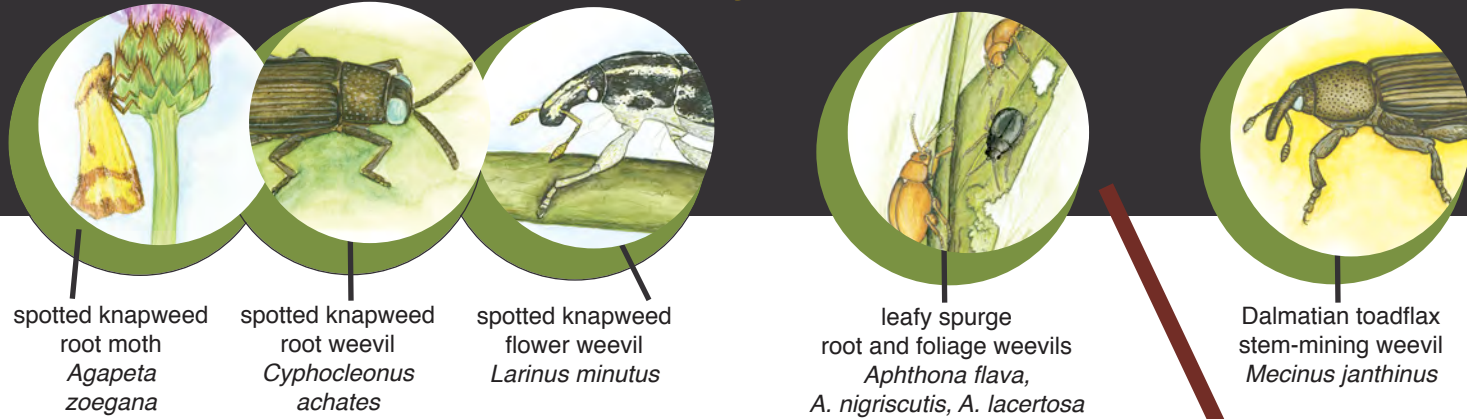


Why do we survey biological control release sites?



spotted knapweed root moth
Agapeta zoegana

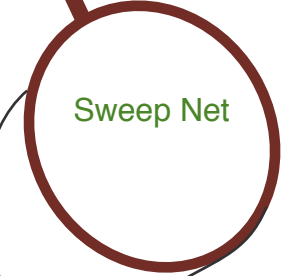
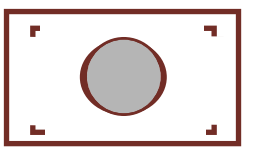
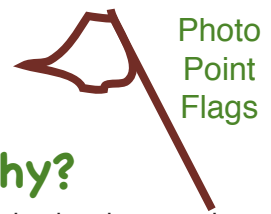
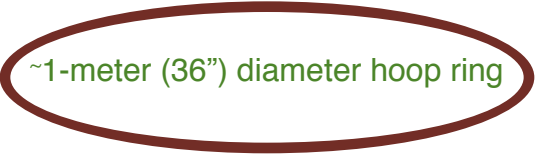
spotted knapweed root weevil
Cyphocleonus achates

spotted knapweed flower weevil
Larinus minutus

leafy spurge root and foliage weevils
Aphthona flava,
A. nigriscutis, *A. lacertosa*

Dalmatian toadflax stem-mining weevil
Mecinus janthinus

What tools do we need?



What do we look at?

- Site Characteristics
- Insect Population
- Weed Population
- Photo Points
- GPS coordinates

Why?

Invasion by plants such as spotted knapweed, leafy spurge, and Dalmatian toadflax, has been expanding and intensifying throughout the western United States. Biological control agents are one of the tools available to help manage these weeds. Once insects are released, follow-up surveys help us know if they survived and are doing their job, reducing weed populations.

Survey Objectives

- determine if insects are established at the release site
- measure the general size of biocontrol agent population
- assess insects' spread beyond the initial release site
- quantify target weed species population and vegetation response at release site (measure changes over time)
- note site characteristics at each location (identify characteristics which lead to insect population establishment/effectiveness)
- establish permanent photo points at each release site (displays weed population changes over time)

Site Objectives

Choosing a site to monitor may be as easy as going to sites where releases have been made in the past or starting a new site. Your county weed coordinator will know where these sites are and where you can find access. It is best to take the person who released the insects with you to show you the exact release location. The release location is where you will set up and flag your photo points, and collect your data year after year.

