

## The Challenge

**H**ave you ever considered why animals behave as they do and what it means for management? Why livestock moved from pastures or rangelands to confinement or vice versa lose their appetites, often get sick, and generally perform poorly for as little as a month or as long as 3 years, even when offered nutritious foods? Why wild and domestic animals moved to unfamiliar environments often suffer from predation, malnutrition and overingestion of toxic plants? Why livestock on pastures and rangelands with only a few plant species perform less well than when they have a wide variety of plants to eat? Why some individuals know exactly which toxic plants to avoid while others don't have a clue? Why animals can safely eat toxic plants under some conditions yet suffer dire consequences under others? Why changes in grazing management can reduce livestock performance for as many as 3 years?

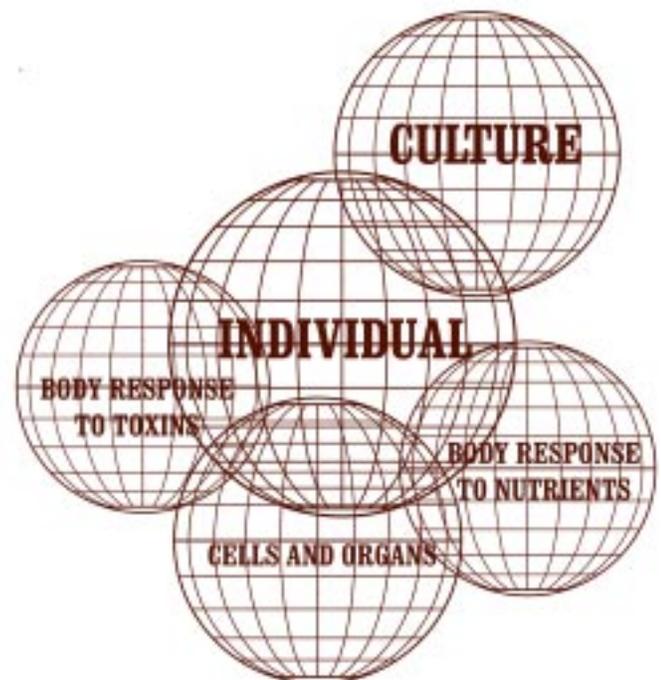
Unfortunately, efforts to help people make a living often ignore how animals make their living. Without awareness of behavior in management, there can be no sustainability of ecological, cultural, or economic systems. Without consideration for behavioral principles in research, scientific conclusions often are inadequate. For the past two decades, we have attempted to develop behavioral principles related to food and habitat selection. Our work has shown how simple strategies that use knowledge of behavior can markedly improve the efficiency and profitability of agriculture, the quality of life for managers and their animals, and the integrity of the environment. The scientific research and real-life situations presented in this booklet provide insight into why animals act as they do, and how understanding their behavior can improve operations in any part of the country.

Life for herbivores exists at the boundary between order and chaos. Animals, humans included, learn habits to create order and predictability. The origins of food habits and habitat preferences involve interactions between the culture and the individual. Young animals learn how to behave through interactions with adults. The origins of preference also entail responses of the body to nutrients and toxins. Each cell and organ of the body is a world unto itself. These "worlds" interact and tell the palate which foods to like or dislike based on postingestive effects—feedback from cells and organs in response to nutrients and toxins. Although both people and herbivores strive for order, they also seek variety. Bodies satiate—get sick and tired—on familiarity and flourish on diversity. Satiety encourages creatures to explore novel foods and habitats, while culture encourages creatures to embrace familiar fares and haunts. This creates an ongoing tension between curiosity about things new and different and a suspicion of them.



**The behavior and well being of animals has an immediate impact on an operation.**

**Unfortunately, efforts to help managers make a living often ignore how animals make their living.**



That's why it's often hard to change an animal's behavior—as the saying goes, you can't teach old dogs new tricks. Still, ongoing changes in social and physical environments challenge creatures to learn new tricks. Those who can adapt, survive. The key to survival for herbivores and the people who manage them is to continually explore new possibilities and to know when to adapt.

Thus, while the behavior of herbivores may appear to be little more than the idle wanderings of animals in search of food and a place to rest, foraging is a process that provides insights into an age-old dilemma faced by herbivores and humans alike: How do creatures of habit survive in a world whose only habit is change? The demands herbivores face in finding food to eat and a place to live are similar to those people face in making a living. These demands arise because climate, soils, plants, herbivores, and people are interrelated facets of systems that change constantly. Change requires that each component of the system continually adapt. Understanding the challenges herbivores face and how they cope can reduce stress and increase profitability.

