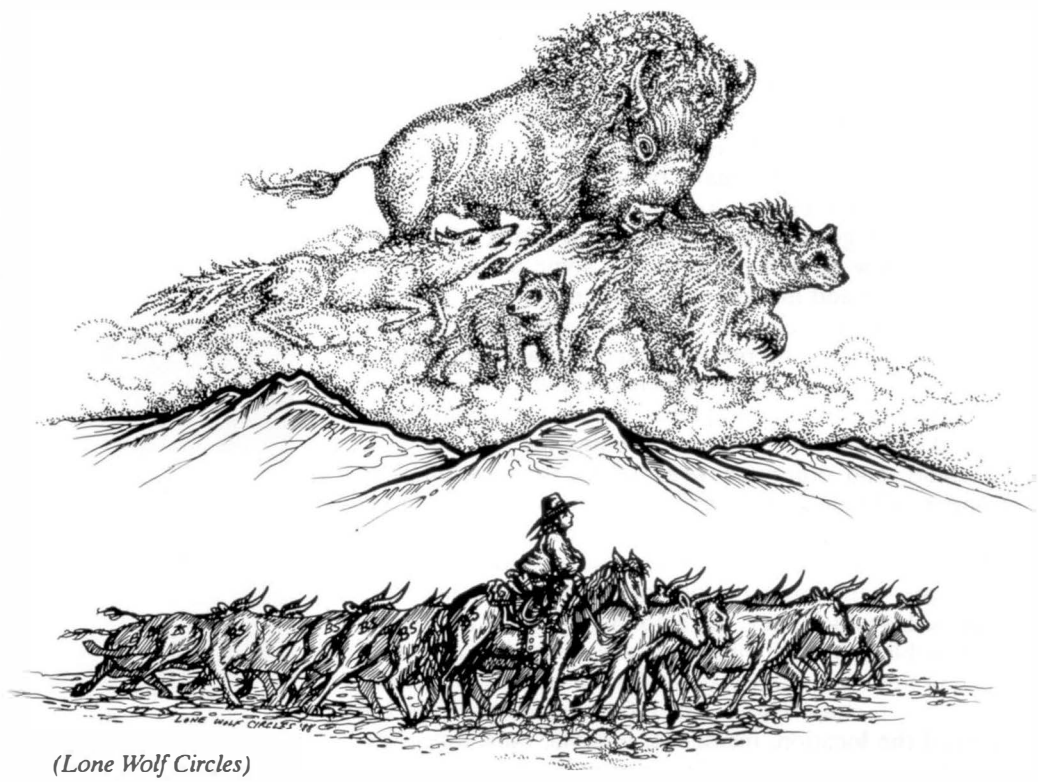
In other words, *livestock grazing throws evolution out the window.*

To the wild animal, the rancher means life . . . .

--Wyoming state Representative and rancher Jim Hageman

Livestock grazing is the single most important factor limiting wildlife production in the West.

--Philip Fradkin, "The Eating of the West" (Fradkin 1979)



(Lone Wolf Circles)

(George Wuerthner)

Fire

Smokey was wrong.

Fire is as natural to this planet as trees, brush, and grass. Indeed, most Western forests, brushlands, and grasslands *need* natural fire to maintain peak health. Their plant and animal species are well-adapted to periodic natural burns, and many actually thrive *because of* fire. Until recently, they had been doing so for thousands or millions of years.

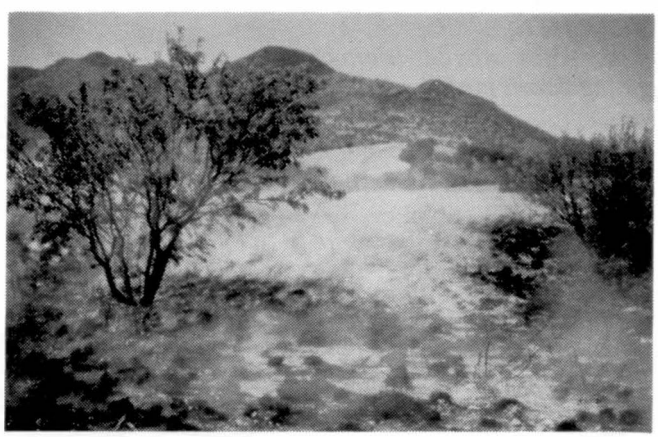
Natural fire provides many important benefits to most Western ecosystems. It creates seedbeds; assists some species' seed germination; initiates sprouting of tender, nutritious new growth preferred by some animals; helps prevent insect and disease epidemics; neutralizes environmental toxins; recycles nutrients not otherwise recycled; diversifies habitat; and prevents excessive accumulation of combustible organic matter which could lead to explosive, destructive fires. For many plants, fire also functions something like an animal predator, "weeding out" the old, sick, deformed, and otherwise weak of the species, allowing stronger individuals to survive and pass on their more favorable characteristics to future generations.

But just as the plants, soil, water, and animals of the West have been denigrated by livestock grazing, so have fire regimes. Livestock alter: the amount, type, and location of combustible material; fuel moisture; humidity and wind speed at fire level; waterways and other natural firebreaks; and other factors which affect fire dynamics. This has changed the location, incidence, interval, burn time, size, and other characteristics of fire on most Western rangeland.

Fires now are generally much more sporadic and less frequent than 150 years ago. They are usually smaller, burn shorter and at different times of the day and year, leave dissimilar amounts and kinds of ash, and so forth. In many areas where livestock prevent fuel buildup, wildfire is now virtually nonexistent. Where livestock are removed, usually natural fire quickly reestablishes itself, if given the chance.

In the Southwest, scattered mesquite trees were a component of many original bunchgrass communities. Lightning-caused fires periodically swept through such communities, burning any given area at intervals of roughly 5 to 20 years. The hotter of these fires burned off the tops of bunchgrasses (and forbs, flowering perennials, and other non-woody plants) and small mesquites alike, but roots of both almost always survived. (Widely scattered large mesquite trees usually were not burned.) Because bunchgrass regrows more quickly than mesquite, it gets a head start over mesquite for the first few years after a fire. But eventually mesquite begins to overshadow and dominate bunchgrass. Mesquite remains prominent until another fire comes through and once again gives bunchgrass the advantage. Fire dynamics maintained cyclic equilibrium and ecosystem health, diversity, and stability.

When livestock change an ecosystem they "play with fire," so to speak. As cattle overgrazed these Southwestern bunchgrass communities in the late 1800s, they stripped off so much ground cover that fire no longer made periodic sweeps. Mesquite was given the advantage and as a result outcompeted bunchgrass in many areas. The combination of overgrazing, harmful range management, and lack of natural fire continues to wipe out not only the native bunchgrasses but many other plants and animals, and even the mesquite in some areas.



This mostly natural fire in a mesquite grassland creates biologic mosaics and promotes healthy ecosystem dynamics. *(Geoff Babb)*

Natural fires can be started by volcanic activity, sparks from landslides or falling rocks, meteorites, or even spontaneous combustion of certain naturally occurring substances. However, the vast majority are started by lightning. This is significant, for lightning is usually accompanied by a storm's cool temperatures, high humidity or rain, and wind. The strong winds associated with thunderstorms often help ignite and spread fires, but the wind and the fires usually don't last long. More than 90% of lightning-caused fires in the West burn out or are rained out before reaching an acre in size.

Human-ignited fires, on the other hand, whether prescribed, accidental (ranching activities are one of the main causes of accidental fires in the West), or arson, rarely occur when or where Nature would have them. Most are started during the wrong weather at the wrong time of day and in the wrong part of the season. They occur too frequently or infrequently and too regularly or irregularly. Accordingly, anthropogenic fires are too big or small, long or short, hot or cool, smoky or clear, etc., to be of maximum benefit to ecosystems that evolved with certain fire patterns. Depending on a host of variables, human-caused fire may benefit or harm an ecosystem, but natural fire is usually much preferable in both the long and short term.

Additionally, a widespread policy of fire suppression by governments under pressure from timber and ranching interests has resulted in great increases in combustible material in many brushland and forest areas since around the turn of the century. Most fires in these areas, both accidental and purposeful in origin, occur when the weather is hot and dry with long-lasting winds -- conditions unlike those associated with thunderstorms. Thus, these fires spread explosively through tinder-dry fuel, often killing nearly everything in their path. They can be so intensely hot that they "scorch" the surface of the ground, change its chemical composition, kill soil microorganisms, and render uppermost soil sterile. (Conversely, livestock depletion of ground cover can result in fires too cool for ecosystems adapted to naturally hotter fires.)

Some natural fires started by lightning at the end of the dry season and onset of the thunderstorm season may also "burn hot" (though subsequent thunderstorms extinguish many). Most natural fires, however, occur as the thunderstorm season progresses. They burn relatively moist fuel and/or during wetter, cooler weather. Usually, they burn comparatively slowly and coolly. Even when strong winds whip them quickly through the grass, brush, or trees, fire temperatures stay comparatively low.

In timberland, most natural fires creep across the forest floor, consuming accumulated duff, dry grass and herbs, occasionally burning logs, small or dead trees, and patches of thick understory. Erratic storm winds may cause fire to leap-frog through the ground cover or up and down through the different foliage levels. In brushland, wildfires move steadily along beneath the brush canopy, consuming dead lower branches and the litter layer of leaves, twigs, and dry grass. Or where sufficient fuel has accumulated, flare-ups burn off brush completely. In grassland, fires sweep or creep across the landscape irregularly, burning off the old, dry vegetation and fertilizing the soil with nutritious ash.

Contrary to what we have been taught from infancy by Smoky the Bear, Bambi, and BLM's Johnny Horizon, natural fire is not an evil monster annihilating everything in its path. As mentioned, relatively few wildfires spread far. Most are extinguished by rain or diminishing thunderstorm winds, or quickly exhaust their fuel supplies. Many are blocked by streams, washes, rocky outcroppings, cliffs, animal trails, moist vegetation, and so on. Some do burn for days or weeks or even months, occasionally becoming gigantic in size, but even these benefit the ecosystems adapted to them.

Wildfire usually leaves a complex mosaic of burned and unburned areas, as well as individual trees and plants that survive the flames. Organic matter that is not yet ready to burn doesn't, and cliffs, rocky areas, waterways, irregularities in growth patterns, differences in fuel moisture, and weather changes during the fire all contribute to a mosaic effect and, eventually, to a complex of vegetation types in various stages of succession which promote ecosystem health, diversity, and stability. The unburned portions of mosaics allow many animals that cannot go underground, run, or fly away to escape the flames. They additionally provide source areas for revegetation of burned-over areas by less fire-tolerant plants and re-colonization by small animals. Ranching influences, particularly overgrazing, can cause either excessive or inadequate fire, and unnatural fire, all of which preclude this biodiversity-enhancing mosaic effect.

> *In some places, the fire had reached the canopy, "crowned out," and incineration was complete. Where the fire had burned fitfully or not at all, there were brown or green islands of surviving vegetation. In many places, it was difficult for us to determine why the flames had skipped over a patch of ground. Already a mosaic of new vegetation was intermixed with the old.*
>
> --Ed Grumbine, ecologist

Natural systems experience cyclic variations in their components. Each component is interlinked with all others in an incredibly complex network of interrelationships no person can fully understand. Because of this complexity, and because the time frames for these cyclic pulses are often longer than those familiar to us, we have a distorted view of many natural events, including fire, as catastrophes when in fact they are essential to maintaining ecosystems.

For example, the Yellowstone area wildfires of summer 1988 burned 1.6 million acres. Not since 1910, when 3 million acres burned, had the Northern Rockies seen fire on such a scale. Because the Yellowstone fires charred such a huge area for the first time in so long, they were widely perceived as "catastrophic." While it is true that historic fire suppression was a contributing factor to the size and intensity of the Yellowstone fires, there is also much evidence that fires of this magnitude naturally occur at intervals of roughly 100-300 years in the region's high country. Thus, the area's natural systems are adapted to, even dependent upon, this size and frequency of burns. (In 1991, the fires' benefits to the Yellowstone ecosystem are evident; the complex mosaic of fires has rejuvenated many biomes and enhanced biodiversity.)

Fire dynamics are influenced by many factors. The unique interrelationships between all components of each ecosystem dictate the timing, amount, and type of fire

inherent to that ecosystem. In turn, each individual component of an ecosystem is best adapted to the fire dynamics unique to that ecosystem. In other words, fire is an integral part of ecosystem dynamics and species evolution.

Periods between natural fires generally are long enough so that climax vegetation reproduces and regrows to maturity, ground water is recharged, animals reestablish themselves, organic litter builds up enough to rejuvenate soil, and so forth. On the other hand, fires are generally frequent enough to assist with the reproduction of dependent species, maintain proper balance between animal species, recharge soil with ashes to maintain proper pH and nutrient levels, suppress plant diseases, and so on. When livestock grazing alters the natural timing of fire, these important interrelationships are impaired. For example, without frequent-enough grassland fires, some grass fungi may spread unchecked and eventually kill grass over large areas.

Fire recovery: A year after a lightning-ignited burn, this ungrazed mountainside is covered with luxuriant vegetation; leafy, fire-promoted species spring forth, and most burned-over perennials, brush, and trees sprout from rootstocks and bases. Dead trees and bushes provide important animal habitat.

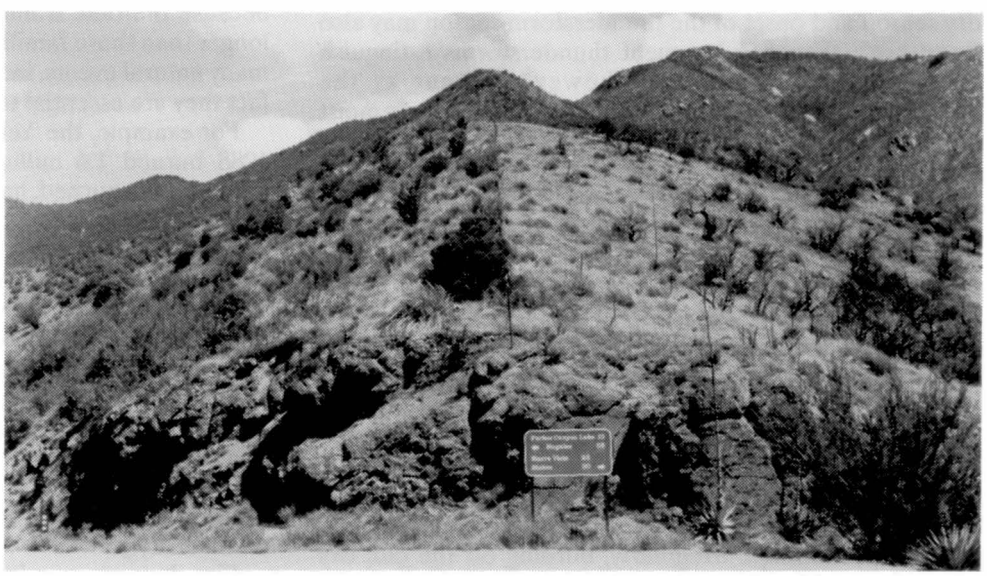
Fire frequency ranges from 5-10 years (California chaparral) to 5-20 (short grass prairie) to 50-100 years (some mid-elevation Rocky Mountain forests) to essentially never (Olympic Peninsula rainforest and portions of the Mojave Desert). Intervals between fires depend on the unique characteristics of each ecosystem, so Nature best provides proper timing. Natural fire occurs on an irregular yet periodic basis. Like rainfall, fire is dependable yet variable. You know it will happen and when and where it might, but never exactly. In this way, fire provides maximum diversity of influence, thus diversity in the environment -- a basis of ecosystem health and stability.

Some plants are specifically adapted to fire and cannot survive without it. Giant sequoia trees are one example. Tom Swetnam, a researcher at the University of Arizona, has studied the tree rings of 1000-year-old sequoias. He says that fire scars among the rings indicate forest fires burned them at fairly regular intervals of 10-30 years, and similar burning probably occurred throughout many Western forests. These natural fires helped sequoia cones open and their seeds germinate, and thinned out competitive shade-tolerant trees and gave sun-loving sequoia seedlings more room. Experts are concerned that fire suppression may be a major factor working against the survival of these 1000-2000 year old trees, the largest living beings on Earth.

Having evolved with frequent fire, prairie plants keep most of their biomass and reproductive structures below ground. After a burn removes their above-ground portions, they regrow quickly from the protected portions in the soil. Some Western grasses and perennial flowering plants have life-spans of 100 years or longer and may sprout from the same burned-over base many times, though too-frequent fire can damage or kill them. Most grasslands burn during dormant seasons, after grasses have matured and cured on the stalk. Dormant grass buds are less susceptible than active buds to damage by fire, so artificial burning during the growing season is detrimental.

Chaparral and many other brush communities are highly dependent upon natural fire. Most of their woody species have numerous, thin stems and resinous, flammable leaves. They form many dead branches after reaching maturity, and their dropped litter is likewise highly susceptible to fire. The seeds of some brush species, some ceanothus and manzanitas for example, require fire scarification to germinate.

Livestock grazing often activates changes in fire dynamics that spell trouble for certain fire-dependent species. Quaking aspen, for example, depends on natural fire to create openings in thick conifer forests. Where fire has burned off all the trees in an area, aspen roots put forth shoots that quickly overshadow new conifer seedlings and form almost pure aspen stands. In some parts of the Rockies



A year before, a wildfire burned the right side of this hill -- ungrazed National Park Service land -- up to the fence at center but not beyond. Left of the fence is grazed National Forest land that could not carry the fire. Via fire, livestock unnaturally alter the character of the land.

heavy grazing has removed so much ground cover that fires cannot spread through the forest. This, combined with fire suppression and with cattle and sheep eating many aspen saplings, has resulted in depletions and local extirpations of aspens.

Manzanita is a red-barked shrub native to brushy areas over much of the West. As mentioned, the seeds of some manzanita species need fire to germinate. But livestock grazing and fire suppression for ranching have so reduced natural fire that in some areas manzanita has been outcompeted by less fire-dependent shrubs and trees, such as shrub oak, silktassel, oaks, and junipers; in many cases it has been replaced by bare dirt).

For thousands of years, people on different parts of the globe periodically burned off grass and sometimes brush and trees for various reasons. Largely because of this, it is argued that humans were the controlling force in these ecosystems -- that these ecosystems, grasslands especially, depended on human-caused fire to maintain their essential character. Usually the message underlying this supposition is that humans must manage these ecosystems, either with fire or (according to ranching advocates) with *livestock* because "fire is no longer a viable management alternative in our modern world."

The theory is contradicted by the facts. First, paleontological evidence shows that, even during humankind's multi-thousand year history of setting fires, anthropogenic fires were still much less widespread and influential than natural fires. In what is now the Western US, aboriginals had probably been setting fires for less than 5000 years, and evidence indicates that most of their mid- and tall-grass prairie burning took place in the past few centuries to improve horse pasture (White 1990). Second, scientific evidence also indicates that these same fire-impacted ecosystems *antedate the origin of fire-setting humans by 25 million years*. Third, numerous other studies show that, naturally, fire has a far greater (and much different) influence than large herbivores in defining the character of vegetation communities, grasslands especially.

Another misconception is that periodic fire will keep any land free from brush. In many cases the opposite is true. Most chaparral, brush, and shrub communities in the West have been subject to periodic fire for millennia. The most successful species of these communities survive fire, even if burned to the ground. After fires they send up new sprouts from near the ground line, and within several years the woody plants have regained their former height. The chaparral-covered foothills of California, some of which naturally burn at cycles averaging less than 10 years, are a prime example.

Due largely to the logging and ranching industry-inspired war against fire, and the attendant propaganda during the past century (see next chapter), natural fire has been neither understood nor appreciated in this country. Compounding common misconception, there are few natural fires for comparison anymore. These days many fires, in those areas where they still ignite, burn out quickly due to lack of fuel caused by overgrazing and other poor land management. We rarely hear about these fires. In other areas they explode into raging infernos due to bad timing and because relentless fire suppression allowed excessive build-up of coarse fuels. We hear about these often; they are the basis for misconceptions about fire in general. Further, due to our society's general lack of interest in grassland, forest and brush fire garners far more attention and research than grass fire.

> *Livestock grazing* [on public land] *helps prevent dangerous forest and prairie fires by preventing the buildup of excess combustible brush and forage.*
> --Patty McDonald, Executive Director, Public Lands Council

One often hears ranchers and range managers say that livestock are necessary on our rangelands -- grasslands, brushlands, forests, and even deserts -- to eat off vegetation and prevent the buildup of combustible plant materials, and thus destructive fires. When other arguments to justify livestock grazing fail, this one usually does the trick. After all, who wants to be accused of condoning destructive fires? But let's examine this argument.

In the first place, if it is indeed necessary to have herbivorous animals reducing the vegetation cover, then why shouldn't we let the native animals that supposedly did this for millions of years do it? Indigenous grazers, the plants they foraged, and fire had kept a remarkable balance. Livestock grazing is subject to the vagaries of politics, market fluctuations, and management irregularities, as well as the laws of Nature. Isn't this another argument to bring back the bison, to reestablish elk, bighorns, pronghorn, and prairie dogs on our public land?

Second, large areas of the West, in deserts especially, were not naturally frequented by fire, or large herds of herbivores. So fire prevention cannot reasonably be used to justify livestock grazing in these areas now, though it often is.

Third, it is much more beneficial to ecosystems to let organic matter build up and burn than to have livestock eat it and carry it off to feedlots and slaughterhouses, leaving a net loss of nutrients on the range.

Fourth, natural fire performs many important functions that any type of grazing cannot. For example, the rapid heating and cooling from fires helps break down rock and soil particles, assisting soil formation. Livestock may scatter rocks and displace soil, but they cannot break apart rocks or individual soil particles. Natural fire helps neutralize plant diseases, whereas livestock may help spread them. In many areas, the ashes left by fire are necessary to reduce soil acidity, whereas livestock cannot adequately reduce soil acidity. Wildfire may destroy or promote the seeds of various plant species according to Nature's way; livestock tend to harm natives. And (unless starving) livestock consume only palatable vegetation, whereas fire can recycle coarse grass, inedible forbs and brush, fallen tree leaves, down branches, logs, and other combustible organic matter. There is no adequate substitute for natural fire, especially not livestock.

Fifth, and perhaps most important, though livestock and fire share some similar influences, fire has always been a *much more potent* force than grazing animals in botanic/fire dynamics.

Yes, of course it is true that livestock have reduced the amount of combustible material on rangeland. It is true to the extreme! Most natural range fire ended suddenly when ground cover was stripped off by livestock in the late 1800s.

For example, the 112,500 acres of grazed grassland that is now the Buenos Aires National Wildlife Refuge experienced its first large natural fire since the 1800s -- a highly beneficial 12,500 acre blaze -- only a couple of years after the Refuge was established and livestock were removed in 1985.

Bare dirt does not burn, nor do mere stubbles of grass. Livestock have so widely and uniformly denuded and trampled the West that vast areas can no longer support fire. Many of these areas have deteriorated to the point that they could not support fire for a long time even if livestock were removed. (In contrast, native herds generally depleted the range much less severely, uniformly, and frequently, thus creating mosaics of fuel that were important to natural diversity.) Furthermore, the many cattle trails, ranching roads, cleared fencelines, stock trails and driveways, and other "improvements" act as firebreaks and, along with constructed firebreaks and grazing industry-inspired fire suppression, prevent fire from spreading and have virtually eliminated natural fire from many areas.

Fires on ungrazed roadsides in the West often burn only up to the fenceline because the denuded range on the other side cannot carry fire.

On the other hand, livestock have so overgrazed the West that much of it has been invaded by unpalatable and extremely flammable species, most notably cheatgrass from Russia. On millions of Western acres, cheatgrass is now the dominant grass species, often the *only* grass species. Much more likely to burn than any native grass, cheatgrass "burns hot" and can carry fire into and burn vegetation that would not normally burn, in many cases causing changes that further the spread of exotics. Thus have cheatgrass fires seriously damaged many Western ecosystems. (Ferguson 1983) Exotic vegetation supports inferior, unnatural fires.

Native bunchgrasses in much of the West were not contiguous in distribution, and carried fire poorly. Some arid to semi-arid areas, much of the Mojave and Great Basin Deserts in particular, historically did not produce the type and spacing of vegetation necessary to keep fire burning for more than short distances. Livestock-initiated invasions of annuals provided a flashy fuel source that resulted in intense, frequent fires that harmed wildlife not adapted to them. Many native desert shrubs, for instance, have declined as a result. (USDI, FWS 1990)

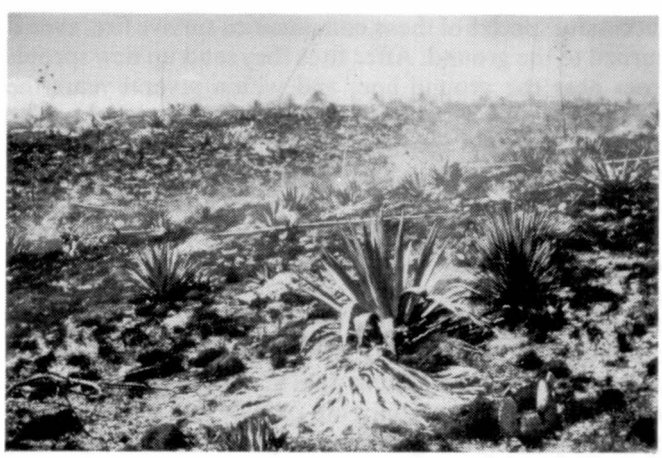
Additionally, livestock have so depleted ground cover that in some types of forest and brushland it no longer supports the relatively frequent fires that used to periodically burn off excess woody fuel. When these large-sized fuels finally do accumulate to the point where they may carry fire regardless of ground cover, they explode into destructive conflagrations. Thus, according to one study, "continued livestock grazing without fuel management will cause reductions in the frequency of low intensity fires, but will promote conditions that favor the occurrence of infrequent, high intensity fires" (Zimmerman 1984).

Another "stock" argument used often by grazing interests is that cattle and sheep, rather than fire, are needed to recycle range nutrients. This is false. When wild animals die, their bodies return to the earth to be reborn throughout the environment again and again. Livestock are shipped off to feedlots and slaughterhouses. In fact, this represents the loss of roughly 1/3 of all large animal biomass from the Western range annually. As we all know, livestock do leave manure upon the land. But compared to their detriments this isn't much of a contribution, and natural fire is a much more efficient rangeland recycler.

In sum, Western ranching has caused (1) a great decrease in the number and quality of natural fires and (2) a great increase in the number of destructive anthropogenic fires. The main factors have been livestock grazing, fire suppression, prescribed burning, range arson, ranching-caused accidental fires, and the primary and secondary effects of ranching roads and other range developments.

Few of us have ever witnessed a truly natural fire. As with the present condition of Western biologic, soil, and water systems, there is a strong tendency to accept the way things are as the way things were and never realize the difference.

The burned landscape is marvelous, mystical, alive with regeneration and fulfillment of natural processes.
--Greg King, environmental activist



A wildfire burns through a portion of ungrazed Fort Huachuca, Arizona, bestowing its many environmental benefits. *(Tony C. Caprio)*

Air

The atmosphere is commonly considered an unalterable, or even a nonentity. How could livestock grazing affect it?

Consider the usual overgrazed landscape. The air is dry, there being little vegetation to transpire moisture, or soil moisture to evaporate, or riparian vegetation or surface water to contribute to humidity. Without healthy, dense vegetation, air moves unhindered across the land, sucking moisture from remaining vegetation and soil. Lower humidity causes temperatures to reach greater extremes. Without dense vegetation to block and scatter the sun's rays, the naked earth becomes a reflector oven, further raising summer temperatures and drying out the air. Likewise, without the subdued colors of vegetation and organic ground cover to absorb and scatter sunlight, a harsh glare is reflected directly off the light-colored dirt, rocks, and sparse, dehydrated plant material. In the winter, the lack of thick, insulting vegetation and of the moderating effects of humidity and surface water cause lower temperatures.

Now, step across a fenceline, or back 150 years into the same landscape never grazed by livestock. Here, the air is moister. The flourishing vegetation, damp, deeper soil, and flowing water all contribute to higher humidity. Thick, healthy, full-sized brush, trees, and plant cover at ground level block air movement which would otherwise suck this moisture away and dry out the plant-soil mantle. Higher humidity moderates air temperatures and thick vegetation blocks and scatters the sun's rays, making it noticeably cooler in summer and warmer in winter. Leaves also absorb and scatter harsh sunlight, and that which is reflected from the ground gives off the subdued colors of herbaceous vegetation, cryptogams, and organic litter. Because dense vegetation and humidity scatter and dissipate sound waves, even sound is gentler here.

The following is from the 6-22-89 *Arizona Republic*:

> *Overgrazing by cattle in* [this area of] *Sonora has made temperatures on the Mexican side of the border an average of 4 degrees hotter than on the Arizona side, according to Arizona State University climatologists. Moving even a few yards from Arizona into Sonora is "like stepping from a playground onto pavement," ASU's Robert Balling said Tuesday. The ASU group's findings are consistent with other studies .... A state agricultural agency in Sonora has calculated that for the past century, 300 times more cattle have roamed Sonoran ranges than the land could support, Balling said.* (Note: The range on the American side also is grazed, just not as badly -- perhaps with only 100 times as many cattle as the land can benignly support!)

Infrared and microwave observations of the 50,000-square-mile study area, taken by satellites, show that the Mexican side has lost more vegetation, loses soil moisture more quickly, and reflects more solar heat than the Arizona side.

So, air near the ground -- for its volume the most concentrated and environmentally significant air in the atmosphere -- is definitely affected by livestock grazing. But the air within, say, 200' of the ground still represents only a tiny fraction of the air volume above it. And when air is in motion local effects from the terrestrial landscape may be quickly dissipated into surrounding areas or the upper atmosphere. So livestock grazing's effect on climate is another matter.

Climate is commonly described as the average weather conditions over a long period of time, usually at least several decades. Most climatic changes are measured fairly easily. Yet determining the causes of those changes is difficult to impossible. Modern scientists can't say for sure if rain will fall tomorrow, much less prove, say, that sheep grazing increased the average amount of summer fog on the Falkland Islands from 3.7 hrs./day to 4.2 hrs./day from 1916 to 1957.

