The Other Grazers

The Interactions of "Non-Charismatic Microfauna" in Rangelands

By J. Kent McAdoo, Lance T. Vermeire, and Wendell Gilgert

Domestic livestock – cattle, sheep, horses, and goats – are typically thought of as the primary grazers (and browsers) on rangelands. Yet, this is the proverbial tip of the iceberg, given the many species that utilize rangelands. Even when wildlife species are thrown into the mix, most people think of the large ungulates – deer, antelope, elk, moose, bison, and bighorn sheep. Let's face it, most rangeland managers, wildlife biologists, and other rangeland users give little or no thought to the more diminutive "other grazers" of rangelands. Rangeland management literature has focused comparatively little attention on the impacts, benefits, and ecosystem interactions of these other grazers.

The Society for Range Management's (SRM) Wildlife Habitat Committee organized and facilitated a symposium for SRM's annual meeting in Casper, Wyoming (3-4 Feb. 2003) to focus on the less-considered "other grazers," including worms, insects, rodents, and birds. The purpose of this symposium was to examine the habitat requirements and ecosystem interactions of these diverse invertebrate and vertebrate species inhabiting rangelands. This paper is a synopsis of the eight contributed papers – the titles and authors of which are listed in Table 1. Interested readers may contact the authors for references used in preparing these papers.

Nematodes

Most of the biological "action" on rangelands is below-ground, with 60 to 90% of net primary production occurring in the soil. Nematodes (non-segmented worms) can have profound effects on primary productivity. They are particularly important in rangelands and occur at inordinately higher densities in grasslands than they do in other ecosystems. These invertebrates are the most abundant animal group below-ground, with the top 4 inches of soil potentially supporting 1.3 million individuals per square foot.

Table 1. Titles and authors of papers presented at the "Other Grazers" Symposium, SRM 2003 Annual Meeting, Casper, Wyo.

Title	Authors & Affiliations
Nematodes: Key Belowground Fauna in Rangelands	Seville, S. and N. Stanton (Dept. of Zool. and Physiol., Univ. of Wyo., Laramie, Wyo.)
Ants and Termites: The Little Things That Run Your Ranch	Bestelmeyer, B.T. and W.G. Whitford (USDA-ARS, Jornada Exper. Range, N.M. State Univ., Las Cruces, N.M.)
Grasshoppers: Inappropriately Abused but Important Participants in Grasslands	Joem, A. (School of Biol. Sci., Univ. Neb., Lincoln, Neb.)
Role of Small Mammals in Structuring Southwestern Rangelands	Curtin, C.G. (Arid Lands Project, Animas, N.M.)
Prairie Dogs: To What Extent Do They Compete With Livestock for Forage?	Detling, J.K. (Dept. Biol., Colo. State Univ., Fort Collins, Colo.)
Grazing Impacts of Lagomorphs on Rangelands	McAdoo, J.K. (Univ. Nev. Coop. Ext., Elko, Nev.)
Response by Birds to Habitat Change in Sagebrush Ecosystems: Indicators of Landscape Integrity	Knick, S.T. and M. Leu (USGS For. & Range Ecosystem Sci. Center, Boise, Ida.)
Managing for Non-Ungulate Grazers	Budd, R. (Red Canyon Ranch, The Nature Conservncy, Lander, Wyo.)

Dozens of species in this assemblage play an integral role in numerous trophic pathways by transporting fungal and bacterial spores and feeding on roots, fungi, and bacteria. Dense nematode populations may consume more than 670 pounds of roots per acre in a single growing season. In fact, elimination of nematodes in the field has increased root biomass by an equivalent of about 25% of the net standing crop.

Bacterivores, on the other hand, may improve plant productivity by increasing the turnover rate of soil microbes. This, in turn, accelerates the mineralization rate and increases nutrient availability for plants. It seems intuitive then that plant productivity could be altered by shifting the balance of plant- and bacteria-eating nematode populations. However, the end results of bacterivore and phytovore interactions are not yet well-understood, although their effects are believed to counteract each other.

