Savory

NURTURING OUR PLANET

ebook three | TOOLS TO MANAGE ECOSYSTEM PROCESSES

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TOOLS TO MANAGE ECOSYSTEM PROCESSES

CONTENTS

INTRODUCTION

The tools available for managing ecosystem processes fall into six broad categories (and two sub-categories), as shown in the diagram below. All tools—from stone-age spears to computers and genetic engineering—fall under one or another of the headings listed in the diagram. They include everything that gives humans the ability, which most organisms lack, to significantly alter our ecosystem in order to enhance or sustain our lives.

Human creativity and money and labor lie outside the brackets because both are required in the use of the other tools. Living organisms include among them two new tools of such importance that they are noted separately—animal impact and grazing. In the Holistic Management framework, there is a dotted line around the living organisms tools and another around the ecosystem process of community dynamics. The dotted lines are a reminder that the tool and the process are one. Living organisms define a biological community. You cannot change one without changing the other in some way.

Of the tools between the brackets, technology is the primary tool used in urban or industrial businesses and professions, as well as by most households. Few of these uses for technology are explicitly intended for the purposes of modifying our ecosystem, though they often do. It is important, even for individuals who are not managing land to understand the impact their use of technology can have on ecosystem processes.

In any land management situation, fire, rest, and technology are the most commonly used tools for modifying our ecosystem. But often these tools cannot reverse the desertification occurring in many brittle environments. As you will see later, the two new tools of animal impact and grazing can help reverse the spread of deserts in environments at the brittle end of the scale, which encompasses the majority of the earth's land surface. And at the nonbrittle end of the scale they can be used to prevent grassland communities advancing to forest.

Engineers, sociologists, economists, environmentalists, politicians, land managers, and others are beginning to reconsider the tools traditionally available to them. This is particularly true as they begin to work together with others outside their professions to solve the complex problems of today. This can be seen at the local level with the expansion of watershed and collaborative groups, and nationally and internationally at the policy level.

When managing holistically, tools are neither good nor bad, and no judgments on the use of any tool or any action should be made outside the context of the whole under management. You must consider your holistic context and the degree of brittleness of the environment you are managing, along with a number of other factors before you can judge whether or not a particular tool is suitable or unsuitable in a given situation at a given time. The way a tool is used can make as much of a difference as whether its use is appropriate. Over the next few sections, we will explore the various tools inside the brackets—technology, fire, rest, and living organisms (including grazing and animal impact). First, let's talk about those outside the brackets—human creativity, money, and labor.

TOOLS TO MANAGE THE ECOSYSTEM PROCESSES

Human Creativity [Technology Fire Rest Living Organisms
- *Animal Impact*
- *Grazing*] Money and Labor

HUMAN CREATIVITY: KEY TO USING ALL TOOLS EFFECTIVELY

An idea that enables one person to attain maximum effect from his or her labor and money may not work for another person, and in fact may not work for the same person under different circumstances. A small family farm, for example, can be as unique as your fingerprint—not the same as any other small farm any place else.

However, unlike your fingerprint, which essentially remains the same throughout your lifetime, that small farm changes continually: the people change, the economy within which they operate changes, and the land itself changes. Thus, every situation requires management that must be an original product of human imagination and even that must evolve as the situation changes.

Human creativity is thus an essential and often minimally used element of our decision making. Those managers who have a clear understanding of the principles and practices of Holistic Management have been highly creative in producing the results they want. That is why so many of them are successful and being honored for the work they do. They would be the first to tell you that they were not always that way—Holistic Management helped them learn to consider all the tools at their disposal.

The Holistic Management 'context checks' (see ebook #5) were developed to help you assess the potential impacts—good or bad, relative to your holistic context—of using any available tool. This is not a task for a computer, or any other technology, for that matter. Evaluating the hopes, fears, and inter- and intrapersonal issues in any whole under management requires the type of human creativity that no computer yet developed can reproduce.

Holistic Management itself serves as merely a bit of 'software' to help you organize your thinking and planning. Your ability to think creatively as you incorporate its principles is what makes for successful application. Creativity is not simply a genetic endowment—it depends on your mental, emotional, and physical health, your environment, and most of all on how deeply you desire the quality of life described in your holistic context. Human creativity is the key to using money, labor, and all the other management tools effectively. It is the only tool that can produce the vision and goals you aspire to and that can be used to plan their achievement.

MONEY AND LABOR: ONE OR BOTH IS ALWAYS REQUIRED

At one point in time people supported themselves by applying creativity and labor directly to the raw resources of our ecosystem. Many societies still do this as do many farm and ranch families not actually paying for the labor of family members. Both then and now we used our creativity to obtain the maximum effect with as little labor as possible.

Because money and labor are often linked—e.g., cash can be exchanged for labor—and because neither can be used to influence our environment other than through another tool, Holistic Management groups them together. Money is often equated with wealth, and once upon a time that was true in that money was merely a token representing goods and services. But the development of credit, the centralized creation of money, interest, and particularly compound interest, gradually destroyed that relationship. Wealth, of course, can be defined even more broadly than money—the natural resources available to us, the homes that shelter us, or the closeness of our ties to one another.

Nevertheless, money is the oil that has kept the wheels of society turning and it remains a useful, if not essential, tool. It can be used more wisely, and sustainably, if you think in terms of the sources of wealth today's money, or dollar, represents.

MINERAL, PAPER, AND SOLAR DOLLARS

Money derived from a combination of human creativity, labor, and natural resources that are mined, used once, or sometimes recycled we term *mineral dollars*. Coal, oil, gas, gold, and other minerals fall into this category, hence the name. Other natural resources can fall into this category, although they should not. Soils that are mined until exhausted or eroded away would be generating mineral dollars.

The second form of money, *paper dollars*, is derived from human creativity and labor alone and consumes no other resources. All we have to do is apply our creativity in thousands of different ways to the many avenues open for investment: speculation in futures markets, stocks, bonds, corporate takeovers, and so on. On the other hand, various services—many of them essential—also fall into this category, including legal, accounting and security services. This form of money is backed by nothing deeper or more solid than the public's confidence in the economy and/or the government and as a result its value can fluctuate greatly due to changes in interest rates, stock prices, land values, inflation, and currency exchange rates.

Third, we can generate income from human creativity, labor, and such constant sources of energy as geothermal heat, wind, tides, wave action, falling water, and, most of all, the sun. We call this class of money *solar dollars*. A characteristic of wealth derived from this combination is that it tends not to damage our life support system or to endanger humankind as far as we know. It is also the only kind of wealth that can actually feed people. Unfortunately, this requires the conversion of solar energy through plants that themselves depend on water and biologically active soils. *Only when plants grow on regenerating soils would the money earned from timber, crop, or forage qualify as solar dollars.*

In practice . . .

Ranchers and farmers are better off measuring their success in solar dollars rather than relying on the paper ones. The more you can generate and rely on solar dollars, the more you insulate yourself from swings in land and commodity prices, interest rates, and the like. All borrowing, especially if it is based on the current real estate market, involves paper dollars to some extent, so obviously your position is more stable and reliable if you can finance your plans out of solar dollars generated by your operation.

