# GRASSHOPPER BIOLOGY AND MONITORING

Compiled by Judee Wargo – previous Chouteau County Extension Agent

*Step 1: How many grasshoppers are there?*

**Reason:** It is important to accurately estimate grasshopper population density to determine if the economic threshold has been reached (the density at which the cost of damage will be greater than the cost of treatment). This threshold varies with: region, cost of treatment, plant growth/condition, forage value, and grasshopper development/species. A density that almost certainly would warrant treatment consideration in all regions of the West is 24 grasshoppers/$yd^2$, and control is rarely justified at densities of less than 14 grasshoppers/$yd^2$. This latter density of pest species can cause a 30% forage loss on typical rangeland. Economics change in drought conditions, when the range is producing less forage and replacement forage costs are high. The best way to determine your economic threshold is through the CARMA software that can be found at: www.wygisc.uwyo.edu/grasshopper/ghwywfrm.htm.

**Method:** The quickest, easiest way to accurately estimate grasshopper population density is the sequential binomial method. With this method you can rapidly determine densities with as few as four samples. This method depends on your ability to consistently estimate a square foot area on the ground 10-12 feet ahead of you. Practice visualizing a sampling area using this sheet and refresh your perception frequently as you survey. It is important to randomly select the visualized sampling area in the habitat. If you always pick a patch of bare ground, for example, your samples won't represent the habitat as a whole. Accurate density estimates are obtained when the temperature is 60 to 95°F, the wind is less than 15 mph, and the vegetation is not wet (a light dew is acceptable).

**Reason**: Determining the extent of the infestation will influence treatment options. Large areas can often be treated quickly and economically by airplane whereas small infestations may be most efficiently controlled with ground equipment.

**Method:** Making survey stops on a 1-mile grid will allow ranchers to find major infestations, but more frequent survey stops (every 1/4-mile) will locate incipient "hot spots." Once you have found an area infested with grasshoppers you need to determine its extent. This will require travel by truck, ATV, or foot, as conditions require. Grasshopper densities change with the habitat (e.g. pine trees, grassy plains, or rocky hills), so a short-distance drop in densities may not signal the edge of large infestation.

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*Grasshopper Population Density Estimation Procedure*

1) Visualize a square foot on the ground 3-4 steps ahead of you. Watch this area as you walk to it.

2) As you approach the visualized area, watch for ***2 or more grasshoppers to jump <u>from</u> within its boundaries*** (but none of those that have jumped <u>into</u> the area). You do NOT need to count the grasshoppers - only see if there are at least 2 grasshoppers. Be sure to completely disturb the **square foot** if less than 2 grasshoppers were seen as you approached. This will flush any remaining hidden grasshoppers (1$^{st}$ and 2$^{nd}$ nymphs often remain hidden instead of jumping).

3) If you saw two or more grasshoppers, score a 1 and mark it in the "Score" column. If you saw only <u>one</u> or <u>no</u> grasshoppers, then score a 0. You will need to determine the scores for at least four square foot areas to generate a sufficient Running Total for a density estimate. NOTE: A wax pencil will allow you to mark, erase, and reuse the score sheet.

4) Compare your Running Total column to the "Lower" and "Upper" stop values. If the Running Total is **less than or equal** to the "Lower" stop value OR if the Running Total is **greater than or equal to** the "Upper" stop value, your density estimate is complete. For example, if you found at least 2 grasshoppers in each of your first four samples, your Running Total will be 4, which is equal to the "Upper" stop value. Whenever you reach the "Upper" stop value, you can be confident that there are at least 24 grasshoppers/yd$^2$. Conversely, if your Running Total matches the "Lower" stop value, there are less than 10 grasshoppers/yd$^2$.

5) If the "Running Total" is between the "Lower" and "Upper" stop values, continue sampling by repeating steps 1-4 above and adding the "Score" to the "Running Total" column. Compare this value to the corresponding "Upper'' and "Lower" stops. Continue this process until you reach a stop value. If you have taken 20 **square foot** samples without reaching either the ''Upper" or "Lower" slop values, the density is close to 14 grasshoppers/yd$^2$.

