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# Biological Weed Control Using Insects

Todd Breitenfeldt  
& Mike Battaiola

A FIELD GUIDE FOR MONTANA



What the symbols mean:

### **Insect Effectiveness**

 Very Effective

 Effective

 Moderately Effective

 Somewhat Effective

 Limited Effectiveness

 Not Effective

 Unknown Effectiveness

### **Attack Vectors**

 Attacks Stems

 Attacks Seed Heads

 Attacks Roots

 Attacks Leaves/Foliage

 Recommended Complex of Insects

## Collection Methods



Hand Pick



Use Accelerator



Sweep Net



Use Aspirator



Insect Vacuum



Tapping and Pan/Bucket

## Sections



Introduction



Recommended/Approved Insects



How to do Biological Weed Control



Insect Handling Tools



Tables



Glossary



Photo Credits



Montana County Weed Districts



Other Useful Contacts

# Table of Contents

Introduction.....	1
Know “The Label” .....	2
Pros & Cons of Biological Weed Control .....	3
Biological Control Cannot Be Used On All Montana Noxious Weeds .....	3
Recommended/Approved Biological Weed Control Insects for Each Weed.....	4
<i>Tansy Ragwort</i> .....	4
Complex of Recommended Insects .....	4
Other Approved Insect .....	9
<i>Canada Thistle</i> .....	10
Recommended Insect .....	11
Other Approved Insect .....	14
<i>Spotted &amp; Diffuse Knapweed</i> .....	15
Complex of Recommended Insects .....	16
Other Approved Insects .....	28
<i>Leafy Spurge</i> .....	34
Complex of Recommended Insects .....	35
<i>St. Johnswort</i> .....	43
Complex of Recommended Insects .....	43
Other Approved Insects .....	46
<i>Dalmatian &amp; Yellow Toadflax</i> .....	51
Recommended Insect .....	52
Other Approved Insects .....	55

How to do Biological Weed Control .....	59
Insect Ecology .....	59
How to Include Biological Control in IWM .....	60
How to Pick a Good Release Site for the Insects .....	61
How to Acquire Biological Control Insects.....	61
How to Collect Biological Control Insects .....	62
How to Release Biological Control Insects.....	63
How to Monitor Biological Control Release Sites .....	64
How to Redistribute Biological Control Insects .....	65
When NOT to use Biological Weed Control.....	65

Insect Handling Tools .....	66
Sweep Net.....	66
Separator or Accelerator .....	66
Aspirator and Pump .....	67
Volume Count Container .....	67
Insect Containers .....	68
Cooler and Refrigerator .....	68
Insect Vacuum.....	69

Table: Manual, Mechanical, and Biological Methods for Many Montana Noxious Weeds .....	71
---	----

Glossary .....	75
----------------	----

Photo Credits .....	77
---------------------	----

Montana County Weed Districts .....	80
-------------------------------------	----

Other Useful Contacts.....	81
----------------------------	----

# Introduction **Hi**

If you are reading this guide you probably already know that noxious weeds are an enormous problem in Montana and you are deciding what to do about it. It is recommended that land managers use Integrated Weed Management (IWM) when controlling weeds on their land. IWM is the use of multiple weed control methods at the same time. These methods include but are not limited to prevention, grazing, biological control, herbicide, cultivation, hand pulling and digging, cutting and mowing, and mechanical removal. This "tool box" of IWM methods can be combined in different ways depending on the location, weed species, and landowner goals. This guide will help you decide if biological control is appropriate for your land and assist you in combining it with the other methods in your IWM tool box.

Biological weed control (sometimes called "classical" biological control) is the practice of importing and releasing for establishment, natural enemies to control an introduced nonnative weed species. These insects have been imported from the continent where the weed came from. They have been carefully tested to be sure that they are safe to release in North America. They are "host specific", meaning they can only eat that weed and nothing else.

Montana noxious weeds that do have approved and recommended biological weed control insects are listed in the table on the following page:

<b>Weed Species</b>	<b>Biological Agents*</b>
Tansy Ragwort	3 insects available
Canada Thistle	2 insects available
Spotted & Diffuse Knapweed	12 insects available
Leafy Spurge	7 insects available
St. Johnswort	4 insects available
Dalmatian & Yellow Toadflax	3 insects available

\* Some of these weeds have other approved biological agents, however, these have not been successful in Montana and therefore were not included in this guide.

