

# RECOVERY PLAN FOR THE PRAIRIE MOLE CRICKET,

## *Gryllotalpa major* Saussure, IN KANSAS



Photograph by T.J. Walker, University of Florida

May 2005

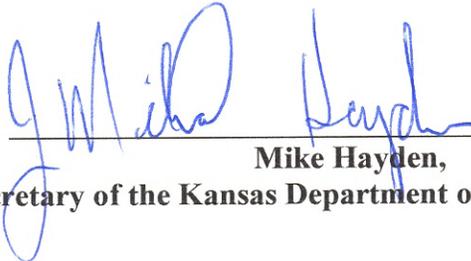
Prepared by

**William G. Layher, PhD., Principle Investigator**  
**Eric Brinkman, Biologist**  
**Kimberly Ruff, Biological Technician**  
**Layher BioLogics RTEC, Inc.**

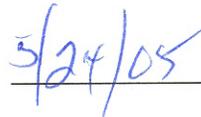
*for*

**Kansas Department of Wildlife & Parks**

Approved: \_\_\_\_\_

  
Mike Hayden,  
Secretary of the Kansas Department of Wildlife and Parks

Date: \_\_\_\_\_



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## **I. INTRODUCTION**

The prairie mole cricket, *Gryllotalpa major*, is considered a “Species in Need of Conservation” (SINC) in Kansas (K.A.R. 115-15-2). The species was formerly known to occur from the southern tall grass prairie region of North America. Its range included areas in Kansas, Missouri, Illinois, Kentucky, Tennessee, Mississippi, Arkansas, and Oklahoma. It is considered extirpated from Illinois, Kentucky, Mississippi, and Tennessee (Figg and Calvert 1987).

## **II. SPECIES ACCOUNT**

### **A. TAXONOMY DESCRIPTION**

#### **1. Original Description**

Earliest records of the prairie mole cricket are from the 1870's with specimens collected from eastern Kansas and southwest Missouri. The type specimen is from Illinois and was collected in 1874 by Saussure (Federal Register 1990). The original description contained the following description of the Illinois specimen: size very large, form robust. Brownish-yellow: pronotum velvety brown, with a faint narrow median groove or oval space smooth, shining and prolonged backward in several lines. Tegmina abbreviated, reaching only the fourth abdominal segment; wings fully developed, surpassing the abdomen. Front legs stout, the trochanter large and of the same shape as in *G. gryllotalpa*. Hind femora more slender than in that species; hind tibiae feebly enlarged at middle, armed as described in key. Claws of hind tarsi equal. Length of body, male, 41; of pronotum 13, of tegmina, 19 mm. Width of pronotum, 10 mm.

#### **2. Taxonomic Description**

The prairie mole cricket is in the Kingdom: Anamalia; Phylum: Mandibulata; Class: Insecta,; Order: Orthoptera; and Family: Gryllotalpidae. Adult prairie mole

crickets are some of the largest insects in North America. They measure up to 2.5 inches in total length (Figg and Calvert 1987). A similar but smaller mole cricket, the northern mole cricket (*Gryllotalpa hexadactyla*), can sometimes be distinguished from the prairie mole cricket by size, with the later ranging from three-fourths of an inch to 1.4 inches in total length. Prairie mole crickets may weigh up to 2.6 grams (Walker and Figg 1990).

The prairie mole cricket can be distinguished from the northern mole cricket by the shape of a process on the trochanter of the foreleg (Federal Register 1990). This process is knife shaped in the prairie mole cricket and somewhat circular in the northern mole cricket. Hence the basal projection of the fore femur is blade-like.

Hind legs are not modified for jumping, hind tibia has seven spines at its apex with four on the inner and three on the outer side, and forelegs are modified into digging tools resembling forelimbs of the mole, hence its name (Figg 1987). Second and third pairs of legs are fitted for pushing the body through the soil (Gates and Peters 1962). Males and females resemble one another, however males possess fore wings which are modified to produce sounds. The female does not produce sounds and possesses the capability of flight while males do not.

Adults are reddish brown or tan. Fore wings are positioned to cover one-third of the abdomen. Under wings extend over the abdomen and curl under the tip of the structure. The mole cricket has small eyes which are closely spaced and located on a small head. Bristles extend back from the abdomen and a pair of antennae project forward from the head (NatureServe 2004).