### Detecting nutrients

Whether they're confined or foraging on open ranges, animals traverse an ever-changing landscape. Like humans, herbivores must cope with changes in themselves and the environment. An animal's nutritional needs vary with age and physical activity. They change throughout pregnancy. They increase when animals are infected with parasites and when they're ill. These changes may transpire gradually during pregnancy or as parasites increase, or they may occur quickly with shifts in physical activity or a change in the weather. Unlike humans who acquire nutritious foods from familiar and predictable haunts—grocery stores, restaurants, gardens—herbivores must sift through an ever-changing landscape fraught with biochemical complexity. Nature constantly alters the quantity of energy, protein, and minerals in the foods herbivores require. Individuals must maneuver through these challenges, recognizing nutritional deficiencies in themselves and in the plants they eat. Individuals who do, survive. Those who don't, won't.

*How do animals detect nutrients in foods and what can managers do to help them select nutritious diets?*

### Minimizing ingestion of toxins

Plants also pose a toxic challenge. Most plants on pastures and rangelands produce toxins, often in high concentrations, that serve as chemical defenses against herbivores. Even garden vegetables—corn, tomatoes, potatoes, broccoli, spinach—contain toxins, but in low concentrations thanks to our efforts to select for low-toxin varieties of plants. There are tens of thousands of toxins, and they all vary in biochemical structures and activities. In animals, they interfere with

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Human foods have labels giving nutrient and toxin information. Grazing animals don't have it so easy.



Even so-called healthy and natural foods humans eat have toxins. Eating too much of one food may cause illness.

Many of our vegetables and fruits have been bred to decrease the level of toxins present but interactions with the environment can increase toxin concentrations. For instance, potatoes that have been damaged, exposed to light, or sprouted have higher concentrations of two glycoalkaloids. Poison symptoms include gastric pain, weakness, nausea, vomiting, and labored breathing.

metabolic processes or reduce digestibility of foods. They can also cause death.

*How do herbivores use plants that contain toxins and what does this mean for managers?*

### Physical attributes of plants

Herbivores also must deal with plant morphological characteristics, such as standing dead material in some grasses, thorns in forbs and woody plants, and differences in plant canopy shape and structure. Morphological characteristics can facilitate or inhibit foraging and increase or decrease ingestion rate, which in turn can influence foraging efficiency and food preferences. Any combination of plant physical and nutritional characteristics that optimizes nutrient intake is likely to be preferred. Animals that can navigate through such structural challenges can enhance their nutritional welfare.

*How effective are herbivores at coping with plant morphological defenses, and what can managers do to maximize foraging efficiency for herbivores on pastures and rangelands?*

### Food on the move

Perhaps the trickiest challenge animals face is the fluctuation in nutrients, toxins, and physical characteristics of foods. While the biochemical composition of foods at the grocery store is relatively constant, the nutrient and toxin concentrations of plants on pastures and rangelands vary from morning to night, from day to day, from season to season, and from place to place. As plants mature, physical attributes that make foraging difficult increase while nutrient concentrations decline. An animal's challenge is to track these biochemical changes as they occur.

*Can herbivores figure out where and when to eat to meet their needs for nutrients and avoid ingesting toxins, and, if so, what are the implications for managing pastures and rangelands?*



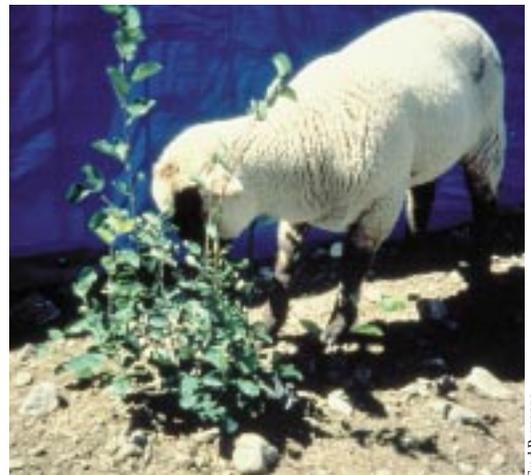
Fred Provenza

Plant morphology counts! These leaves are too small to efficiently graze a good meal . . .



Fred Provenza

And these stems are too large . . .