Even a small understanding of ecology tells us that any significant alteration in the environment will have repercussions in the surrounding environment. Obviously, climate affects surroundings. Conversely, though not so obvious, surroundings affect climate. Since ranching-caused alteration of Western ecosystems has been extreme, it is reasonable to assume that climate has been affected in some way. But ascribing general climatic changes to any human influence is still largely conjecture. And for every measured change in climate traced to an influence, any number of unrecognized, unrelated influences may be working to make the change more or less so.

Determining cause-and-effect on microclimates is a much easier proposition. As mentioned above, livestock grazing may cause obvious changes in humidity, temperature, air movement, light, and sound. It is reasonable, then, to conclude that when changes in many microclimates are taken as a whole the influence on regional climate may be appreciable. For example, overgrazed ranges commonly have an albedo 2 or more times higher than that of healthy ranges. Studies show that livestock-induced desertification in Africa's Sahel is increasing regional albedo as much as 4% and is probably affecting the climate (Schlesinger 1990).

We know that land masses heat up and cool off faster and to greater extremes than equivalent areas of water. This creates the comparatively low summer and high winter atmospheric pressure regimes found over continents. The resulting differences in seasonal atmospheric pressure between continents and oceans influence global storm patterns. Generally, low pressure pulls; high pressure pushes. Now, theoretically, since livestock have depleted vegetation in localized areas throughout the southwestern quarter of North America, average summer and winter temperatures may rise and fall accordingly, leading to lower summer and higher winter atmospheric pressures. This, in turn, could lead to changes in continental storm patterns, and some kind of change in North American climate. Or, if nothing else, the many localized warmer summer and cooler winter temperatures themselves would, at least in the lower level of air, amount to a cumulative, de facto change in regional climate. Thus, with respect to ground level temperature, humidity, wind, and albedo, much of the West has experienced a de facto change in climate.

Livestock grazing also affects air quality. Plants transpire oxygen into the atmosphere, which is currently 21% oxygen, having dropped slightly in the past few centuries. Livestock's depletion of vegetation in the West (and around the world) has undoubtedly decreased the atmospheric oxygen level by some small, as-yet undetermined degree.

Studies show that plant leaves also extract air-borne pollutants. Biotic degeneration caused by livestock has

undoubtedly increased atmospheric pollution levels, again by some small, undetermined degree.

Increased dust can be linked much more easily to livestock. Bared and displaced soil is vulnerable to wind erosion. Heavier particles blow horizontally through the air. They pollute waterways, hamper and injure wildlife, damage vegetation, and bury small plants and animals, topsoil, and seeds. They pit windows and windshields, damage a wide range of developments, and degrade outdoor activities.

Fine grains may be carried high into the atmosphere as widespread particulate pollution. They block sun rays and reduce the amount that reaches the Earth's surface; trap solar radiation reflected from the Earth's surface; settle into streams, lakes, and oceans, and augment pollution and cause chemical and mineral changes. Settling dust dirties homes and businesses and affects many human developments and activities.

In some areas dust storms are natural occurrences. But their distribution, frequency, intensity, and destructiveness have been much exacerbated by livestock grazing. Worsening dust storms have been linked to livestock in many parts of the globe, including north Africa, the Middle East, China, Australia, and the Western US (Schlesinger 1990).

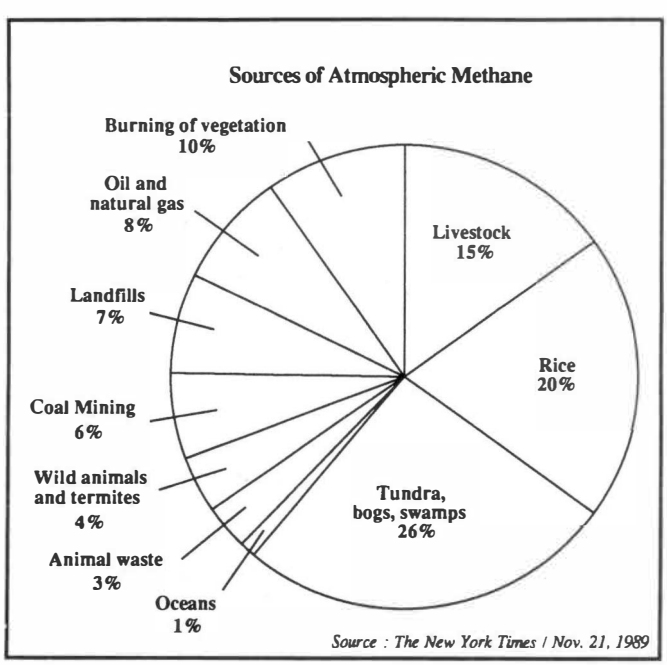
Dust storms sweep off Western ranchlands. Often called "natural" or blamed on drought, etc. by vested interests, dust storms in the American West usually are caused mostly by livestock grazing and ranching activities.

According to scientists, the Indus River region of eastern Pakistan and northwestern India was covered with dense vegetation 2000 ago. Since then, livestock grazing and farming have caused a Texas-sized area to evolve into barren waste -- the Great Thar Desert -- and precipitation to drop to below 10" per year. And yet the air over this region was and is *moist*, containing 80% as much water vapor as the air over tropical rainforests. In **Climates of Hunger**, Reid Bryson and Thomas Murray explain that the region's atmospheric dust, among the thickest and most persistent of any region on Earth, in several ways hinders the formation of monsoonal rain clouds.

Cattle are *ruminants*, named for a rumen compartment in their stomachs where cellulose is broken down by bacteria into cud and gas. A Colorado University study found that a cow belches or farts every minute and a half (much more than most wildlife, or even Al Bundy or Sam Kinnison), emitting up to 400 quarts of methane gas daily. Scientists say methane is the second largest contributor (at 15%, behind only carbon dioxide) to the Earth's "greenhouse effect." (They think that global livestock production activities have also significantly increased the atmospheric CO_2 level, now 25% higher than preindustrial levels, which also accelerates the greenhouse effect.) Researchers further state that, after rice paddies, the main source of non-natural methane in the Earth's atmosphere is the eructations (emitting digestive gasses via the throat), flatulence, and manure of cattle. Another significant contributor is the vastly increased numbers of termites found where forests and brushlands have been leveled for livestock; termites produce methane while digesting wood.

Excess methane gas accumulates in the upper atmosphere, where it acts as a blanket to trap energy from the sun reradiated from the Earth's surface, preventing it from passing into outer space as it would normally, thereby warming the Earth's atmosphere. According to most experts, in the 21st century the effects from this warming may well prove disastrous (Stone 1989). US and British study teams report that 1990 was the world's warmest year since records have been kept.

Today, scientists say there is twice as much methane in the air as there was 200 years ago (Worldwatch Institute 1990). Global atmospheric levels of methane grew by *1.5%* annually during the last decade. The Earth's cattle population grew by an even greater percentage, and is now growing faster than its human population. Could the world's 1.3 billion cattle with their yearly contribution of about 150 *trillion* quarts of methane be significantly warming the Earth's atmosphere? Many scientists think so. (Pearce 1989) In fact, in 1990 the US Congress authorized spending $19 million to study the livestock/methane problem, and the Washington-based Foundation on Economic Trends has filed a lawsuit accusing the Agricultural, Interior, and Energy Departments of failing to measure how much methane US livestock are contributing to the atmosphere.



What we need is rain. And that is the universal cry of stockmen.
--Texas rancher

Drought does not cause desertification.
--Professor Harold Dregne, Texas Tech University

Vegetation transpires water into the atmosphere, augmenting precipitation. For example, studies show that warm, moist air rising from densely vegetated tropical areas promotes build-up of local thunderstorms so that these areas receive as much as 40% more rain than neighboring devegetated areas. Areas overgrazed and/or denuded of trees and brush for livestock production contribute significantly less moisture to the air. Additionally, dry air currents rising from hot ground weaken incoming storm fronts.

Many overgrazed regions of the Earth have been desertified with little apparent effect on climate. However, much evidence indicates that historic overgrazing in some regions has caused or contributed to a drying in climate, greater temperature fluctuations, etc., for example, in north Africa, northwest India, and portions of the Middle East and interior Asia. These areas all supported abundant life 10,000 years ago, just before the rise of pastoralism. However, overgrazing in these regions has continued for *centuries or millennia*, not merely a century or so as in North America.

Still, some people contend that livestock grazing has similarly desertified the climate of the Western US, and that consequently precipitation has decreased significantly since the 1800s. Conversely and conveniently, ranchers claim a drying climate -- not their livestock -- is responsible for the decline in range conditions since the 1800s. This is disproved by statistics (see graphs on following pages). In fact, the National Oceanic and Atmospheric Administration recently stated that in the past 93 years in the US there has been: "1. No great change in temperature.* 2. No great change in precipitation."

* Some experts cite a slight warming trend during the past decade or so.

Regardless, livestock's *influence* on Western climate may be significant. It may well be that the depletion of vegetation caused by livestock and the resulting change in the continental atmospheric pressure is initiating changes in storm dynamics that will result in *more* storms being drawn across the West, ironically counterbalancing the desertifying effects of overgrazing. Or it may be that other unrelated human-caused changes during the past century have had a similar influence. Or perhaps grazing's influence has been offset by a naturally occurring climatic fluctuation. And then, it could be that Western ranching has simply not had a strong enough influence to significantly affect climate, though this seems doubtful. In any case, there are simply too many variables and unknowns to prove a definite cause- and-effect relationship.

One climatic change that does seem likely in recent decades, however, is the weather becoming more and more *erratic*, not only in the West but throughout the world. No doubt part of this is illusory; each year there are simply more humans and human developments to be adversely affected by weather extremes and, therefore, more "natural disasters." And with advanced communications we are more likely to hear about these events. Nevertheless, extremes in temperature, rain and snowfall, wind, violent storms, and other weather phenomena do seem increasingly frequent as the years pass.

Whenever the natural balance is upset, detrimental environmental changes, often radical, are the result. Climate is no exception. Though we may not understand how, it seems certain that human influence is significantly altering microclimates, regional climates, and world climate. Ranching -- as the rural West's most environmental destructive entity -- is playing some mostly unknown part in that change.

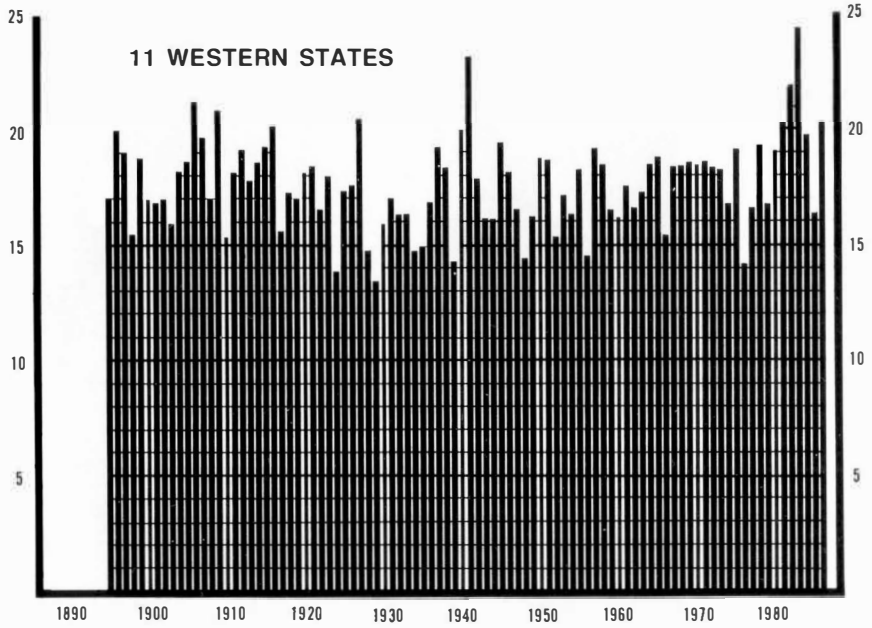
Trampling and overgrazing finish off the ground cover. Wind blows dust into the atmosphere, a devegetated land reflects the sun's rays back into the sky, heating the dust. There is little moisture to evaporate into the air from such a land, and when humid air moves into this dry region from elsewhere it is very difficult for rain clouds to form. Precipitation decreases over time, lakes and streams dry up, and a desert is created. . . . The notion that land is merely a passive factor in climatic change, reacting helplessly to the vagaries of rain and temperature, can no longer be accepted. . . . Conditions of land surface are inter-active with variables determining climate, and changes in the land can cause micro-climatic changes, with as yet unknown effects at the macro level.
--Daniel Stiles, United Nations Environment Program

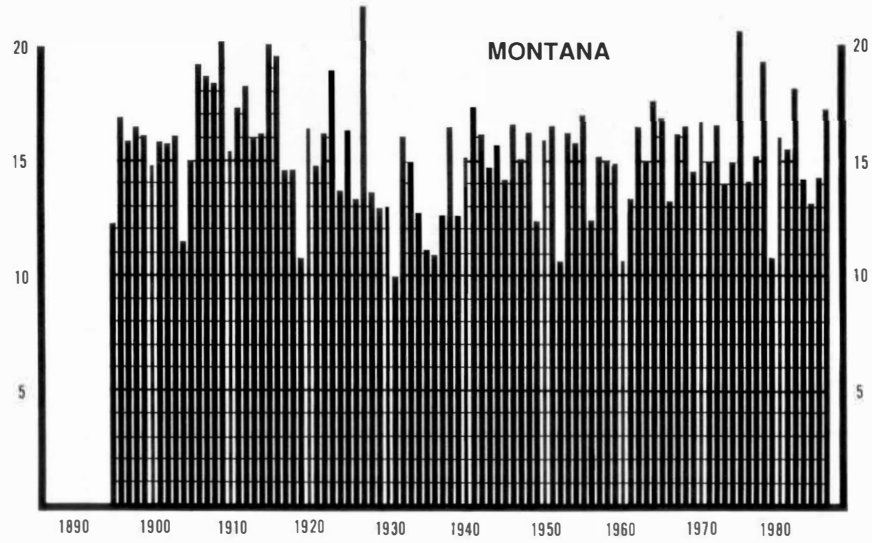
As is traditional around the ranchland West, California ranchers recently blamed drought for barren ranges such as that on left. But look at the fenced roadside!

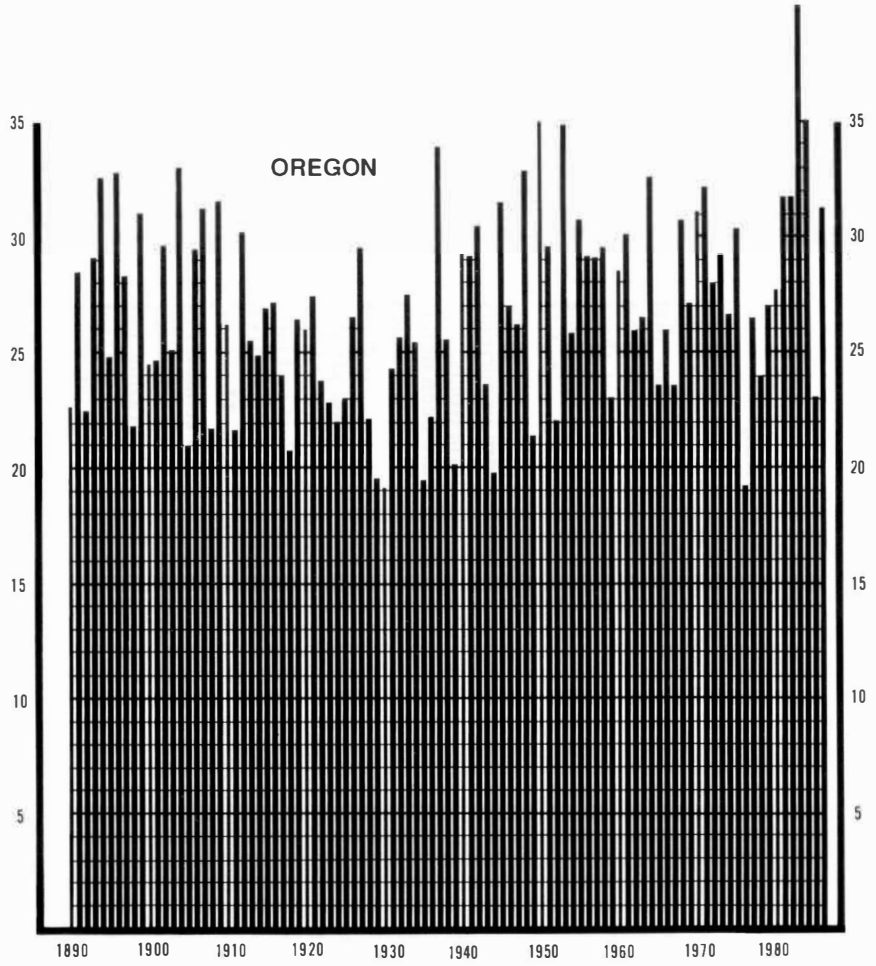
HISTORIC AVERAGE ANNUAL PRECIPITATION

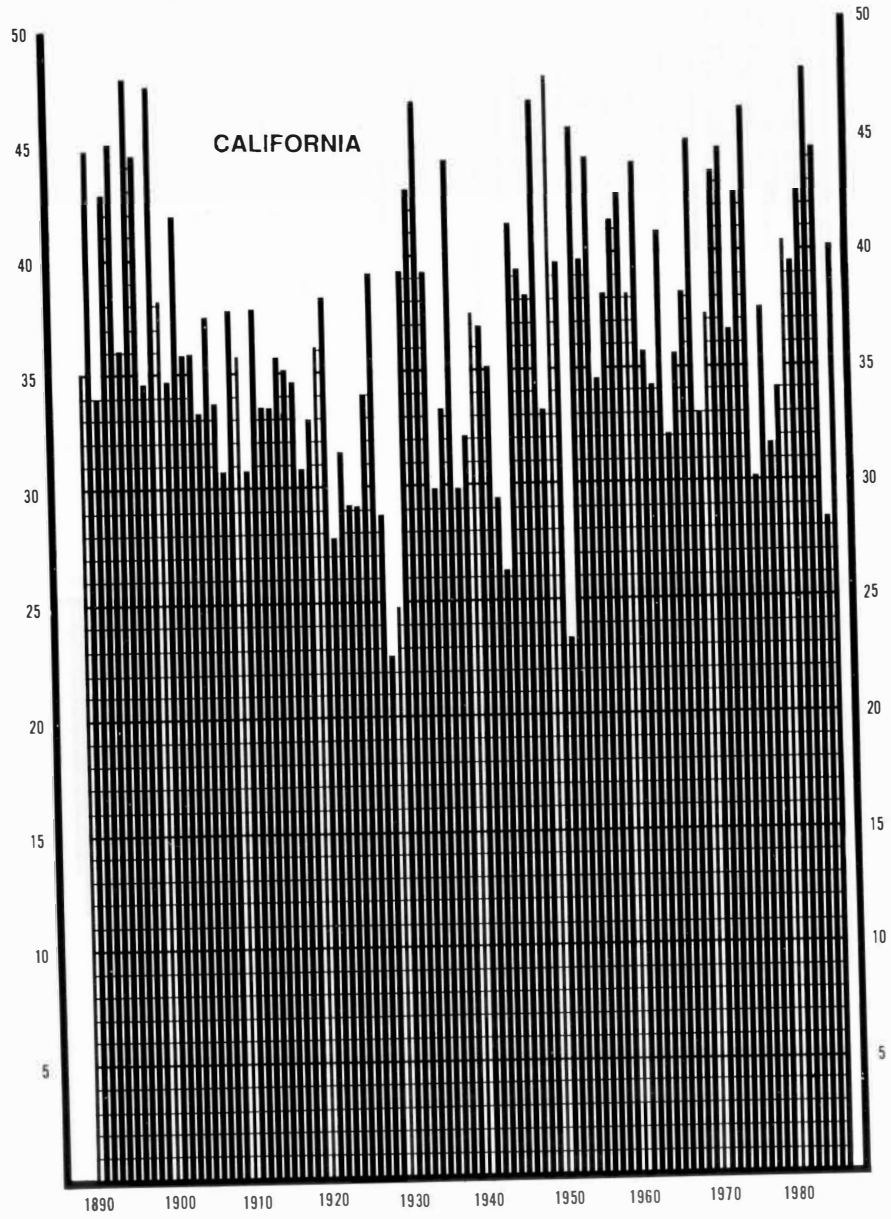
(inches)

Graphs on the following 4 pages are based on averaged annual precipitation statistics from all official weather stations in each of the 11 Western states. Additionally, records from 13 stations in 10 Western states indicate relatively normal precipitation for the West as a whole for the period 1850-1890. Records for 1987-1990 show precipitation below normal for California and the Northwest and approximately normal elsewhere, except New Mexico and Colorado above normal. Records also show insignificant changes in seasonal precipitation patterns. *Claims of deteriorating range condition due to drying climate are unfounded.* (Source: **World Weather Records**, Smithsonian Institution)





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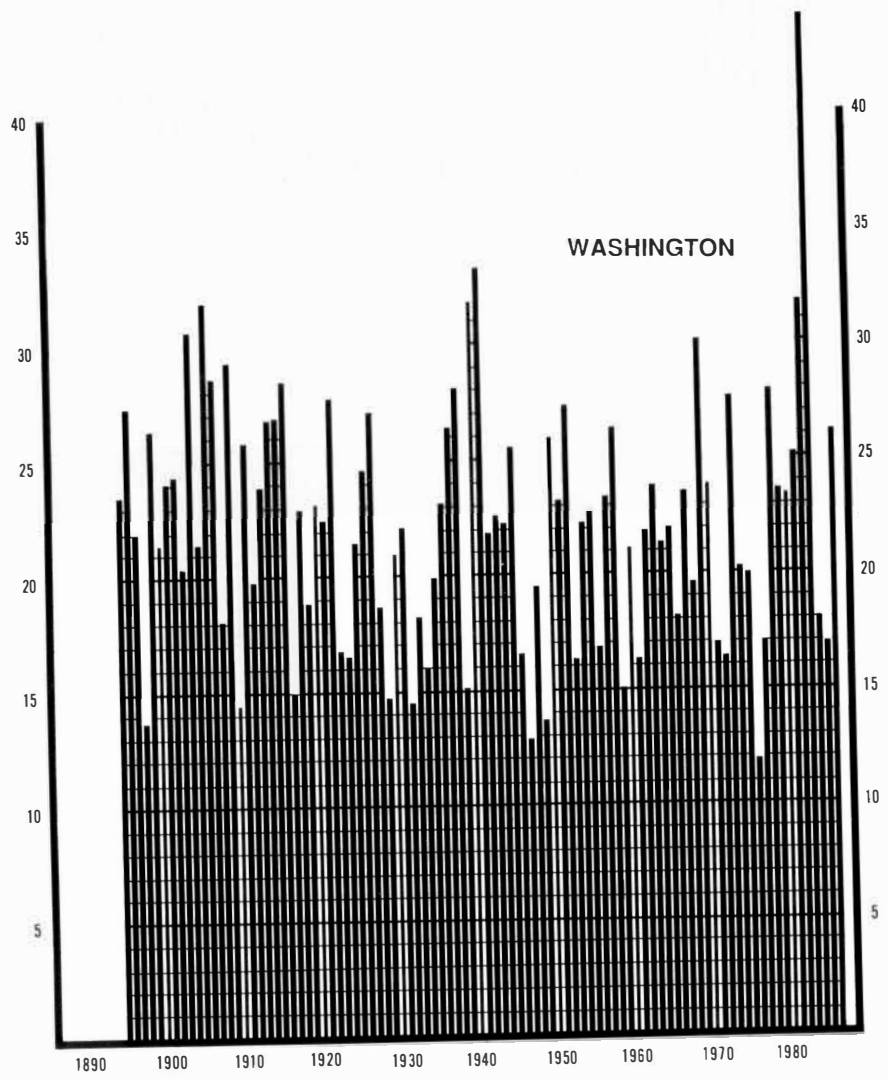
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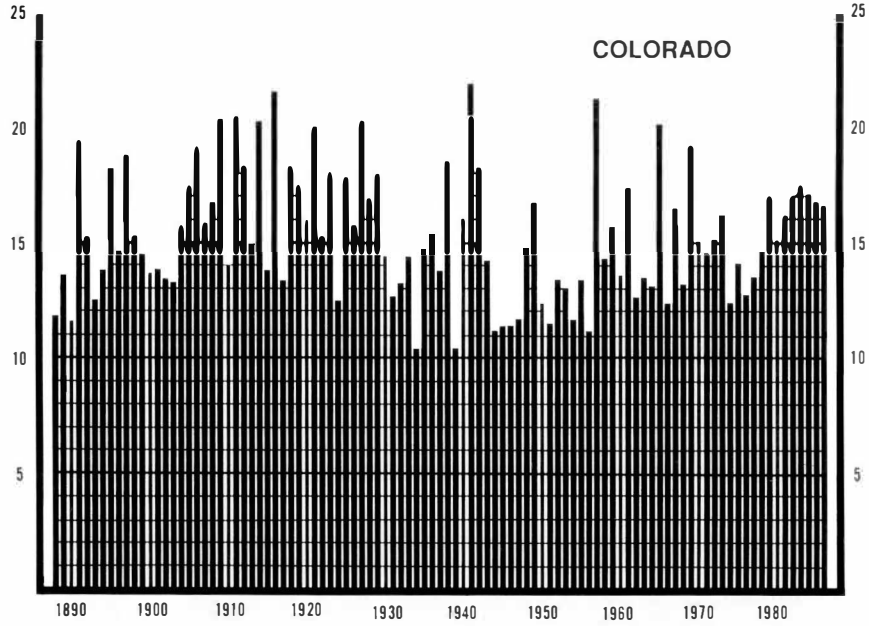
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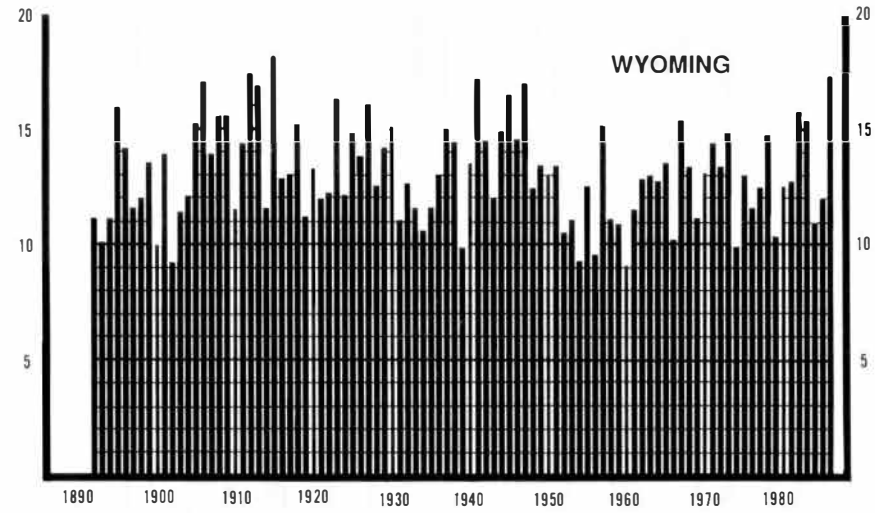
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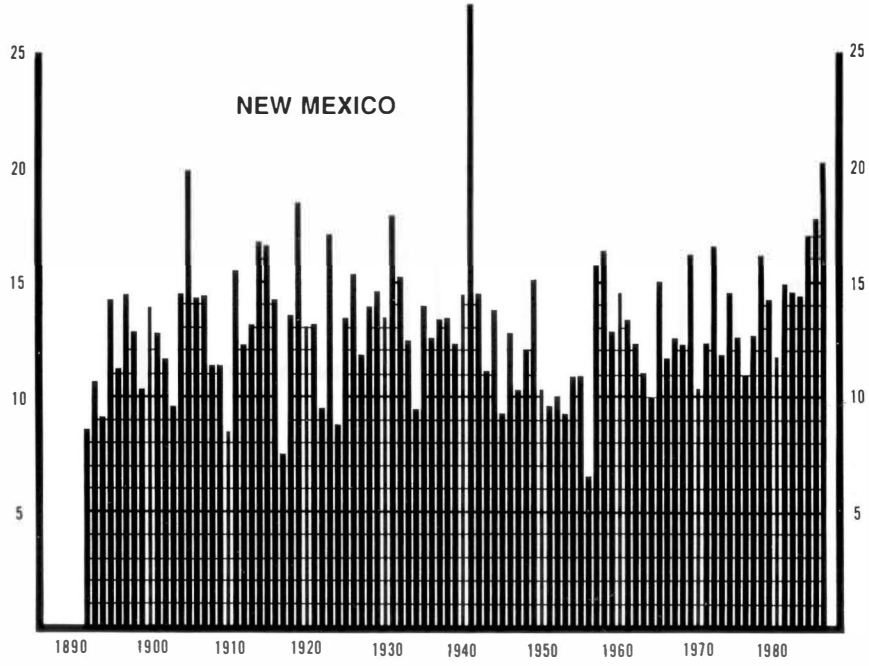
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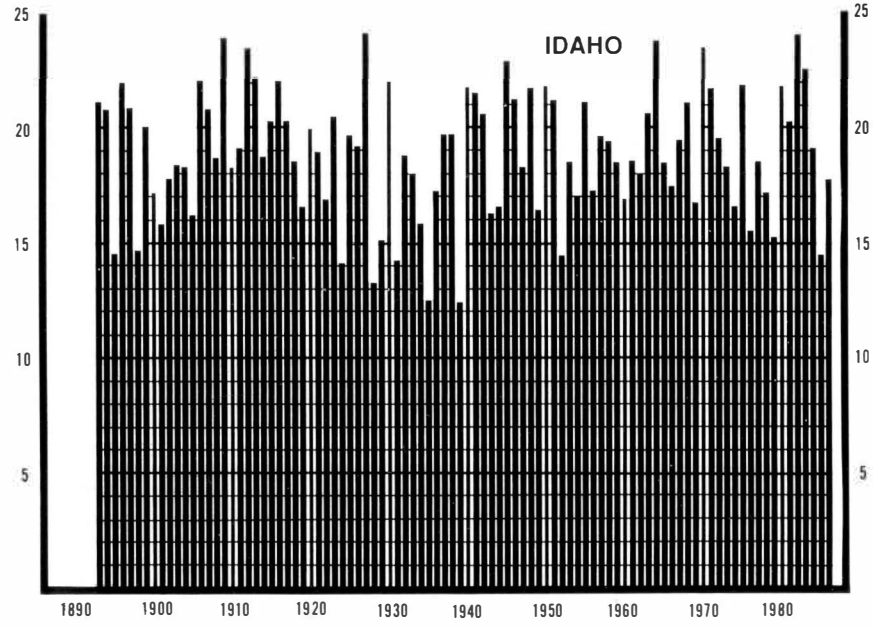
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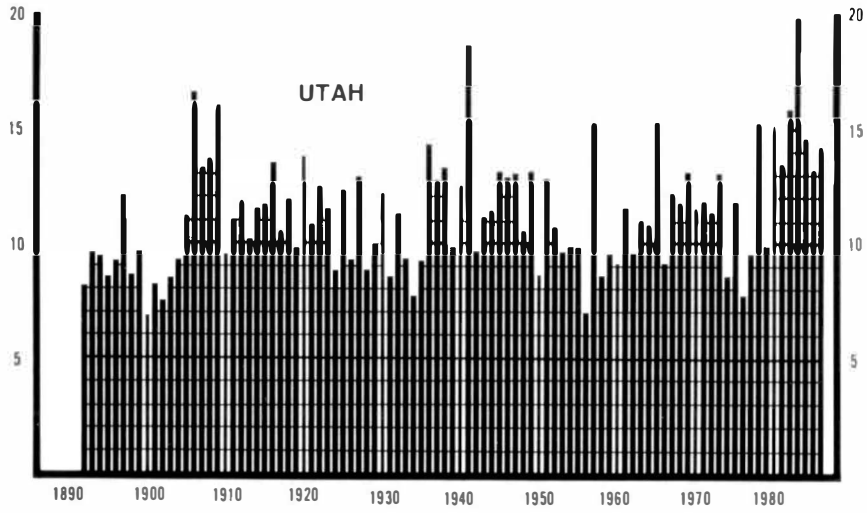
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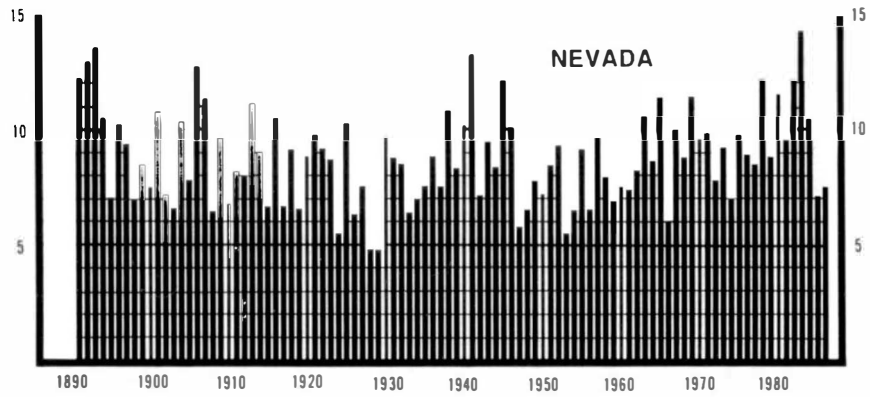
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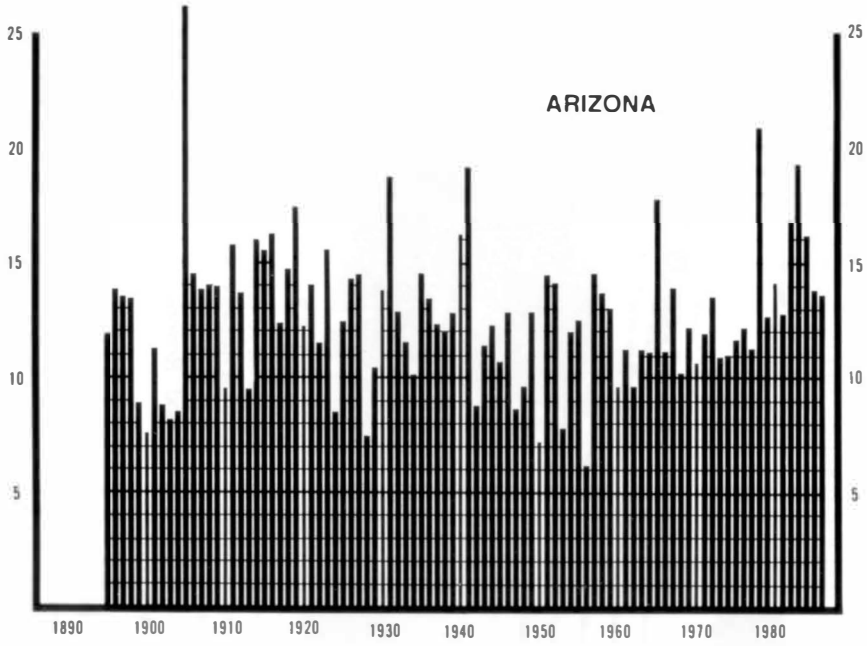
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Understanding Livestock Grazing