## **B. Historical and Current Distribution**

### **1. Description of habitats and locations of occurrence**

Caire et al. (1993) suggests a paucity of information concerning either distribution or ecology for the prairie mole cricket. The species was thought to be extinct in 1984 (Federal Register 1990). Figg and Calvert (1987) examined specimens from natural history collections and entomological collections. Based on a review of specimens examined along with notes on locations of collections, they surmised that the species original range included the southwest portion of the tallgrass prairie ecoregion which includes east and central Kansas, Oklahoma, southwest Missouri and northwest Arkansas. Interestingly, the type specimen is thought to be from Illinois, however no other information was recorded on the specimen label. Some additional records of occurrence are known from Mississippi. The Mississippi and Illinois populations are considered disjunct populations (Figg and Calvert 1987). Surveys conducted in 1986 and 1987 produced 63 locations of prairie mole cricket occurrence (Figg and Calvert 1987). Two of those sites were in Kansas, one in Bourbon County on the Hollister Wildlife Area and the other in Crawford County. Subsequent surveys increased the number of known sites in Kansas to 19 sites distributed in nine counties (Busby 1991). Busby (1991) conducted surveys throughout the Flint Hills except along its western edge. Findings indicated good populations in the extreme southern Flint Hills and also in grasslands in counties to the east of the Flint Hills. Populations were noted in the northern Flint Hills in Clay County and former populations were abundant in adjacent Riley County from 1874 until 1933. The historic range of the prairie mole cricket in Kansas has now been reduced to approximately the eastern one-half of the former range. Conversion of

grasslands to croplands has probably reduced the range in part. Interestingly the prairie mole cricket is absent from much of the northern Flint Hills in what still remains large tracts of unbroken grassland. The areas of Clay County and Riley County are not nearly as “rocky” as some other parts of the northern Flint Hills and soil types and depth may play a role in the insect’s distribution. Factors that determine habitat quality remain poorly understood (Busby 1991).

Busby (1990; 1991) indicates that prairie mole crickets are not found in cropland, tamegrass pastures, or woodlands. Populations have been found in grazed pastures, hayed prairies, and idle pasture areas with brushy invasion. Frequency of occurrence data and population density data suggest that prairie hay meadows without grazing are the most suitable habitats for the species. Figg and Calvert (1987) also concluded that prairie mole crickets did not occur in crop fields, old fields, fescue pastures, or forests. Additionally, they found that habitats within prairies that did not support the species included dry loess hills, dolomite glades, wet prairies, marshes, or other frequently saturated soils. They found that most populations occurred in dry-mesic prairies and hardpan prairies. Some plant species that occurred on these sites included big bluestem (*Schizacharium gerardii*) and Indian grass (*Sorgastrum mutans*). Busby (1991) concluded ungrazed prairies with high plant diversity produced greater populations of mole crickets. Vaughan et al. (1993) found that sites containing calling prairie mole crickets contained higher percentages of silt and higher plant diversity than sites which had no calling prairie mole crickets. They hypothesized that silt content is essential for proper burrow construction. This in part may explain the species absence throughout much of the northern Flint Hills. It is unknown however whether or not the species

spends its life in the same areas where calling occurs. Contrary to other studies, Caire et al. (1993) found prairie mole crickets in Oklahoma in heavily grazed pastures, hayfields, closely mowed lawns, front yards, and secondary growth fields. These areas may have represented recently disturbed populations and their persistence is unknown.

## **2. Known Collection Sites**

Specific locations of collection sites of prairie mole crickets were plotted on county maps and provided to KDWP. However, these maps are not included in this report to maintain landowner privacy and to prevent unwanted collection, observation, or disturbance to the species. The Kansas Natural Heritage Program, Kansas Biological Survey maintains records of known locations for Kansas that were used to produce the figures (Table 1). Collections represent primarily the southern Flint Hills and southeastern counties in Kansas. Notable exceptions include Clay County and Riley County in the north-central Kansas.

## **C. POPULATION SIZES AND ABUNDANCE**

Population biology of prairie mole crickets is poorly understood (Figg and Calvert 1987). Most studies documenting occurrence of the species have been based on male calling behavior. In their study, qualitative information indicated the some 15.6 percent of sites exhibited only one calling male; 20.3 percent had very few; and 64.1 percent had good populations. However weather and other factors influence such estimates based on calling patterns. Additionally, Busby (1991) in interviews with observers noted that male calling did not occur with the same frequency or duration on the same areas despite relatively constant weather patterns. Largest populations seem to occur as noted earlier in areas with a low history of grazing. Grazing is thought to compact soils making them less suitable for the burrowing activities. Other research

indicates that largest populations occur in areas that have other suitable habitats in proximity. Relating numbers of individuals to area size has not been accomplished.