TECHNOLOGY: FROM STONE-AGE SPEARS TO GENETIC ENGINEERING

Technology encompasses an enormous variety of human inventions—from computers to farm machinery to global positioning satellite systems, and genetic engineering. The use or overuse of some technology, in the interest of short-term solutions, often leads toward long-term challenges and adverse impacts we may not have anticipated.

TECHNOLOGY AND THE QUICK FIX

Much technology developed out of our desire to dominate nature, a desire that goes back a long way. In resource management, agriculture, health care, and many other fields, all but a few professionals define their work in terms of their technological tools. They rarely consider the broader principles that govern our ecosystem. It is not surprising then that so many of us devote our energy to quick, unnatural answers, and often achieve immediate, dramatic, and profitable results. Yet, such quick fixes can prove very costly in the long term. Nowhere is this more apparent than when we use technology to bolster production on deteriorating land, or to drastically modify an environment to better suit our purposes.

Consider the following examples:

> Suppose we want to change the successional level of a community. On unproductive rangeland, machines or herbicides will clear the brush and scrub, and we can drill in seed. Where a mixed forest makes logging inconvenient, we can remove the native trees and plant uniform stands of faster growing species that permit mass processing. When our chosen plants falter, we can kill their enemies and fertilize their soil. All these actions conflict with how nature functions. Successful as they appear, in the end they often fail, while generating new, more severe problems. When water cycles become less effective, we can use machines to scour out contour ridges to slow, spread or harvest runoff rainfall, and ditches to drain waterlogged soils, deep rippers to reverse the compaction caused by heavy wheels, and irrigation pumps to put water back where it came from. In doing so we show little understanding of how water cycles function and our immediate successes often result in long-term failure.

> When mineral cycling is poor, we might turn to a fertilizer salesman who can supply anything our land lacks and change the soil pH to suit any crop. But the treatments need repeating in ever-stronger doses, and the mineral cycle does not improve. In fact, it is often damaged.

> We want more energy flowing into cash crops, so we look to jungles, marshes, and forests, believing that we can cut, burn, drain, irrigate, spray, or bulldoze them into any form we imagine to achieve that end.

Forms of technology often used by the land manager

Technology, along with fire, rest, and living organisms, is never in and of itself bad; but as with all tools it must be used with great care. You must check to make sure it is aligned with your holistic context (see ebook #5) and leads to the achievement of your goals in the most socially, financially and ecologically sound way.

FIRE: AN ANCIENT TOOL TIED TO ANCIENT BELIEFS

Fire has existed in nature for millions of years, but its use as a tool for intentionally modifying our ecosystem is relatively new—perhaps a million years. The effects of fire will vary greatly depending on numerous factors including the amount and frequency of precipitation following the fire, how frequently an area is burned, the intensity of the burn, what other tools are used along with fire, and the brittleness of the environment.

In North America, Africa and Australia, the earliest people used fire a great deal, transforming whole landscapes in the process. The decimation of large animal populations, only exacerbated this situation. It was quite possibly the combination of factors—fire, grazing animals, and predator-produced animal movement—that created the lush and diverse grasslands found by early European settlers on the American prairie. Today, large areas of Africa, Australia, and North America are dominated by vegetation that is fire-dependent. Scientists cite evidence that this is likely due to frequent burning by humans, which caused fire-sensitive species to disappear.

THE IMPACT OF FIRE ON BIOLOGICAL COMMUNITIES

When deciding whether or not to use fire in any year, you need to understand what it does and does not do, and how it affects biological communities. Those effects will vary depending on how brittle the environment is and how high or low the rainfall.

Fire is used far less as a management tool in nonbrittle and less brittle environments simply because the higher year-round humidity inhibits fire, and it is more difficult to get vegetation to catch and stay alight. When fire is used in these environments they recover more quickly from its adverse effects than do brittle environments. For this reason, the focus in this ebook is on brittle environments.

The Impact of Fire on Soil Surfaces

In all environments, fire tends to destroy litter and expose soil surfaces. Especially in low-rainfall, brittle environments, the soil may remain bare for many years. As you recall from earlier discussion, the condition of the soil surface is key to the functioning of all four ecosystem processes, and uncovered soil is what we are striving to eliminate in any environment. Bare ground becomes obvious right after a fire and remains until new growth appears to hide it. More critical, however, is the time it takes to build up the litter between plants. That depends on such things as the brittleness of the environment, the amount and pattern of rainfall, the amount of grazing or overgrazing by livestock or wildlife concentrating on the burned area (as they tend to do), and the degree and timing of animal impact.

Fire appears to have the most lasting impact where soil cover takes longest to form, the lower rainfall, very brittle environments. The lower rainfall produces less vegetation that might restore cover, but the fact that bare soil makes rain *less effective* compounds that effect because the entire biological community is only operating on a portion of the rainfall received, the rest being lost to both surface evaporation and runoff (refer back to the discussion of the water cycle in ebook #2).

If the land is left undisturbed following a fire, soil cover accumulates even more slowly. The guidelines for burning detailed in *Holistic Management* (chapter 36) discuss using other disturbances with fire instead of the total rest so commonly recommended.

The Impact of Fire on Plant Communities

Fire affects plants in different ways. Some sensitive perennial grasses disappear if burned. In brittle environments the majority of perennial grasses initially thrive when burned. This is in part because burning removes the old material that when allowed to accumulate prematurely kills grasses. Some plants thrive on periodic fire, having seeds adapted for establishing after a fire. A number of grass seeds have awns or tails that actually twist and drill the seed into exposed soil when they become moist, suggesting an association with fire, which exposes soil.

Woody plants also respond to fire in different ways. Some are extremely sensitive, others resilient. Most of the trees and shrubs considered problem species are resilient when burned. Though they may appear dead immediately afterward, they soon resprout more stems than before. Many tree species are damaged by fire, yet some can still survive in the shrub form where burning is prolific.

If fire is not followed by well thought-out soil disturbance, major changes within a community can occur because fire tends to create bare ground that favors the few plant and animal species adapted to it. In a community where some mature organisms survive the fire, the new species that establish on the bare soil may initially increase diversity. Frequent repetition of the burning, however, will provide a largely similar microenvironment over large areas for so long that complexity diminishes. A uniform microenvironment leads to fewer species in general, and often a near monoculture and low stability. Where a periodic fire can result, at least initially, in greater diversity, repeated frequent fires alone tend to do just the opposite.

The Impact of Fire on Animals

Animals, like plants, also vary greatly in their response to fire. And like plants, the mature members of a population may thrive in the short term, but the population as a whole may suffer in the long term. Many animals do not escape easily. Many others do. Some are attracted to a fire because they can easily feed on insects and other small creatures fleeing the fire. It is a myth to think that larger game animals always panic and flee from fire. Though people may drive them to panic with flames and noise, left alone and undisturbed they usually just get out of the way calmly. Some animals appear to seek out burned areas very soon after a fire, especially when new green growth appears. Through its influence on soils and vegetation, fire, especially when used frequently, has profound effects on animals too complex to cover here.