## Know The Label

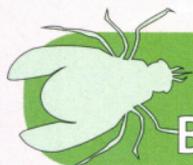
To use biological weed control effectively you need to "Know The Label" of each insect species. Know the label is a term that comes from using herbicides, where you must read and understand the herbicide's directions as listed on the package label. For biological weed control insects The label is each species' individual ecological needs, life cycle, and how to use them. You should understand this information before releasing a species of biological weed control insect. This guide will provide information to help you decide if biological weed control is appropriate for your land and if so, help you learn the label for the insects you choose to add to your IWM efforts.

## Pros & Cons of Biological Weed Control

There are pros and cons to biological weed control. The pros include: 1) the insects only affect the target weed species, 2) once established, they are permanent, 3) they often spread to new areas by themselves, 4) they are inexpensive (you usually only have to release them once), and 5) they require little additional care. The cons include: 1) they are sometimes hard to establish, 2) the results are often slow, and 3) they will never completely wipe out the weed (if they did, they would have become extinct on their continent of origin). Therefore, if you want complete control of that weed, do not include biological control in your IWM efforts.

## Biological Control Cannot Be Used On All Montana Noxious Weeds

There are two reasons why biological weed control cannot be used on all noxious weeds in Montana. First, effective and host-specific insects have not been found for all the weeds in North America. This is often because the weed is closely related to one or more of our native species and the insects that feed on it would also damage our native species. Second, if the weed is not commonly established in a large area of Montana we still have a chance to completely eradicate it with other methods such as hand pulling and herbicides. Insects would not be appropriate to use in this case, as they at best will greatly lower the weed's density.



## Recommended/Approved Biological Weed Control Insects

### Tansy Ragwort



Biannual or short-lived perennial with a short tap root. Stems up to 6 feet.

#### *Recommended Insects:*

1. **Cinnabar moth.**  
Very effective.
2. **Tansy ragwort flea beetle.**  
Effective.

#### *Other Approved Insect:*

3. **Ragwort seed head fly.**  
Limited effectiveness.

#### *Complex of Recommended Insects:*



The cinnabar moth and the tansy ragwort flea beetle are best when used together.

# Tansy Ragwort



## 1. **Cinnabar moth.**

Very effective.

*Scientific name:*

*Tyria jacobaeae*

### *Life cycle:*

These showy moths emerge in spring to early summer. They lay eggs on the leaves and the larvae soon hatch. The larvae feed in groups, defoliate the plant, and overwinter as pupae.



Black and yellow cinnabar moth larvae.

### *Mode of attack:*

Larval defoliation.

### *How to use:*

Release 200+ larvae onto tansy ragwort plants

## Tansy Ragwort

in warm, open areas that will not flood. Do not release in areas of high ant numbers. Best used in combination with the ragwort flea beetle.

*How to collect:* 

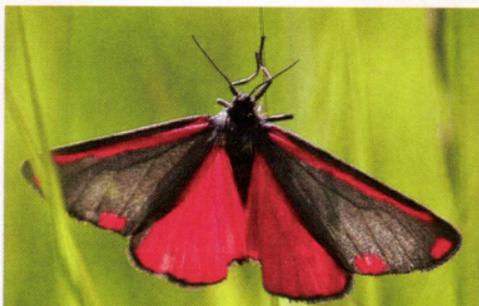
Collect the larvae by hand picking or shaking the plants into a bucket. Place them in containers with foliage and transport/store in a cooler or refrigerator. Larvae can be stored for several days.

*How to monitor:*

Look for the yellow and black larvae feeding on the plant in late spring and summer. Larval feeding damage is often obvious as groups of these larvae completely strip the plant down to the stalk. From midspring to summer, check porch lights after dark for adult moths. A black light-illuminated white sheet after dark will attract this black and cinnamon colored moth.

*In Montana:*

These insects have been very effective in northwestern Montana (Lincoln and Flathead Counties).



Adult cinnabar moth.

# Tansy Ragwort



## 2. **Tansy ragwort flea beetle.**

Effective.

*Scientific name:*

*Longitarsus jacobaeae*

### *Life cycle:*

These beetles have a variable life cycle in Montana. The adults emerge mid to late summer and into the fall. After emergence they feed for a time and then start to lay eggs. Some populations overwinter as eggs while others overwinter as both eggs and larvae. All populations pupate about midsummer.

### *Mode of attack:*

Larval root-feeding causes the most damage. Fall adult feeding on the leaves and rosettes can sometimes kill



Tansy ragwort flea beetle adult.