Seldom in history have so many been so thoroughly brainwashed by so few. The truth of the matter is: No industry or human activity on earth has destroyed or altered more of nature than the livestock industry. The slow-talking cowboy and his docile cows . . . are the center of a monstrous myth, a part of Americana that rests on concocted imagery and fabrication -- an enormous falsehood based on profound ignorance.

--from **Sacred Cows at the Public Trough** by Denzel and Nancy Ferguson (Ferguson 1983)

By now it should be apparent that domestic livestock do not belong on the Western range -- particularly public lands -- never did and never will. But I know many readers are still skeptical. Most of the West doesn't *look* devastated. Perhaps I exaggerate? Surely some kind of livestock grazing would be acceptable. If the situation is so bad, wouldn't we have heard a lot more about it? Wouldn't the public be outraged? Wouldn't the government have stopped it? Why should we care anyway? Aren't there more important issues?

Thoughts similar to these run through people's minds when confronted with the issue. All are reasonable reactions considering our culture's long-standing myths, social and political realities, and the nature of livestock grazing.

Americans mythologized the cowboy/rancher while steadfastly ignoring the ecological devastation wrought by his cattle and sheep.

--Charles Lee Atwood, *Restoring the Ravaged Range* (Atwood 1990)

The Western rancher is America's most enduring legend, our mythological national hero, and we all know that heroes do only good. To suggest that our shining paragon is causing massive environmental destruction amounts to sacrilege. So there is great reluctance in our society to question what ranchers do on public land, or assign them or their animals responsibility for anything deleterious. This makes the problem difficult to address, for whenever it is approached it seems to melt away in a plather of cowboy sentiment. In fact, we usually end up changing the rules, or the public's reality, or the land itself, rather than offending or burdening public lands ranchers by asking them to stop what they are doing. (Ranchers' social and political clout is discussed in Chapters VIII and IX, respectively.)

The practice of grazing livestock on the western lands, 60% of which are publicly owned, is the least understood activity. . . . The public is misled by the Bureau of Land Management, which touts the land's importance for "red meat production." Confusion is added by the Marlboro Man image of the western stockraiser. The stockraiser who sincerely believes he is a conservationist raids and degrades the rangeland. . . . More than any other group rangemanagers are tethered by their chauvinistic devotion to ranching.

--Bernard Shanks, **This Land Is Your Land** (Shanks 1984)

Livestock grazing is also extremely low profile. It happens out on the range, out of sight and out of mind of the great majority of Americans. Stockmen like it that way; they figure the less the public knows, the less it will interfere. Since they have historically done pretty much what they want, why rock the boat? Government agencies and many politicians, as components of the ranching establishment, also have ample reason to keep the issue under wraps. Their general attitude: "Leave it to us; we're the experts; we're taking good care of your land; there's no reason for the public to get involved."

Years ago I learned a shocking fact. If you drop a frog into a pot of boiling water, naturally it will jump out. But if you place that frog in water of comfortable temperature and slowly heat it to boiling, the frog will sit there calmly as it boils to death, never noticing the heat coming on slowly and steadily, deadly.

--Nina Mohit, Prescott, AZ, *Prescott Peace News*

From 1960 to 1975 about 50,000 Americans died in the Vietnam War; it was the major news story of those years. During that same period a comparable number of Americans died in motor vehicle accidents *each year*.

Following a stream up the floor of a canyon, Joe [Feller, a law professor at Arizona State University] *was struck with the horror of what he saw. Puzzled, he tried to imagine what natural disaster might have caused such devastation. A tornado? A fire? A flood? Finally he noticed the abundance of cow pies. "My God -- it's grazing! . . . with cowpies instead of shrapnel left behind."*

--Ray Wheeler, "He Doesn't Give Up" (Wheeler 1990)

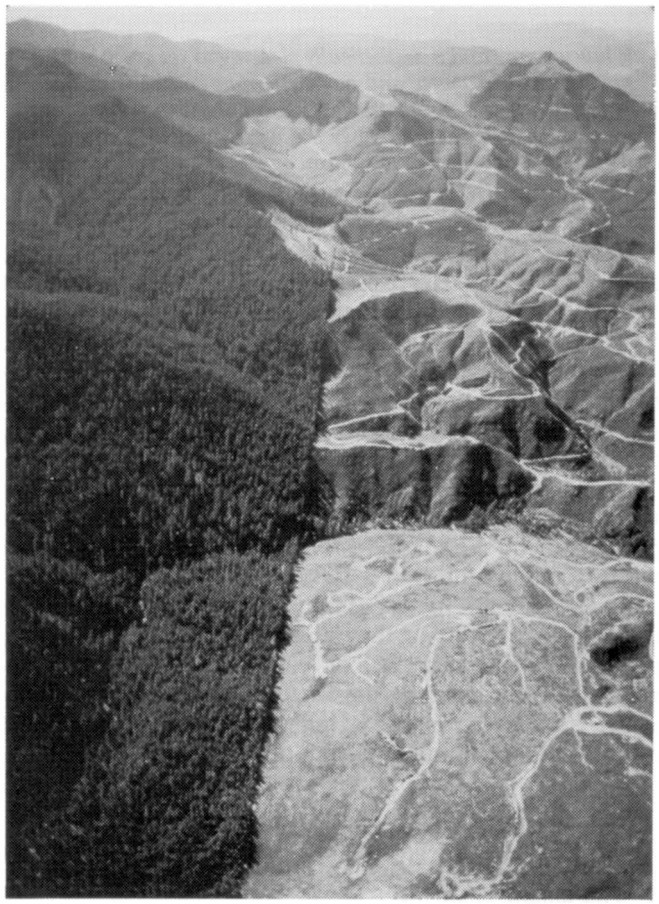
When a war or hurricane devastates the landscape, it makes headlines. When cattle do the same over a period of years, 1 mouthful and 4 hoof steps at a time, it's not even news. Livestock grazing is rarely a dramatic event. With most kinds of environmental exploitation, some outside force comes into an area and does something dramatically destructive. The place seems under attack. Maybe a development corporation builds a ski resort in a pristine

mountain valley, or fur sellers club to death thousands of baby seals on the Arctic ice, or a mining company dumps toxic wastes near a residential area, or a timber sale allows a logging company to clearcut an old-growth forest. Usually though, when the attack is over, it's over, and restoration proceeds.

Cattle and sheep, on the other hand, have occupied most of the West for more than 100 years, quietly, insidiously, relentlessly degrading the land. They *stay* there forever, unless grazing is halted, so restoration *never* proceeds (as it does after a clearcut or tailings washout, for example). Instead, unrecognized progressive deterioration continues indefinitely.

But who wants to see, read, or hear about a bunch of munching cows? These other issues would seem more interesting, more exciting, even if the damage from livestock is a thousand times greater -- which it usually is. Other threats are perceived as more "imminent," more "immediate," even though livestock actually create a more imminent and immediate situation overall than any other entity. To a society jaded by dramatic events, ranching impact simply isn't very "mediagenic" or "sexy."

For example, the bones of more than 500 free-roaming horses, shot by public lands ranchers to reduce competition with their cattle, were found recently on BLM land in central Nevada. This gruesome discovery probably created for a few weeks more public furor against public lands ranching than all the industry's other effects combined -- effects which during that time period undoubtedly caused an overall environmental impact hundreds of times greater than the horse killings.



(Daniel Dancer)

The logging clearcutting in the photo at top right is a tragedy. The livestock clearcutting above is no less a tragedy. It occurs every year -- so recovery never proceeds -- and to a total area of the West many times larger than that affected by logging. *(Elliott Bernshaw)*

While we may find it aesthetically pleasing to see green rolling hills covered in sheep, and cattle roaming on the wide open range, we should not be tricked into thinking that these pastoral scenes are natural. They are industrialized landscapes that should be returned to nature.

--Dr. Michael W. Fox, **Agricide** (Fox 1986)

Imagine a typical Western landscape -- miles of rustic terrain. Over the years livestock grazing has eliminated half of the original vegetation and reduced species diversity by 50%. Most of the former creeks now flow only sporadically. Those that remain are enclosed by cutbanks, their streambanks trampled and water fouled. Half of the original topsoil has eroded away, and most of the wildlife is gone. Fifty cattle graze placidly on a creek bottom.

An "average American family" arrives on the scene. They see a pair of jeep tracks cutting up a hillside. "Why can't people stay on the roads?" Mother complains. They notice the freshly cut stump of a large creek-side tree. "Damn!" exclaims Father, "Doesn't seem right cutting a fine tree like that." On a creek bank, they stumble over some Coke cans, pieces of rotting watermelon, and a greasy rag. "How disgusting!!" the kids cry in unison. Father gazes nostalgically at the foraging cows and wonders how people can be so disrespectful of Nature.

My first backpacking trip, in a grazed county-owned wilderness, brought disappointment so subtle I didn't acknowledge it to myself, for like many Westerners, I accepted cows as part of the natural landscape.

--Candace Crane, "In the Shadow of Livestock" (Crane 1989)

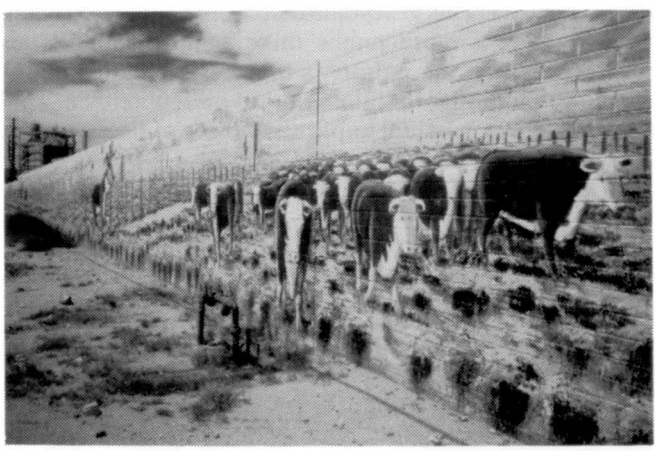
Livestock grazing also differs greatly from other issues in being so widely and evenly dispersed. Says Bill Marlett of the Oregon Natural Desert Association, "I challenge anyone to go anywhere in the Western United States and travel for more than a day and not see extreme ecological damage caused by grazing." No commercial land use in the West comes close to utilizing as much area. In "A Public Beef," Dyan Zaslowsky goes so far as to state that, "Scientists have said for years that grazing by domestic livestock, particularly cattle, has diminished or destroyed more Western land than all other human activities combined" (Zaslowsky 1989). Grazing occurs in all of the West's 412 counties, excepting perhaps San Francisco County, which is completely occupied by the city. Because almost all grazable range (especially the more productive portions) either is or has at some time been grazed, very few places remain where a person can realistically compare grazed and ungrazed or never-grazed land.

Compounding the problem, like a child spreading unwanted peas out evenly across a dinner plate, livestock impacts are spread out relatively evenly across the land (about 70% of the West), making the damage seem far less significant than it actually is. Strip mining, oil drilling, commercial development, logging, and so on may do more damage to localized areas, but in the West nothing comes close to causing as much overall damage as livestock grazing, or provides less for humans relative to the amount of damage done. In short, ranching is nickel-and-diming the West to death.

DEGRADATION OF HABITAT
IS LOSS OF HABITAT.

Well then, if livestock are really so harmful, why hasn't research been done to document the damage? It has. Over the years literally *thousands* of studies have been conducted, in diverse terrain and conditions all over the West, to determine various environmental effects of livestock grazing (or, more accurately, the effects of the environment and manipulation of the environment on livestock production). Though I could not begin to describe or even list all these studies, many are detailed herein and/or listed in the bibliography.

Most of the data collected show that livestock grazing in any form significantly diminishes environmental quality. In fact, numerous studies show that traditional grazing reduces water infiltration; increases runoff, sediment loads, and erosion; lowers water quality; damages watersheds and riparian areas; degrades vegetation cover; harms wildlife; and much more.



The only environmentally harmless cattle are those painted on walls or otherwise intangibly rendered.

But just because studies show that cigarette smoking is harmful doesn't mean people will stop smoking, or that tobacco companies will stop selling cigarettes. The ranching establishment controlling public land *demands* that the land be grazed. So study results are commonly misunderstood, misused, distorted, refuted, or ignored.

Bernard Shanks writes in **This Land Is Your Land**:

In western legislatures, line-item budget appropriations provided land-grant colleges of agriculture and livestock with the means to conduct "studies," a popular academic industry during the 1960s and 1970s [and still]. *Many of the studies were at best pseudo-scientific and designed with obvious biases, often to establish a need for predator control, lower grazing fees, vegetation manipulation, or simply the importance of livestock to the state's economy.* (Shanks 1984)

Most grazing studies are instigated and/or funded by government land managing agencies, agricultural extensions, and/or range colleges at land grant agricultural universities. Most of the range scientists at these institutions

are, in the words of Ed Marston, editor of *High Country News*, "handmaidens of the industry rather than independent researchers." A friend calls them "cow-centric." Job security for these professionals comes from serving their rancher clientele. To range scientists, continued grazing is universally preordained, and few question this overwhelming mandate, even if they realize its destructiveness. For example, several range researchers at the University of Arizona recently confided that they thought grazing public lands was a bad idea, but that if they didn't produce grazing-promoting studies, they would lose their jobs. Indeed, most range studies are implemented, in whole or large part, specifically to explore possibilities for expanded and more profitable grazing. Others look for ways to mitigate existing grazing problems without reducing livestock operations.

Range professionals have over the years explored nearly every conceivable method of increasing livestock profits. To get a better idea of what I mean, consider a sampling of titles of study reports: "Effects of Season and Stage of Rotation Cycle on Hydrologic Condition of Rangeland Under Intensive Rotation Grazing"; "Salt and Meal-salt Help Distribute Cattle Use on Semidesert Range"; "An Economic Analysis of Two Systems and Three Levels of Grazing on Ponderosa Pine-Bunchgrass Range"; "Vitamin A Reserves of Sheep Maintained on Mulga (*Acacia aneura*)"; "Changes in Perennial Grass Cover Following Conversion from Yearlong to Summer-Deferred Grazing in West Central New Mexico"; and "Accuracy of Roughage Intake Estimates as Determined by a Chromic Oxide in-Vitro Digestibility Technique." *Ad infinitum*.

Both the results and interpretations of the results of these kinds of studies are at best questionable. Often an individual or study team, if not already under a pro-grazing bias, is under subtle pressure to produce the desired results. The study plan itself is often faulty or contains built-in bias. Implementation and monitoring are improperly conducted. Important variables aren't taken into consideration. Questionable evaluation techniques and parameters lead to incorrect or slanted conclusions. Many reports, in trying to promote ranching, are filled with vague qualifiers, such as "appears to," "seemed to," "suggested that," "indicated that," "might," "may have," "can be," "could be," "has potential," "sometimes," and so on (see Holechek 1989 in bibliography for numerous examples). In this way, they mislead the reader without openly falsifying.

According to a NOVA video documentary, over 1 million scientific papers are produced every year in the US. Described was one scientific study which showed 70% of all scientific studies are in some manner invalid or fraudulent! The highly specialized, secretive, and influenced nature of the ranching establishment calls into question an even greater percentage of range studies.

Moreover, the studies themselves are nearly always environmentally destructive. Our public land is a guinea pig for range research. Each experiment requires the manipulation and damage of some aspect of the natural environment to produce the desired comparative effects. For example, a typical study will have a grazing range divided into several test areas of many acres each. The pastures are grazed under various management methods, and the results compared. Some pastures are heavily damaged, some moderately, and some lightly, but usually all exhibit more damage than if unmanipulated, and usually more damage than if grazed traditionally. Thus do hundreds of studies damage thousands of acres.

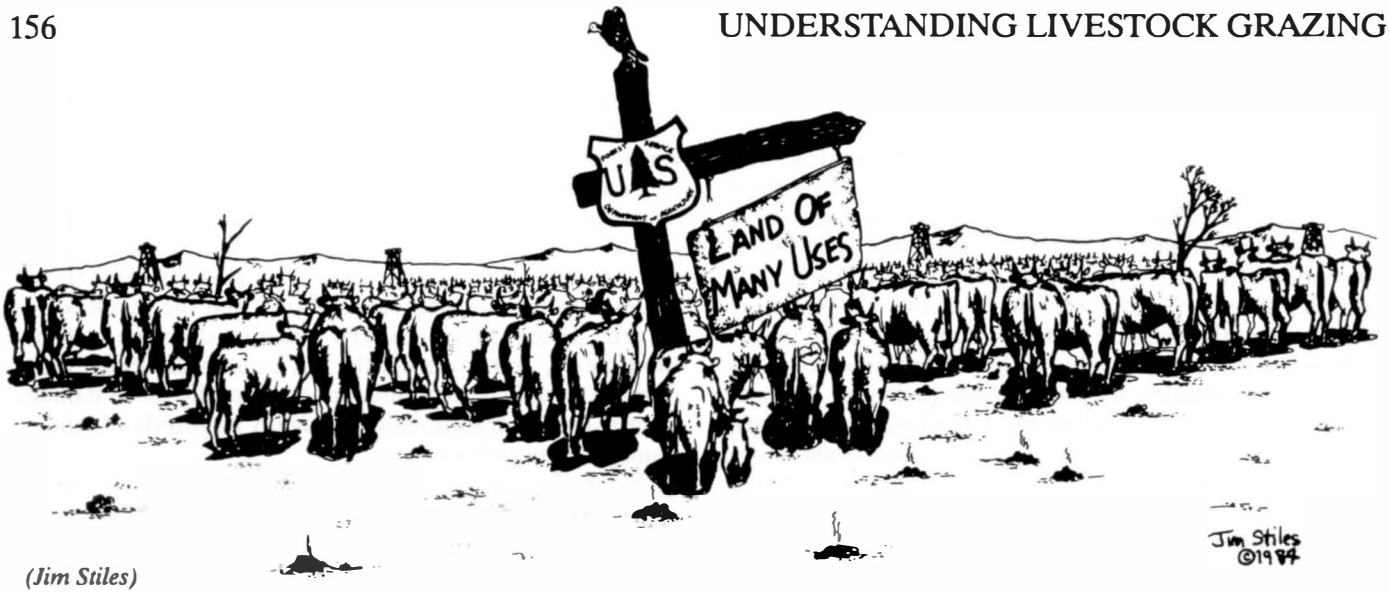
"Scientific" range study is a game, and the most skillful and the vast majority of the players are part of and funded by the ranching establishment. Those who follow the industry's established unwritten rules and produce "useful" (grazing-promoting) reports are the winners -- not only in terms of acceptance and credibility, but future government funding and private employment. Knowledgeable range professionals can pick out and cite whichever reports they need to "document" nearly anything they want to prove. Indeed, range studies so usually contradict each other that, even after nearly a century of research and thousands of experiments, range professionals frequently disagree on ranching methods and techniques. Thus, it would be pointless to use half this book to cite, compare, and discuss livestock grazing studies.

Interestingly, however, even most professional range studies strongly indicate that livestock harm overall environmental health. Even more curiously, few evaluation reports recommend significant reduction, much less removal, of livestock. Instead, they opt for practically any management scheme that protects grazing interests, usually some type of taxpayer-sponsored range development (or the ever-popular "no action" alternative). The study results are then used to justify and implement the new management plan.

Grazing studies are cranked out on a steady basis -- scores of them every year. Range research is itself an industry. (The Society for Range Management even sells a 336 page textbook on how to conduct range research.) Scientists, range professionals, agency personnel, and ranchers ponder the results and argue the merits and demerits of various grazing plans derived from pondering the results. The public generally stands by, hands in pockets, and leaves it all up to "the experts." Consistently and completely avoided is the most important question of all: *Is livestock grazing inherently a wise use of public land?*

Overgrazing is much too weak a term. Most of the public lands in the West, and especially in the Southwest, are what you might call "cowburnt." Almost anywhere and everywhere you go in the American West you find hordes of these ugly, clumsy, stupid, bawling, stinking, fly-covered, shit-smeared, disease-spreading brutes. They are a pest and a plague. They pollute our streams and rivers. They infest our canyons, valleys, meadows, and forests.

--Edward Abbey (Abbey 1986)



(Jim Stiles)

So, are public lands really under siege? On one hand, we say that public land is "overrun" with livestock that are causing more environmental damage than any other agent. On the other, we say that all public grazing lands combined -- 41% of the West -- produce only a tiny fraction -- 3% -- of this country's livestock. Isn't this a gross contradiction? To the contrary, that so few cattle and sheep can do so much damage is the perfect testament to public land's inherent unsuitability for livestock grazing.

Indeed, as proved every year, much of the West is impractical for livestock grazing merely in terms of available livestock herbage. Many cattle and sheep turned out onto the public range at the beginning of the grazing season barely maintain normal growth, lose weight, or eventually starve to death without supplementary feed. In other words, because the range is so sparsely vegetated (often due largely to past livestock grazing) livestock use as many or more calories searching for and consuming range herbage than is contained in the herbage. In **Livestock Pillage of Our Western Public Lands**, Edwin G. Dimick concludes that 75% of public grazing land "does not produce sufficient forage to qualify as rangeland." Including factors other than herbage, such as predators, disease, environmental damage, range developments, and so forth, perhaps none of Western public land is truly suitable for livestock.

Grazing of the grass cover by livestock is necessary to maintain the ecological balance.
--George D. Lea in **Grasslands of the United States**

Now, the livestock grazing industry would have us believe that it is merely replacing native grazing animals with domestic grazing animals. Consider the calculated words of recent BLM Director, public land rancher Robert Burford:

With regard to livestock grazing, the American rangelands have continuously been grazed for millions of years. The vegetation there evolved under the influences of grazing and fire. While the prehistoric grazers are now extinct, they were replaced with the buffalo, deer, elk, wild sheep, and antelope found by early European explorers nearly 500 years ago. Grazing is a natural process on rangelands....

Cattle and sheep, the vested interests also insist, are merely harmless, roving lawn mowers and hedge trimmers, neatly clipping off and ingesting forage and browse otherwise "wasted," thus "stimulating new growth." Under their reality, how could their livestock be guilty of any more environmental damage than done by native grazers or your lawn mower?

What appears to be a rocky outcropping on the bottom of this valley is actually hundreds of sheep. Wind River Mountains, Wyoming. *(Paul Hirt)*

This contains a grain of truth, and may seem convincing to the uninformed. In reality, it is extreme exaggeration. Among the many things Burford and the others fail to mention is that there were many different kinds of native grazing animals. Each species had different types of influences on Western ecosystems than those of other species. Each had evolved for millennia to mesh into the web of interrelationships that composed the environment. Each had developed the qualities needed to fulfill important environmental functions. What we have today is an incredible overpopulation of just 2 exotic species -- cattle and sheep -- that do not and inherently cannot begin to fulfill these functions. The industry's simplistic, self-serving interpretation of the Western environment is overwhelmingly fictitious.

Further, as we have seen, every cow or sheep added to an ecosystem causes not only a corresponding, but much greater overall decrease in native lifeforms, as well as increased damage to soil, water, etc. And their impact is even greater than this because livestock are removed from the land and shipped off to feedlots (where, according to the *New York Times*, 82% of all American cattle eventually end up) and slaughterhouses. Even beyond all this, why would forage and browse plants be wasted if eaten by wild animals instead of livestock or, as would naturally be the case with most plants, just left to live out their plant lives unimpeded?

You must have proper grazing of some kind to maintain a healthy, viable grass resource. It's very similar to what would happen to your personal lawn if not mowed for some time.
--Pete Talbott, Chairman, Oregon Cattlemen's Association Public Lands Committee

Lawn grasses are characteristically short-leaved, and cutting them to the height of a lawn does not remove critical amounts of photosynthetic food and manufacturing material. These grasses are artificially seeded, watered, fertilized, and protected from invading weeds and hungry insects. Regardless of how shallow the roots become from leaf removal, water and nutrients are constantly available for regrowth.
--Edwin G. Dimick, **Livestock Pillage of Our Western Public Lands**

When the roving lawn mower image doesn't take hold as intended, many ranching advocates pull another from their bag of tricks. This one imagines that livestock grazing is not so bad because although some native plant and animal species decline, others prosper. Maybe somehow things just kind of even out? Perhaps cheatgrass takes over for native forbs, sagebrush replaces bunchgrass, thrashers substitute for meadowlarks, and cattle pinch-hit for bighorns. Things are reordered, but all in all nothing is lost -- a nice consolation prize, at worst. And as always, whatever the case, it is undoubtedly a small price to pay for maximum beef production and to keep cowboys happy.

As we have seen, however, this is a far cry from rangeland reality. From a human standpoint, certain plant species (increasers and invaders) may seem to benefit from livestock grazing. But if they actually do, they do so in numbers only, and usually on a temporary basis. Individual plants are usually broken and stunted, while their local survival is short-lived. Pest animal species may explode in numbers, only to suffer overcrowding, starvation, disease, parasites, or other detriments to their quality of life. Their unnatural, widely fluctuating populations exist under dire circumstances and are always in imminent danger of being wiped out.

When livestock graze an area, the destructive effects reverberate throughout the ecosystem, creating the familiar "ecological chain reactions" discussed in high school science. Follow one of these series of events to see how cattle help kill kingfishers: Trampling cattle compact and dry out the soil of a valley bottom, killing worms and insects, reducing food for moles and eventually lessening mole numbers, which in turn reduces the number of mole tunnels that formerly helped water infiltrate into the valley water table, lowering the water table and reducing flow in the nearby creek, causing the eventual death of a some cottonwood trees in marginally wet areas, which in turn reduces the number of tent caterpillars that rely on the cottonwoods, leading to a decrease in the number of moths falling into the creek, less food for fish, fewer fish, less food for kingfishers, thus, finally, fewer kingfishers.