#### **D. REPRODUCTION**

Most information concerning reproduction in prairie mole crickets is presumed and has been published by Figg and Calvert (1987). The prairie mole cricket is thought to require two to three years to mature. Studying the life history in the field has proved to be nearly impossible due to the prolonged periods the insect spends underground.

Eggs are thought to be laid during June and July. Hayslip (1943) described egg laying in *N. hexadactyla*, another type of mole cricket, and found 30 to 70 eggs are laid and guarded until hatching. It is thought that *G. major* lays eggs in a similar manner. Nymphs are also thought to resemble adults in miniature and to pass through as many as seven juvenile stages during development.

Mole crickets are active at certain times of the year. A few individuals have been found on the surface during October. Some species of mole crickets may exhibit small fall flights (Walker and Fritz 1983).

Prairie mole crickets surface in the spring for courtship and reproduction. Males and females are similar except for the modified wings of the male, which are used to attract sexually responsive females (Alexander 1975). Calling usually commences in mid-April and continues until the end of May by which time it declines.

Males construct specialized chambers at burrow entrances. These chambers resonate calling sounds. Calls can be heard up to one-fourth of a mile from burrow entrances by humans. Calling appears to last for fifty minutes on the average and commences five to ten minutes after sunset, ending at darkness.

Females conduct flights coinciding with male calling activity. Flights may cover up to five miles in length. Hence suitable habitats for populations within that range may aid dispersal and reproduction. Soil conditions also affect acoustics of the calling chamber. Moisture and temperature affect calling patterns. Males do not call when temperatures are below 17 degree Centigrade or when wind speeds exceed 25 mile per hour. Droughty springs shorten calling periods as do cool temperatures which also reduce female flights. Variability of courtship activity is pronounced from site to site and from year to year. Males which are calling appear to have a clumped distribution which is not related to soil type. Reasons for the aggregations are unknown but may be a result of reproductive success in a former year in a given area.

#### **E. FOOD AND FEEDING REQUIREMENTS**

Figg and Calvert (1987) examined gut tracts of seven males and one female. Crops in all males were empty. Female gut contents were thought to be masticated roots. Other researchers noted empty male guts during breeding activity when specimens can be collected. It is thought that males may cease feeding during courtship but that females may continue to feed to nourish developing eggs. Other analysis of gut tracts indicated both plant and animal material had been consumed. Parts of both insects and spiders were identified. No information is available on differences in feeding between adults and juveniles or between sexes.

#### **F. OTHER PERTINENT INFORMATION AND SUMMERY**

Life history information for the prairie mole cricket is largely based on Figg and Calvert (1987). Current distributional information in Kansas is limited to studies by Busby (1991). Sound of calls has been described by Hill (2000) and related to social interactions within species density (Hill 1998; Hill and Shadley 2001). Information examining chorusing sites in Oklahoma has been published by Vaughn et al. (1993) and Vaughn et al. (1992). Acoustic burrows of *G.*

*major* have been described by Walker and Figg (1990). Survey methods have been compiled by Busby (\_\_\_\_\_) and Figg et al. (1992).

Migratory and local flight patterns have been studied for some related species of mole crickets (Walker and Fritz 1983). Sound patterns and development of capture techniques using sound have been studied for some other species of mole crickets as well (Walker 1982; Matheny et al. 1983; Forrest 1980; Forrest 1983; Walker 1983; Kleyla and Dodson 1978). Genetic differences in calling patterns among species of mole crickets were examined by Nevo and Blondheim (1972). Prairie mole crickets are not considered pests but damage to lawns by imported species of mole crickets has occurred in Florida (Walker et al. 1982).

