VII.16 Grasshoppers—Plus and Minus: The Grasshopper Problem on a Regional Basis and a Look at Beneficial Effects of Grasshoppers

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Introduction

From an environmental perspective, grasshopper control in rangelands of the Western United States poses several unique and difficult problems compared to the control of many other insect pests.

- When scientists or land managers speak of grasshoppers, they are not referring to a single pest species but to a group of insects that contains more than 400 species, with as many as 30 to 40 species found in any given area. Some of these species cause economic damage, but most do not; however, current control methods influence all (Lockwood 1993a and b, Carruthers and Onsager 1993).
- None of these insects has been introduced to the West by humans. All are natural elements of a complex ecological system that is highly productive for livestock and wildlife. Therefore, grasshoppers are an important consideration in conservation planning (Lockwood 1993a and b, Carruthers and Onsager 1993).
- While managers often consider rangelands to be uniform grasslands, rangelands can refer to mountain meadows, savannas, forested parklands and shrublands, and steppe grasslands. Rangelands vary dramatically in plant species composition; the amount, frequency, and annual distribution of precipitation; and forage production.

Seeking or expecting a single control strategy for pest grasshoppers may be fruitless. Grasshoppers form a diverse group of species that inhabit a diverse group of habitats. Advocating the elimination or dramatic reduction in grasshopper numbers, even if this action were biologically and economically feasible, could be destructive to the very ecological system whose production we are trying to maintain and exploit (Lockwood 1993a and b, Mitchell and Pfadt 1974). Consequently, control may not be a desirable goal. Management may be the more appropriate perspective.

Grasshopper management should attempt to minimize competition for forage between grasshoppers, livestock, and wildlife in cases when most rangeland production is needed for livestock and wildlife. Of course, all forage that grasshoppers eat cannot be consumed by livestock and wildlife. Grasshoppers have an important role in the ecological processes that make U.S. rangelands so productive. Shifting the management viewpoint from elimination to suppression is a difficult undertaking but places grasshopper management within the larger context of sustainable ecosystem management and the preservation of biodiversity.

Given past concern over grasshopper damage to rangeland production, one would think that the scientific ability to address the central issues would be much more extensive than it is. Most efforts have focused on control, and perhaps in some cases eradication, of grasshoppers. With the development of commercially produced synthetic pesticides in the 1930's, this focus led to a predominance of studies intended to produce better insecticides and means of application. Such a focus also replaced investigating grasshopper biology in ways that might form a basis for alternate approaches.

An integrated pest management approach must be founded upon the biology of the pest species. The Grasshopper Integrated Pest Management Project has helped provide us with more information on grasshopper control and biology. Project-funded investigators have identified many important questions that a pest manager must consider. Considering such questions is the critical first step in fostering the development of management strategies for particular rangeland locations in the future.

Grasshopper Management Over the Variety of Rangelands

One simple observation from grasshopper studies illustrates the enormous task posed by grasshopper management over the range of species and habitats found in the Western United States. In the southern rangelands, increased precipitation and possibly cooler temperatures appear to increase grasshopper numbers. In northern rangelands, the opposite conditions (warm and dry) appear to increase grasshopper numbers (Capinera and Horton 1989). This comparison covers an immense region and glosses over the variability in vegetation among different areas. There also are other ecological factors that lead to variation in grasshopper numbers and species composition (Joern and Gaines 1990). Furthermore, we have little idea of what particular mechanisms are driving the above patterns (including changes in plant production, plant nutritional value, grasshopper developmental rate, predation rate, fungal infection rate, and more), because the weather variables are no more than correlates with grasshopper numbers (Joern and Gaines 1990).

To illustrate further the problems arising from the diversity of rangeland habitats, there are two other major differences that emerge in comparisons of southern and northern rangelands. In the South, warm-season grasses dominate, and the smaller bodied, slantfaced (Gomphocerinae) grasshoppers are most abundant. In northern areas, cool-season grasses dominate, and the larger bodied, spurthroated (Melanoplinae) and bandwinged (Oedopodinae) grasshoppers are most abundant. Warm-season grasses generally are less nutritious for grasshoppers than cool-season grasses. Slantfaced grasshoppers that dominate in areas with warm-season grasses are better at feeding on these plants. Therefore, the weather correlates observed over the rangelands of the Western United States are further complicated by major changes in vegetation and grasshopper species composition.