The game can be played with any aspect of any ecosystem. It begins when the ecosystem is perverted by a significant, unnatural force and ends when you get tired of linking things together. The point is, naturally the chain reactions of an ecosystem function more or less smoothly, predictably, to the overall benefit of each of the individual parts and the ecosystem as a whole. When livestock introduce radical, unnatural changes to which no component of an ecosystem is (or possibly could be for millennia) fully adapted, detrimental effects are bound to occur and be passed along these chains of interactions indefinitely. An influence at any stage may have a greater or lesser impact than the one before or after, because each influence is unique. The chains usually snowball in number, but countering this usually is a general, progressive dissipation in relative impact as the interactions continue to spread (like ripples from a rock thrown in a pond). Individual effects at any point along the way may or may not seem significant, but the *cumulative* impact is usually considerable.

This northeast Arizona range has been severely degraded by a century of livestock grazing, but how many of us would know this to look at it today?

A ranching road winds through a rustic Western scene -- actually a heavily damaged ecosystem.

I have been a geologist in the "wild" West for 30 years now and I have driven to the end of a thousand dirt roads and hiked up a thousand canyons in our living desert. Please believe me, things are a lot worse than you think or **Sacred Cows** *says they are.*
--Bill Davis, "Our Living Desert Is Becoming a New Sahara" (Davis 1990)

When we look at the Western landscape, we may see plants being eaten and soil trampled by cattle and sheep. But we generally understand little of subsequent ecological chain reactions whose overall impact is much greater. Unfortunately, as soon as an influence becomes once-removed from plain view, its origin becomes irrelevant to 99% of people. Because secondary cause-and-effects are inherently vague, it is difficult to make the connection, even when we try. Even professional range ecologists exhibit little understanding of the myriad subtle, often nearly incomprehensible, effects of livestock grazing.

It really disturbs me to look at the Utah Travel Council Calendar. Every photo shows signs of overgrazing....
--Pamela M. Poulson, Chair of the Board, Utah Native Plant Society

Most people, however, don't even see the *obvious* effects of livestock grazing. They look out over the Western countryside and see a familiar land, as they imagine it has always looked. To them, it doesn't look so bad -- a little scruffy and barren, maybe, but then that's how the West is supposed to look, isn't it?

Most of us derive our "first-hand" knowledge of livestock grazing from viewing landscapes as we drive or walk alongside fences. But this can be deceptive (see photos at right). Looking down at a roadside, bare spaces between plants are easily seen. When gazing out over a roadside fence at a grazed vista, plants are viewed at a greater distance, horizontally, and appear much more closely spaced, perhaps as a solid mass of vegetation. It may be assumed that the spacing, condition, and composition of the plants marching off to the horizon are superior to those along the ungrazed roadside, when in fact nearly always the opposite is true. As they say, the grass looks greener on the other side. (Indeed, to convince the public of what good shape the range is in, the government land managing agencies sometimes leave wide strips of ungrazed range adjacent to highways, as the Forest Service commonly leaves strips of uncut forest along highways to hide clearcuts from the public [Dimick 1990].)

> *In Arizona, for example, about 97% of the land either has been or is being grazed at some time during the year. To find areas for study of ungrazed plants, botanists must search diligently, and often must resort to corners of old fenced cemeteries, or lofty buttes and mountain tops too steep even for a starving cow.*
> --Steve Johnson, Southwestern Representative, Defenders of Wildlife

Aside from our collective infatuation with cowboys and cows, probably our main obstacle to understanding is that most of the West is so different now than in centuries "B.C." (Before Cattle). Our environment was severely damaged beginning about 130 years ago and has been kept in a **dynamic state of degradation** ever since. Because little obvious new destruction takes place, one thinks that little damage is occurring, when in fact heavy damage is continually occurring. Thus, for example, it is understandable that pre-Columbian wildlife numbers are usually underestimated, even by experts.

> *Because many of the changes occurred long ago, land managers and environmentalists tend to accept the present condition as the starting point in any discussion. Thus, while many conservationists argue that livestock should be reduced or better managed on public lands, few challenge the basic assumption that the livestock industry is entitled to priority rights on public rangelands.*
> --George Wuerthner, "Counting the Real Costs of Public Lands Grazing" (Wuerthner 1989)

We tend to accept current conditions as the norm. We have nothing to compare them to because, of course, none of us was around 150 years ago to see the West in its natural condition. All we have are limited and often questionable descriptions by early explorers, trappers, and settlers (along with bits and pieces of scientific evidence). Nearly all of these people came from the comparatively lushly vegetated East or Europe. Many of them described any place without trees as "wasteland" or "desert," even the most verdant of Western grasslands. Landscapes covered with sagebrush, bunchgrass, and forbs were frequently termed "lifeless," "worthless," or "destitute." Consider, for example, an 1849 account by an explorer named Simpson: "the country is one extended naked, barren waste, sparsely covered with cedar and pine of a scrub growth, and thickly sprinkled with the wild sage, or artemisia" (Simpson doesn't even bother to include the unimpressive bunchgrasses and herbaceous plants that undoubtedly grew between and underneath the sage.) To almost all US Americans 150 years ago everything west of the Mississippi River was "The Great American Desert," as in this account from a popular journal of the time: "water-less, windswept land of sand and stone, this howling, hopeless, worthless cactus-bearing waste inhabited by savages of extreme fierceness and cruelty, and haunted by prowling beasts of unexampled ferocity."

Viewed from the fenced roadside (above), the grass on both sides of the fence looks uniform. Actually, the grass in the ungrazed right-of-way (middle) is nearly twice as thick as that on the grazed range (bottom).

Most early US Americans had little understanding or appreciation of the West, and this is surely reflected in their writings and actions. They were chiefly concerned with 2 aspects of their environment: (1) "game" animals and (2) forage for livestock. They therefore documented little else. Additionally, except for the earliest travelers, most of their descriptions of the early West were made along established routes, where heavy livestock grazing and other human impacts had already altered the landscape. (White 1990) And, of course, impressions varied according to the recent weather, season of year, particular year, and the traveler's character, intelligence, awareness, bias, and imagination.

Furthermore, because photography wasn't introduced to the West until just after the Civil War and did not come into general use until the 1880s, even the earliest photographs are too recent to show conditions before heavy use by livestock. (The famous early photographer William Henry Jackson, as part of the US government's Hayden Survey, did make a number of Western rangeland photos in the early 1870s, most of which show comparatively lush vegetation.) Thus, according to David L. McWilliams in the 3-2-88 *Casper Star-Tribune*, "Trotting out century-old pictures and comparing them with modern photos only verifies that the range is in as poor condition now as it was 100 years ago, and merely serves to obfuscate the issue of public lands degradation."

Even so, if we dig deep enough and read between the lines, we can get a good idea. Numerous historical accounts do confirm drastic, detrimental changes in plant and animal life, soil, water, and fire conditions throughout most of the West. These reports progressively establish livestock grazing as the biggest single perpetrator of these changes, particularly considering that it was the only significant land use over most of the West.

One of the most useful and informative descriptions of the early West was that of Meriweather Lewis and William Clark on their famous expedition across the northern Midwest, Rockies, and Pacific Northwest from 1804 to 1806 (Thwaites 1959). Their descriptions of the unconquered West are of a world we can scarcely imagine: landscapes filled with wildlife; great diversities of lush vegetation; highly productive, free-flowing rivers, creeks, and springs; abundant, dark, fertile soil; unaltered, unimpeded fire and other natural processes. Of the Montana plains, one excerpt from Clark reads, "we observe in every direction Buffalow, Elk Antelopes & Mule Deer inumerable and so jintle that we could approach them near with great ease." Another states,

> *We saw a great number of buffaloe, Elk, common and Black tailed deer, goats* [pronghorn] *beaver and wolves. Capt. C.* [Clark] *killed a beaver and a wolf, the party killed 3 beaver and a deer. We can send out any time and obtain whatever species of meat the country affords in as large quantity as we wish.*

In the West today only ungrazed Yellowstone National Park supports nearly this variety and density of large wild animals. The Lewis and Clark journals tell of killing buffalo, elk, pronghorn, bighorns, deer, bear, and beaver almost every day for months at time. Clark's complaint of a *poor* wildlife day: "Saw but five Buffalow a number of Elk & Deer & 5 bear & 2 antilopes to day." In the 1990s, who would not be thrilled to see these animals in a single day? And most early explorers rarely bothered recounting sightings of smaller animals.

Lewis and Clark's and other historic journals attest that buffalo, elk, deer, bighorns, pronghorn, mountain goats, moose, horses, grizzly and black bears, wolves, foxes, cougars, bobcats, beaver, muskrats, river otters, fish, porcupines, wild turkeys and other "game" birds, waterfowl, snakes, prairie dogs and other rodents, most insects, and the vast majority of wild animals were all many times more abundant then than now. So too were native plants; the journals describe a great abundance and diversity of grasses and herbaceous vegetation, willows and deciduous trees, cattails, rushes, sedges, wild grapes, chokecherries, currants, wild cherries and plums, gooseberries, "red" and "yellow" berries, service berries, flax, dock, wild garlic and onions, sunflowers, wild roses, tansy, honeysuckle, mints, and more, a large number being edible. Most of these plants have been depleted through the many effects of livestock grazing for 100 years and are today comparatively scarce.

Of northwest Arizona (the remote "Arizona Strip" northwest of the Grand Canyon), the National Park Service states:

> *The vast flatlands and broad desert valleys, which are now wastelands of sagebrush, tumbleweed, and cheatgrass, were once rich with perennial grasses and flowering plants that the early explorers described as brushing up against their horses' bellies.*

Ernst Antevs writes in "Arroyo-Cutting and Filling":

> *In Utah "grass was originally an important and conspicuous element of the foothill vegetation." In some places it formed pure grasslands, in others it was associated with shrubs. At present these vast uplands are dominated by sagebrush, rabbitbrush, and shadscale.*

Jon R. Luoma relates in "Discouraging Words":

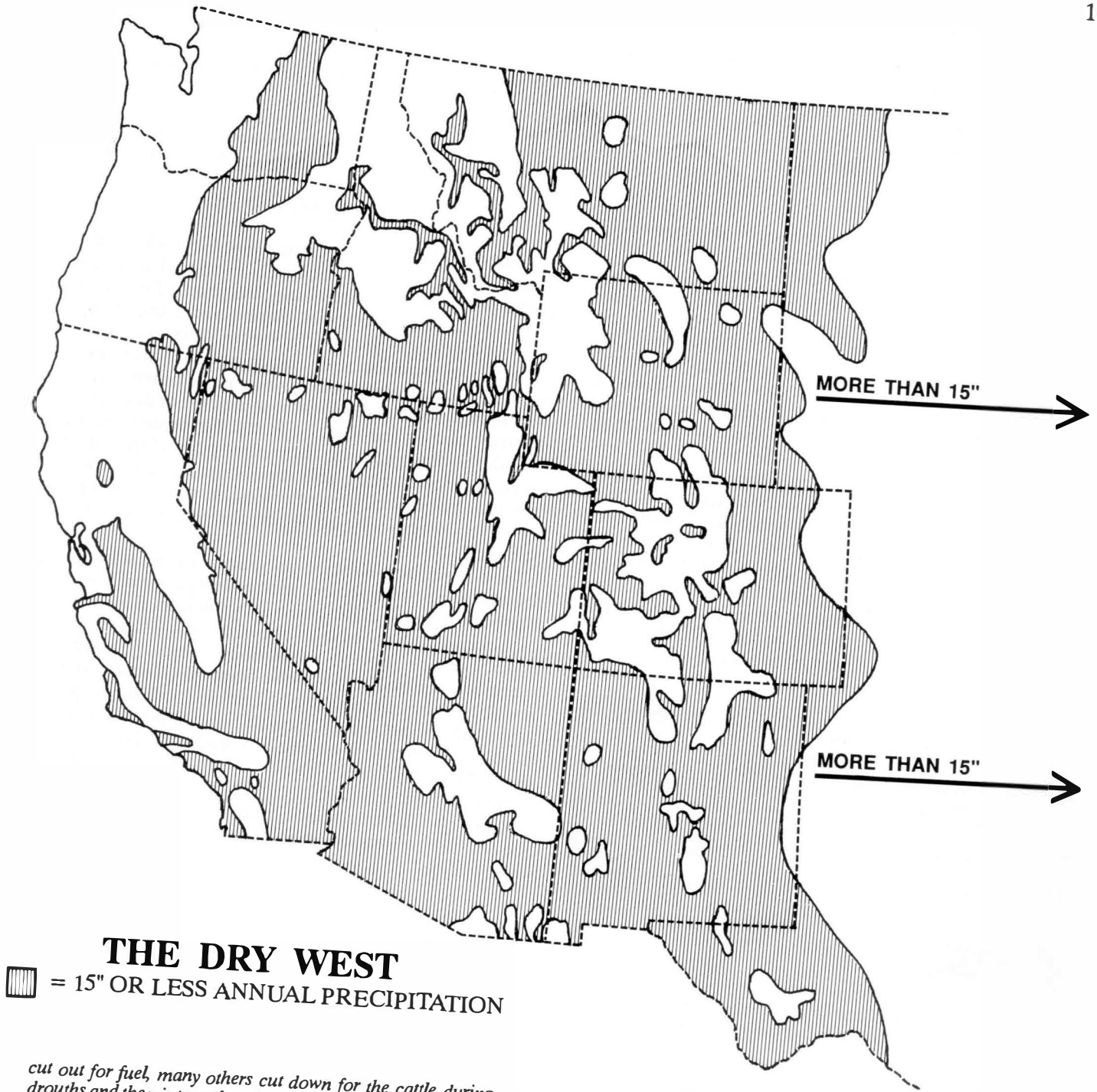
> *Here in the Great Basin, a typical scene was expanses of bluebunch wheatgrass, interspersed with sagebrush, and dozens of other species of grasses, shrubs, and wildflowers. Rodents -- ground squirrels, pocket gophers, mice -- abounded, as did their raptor predators, including ferruginous hawks, golden eagles, and kestrels. Sage grouse were abundant. The grasslands provided forage for tens of thousands of prong horns, mule deer, and elk. (Luoma 1986)*

Of the Sonoran "Desert," Padre Ignaz Pfeffercorn wrote in the 1760s:

> *On the hills, as well as on the plains, there are the most excellent pastures, where grow a superabundance of the choicest grass and all kinds of healthful herbs. Because of this Sonora has the most desirable conditions and conveniences for a considerable livestock industry . . . .*

In 1926, Senior Forest Ranger Fred W. Croxen of the Tonto National Forest in central Arizona, wrote this account of the reflections of Florance A. Packard, "the oldest living man to settle in the Tonto Basin":

> *He told of blackfoot and crowfoot grama grass that touched one's stirrups when riding through it, where no grama grass grows at present. The pine bunch grass grew all over the Sierra Anchas in the pine type and lower down than the pine timber on the north slopes. There were perennial grasses on the mesas along Tonto Creek where only brush grows at the present time. Mr. Packard says that Tonto Creek was timbered with the local creek bottom type of timber from bluff to bluff, the water seeped rather than flowed down through a series of sloughs and fish over a foot in length could be caught with little trouble. Today, this same creek bottom is little more than a gravel bar from bluff to bluff. Most of the old trees are gone, some have been*



THE DRY WEST

▨ = 15" OR LESS ANNUAL PRECIPITATION

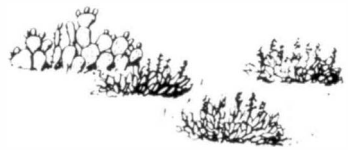
cut out for fuel, many others cut down for the cattle during drouths and the winters when the feed was scarce on the range, and many have been washed away during the floods that have rushed down this stream nearly every year since the range started to deplete. The same condition applies to practically every stream of any size in the Tonto.

Numerous similar descriptions abound. It is clear that enormous changes in the Western landscape have occurred since European settlement.

In 1930, an Indian returned to her former home in southern Utah for the first time in 40 years and observed the effects of white occupation. She noticed that, "This country is no good anymore; everything is dry; the creeks are cut deep; the plant foods are all gone."

--Charles Kay, wildlife biologist

Other misunderstanding stems from the fact that the most verdant and productive vegetation in the West is now gone. Originally, ranchers claimed the best forage plants on the most well-watered land throughout the West. After each rancher staked out his territory, his livestock relentlessly sought out and consumed the best of the best in each area. Every subsequent year for more than a century, ranchers and their livestock have searched out the best of the remaining best. Consequently, we have come to accept vegetation that is less and less productive as the norm, failing to realize what has been lost. Thus have the most biologically significant portions of Western public land also been the most heavily abused by livestock.



The best lands were privatized long ago, and what remains as public grazing lands is the ugliest, meanest, driest, least desirable country found west of the 100th meridian.
--George Wuerthner, writer/naturalist

The common public image of Western rangeland is "the rugged West," although what is actually "rugged" or "hardy" is not so much the land itself but our conception of living on that land -- a conception fostered largely by the ranching industry itself, ironically. Compared to the East (east of the 100th meridian, roughly), most of the West is dry. Approximately 80% of Western water falls on only 20% of the land, and 95% of all BLM land receives less than 15" of precipitation annually. The West generally is also much more precipitous, with a shallow, often alkaline, stony soil layer, or even no soil, and sparse ground cover. Accordingly, the West, rangeland especially, is much more "fragile" than the East, and ecosystems here are termed "unstable." The eastern US, mostly flat to gently rolling, well watered -- averaging more than 40" precipitation annually -- and fertile with deep soil, is much better suited for raising livestock. That 79% of all US livestock are raised there despite a higher human population density amply demonstrates this.

The grassy green of a grazed range in a moist climate may seem in good condition, but most of this conception is relative.

This Black Hills, Wyoming, range is grassy and moist, yet severely overgrazed.

Grass, on the other hand, is to most people simply a green carpet. The kinds of plants, their abundance, and their vitality are matters which escape the casual. So long as all is green, all is well.
--Paul B. Sears, **Deserts on the March** (Sears 1967)

Understandably, most people think livestock grazing in wetter Western climes is relatively benign, that, in direct proportion, the drier the clime, the more damage from livestock. As suggested above, there is a measure of truth in this, but it isn't a great one. The wetter West contains more "stable" ecosystems but is also much more heavily stocked -- much of it literally *hundreds of times* more heavily stocked! And though the moister West is somewhat better suited to livestock than is the drier, it is still far behind the East, considering that generally the wettest parts of the Western range are steep terrain with comparatively sparse vegetation and shallow soil. (Even the East, however, is not really suited to domestic livestock and has thus been seriously damaged.)

In the moister West, most grazed range stays green through the growing season, and to most people if it is green it must be doing fine. But green isn't much good if plants are kept cropped short most of the year, year after year, and other livestock impacts are serious. Green is much less useful if composed of non-native plants. So, damage to these moister areas is often similar, relatively speaking, to grazed arid land. In fact, many parts of the comparatively moist plains of Montana, Wyoming, Colorado and New Mexico, the Pacific Northwest, and the high-elevation Western mountains are in terrible condition, even according to federal reports. Perhaps more importantly, why should even the wetter Western range be dedicated to livestock rather than wildlife?

I worked in the resource management division at Sequoia-Kings Canyon National Park for several years, and though we no longer had much cattle grazing there, I spent a considerable amount of time correcting meadow erosion which was caused by overgrazing during the 1930's.
--Steve Sorenson, Leucadia, CA, personal correspondence

Another important factor in our failure to understand the impact of livestock grazing is that **more than half** of the grazing potential of Western range was lost during the initial rush of grazing madness, the late 1800s and early 1900s. The 1934 Taylor Grazing Act grew partly out of reports to Congress that over 36% of public lands suffered "extreme depletion" and another 47% "severe depletion," in the language of the Grazing Service itself (Williams 1990).

A general land survey made by the US Department of Agriculture during the 1930s documented for the first time the extent of the damage. A resulting report stated, "A range once capable of supporting 22.5 million AUM's can now carry only 10.8 million" (US Senate 1936). Thus, any comparisons made after 1936 using this report are based on rangelands whose **productivity is estimated to have deteriorated by more than 50% from original conditions.**

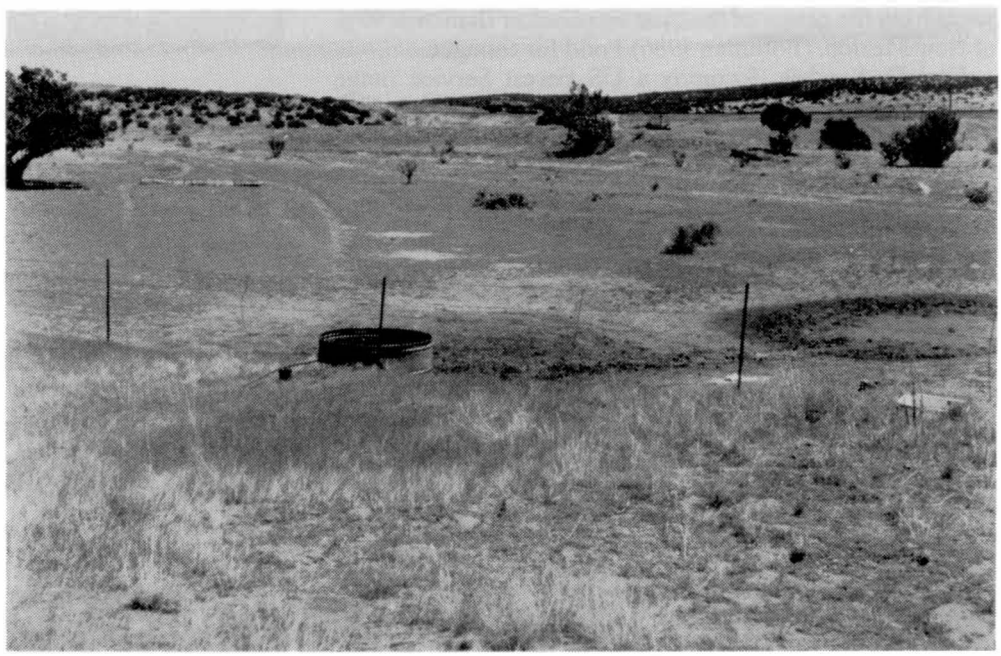
Since 1936 the overall biomass of ground cover on most of the Western range has increased somewhat because plants in most areas have not been eaten as closely to the ground. While this may seem an improvement, the condition of the Western range has in many ways declined since the 1930s due mostly to continuing livestock grazing (see Chapter XI). And many areas, including those previously inaccessible to livestock, have experienced decreases in groundcover.

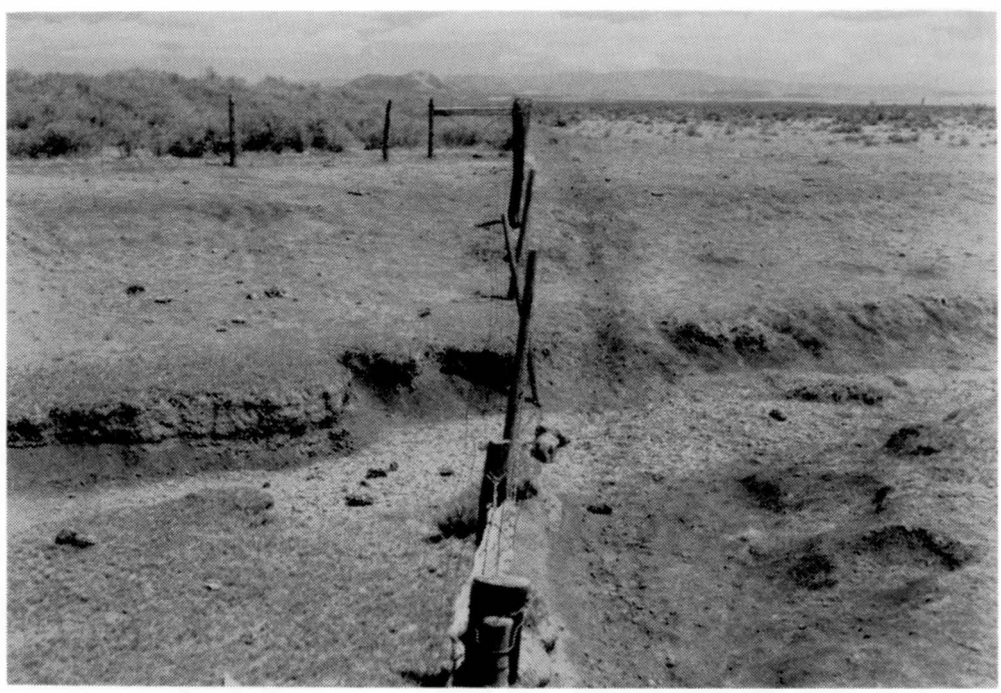
The 1936 report concluded that it would take at least 100 years to restore public rangeland to its original productivity. This was, of course, assuming that a sensible course of restoration would be pursued during the following 100 years; 50 years later, we have never come close. Restoration to anywhere near "original productivity" within another 50 years is impossible, especially given that most topsoil has been and continues to be lost and could not be replaced within this time frame even under optimum circumstances. Heavy ranching abuse has continued essentially unabated since 1936, and despite considerable artificial restoration effort the range we see today undoubtedly operates at less than half aboriginal capacity and is probably still declining in overall productivity.

Further, an additional, ever-increasing strain is placed on Western grazing land each year as more and more of it is converted to government installations, mining developments, reservoirs, fenced parks and recreation areas, roads, resorts, airports, and other developments, while ranchers and government try to maintain or increase numbers of livestock (this aside from grazing land expansions).

Also of note is that contemporary comparative studies of past and present livestock grazing usually consider today's full-grown range cattle (typically weighing about 1000 pounds) as representative of yesterday's cattle, when in fact the Texas longhorns common during grazing's early years averaged only about 650 pounds, and the typical cow at the turn of the century weighed around 800 pounds. Today's half-ton beeves probably eat about 25% more than their 800-pound predecessors (Wagner 1978), and perhaps 40% more than the 650-pound longhorns. Additionally, in sheer numbers, in ranching's early days there were many times more sheep than cattle. So, then-and-now comparisons of livestock *numbers* are misleading and don't necessarily reflect relative grazing pressures on the land. For example, 1000 cattle in 1990 would eat roughly the same amount of vegetation as 1000 cattle *and* 1000 sheep in 1900.

All these factors, along with other intentional deceptions by the ranching establishment, have given us a very misleading picture of livestock grazing. Denzel and Nancy Ferguson, in **Sacred Cows at the Public Trough**, report that in the West as a whole there are now *more and bigger* cattle than ever before (Ferguson 1983). They and some other experts think that overall grazing pressure on public land may now be near an all-time high.





One question has always stuck in my mind: Why would anyone want to graze cattle in this type of environment [public land]. *I still don't understand it. What a waste of land and water. Cattle can be grown on lots anywhere.*

--Tom Thompson, Vail, CO, personal correspondence

The livestock grazing practiced on the comparatively sensitive ecosystems of the West amounts to an annual clearcutting of herbage. The peaceful-looking, pastoral scenes we see as we speed down the highway are in reality disasters to the natural systems of our public lands. Ranching is a subtle, silent, slow death to Nature.

Several years ago a range expert in New Mexico flew over the Trinity Site, where the first atomic bomb was tested. The area hasn't been grazed by livestock since the explosion, more than 40 years ago. He stated that range conditions 20 yards from the center of the blast were better than over 90% of New Mexico. (Foreman 1986) Food for thought.

Earl D. Sandvig, formerly a US Forest Service range specialist and employee for 36 years, now retired, said it plainly: "No use of our federal lands has caused so widespread and serious damage as livestock grazing" (Ferguson 1983).

What has four legs and doesn't belong here? What turns singing high-country streams into silent mud bogs? What reduces green hillsides to brown earth and dust? What wipes out entire species if they get in its way? Hint: It goes moo. . . .

The single best thing that could be done for our Western lands, far and away, would be to get cattle off.

--Donald M. Peters, 5-30-90 *The Arizona Republic* (Peters 1990)

Home on the Range

Oh, give me a home
Where the buffalo roam
Where the deer and the antelope play
Where seldom is heard a discouraging word
And the skies are not cloudy all day

Home, home on the range
Where the deer and the antelope play
Where seldom is heard a discouraging word
And the skies are not cloudy all day

--Traditional

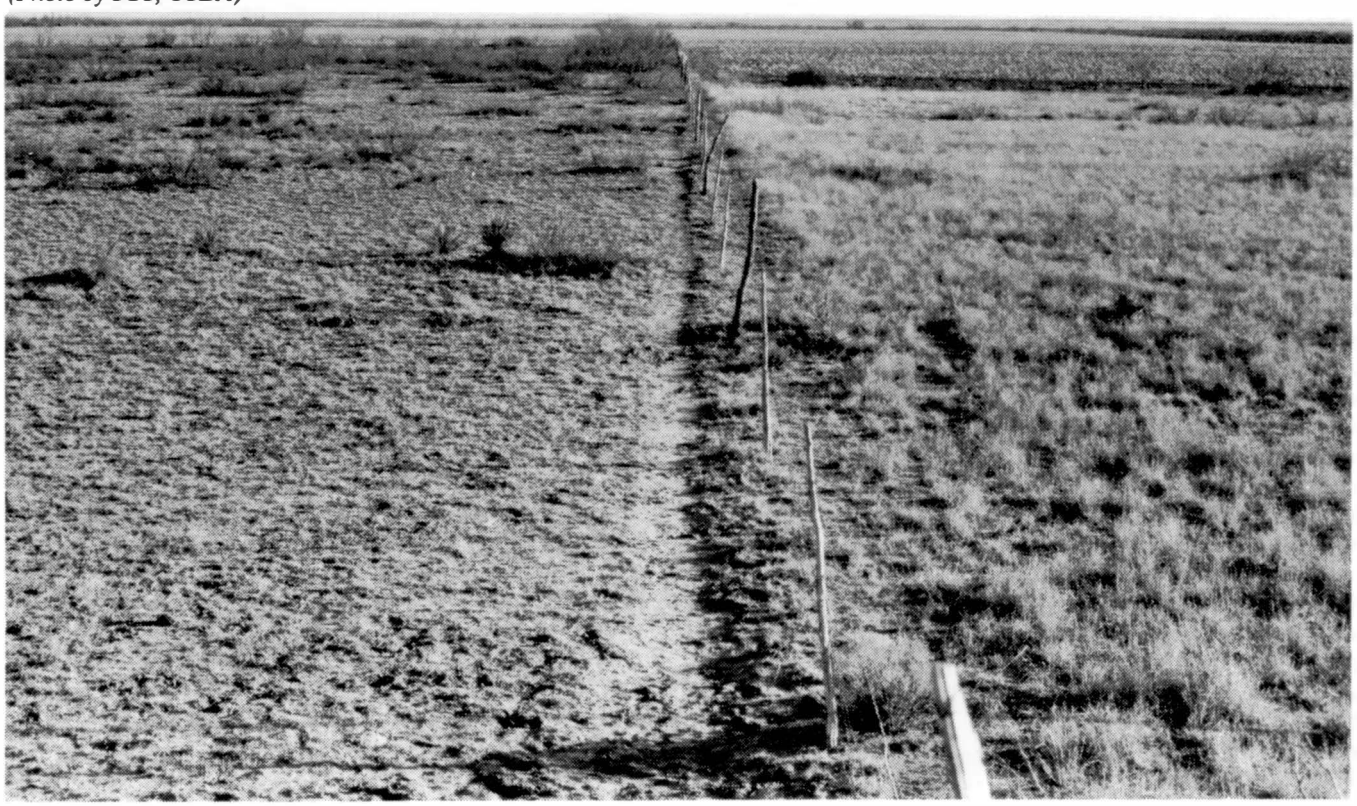
Home on the Range #2

Oh, give me a home
Where the buffalo roam
And the deer and the antelope play;

Where seldom is seen
The hamburger machine
And the flies are not swarming all day

--Edward Abbey

(Photo by SCS, USDA)



Things Aren't Always As They Seem
(A Short Story)

"Great spot!" I thought to myself as we sprawled onto some rocks near a small waterfall. It was a warm, clear spring day, and my kids and I were hiking up along a mountain stream and decided to take a rest. We had seen few obvious signs of cattle along the way -- a welcome change from the cowburnt wastelands we'd visited recently.