Nematode populations seem to be affected by above-ground herbivory. Nematodes tend to be more abundant in areas with above-ground grazing than those not grazed. However, grazing effects may vary with the intensity of use. Limited experimental studies have shown that phytovores are more abundant beneath moderately clipped plants than heavily or non-clipped plants. The variable response of phytovores, fungivores, and bacterivores to above-ground grazing suggests the balance of these functional groups may be altered with grazing management. High-intensity low-frequency grazing and similar systems of heavy use followed by rest are hypothesized to reduce plant parasites and increase bacterivores and fungivores. Therefore, the potential exists for reducing root herbivory while increasing nutrient availability. Further investigations will be required before management recommendations can be made, but the possibilities are intriguing.

Ants & Termites

Ants and termites are living examples that big things sometimes come in small packages. Consider the number of ants or termites that might be required to equal the mass of a single cow or elk. Despite the minute size of these individual animals, scientists estimate ants and termites each account for 10% of the world's animal biomass. Managing rangelands without regard for 20% of the animal biomass would certainly be less than prudent.

Definitions

Trophic Pathways—routes of energy transfer from one level of the food chain to another.

Bacterivores—organisms that eat bacteria.

Phytovores—organisms that eat vegetation

Fungivores—organisms that eat fungus

Detritivores—organisms that eat organic material/waste (detritus).

Humivores—organisms that feed on the dark brown part of soil consisting of decomposed plants and animals (humus).

Omnivores—organisms that eat both plant and animal matter.

Lagomorphs—an order of mammals that includes rabbits, hares, and pikas.

Neotropical Migrants—birds that breed in North America and migrate to Central or South America to winter.

Ants and termites are diverse insect groups with respect to the number of species and the functions they perform. Both groups make critical contributions to long-term soil development and short-term soil quality. Many of these effects are centered on their burrowing activities.

For example, soil stability is improved as aggregated soils are moved upward and deposited on the soil surface. Burrowing is also known to increase water infiltration into the soil. The saliva and excrement some species use to form their tubes further alters soil structure and chemistry. Scavenging ants incorporate large amounts of dead animal matter into the soil. In addition to the plant and animal matter they collect, the ants and termites themselves serve as nutrient reservoirs that may be rapidly available for other life forms following nuptial flights.

The diets of ants and termites are highly varied. Some ants are carnivores, feeding primarily on other insects and their eggs, whereas others are herbivores, consuming mostly fresh plant material. On the other hand, termites are detritivores, feeding on dead organic matter and associated microbes.

Annually, 90% of the grass decomposition in West Africa has been attributed to termites. Where they are abundant, termites regulate and may even reduce the amount of organic matter in the soil. However, without termites decomposing dead plant material, we could be knee-deep in detritus. The termites most people are aware of are those that eat dead wood, such as that holding our houses together. However, there are numerous species that feed on intact leaves and stems, and others are classified as humivores. The humiverous species ingest soil and decaying organic matter, much like earthworms, and have similar positive effects on the soil. They are particularly important in temperate systems.

Even the most basic information about ant and termite effects on soils and plant communities will indicate these tiny animals should not be overlooked. The inherent diversity and sheer volume of these insects are impressive, but the roles they play in the function of ecosystems are vital.

Grasshoppers

Grasshoppers are a microcosm of the large herbivore world. Some have very specific diets limited to a few plant species, but most are somewhat generalist in their food selection. Among the 400-plus species in western North America, there are grasshoppers that eat only grasses, those that consume only forbs and shrubs, and some that feed opportunistically on a mixture of these plant forms.

Despite the potential havoc caused by pest species, it is important to note that out of the hundreds of grasshopper species, only about a dozen regularly cause significant damage and reach outbreak levels in North America. The majority of species tend to be neutral or beneficial in their effects on ecosystems. Grasshoppers add considerably to the diversity of rangelands and provide a concentrated source of protein important to numerous wildlife species. Some researchers have suggested that grasshoppers may even increase net primary productivity through increased nutrient cycling.