## Tansy Ragwort

the plants. Adult leaf-feeding causes numerous holes and makes a “shotgun” like effect.

### *How to use:*

Adult beetles can be collected mid to late summer. Release 100+ beetles on open sites. Avoid shaded areas or areas that will flood.

### *How to collect:*



Sweep net on warm afternoons from midsummer to fall. Use an insect vacuum on the basal rosettes in the fall.

### *How to monitor:*

Look for adult feeding damage on the leaves from midsummer through fall. This leaf feeding causes numerous holes and makes a “shotgun” like effect. You can also sweep net or visually inspect the plants for adults all summer and fall. Look closely at the basal rosettes in the fall. The larvae are too small to easily observe. They can be seen at other times of the year.

### *In Montana:*

These insects have been effective in northwestern Montana (Lincoln and Flathead Counties).

# Tansy Ragwort

*Other approved insect:*



### 3. **Ragwort seed head fly.**

Limited effectiveness.

*Scientific name:*

*Botanophila seneciella*

The seed head feeding larvae reduce seed production. The adults look like small house flies.

#### *In Montana:*

Released in Lincoln and Flathead County. Widespread, but limited effectiveness.



Left: Tansy ragwort seed head fly larva in a seed head. Right: Adult fly.

## Canada Thistle



Perennial thistle with horizontal and vertical roots and a stem 1 to 4 feet tall. The flowers are purple fading to white; often forms thick patches.

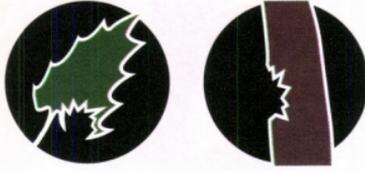
### *Recommended Insect:*

1. **Canada thistle stem weevil.**  
Somewhat effective.

### *Other Approved Insect:*

2. **Canada thistle stem gall fly.**  
Not effective.

# Canada Thistle



## 1. **Canada thistle stem weevil.**

Somewhat effective.

*Scientific name:*

*Hadroplontus (Ceutorhynchus) litura*

### *Life cycle:*

Adults emerge in late summer to early fall, feed on foliage and overwinter in the soil. Adults come out of the soil in early spring and start the cycle over again. They lay their eggs on the leaves of newly emerging plants in the spring. Larvae soon hatch and eat their way along the leaf and into the stem/root crown. They feed all spring through mid to late summer. They then eat their way out of the plant leaving many exit holes and pupate in the soil.



Canada thistle stem weevil, adult.

# Canada Thistle

## *Mode of attack:*

Large numbers of larvae can kill the weed by feeding within the stem/crown of the plant and then chewing many exit holes below the soil surface. These exit holes allow other organisms to enter the stem which causes more damage to the plant. These weevils are known as a somewhat effective agent because they reduce the overwintering survival of Canada thistle. Adults do some damage by feeding on the leaf/stem. They also make cavities in the midrib of the leaf to deposit eggs.



Canada thistle stem weevil larvae and their damage within the stem.

## *How to use:*

The cold-hardy adults overwinter in the soil and attack emerging Canada thistle plants in early to midspring. Release a minimum of 100+ adult weevils either in the spring or fall on a patch of thistles. You can start collecting them for redistribution when you see 1-2 weevils per plant.

# Canada Thistle

*How to collect:* 

The weevils can be collected two times per year; collect by sweep netting, hand picking, tapping, aspirator, or insect vacuum. First in early spring collect by sweep netting, aspirating, or hand picking adults from emerging thistle plants. Second, in mid to late summer collect the newly emerging adults by pan/tapping them into a net, bucket or pan, or by sweep netting with an upward motion along the thistle plants. Weevils should be hand picked from the nets and placed in suitable containers. Transport/store them in a cooler or refrigerator.

## *How to monitor:*

Look or sweep net for adult weevils in early spring through fall. They are easiest to see in spring when the plants are small. Often there is dark staining on the lower stem fibers. You can also cut the lower stems open during spring and early summer to see white grub-like larvae and/or feeding damage. Larval feeding damage causes hollowing of the stem and leaves dark-colored frass within the plant stem.

## *In Montana:*

Well-established at many locations with some impact reported.

# Canada Thistle

*Other approved insect:*



## 2. **Canada thistle stem gall fly.**

Not effective.

*Scientific name:*

*Urophora cardui*

The larvae cause a stem gall to form which damages the stem above the gall. The adult flies have a distinct black "W" on each wing.