FIRE AND THE BRITTLENESS SCALE

Very brittle		Nonbrittle
Generally reduces the effectiveness of the water cycle; exposes soil and destroys litter. The lower the rainfall the greater the impact.	◄ WATER CYCLE ►	Tends to damage water cycle by exposing soil; effect is temporary due to better annual distribution of humidity and more rapid succession on bare surfaces.
Speeds the mineral cycle in the short term, converting dead material to ash; but it exposes soil.	◄ MINERAL CYCLE ►	Appears to speed up cycling of nutrients, although the effect is temporary.
In short term, increase diversity of species; repeated fires reduce diversity.	◄ COMMUNITY DYNAMICS ►	In short term, increase diversity of species; repeated fires reduce diversity.
Initially increases energy flow; in the long term, it reduces energy flow due to increased soil exposure leading to less effective water and mineral cycles.	◄ ENERGY FLOW ►	Disrupts the energy flow in the short term, but it recovers quickly; frequent fires tend to damage all four ecosystem processes.

This summary assumes that the fire is followed by a period of rest, which is standard practice.

THE IMPACT OF FIRE ON THE ATMOSPHERE

Perhaps the greatest impact of fire is on our atmosphere—directly through pollution, and indirectly through soil damage. Biomass burning produces excessive amounts of ozone, carbon monoxide and methane that soils damaged by fire can no longer store as effectively. Thus fires (biomass burning) are a significant contributor to climate change.

As with all tools, the decision of whether or not to use the tool of fire should be checked to make sure it is aligned with your holistic context. It is important to have clarity on the future landscape you envision and how fire tends to affect that landscape depending on where it lies on the brittleness scale and how often you use it. If other tools can accomplish the same objective without exposing soil or polluting the atmosphere, then you might be wise to use them instead.

REST: THE MOST MISUNDERSTOOD TOOL

High rainfall brittle environment in Zimbabwe. Without grazing animals, the land would deteriorate.

Disturbance comes in many forms. Rest as a tool to modify ecosystem processes refers to the rest from disturbance—fire, physical disturbance by animals, or technology. Large animals—domestic and wild, particularly those that exhibit herding behavior—impact both soils and vegetation. So do machinery and fire. A policy or practice of withholding all of these forms of disturbance completely for considerable time amounts to applying the tool of total rest. Partial rest is applied in the presence of livestock or wild grazers, but with such calm behavior in the absence of pack-hunting predators that a large proportion of the plant life and soil surface remains undisturbed despite their presence and grazing. Rest, in either form, can be good or bad, depending where the land lies on the brittleness scale, as you will see.

Partial rest is a relatively new concept that many find hard to grasp. How can the land be resting while high numbers of livestock or game are grazing on it? Its effects, however, vary little from the effects of total rest and are evident anywhere livestock or wildlife are spread out and seldom bunch together. The more scattered they are, the greater the degree of partial rest.

Using rest in either form (total or partial) as a tool, is a more recent idea than either fire or technology; it dates back approximately 10,000 years to when cattle, sheep and goats were first domesticated. But it is only in the last few decades that we have understood that the effects of rest vary greatly in brittle and non-brittle environments. In nonbrittle environments, rest is perhaps the most powerful tool there is for restoring biological diversity to degraded lands. But in brittle environments, which evolved with large herding herbivores and pack-hunting predators, rest tends to have the opposite effect, leading to a loss of biodiversity. Because this difference in response based on brittleness has largely gone unrecognized, we have hastened the advance of deserts in the world's brittle environments.

EFFECTS OF REST IN NONBRITTLE ENVIRONMENTS

Sheep grazing in a nonbrittle environment. If the tool of rest were applied, the grassland would revert to forest.

In nonbrittle environments (1 to 3 on a scale of 1 to 10), old plant material by definition breaks down quickly through biological decay. Decomposition starts close to the ground, where large populations of insects and microorganisms assist in the decay process. This close-to-the-ground decomposition particularly suits perennial grasses, because dead leaves and stems weaken at the base and fall aside, letting light reach the new, ground-level growing points. This rapid, bottom-up decomposition on dead woody vegetation as well as grasses allows nonbrittle biological communities under total or partial rest to maintain a high degree of stability and species complexity in grassland or forest.

Even very prolonged rest from the rare fire or physical disturbance has little or no adverse effect on the water and mineral cycles, community dynamics, and energy flow.

LEAVING IT TO NATURE

Some say it is better to leave the management of biological communities to nature because nature knows how to manage them better than we do. Left to nature, most communities would eventually regenerate. In less brittle environments that might happen fairly quickly because rest from human activity, including livestock grazing, is a powerful tool for restoring biodiversity. In the more brittle environments, which cover most of the earth's land surface, the time scale for regeneration would be long, possibly a geological one. These lands will not recover within our lifetimes unless we restore the ecological processes through the use of animals that can simulate the effects produced by the herds and predators that once made these environments functioning wholes.

If your holistic context describes a future resource base that includes stable grasslands and you suspect that natural succession will lead it toward forest, then you need to avoid either form of rest (partial or total) to keep succession from advancing to forest. Properly managed grazing would help maintain a vigorous grass root system that makes it difficult for tap-rooted, woody plants to establish. You could also use the tools of fire or technology (mowing, for example) as a means to promote vigorous root growth. All of this works so well in nonbrittle environments that it masks the fact that it often does not work in brittle ones. In totally rested nonbrittle environments, it is virtually impossible to expose vast areas of soil and keep them bare. The soil surface will cover over again quickly if totally rested because the consistently high humidity promotes plant growth.

EFFECTS OF REST IN BRITTLE ENVIRONMENTS

Dying, overrested plant in a brittle environment

In very brittle environments (8 to 10 on a scale of 1 to 10), by definition, old plant material breaks down slowly and succession also progresses slowly, particularly when starting from bare soil. Most organisms of decay, especially in communities that have lost biodiversity, are present in high numbers only intermittently when moisture is adequate.

Under total or partial rest conditions, if animal numbers are also low, most of the breakdown of plant materials is through oxidation and physical weathering. The tips of leaves and stems break down first, as they are most exposed to the weather, be it wind, rain, heavy snows, or hail.