I got out the camera, but looking through the viewfinder something seemed wrong. Yes, the rocks in the creek seemed oddly strewn about. Looking closer, I saw that most of the small plants around them were dead. Cattle! Apparently, the plants had grown in favorable locations only to have their host rocks upended and scattered by trampling cattle. No doubt many small animals that dwelled or sheltered under these rocks were also killed.

Now I'm writing my observations.

I stoop down for a closer look at the creek bottom. The silt and organic matter that would normally settle around the rocks, secure their bases to the stream bed, and promote plant growth are churned up and washed away. At creekside, I notice small tree stumps -- the results of cutting for fence posts? (Later, we climb a ridge and find the omnipresent barbed wire barrier.) Cattle have eaten and trampled those small trees that haven't been cut.

Looking through the viewfinder again, I see rocks piled up along the bank on the far side of the creek. They have been rolled down the adjacent, steep hillside by cattle, precluding streamside vegetation. I cross the creek to study this rock levee. Like channelization, it prevents the stream channel from meandering. The tumbling rocks have bent or broken all of the surviving small trees at creekside. Dirt, sand, and gravel likewise have slid and washed down the slope into the creek. Cattle trails, hoof prints, and cow flops are obvious on the slope, and hillside vegetation is eaten and trampled.

I jump back across the creek once more and finally take a picture -- the one on the right.

Now, scanning up and down canyon, I notice that most lower leaves have been eaten off the larger cottonwoods, velvet ash, and Arizona walnut. Entire lower branches are broken off, and a haphazard jumble of broken branches, twigs, and overturned stones litters the ground.

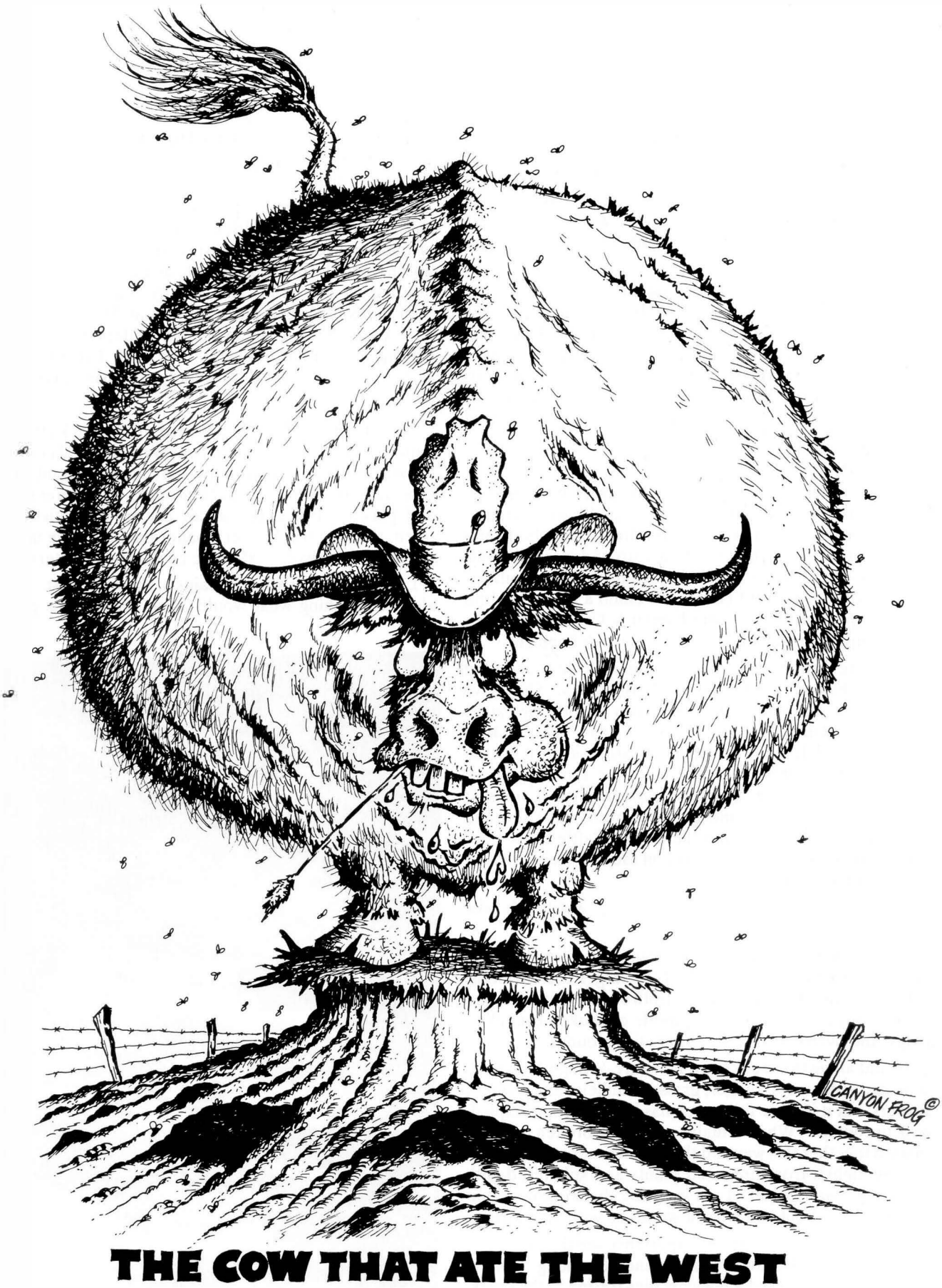
In and along the creek grow moisture-loving plants such as algae, watercress, sedges, grasses, mullein, and monkey flowers, but it is clear that much has been eaten, trampled, and uprooted. What remains grows in broken clumps, matted together this way and that, sometimes covered with organic debris from uprooted plants and splattered with mud, sand, and gravel. I am guessing that riparian plant cover is only about half what it would be without cattle.

Further detracting from the experience are the many flies that make it unpleasant to stay in one place long. On the hike up here, I spotted a few cow pies rotting in the creek. So now I am wondering if we should have brought that canteen after all. So much cool mountain stream water, but should I risk getting sick, maybe for weeks or months with giardia? I drink it anyway.

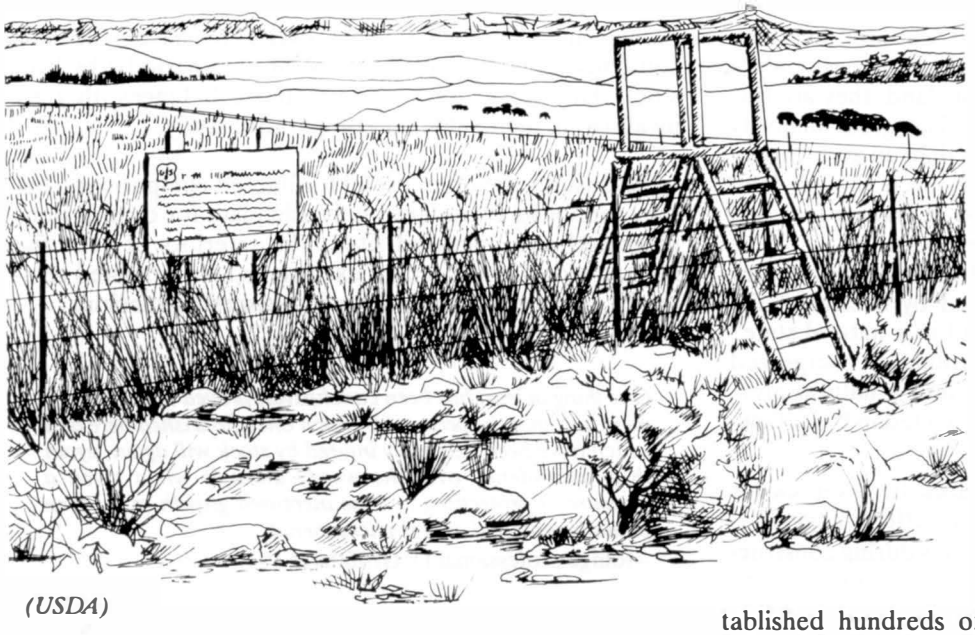
We stretch out on bedrock, streamside. Looking into and around the creek, I see . . . muddy hoof ruts. Clumps of mud and roots lie dissolving and rotting in the slower water along the bank. Likewise, dead, rotting vegetation is exuding an oily scum into nearby stagnant, water-filled hoof holes. In some places, plants and their root masses have been "peeled" clean off the underlying bedrock by cutting and sliding hooves. The rock I am lying on is spattered and smeared with mud and bovine excrement.

Despite it all, this place is nice. But it lacks the abundance, vitality, integrity, and beauty of a natural ecosystem. Most of the Western landscape may seem pleasant enough, especially to those of us accustomed to concrete, metal, and plastic. But appearances can be deceptive. Most often, the pastoral Western panoramas we gaze upon are in reality settings for extensive ecological disasters.

Let's appreciate what remains of the wild West. But let's also keep asking what would, what should, this place be like?



(Roger Candee)



(USDA)

Exclosures and Fenceline Contrasts

It's amazing how pervasive grazing has been. There aren't many pristine areas left.
--Nick Van Pelt, head of Natural Heritage Program for Utah Nature Conservancy (Williams 1990)

From the onset of the livestock invasion until the early 1900s stockmen grazed their cattle and sheep indiscriminately nearly every place with a blade of forage or leaf of browse. Even so, some of the West was inaccessible to livestock due to availability of water or rugged topography. As the years passed, water and access developments opened these areas to ranching, and soon few places remained that had not been significantly and (on the human timescale) irreversibly altered from original conditions.

Long before enactment of the Taylor Grazing Act in 1934, it became apparent that the productivity of the Western range was being seriously reduced. Even ranchers were calling for restoration of the West's public "forage resources." How this restoration would be accomplished was debatable, but one thing was certain: **stockmen would not remove their livestock**. The government would have to explore other possibilities.

Whatever the future held, scientific studies would have to be conducted to identify and measure ranching's effects on the range. But without ungrazed lands for comparison, how could this be accomplished? A series of fenced, ungrazed study plots would have to be established. To encompass the great diversity of grazing situations, plots would need to be located at representative sites, in varied terrain, and in disparate vegetative and climatic regimes throughout the rangeland West. To maximize their representative value, they would have to be numerous.

Consequently, in the early 1900s various government agencies established hundreds of "exclosures" to evaluate livestock impacts (or the lack thereof) and to serve as standards for assessing range condition. Hundreds more were built in the 1930s and 1940s, when thousands of men from the Civilian Conservation Corps (CCC) were placed at the disposal of the Division of Grazing (later the Grazing Service) and Forest Service. Since the 1940s, lesser numbers have been constructed sporadically for various reasons by government and private entities.

Most of Arizona rangeland probably has been grazed by livestock for more than a century. Changes in vegetation on some of these rangelands are so marked and so extensive that current concepts of natural vegetation are based on landscapes that are quite unlike those present before human obtrusion.
--Raymond M. Turner, *et al.*, *Arizona Range Reference Areas*

Looking into a 75-acre livestock exclosure near Globe in central Arizona. Fenced in the 1950s, the protected land is slowly recovering and currently supports roughly twice the plant and animal biomass per unit of area as the grazed land around it. As is apparent in this photo, native grasses are reestablishing, whereas cheatgrass composes virtually 100% of the grass cover outside.

Today the West has a few thousand scattered livestock exclosures. Yet, all of them combined encompass only a minuscule fraction of the area of public land; they are tiny specks in a vast sea of overgrazing. The great majority enclose several acres or less, most less than an acre. Stockmen rarely tolerated anything larger, even though land retired from grazing was not included in grazing fees and minimally interfered with grazing operations.

These areas are now fenced from livestock, but are they truly representative of lands ungrazed by livestock? Do studies conducted thereon reflect land in a natural state? Not at all! Merely building a fence around an overgrazed acre does not magically transform it into a natural area. Livestock exclosures are unnaturally affected in the following ways:

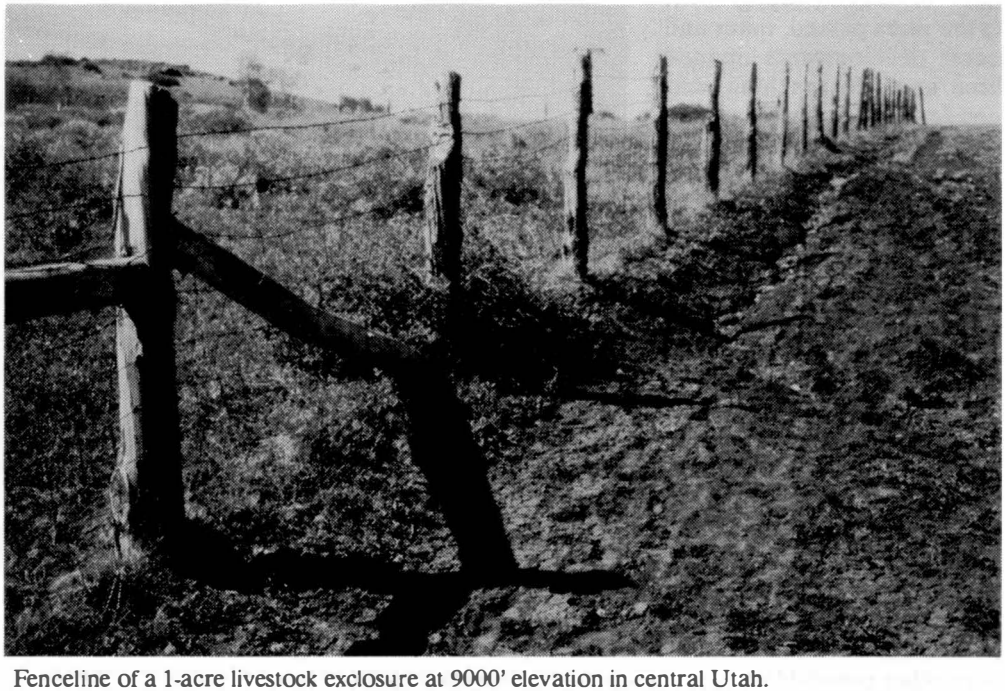
- Most of these areas were heavily grazed by livestock for decades before being fenced, so residual effects linger.
- The physical disturbance of exclosure sites during construction and subsequent concentration of human impact in the areas influence their condition.
- Few exclosures are large enough to provide for proper ecosystem dynamics, e.g., seed dissemination, plant and animal migration, biologic succession, and genetic viability.
- Overgrazing, range developments, and other human obtrusion in surrounding areas affect the interiors of most exclosures and hamper restoration. Perimeter effects include excessive water runoff and soil erosion; sediment deposition; increased low-level wind speeds and drying of soil; decreased shade; reduction or elimination of natural fire; absence of native species needed for repopulation; diminishment of native animals; and net loss of organic matter, as it is blown and washed from comparatively verdant exclosures to surrounding depleted areas but not reciprocally replenished. Enclosed stream segments are affected by upstream ranching.
- Wild animals from surrounding grazed areas are attracted to ungrazed exclosure interiors, where they find a greater abundance of plant and animal food, shelter, nesting materials, moisture, etc. They therefore unnaturally affect and deplete exclosures.
- To "destroy the evidence" that livestock are damaging the land, express their displeasure with government interference, and allow their livestock to "utilize" what they consider "wasted" herbage, many ranchers covertly tamper with exclosures. They destroy exclosure vegetation, spread seeds of "undesirable" plants, damage soil with minerals or chemicals, "accidentally" leave gates open (though most exclosures don't have gates), break fence posts or push them over, and cut exclosure fences, all of which reduces or destroys exclosure validity.
- Perhaps most significantly, *most* exclosures have since their construction been grazed (often for long periods) by livestock that knock down or push through fences, thereby invalidating their value for comparative study.

Exclosures are often useful for limited comparisons, but they cannot be considered fully adequate for comparisons of grazed and ungrazed sites. The interiors of even the largest, oldest, most secure exclosures are corrupted relative to entire ecosystems never influenced by ranching.

One thing at least has been conclusively proved in this experiment, i.e., that the perennials which once flourished here and which have been decidedly injured by stock will again regain their ascendency over the weedy annuals when given a measure of protection. . . . the increased growth of an even partially protected area is phenomenal.
--Range professional D. Griffiths in 1910

A 200-foot-wide stretch of land containing 300 feet of stream was fenced, and recovery there he said, "shows that riparian areas can come back something fierce." Prunty [Jim Prunty, a former rancher and 20-year Forest Service employee] *said the exclosure is especially impressive because of the dramatic difference between the protected stretch and the heavily grazed sections upstream and downstream from it.*
--Ed Marston, "Ranchers' Hold on Agency Revealed" (Marston 1990)

One friend reports having a flash of understanding when he stood by a fence that separated grazed and ungrazed portions of the same creekbed. One side was lush and verdant. The other side looked like the face of the moon. Moo.
--Donald M. Peters, "Give Me a Range Where Never Is Heard a Discouraging Herd" (Peters 1990)



Fenceline of a 1-acre livestock exclosure at 9000' elevation in central Utah.

In 1932 a one-square mile livestock exclosure was constructed to study the effects of livestock grazing on the natural vegetation of the Jornada del Muerto, thirty miles north of Las Cruces, New Mexico. In 1935 vegetation was measured along permanent transects, and these measurements were repeated in the 1950s and again in 1980. In 1935 the vegetation both inside and outside the exclosure was dominated by black grama grass with almost no mesquite. By 1955, however, mesquite was clearly on the increase outside the exclosure, and black grama was declining. In 1980 the exclosure was a small island of grass, surrounded by country in which black grama was almost completely absent and mesquite was dominant. In addition, on what had been a more or less level plain, sand hummocks or coppice dunes like those along the route from Fort Bowie to Las Cruces had formed around the mesquite.

A similar pattern of change is reported for extensive areas of southeastern Arizona and southwestern New Mexico.

--Gary Nabhan in **Arizona: The Land and the People**

Despite their limitations, the great majority of livestock exclosures exhibit dramatic environmental recovery. For example, after SCS established several large exclosures on the Navajo Reservation in the 1930s, "The Service reported both dramatic recovery of the range and improved conditions of the [stock] animals in virtually all these areas and continued to report progress in succeeding years" (White 1983). Though not always visibly obvious, exclosure interiors commonly have at least *twice* the organic ground cover, overall biomass, numbers of individuals and species, topsoil, and soil moisture. I have visited scores of livestock exclosures, in every Western state, and **all** of them exhibited as good or better environmental condition (even herbage production) than the livestock-grazed land around them. For most, the comparison was not only impressive but remarkable. Curiously, on the other hand, nobody -- not even ranchers -- raves about the comparative range condition *outside* exclosures. Why do cattle so frequently risk bodily harm to break *into* exclosures?

Exclosures are among the few places left in the West where we can witness land and water that has not been directly affected by livestock for decades. Thus, these sites are irreplaceable, vitally important, and should be protected. Unhappily, they are not. Though most were originally well-constructed, they have over the years deteriorated to the point where probably most are broken into by livestock occasionally, many routinely. They are poorly maintained, if at all. For example, when I asked a Utah BLM range specialist why the few hundred yards of exclosure fences in his district could not be properly maintained, he replied that funding simply wasn't available (though it was for *hundreds of miles* of ranching fences).

A livestock exclosure at 8000' elevation in the Dixie National Forest, Utah. The interior supports several times the plant and (non-livestock) animal biomass, many more species, and moister, more fertile soil. Without this exclosure for comparison and under continued livestock grazing, how would we have any idea what this particular landscape should be like?

One by one, these last tiny representatives of a more natural environment are falling to ranching. Funding for new exclosures is scant to nonexistent, but new ones are much less useful than the old ones anyway.

If they won't end ranching, our land managing agencies at least should immediately begin protecting all existing livestock exclosures by maintaining fences, erecting new fences where necessary, and actively resisting trespassing and tampering ranchers. Also they should establish many large, new exclosures in representative areas of the rangeland West, enclose them with sturdy fences, and fully maintain and defend them. These ungrazed areas should not be mere acres, but *thousands or millions* of acres so we may eventually study whole, and largely unaltered, ecosystems and make valid comparisons. Allotments of habitual permit violators could be retired and established as units of this system of ranching-free zones; all the necessary boundary fencing would already be in place!

A fenced highway right-of-way in central Arizona.

Instead of having 3,778 acres [on the Box Allotment, Pawnee National Grasslands, CO] "*suitable and open to grazing*" *and only a mere 16 acres for exclosures, why not have it the other way around?*

--Cindy Bishop, Co-coordinator, Prairie Dog Rescue, Inc.

By far the most common livestock exclosure in the West is de facto -- the narrow, fenced strips along roadways. They provide a great diversity of grazed/ungrazed contrasts for almost every portion of the West. Even so, fenced roadsides are not fully adequate for comparative purposes, for most of the reasons listed above.

ROADSIDE

Between pavement and barbwire
Between cows and cars
Narrow strip
No cattle graze
tall grasses
short grasses
sage, yucca
other plants whose names
I do not know
Roots deep
tenacious
Tough survivors
I kneel and give thanks

--Michael Adams, Eldorado Springs, Colorado

The grassland, roughly 300 acres, sticks out like a green postage stamp on the vast, dry range. Surrounded by high sandstone cliffs, its pastures have never felt the mandibles of a cow, sheep, or horse. The tall bunchgrasses here are native. There is no Russian thistle, no tumbleweed, no cheatgrass; there is not even sage.

The land is an almost intact gift from the past, and because of the meadow's pristine condition, scientists treat it as a rare clue to how the West might have looked before the arrival of Europeans.

The meadow's most striking feature is not grass; it is cryptogam from which the grass springs. Elsewhere in Canyonlands National Park, the cryptogam is pink and knubbly, just beginning to recover from years of intensive cattle grazing. But on these few hundred relict acres, it is a thick, dark, ancient matrix of lichen and moss.

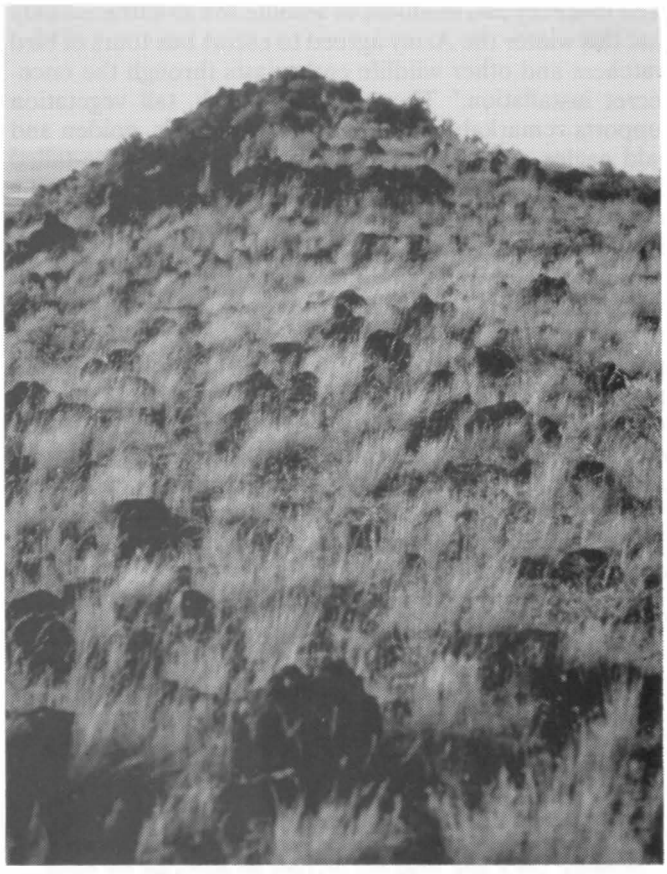
--Florence Williams, "The West's Time Capsules" (Williams 1990) (Ranching guru Allan Savory insists that a large herd of cattle should be moved onto this secret meadow a.s.a.p.; he thinks the meadow is deteriorating due to lack of animal impact. See Savory's Salvation in Chapter XII.)

In many areas of the West, *vacant lots in cities and towns* display the best range conditions -- by simple virtue of not having been used by livestock for so long.

With few exceptions and relatively speaking, the best environmental conditions in rangeland portions of each Western state are found where livestock have never grazed or have been excluded for long periods. Some of the best range conditions in southern Nevada, for example, are found on the vast, unranched Nevada Test Site. In Arizona, marginal desert grassland in the ungrazed Petrified Forest National Park averages more herbaceous cover than the overgrazed naturally grassy lowlands around it. Similarly, the buffalo-grazed "badlands" of Badlands National Park in South Dakota is luxuriant with tall grasses and flowering plants -- in contrast to short-cropped, depleted surrounding livestock-grazed prairie. Ungrazed portions of Vandenberg Air Force Base on California's central coast support a lush diversity of plants and animals compared to adjacent grazed land. Areas of the Colorado Plateau where one can experience a relict (never-grazed) environment include No Man's Mesa in the upper Paria Creek drainage, Powell Plateau in Grand Canyon National Park, and Romona Mesa, 10 miles northeast of Glen Canyon Dam on the Utah-Arizona border. Romona Mesa is a steep-sided, inaccessible table that has never been grazed by *any* large ungulate. Despite its rocky, windy, dry location, it supports a much more abundant and diverse biologic community than the vast grazed lowlands surrounding it.

For the past seven years, cattle have not been allowed to graze at the U.S. Army Pinyon Canyon maneuver site near Trinidad in southeastern Colorado. According to Tom Dougherty of the National Wildlife Federation, "The real paradox is that even with the maneuvers, which most people would believe tear up the soil, we're noticing that the vegetation and wildlife communities seem to be infinitely better off."

--from news release for the film *The New Range Wars* (National Audubon Society 1991)



This inaccessible, volcanic hilltop on Hart Mountain National Wildlife Refuge in Oregon is inaccessible to livestock and so supports a lush covering of bluebunch wheatgrass and other native plants -- in stark contrast to the sparse covering of mostly exotics on the grazed land below. *(George Wuerthner)*

One of the few large livestock exclosures of any kind on the Great Plains is the Rocky Mountain Arsenal near Denver, Colorado. The US Army fenced the 27-square-mile area during World War II and built chemical plants at its center, using the rolling open grassland around them as a natural buffer zone. After 47 years of complete protection from ranching, the area is so thick with wildlife that Wendy Shattil, a world-traveling wildlife photographer, describes it thus: "For public viewing and diversity and quantity of wildlife, I don't think there is anything that compares to this, outside of Yellowstone National Park." In a 3-12-89 *New York Times* article entitled "Nature Sows Life Where Man Brewed Death," William E. Schmidt reports:

This ungrazed roadside offers not only several times more ground cover and vegetative biomass per unit of area than the miles of livestock range around it, but more species and diversity of grass, flowering herbaceous plants, and cryptogams, plus all the wild animals that go along with them.