Naturally, grasshoppers receive the most attention when they are at outbreak levels and in an advanced stage of development. In such cases, most of the damage has already been inflicted and the forage intended for other animals has been lost. Forage consumption by grasshoppers can be considerable (55 to 380 lb/ac). However, much of the impact is the result of greenfall (vegetation clipped but not consumed), which is generally 1 to 2 times the amount of forage consumed. In other words, grasshoppers under outbreak conditions could increase the stocking pressure to 1.5 AUM/ac above the rate determined for other uses.

Grasshopper outbreaks are not yet as predictable as we would like them to be. Populations vary widely in time and space, with peaks generally occurring in 7- or 8-year cycles. Factors affecting the variability in grasshopper populations include microclimate, disease, and predation. Most of the predation on grasshoppers is from birds and spiders. Weather is the common connection among these factors, yet it explains outbreaks only about 30 to 35% of the time. The activity budgets and hatching dates of grasshoppers are highly temperature-dependent. Excessive cold or heat causes grasshoppers to invest more time toward activities regulating body temperature and less time feeding and breeding. Since hatching dates are based on the number of degree-days, warm spring temperatures can cause an early hatch and hasten development. Moisture also plays a large role in grasshopper populations because of their susceptibility to fungal disease encouraged by moist conditions.

Researchers are currently using this information to develop grazing systems that will alter the microclimate and reduce the frequency and intensity of outbreaks. There is also some indication that prescribed fire may selectively control some pest species. Ongoing research should allow improved moderation of pest species populations and provide greater insight on the role grasshoppers play in the integrity and function of rangeland ecosystems.

Small Mammals

In terms of diversity, biomass, and ecological interactions, small mammals are significant components of rangeland ecosystems, yet research on these animals has lagged far behind that focused on charismatic megafauna (larger, more visible wildlife species). This lack of scientific information has resulted in minimal consideration by range managers with regard to the habitat requirements and impacts of these species.

Fig. 1. ***Although rodent species can collectively remove 30 to 50% of the net primary productivity in rangeland ecosystems, some species, such as the kangaroo rat pictured here, can significantly enhance the seed germination of desirable plant species.***

Rodents may remove 30 to 50% of net primary production in grassland ecosystems by consumption of foliage, seeds, bulbs, and roots. But some scientists have estimated that only a fraction of small mammal impacts in grasslands are caused by consumption, especially during short-term population highs. For example, burrows can accelerate erosion, reduce plant vigor, disrupt irrigation, and cause livestock accidents. Some vegetation is removed and not consumed ("waste cutting"), and den areas are frequently denuded. It should be obvious that some rodent species can have detrimental effects on rangeland forage and adjacent croplands.

On the other side of the ledger, several rodent species are especially important because they increase soil aeration, deepen soils, improve soil water holding capacity, and recycle nutrients. Rodents can also enhance plant germination and recruitment, change plant community structure, and increase plant biomass and species diversity. At least seasonally, various rodent species are an important enough component in the diet of large predators like coyotes that their availability may take predation pressure off livestock.

Although debate over the health of rangeland has often focused on the role of livestock, long-term experimental studies in southern Arizona and New Mexico illustrate that cattle can have relatively small impacts on the structure of many arid and semi-arid ecosystems. Interestingly, experimental studies indicate that climate is of overwhelming importance, with small mammals playing an important role in mitigating climatically driven vegetation change.

In essence, through burrowing and direct harvest of seeds and vegetation, small mammals redistribute resources spatially and temporally within these ecosystems. Some rodent species actually enhance the germination rates of seeds by removing seed coats and caching seeds in "safe-sites" that promote seedling growth. However, they also eat the new coleoptiles that emerge from these caches.

