University of Wyoming
Department of Ecosystem Science and Management

In Cooperation With

USDA APHIS PPQ, and the
Cooperative Agricultural Pest Survey Program

Distribution Atlas for Grasshoppers and Mormon Crickets in Wyoming 1987-2021

Lockwood, Jeffrey A.
McNary, Timothy J.
Larsen, John C.
Zimmerman, Kiana
Shambaugh, Bruce
Latchininsky, Alexandre
Herring, Boone
Legg, Cindy

Revised April 2022

Revisions consisted of updating the distribution maps. Text was revised only to indicate information pertaining to this revision such as contributors and dates.

Introduction

Although the United States Department of Agriculture's Animal and Plant Health Inspection Service has conducted rangeland grasshopper surveys for over 40 years, there has been no systematic effort to identify or record species as part of this effort. Various taxonomic efforts have contributed to existing distribution maps, but these data are highly biased and virtually impossible to interpret from a regional perspective. In the last thirty years, United States Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine Program (USDA-APHIS-PPQ), Cooperative Agricultural Pest Survey Program (CAPS), and the University of Wyoming have collaborated on developing a systematic, comprehensive species-based survey of grasshoppers (Larson et al 1988). The resulting database serves as the foundation for information and maps in this publication, which was developed to provide a valuable tool for grasshopper management and biological research.

Grasshopper management is increasingly focused on species-based decisions. Of the rangeland grasshopper species in Wyoming, perhaps 10 percent have serious pest potential, 5-10 percent have occasional pest potential, 5 percent have known beneficial effects, and the remaining species have no potential for economic harm and may be ecologically beneficial. Given that some 80-85 percent of the grasshopper species are "nontargets" with respect to management, information on species distributions is essential to efficient and defensible pest management strategies. In this regard, there are five types of information that the manager can extract from this publication:

1) For a given pest species, the distributional information in this document may be integrated with R. E. Pfadt's (1988-2002), Field Guide to Common Western Grasshoppers

(available through the University of Wyoming). In this manner, the distribution of each species can be considered in context of the organism's biology and pest potential.

2) For all species, including those not covered in the Field Guide, the maps are accompanied with a brief description of the grasshopper's biology, ecology, and damage/benefit potential. This information will also allow the manager to interpret the maps with particular attention to those species of greatest economic concern.

3) The distribution maps of the primary pest species in Wyoming reveal important ecological relationships. In particular, it is apparent that most of serious pest species have very broad distributions, and some are statewide. A few important pests are restricted to particular geographic regions, and this information should be incorporated into the timing and assessment of grasshopper surveys.

4) Perhaps one of the most striking realizations from these maps is the diversity of the acridid fauna of Wyoming. Given the mandate that federal lands will be managed in context of preserving and enhancing biological diversity, the information on the distribution and location of grasshopper species should be of significant use to both pest and wildlife managers.

5) Mapped distributions indicate that most species are restricted to particular geographic or ecological regions that are delimited by natural barriers. These regions include the western mountain ranges (Salt, Snake, Wind River, and Wyoming), the Big Horn Basin, the Big Horn Mountains, the Thunder Basin grasslands, the Platte Valley region, and the Red Desert. Several beneficial and pest species are found only or primarily in a subset of these regions, and this information should be useful in guiding survey programs.

The scientific research community should also find this publication of considerable value. Given the paucity of information on grasshopper distributions, these maps should provide important insights for the formulation and testing of biological theories. There are at least six areas of research that can be well-served by this series of maps.

1) Zoogeographic studies will be essential in identifying the boundaries that limit the grasshopper species distributions. In some cases, the boundaries are evidently gross geological features. However, there are many species that have distribution patterns that cannot be explained simply by topographic features. Understanding the roles of elevation, vegetation, and climate on grasshopper distribution is a complex and vital issue in ecology.

2) Studies of evolution and speciation are clearly suggested by the distribution of some grasshoppers. It appears that some species are geographically isolated, and the possibility of evolutionary divergence and ongoing speciation is an area of tremendous research potential.