In summary, prairie mole crickets were first observed in the 1870's with the type specimen originating in Labette County, Kansas. The species appeared in collections throughout approximately the 1930's. At the time of writing the U.S. Fish and Wildlife Service's 1984 Invertebrate Species Notice of Review (49 FR 21664), the prairie mole cricket was thought to be extinct. Figg and Calvert (1987) conducted surveys in 1986 and 1987 and found prairie mole cricket populations in Arkansas, Missouri, Oklahoma, and Kansas. Populations were rated from one to good. The two Kansas populations were identified as a single specimen on the Hollister Wildlife Area in Bourbon County to a good population listed as 20<sup>th</sup> Street Prairie in Crawford County. The U.S. Fish and Wildlife Service proposed the prairie mole cricket for threatened status in the Federal Register, Vol. 55, No. 80 on April 25, 1990. After a series of meetings and comments received from various conservation agencies, the U.S. Fish and Wildlife Service funded several studies to learn more information concerning especially the distribution of the species. Busby (1991) conducted surveys in the Flint Hills of Kansas and found significant populations in the southern portion of the Flint Hills and few populations in the northern Flint

Hills. Other populations were noted east of the Flint Hills in Kansas. Simultaneously, populations were also found in Oklahoma. Additionally, populations were found in some habitats that were disturbed with some native grasses remaining suggesting that the species was not entirely dependent on undisturbed native prairie as originally thought. The U.S. fish and Wildlife Service withdrew its nomination for listing the species as threatened by a notice in the Federal Register, Vol.57, No. 13 on January 21,1992. Their decision was based largely on the surveys of Busby (1991) as well as other surveys in Oklahoma which strongly suggested habitats were not as specific as once thought.

### **III. OWNERSHIP OF PROPERTIES**

Ownership of properties where prairie mole crickets have been found is primarily on private lands. As noted above, one population was discovered on the Hollister Wildlife Area. It is unknown what public lands may contain populations of the prairie mole cricket, however the possibility that the species occurs on public lands within its range is quite good.

### **IV. POTENTIAL THREATS**

The prairie mole cricket is thought to be associated with tallgrass prairies. The decline of prairie undoubtedly played a role in the species decline from its former range. "Sodbuster" provisions of recent farm bill legislation provide deterrents to landowners who might otherwise consider breaking existing rangeland for agricultural production. It would seem that habitats within the Flint Hills of Kansas are relatively stable at present. This coupled with information that the prairie mole cricket can exist on disturbed grasslands with some remaining native vegetation suggest that its current distribution and habitat may not be threatened. Urbanization of prairie land may be the biggest threat to some populations.

## **V. PROTECTIVE LAWS**

### **A. FEDERAL**

No federal laws are in place which afford protection to the prairie mole cricket or its habitats directly. Farm bill provisions aimed at preventing the breaking of virgin prairie afford some indirect habitat protection to some populations of this species. The prairie mole cricket is listed as a category 2 species, which enables the U.S. Fish and Wildlife Service to continue funding studies related to the species. If future studies and data indicate a stable distribution or one expanded from current knowledge, the species would be placed in category 3, which would indicate no current threat to its existence.

### **B. STATE**

The prairie mole cricket is listed as a “Species in Need of Conservation” under Kansas regulations administered by the Kansas Department of Wildlife and Parks. While no habitat protection is afforded the animal, developers and other agencies are notified of the occurrence of species on the species in need of conservation list to try to minimize impacts of development on those species’ habitats. Collecting of the prairie mole cricket is prohibited except as allowed under scientific collecting permit authorization.

## **VI. RECOVERY**

### **A. OBJECTIVES**

The objective should be to eventually remove the prairie mole cricket from the species in need of conservation list due to either additional identifiable populations, designation of no imminent threat to its habitats, or expanded populations through conservation efforts. Should populations show declines respective to past surveys, Section VII; 1; 1.1, 1.2, there would be a

possibility that critical habitat should be established based on the findings of in-depth habitat analysis, Section VII; 2; 2.1, 2.2.

## **B. RECOVERY CRITERIA**

The prairie mole cricket should be considered recovered if continued monitoring suggests no decline or an expansion of known population sites as compared to those found by Busby (1991). Further evidence to support down-listing from a species in need of conservation would be the concurrence of data presented by Oklahoma researchers that suggest the prairie mole cricket may survive in degraded habitats as long as some native grasses remain.