Sampling

Site data is important because it reveals characteristics scientists use to compare diverse sites and learn which characteristics potentially lead to successful insect establishment. Site data includes information like which weeds are present, how much it rains each year, who owns the land, vegetation type (grassland, shrubland, cropland, coniferous forest, deciduous forest, riparian area, other), topography (valley bottom, ridgetop, hillside with % slope), burn or treatment history, and the approximate size of target weed population (acres).

Establish or confirm the release site and flag it. Record GPS coordinates and legal description. All survey activities originate from these coordinates. Set up a photo point (see survey activities).

Measuring Noxious Weed Population

Three measuring activities are detailed on accompanying flash cards. Students will learn how to use two common measuring tools, the hoop ring to measure knapweed populations and the Daubenmire 20 x 50 cm frame to measure leafy spurge and Dalmatian toadflax.

Measuring Insect Population

Measuring insect populations requires a different method for each insect species surveyed. Insects are not all alike. They are not visible at all times of the year, nor are they visible at the same time of year every year. The time of year insects are visible is affected by biology, climate, precipitation, temperature, and site characteristics. Learn measuring methods using the survey activity flash cards for knapweed, spurge, and toadflax; and the Advanced Data Collection flash card.

Statewide Noxious Weed Awareness and Education Campaign

Montana State University Dept. of Land Resources and Environmental Sciences in cooperation with United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine



When and what do we look for at release sites?



spotted knapweed
flower weevil
Larinus minutus

Spotted knapweed flower weevil

The *Larinus minutus* weevil is an abundant biological control agent that can utilize spotted, diffuse, and squarrose knapweeds. The insect overwinters as an adult, which is long-living and emerges in the spring when they begin to feed on knapweed foliage. Females produce between 28 and 130 eggs which they lay in clusters in open flowers.

The hatching larvae feed on seeds and receptacle tissues and later construct cocoons within the seedheads using pappus hairs. After four weeks, pupation occurs within this cocoon. Emerging adults chew a characteristic round hole in the top of the cocoon that is visible when viewed from above.



leafy spurge
root and foliage weevils
Aphthona flavata,
A. nigriscutis, *A. lacertosa*

Leafy spurge flea beetle

The *Aphthona* species complex consists of six different species all with a smaller biology. The larval stage is the most destructive whereby the larvae feed on fine and lateral spurge roots, impairing the roots and preventing moisture and nutrient uptake. Additionally, the root-feeding provides entry points for deleterious pathogens. They overwinter in the spurge roots as larvae which can be found from July to early spring of the following year.

Pupation occurs in the soil near the plant with adult emergence occurring in June, July, and August. Adult feeding damages the host and reduces the plant's ability to make sugars for root reserves. The effective species are typically best suited for dry sites with a large amount of sun exposure. Recent studies suggest that these insects can be used as a "bio-herbicide" in riparian areas as well. Avoid releases in areas with high ant or grasshopper populations.



Dalmatian toadflax
stem-mining weevil
Mecinus janthinus

Dalmatian toadflax stem-mining weevil

Adult weevils are small, somewhat elongated bluish black weevils which emerge from last year's Dalmatian toadflax stems in April-May.

Adults feed on leaves and stems before mating and laying eggs inside new shoots which are at least 1 mm (0.04 inches) in diameter. Adults are active into July. The eggs hatch and larvae tunnel within the stem as they feed, moving no more than .5 cm (1.2 inches) from where the egg was laid before pupating.

Larval mining impacts the plants by causing premature wilting of shoots and suppression flower formation. They overwinter as adults inside their pupation chamber. The effects of the weevil on the plant are reportedly enhanced under drought stress.

Collect Site Data

(Create your form for the field and collect this information)

Site Characteristics

Observer (your name) _____
 Today's date _____
 Landowner (manager) _____
 Permanent monitoring site? Yes No
 Site name _____
 Target weed _____
 Target biocontrol agent _____
 Insect stage of growth _____
 Location: Sec. _____ Township _____ Range _____
 Previous # of insects by species releases/dates _____

Hill Aspect (slope direction) _____
 Topographic Type (valley bottom, ridgetop, hill-side, other) _____
 Vegetation Type (shrubland, grassland, cropland, coniferous forest, deciduous forest, riparian, other) _____

PHOTO POINTS AND GPS

Date _____
 Site Name _____
 Forest/District/County _____

Photo #	Degree	Comments

GPS site code _____
 (your initials, kw03, # starting with 1 at first site)
 Latitude _____
 Longitude _____
 Elevation _____

Advanced Data Collection

Advanced Vegetation Cover

Measure vegetation in percentage of 100% cover inside the frame (round to 5%).