3) From a taxonomic perspective, the collection of particular species for systematic studies should be facilitated by the distribution maps. General regions or habitats most likely to harbor particular species can be gleaned from the maps. In addition, extremely specific distributional data (latitude and longitude) corresponding to each plotted location can be requested from the Wyoming Grasshopper Information System, (WGIS), (Larsen et al, 1988).

4) Ecological insights regarding the habitat and food preferences of grasshopper species can be inferred from the distributional maps. Clearly, some grasshoppers flourish in habitats that support particular plant communities. These maps also suggest some interesting possibilities of niche partitioning among related grasshopper species.

5) The structure of grasshopper communities is a topic of great interest in insect ecology and management. From these maps, it is possible to begin to understand the overlapping distribution patterns that give rise to regional community structure. The possibility of antagonistic and cooperative ecological relationships between species may be initially inferred from careful study of the overlapping and exclusionary species distributions.

6) The previous research topics can be addressed in isolation, but there is also the potential for integrating two or more of these essential biological questions through the use of a Geographic Information System (GIS). Using GIS, large-scale, interacting factors (e.g., precipitation, temperature, soil type, etc.) can be studied with respect to their role in defining the distributional patterns of grasshopper species, guilds, and communities.

Any use or interpretation of these distribution maps must take into account the manner in which the data were collected. The database was not developed without bias, and therefore the maps may be more directly interpretable to the manager than to the researcher. However, we believe that these maps represent the most comprehensive, ongoing, geographical database of grasshopper distributions in existence. As such, we look forward to widespread and collaborative use of this information, and we encourage the development of similar databases in other states and regions.

Data Collection, Storage, and Map Production

These maps were generated from the identification data from 14,997 bulk grasshopper collections taken during 1987-2021. (Figure 1). The data resulted from the identification of 443,619 grasshoppers during this period. These data are stored on the Wyoming Grasshopper

Information System (WGIS) database and the distribution maps were generated using ArcGIS 10.7 as a part of the Cooperative Agricultural Pest Survey (CAPS) program in Wyoming.

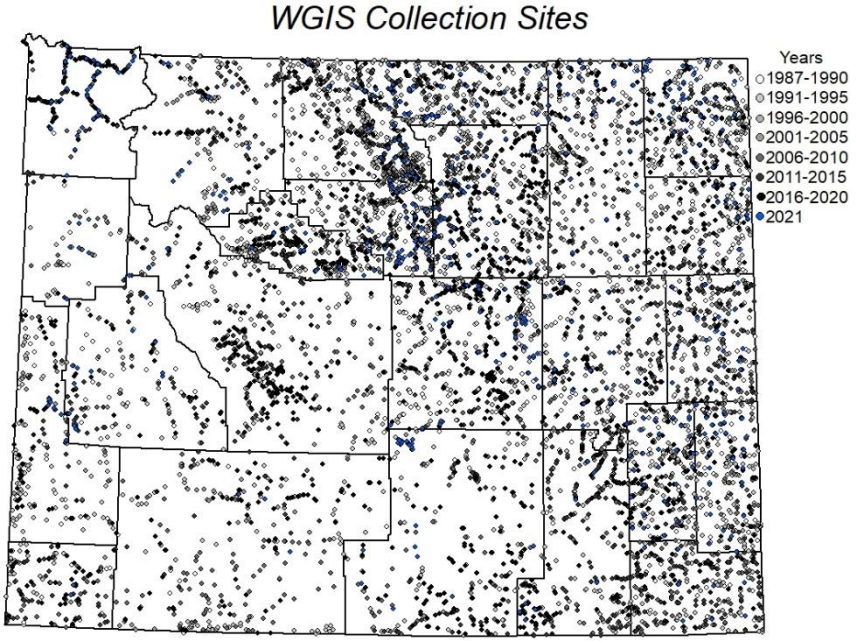

Figure 1. Grasshopper collection sites in Wyoming.

Most of the collections were made during the Adult Grasshopper and Mormon Cricket Survey conducted in support of the Cooperative Grasshopper Management Program.

The remainder of the collections were "special collections" taken in conjunction with other APHIS survey activities, University of Wyoming research projects, and personal collecting efforts. These collections were not conducted in accordance with the Guidelines of the Adult Grasshopper and Mormon Cricket Survey.

