V.1 The Importance of Grazing Strategies to Grasshopper Management: An Introduction

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For some rangeland ecosystems, certain grazing-management strategies appear to offer great potential for reducing periodic grasshopper outbreaks. For most of the prairie grassland ecosystems, grasshopper densities tend to increase with drought and grazing intensity. In several different studies since 1940, grasshoppers have been reported as being most abundant during dry seasons in heavily grazed pastures. The study sites included mixed-grass prairie in Montana and Oklahoma, tall-grass prairie in Kansas, and fescue grassland in Alberta (see Onsager 1987 and Kemp 1992).

In the Montana studies, grasshopper densities generally were inversely proportional to plant height and amount of cover. Therefore, grazing strategies that manipulate the time, rate, and severity of forage harvest can, in turn, affect the time, rate, and degree to which prairie rangeland habitats are improved for grasshoppers.

For some rangeland ecosystems, an almost opposite situation appears to be true. Examples include short-grass prairie in Arizona (Nerney 1958) and Colorado (Capinera and Sechrist 1982) and Intermountain sagebrush-grass range in Idaho (see V.2), where food supply usually limits grasshopper density.

During dry or normal seasons in food-limited habitats, densities generally are low but tend to be highest in ungrazed or lightly grazed pastures. Infestations tend to increase during years with above-normal precipitation and above-normal forage production, but it is not practical to attempt grasshopper suppression through removal of forage with livestock (see V.6). Periodic grasshopper outbreaks, therefore, probably will continue in such habitats regardless of the presence or intensity of livestock grazing.

Hart et al. (1987) discuss some relationships between grazing management and pest management: The primary forage plant species determine to a large degree what pest species will be of most importance, the return from grazing management affects the resources available for pest management, and good grazing practices should maintain vigorous plant communities that resist pest outbreaks and recover from attack.

Hart's team also discusses five "families" of grazing strategies, four of which involve systems for rotation or alternation of periods of grazing versus no grazing. The fifth strategy is continuous or season-long grazing.

Perhaps the primary criticism of continuous grazing is that the plant species most preferred by livestock tend to be grazed and regrazed at the same growth stages year after year. This repetitive selection favors growth of plant species that are less palatable or species with unique competitive advantages and, consequently, favors the same species of grasshoppers year after year.

The boundaries between proper, sustainable, season-long grazing and abusive grazing usually are not clear and can vary from season to season. Management options are largely limited to adjustments in herd size, an option that may or may not stop the abuse. (Reducing the herd size could simply alter the number, area, or distribution of patches where abuse continues unabated.) Because frequent lapses into an abusive scenario can favor undesirable plant species, such lapses can favor undesirable grasshopper populations as well. In fact, the ability to thrive in disturbed habitats is a prominent characteristic of many of the grasshopper species that cause the highest levels of damage. Therefore, the continuous grazing strategy does not seem to offer much opportunity for proactive grasshopper management.

Hart's four "families" of grazing systems include (1) rotationally deferred grazing (grazing is not allowed in selected pastures until after a certain interval, and the deferment is rotated among pastures), (2) rest-rotation grazing (rest periods with no grazing intended to allow seed production and seedling establishment are rotated among pastures), (3) high-intensity, low-frequency grazing (heavy, nonselective grazing is followed by a relatively long period of rest before the next grazing), and (4) high-intensity, short-duration grazing (relatively short periods of intense grazing are interspersed between relatively short periods of rest). Devised in different rangeland ecosystems to meet different goals and objectives, these four grazing systems seem to share some common goals. These include improvement of range condition, maintenance of plant diversity, and avoidance of repetition, all of which are compatible with sound grasshopper management.

Besides providing a food source, plant canopy can affect grasshopper microhabitat in many ways. Thanks to both direct experimentation and modeling studies, we can now predict some of the responses of grasshoppers to grazing. High diversity in canopy structure and plant species composition tends to support high diversity in grasshopper species (Joern 1979, Pfadt 1982). This diversity and composition tend to provide stability and to suppress pest species that exploit disturbance.

Canopy removal increases solar radiation of the soil surface and increases airflow over the ground. Thus, canopy removal increases both soil and air temperatures and decreases relative humidity for grasshoppers. All of this is favorable to pest grasshopper species because sunlight and low humidity discourage important grasshopper pathogens and because higher temperatures accelerate grasshopper egg development, growth, maturation, and egg production. Canopy removal also can affect basking sites, which provide for early morning thermoregulation (to hasten grasshopper warmup); perching sites, which provide for avoidance of high midday temperatures; and availability or frequency of sites favored for egg-laying (some species require patches of bare soil).

The preceding two paragraphs suggest that any range-management practice that significantly opens up the prairie grassland canopy will tend to favor one or more pest grasshopper species. Therefore, the possibility is unlikely that any grazing strategy, season-long or systematic, can negatively affect every pest grasshopper species in every pasture during every season. However, some attributes of grazing systems should provide some benefits in all pastures every year. Both deferment and alternation of grazing can manipulate the time, rate, and degree of defoliation, and these factors affect the timing, rate, and degree of improvement in habitat for discouraging increases in pest grasshoppers. Both strategies also can prevent repetitively favoring the same pest species for consecutive seasons. Even subtle changes in microhabitat can cause significant decreases in grasshopper development rates and survival rates, and reducing these rates can not only increase the interval between periodic outbreaks but also decrease their intensity and duration.

Different grazing systems can rely on different mechanisms to achieve similar goals. For example, in eastern Montana, Banister (1991) essentially uses periodic high-intensity grazing to increase his forage base (he forces utilization of unpalatable forage, which is about as nutritious as palatable forage). He then uses long periods (about 23 months) of rest to allow plant recovery and to generate plant litter and a tall, dense canopy, which discourage grasshoppers.

Meanwhile, in western North Dakota, Manske (see V.7) promotes use of a "twice-over" rotational grazing system that he developed specifically for use in the northern Great Plains. He allows grazing during a critical period of plant growth to induce subsequent increases in total forage production. The system increases cover and encourages the reproduction of preferred forage (the grasses that are preferentially grazed are selectively induced to produce tillers). The heavier canopy created by this rotation of grazing schedules discourages grasshopper populations.

All observations to date indicate that both systems have merit. Infestations on Banister's lands seem to comprise mostly *Melanoplus sanguinipes* (a very mobile species), and the grasshopper densities seem to decrease with length of the rest period and with distance to adjacent cultivated crop- or rangeland under more traditional management.

Infestations affecting Manske's land have been shown to suffer from unusually long periods for development of immature grasshoppers and from rather high daily mortality rates of all stages. Neither system supports pest species that need bare soil for egg-laying. The biggest difference seems to be that the former modifies grazing behavior of the animals while the latter increases production of preferred forage plants. Both systems are ingenious, and both represent creative approaches to the solution of complex, interrelated problems. I hope that their examples will inspire similar integrated management packages that will discourage grasshoppers in other rangeland ecosystems.

The chapters in this section provide an overview of grazing management and the role of grasshoppers in healthy range ecosystems. The introduction of nonnative rangeland plants in the rangeland States unquestionably has had an effect on grasshopper populations, and moisture is a key variable in any range management decision. Grasshopper management through controlled removal of vegetative cover appears to have promise in some situations and may prove to be a key approach to integrated grasshopper management in the future.

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