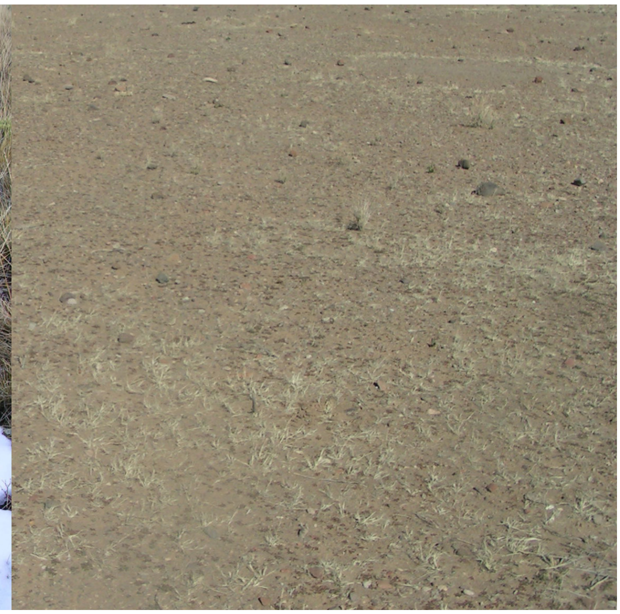
While this top-down breakdown has few negative effects on woody plants, it severely hinders perennial grasses with ground level growth points that often remain shaded and obstructed for years. Old plant material that lingers through the next growing season weakens most perennial grasses and over a period of several years the accumulation can actually kill them. It also negatively affects the diets and productivity of grazing animals that try to balance their diets and avoid old, oxidizing plant material.

Some perennial grasses can withstand long periods of rest. These grasses usually have growth points that are above the ground in branching stems. This allows enough growth to keep the plant alive even when a mass of undecayed material chokes most of it. Other rest-tolerant species are very short in stature or can have sparse, thin leaves that can allow some light to reach ground-level growth points, in spite of an accumulation of old growth.

When the soil surface in brittle environments remains undisturbed, new plants do not easily replace those that are dead or dying. The capping created by rain falling on bare, rested soil offers poor opportunity for germinating seed.

Very brittle, low-rainfall environments given extended periods of rest (partial or total) characteristically have wide bare spaces between perennial grass plants. These remaining plants survive because light can reach the ground-level growing points around the edges of each plant, but the centers may already be dead. After adequate disturbance of the soil surface, closely spaced perennials often do establish. If such land is then rested again, however, the closely spaced plants kill one another off prematurely, as old growth that has accumulated on them shades even the edges of the neighboring clump.

Left: Rest (total or partial) applied as a tool in a brittle low rainfall environment in Southern Patagonia, Argentina, leads to dead plants, bare ground, and malfunctioning ecosystem processes.



Right: Bare ground caused by years of total and partial rest and continuous grazing in a low rainfall brittle environment in New Mexico, USA.

The effects rest tends to produce are easier to predict at the extreme ends of the brittleness scale. It is much more difficult to see these effects in less brittle environments (4 to 7 on the brittleness scale). In these environments it can be challenging to determine at which point the effects of rest change over from enhancing soil cover, energy flow, and the health of perennial grasses to damaging them. In these less brittle environments the effects may take much longer to show up.

Overrested sites tend to favor the establishment of brush and trees. Overgrazed sites tend to favor the establishment of herbaceous forbs (weeds). If your holistic context does not involve this kind of change, don't apply either partial or total rest. Most of the brush and tree encroachment many consider a problem today owes its existence to heavy doses of the tool of rest, mainly partial.

THINK ABOUT THIS

In the sparsely populated brittle environments of the western United States where there are few animals on the land, a few perennial grasses with high tolerance for rest dominate the scene. By contrast, in the densely populated brittle environments of India, there are millions of cattle on the land. There, grasses that can withstand high levels of overgrazing dominate the landscape. In both cases, on similar types of land, the amount of bare ground between plants remains about the same. Both are using partial rest to a greater extent than any other tool, and rest generally promotes bare ground—the more bare ground, the more brittle the environment.

Total and partial rest in brittle environments produce bare ground and malfunctioning ecosystem processes.

The effects of partial or total rest vary widely depending on how brittle the environment is and the land's current condition. In very brittle environments, rest in either form is extremely damaging to biodiversity and soil cover. When the land sits somewhere in the middle of the brittleness scale, partial or total rest shifts from being increasingly positive to increasingly negative in terms of maintaining soil cover, energy flow and healthy perennial grasses. Because rest has such clearly different tendencies at the extremes, the condition of rested land generally indicates the underlying brittleness of an area.

If rest is a tool you are thinking of using, consider where the land sits on the brittleness scale, the current condition of the land, and the effects rest is likely to produce—are they in line with the future landscape described in your holistic context? The context checks in ebook #5 will help you decide.

The following table summarizes the effects that rest (partial or total) tends to produce at the extreme ends of the brittleness scale.

REST (PARTIAL OR TOTAL) AND THE BRITTLENESS SCALE

Very brittle		Nonbrittle
Water cycle becomes less effective.	◄ WATER CYCLE ►	Water cycle builds and maintains high levels of effectiveness.
Mineral cycle becomes less effective.	◄ MINERAL CYCLE ►	Mineral cycle builds and maintains high levels of effectiveness.
Biological communities decline and greater simplicity and instability ensue. The lower the rainfall, the greater the adverse effect.	◄ COMMUNITY DYNAMICS ►	Biological communities develop to levels of great diversity and stability.
Declines significantly.	◄ ENERGY FLOW ►	Reaches a high level.

LIVING ORGANISMS: BIOLOGICAL TOOLS FOR SOLVING MANAGEMENT CHALLENGES

Living organisms refers to all the living things we harness to modify the environment, from the smallest microorganisms used to supplement soil preparations, to insects we might use to consume crop pests, to livestock that help restore or maintain grasslands, or to many other creatures we modify through breeding or genetic engineering to achieve similar aims.

As a tool, living organisms offer potential biological solutions to a problem as opposed to technological ones. Also, it encourages us to treat the whole complex of life in our environment as a whole rather than as a menu of detrimental or beneficial creatures that we either eliminate or make use of.

LIVING ORGANISMS AND COMMUNITY DYNAMICS

In the Holistic Management framework, a broken line surrounds both the ecosystem process of community dynamics and the living organisms tool because they merely represent two aspects of the same thing. The dynamics of any biological community is manifested in living organisms. And living organisms cannot be isolated from the communities they nurture and that nurture them. Most importantly, all living organisms both create and are created by the communities they inhabit and will not thrive outside them unaided.

Japanese farmer and scientist, Masanobu Fukuoka, used the principles of community dynamics and the organisms associated with particular successional levels to produce high yields of small grain crops without synthetic fertilizers, compost, pesticides, soil disturbance, or weeding. He succeeded because his understanding of community dynamics allowed him to use a great number of plants, insects, birds, small animals, and microorganisms as tools in creating an environment where his grain thrived in the protection of such complexity.

Unlike Fukuoka, farmers operating in brittle environments generally have to enlist larger animals to aid in regenerating soils and soil life and to boost yields. The same is true when attempting to reverse desertification in these environments. Trees planted to prevent deserts spreading, effective as they may be as wind breaks, *cannot grow and reproduce independent of the level of development of the biological community as a whole.* Livestock, however, can be used to help cover the bare ground and move succession forward.

The domestication of livestock about 10,000 years ago offered new possibilities for the use of living organisms in the service of management, but livestock were not recognized as such until very recently. Because their power to transform whole landscapes through their physical impact and grazing is so significant we break them into two tools (*animal impact* and *grazing*) within the living organisms category and discuss their use in detail in the next two sections.