"The diversity and numbers of wildlife are so extraordinary that this winter the Army agreed to escort bus tours of bird watchers and other wildlife enthusiasts through the once-secret installation." The exclosure's lush, tall vegetation supports remarkable numbers of hawks, owls, golden and bald eagles, coyotes, prairie dogs, mule and white-tailed deer, badgers, and much more. The land outside the installation's fences seems desolate in contrast. The main difference is ranching. (Schmidt 1989)

Financing for study and maintenance of exclosures and relict areas is scarce, due largely to pressure from livestock interests. According to Canyonlands National Park biologist Tim Graham, "Funding has been abysmal. It's probably my cynical view, but if we knew what the landscape was like 200 years ago, we'd have a model we'd have to be working toward." Graham notes that this might "require a big change in behavior" on the part of stockmen, that some ranchers may want to keep a lid on such studies, and that the grazing industry carries a lot of weight to suppress such studies. (Williams 1990)

Inside the split-rail fence the growth was green and luxuriant. Outside there was no growth, just desert. The ranchers hate such exclosures because they teach the public that cattle are the scourge of the earth.
--Ted Williams, "He's Going to Have an Accident" (Williams 1991)

I have never known a person who, once being shown a dramatic fence line, does not become an advocate for range improvement.
--Johanna Wald, attorney for public lands issues, Natural Resources Defense Council (Zaslowsky 1989)

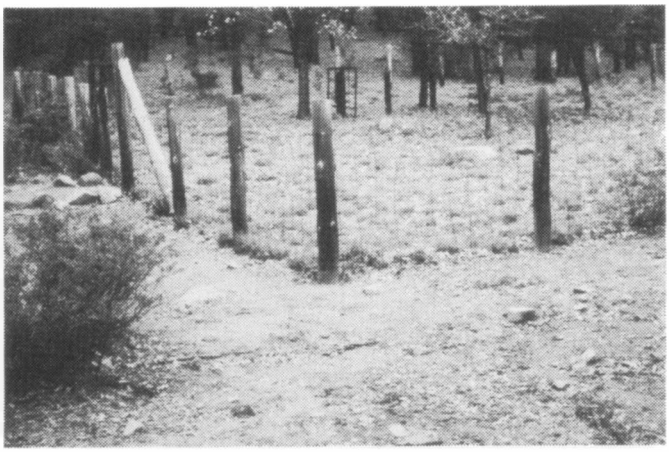
Following is a pictorial account of some representative livestock exclosures:

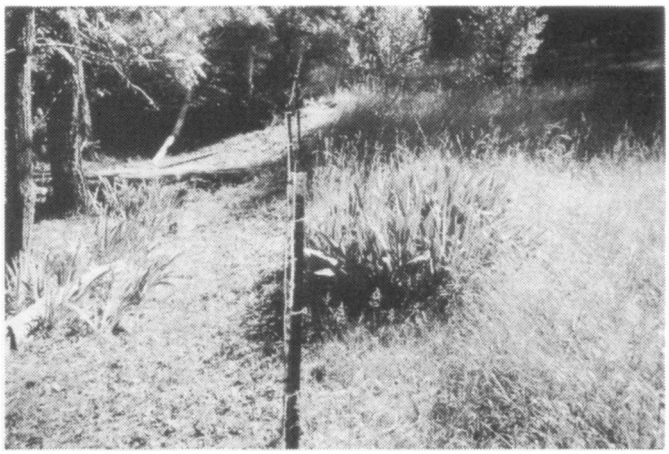
This fallow field on the Fort Apache Indian Reservation in east-central Arizona, fenced to prevent cattle from destroying crops, is a de facto exclosure, lush with vegetation compared to the thousands of grazed Reservation acres around it.

A small exclosure in the Hawksie-Walksie Wilderness Study Area, Oregon, with cattle and a beaten range beyond the fence in the middle distance. *(Nancy Peterson)*

On the left is a small BLM cattle exclosure near Deadhorse State Park in southern Utah. The contrast between grazed and ungrazed land seen here is typical for exclosures in the region. *(George Wuerthner)*

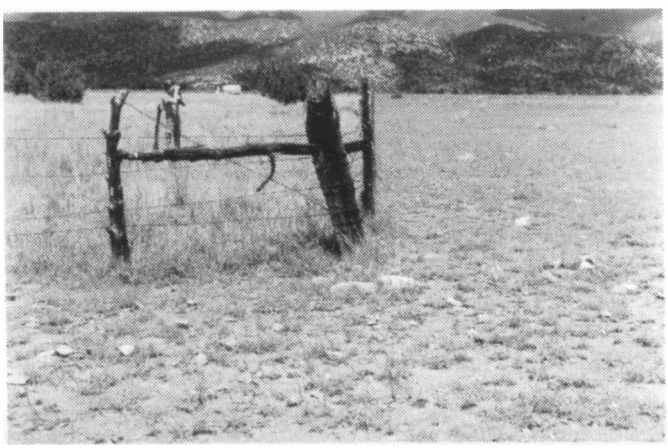
Boundary of a mile-square exclosure in southern Arizona, fenced in the 1940s..

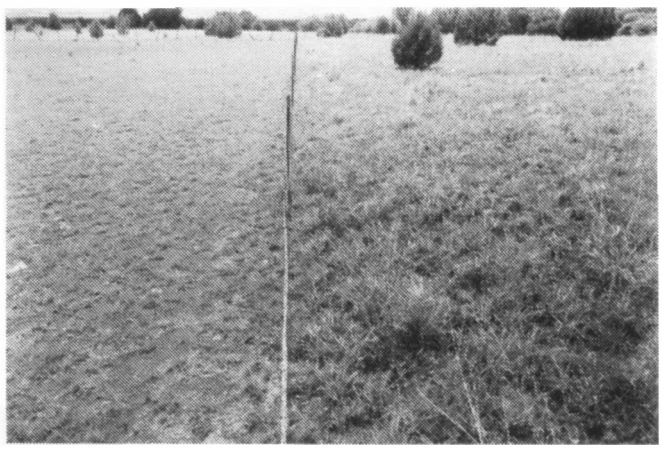




A small cemetery (left) in pine-oak woodland near Palace Station in the Prescott National Forest, central Arizona. The burial ground has been fenced from livestock for nearly a century and supports perhaps 3 times as much ground cover as the surrounding woodland.

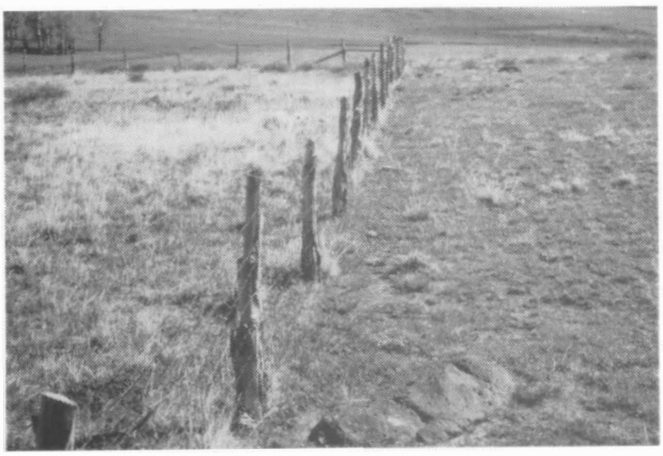
Near the cemetary, a portion of a forest meadow (right) has been protected from livestock for several decades. The exclosure is almost completely covered with many species of tall, thick grass; wild iris; herbaceous perennials; shrubs; and bushes; with many insects buzzing and crawling about. Outside the exclosure is trampled, mostly bare ground; stubbles of grass of only a few species; wild iris only half the size; mostly annuals rather than herbaceous perennials; fewer, smaller shrubs; eaten, stunted bushes stripped of their lower branches; and vastly fewer insects.

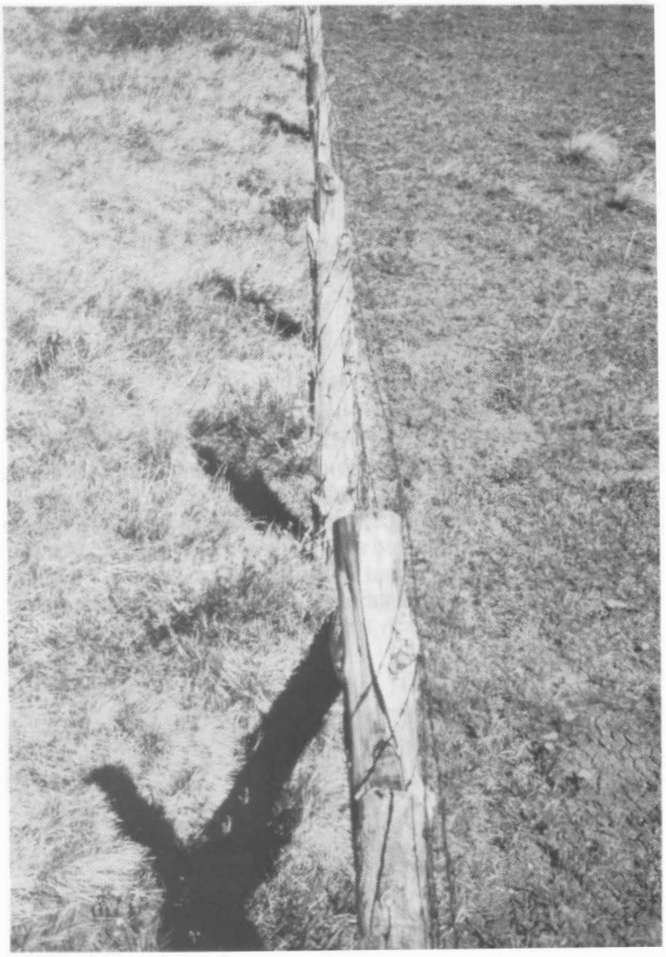




Lone Mountain Exclosure, established in 1935, is situated at 5500' elevation in the Coronado National Forest near the Mexico-US border in southeast Arizona. The protected 5 acres has made a fair recovery thus far, and supports about twice the amount and density of ground cover as the unprotected land around it. Parts of the exclosure harbor cryptogams; almost none of the grazed range has cryptogams. Quail, doves, songbirds, small mammals, and insects are more common inside the exclosure.

Two photos taken from the same spot on an exclosure fence, one facing the interior of the exclosure (left), and one viewing the cattle-grazed range outside (right). BLM, southeast Utah.

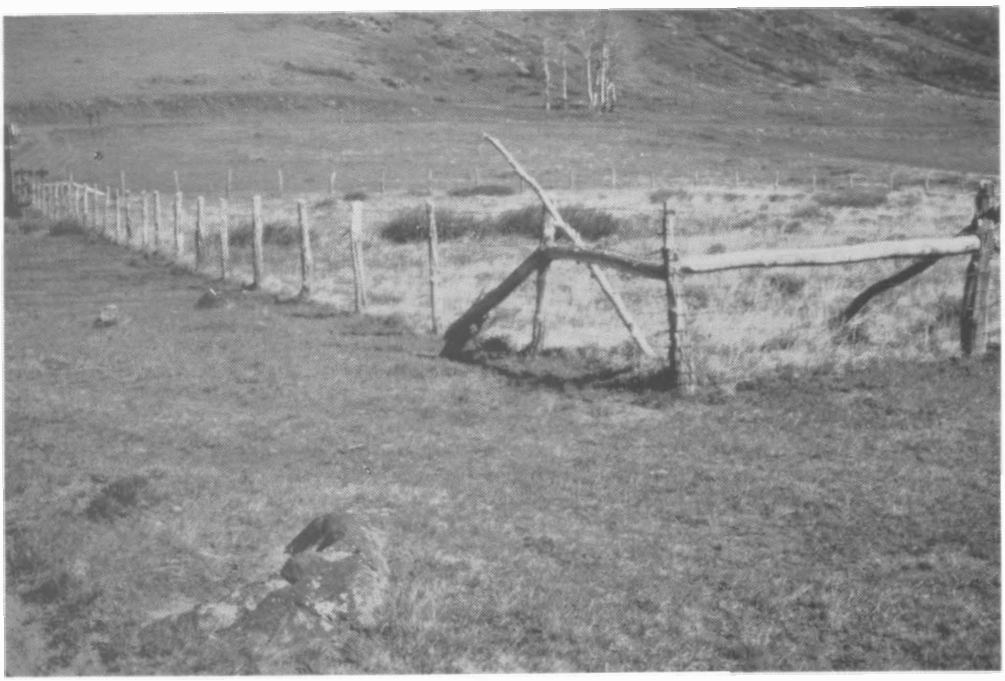




Roundup Flat Exclosure is located in a wide saddle at more than 9000' elevation on the Aquarius Plateau in south-central Utah. The Plateau rises to more than 11,000' and is the largest expanse of high country in southern Utah, but destructive cattle and sheep grazing is common throughout, even in the aspen groves and pine-fir forests.

When the acre plot was fenced in 1957, the protected land immediately began the restoration process, the current results of which can be glimpsed in these photos. The vast improvement in the vegetation is evident, but what is not so obvious is the concurrent improvement in soil, water, animals, and so on. Look closely, for example, at the difference in the amount of exposed ground in the photo at top right.

Imagine the incredible restoration if the entire Aquarius Plateau was a livestock exclosure!



Norrell Range Study Plot, created in 1937, is located at 2250' elevation about 50 miles east of Phoenix, Arizona. At 175 acres, it is among the largest livestock exclosures in the West.

Norrell provides a prime example of how deceptive the influence of livestock grazing can be. I first discovered the exclosure by chance. My family and I were driving through the sub-tropical Sonoran Desert on a small dirt road. Suddenly, I noticed a small Forest Service sign off to the left. We had been driving alongside a fence but until now I had seen nothing that would have indicated that it was the boundary of a livestock exclosure.

Even as I stood there reading that this place had not been grazed since 1937, I discerned little difference between it and the grazed expanse to my back. Only after I climbed the fence and began exploring did things finally click.

Outside of the exclosure, the ground cover was virtually 100% cheatgrass. Inside, cheatgrass still composed probably 90% of ground-level vegetation, but here and there stands of various native grasses were coming back. These grasses grew only to the fence-line, not beyond.

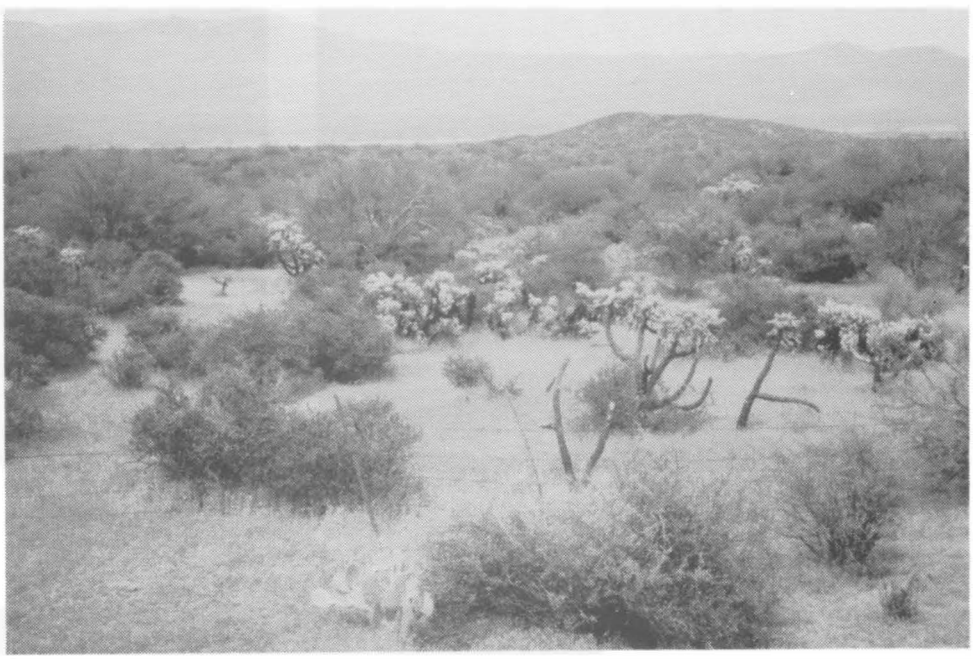
I was surprised to suddenly realize that the inside of the exclosure contained about twice the biomass of shrubs, bushes, and trees per unit of area as the ranchland that we'd been driving through. As you can see in the photos at right, the woody plants on the grazed range (bottom) are sparser, smaller, more scraggly, and have been divested of most of their lower branches.

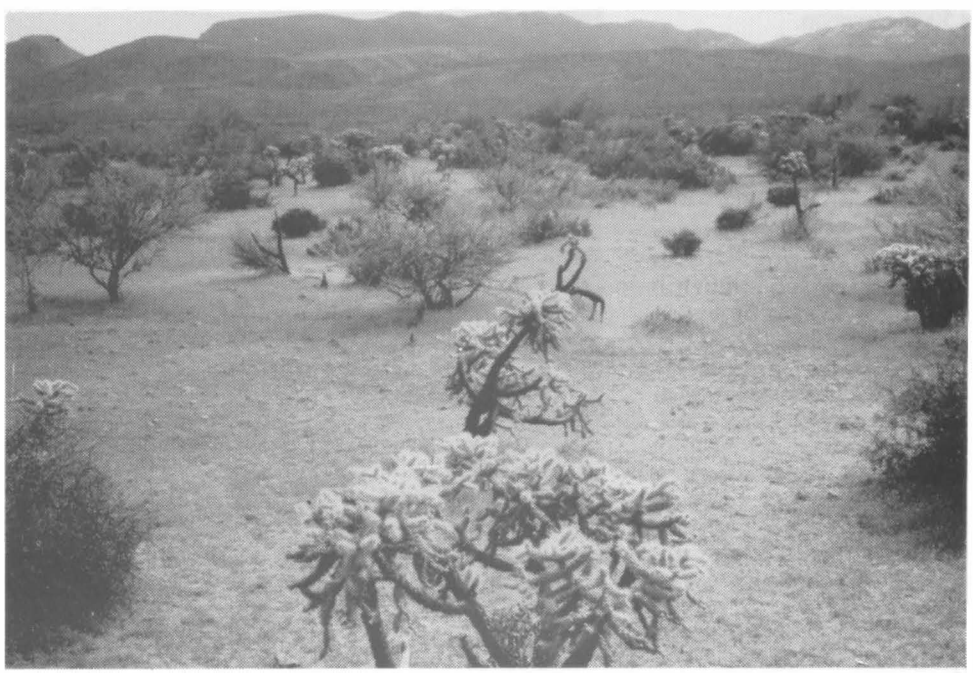
I walked back and forth between the exclosure and the grazed range. Inside, with thicker vegetation and organic litter, I found more birds, small mammals, lizards, and insects; and more nests, burrows, and tracks.

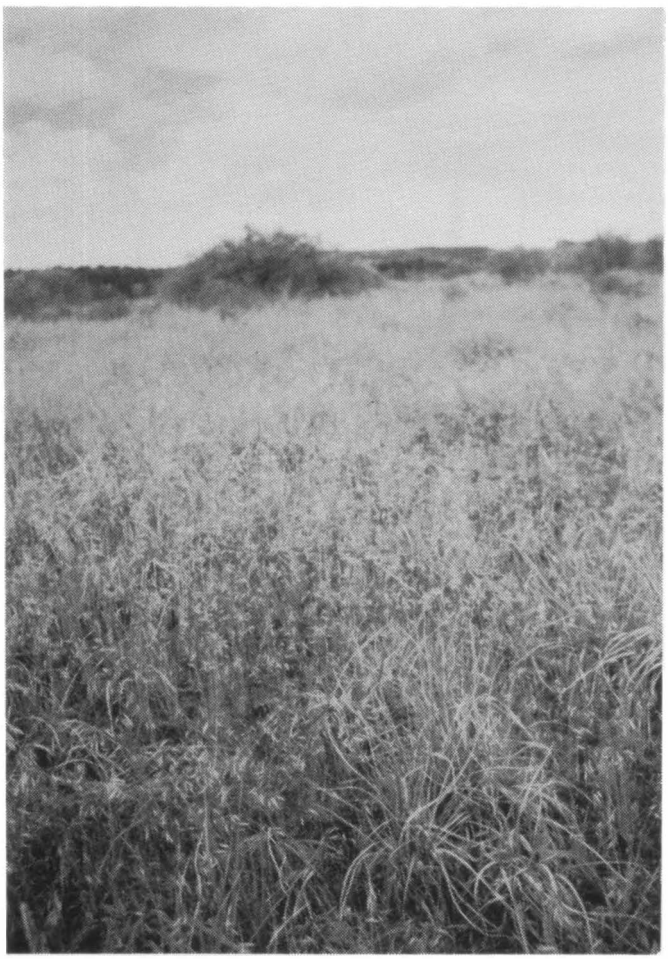
I strolled up a small, sandy wash. Its banks were covered with grass and dried-out herbaceous plants. The dense bushes and trees overhanging the drainage had trapped piles of flood debris and dropped much litter of their own. Lizards scurried into this organic material at my approach. Further along, a covey of quail exploded from a brush thicket and a large owl winged silently from a palo verde.

I encountered and negotiated barbed wire and continued up the wash. Immediately the drainage widened. Its banks were bare and trampled. Little overhanging vegetation or organic litter. Few piles of debris for lizards. No dense thickets for quail. No clean, unmarked sand. Cow pies, hoof prints, and environmental travesty everywhere.

I headed back to the exclosure.





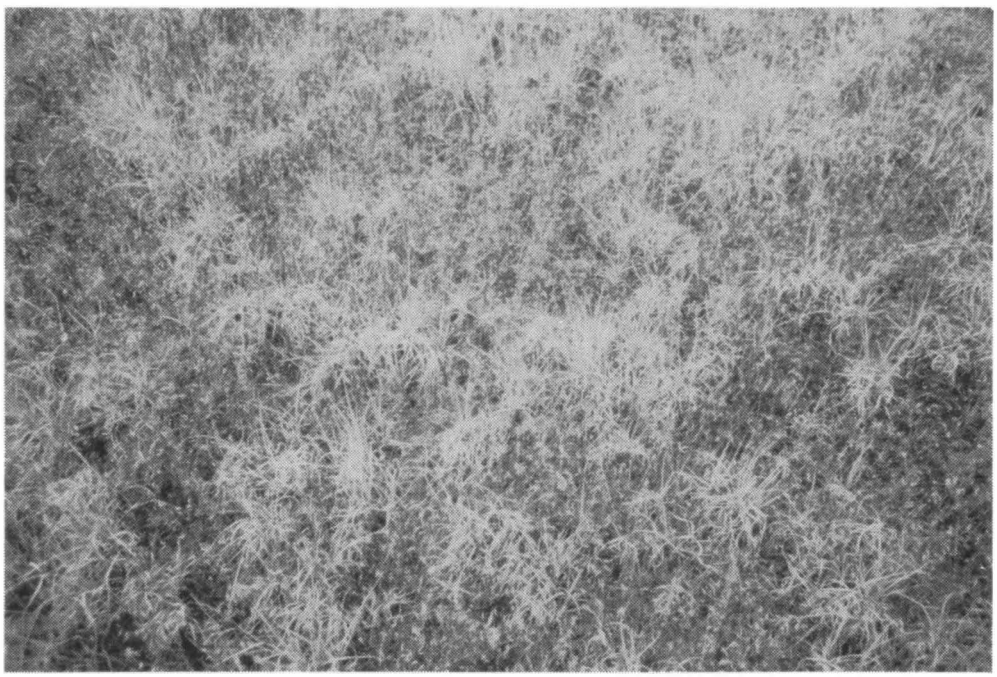


The exclosure featured on these 2 pages can be found along a small dirt road 30 miles northeast of Moab in east-central Utah. It covers a couple of acres of semi-arid (former) grassland at 5000' elevation.

Both photos above were taken from the same spot on the exclosure fence. The top right photo looks out toward livestock-grazed land typical to the region. Note that the cow pie -- much-touted by ranchers as an essential range fertilizer -- is like a drop in the ocean compared to the massive denegration wrought by their contributing animals.

The top left photo of the exclosure's interior reveals what much of the region might look like if similarly protected from livestock. Though mostly grass, the unranched land also supports many shrubs, bushes, trees, flowering plants, and cryptogams in and amongst the grasses.

The bottom photo displays a typical fenceline contrast.



The ground within the exclosure (top photo) is so thickly covered with grasses, herbaceous plants, cryptogams, and organic litter that less than 5% of the actual ground surface is bare. Soil here is rich with humus, dark, moist, and wonderful to smell.

In contrast, bare ground on the grazed range averages about 50%. Soil here is exposed to the elements, eroded, light-colored, dry, and smells more like a dusty road.

Page Experimental Ranch was established in the 1940s by the University of Arizona as a place to research various agricultural techniques. To prevent roving cattle from disturbing the study projects, a square-mile section of Sonoran Desert (former) grassland was enclosed with barbed wire. Over the years, many experiments have been conducted thereon, but much of the exclosure remains basically natural, and most of it has seen few livestock for decades.

To visit Page you cross miles of typical state and private cattle-land -- rather barren, eroded country with sparse exotic grasses and scraggly, scattered shrubs, cacti, and mesquite. You might imagine that the area is naturally like this.

When you climb over the fence into the Page exclosure, however, you enter another world. Suddenly, as if by magic, you are immersed in a rich mosaic of life and healthy natural processes. Tall native grasses everywhere. Wild flowers of a dozen bright colors. Insects and birds fill the air. Small mammals and lizards scurry through thick grass and dense shrubbery. Large, healthy cacti. Small vines and strange-looking plants you have never seen. A glimpse of a kingsnake as it slithers into an ancient packrat nest. Curious and colorful bugs and beetles crawl across the thick organic compost -- a mat so thick that much of it feels spongy to your step. Fragrant and earthy smells hang in the moist air. You drift gently into another world . . . and for just an instant you feel an overwhelming primeval oneness with these wild and wonderful surroundings. . . .

And then a slap in the face!: you snap back into "reality" -- a university experimental area on the vast Arizona livestock range.

The livestock-grazed range adjacent to the exclosure (top) is typical of a large percentage of central and southern Arizona -- an impoverished land of mostly bare dirt. In comparison, the exclosure is a wonderland of Nature.

Health, integrity, abundance, and diversity are the rules inside Page; in contrast the land outside is ill, fragmented, deficient, and simplified.

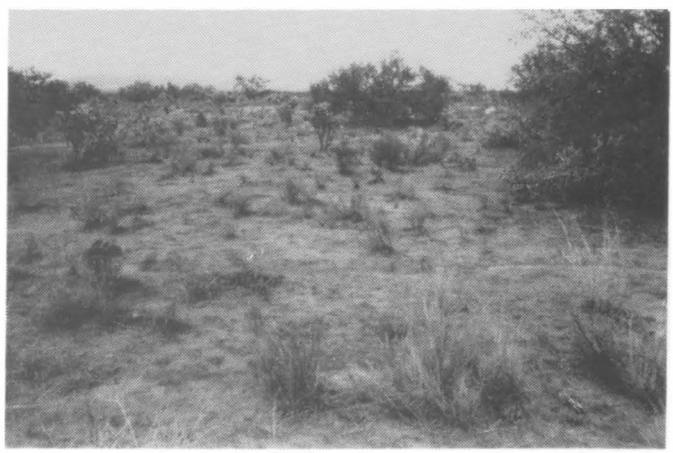
Pull back the grass, scrape off the litter, and grab a handful of moist, dark, loose, humus-filled, microbe-enriched soil. Smells great!

The University of Arizona recently decided to sell Page and no longer maintains the protective fence. Already, cattle have broken into the exclosure and damaged some of the beautiful vegetation, and evidence strongly suggests that the local state-land rancher has several times twisted wire strands of the fence together to let his cattle in.

The ground just inside the exclosure fence.

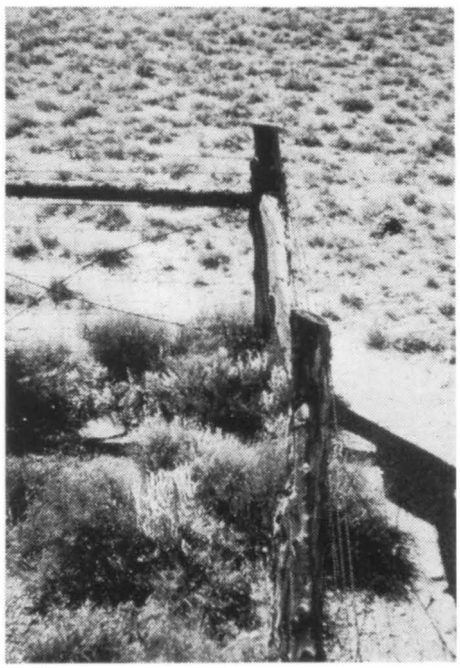
The ground in the same location just outside the fence.

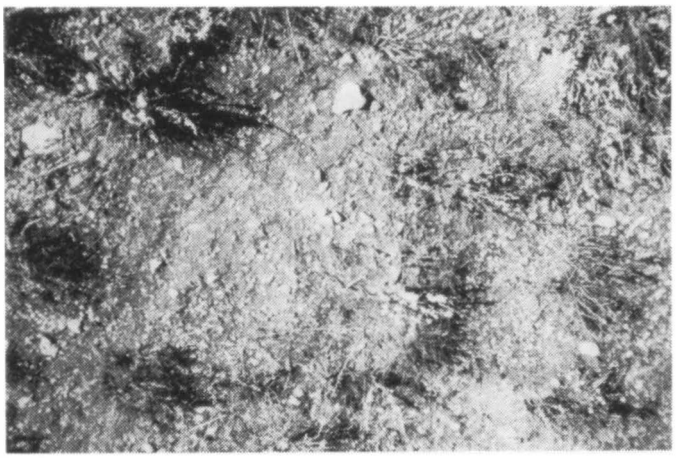
An unusual couple of yuccas in the Page exclosure. It is doubtful that these yuccas could have reached this size and perfection of shape under the abusive influence of cattle.

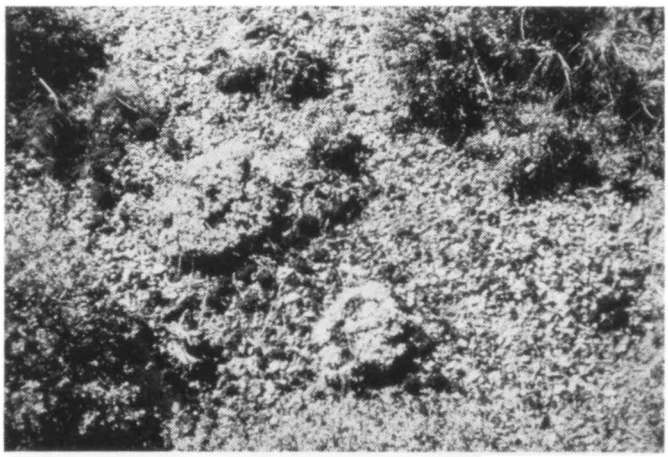


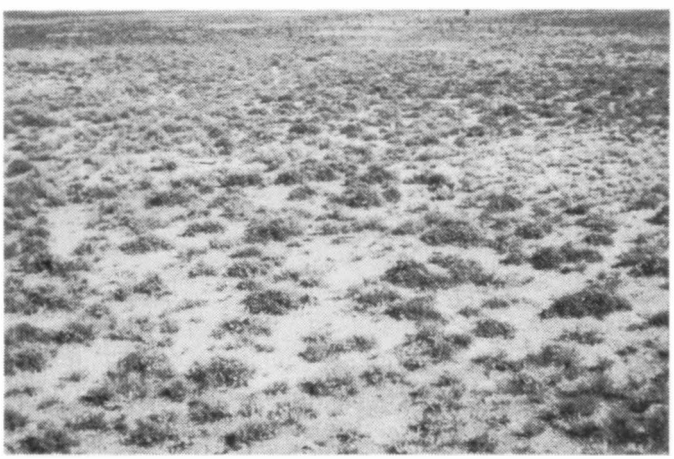
A scene outside. The lack of grass may make it seem that shrubs are doing well here; most shrubs inside the exclosure are hidden behind tall grass. Note these shrubs' poor condition.