"T" means trace amounts less than 5%

- frame (Daubenmire size, or loop diameter)
- target weed percentage inside frame
- other weed percentages by species
- forb/shrub percentages
- grass percentages
- bare ground/plant litter percentage

Advanced Target Weed Size/Density

- frame (which frame - Daubenmire size or loop diameter)
- number of stems inside the frame
- height of tallest stems (cm) inside the frame

Advanced Biological Control Agents

Sweep Site. In an area within the same weed infestation as the transect, identify 6 sites at least 15 meters away from the transect. Count the number of insects per 10 sweeps (Standing at one location)? An estimate (visual) may be useful to count Dalmatian toadflax Repeat the 10 sweeps and document the count six times moving at least 2 steps away from the first sweep location.

The Advanced Data Collection conforms and is useful when shared with other land management agencies. Advanced Data Collection concepts were developed by Idaho Department of Agriculture and recommended by U.S. Forest Service scientific reviewers for targeted youth audiences. Activities for leafy spurge, spotted knapweed and Dalmatian toadflax monitoring were developed by Missoula County Weed District.

Statewide Noxious Weed Awareness and Education Campaign

Montana State University Dept. of Land Resources and Environmental Sciences *in cooperation with* United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine



How to survey leafy spurge/Dalmatian toadflax biocontrol agents!



leafy spurge root/foilage weevils
Aphthona flava,
A. nigricutis, *A. lacertosa*



Dalmatian toadflax stem-mining weevil
Mecinus janthinus

STEP One (see Why do we survey biological control agents).

Confirm the release site and flag it. Set up a photo point. Fill in "Site Characteristics" on the Card backside.

STEP Two.

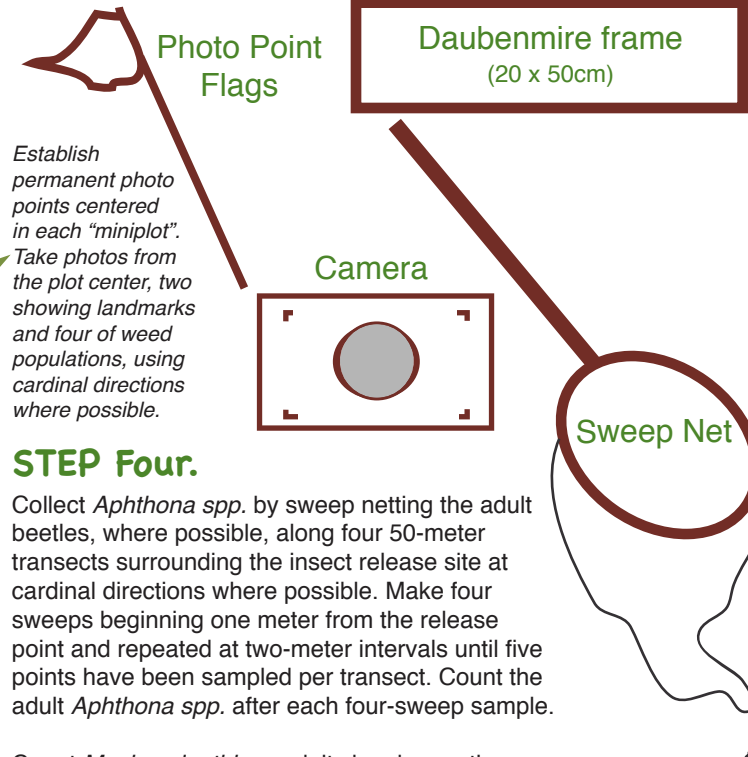
Measure leafy spurge along four transects radiating out from the release point. Where possible, place transects in cardinal directions (0, 90, 180 and 270 degrees). Drop the Daubenmire frame (20 x 50 cm) at 1, 3, 5, 7, and 9 meters (total 20 measurement points per "mini-plot") along each transect. Collect leafy spurge plant measurements:

- number of leafy spurge stems - (example, 14)
- average leafy spurge plant height - (example, 4.5 cm)
- percent of canopy covered by leafy spurge - (ex, 6%)

STEP Three.