ANIMAL IMPACT: REGENERATING SOILS AND SHAPING LANDSCAPES

Animal impact refers to all the things grazing animals do besides eat. Instinctively we have considered defecating, urinating, salivating, rubbing, and trampling of large animals as generally inconvenient conditions of their presence. Recently, however, we have discovered in the lumbering, smelly, but powerful behavior of grazing animals, a powerful tool for reversing desertification and for better management of water catchments, croplands, forests, and wildlife.

The third of the four key insights (ebook #1) showed why the development of this tool was critical: in brittle environments relatively high numbers of large, herding animals, concentrated and moving as they naturally do when pack-hunting predators are present, are vital to maintaining the health of the grasslands we thought they destroyed.

The examples in the table on page 3|23 provide an idea of the power and versatility of this tool. Animal impact can often play a vital role in the revegetation and maintenance of more brittle environments and can also be an extremely useful and practical tool for use in less brittle ones.

TIMING AND DONKEY DAYS

Suppose you have a small house on a hill and you and your donkey fetch water each day from the stream below. After one year of trampling the same path day after day, a substantial gully forms and the stream bank where you load the water becomes a trampled bog.

You could say that you have 365 donkey days of trampling. For many years we observed such damage and said we had too many donkeys.

Now suppose you took a herd of 365 donkeys down the hill and hauled up a year's worth of water in one morning. In this case, you would again have 365 donkey days of trampling.

Someone passing by would remark on severe trailing and trampling of the stream bank. But those 'wounds' would have 364 d ays of plant growth and root development to heal before you had to go back down to the stream.

When you did head back to the stream, you would probably find both the trail and the loading place overrun by new growth. In fact, both might be greener and healthier than before with the old grass removed and the manure and urine deposited, though they had still absorbed 365 donkey days of traffic per year.

So time, rather than animal numbers was the critical factor in trampling.

ANIMAL IMPACT AND STREAMS

Most stream banks should be well vegetated not only to stabilize them, but also to provide shade and cover for fish. Bare stream banks are unstable. Their steep edges are more prone to erosion and will keep cutting back, widening the stream and making it shallower. Animal impact can break down the sharp cutting edges and create conditions for plant growth to heal them.

Photos taken on a bridge of a stream in Wyoming, USA.
Left: Upstream land—Properly managed using Holistic Management (250% increase in livestock numbers)
Right: Downstream land—Managed conventionally. Same stream, same day, different management.

We have discovered in the lumbering, smelly, but powerful behavior of grazing animals a significant tool for reversing desertification and for better management of water catchments, croplands, forests and wildlife.

There are a number of other situations where animal impact has been found to be the most practical tool available. It is such a versatile tool that Holistic Management practitioners can run the risk of prescribing it as automatically as some folks now prescribe fire, rest, and/or technology. The context checks covered in ebook #5 help prevent that.

ANIMAL IMPACT AND THE BRITTLENESS SCALE

Very brittle		Nonbrittle
Periodic high impact generally improves water and mineral cycles. Low impact reduces water and mineral cycles below the land's potential.	WATER AND MINERAL CYCLE	Periodic high impact tends to improve both water and mineral cycles. However, while it tends to sustain a grassland for example, it may result in less effective water and mineral cycles than possible in woodlands. Low animal impact has little effect.
Promotes the advancement of biological communities on bare, gullied, or eroding ground; tends to maintain the biological community at grassland level, preventing shift to woody community. Low animal impact or partial rest tends to produce bare ground.	COMMUNITY DYNAMICS	Periodic high impact maintains grass root vigor and discourages establishment of woody plants and slows the shift to woody communities.
Periodic high impact tends to build community complexity and improve water and mineral cycles, and as a result increases energy flow. Low impact reduces energy flow below its potential. The shortfall becomes severe if compounded by the overgrazing of plants.	ENERGY FLOW	Periodic high impact tends to increase energy flow, although when used to maintain grassland in lieu of forest, energy flow will never reach its full potential. Low animal impact has little effect.

WHAT ANIMAL IMPACT DOES

Cattle under Holistic Planned Grazing providing animal impact in South Dakota, and Montana, USA.

There are three primary things animal impact does and for which we use it as a tool:

1. Hoofed animals tend to compact the soil. With each step they concentrate a big weight on a small area.
2. When animals are excited or closely bunched, their trampling causes breaks and irregularities on the soil surface.
3. Such animals tend to speed the breakdown and reduce the volume of plant material returned to the soil surface through their dung and urine. They also speed the return of uneaten old plant material to the soil surface through the litter they trample down.

Whether any of these tendencies work for good or bad on the land depends on management—particularly of the time factor. Differences in the utility of animal impact vary between the brittle environments that evolved with large herds of grazers and the nonbrittle environments that did not or experienced it far less.

Here's an example of what animal impact can accomplish. On the left is the before picture of Kachana Station in Western Australia. On the right is the same point seven years later. The only tools applied were animal impact and grazing.

STOCK DENSITY AND HERD EFFECT

Herd effect is a common occurrence in the wild. Domestic livestock managers can mimic this behavior in their herds by increasing herd size and keeping animals bunched.

The herding animals that contribute most to the maintenance of the more brittle environments behave in a variety of ways that produce different effects. Two management guidelines—stock density and herd effect—show how to harness these effects when applying the tool of animal impact. *Stock density* refers to the concentration of animals within a subunit of land, or grazing division, at any given time. (Stocking rate describes the number of animals continuously supported on a given unit of land, or whole grazing area.) *Herd effect* refers to the impact on soils and vegetation produced by a herd of bunched animals.

Normally, grazing or walking animals place their hooves carefully, avoiding coarse plants and barely breaking the soil surface. Their hooves still compact the soil to some degree, particularly where the soil is wet or where underground root structures and organic matter are damaged or reduced.

Animals that remain bunched (as wild herds do when under threat of predation, in full migration, or when being driven) will trample coarse plants, lay down litter, raise dust, chip soil surfaces—opening them to aeration—and compact them enough to provide seed-to-soil contact. This behavior change can be induced in livestock by herders who keep them bunched for much of the day, by a combination of herding and portable fencing that also keeps animals bunched and moving frequently, or through the use of attractants (such as feed cubes) that excite them and keep them bunched briefly.

ANIMAL IMPACT IN BRITTLE AND NONBRITTLE ENVIRONMENTS

One of the greatest immediate benefits from animal impact can be seen in the restoration and maintenance of brittle environment water catchments. While partial or total rest can sustain soil cover in nonbrittle environments, no technology exists that could replace animal impact on all the ranches, farms, national parks, and forests in brittle environments, where either form of rest has the tendency to reduce soil cover.