## **VII. NARRATIVE OUTLINE**

### **1. Additional species information needs-Biology-life history**

While the life history of the prairie mole cricket has been published (Figg and Calvert 1987), most of the conclusions in the paper are drawn from a paucity of information, distributional records, and supposition that the species “performs” in a similar manner to other species of mole crickets. This is not to say that the work of Figg and Calvert (1987) is in any way flawed. It simply means that more definitive studies are needed to clearly define the life history of the species. To better understand the organism, items 1.1, 1.2, and 1.3 should be investigated. Knowledge of distribution, habitat requirements, reproduction, dispersal, longevity, and microclimate needs would enhance our understanding of the species needs.

1.1 Determine current distribution of the species in Kansas through additional surveys.

1.2 Conduct surveys of known populations to determine if they are continuing to exist.

1.3 Conduct both field and laboratory studies to determine factors related to reproduction such as timing of mating, egg laying, habitats utilized, dispersal mechanisms, population densities, range of flying females to find mates, etc.

- 1.4 Determine diet of adults and juveniles and feeding habits related to periods of reproduction in sexes.
- 1.5 Determine number of juvenile stages, life span, age of maturity, and related life history data.

## **2. Management activities for maintaining species populations and for species recovery**

Management activities to sustain or enhance populations of prairie mole crickets should be determined. We recommend the following activities associated with this topic:

- 2.1 Examine populations' habitats to determine factors associated with various population levels, even if qualitative assessment of population size is used.
- 2.2 Categorize habitats of occurrence with regard to impacts of land management. Such categories could include grazing scenarios, hay cutting, herbicide-pesticide use, soil disturbance, etc. This information would enhance our understanding of potential habitats utilized by the species. Share this information with appropriate USDA, NRCS, and County Conservation District employees to incorporate into programs administered by these agencies.
- 2.3 Examine Conservation Reserve Plan areas to determine if the prairie mole cricket has the ability to re-colonize habitats that are restored. Based on known probable dispersal of females, CRP lands within five miles of existing prairie mole cricket populations should be surveyed to document possible expansion of populations. If no evidenced of such is found, experiments should proceed to attempt to introduce the species to such CRP lands to determine the possibility of re-introductions to restored tallgrass prairie lands.

2.4 Develop incentives to protect native hay meadows from being turned into “ranchettes” or housing developments as has occurred in some areas such as Montgomery County.

### **VIII. COSTS OF RECOVERY PLAN IMPLEMENTATION**

Additional research is needed to conclusively determine the status of the prairie mole cricket in Kansas. Additionally little is known conclusively about the life history of the organism. Further studies are warranted to document the biology of the prairie mole cricket. Cost requirement to implement the recovery plan can only be estimated as follows.

Item 1.1. Additional surveys are estimated at \$5,000 to survey lands west of the Flint Hills and additional potential areas in the eastern part of the state.

Item 1.2. Survey known population sites to determine their continued existence at a cost of \$4,000.

Item 1.3-1.5. Life history information is difficult to estimate the cost of investigation. Due to the number of unknown factors in the life history of the prairie mole cricket it is surmised that a number of simultaneous investigations would need to be conducted. This could possibly be performed through the use of graduate students at a number of state universities with departments specializing in biological investigations. Exact costs are difficult to quantify but could easily exceed \$50,000.

Item 2.1 Using existing population occurrence data, sites could be examined to quantitatively define habitat components describing the areas. This

information could be related to population estimates from calling data gathered during site surveys. Cost would be expected to be \$10,000.

Item 2.2 Landowners should be queried about land management practices on lands examined in item 2.1. Management practices resulting in habitat conditions defined in the above item 2.1 could be tabulated. Hence, practices resulting in habitat conditions supporting large prairie mole cricket populations could be determined. Costs would be estimated at \$10,000.

Item 2.3. Examining CRP lands in proximity of known populations of prairie mole crickets to determine if re-colonization is occurring would be easiest to conduct as part of surveys to be conducted under item 1.1. Re-introduction efforts would require perhaps capture of calling males to be placed in CRP areas with follow ups in successive years to see if such males survived and attracted females resulting in reproduction on the area.

Item 2.4. Develop a conservation easement program to protect prairie mole cricket habitat using tax incentives. Program costs would be in-house administration.