During this survey approximately 107 state records and 1,348 county records were established.

Identification

The taxonomy followed for Gomphocerinae (slantfaced) was Otte 1981, Otte 1984 for Oedipodinae (bandwings) and Pfadt 1986 for Melanoplinae (spurthroated). The identifications were from field frozen specimens. Unidentified nymphs and female Melanoplus are not included in the maps. A limited number of voucher specimens of each species are permanently mounted at the PPQ Office in Cheyenne, Wyoming or at the University of Wyoming's Rocky Mountain Systemic Entomology Laboratory. Tim McNary, Boone Herring, John Larsen, Kathleen Meyers and Bruce Shambaugh from PPQ were responsible for the majority of identifications. Verification of some species was done by Dr. Robert Pfadt (University of Wyoming), Dr. Daniel Otte (Academy of Natural Sciences, Philadelphia), and Dr. David Nickle (US National Museum).

The Limitations in the Survey

Survey and collection efforts varied greatly from year to year, due to available time and funding. For example, when there was little or no funding, as was the case in 1999, zero collections were made. During years of heavier grasshopper outbreaks, funding was more available and a greater amount of time and energy was spent conducting surveys and obtaining collections. In 1991, 751 collections were taken.

1. Timing

The greatest portion of the sampling was timed to ensure maximum data collection for the important damaging species found on Wyoming rangelands. In excess of 85 percent of the collections were taken from July 1 to August

20. This means that for species which overwinter as nymphs or adults, and for very early-hatching species, natural mortality would have reduced numbers significantly by the time survey activities were underway in early July. Late-season species (those that would be present as adults from late August and into the fall) are also underrepresented because of timing. Records of species with this seasonality (spring or fall) are predominantly from the "special collections."

2. Collection Site Selection

The survey guidelines for the APHIS-conducted adult grasshopper survey direct the surveyor to collection sites in which the rangeland vegetation is "typical of the rangeland area being surveyed." Surveyors are also directed away from collecting at "roadsides, stream banks, wet areas, weedy areas, and cropland." The impact of these guidelines is that grasshopper species associated with typical rangeland vegetation are well represented and that species preferring other habitats may be underrepresented.

3. Geographic Areas of Concentration

Figure 1 shows all the collection sites from 1987-2021. This map clearly shows the bias in favor of eastern Wyoming and parts of the Big Horn Basin area. These areas are the areas that have both historically, and in the years 1987-2021, experienced grasshopper or Mormon cricket outbreaks. Thus, the survey activities were concentrated in these areas. The desert southwest and mountainous areas had the least collecting effort.

4. Grasshopper Behavior

The primary collecting method employed was sweeping. While sweeping is a good technique for sampling the

majority of economic species, other species may commonly flush ahead of a sweep net and fly long distances. Some species hide in heavy vegetation or on the ground and thus may be underrepresented.

5. Economic Species

The survey was heavily biased in favor of recording the economically important rangeland grasshoppers that occur on Wyoming rangelands. The maps could be considered to be very complete for the economic species occurring in Wyoming's eastern shortgrass and mixedgrass rangelands for these years.

Based on these five limitations, here are some examples of underrepresented species:

- very early spring-hatching species such as *Aeropedellus clavatus*, *Melanoplus confusus*, and *Bradynotes obesa*;

-late hatching species such as *Melanoplus gladstoni*, *Encoptolophus costalis*, and *Trachyrhachys aspera*;

-overwintering species such as *Chortophaga viridifasciata*, *Arphia conspersa*, *Eritettix simplex*, and *Psoloessa delicatula*;

-weed-feeding species such as *Hesperotettix viridis*, *Aeoloplides turnbulli*, *Brachystola magna*, and *Dactylotum bicolor*;

-crop-feeding species such as *Melanoplus bivittatus*, *Melanoplus differentialis*, and *Melanoplus femurrubrum*;

-species that avoid sweep net collecting because of highly active flight characteristics such as *Circotettix rabula*, *Dissosteira carolina*, and many other bandwinged species.