The above points illustrate the need to better define the environmental conditions that affect grasshoppers in different regions and the ways that grasshopper populations function. Furthermore, some evidence suggests that rapid, human-induced climate changes could make identifying regional patterns worth little to managers. Climate changes may produce new patterns rather than simple latitudinal displacements of existing patterns (southern rangelands may not simply move northward). Similarly, other human-induced changes in the environment (changes in the abundances of native plant species and introductions of exotic plants and animals) could disrupt observed patterns. Therefore, people need to understand the different processes creating the patterns observed in different western U.S. rangelands. By doing so, managers can anticipate and plan responses to the changing environments, policies and values that will confront us in the future.

The Ecological Role of Grasshoppers

Grasshoppers play an important role in the functioning of rangeland ecosystems (Mitchell and Pfadt 1974). First, results from a variety of studies reveal that grasshoppers typically consume at least 10 percent of available plant biomass. Second, grasshoppers often harvest more plant biomass than they consume, influencing the availability and distribution of litter in the environment. This consumption and harvesting could be deemed negative from the perspective of available plant biomass for livestock production. But such "harvesting" processes can serve important functions for the cycling of nutrients.

Microbes can break down the feces produced by grasshoppers more easily than those produced by larger herbivores, such as cattle or sheep. Grasshopper-generated fecal nutrients are therefore more available for plant production. Also grasshoppers have a shorter lifespan and generally decompose where they die. The nutrients in their bodies return more rapidly to the soil for plant use than do nutrients found in the bodies of livestock. Even when grasshoppers create litter, they are enhancing plant production because increased litter increases the water retention of soils and reduces summer soil temperatures. These phenomena, in turn, enhance plant production by making more water and nutrients available in the semiarid and arid conditions of the West. In total, grasshoppers may exert a positive influence on rangeland plant production.

Grasshoppers selectively feed on different plant species and, consequently, influence the plant species composition of the ecosystem. Sometimes, the grasshoppers harvest plants that livestock prefer. In other instances, grasshoppers consume plants that are poisonous or competitively reduce the abundance of plants preferred by livestock. The selective consumption of different plant species by grasshoppers can change the nutrient cycling dynamics in a rangeland. This change happens because the total nutrient content and decomposition rate of the litter depend on the plant species composing the litter (Pastor et al. 1987). Therefore, selective consumption of certain plant species can have a positive or negative effect on primary production for livestock by changing plant species abundances and nutrient cycling.

Grasshoppers are a major food source for other species that inhabit rangelands, especially spiders, reptiles, birds, and small mammals. Consequently, grasshoppers support other biological components of the ecosystem and influence their ability to affect ecosystem functioning. Again, grasshoppers can positively or negatively influence the biological composition of ecosystems and their productivity for livestock.

With the increasing emphasis placed upon ecosystem management by Federal and State agencies, grasshoppers in the rangelands of the Western United States must be considered in terms of their beneficial actions, not just in terms of their potential to reduce the abundance of forage for livestock. Consequently, pest management cannot be considered in isolation from larger ecological issues. This is especially true when the pest is a natural, coevolved component of the ecosystem, as grasshoppers are in western rangelands. Land managers must explicitly acknowledge that in most years, in most places, most grasshopper species do not harm the rangeland resource; rather they may benefit the resource.

Grasshoppers as a Range-Management Tool

Considering the important role grasshoppers serve in ecosystems, these insects deserve consideration as a tool land managers could employ to enhance rangeland productivity for livestock. First, nutrient cycling must be maintained to preserve or enhance rangeland production, and grasshoppers may aid in this goal. Second, the selective foraging of grasshoppers on different plant species might increase the abundance of plants that are more palatable and beneficial to livestock. Therefore, the negative effects of grasshoppers on forage availability for livestock must be compared against their positive effects on maintaining or enhancing rangelands.