ANIMAL IMPACT VS OTHER TOOLS

Situation	Potential use of other tools	Effects of animal impact
In a fairly brittle high rainfall environment overrest has allowed plants to accumulate several years of old material. Roots have suffered severe damage and the community has started to shift to forbs, shrubs, and trees where we want to maintain open grassland.	Fire would pollute the atmosphere, while exposing soil and invigorating many of the woody plants. Chemicals or machinery might clear the ground, but would not guarantee that plants would establish.	Periodic high animal impact, together with grazing (but not overgrazing) could remove old material, invigorate existing plants without exposing soil, create conditions for new plants to establish, and move the biological community away from noxious weeds or woody plants.
Leafy spurge, knapweed, snakeweed or some other noxious plant has invaded a piece of ground.	Thousands of dollars have already been spent attempting to use chemicals or machinery or other forms of technology to eradicate them.	Using continual doses of high animal impact, followed by well-planned recovery periods, cause the offending plants to diminish by moving succession beyond the stage that suits them.
Bare eroding ground is hastening the desertification process in an area.	One might fence off and seed this area at great expense.	Subject the area to periodic heavy animal impact by giving a large herd a few bales of hay. This excites them and concentrates them on that area. New plants can then establish on the broken, litter-covered ground, at no cost or lost production.
Erosion gullies whose steep banks offer no foothold to plants are spreading across an area.	One could use a bulldozer to slope the banks, chewing up more land, consuming diesel fuel, and polluting the air.	A herd of livestock or game animals attracted to the gully can break down the sharp cutting edges and create conditions for plant growth to heal them. The high animal impact, while fixing the gully also tends to correct the noneffective water cycle that caused the damage in the first place.

GRAZING: ENHANCING PLANT AND ANIMAL HEALTH AND PRODUCTIVITY

Grazing ranks as a tool because as land managers we can manipulate the intensity and timing of it and the animal-plant relationships that govern it. Unlike some of the other tools, however, it has natural aspects to it that humans did not design—the mouths of livestock and other grazers, for example. And, though some innovations have been made in this regard, we generally do not teach them what to eat or how to behave. Because the ways in which they do these things are critical to the results of management, it's important that we understand them better.

When we talk about grazing as a tool for managing land, it is important to remember the fourth key insight regarding timing. Overgrazing of plants and damage from trampling has less to do with the number of animals on the land, and more to do with the amount of time the plants and soils are exposed to animals.

In this section we will consider grazing as if animals float over the ground without dunging, urinating, salivating, or trampling as they feed. Though grazing never occurs apart from these things, separating the act of grazing from the other simultaneous influences of the animals on the land (animal impact) helps us to better understand the influence of each and thus the use of each as a tool.

Cattle grazing under Voisin's principles in the nonbrittle Argentine Pampas.

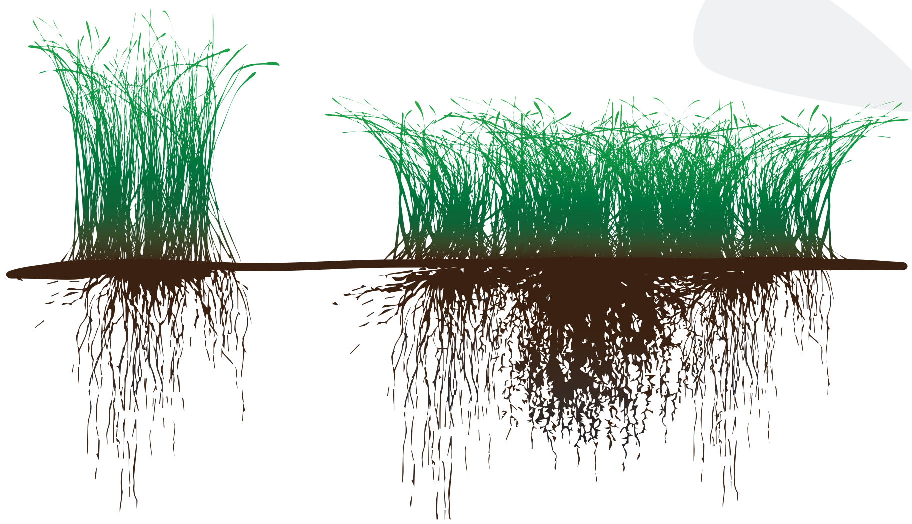
Cattle grazing under Holistic Planned Grazing in moderately brittle environment in Southern Africa

Several examples from environments that lie closer to the very brittle end of the scale show how widely the effects of either grazing or animal impact can vary:

- Grazing might be maintaining the health of individual plants, while low animal impact (partial rest) is simultaneously exposing the soil between the plants as fewer new plants can establish.
- Grazing applied as overgrazing may weaken or kill some plants in the community, while at the same time high animal impact is tending to increase the number of plants, the amount of soil cover, and the effectiveness of rainfall.

> Grazing, together with adequate animal impact, can maintain soil cover, keep grass plants healthy and more productive, and in general enhance the functioning of all four ecosystem processes. However, overgrazing combined with low animal impact (partial rest) produces the opposite effect. This latter combination is the most commonly applied and is the one with the greatest tendency in the more brittle environments to lead to desertification.

The concept of grazing generally refers to simply eating grasses, not other forms of vegetation, such as brush, trees, and woody forbs, which are technically browsed. However, the tool of grazing encompasses both. To better understand grazing and overgrazing it helps to note the differences between annual and perennial grasses, and their relationship with grazing animals.



If two types of grasses are grazed severely, less leaf is removed from individual runner-grass plants (right), because of their horizontal spread, than from bunched grass plants (left).

> *Annual plants* include grasses and forbs that germinate, grow, and die in one season. Their populations usually fluctuate widely in numbers from season to season. In some seasons they may fail to establish altogether, leaving the soil exposed. Annual grasses are less prone to overgrazing because they do not live long enough; they generally begin to die once they have produced seed.

> *Perennial plants*—be they grasses, forbs, shrubs, or trees—can be very long lived. Their populations fluctuate far less in numbers, and their roots help to hold the soil in place year-round, keeping more soil covered throughout the year compared to lands dominated by annuals. The lower the rainfall and the more brittle the environment, the more important the role played by perennial grasses in keeping the soil covered and stable. Most perennial grasses, however, can easily be overgrazed.

- *Perennial grasses* mainly grow in two forms: upright or prone with lateral running shoots above- or belowground. The more brittle the environment, the more likely the upright perennial grasses will appear as distinct bunches, the less brittle, the more likely they will appear as a sward or mat in which individual plants are hard to distinguish. This variation in the upright grasses can occur even within a species, which may grow in a matted form in a less brittle environment but in a bunched form in a more brittle environment. The runner grasses do not appear to change form at different points on the brittleness scale, and they commonly become dominant where moisture is adequate, many plants are overgrazed simultaneously and repeatedly, and animal impact is high.
- *Severe grazers* and some perennial grasses are dependent on each other. The buds, or growth points, on perennial grasses of either form occur either very close to the ground near the plant base, or well aboveground, along or at the ends of the plant stems. The position of these growth points probably indicates the evolutionary development of the species. Those with growth points close to the ground probably evolved in close association with severe grazing animals that kept the plant clear of old stems so that light could reach the growth points. If they remain ungrazed, these plants can die prematurely. They have in effect become *animal dependent*. Those plants with growth points well aboveground probably evolved in places under little or no pressure from severe grazers (such as on the steep slopes of gorges), because they can be set back by severe grazing, but they thrive when rested. They are in effect *rest-tolerant* grasses.