## SCORE SHEET

| Sq. Ft # | "Lower" Stop Value | Score [0 or 1] | Running Total | "Upper" Stop Value |
|---|---|---|---|---|
| 1 | NA | | | NA |
| 2 | NA | | | NA |
| 3 | NA | | | NA |
| 4 | 0 | | | 4 |
| 5 | 0 | | | 5 |
| 6 | 1 | | | 6 |
| 7 | 1 | | | 7 |
| 8 | 1 | | | 7 |
| 9 | 1 | | | 8 |
| 10 | 2 | | | 9 |
| 11 | 2 | | | 10 |
| 12 | 2 | | | 10 |
| 13 | 3 | | | 11 |
| 14 | 3 | | | 12 |
| 15 | 3 | | | 12 |
| 16 | 4 | | | 13 |
| 17 | 4 | | | 14 |
| 18 | 4 | | | 14 |
| 19 | 5 | | | 15 |
| 20 | 5 | | | 16 |

*Step 2: How to collect grasshoppers*

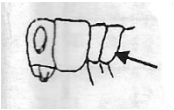
After estimating the population density and determining that a treatment threshold has been reached, you should sample the population to determine the developmental stage and identity of the grasshoppers. The best way to collect the grasshoppers is with an insect net (a 2-foot handle with a 15-inch hoop and a heavy-duty net works well). In moderate to high densities a sufficient sample (30 to 50 individuals) can be collected with 100 sweeps. Take 50 sweeps very close to the ground while walking slowly (to sample the smaller/slower individuals), and 50 sweeps at the top of the vegetation at a rapid walk (to sample larger/faster individuals). If many adult grasshoppers fly away as you sweep, then this must be taken into account when judging the developmental stage. After sweeping, swing the net rapidly to force the insects to the bottom of the net. Grasp the net above the grasshoppers to contain them. Then invert the net into a gallon size plastic bag (Ziplocs work well). Seal and label the bag with the location and store in a cool place if you aren't going to immediately kill and sort the sample. To kill the sample for sorting, place the bag in a freezer for one hour or, if you have to, in the hot sun on a car dash for 10 minutes.

Insect nets are available from:
www.gemplers.com 800-382-8473
or
www.bioquip.com 310-324-0620

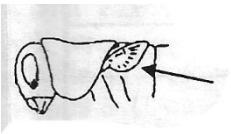
*Step 3: How old are they?*

**Reason:** The age of the grasshoppers has important implications for treatment. For example, insecticides that are insect growth regulators must be applied while the grasshoppers are immature, and those with short residual efficacy periods need to be applied after the hatch is complete.

**Method**: The best way to determine age is to collect at least 30 grasshoppers with an insect net. Then examine them using the development of the wing pad and body length to determine the developmental stage.



1st and 2nd instar (phase) nymphs are usually less than 3/8” long and no wing pads are visible.



3rd and 4th instars are usually 3/8” to 1/2” long and have small wing pads.

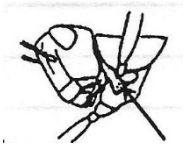
5th instars are usually more than ½” long and have distinct wing pads.

Adults of most pest species have fully formed wings. The presence of wings is the critical feature, as some pest species will be less than 1 inch long as adults and others will be more than 3 inches long.

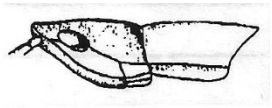
*Step 4: What kind are they?*

**Reason**: The ability to distinguish species or at least subfamilies is important because of feeding differences among grasshoppers. For example, an infestation of slantfaced species would pose no threat to an adjacent alfalfa field, so treatment to protect the crop would be unnecessary. A complete source for photos to aid in identification of all major pest species can be found at: www.uwyo.edu/entomology/grasshoppers/field-guide/index.html#fieldguidetoc.