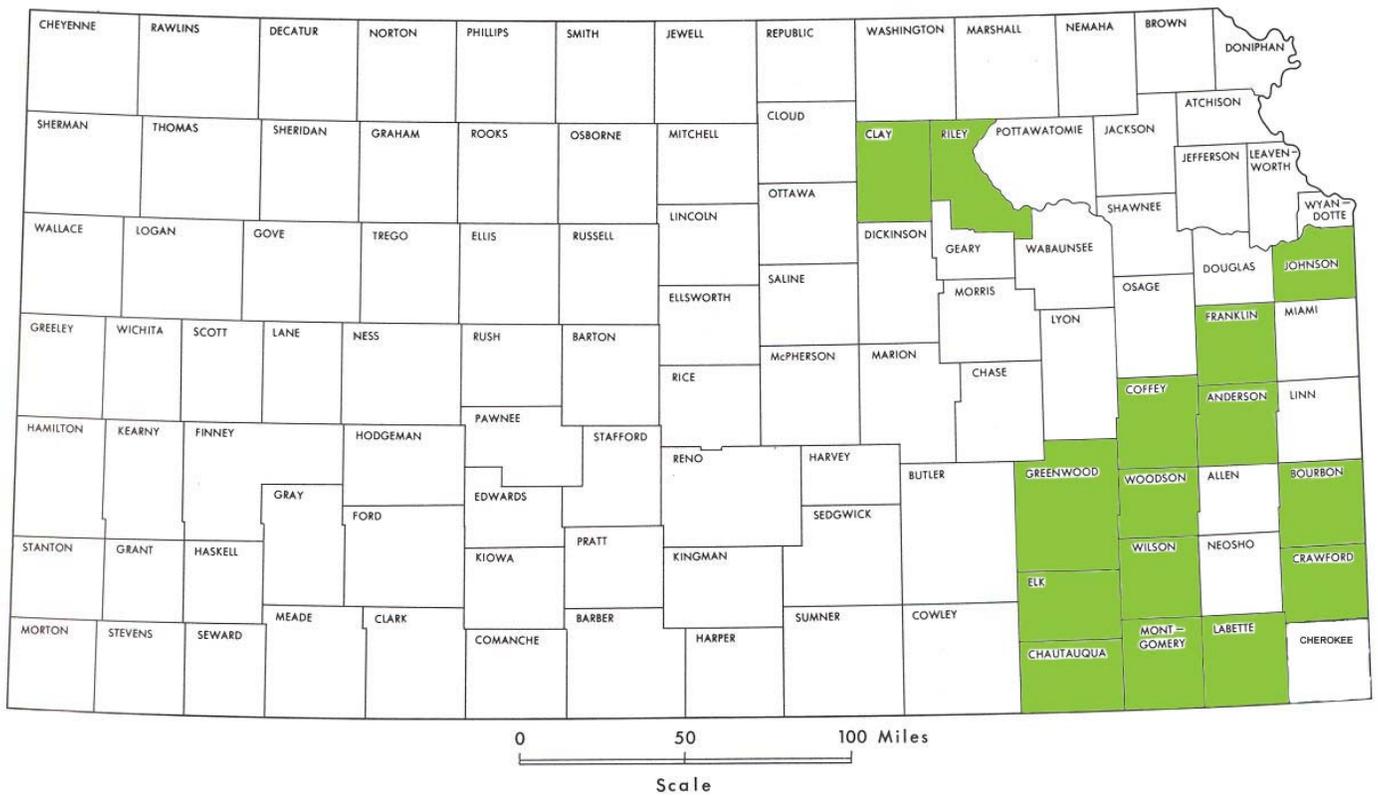
**Table 1. Prairie mole cricket observations for sites of occurrence.**