Use the *Alien Insect Flash Cards* to identify the leafy spurge biological control agents: *Aphthona flava*, *A. nigricutis*, and *A. lacertosa*; or Dalmatian toadflax agent *Mecinus janthinus*.

What tools do we need?



Establish permanent photo points centered in each "miniplot". Take photos from the plot center, two showing landmarks and four of weed populations, using cardinal directions where possible.

STEP Four.

Collect *Aphthona spp.* by sweep netting the adult beetles, where possible, along four 50-meter transects surrounding the insect release site at cardinal directions where possible. Make four sweeps beginning one meter from the release point and repeated at two-meter intervals until five points have been sampled per transect. Count the adult *Aphthona spp.* after each four-sweep sample.

Count *Mecinus janthinus* adults by observation. Observe the insects for five minutes at each "mini-plot" along all four transects. For more advanced monitoring documentation go to the *Advanced Data Collection* flash card.

Collect Site Data

(Create your form for the field and collect this information)

Site Characteristics

Observer (your name) _____
 Today's date _____
 Landowner (manager) _____
 Permanent monitoring site? Yes No
 Site name _____
 Target weed _____
 Target biocontrol agent _____
 Insect stage of growth _____
 Location: Sec. _____ Township _____ Range _____
 Previous # of insects by species releases/dates _____

Hill Aspect (slope direction) _____
 Topographic Type (valley bottom, ridgetop, hill-side, other) _____
 Vegetation Type (shrubland, grassland, cropland, coniferous forest, deciduous forest, riparian, other) _____

PHOTO POINTS AND GPS

Date _____
 Site Name _____
 Forest/District/County _____

Photo #	Degree	Comments

GPS site code _____
 (your initials, kw03, # starting with 1 at first site)
 Latitude _____
 Longitude _____
 Elevation _____

Insect Population Check for 5-minute timed plot (*Mecinus*)

Species	Adults			Feeding Damage		
	Date	#Observed	#Collected	None	Occasional	Widespread
<i>Aphthona lacertosa</i>						
<i>Aphthona nigricutis</i>						
<i>Mecinus janthinus</i>						

Weed Population leafy spurge Dalmatian toadflax

Distance from release point	North	East	South	West	Other
1 meter	Number of stems				
	Average height				
	Percent Cover				
3 meter	Number of stems				
	Average height				
	Percent Cover				
5 meter	Number of stems				
	Average height				
	Percent Cover				
7 meter	Number of stems				
	Average height				
	Percent Cover				
9 meter	Number of stems				
	Average height				
	Percent Cover				

Statewide Noxious Weed Awareness and Education Campaign

Montana State University Dept. of Land Resources and Environmental Sciences
 in cooperation with United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine

How to survey spotted knapweed biological control agents!



spotted knapweed root moth *Agapeta zoegana*
 spotted knapweed root weevil *Cyphocleonus achates*
 spotted knapweed flower weevil *Larinus minutus*

STEP One

Confirm the insect release site and flag it. Set up photo points. Fill in "Site Characteristics" on the Card backside.

STEP Two.