Prairie Dogs

Prairie dogs can exert variable impacts on rangelands. These rodents can decrease soil compaction and increase soil aeration. Also, soils in prairie dog colonies may be richer in nitrogen, phosphorus, and organic matter than soils in adjacent rangelands. In some parts of their range, prairie dogs can affect plant structure and composition by destroying tall vegetation. These rodents can also stimulate the growth of new plant tissue, which usually has higher nitrogen concentration and greater digestibility than that of ungrazed plants. Several researchers have noted that prairie dog towns have greater plant species diversity than similar habitats without these rodents, but these effects vary by location. Where diversity is increased, it is typically through increased forb production.

Fig. 2. ***Prairie dogs can improve soil characteristics, stimulate forb production, and even improve forage quality, but these rodents can also denude large areas and compete with livestock for forage.***

Burrowing by prairie dogs can contribute to deepening of soils by bringing subsoils to the surface where leaching, mixing, and distribution occur. The associated loosening of the soil admits air and water to plant roots. The interaction of these animals with the soil may reduce soil erosion by improving the water holding capacity of soil. In turn, greater vegetation cover may be produced, depending on the age of the colony and vegetation prior to colonization.

On the other hand, prairie dogs clip shrubs and tall grasses to increase their visual ability to detect predators, reducing the most productive plants to ground level. This can lead to large denuded areas and elevated soil temperatures. Colonization by prairie dogs can also cause a decrease in plant biomass, a change in plant composition from perennial grasses to forbs and annual grasses, a shift toward C_4 photosynthetic species, and higher silicon concentrations in forage.

The geographic range of black-tailed prairie dogs in North America largely coincides with that of the mixed prairie and shortgrass steppe. Many of the dominant plant species of these grasslands, particularly perennial grasses, are important components in the diets of prairie dogs, cattle, sheep, and other large herbivores. In spite of relatively high dietary overlap between prairie dogs and livestock, consensus has not been reached concerning the degree to which prairie dogs affect livestock production. In part, this confusion may result from the fact that heavy grazing by prairie dogs substantially reduces the biomass of most dominant grasses within a colonized area, but may simultaneously increase forage quality (e.g., crude protein concentration, digestibility) of those same species.

The extent to which each of these potentially offsetting effects occurs likely depends on the ecosystem involved (e.g., shortgrass steppe vs. mixed grass prairie) and recent years' weather patterns. Although prairie dog grazing has not been proven to reduce livestock weight gain, simulation modeling of a 5,200-ac pasture in South Dakota suggested that cattle carrying capacity would be reduced by about 2 cow-calf years for each 49 ac of land colonized by prairie dogs. It is easy to see why contrasting opinions exist about the impacts of prairie dogs on rangelands.

Rabbits & Hares

Black-tailed jackrabbits, white-tailed jackrabbits, and cottontail rabbits are the most common lagomorphs on western rangelands. Of these, the black-tailed jackrabbit typically exerts the greatest impact on forage resources. Black-tailed jackrabbits are opportunistic feeders that select for succulence. Though associated with rangeland vegetation, they are known to preferentially use cultivated crops and grass seedings when available. In high densities, they can cause extensive damage to agricultural production.

Fig. 3. ***Black-tailed jackrabbits are opportunistic feeders that select for plant succulence. High populations can compete with livestock for forage, but also serve as a "buffer species" that reduces predation pressure on livestock.***

Cultivated crops adjacent to rangeland vegetation, where jackrabbits can hide from predators, are especially vulnerable to depredation by these lagomorphs. Research in central Nevada showed that black-tailed jackrabbits consumed up to 178 lb/ac of crested wheatgrass seedlings where alternative forage was scarce and jackrabbit numbers were high. During such population peaks, jackrabbit concentrations may be significantly higher near such a preferred food source.