Left: Gall caused by the Canada thistle stem gall fly. Right: Adult fly.

## Spotted & Diffuse Knapweed

Short-lived perennial with tap root. Basal rosette, bolts and blossoms in summer. Spotted knapweed flowers are usually purple, occasionally white. Diffuse knapweed usually has white flowers, occasionally rose or lavender.



### *Recommended Insects:*

1. **Knapweed root boring weevil.**  
Very effective.
2. **Knapweed root boring moth.**  
Effective.
- 3-4. **Knapweed seed head weevils.**  
Effective.
- 5-6. **Knapweed seed head flies.**  
Somewhat effective.

### *Other Approved Insects:*

7. **Spotted knapweed seed head moth.**  
Somewhat effective.
8. **Broad nosed seed head weevil.**  
Unknown effectiveness.
9. **Brown winged root moth.**  
Unknown effectiveness.

## Spotted & Diffuse Knapweed

10. **Bronze knapweed root borer.**  
Somewhat effective.
11. **Green clearwing fly.**  
Unknown effectiveness.
12. **Knapweed peacock fly.**  
Unknown effectiveness.

### *Recommended Complex of Insects:*



At many sites where the Recommended Insects (numbers 1 through 6) are present in strong numbers, knapweed density is declining over time. The 4 seed head feeders (the two seed head weevils and the two seed head flies) destroy most of the seeds. The root boring moth damages the plants, and the root boring weevil kills the larger knapweed plants. Over the next 8-10 years the number of knapweed seeds in the soil is gradually reduced and the root borers (especially the weevil) kill the larger knapweed plants. The large plants die out and fewer and fewer new plants sprout. Seeding with native/useful plants will help this process by out-competing the new knapweed sprouts. This recommended "winning team" of insects is working on many dry, warm sites throughout Montana. Expect slower results at higher elevations.

# Spotted & Diffuse Knapweed



## 1. ***Knapweed root boring weevil.***

Very effective.

*Scientific name:*

*Cyphocleonus achates*

### *Life Cycle:*

Adults emerge from the roots mid to late summer. A female can lay up to 100 eggs during her 8-15 weeks as an adult. The eggs are laid usually 1-2 per plant on the root crown. Adults survive into the fall until cold weather kills them. The larvae soon hatch and mine into the cortex (center) of the root. They feed within the roots until the following summer. Pupation occurs about midsummer within the root. The adults chew their way out of the root in mid to late summer and start the cycle again.

### *Mode of attack:*

Larval feeding within the roots causes the most destruction. Adult feeding on leaves can cause

## Spotted & Diffuse Knapweed

damage when high numbers of weevils are present.

### *How to use:*

One hundred or more adults should be released in late summer and early fall in areas where large knapweed plants occur (roots greater than ½ inch in diameter). The release sites should be as hot and dry as possible with no flooding. Simply shake all the weevils onto several plants in close proximity. These weevils do not fly, and thus require a full release about every 1/4

mile. Best when used in combination with seed head feeders, especially the two seed head weevils in the genus *Larinus*.

### *How to collect:*

Hand picking or sweep netting are the best methods. For being a large weevil, these insects blend in very well and it takes a while to develop an "eye" for them as you hand pick. The weevils



Above: Adult weevil. Below:  
Note the C-shaped larvae and  
the damage they do to the root.

## Spotted & Diffuse Knapweed

will either cling to the plant or drop off and play dead. If you sweep net, pick them out of your net often so as not to damage them in the netting process. Place them in a paper container with some knapweed foliage to cling to. Transport/store them in a cooler or refrigerator.

### *How to monitor:*

Pull up the roots of knapweed any time of the year and look for feeding damage and root galling in larger plants. Cut or tear apart the roots. The inside of infected roots will be black with frass and have hollow chambers where the larvae fed. As you pull up damaged roots (wear gloves) they will often break off just below the root crown. In healthy knapweed, the whole tap root will pull up like a skinny carrot. From mid to late spring to late summer you can find the large C-shaped larvae, pupa, or adults within the roots. Adults can be located by sweep netting through knapweed plants on warm afternoons from mid to late summer and well into fall. Visual inspection for the adults on the plants can be done on warm afternoons mid to late summer and into fall. Root damage from the knapweed root boring moth *Agapeta* looks much like damage from this weevil.