This 2-acre BLM exclosure in Spring Valley near Majors, White Pine County, Nevada, hints at what ranching has done to much of the Great Basin. After 60 or 70 years of devastating livestock use, cattle and sheep were fenced off of this land in 1937. The subsequent 50 years of recovery is seen in these photos. The recovery is remarkable, but try to envision the aboriginal landscape.

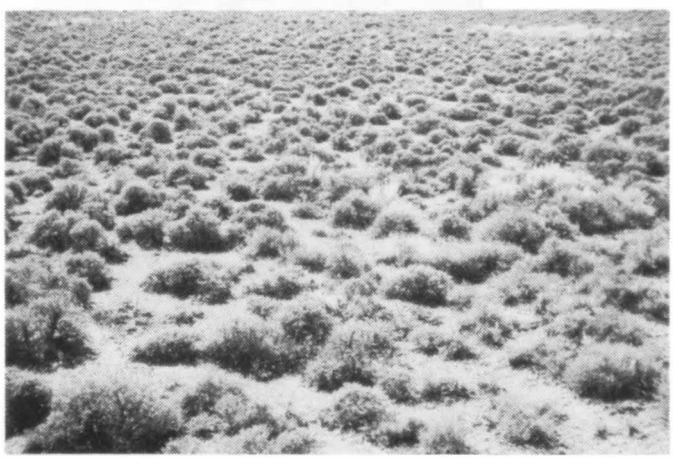








View from the Majors exclosure fenceline looking at grazed range. Nevada, 87% of which is federal land, is the overall driest and naturally most barren state in the continental US. Still, for more than a century more than 80% of it has been used by livestock. As a result, a large percentage of Nevada now looks something like this.

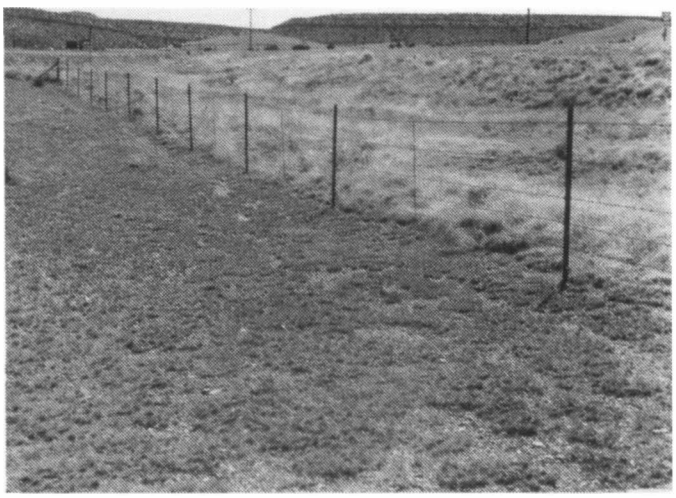


Much of Nevada would look more like this if similarly protected from livestock for 50 years. Clearly, the exclosure has at least twice the plant biomass per unit of area and much healthier plants than the grazed range. If all federal land in Nevada was protected from livestock, the state could support many times more wildlife. Nevada might not be considered a wasteland.

Following is a pictoral account of some representative fenceline contrasts:

Roadside on BLM range in central New Mexico.

Fenceline during recent drought, west-central California.



View of roadside from grazed range, central New Mexico

Northeast Nevada.

Roadside in the Santa Fe National Forest, New Mexico.

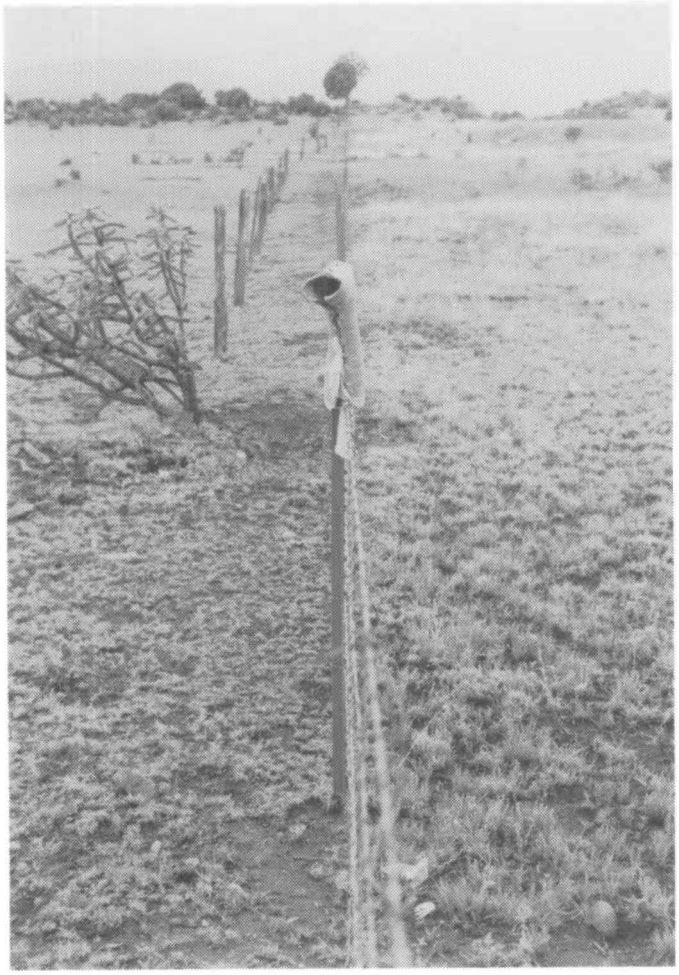
Standing on a fence, looking at the ground through a wide-angle lens, at 8000' elevation in the Bighorn National Forest in north-central Wyoming. The right side of the fence looked like the left side only several days before -- when sheep were brought in. Hundreds of acres in the immediate area were similarly devegetated.

Cibola National Forest in west-central New Mexico.

Navajo Reservation, Arizona.

BLM land, somewhere in Nevada. *(BLM)*

National Forest *(USFS)*

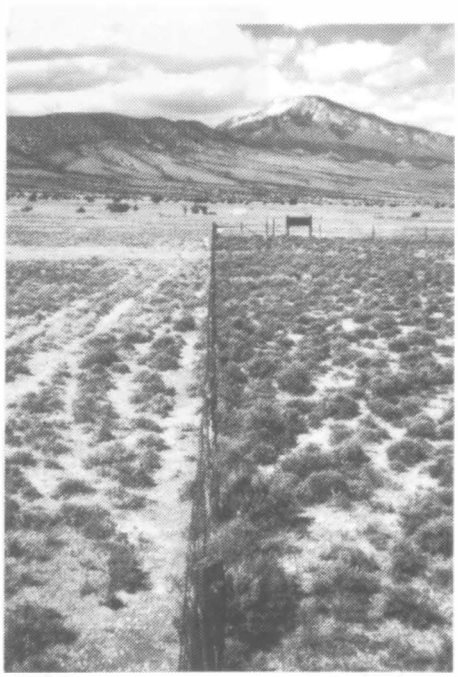


BLM highway right-of-way in northwest New Mexico. Note the obsolete fence.

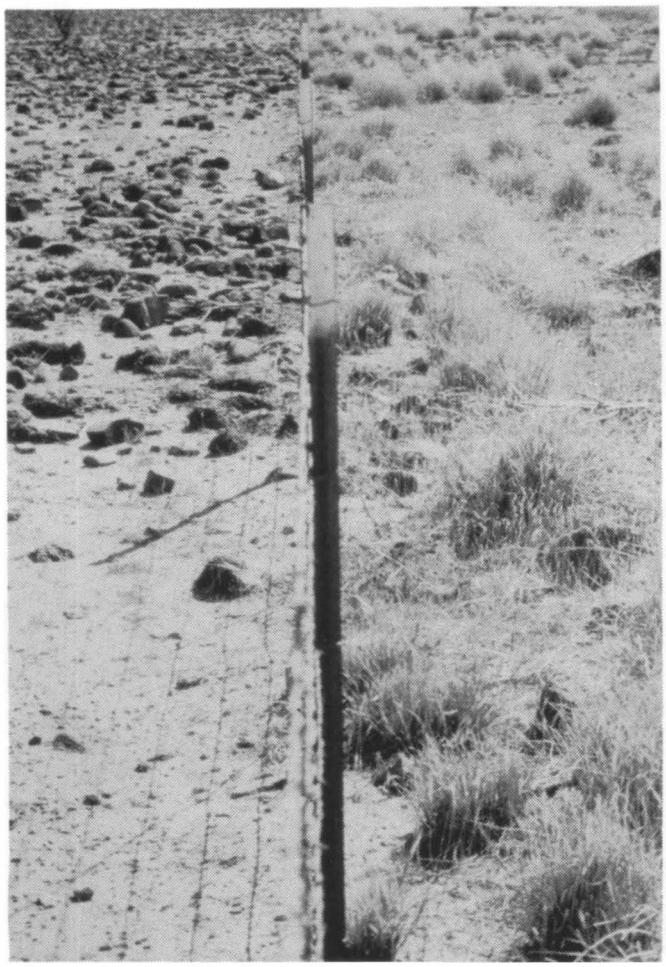
Ungrazed roadside at left. West-central New Mexico.

This side of the fence is grazed by cattle. Kern County, California.

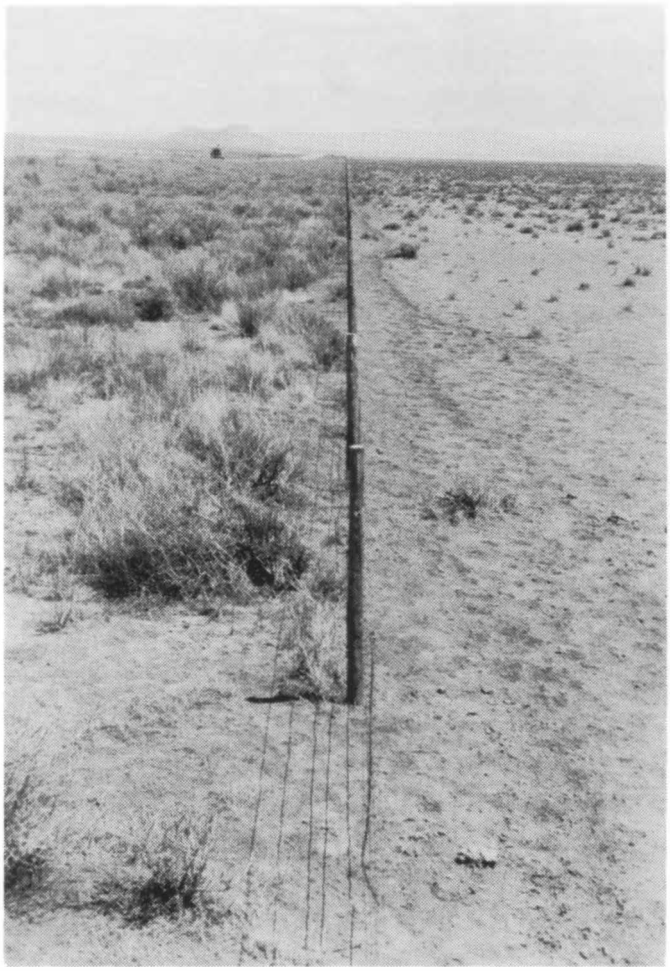
Socorro County, New Mexico.



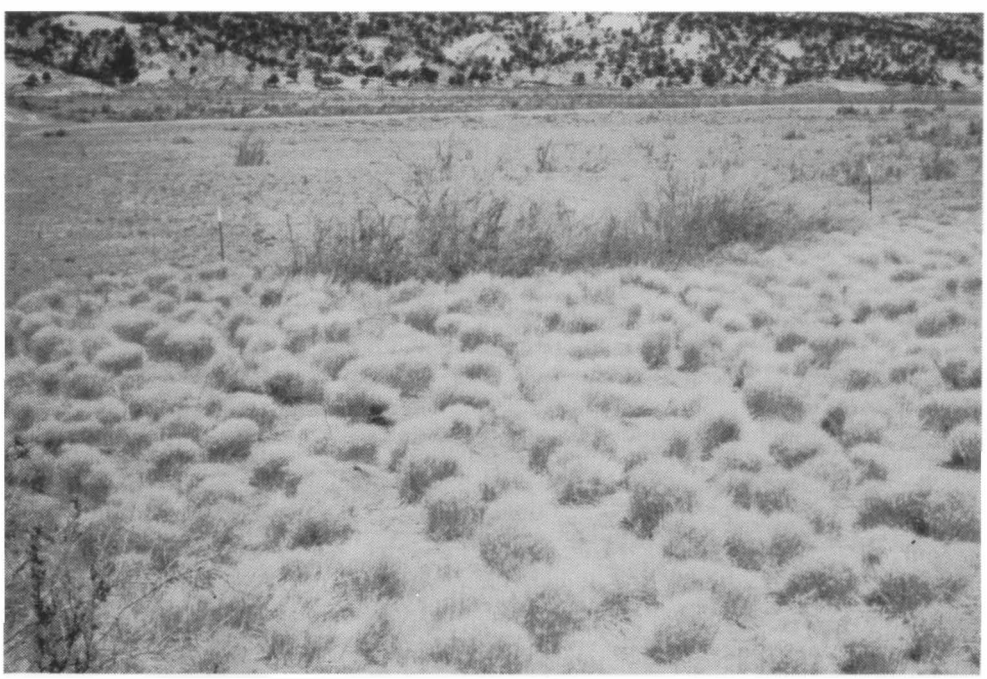
Central Nevada.



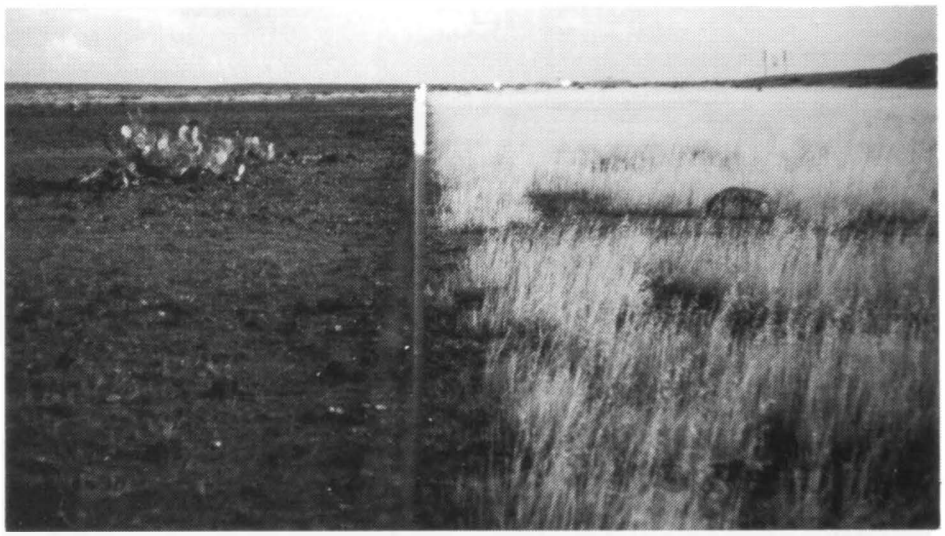
Freeway right-of-way in central Arizona.



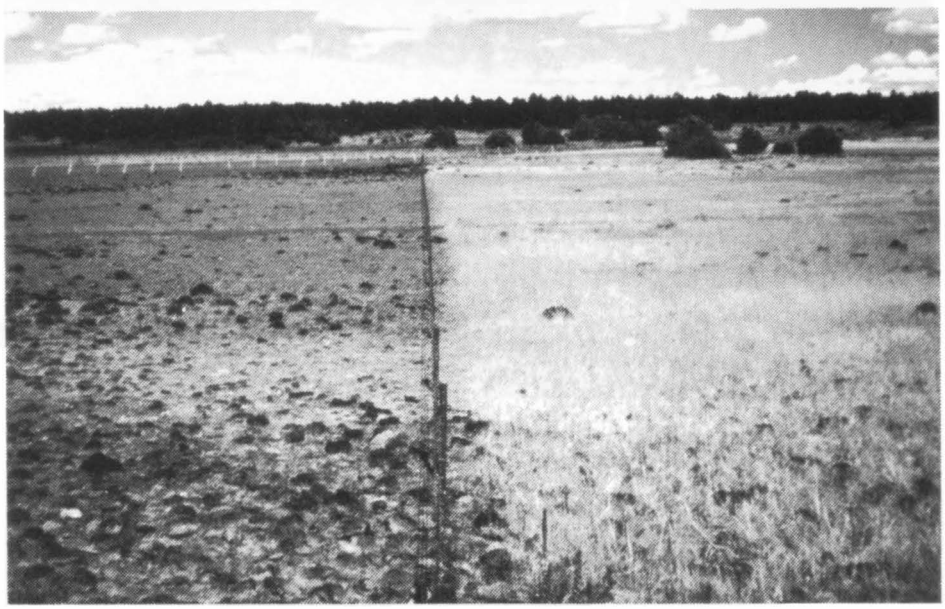
Roadside on central New Mexico BLM range. Hundreds of square miles of grazed land similar to that on the right surround this lonely highway.



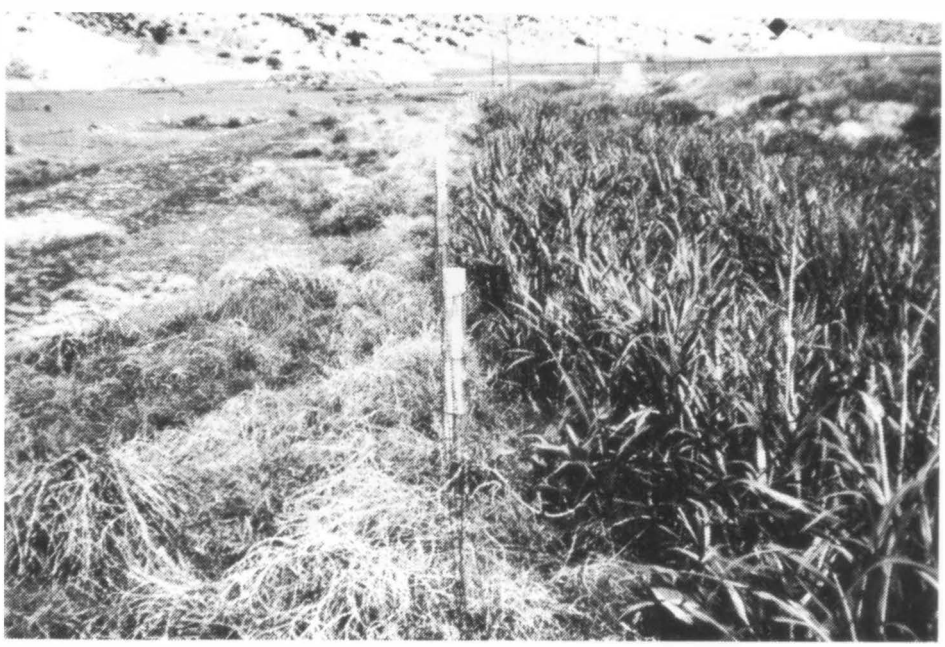
Healthy bunchgrass and brush end at the roaside fence.



Most livestock grazing in the West amounts to an annual clearcutting of ground-level vegetation. Freeway right-of-way, Yavapai County, Arizona.

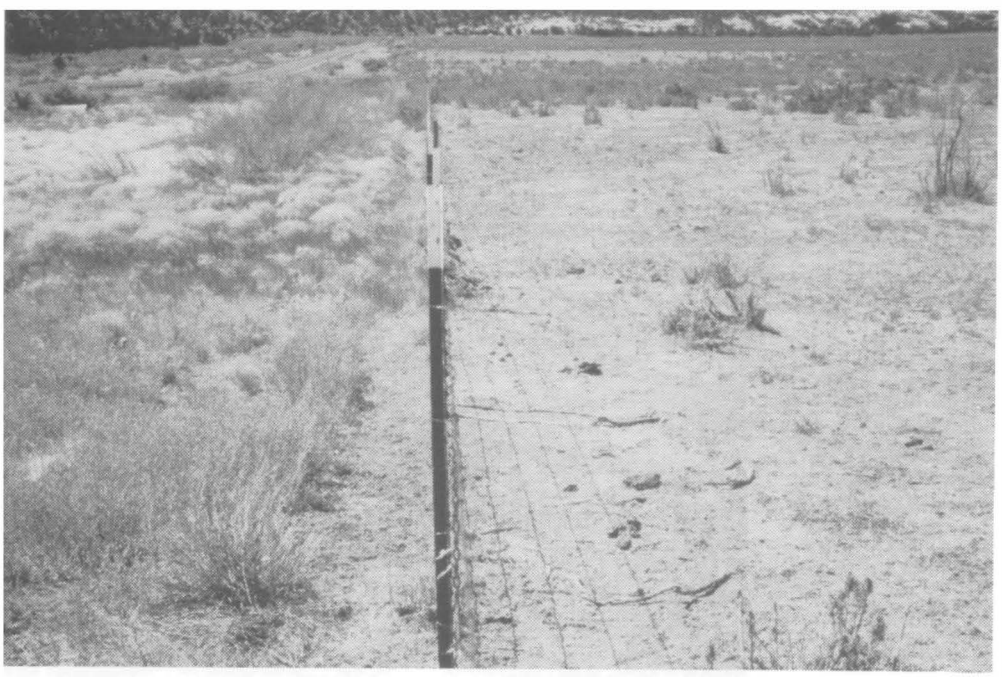


BLM land, Valencia County, New Mexico.

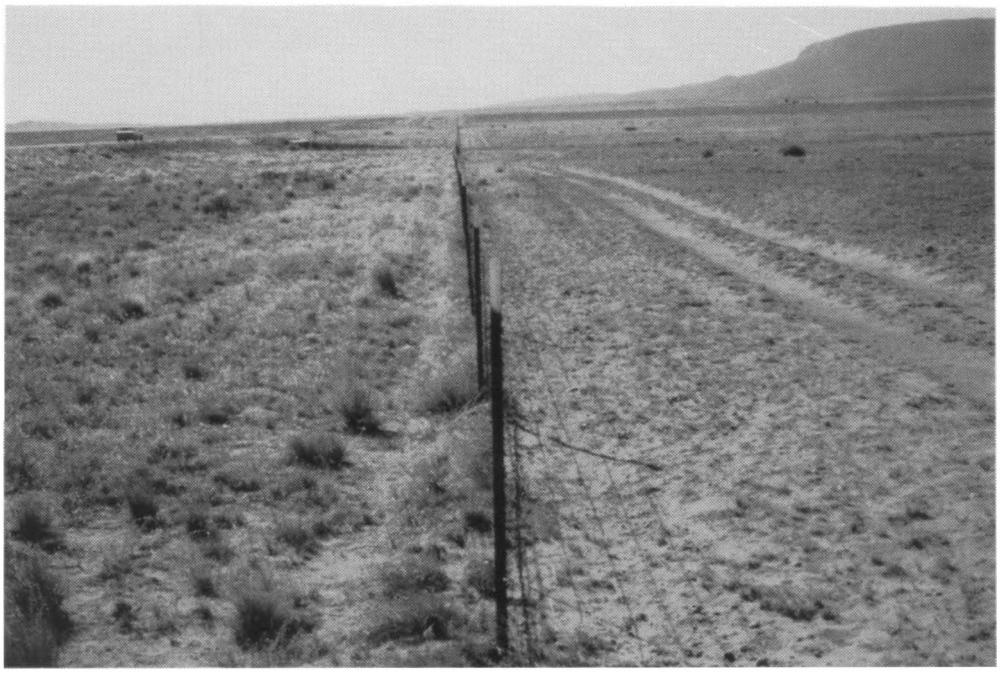


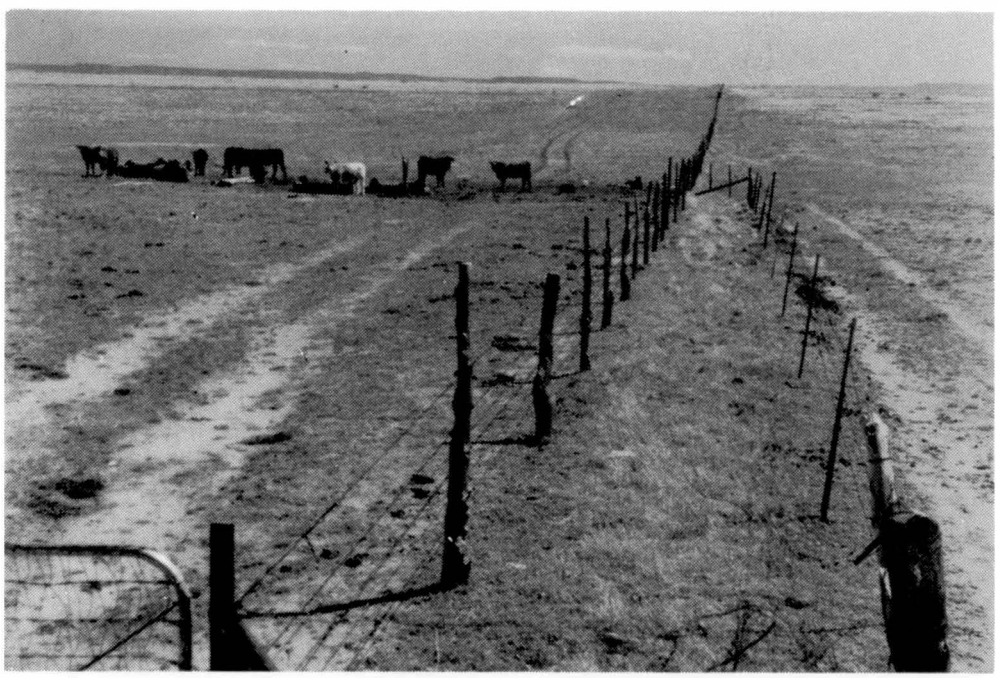
The fenced roadside on the right is a veritable jungle of Johnson grass and other vegetation. Tumbleweeds have piled up against the fence on the barren left side. BLM land, Grant County, New Mexico.

Highway fenceline, Pawnee National Grassland, northeast Colorado.



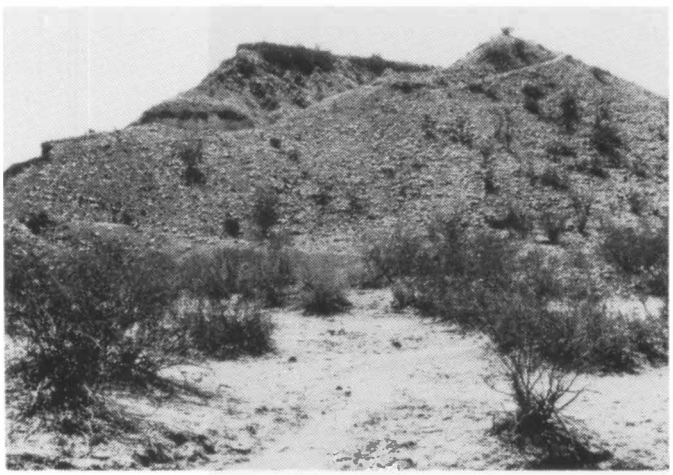
Utah highway right-of-way. Note where cattle have reached through the fence for forage.



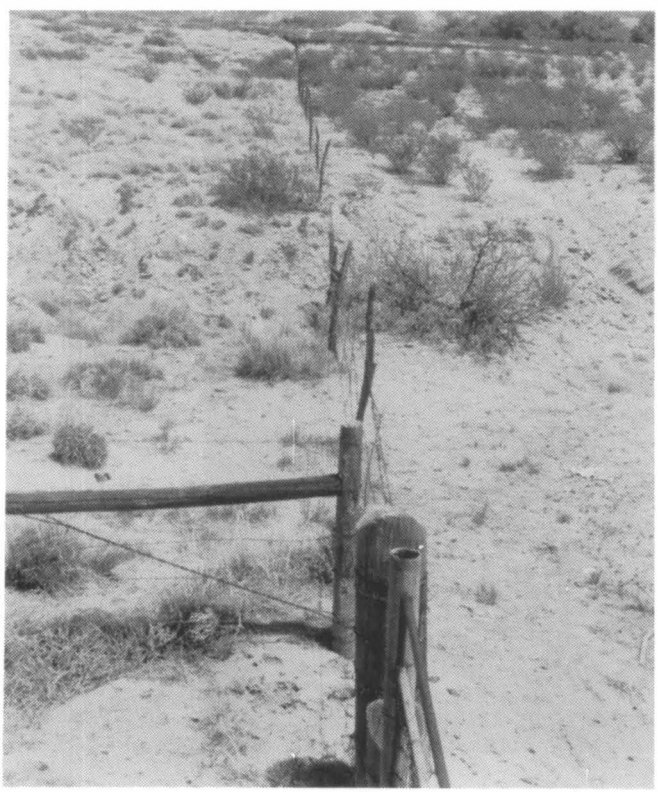


The narrow strip between the 2 fences has become a de facto exclosure. The wooden fence stretches for miles through similarly degraded terrain. The cattle are clustered around blocks of salt, an essential mineral.