Estimates of jackrabbit foraging potential in the literature are highly variable, with reports that 6 to 31 black-tailed jackrabbits consume as much forage as one ewe, and 55 to 392 of these animals consume as much as one cow. The greatest direct competition for forage between jackrabbits and cattle occurs in early spring when both species prefer succulent vegetation. High jackrabbit populations can also damage haystacks in winter by eating and thereby undermining the base of the stacks, causing them to collapse or allowing water and other unwanted material to accumulate under the stacks.

The benefits of jackrabbits are often unheralded. Even blacktailed jackrabbits, considered by many ranchers to be pests, are beneficial in several ways. In addition to being a source of sport hunting, food, and fur for humans, jackrabbits also constitute the major prey base for some mammalian predators, especially the coyote. As such, they may serve as a "buffer species," taking at least some predation pressure off livestock during high jackrabbit population peaks. Jackrabbits sometimes kill shrubs by stripping bark and clipping off branches, thus reducing competition for desirable grasses and forbs. They can also influence secondary succession in a positive way in denuded areas by dispersing seeds in fecal pellets and increasing the viability of some seeds through their digestive process.

Birds

Very few rangeland birds are true "grazers" in the strict use of the term. However, with regard to sagebrush habitat, sage grouse are the exception. During winter, these birds are "browsers," eating the leaves of sagebrush almost exclusively. During the breeding season, they eat the leaves, buds, and flowers of associated forbs and grasses. True omnivores, sage grouse also dine on insects, especially during the summer. Along with sage grouse, three neotropical migrant songbird species (sage sparrows, Brewer's sparrows, and sage thrashers) are considered true sagebrush obligates, requiring sagebrush for at least some part of their life cycle. Approximately 100 bird species may use portions of sagebrush habitat throughout the sagebrush ecosystem. Sage grouse nest beneath sagebrush, whereas the other three obligates require sagebrush as a nesting stratum. The neotropical obligates eat primarily seeds and/or insects.

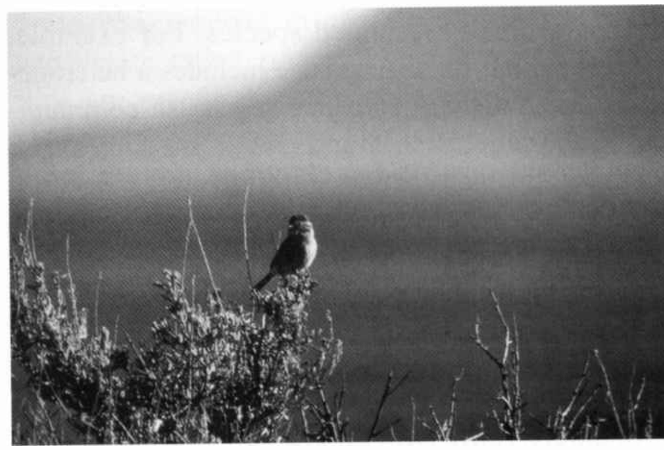

Fig. 4. ***Brewer's sparrows are one of four bird species considered to be sagebrush obligates. They require sagebrush for nesting structure and are closely associated with sagebrush habitats having abundant scattered shrubs and a perennial grass understory.***

Scientists are just beginning to discover the ecological importance of rangeland birds and their delicate relationships with habitat disturbance. For example, in the sagebrush ecosystem much of the original distribution of sagebrush has been fragmented or lost due to agriculture, urbanization, and natural resource use, or converted to expanses of exotic annual grasslands. Alteration of disturbance regimes (e.g., wildfire) has changed the composition of sagebrush communities as well as the landscape configuration. Consequently, populations of birds dependent on sagebrush ecosystems have declined, and many species now receive special conservation status. The mechanisms causing population declines are not clearly defined.