Note that *Schistocerca alutacea*, which was not collected during this survey period but has been historically, is such a strong flyer that sweep net collecting techniques are usually futile;

-species such as *Melanoplus cinereus* and *Hypochlora alba*, which hide in sagebrush, and others that are similarly secretive are underrepresented;

-species underrepresented for geographic reasons include *Melanoplus oregonensis*, *Melanoplus marshalli*, *Trimerotropis suffusa*, and other high-elevation mountain meadow species, and species from the desert southwest such as *Trimerotropis inconspicua* and others. *Boopedon nubilum* is thought to be underrepresented because of its habit of occurring in very spatially limited areas of population that can easily be missed by surveyors;

An example of overrepresentation of an economic species would be *Anabrus simplex,* the Mormon cricket. In most localities where Mormon crickets were observed, a collection was made.

Additional Grasshopper Species in Wyoming

In addition to the 107 species of grasshoppers and the Mormon cricket that were recorded during this survey, 7 other species have been reported from Wyoming and an additional 8 species probably occur here. They are:

-Species previously recorded in Wyoming are:

Circotettix undulatus reported from the Big Horn Basin
Conozoa sulcifrons reported from western Wyoming
Dissosteira longipennis reported from eastern Wyoming
Melanoplus spretus reported extirpated, early 1900s
Schistocerca alutacea reported in southeastern Wyoming

Trimerotropis californica reported in southwestern Wyoming
Tropidolophus formosus reported in southeastern Wyoming

-Species probably occurring in Wyoming are:

Aeoloplides chenopodii probably along the lower Green River
Aeoloplides tenuipennis probably in the Bear River watershed
Dissosteira spurcata probably in extreme western Wyoming
Mermiria picta probably in southeastern Wyoming
Oedaleonotus enigma probably in extreme southwestern Wyoming
Stethophyma celata probably in the Black Hills
Trimerotropis cyaneipennis probably in southwestern Wyoming
Trimerotropis salina probably in southern Wyoming

The Collectors

Josie Anderson, PPQ; Paul Anderson, PPQ; Ray Angel, PPQ; Derek Asche, PPQ; Ely Asche, PPQ; Steve Barkely, PPQ; Tim Barrus, PPQ; Cameron Berry, PPQ; Joshua Berry, PPQ; April Bock, PPQ; Abby Boller, PPQ; Charles Bomar, UW; Timothy G. Bonnel, PPQ; Mike Brewer, UW; Joe Budd, PPQ; Larry Cain, PPQ; Haley Carl, PPQ; Julie Christy, PPQ; Hannah Clapper, PPQ; T. Coles, PPQ; Codie Coon, PPQ; Cody Cox, PPQ; Ron Coy, PPQ; Larry DeBrey, UW; Teresa Doherty, UW; Michael Edwards, PPQ; Brodie Epler, PPQ; Reba Epler, PPQ; Joshua Fearing, PPQ; Russ Ferree, PPQ; Amberle Filley, PPQ; Tom Finnerty, PPQ; Landon Fuller, PPQ; Linda Fuson, PPQ; Jesse Garson, PPQ; Elise Geier, PPQ; Justin A. Gentle, PPQ; Kevin W. Gorzalka, PPQ; Jordan Guyer, PPQ; Steve Hanlin, PPQ; Matt Haun, PPQ; Pake Haun, PPQ; Boone Herring, PPQ; Cody Hoffman, PPQ; Haylee Hoffman, PPQ; Hannah Hopp,