Site Number	Site Name	Number of prairie mole crickets recorded & observation year
IIORT17010*004*KS	ELM CREEK PARK SITE	1987: 1
IIORT17010*003*KS	TWENTIETH STREET PRAIRIE	1987
IIORT17010*018*KS	GIRARD HIGH SCHOOL	1988: 1
IIORT17010*016*KS	FREDONIA HIGH SCHOOL	1989: 1
IIORT17010*017*KS	BURLINGTON HIGH SCHOOL	1989: 1
IIORT17010*005*KS	DE SOTO PRAIRIE	1989: 1
IIORT17010*001*KS	WELDA PRAIRIE NORTH	1988: 15-30; 1989: 24-30
IIORT17010*009*KS	HINTON CREEK PRAIRIE	1989: 8
IIORT17010*008*KS	PAWNEE PRAIRIE	1989: 5
IIORT17010*007*KS	RONALD PRAIRIE NORTH	1989: 1
IIORT17010*046*KS		1989: 1
IIORT17010*006*KS	OHIO PRAIRIE	1989: 2
IIORT17010*013*KS	COAL CREEK PRAIRIE	1990: 10+
IIORT17010*012*KS	FRUITLAND PRAIRIE EAST	1990: 12
IIORT17010*015*KS	LIBERTY PRAIRIE	1990: 10-20
IIORT17010*014*KS	YATES CENTER PRAIRIE	1990: 15-30
IIORT17010*011*KS	MIDDLE CREEK PRAIRIE	1990: 1
IIORT17010*019*KS	CROOKED CREEK PRAIRIE SOUTH	1990: 1
IIORT17010*040*KS	KNOLLWOOD DRIVE PRAIRIE	1991: 1-4
IIORT17010*028*KS		1991: 1
IIORT17010*031*KS		1991: 1
IIORT17010*029*KS		1991: 1
IIORT17010*030*KS		1991
IIORT17010*020*KS		1991
IIORT17010*027*KS		1991: 1
IIORT17010*021*KS		1991
IIORT17010*022*KS		1991: 1
IIORT17010*038*KS		1991: 1
IIORT17010*042*KS	BUTCH PRAIRIE	1991: 20-30
IIORT17010*023*KS		1991
IIORT17010*043*KS	STRAUSS PRAIRIE	1991
IIORT17010*041*KS	BROWNSTONE PRAIRIE	1991: 15-20
IIORT17010*044*KS	UPPER SALT CREEK PRAIRIE	1991: 10+
IIORT17010*045*KS	NEWARK PRAIRIE	1991: 12
IIORT17010*032*KS		1991
IIORT17010*039*KS		1991: 1
IIORT17010*033*KS		1991: 1
IIORT17010*026*KS		1991: 1
IIORT17010*025*KS		1991: 6; 1990: 10+
IIORT17010*002*KS	SUNSET PRAIRIE	1991: 15+; 1988
IIORT17010*036*KS		1991
IIORT17010*024*KS	SYCAMORE PRAIRIE	1991: 100+; 1992
IIORT17010*047*KS	FT. RILEY - TIMBER CREEK	1992: 1
IIORT17010*035*KS	TORONTO STATE LAKE	1993: 1
IIORT17010*010*KS	BIG SANDY HILLS	1990: 20

Table 1 Continued

IIORT17010*049*KS	KAAP	1994: 20+
IIORT17010*051*KS	KAAP PRAIRIE-SOUTHEAST	1994: 10+
IIORT17010*048*KS	MILFORD LAKE EAST	1991: 5-10; 1991; 1994: 15+
IIORT17010*050*KS	KAAP PRAIRIE-CENTRAL	1994: 10+
IIORT17010*037*KS	FT. RILEY MILITARY RESERVATION	1998: 5
IIORT17010*034*KS		2000: 4

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**Figure 1: Counties of prairie mole cricket occurrence in Kansas since 1980.**

## Literature Cited

- Alexander, R.D. 1975. Natural Selection and Specialized Chorusing Behavior in Acoustical Insects. P. 35-37. In D. Pimental (Ed.), *Insects, Science and Society*. Academic Press, NY.
- Busby, Bill. \_\_\_\_\_. Survey Methods for the Prairie Mole Cricket.
- Busby, W.H. 1991. Prairie Mole Cricket survey report for Kansas. Rept. No. 47 of the State Biol. Surv. of Kansas, Lawrence.
- Busby, W.H. 1990. Recent Prairie Mole Cricket Records in Kansas. Kansas Natural Heritage Program.
- Caire, W., T. Harrison, S. Stevens, R. Grantham, M. Thies, and K. Thies. 1993. Notes on the Ecology of the Prairie Mole Cricket, *Gryllotalpa major*, in northeastern Oklahoma. *Proc. Okla. Acad. Sci* 73: 73-75.
- Federal Register. 1990. Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17, RIN 1018-AB, Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for Prairie Mole Cricket. Proposed Rules, Vol. 55 No. 80. (primary author William F. Harrison)
- Figg, D.E. 1987. Prairie Mole Cricket. TNC Missouri Chapter Newsletter, Sept.
- Figg, Dennis, K. Lister, and C. Deitrich. 1992. Improving the Status of Endangered Species in Missouri, Endangered Species Project SE-01-18. Population Monitoring of the Prairie Mole Cricket, *Gryllotalpa major* Saussure. Natural History Division, Missouri Department of Conservation. Jefferson City, Missouri.
- Figg, D.E. and P.D. Calvert. 1987. Status, Distribution, and Life History of the Prairie Mole Cricket, *Gryllotalpa major* Saussure. Unpublished report, U.S. Fish and Wildlife Service and Missouri Dept. Conservation Contract No. 14-16-0003-86-929 (1987). Jefferson City, Missouri. 40 pp.
- Forrest, T.G. 1983. Calling Songs and Mate Choice in Mole Crickets. Pp 185-204. In D.T. Gwynne and G.K. Morris (Eds.), *Orthopteran Mating Systems: Sexual Competition in a Diverse Group of Insects*. Westview Press, Boulder, Co.
- Forrest, T.G. 1980. Phonotaxis in Mole Crickets: Its Reproductive Significance. *Florida Entomologist* 63(1): 45-53.
- Gates, D.E. and L.L. Peters. 1962. *Insects in Kansas*. Jean M. Neibarger, Topeka, Kansas.
- Hayslip, N.C. 1943. Notes on Biological Studies of Mole Crickets at Plant City, Florida. *Fla. Entomol.* 26(3):33-46.

