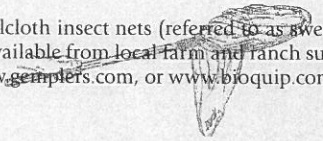
Step 3: Collect a grasshopper sample

After estimating the population density and determining a treatment threshold has been reached, 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, this must be taken into account when judging the average 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 (Zip-loc-type bags work well). Seal and label the bag with the location and store in a cold place if you are not 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 your dashboard for **10 minutes**.



Heavy-duty sailcloth insect nets (referred to as sweep nets) may be available from local farm and ranch supply stores, www.gempler's.com, or www.bioquip.com.

Step 4: How old are they?

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

Method: The best way to determine age is to randomly collect at least 30 grasshoppers with an insect net. Examine them using the development of the wing pad and body length to determine the developmental stage. A small ruler will be a big help.

1st and 2nd instar (phase) nymphs are usually less than 3/8 inches long and wing pads are hardly visible. Body size, depending on species, is about the size of a grain of rice.

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

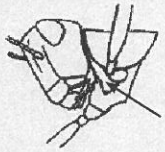
5th instars are usually more than 1/2 inches long and have distinct wing pads.

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 5: What kind are they?

Reason: The ability to distinguish genus 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/grasshopper

Method: Pest grasshoppers occur in three subfamilies: slantfaced, spurthroated, and bandwinged. Separating grasshoppers into these groups is relatively easy with a magnifying glass. 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. Bandwinged grasshoppers are often out of synchrony with other grasshoppers in an area (adults are present in early spring and nymphs hatch in late summer).

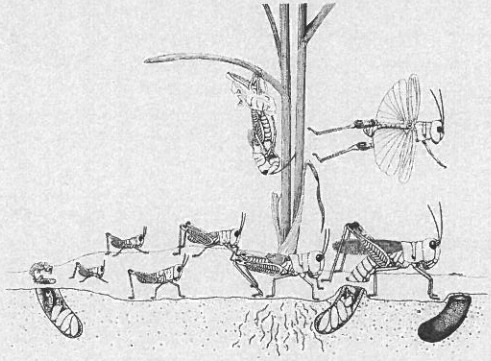


Spine on the "throat" of a spurthroat grasshopper.

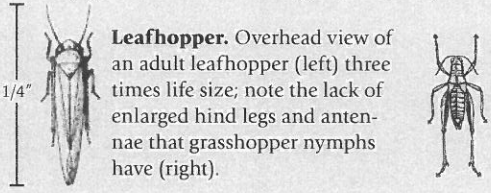
Slantface, as above, or with a big head as in life cycle figure.

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 makeup 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 larger through each nymphal phase (instar) to adulthood. They often hang upside down on grass stems to molt. A grasshopper takes five to seven 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.

Grasshopper Life Cycle



(Figures from Western Grasshoppers; Pfadt, 2002)



Leafhopper. Overhead view of an adult leafhopper (left) three times life size; note the lack of enlarged hind legs and antennae that grasshopper nymphs have (right).

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 engage in 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. NOTE: there are some short-winged adult grasshoppers, but these are not serious pest species.
6. Only mature adults can reproduce so egg laying is prevented if nymphs or very young adults are treated. Adult female grasshoppers require one to two 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 also help keep grasshopper densities in check.

Step 1: How many grasshoppers are there?

Reason: Accurately estimating grasshopper population density is important 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 in all regions of the West is **24 grasshoppers/yd²**, and control is rarely justified at densities of less than **14 grasshoppers/yd²**. This latter density of pest species can cause a 30 percent 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 for treatment is through the free CARMA software on the Internet at **carma.johnhastings.org**

Method: Accurate density estimation depends on your ability to consistently estimate a square foot area on the ground 15-20 feet ahead of you. **This sheet is 1 square foot and is provided as a training aid to help calibrate your perception to the proper sampling area**. Practice visualizing a sampling area by using this aid and refresh your perception frequently as you survey. Randomly selecting the visualized sampling area in the habitat is important. 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). Follow the procedure outlined in the right-hand column.

Step 2: How large is the infestation?

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 ¼ mile) will locate incipient "hot-spots." Once an area infested with grasshoppers has been found, you need to determine its extent. This will require travel by pickup 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 a large infestation.

S. P. Schell and A. Latchininsky
CES-Entomology, Renewable Resources
College of Agriculture, Univ. of Wyoming, Laramie, WY 82071
(307)766-2508, sschell@uwyo.edu www.uwyo.edu/grasshopper

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Grasshopper Population Density Estimation Procedure

1. Calibrate your vision to the size of a 1 square foot area with this training aid to consistently estimate the same area on the ground.
2. Walk at least 50 to 100 feet away from roadsides to find typical rangeland vegetation.
3. Stop walking and visualize the square foot area approximately 15 to 20 feet in front of you.
4. Now walk slowly toward the visualized area and count the number of grasshoppers that jump, fly, or walk to escape its boundaries. Do not count grasshoppers that enter the **selected** area once you have started counting. Once you have reached the square foot, you may need to brush it with your hand or foot to make sure all grasshoppers, especially very small nymphs that have just hatched, have been counted.
5. Stop and write on a piece of paper the total number of grasshoppers you saw escape from the visualized area.
6. Repeat Steps 3 through 6 until 18 counts have been made.
7. Add the 18 counts and divide that total by two. This figure will be an average estimated density of the grasshoppers per square yard. If necessary, round up to the next whole number.

Sample count 1	**Sample count 2**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
Subtotal	**Subtotal**
Total _____ **/2=** _____ **per yard²**	

Local Contact Info: _____

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