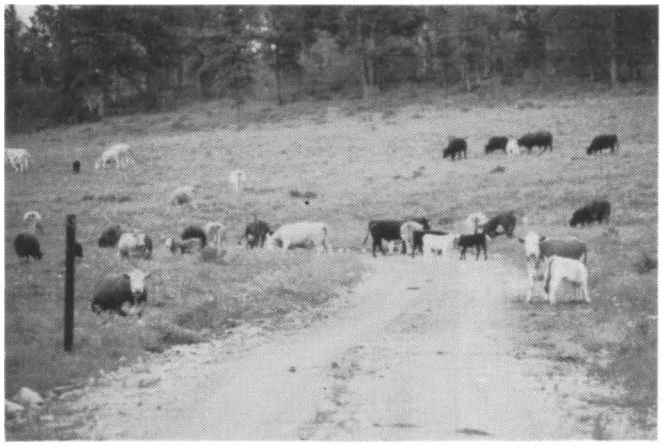
Livestock Grazing Photos



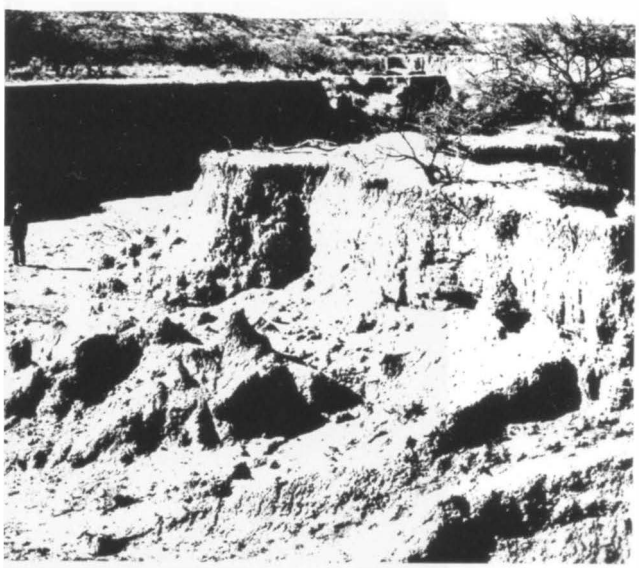
Livestock-grazed range in Big Bend National Park, Texas. Note the lack of ground cover, pedestaled plants, and severe erosion. Surviving plants are creosote. *(George Wuerthner)*



The right side of this fence was for decades more heavily grazed by cattle than the left side. As a result, creosote has mostly outcompeted the grass, shrubs, and other plants that survive on the left. In this case, creosote is an increaser. Such has been the case on millions of acres in the Southwest and California. Note the cattle trail on right.



Cattle and sheep grazing causes serious damage to much of the Bighorn National Forest in north-central Wyoming.

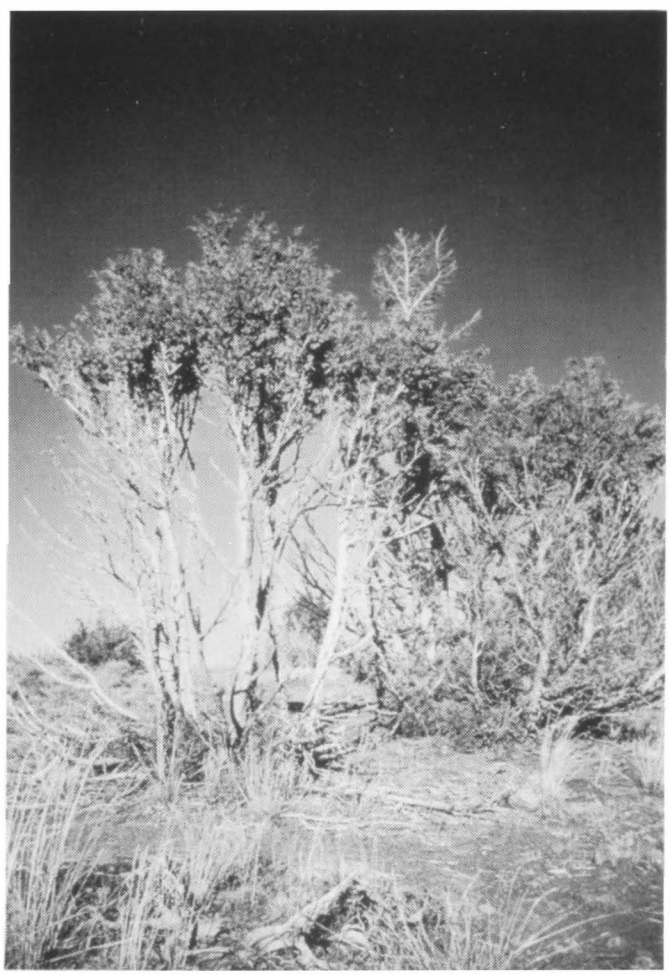


Cattle-caused arroyo-cutting near Tombstone in southeast Arizona. *(BLM)*

A beaten riparian area along the Rio Grande River in central New Mexico. Note the stunted willows, paucity of riparian vegetation, hoof ruts, cattle trail, and, of course, cattle.

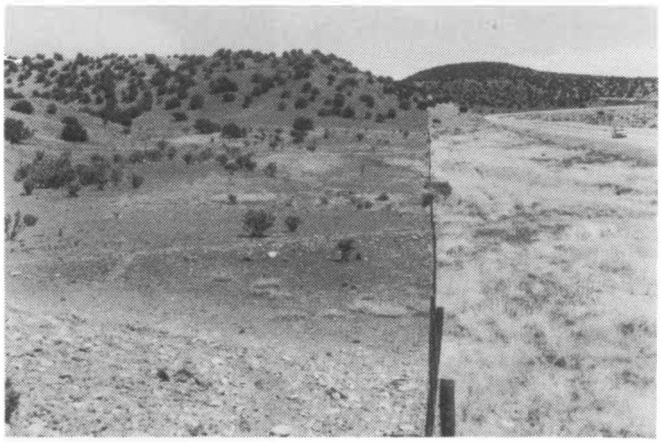
On steep, open slopes with plenty of forage, cattle tend to walk along contours as they graze, creating "terraces" such as these in central California.

A trampled-down bank and a cattle trail across a wash on BLM land in central New Mexico. Cattle prints mar the sand for miles up and down the wash.



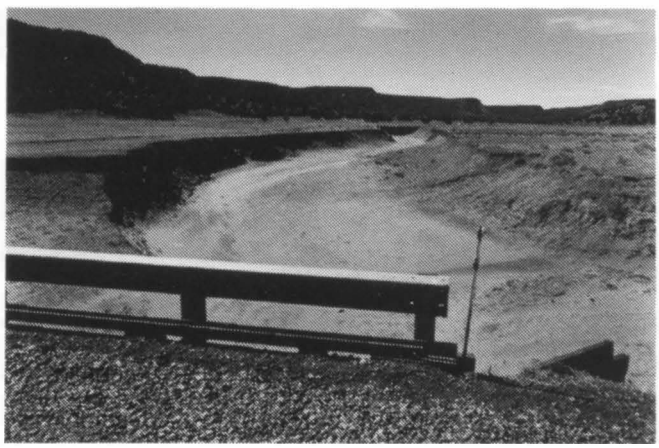
Cattle-ravaged riparian area. Note the poor condition of the trees. Banches have been broken off, trampled to pieces, and scattered. *(USFS)*

Cattle grazing near Saratoga, Wyoming. Note the lushly vegetated roadside. *(Harvey Duncan)*



Cattle grazing on left; fenced roadside on right. New Mexico BLM.

Close-up of a boggy area in northern Nevada -- devegetated, trampled, and polluted by cattle.

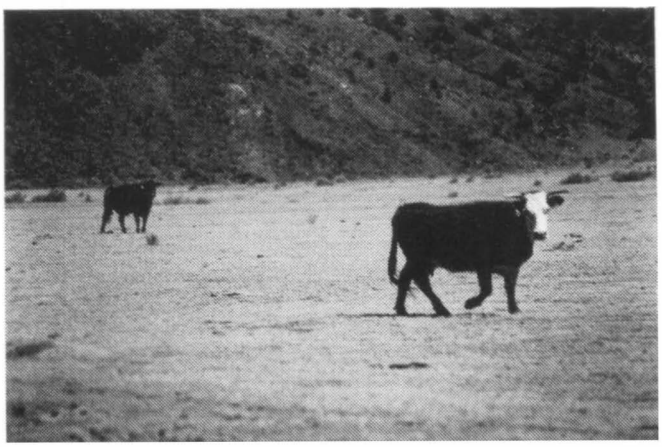


Cutbanks and denuded, trampled drainages succumb to flood-waters from depleted watersheds.

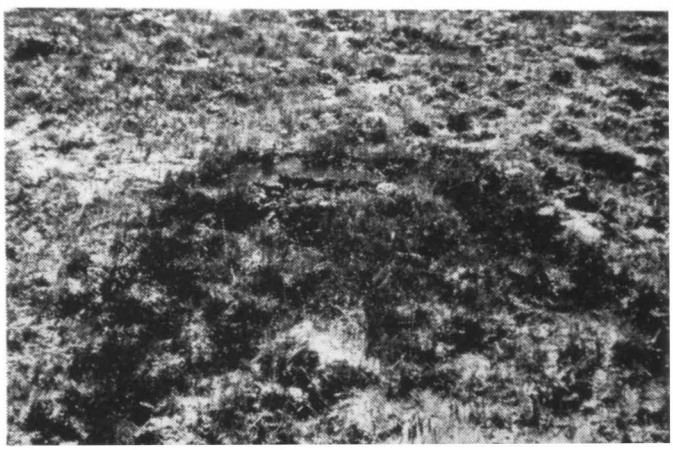
More than 1000 sheep degrade this fragile sub-alpine meadow. *(BLM)*

Gully erosion of old cattle trails has formed gulches. Central California.

Deforested range in Coconino National Forest, northern Arizona, beaten by cattle.



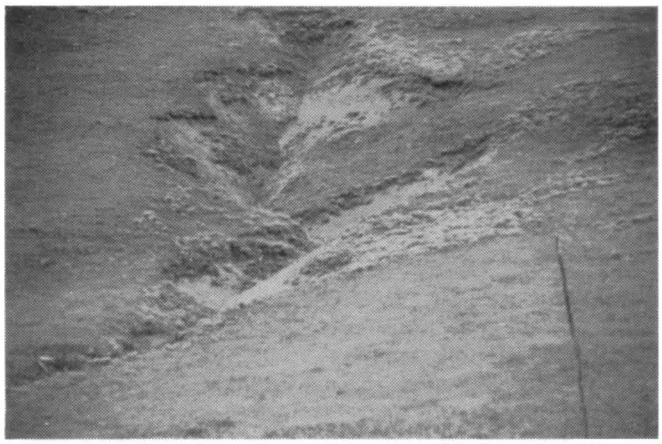
Livestock have converted tens of millions of acres in the West into virtual biological wasteland.



Cattle turned this once-beautiful warm spring into trampled mire. Nevada BLM.

Ash Springs, Chiricahua Mountains, Coronado National Forest, southeastern Arizona. *(Paul Hirt)*

Gully erosion in coarse sediment on cattle-beaten range.

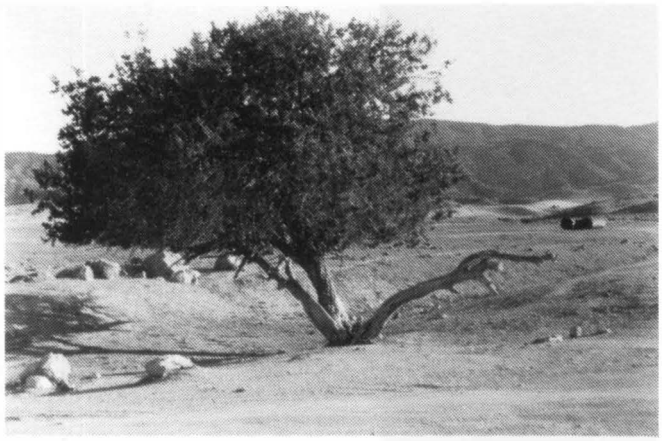


Cattle-beaten range in northern Wyoming mountains.

Gully erosion on barren California range.

Kern County, California.

Cattle and domestic horses degrade this BLM scene in the Owyhee Mountains, Idaho: an impoverished range; unstable and eroding streambanks; ravaged riparian vegetation, mostly liquidated long ago; turbid, polluted, depleted water; an obstructing fence; and utter lack of wildlife. Without livestock, this would be a verdant, dynamic ecosystem. *(George Wuerthner)*



Shade trees on open ranges become centers of activity -- thus destructive influence -- for cattle. The trees are damaged, stunted, and, finally, killed, and the nearby range is trashed..

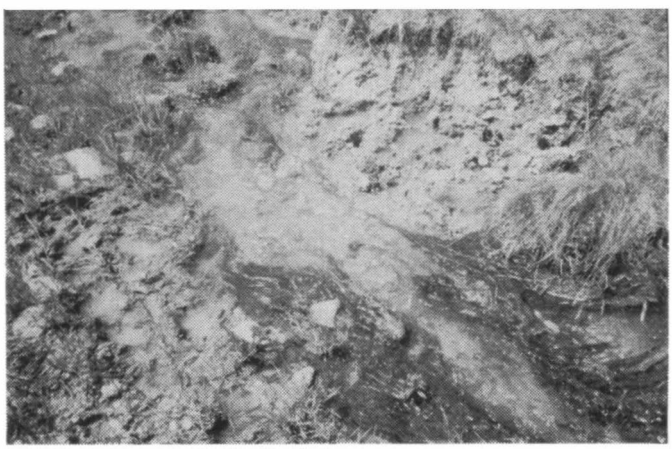
Cattle harm the unique and impressive salt lakes on the plains in the geographic center of New Mexico. Long lines of hoof prints mar their smooth, white surfaces, and (as here) fences jut out into their salty expanses.

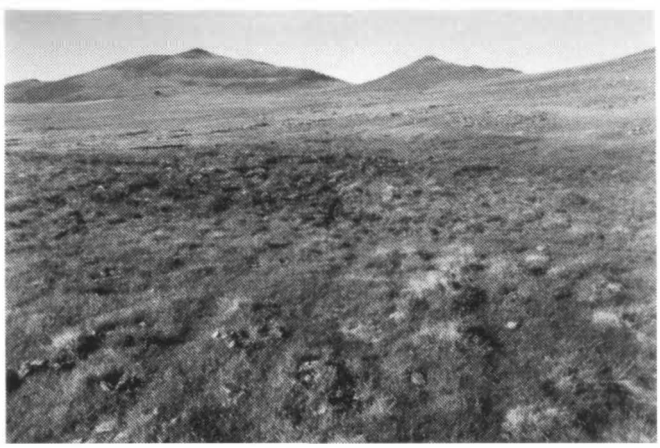
Kaibab National Forest, northern Arizona.

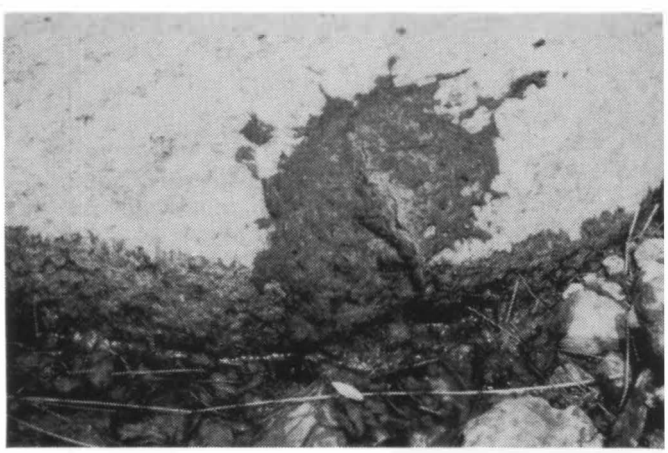
A roadside view in Southern California.

A dying riparian area in California. With continued livestock grazing, in several decades nothing will remain but a bare field. Note the cattle congregation area at upper right, fences, road, and denuded range.

Dying cottonwood on a dying range. Fallen branches are reduced to chaotic debris; organic litter is depleted; soil and roots are damaged. Note terracing on hill.

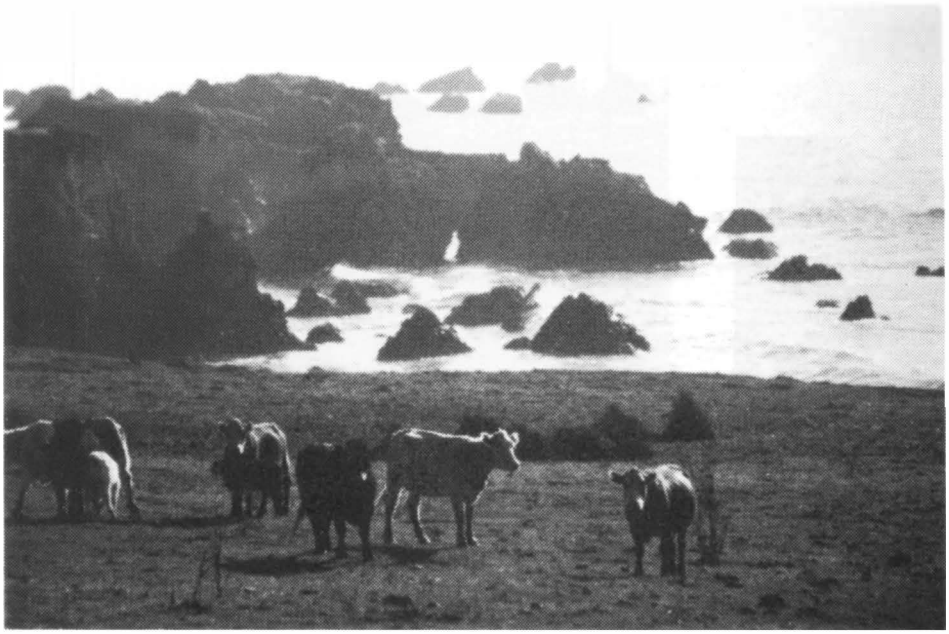






The top photo shows a mountain stream in Wyoming, trampled by cattle. The water is murky and algae-infested. Nearby, a cow splat covers a rock at stream's edge.

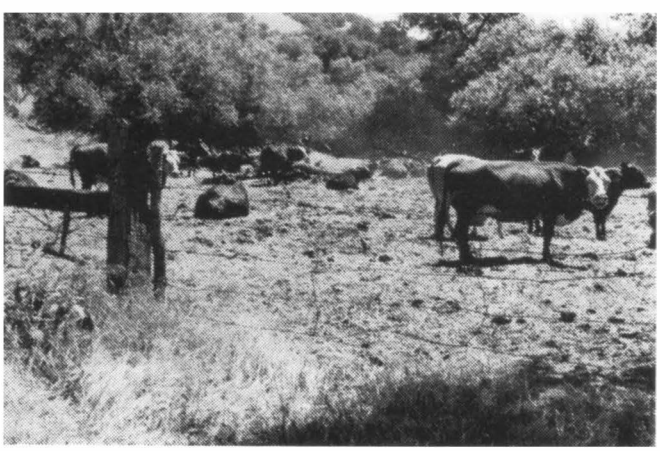
Top photo is of a cattle-trampled sub-alpine bog above 12,000' elevation in the White Mountains, Inyo National Forest, California. Bottom photo shows a nearby spring, fenced to protect the water from cattle for domestic use.

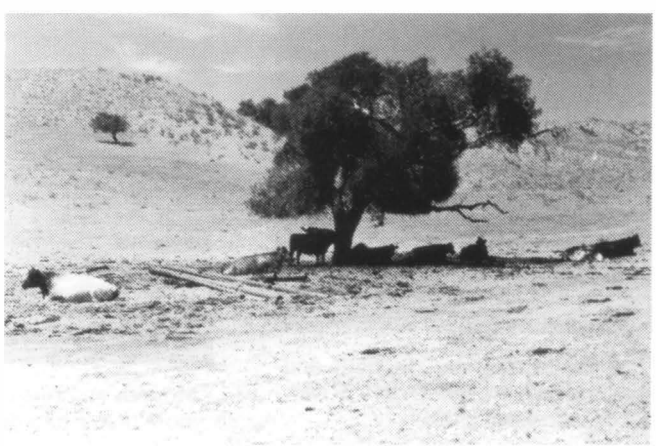


From sea to shining sea. . . .

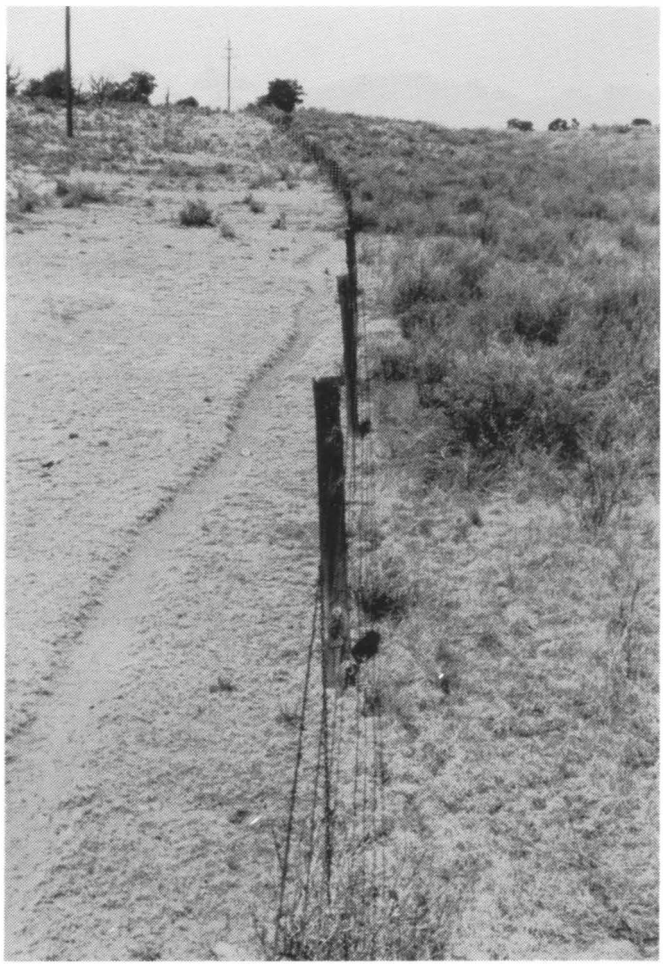
Los Padres National Forest. This cool, foggy, moist central California coast would, if not for livestock, be a paradise of green and gold.

A livestock-devastated landscape in central Utah.

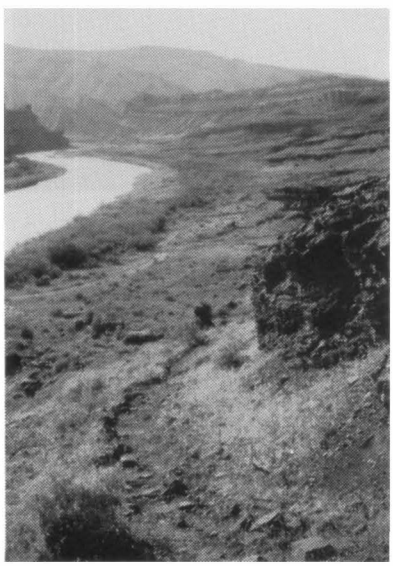




Gully erosion caused by livestock. BLM land, Mariposa County, California. *(USGS)*

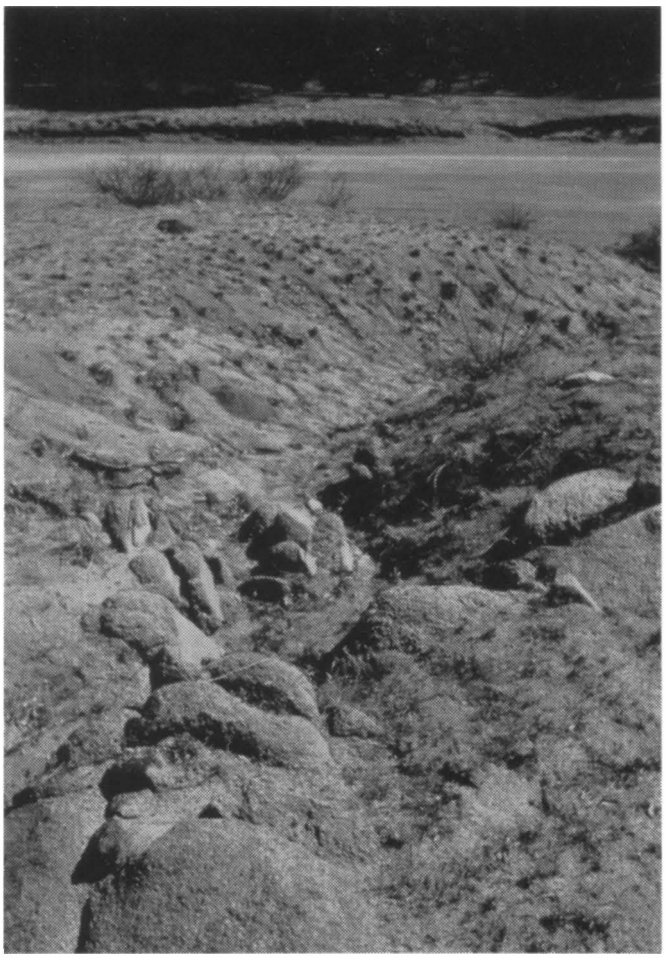


In many areas throughout the West, livestock reduce not only grass, but shrubs, herbaceous plants, and other vegetation types as well.



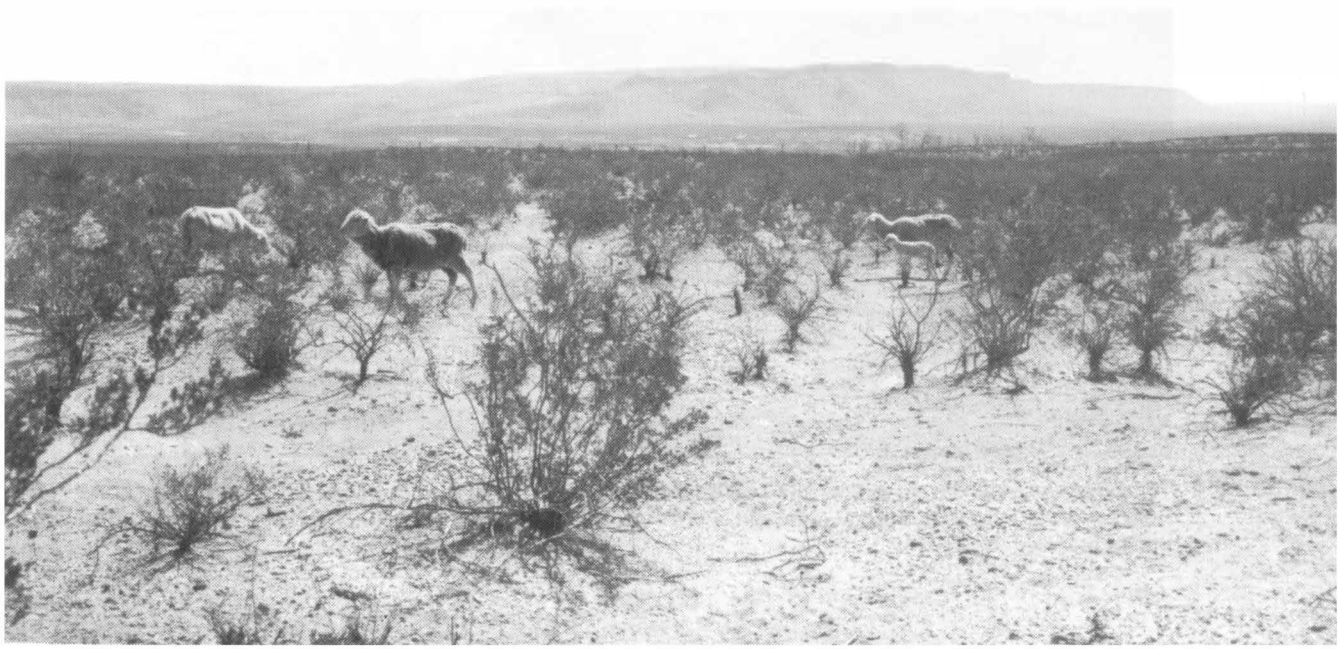
This cattle trail skirts a bluff and winds down to the Green River. BLM, northeast Utah.

Mounds and ruts created by cattle in a hot springs bog in Nevada. Some of the ruts are more than a foot deep.

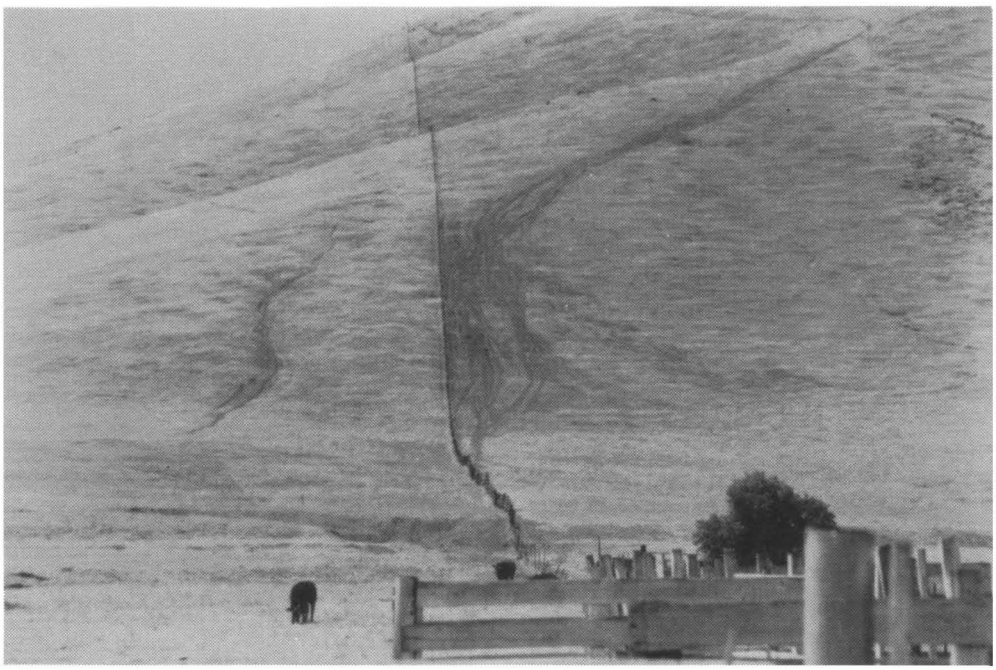


Cattle-caused erosion in the Coronado National Forest, southeast Arizona. *(George Wuerthner)*

Our public land in Wyoming; sheep.



Sheep on ragged creosote range in Texas. *(SCS, USDA)*



Cattle create eroded trails as they move between areas of food, water, salt, and shade. Note that there is a cattle trail even through the thick brush in the left half of the photo (the large trees there are used for shade).

No single activity or combination of activities
has contributed more
to the deterioration of plant and animal life
than the nibbling mouths and pounding hooves of livestock.

--Richard and Jacob Rabkin, **Nature in the West** (1981)