- Hill, P.S.M. 1998. Environmental and social influences on calling effort in the prairie mole cricket (*Gryllotalpa major*). *Behav. Ecol* 9: 101-108.
- Hill, P.S.M. 2000. Elements of the acoustic repertoire of the prairie mole cricket (Orthoptera: Gryllotalpidae: *Gryllotalpa major*). *Journal of the Kansas Entomological Society* 73: 95-102.
- Hill, P.S.M. and J.R. Shadley. 2001. Talking back: sending soil vibration signals to lekking prairie mole cricket males. *American Zoologist* 45:1200-1214.
- Kleyla, P.C. and G. Dodson. 1978. Calling Behavior and Spatial Distribution of Two Species of Mole Crickets in the Field. *Entomological Society of America* Vol. 71, no. 4: 602-604.
- Matheny, Jr., E.L., R.L. Kepner, and K.M. Portier. 1983. Landing Distribution and Density of Two Sound-Attracted Mole Crickets (Orthoptera: Gryllotalpidae: *Scapteriscus*). *Annals of Entomology Society of America* 76(2): 278-281.
- NatureServe Explorer. 2004. Comprehensive report: *Gryllotalpa major*-Saussure. <http://www.natureserve.org/explorer>
- Nevo, E. and S.A. Blondheim. 1972. Acoustic isolation in the speciation of molecrickets. *Annals of the Entomological Society of America* 65: 980-981.
- Nickerson, J.C., D.E. Snyder, and C.C. Oliver. 1979. Acoustical Burrows Constructed by Mole Crickets. *Entomological Society of America*. Vol. 72, no. 3: 438-440.
- Vaughn, C.C., S.M. Glenn, and I.H. Butler. 1993. Characterization of Prairie Mole Cricket Chorus Sites in Oklahoma. *Am. Midl. Nat.* 130: 364-371.
- Vaughn, C.C., S.M. Glenn, and I.H. Butler. 1992. Final Report Section 6 Endangered Species Act, Federal Aid Project E-16, Prairie Mole Cricket in Oklahoma. Oklahoma Department of Wildlife Conservation.
- Walker, T.J. 1983. Diel patterns of calling in nocturnal Orthoptera. In D. T. Gwynne and G. K. Morris (eds.), *Orthopteran mating systems: Sexual competition in a diverse group of insects*, pp. 45-72. Westview Press, Boulder, Colorado.
- Walker, T.J. 1982. Sound Traps for Sampling Mole Cricket Flights (Orthoptera: Gryllotalpidae: *Scapteriscus*). *Florida Entomologist* GS(1): 105-110.
- Walker, T.J. and D.E. Figg. 1990. Song and acoustic burrow of the prairie mole cricket, *Gryllotalpa major* (Orthoptera: Gryllidae). *Journal of the Kansas Entomological Society* 63(2):237-242.
- Walker, T.J. and G.N. Fritz. 1983. Migratory and Local Flights in Mole Crickets, *Scapteriscus* spp. (Gryllotalpidae). *Environmental Entomology* 12(3): 953-958.