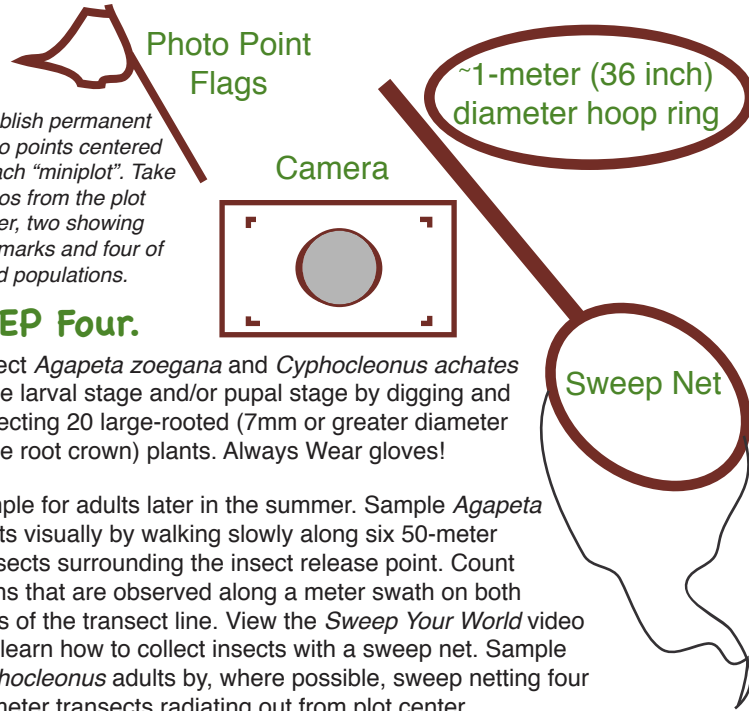
Spotted knapweed population is measured by dropping a ~1-meter (36") diameter hoop ring at intervals of 2 and 9 meters (5' and 25') along four transects radiating out from plot center. Where possible, run transects in cardinal (0, 90, 180 and 270 degrees) directions from plot center. Collect plant data at each "mini-plot" identified by the ring, along all four transects.

- percent of ground covered by the target weed (spotted knapweed) - (example, 23%)
- average weed (knapweed) height - (example, 6.5 cm)
- total number of mature weed (knapweed) plants - (14)

STEP Three.

Use the *Alien Insect Flash Cards* to identify three spotted knapweed biological control agents: *Agapeta zoegana*, *Cyphocleonus achates*, and *Larinus minutus*.

What tools do we need?



Establish permanent photo points centered in each "miniplot". Take photos from the plot center, two showing landmarks and four of weed populations.

STEP Four.

Collect *Agapeta zoegana* and *Cyphocleonus achates* at the larval stage and/or pupal stage by digging and dissecting 20 large-rooted (7mm or greater diameter at the root crown) plants. Always Wear gloves!

Sample for adults later in the summer. Sample *Agapeta* adults visually by walking slowly along six 50-meter transects surrounding the insect release point. Count moths that are observed along a meter swath on both sides of the transect line. View the *Sweep Your World* video and learn how to collect insects with a sweep net. Sample *Cyphocleonus* adults by, where possible, sweep netting four 50-meter transects radiating out from plot center.

Measure *Larinus* populations by sweep netting the adult beetles as described for *Cyphocleonus achates*. The best time for measuring is during spotted knapweed bloom (typically late June to August). Timing to find Dalmatian toadflax and leafy spurge bioagents is on the "When and what do we look for at release sites?" flash card.

Collect Site Data

(Create your form for the field and collect this information)

Site Characteristics
 Observer (your name) _____
 Today's date _____
 Landowner (manager) _____
 Permanent monitoring site? ___Yes ___ No
 Site name _____
 Target weed _____
 Target biocontrol agent _____
 Insect stage of growth _____
 Location: Sec. _____ Township _____ Range _____
 Previous # of insects by species releases/dates _____

 Hill Aspect (slope direction) _____
 Topographic Type (valley bottom, ridgetop, hill-side, other) _____
 Vegetation Type (shrubland, grassland, cropland, coniferous forest, deciduous forest, riparian, other) _____

PHOTO POINTS AND GPS

Date _____
 Site Name _____
 Forest/District/County _____

Photo #	Degree	Comments

GPS site code _____
 (your initials, kw03, # starting with 1 at first site)
 Latitude _____
 Longitude _____
 Elevation _____

Insect Population

Species	Larvae			Adults		
	Date	#roots dissected	# infested	Date	#moths observed	#weevils collected
<i>Agapeta zoegana</i>						
<i>Cyphocleonus achates</i>						
<i>Larinus minutus</i>						

Weed Population Spotted Knapweed

	Transect #1	Transect #2	Transect #3	Transect #4
Percent of ground covered by spotted knapweed				
Average spotted knapweed plant height				
Total # of mature spotted knapweed plants				

Advanced Data Collection: Use this card to experience using the loop for measuring and the sweep net for collecting and counting insects. Use the *Advanced Data Collection Card* instructions for collection and documentation when you want your data to conform with and be useful to other land management agencies.

Statewide Noxious Weed Awareness and Education Campaign
 Montana State University Dept. of Land Resources and Environmental Sciences
 in cooperation with United States Department of Agriculture Animal and Plant Health
 Inspection Service Plant Protection and Quarantine