**Method**: Pest grasshoppers occur in three subfamilies: slantfaced, spurthroated, and bandwinged. It is relatively easy to separate grasshoppers into these groups. The slantfaced grasshoppers are often brown or grey as nymphs and have either slanted "faces" that are pointed in profile or they have disproportionately large heads. The spurthroated grasshoppers are often green as nymphs, and they have a spur or spine on their "throat" (between the front legs). Most bandwinged grasshoppers have bright red or yellow hind wings as adults and are large-bodied and well-camouflaged as nymphs. They are often out of sync with other grasshoppers in an area (adults are present in early spring and nymphs hatch in late summer).



Spine on the “throat” of a spurthroat grasshopper.



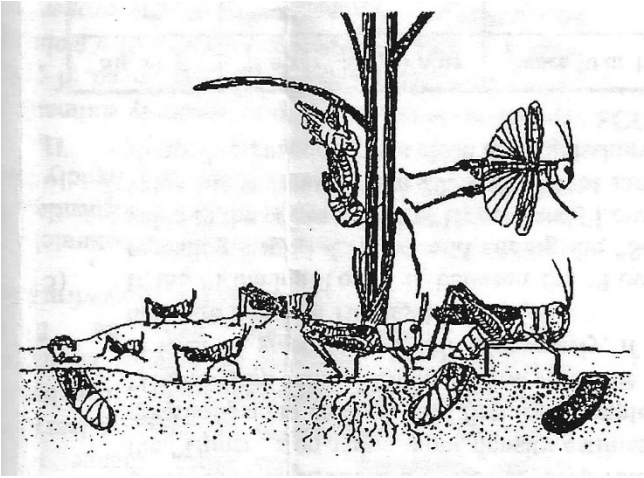
Slantface, as above, or with a big head as in Life Cycle figure.

*Grasshopper Life Cycle*

1. Most pest species hatch from mid-May to late June, when soil temperatures allow the over-wintering embryos to complete their development. However, the grasshopper species, temperature, and soil moisture influence the timing of hatch. Usually, several species make up an infestation and hatch at different times. A few species of bandwinged grasshoppers spend the winter as nymphs, rather than eggs. These nymphs mature in the early spring and the red- or yellow-winged adults are the first grasshoppers seen in the field.

2. Grasshoppers have to shed or molt their hard exoskeleton to grow bigger through each nymphal phase (instar) to adulthood. They often hang upside down on grass stems to molt. A grasshopper takes 5 to 7 days to complete an instar.

3. Grasshopper nymphs in the 1st and 2nd instars can be confused with leafhoppers and other small grassland insects. Closely examining the insects allows you to distinguish the miniature grasshoppers from other insects, like leafhoppers (see figure). The 3rd – 5th instar nymphs are more active and easier to see than earlier instars.



(Figures from Western Grasshoppers: Pfadt. 2002)


**Leafhopper**. Overhead view of an adult leafhopper (above), 3X life size; note the lack of enlarged hind legs and antennae that grasshopper nymphs have (below).

4. Most species have five nymphal instars. Those that have four instars and those over-wintering as nymphs develop into adults in early spring while most of the other species are still nymphs.

5. The last molt results in an adult with functional wings that allow low evasive flight as you walk through the infested area. Some species are capable of much longer flights and will migrate when they have exhausted the forage in an area.

6. Only mature adults can reproduce, so egg laying is prevented if nymphs or very young adults are treated. Adult female grasshoppers require up to 2 weeks to reach reproductive maturity, after which they produce 20 to 100 eggs in several clusters or pods deposited in the soil.

7. Eggs are resistant to cold and desiccation, but they are vulnerable to parasites (tiny wasps, flies, and blister beetles) whose larvae feed on the eggs. Birds and other predators feed on nymphs and adults and help keep grasshopper densities in check.