PPQ; Diane Howell, PPQ; Quinn Hunter, PPQ; Kelsey Jenkins, PPQ; Matt Jolivet, PPQ; D. Tom Jones, PPQ; Duane Keller, PPQ; Kathleen King, PPQ; Nicholas King, PPQ; Makala Knox, PPQ; Jessica Knudson, PPQ; Karen Lambert, PPQ; John C. Larsen, PPQ; Robert Lavigne, UW; Kerry Lehto, PPQ; Jeff Lockwood, UW; Troy Marshall, PPQ; Megan McCormick, PPQ; Angela McGuire, PPQ; Timothy McNary, PPQ; Max Merritt, PPQ; Steve Mitchell, PPQ; Isaac Moon, PPQ; Mike Mooney, PPQ; Wayne Mosegard, PPQ; Steve Munn, PPQ; Jeremy Newland, PPQ; Tyler Northrup, PPQ; Hayden O'Hara, PPQ; Daniel Otte, Academy Ntl Sci, Phil.; Clayton Palmer, PPQ; Whit Peterson, PPQ; Robert E. Pfadt, UW; Brittany Randall, PPQ; Margaret Reichenbach (Rayda), PPQ; Lori Reisland, PPQ; Karyn Rieger, PPQ; Brett Ruiz, PPQ; Kayla Ruiz, PPQ; Jane Ryan, PPQ; Bruce Schaffer, PPQ; Dani Schainost, PPQ; Seth Schafer, PPQ; Scott Schell, UW; Bradley Schieck, PPQ; Lynda Schwope, PPQ; Michael (Chad) Sears, PPQ; Bruce Shambaugh, PPQ; Dee Smith, PPQ; Steve Stearns, Jacob Steben, PPQ; PPQ; Kara Stoll, PPQ; Clay Stoner, PPQ; Robert Stuckey, PPQ; Jim Sutherland, PPQ; Cameron Sutton, PPQ; Andrew Tapparo, PPQ; Tiffany Thronburg, PPQ; Jennifer Walker, US Park Service; Jordan Wambeke, PPQ; Timothy Williams, PPQ; Lisa Zezas, PPQ; Jane Zumwalt, PPQ.

References

Capinera, J. L. and T. S. Sechrist 1982. Grasshoppers (Acrididae) of Colorado, Identification, Biology and Management. Colorado St. Univ. Exp. Stat. Fort Collins. Bull. No 584s:1-161.

Gurney, A. B. and A. R. Brooks 1959. Grasshoppers of the Mexicanus group., Genus *Melanoplus* (Orthoptera: Acrididae). Proc. U.S. National Museum 110:1-93.

Hebard, M. 1936. Note: Melanoplus Indigens Group indigens indigens. Trans. Amer. Entomol. Soc. 62:177.

Helfer, J. R. 1987. How to know the Grasshoppers, Crickets, Cockroaches and Their Allies. Third Edition. Dover Publications, Inc., 364 pp.

Larsen, J. C., J. Hutchason, T. J. McNary 1988. Wyoming Grasshopper Information System (WGIS). Computerized Data Base. Univ. Wyoming., Plant Soil and Insect Sci. Dept.

Mills, H. B. and J. H. Pepper 1938. Key to the Grasshoppers of Montana. Montana State College Agricultural Experiment Station, Bozeman, Montana Mimeo. Cir. 9.

Otte, D. 1981. The North American Grasshoppers. Vol. I, Acrididae: Gomphocerinae and Acridinae. Harvard Univ. Press. 275 pp.

Otte, D. 1984. The North American Grasshoppers. Vol. II, Acrididae: Oedipodinae. Harvard Univ. Press. 366 pp.

Pfadt, R. E. 1986. Key to Wyoming Grasshoppers. Acrididae and Tetrigidae. Revised Agric. Exp. Stat. Univ. Wyoming Mimeo Circ 210.

Pfadt, R. E. 1988-92. Field Guide to Common Western Grasshoppers. Wyoming Agric. Exp. Stat. Bull. 912.

Rehn, J. A. G. and M. Hebard 1906. A contribution to the knowledge of the Orthoptera of Montana, Yellowstone Park, Utah and Colorado. Proc. Acad. Natural Sciences (Vol. LVIII, Part II): 358-418.

Richman, D. B., D. C. Lightfoot, C. A. Sutherland, and D. J. Ferguson 1993. A Manual of the Grasshoppers of New Mexico Orthoptera: Acrididae and Romaleidae. New Mexico State University Cooperative Extension Service.

Strohecker, H. F., W. W. Middlekauff and D. C. Rentz 1968. The Grasshoppers of California (Orthoptera: Acridoidea). Bull. California Insect Survey 10: 1-77.

Wyoming Grasshopper Information System (WGIS), Wyoming Cooperative Agricultural Pest Survey (CAPS) Program, University of Wyoming, Ecosystem Science and Management.

Species Index