Complicating this picture is the fact that habitat requirements differ among sagebrush obligates and other sagebrush-associated species. For example, optimal habitat for sage grouse includes a heterogeneous combination of diverse sagebrush communities (i.e., sagebrush stands with varying shrub heights and canopy cover and a diverse understory of perennial grasses and forbs). The proportion of sagebrush, perennial grasses, and forbs in an area varies with the species or subspecies of sagebrush, the ecological potential of the site, and condition of the habitat. Sage sparrows, Brewer's sparrows, and sage thrashers all require sagebrush for nesting, with nests typically located in the sagebrush canopy. Sage thrashers typically nest in tall dense clumps of sagebrush within areas having some bare ground for foraging. Sage sparrows prefer large continuous stands of sagebrush, and Brewer's sparrows are associated closely with sagebrush habitats having abundant scattered shrubs and short grass.

Food limitations or competition with other grazers may not be significant factors affecting birds in sagebrush rangelands. Although insects are important components in the diet of sage grouse chicks and songbird nestlings, the bird community consumes only a fraction of available biomass. Therefore, food may be limiting only during years of extreme weather and periods of ecological crises.

Similarly, most songbird populations likely do not reach high densities because of external factors such as mortality outside of the breeding range (i.e., in central and South America). One hypothesis is that the loss of sagebrush landscapes causes population declines primarily due to behavioral responses to habitat fragmentation and secondarily through changes in habitat composition. Songbirds dependent on sagebrush habitats are highly sensitive to landscape configurations at scales much larger than that within which individual home ranges are embedded. Similarly, greater sage grouse may respond to habitat fragmentation at regional scales.

Because landscape configuration is an important component regulating spread of exotic vegetation or facilitating disturbance such as wildfires, birds associated with sagebrush ecosystems may be extremely important as indicators of larger-scale changes and predictors of potential collapse in these systems.

Managing for the Other Grazers

There are few examples of land management that take into consideration the value of "other grazers" in making land management decisions. One exception is the Red Canyon Ranch in Wyoming, where management for non-ungulate wildlife species, including invertebrates, is considered an integral part of the operation. The ranch manager (Bob Budd) understands the assets and liabilities that insects can bring to a western rancher's operation. Specifically, pollinating insects are acknowledged as indispensable to hay production, while grasshoppers may have devastating economic impacts during years of high infestations. However, Budd acknowledges that grasshoppers have also had a significant impact on the area's noxious knapweed population.

The ranch works to balance economics, ecology, and culture. Because of this approach, nongame species like beaver, smaller rodents, songbirds, and even predators are viewed as having a proper niche and role in the ranch's ecological setting. Management sees the resilient beaver population as an integral component to healthy riparian systems. Other rodents, as long as they are not at cyclic highs, function to aerate the soil and serve as a prey-base for both avian and mammalian predators, reducing predation on livestock. The ranch manages vegetation to provide the vertical and horizontal diversity required for diverse songbird species that prey on insects and provide esthetic value.

Collectively, these "other grazers" are considered qualitative indicators of ecosystem health – the presence or absence of some species sometimes indicating whether the system is declining, static, or rebounding. In a utilitarian sense, the "other grazers" are considered another tool in rangeland management, along with hoofed animals, rest from grazing, fire, and other technology.

Conclusions

General nutritional needs, expressed as animal-unit months (AUMs), are known for most kinds, ages, and types of livestock and have also been developed for most ungulate wildlife species. Allocation of forage to meet the nutritional needs of livestock is a primary focus of ranchers, range conservationists, range ecologists, and others who are engaged in grazing land management. Development of annual and long-term grazing plans often hinges on the availability of forage. However, we know there is a myriad of "other grazers" on rangeland landscapes. These non-hoofed species must also satisfy their life history requirements on the land they share with their larger, hoofed, grazing brethren.

The information reviewed in this paper suggests that range managers should focus not just on the role of livestock in rangelands, but also on the interaction of livestock with native grazers, even the smaller ones. Instead of just "competing for forage" as they have been characterized in the past, these "non-charismatic microfauna" are important ecosystem stabilizing and sustaining agents and thus are essential to the maintenance of healthy rangeland ecosystems. The interactions of these other grazers in rangeland ecosystems are more complex than ever imagined, and we are just beginning to scratch the surface with our current understanding.

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