GRAZING AND OVERGRAZING

To grasp the difference between grazed and overgrazed plants, picture a healthy perennial bunch grass plant with ground-level growth points, and imagine that a large animal bites the whole plant down to three or four centimeters (an inch or two) above the soil. That is severe grazing, but not unusual or bad in that most herding animals evolved to graze in such a manner. In the growing season, the plant receives a brief setback while it uses energy previously converted from sunlight that it now takes from its crown, stem bases, or roots to reestablish new growing leaf. But it also receives a long-term boost because the plant tends to end the season better off and less encumbered with old leaf and stem than its ungrazed neighbors. The growth points at the base remain intact, and no old growth of the previous year stands in the way of regeneration.

The soil also receives a boost because any time a plant is severely defoliated while growing, root systems die back and become feed for communities of bacteria, leaving porous passages and carbon-rich biomolecules that are aggregated into a sticky substance called humus. When the animals move on, the root systems regrow along with the aboveground leaves. The process repeats itself when the regrown perennial grass is grazed again, increasing soil porosity and water and carbon content at the same time.

Overgrazing occurs when a plant bitten severely *in the growing season*, gets bitten severely again while using energy it has taken from its crown, stem bases, or roots to reestablish leaf—something perennial grasses routinely do. This can happen at three different times:

1. When the plant is exposed to the animals for too many days and they are around to regraze it while it's trying to regrow;
2. When animals are moved away from it but allowed to return too soon and graze the plant again while it is still using stored energy to reform leaf; or
3. Immediately following dormancy, when the plant is growing new leaf from stored root energy.

Sheep overgrazing in nonbrittle northern England

In the growing season, any time a plant is severely defoliated, root growth halts as energy is redirected from growing roots to regrowing leaves. This movement of energy back and forth between leaves and roots is important to sustaining the plant over dormant, nongrowing periods. At the end of the growing season, perennial grasses transfer nutrients and energy from leaves and stems to crowns, stem bases and/or roots.

These reserves are critical in carrying the plant through the dormant period and supporting the first growth of the following season. If bitten during the early growing season, when much of the reserves have already been tapped to provide that initial growth, plants have to use what little energy is left to sustain the growth. This happens at the expense of the roots. If subsequent bites occur before the roots have reestablished, roots will die. Eventually the root mass decreases until the plant dies.

So a simple definition of overgrazing is any grazing that takes places on leaves growing from roots that have not yet recovered from a previous grazing.

If the grass plant is a runner type rather than erect or bunched, there is less danger from overgrazing, even when animals linger too long or return too soon. When plants are severely grazed, a lesser percentage of leaf is removed than with an upright plant. So much leaf, as well as stems with growing points, remain below the grazing height of most animals that fewer roots are affected. This helps to explain why, as bunch grasses are severely damaged or killed by overgrazing, that space tends to be filled in with a runner grass as long as there is sufficient moisture to sustain it; hence the runner grass mats so common close to water points and areas of very high animal concentration.

A simple definition of overgrazing is any grazing that takes place on leaves growing from stored energy, at the expense of roots, rather than directly from sunlight. In a sense, overgrazing is 'grazing of the roots.'

IMPACTS OF OVERGRAZING PERENNIAL GRASSES

If the aboveground part of the plant grows less, it provides less material to feed the animals and less leaf and stem to cover the soil as litter and mulch.

In the more brittle environments, most soil cover comes from litter, rather than the bases of living plants.

If the root mass of the plant is reduced, less energy and organic material are available for soil life.

GRAZING AND THE BRITTLENESS SCALE

The table on page 3|32 summarizes the effects the tool of grazing tends to produce on ecosystem processes in very brittle and nonbrittle environments. These are the straightforward tendencies that can guide you in your management decisions. In reality, they interact with so many other factors that you cannot always predict how significant their impacts will be. But, knowing what these tendencies are will enable you to monitor your use of the grazing tool more effectively.

GRAZING AND THE BRITTLENESS SCALE

Very brittle		Nonbrittle
Enhances water and mineral cycles by maintaining healthier and more stable root mass, increasing microorganism activity and aeration, and producing plants with more shoots and leaves that later provide more litter.	◄ WATER CYCLE ►	Will not expose soil, but cause even denser cover; will thus enhance water and mineral cycles in grasslands.
	◄ MINERAL CYCLE ►	Enhanced by grazing in grasslands.
Maintains grassland communities, increases their diversity and covers soil, retards shifts toward woody species. Increases organic content, structure, aeration, and soil biological activity because more leaf and more roots are produced.	◄ COMMUNITY DYNAMICS ►	Because plant spacing is naturally close and soil cover hard to damage; grazing tends to maintain grass root vigor, soil life, and structure.
Increases energy flow by promoting vigorous root and leaf growth. Healthier, more massive root systems support millions of microbes and below ground life.	◄ ENERGY FLOW ►	Grazing increases energy flow; both above- and belowground in natural grasslands and pastures.

Note: Overgrazing of grass plants tends to produce the opposite effects of regenerative grazing These effects, or tendencies, are difficult to isolate because overgrazing is commonly associated with prolonged time on the land, low density of animals and thus high partial rest. Generally, in brittle environments, partial rest tends to be more damaging to all four ecosystem processes than overgrazing of plants.

HOLISTIC MANAGEMENT FRAMEWORK

WHOLE UNDER MANAGEMENT

Decision Makers — Resource Base — Money

HOLISTIC CONTEXT

(Statement of Purpose) — Quality of Life — Future Resource Base

ECOSYSTEM PROCESSES

Water Cycle — Mineral Cycle — Community Dynamics — Energy Flow

ECOSYSTEM MANAGEMENT TOOLS

Human Creativity

[Technology   Fire   Rest   Living Organisms
- *Animal Impact*
- *Grazing*]

Money and Labor

ACTIONS AND DECISION MAKING

Objectives, Goals, Tactics, Strategies, Policies
Customary Selection Criteria (past experience, expert advice, research, etc.)

CONTEXT CHECKS

- Cause and Effect
- Weak Link
  - *Social*
  - *Biological*
  - *Financial*
- Marginal Reaction
- Gross Profit Analysis
- Energy/Money Source and Use
- Sustainability
- Gut Feel

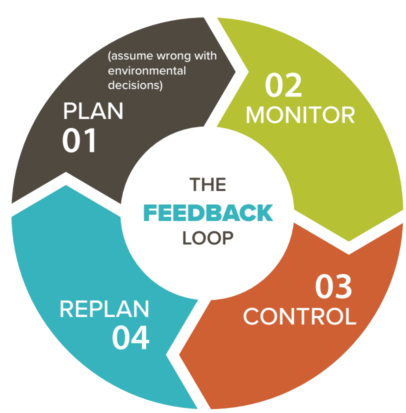
MANAGEMENT GUIDELINES

- Time
- Stock Density and Herd Effect
- Cropping
- Burning
- Population Management

PROCEDURES AND PROCESSES

- Holistic Financial Planning
- Holistic Land Planning
- Holistic Planned Grazing
- Holistic Policy Development
- Holistic Research Orientation

FEEDBACK LOOP



GLOSSARY

Animal Impact The sum total of the direct physical influences animals have on the land—trampling, digging, dunging, urinating, salivating, rubbing, and so on. Most commonly achieved by herding animals in high concentration. The larger the herd, the greater the effect.