Perhaps the greatest potential of grasshoppers as a management tool may be to alleviate the growing problem of weed control (Lockwood 1993a). For example, it appears that the grasshopper *Hesperotettix viridis* may control the abundance and spread of snakeweed *(Gutierrezia* spp.), rabbitbrush *(Chrysothamnus* spp.), ragweed *(Ambrosia* spp.), and locoweeds *(Astralagus* spp.). The grasshopper *Melanoplus occidentalis* may reduce the abundance of prickly pear cacti. Even more important, grasshoppers may prevent or retard the spread of exotic weeds, as with feeding by *Aeoloplides turnbulli* and *Melanoplus lakinus* on Russian thistle *(Salsola iberica).* Scientists need to investigate more fully the potential benefit of weed control through grasshopper feeding. This area of research could become especially important with the difficult problem of controlling the spread of exotic weeds on rangelands. Weeds compete with native flora, and livestock find many weeds especially unpalatable.

Grasshoppers and Conservation

Clearly grasshoppers can provide many benefits that the public frequently has overlooked for the conservation of rangelands. In addition, there is growing social and political concern for the protection of biodiversity. Concern increases because of unrecognized benefits provided by many species and their important role in maintaining healthy ecosystems, and because these species are an important part of our cultural history and they are esthetically pleasing (Wilson 1989). Finally, there is a growing view in U.S. society that people have an ethical obligation to ensure the continued existence of all species and the ecosystems that they inhabit. The view is that each species has the same evolutionary value as the human species, and ecosystems have the same value as human society (Kellert and Wilson 1993).

Grasshoppers usually are abundant enough to be exempt from threats of extinction. Nonetheless, at least one species of grasshopper that was a very abundant pest appears to have become extinct, the Rocky Mountain locust *(Melanoplus spretus).* This species did not die out from control efforts but probably from habitat destruction caused by agriculture and livestock grazing (Lockwood and DeBrey 1990).

Not many years ago, the loss of the Rocky Mountain locust was considered a benefit. Today, many view this loss with apprehension. Few people would wish a return to the state where this species destroyed croplands, but the public can no longer experience, even on a small scale, the swarms that darkened the skies and stopped transcontinental railroads as told as part of America's national heritage and folklore. More importantly, the loss of the Rocky Mountain locust means that an important element of the Nation's pristine rangelands has been lost, and the loss exemplifies the general assault upon natural environments, especially rangelands, by human actions.

For example, exotic plant species have almost entirely replaced the native annual grasslands of California. Only remnants of tallgrass prairie remain, and the introduction of exotic plants threatens most other western rangelands. What will happen to the native grasshoppers that inhabit these ecosystems? Several species of monkey grasshoppers in native desert grasslands are considered threatened and may eventually be listed for protection under the Endangered Species Act.

The decline of grasshoppers also affects other species, especially those that consume them. Recently, the U.S. Fish and Wildlife Service announced that western rangeland birds have dramatically declined in abundance over the last decade, with the numbers of some species decreasing by as much as 70 percent. Many of these birds feed on grasshoppers as adults, and almost all rely heavily on grasshoppers to provision their nestlings. Therefore, the control of grasshoppers must be considered in a broader conservation perspective than forage production for livestock, protection of threatened grasshopper species, and the maintenance of the ecosystem functions provided by grasshoppers. Grasshopper reduction also might harm declining or threatened species that depend on these insects as food (Belovsky 1993).

Conservation concerns are becoming more pronounced in formulating management plans because of legal and social mandates. Therefore, the scope and scale of grasshopper control programs will no doubt become more restricted in the future and will require consideration of far more than the short-term economic costs of grasshopper consumption of livestock forage.

Questions for the Future

One certainty for the future is that grasshopper management will be changing. There will be little "business as usual."

- The methods of grasshopper control will change as society becomes more concerned with environmental degradation and the protection of all native species. Therefore, new and innovative control methods that are environmentally sound will need to be found and used.

- Grasshoppers, as native components of rangelands, will no longer be considered solely as pests to be suppressed or eradicated, but as important elements for the functioning of our natural ecosystems. Furthermore, society is beginning to view all species that are part of our native biodiversity as having esthetic value, as providing a reflection of our national heritage that deserves some level of protection, and as requiring protection from an ethical perspective. The short-term economic costs/benefits of pest control to livestock production will become less important in decisionmaking and more subject to review by society.

- The general patterns of grasshopper abundance in different regions will change if humans change the global climate as projected by many scientists. Therefore, managers must act in places and ways previously unanticipated. The result is that pest managers need to adopt a broader perspective of their role, become more flexible in their actions, and view the changing environment as an exciting challenge, rather than a hindrance.

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