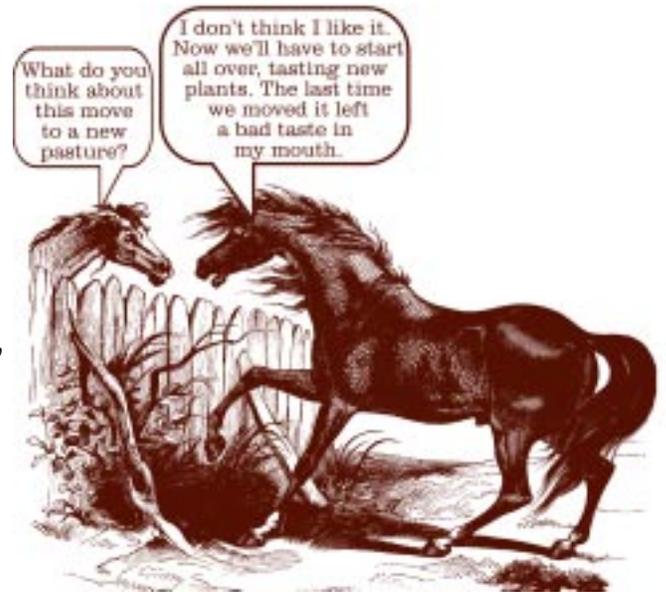
Fred Provenza

But these leaves are just right. The bite-sized morsels of this plant make foraging a pleasure. Appropriate bite sizes decrease bite rates and time spent grazing, all of which make foraging more efficient.

### Animals on the move

Changes in terrain pose yet another challenge. Either by catastrophic events like floods and fires or by an animal's being moved to a new location, the environment regularly presents an unfamiliar smorgasbord to an animal. Like a person shopping for the first time in a foreign country, herbivores that adjust quickly to drastically altered terrain can reduce nutritional stress and greatly increase chances for survival.

*How well do animals adapt to new foraging environments and how can managers help to reduce the stress of moving and thereby increase profitability?*



Mary Donahue

A puzzling change in terrain . . . . These barn-raised cows in upstate New York are let out to the pasture for the first time. They ran around for awhile before trying to go back to the barn. It took them some time to figure out they should be eating the grass.

### People on the move

Just as herbivores must adapt to constantly changing environments, changes in social and physical environments transform the beliefs and values of people. During the frontier days of the 1800s values were shaped largely by the challenge of eking a living from farms and ranches. During the past century, values have been shaped increasingly by life in the city. In the process, people have come to embrace lifestyles that emphasize recreation and conservation rather than production of commodities such as livestock. As a result, many of the practices ranchers have come to rely on to manage their animals have become socially unacceptable and prohibitively expensive. Nowadays, the challenge is to learn to manage landscapes in ways that blend culture, ecology, and economics.

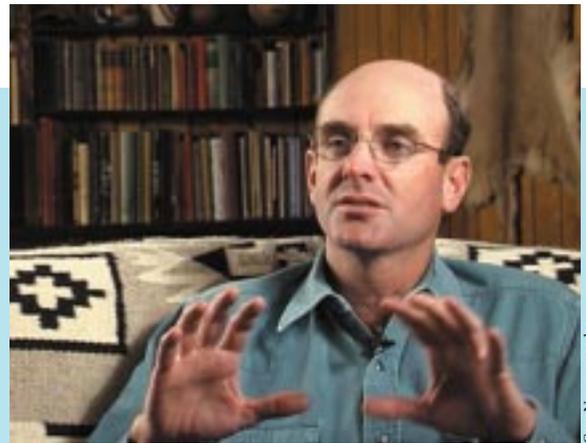
Jim Winder, a rancher in southern New Mexico, blends environmental and economic values by managing livestock behavior. As Jim points out, once mastered, behavioral principles and practices provide an array of solutions to the problems faced in management and improve the economic viability of ranchers and the integrity of land. Unlike the infrastructure of a ranch such as corrals, fences, and water development, behavioral solutions cost very little to implement and are easily transferred from one situation to the next.

Unfortunately, scientists and managers often ignore the power of behavior to transform systems, despite compelling evidence. We know that the environment, continually interacting with the genome during the growth and development of an organism, is as important in shaping creatures as their genetic code. Though experiences during development in utero and early in life are especially critical, genome-environment interactions continue throughout life.

Thus, the issue isn't if animals are adapting to ongoing changes in social and physical environments—they do so every day of their lives. The only question is whether or not people want to be a part of that process. For those willing to understand how environments interact with genomes to influence behavior, the potential benefits are virtually unlimited: improved economic viability and ecological integrity of pasture-based enterprises, enhanced and sustained biodiversity of rangelands, restored pastures and rangelands once dominated by weeds, mitigated livestock abuse of riparian areas, minimized wildlife damage to crops, pastures, and rangelands, improved ability to manage complex adaptive systems . . .

As Winder maintains, the challenge is to understand why creatures do what they do, and then to use that understanding as the basis for managing landscapes. To do so requires integrating curiosity with careful observations and experimental manipulations. The rewards are great, but it's not easy and it requires a change of perspective.

So what happens if we decide to make behavior an integral part of our management? We come to rely less on technology and tradition and more on behavioral adaptation and innovation. In this arena, there's a new sort of independence, where it's more gratifying to question than to confirm, more inviting to participate than to withdraw, and more rewarding to evolve than to hold on.



Gary Neuwander

Jim Winder talks about the use of creative strategies to keep his southwest New Mexico ranch in business.