Biodiversity The diversity of plant and animal species and their genetic material, as well as the age structure of their populations within a given community.

Brittleness Scale All terrestrial environments, regardless of total rainfall, fall somewhere along a continuum from nonbrittle to very brittle. For simplicity, we refer to this continuum as a 10-point scale, 1 being nonbrittle and 10 being very brittle. Completely nonbrittle environments are characterized by (1) reliable precipitation, regardless of volume; (2) good distribution of humidity throughout the year as a whole; (3) a high rate of biological decay in dead plant material, which is most rapid close to the soil surface (thus, dead trees rot at their bases and topple over relatively quickly); (4) speedy development of new communities on any bare surface; and (5) the development of complex and stable communities even where they are not physically disturbed for many years. In such environments it is virtually impossible to produce or maintain millions of acres where the ground between plants is bare, other than on croplands that are continually exposed by machinery. Very brittle environments, on the other hand, are characterized by: (1) unreliable precipitation, regardless of volume; (2) poor distribution of humidity through the year as a whole; (3) the chemical (oxidizing) and physical (weathering) breakdown of dead plant material, generally slowly and from the upper parts of plants downward (thus, dead trees remain standing for many years); (4) very slow development of communities from bare soil surfaces unless physically disturbed; and (5) algae and lichen covering soil surfaces for centuries unless adequately disturbed. In such environments it is very easy to produce millions of acres where the ground between plants is bare or algae- or lichen-capped, merely by resting the land excessively, burning it frequently, or overgrazing many grass plants. Such areas tend to maintain biodiversity and stability only when they receive adequate disturbance periodically.

Community Dynamics The development of communities of living organisms. This process is ongoing due to the constant interplay of species, changing composition, and changing microenvironment. However, the greater the biodiversity within a community, the more complex, and thus the more stable, it tends to be.

Desertification A process characterized by a loss of biodiversity, plant mass, and soil cover. Symptoms include increased incidence of flood and drought, declining levels of soil organic matter, increased soil surface exposure, and erosion.

Energy Flow The flow of energy from the sun to green growing plants, which convert the energy (through photosynthesis) to the food that fuels all life. Sunlight energy does not cycle, it is a one-way flow through our ecosystem.

Herd Effect The impact on soils and vegetation produced by a herd of bunched animals. Herd effect is not to be confused with stock density, as they are different, although often linked. You can have high herd effect with very low stock density (e.g., the bison of old that ran in very large herds at very low stock density, as the whole of North America was the paddock.) You can have high stock density with no herd effect, such as when two or three animals are placed in a half-hectare (one-acre) paddock. At ultra-high densities, the behavior of livestock will change adequately to provide herd effect.

Note: Herd effect is the result of a change in animal behavior and usually has to be brought about by some actual management action—stimulating the behavior change with the use of an attractant, crowding animals to ultra-high density, or, on large tracts of land, herding animals—the larger the herd, the better—and keeping them bunched through much of the day.

Holistic Planned Grazing The planning of livestock moves using a step-by-step planning guide that enables managers to deal with a great degree of complexity, and a grazing chart. The planning enables you to integrate any type of grazing livestock—taking into account their behavior and their time on or off any unit of land—with other land users and uses (wildlife, cropping, forestry, etc.,) while catering for many variables, issues or problems, such as droughts. Holistic Planned Grazing is suited to all environments, to any size of farm, ranch, or pastoral grazing area, and with or without fencing.

Mineral Cycle The movement of mineral nutrients from soil to plants and animals and back to soil again. A healthy and productive environment will promote the movement of minerals from deep soil layers to aboveground plants with a minimum of mineral loss from soil erosion or mineral leaching.

Overgrazing This occurs when a plant that has been bitten severely in the growing season gets bitten severely again while using energy it has taken from its crown, stem bases, or roots to reestablish leaf. Generally, this results in the eventual death of the plant. In intermediate stages it results in reduced production from the plant. Overgrazing commonly occurs at three different times: when the plant is exposed to the animals for too many days and they are around to regraze it as it tries to regrow; when animals move away but return too soon and graze the plant again while it is still using stored energy to re-form leaf; and immediately following dormancy when the plant is growing new leaf from stored energy.

Overrested Plant A bunched perennial grass plant that has been rested so long that accumulating dead oxidizing material prevents light from reaching growth points at the plant's base and hampers new growth, weakening or eventually killing the plant. Overrest occurs mainly in the more brittle environments, where, in the absence of large herbivores, most old material breaks down in sunlight through oxidation and weathering rather than biological decay.

Plant Litter Dead plant material—leaves, stems, twigs, bark, needles that has fallen or been trampled onto the ground. Plant litter, rather than living plants, provides most of the soil cover in brittle environments.

Recovery Period, Effective A period in which a severely-grazed plant has actually grown new leaves and stems and restored energy reserves in, depending on the species, reestablished roots, stem bases, or crowns. This can occur only under active growing conditions.

Rest, Partial This takes place when grazing animals are on the land but widespread with little bunching behavior and herd effect. Even when plant overgrazing is stopped with Holistic Planned Grazing, partial rest remains a problem in brittle environments on large fenced ranches (as opposed to where livestock are herded), where it can cause land improvement to stagnate if not detected and acted upon. In less brittle environments partial rest may result in a build up of moss communities and a successional advance to woody plants.

Rest, Total Prolonged nondisturbance of soils and plant or animal communities. A lack of physical disturbance (by animals or machinery) or fire.

Stock Density The number of animals run on a subunit (grazing division) of land at a given moment of time. This could be from a few minutes to several days. Usually expressed as the number of animals (of any size or age) run on one hectare or acre. Some express this as total weight of animals on a unit of land.

Stocking Rate The number of animals run on a unit of land usually expressed in the number of hectares or acres required to run one full-grown animal throughout the year or part thereof.

Succession An important aspect of community dynamics, succession describes the stages through which biological communities develop. As simple communities become ever more diverse and complex, succession is said to be advancing. When complex communities are reduced to greater simplicity and less diversity, succession is set back. If the factors that set it back are removed, succession will advance once again.

Water Cycle The movement of water from the atmosphere to the soil (or the oceans) and eventually back to the atmosphere. An effective water cycle is one in which plants make maximum use of precipitation, little evaporates directly off the soil, and any runoff causes no erosion and remains clear. Also a good air-to-water balance should exist in the soil, enabling plant roots to absorb water readily. For the water cycle to be effective in brittle environments, the soil must be covered with living plants or litter, as vast amounts of water are lost through the bare, exposed soil between plants.