# Spotted & Diffuse Knapweed

## *In Montana:*

These slow-acting but effective root borers are well established in many scattered areas throughout the state. They are controlling large areas of knapweed at some locations. However, since they do not fly they need to be aggressively redistributed throughout the state.



## 2. ***Knapweed root boring moth.***

Effective.

*Scientific name:*

*Agapeta zoegana*

## *Life Cycle:*

From late spring to late summer the short-lived adult moths lay eggs on the lower stem and leaves. The larvae hatch and migrate to the root crown where they mine the root. They spend fall through next spring feeding within the roots and pupate in the root or soil near the root. The adults emerge and do it all again.

## Spotted & Diffuse Knapweed



Left: Adult moth. Right: Larva; note damage within root.

### *Mode of attack:*

Larval feeding within the root. The adult moths do not damage the plant.

### *How to use:*

Release 70-100+ adult moths onto spotted or diffuse knapweed soon after collection as they are short-lived. Best used in combination with the seed head feeders and *Cyphocleonus*.

### *How to collect:*

Hand picking or sweep netting. Collect whenever adults are present.

### *How to monitor:*

Sweep netting or visual inspection on or near knapweed plants for adults from late spring to late summer. Check porch lights just after dark for adult moths. An ultraviolet light-illuminated white sheet after dark will attract mostly male

## Spotted & Diffuse Knapweed

moths. Pull up the roots of knapweed any time of the year and look for larval feeding damage. Larvae large enough to observe are present in the roots about midspring and are slender and straight rather than C-shaped like *Cyphocleonus*. Root feeding damage from the knapweed root boring weevil *Cyphocleonus* looks much like damage from this moth.

### *In Montana:*

They are well-established in western Montana and are increasing east of the divide. They do not kill knapweed plants as rapidly as the knapweed root boring weevil.

## Spotted & Diffuse Knapweed



### 3-4. **Knapweed seed head weevils.**

There are two species – both effective at reducing seed production in spotted and diffuse knapweed. Effective at controlling diffuse knapweed. It is almost impossible to visually differentiate these two species, so a release of either one or the other will do.

#### *Scientific names:*

*Larinus minutus* & *Larinus obtusus*

#### *Life cycle:*

The long-lived adults gather at knapweed plants from midspring to late summer. They lay one or more eggs in the flower bud and the larvae feed on the seeds. They pupate within the mature seed head. The newly emerged adult exits the seed head in late summer to early fall and spends the winter in the soil litter.

## Spotted & Diffuse Knapweed



Left: Extreme close-up of an adult knapweed seed head weevil.

Right: Note the exit hole made as an adult left the seed head (ball-point pen for scale).

### *Mode of attack:*

The larvae feed on the developing flower, destroying all or most of the seeds. High numbers of adults cause severe feeding damage on the leaves and flowers. In spotted knapweed they greatly lower seed production and in diffuse knapweed they will control it.

### *How to use:*

Release 100+ adult weevils on spotted or diffuse knapweed. The knapweed infestations should have plants 1-2 feet apart and should be available for a long term (5 to 10 years) undisturbed. *Larinus* prefer warm dry climates. Best when used in combination with the knapweed root borers.

# Spotted & Diffuse Knapweed

*How to collect:* 

Adults can be collected by sweep netting from late spring into late summer. Handpick or aspirate the insects out of the sweep net into suitable containers. Collect whenever adults are present.

*How to monitor:*

The best way to monitor is to look for adult exit holes in the old dried-up knapweed seed heads. You can do this any time of the year as old dead knapweed stems and seed heads often persist for over a year. From late spring through late summer sweep net or visually inspect knapweed plants for the small brown adult weevils, or dissect seed heads and observe larvae or pupae. The larvae/pupae are much larger than those of the knapweed seed head flies.

*In Montana:*

These small weevils are fairly wide-spread throughout the state so be sure to check for establishment before procuring a release. They have successfully controlled diffuse knapweed in the Helena Valley and are decreasing seed production in both species of knapweed throughout large areas of Montana.

# Spotted & Diffuse Knapweed



5-6. ***Knapweed seed head flies.***

Effective at reducing seed production.

### *Scientific names:*

*Urophora affinis* & *Urophora quadrifasciata*

### *Life Cycle:*

The adults emerge spring through midsummer as flower buds form on knapweed. The eggs are laid in immature flower heads late spring into summer. The larvae cause a gall to form within the flower, reducing seed production. There are often multiple galls within each seed head. The larvae overwinter in the seed head and pupate the following spring. They emerge the following spring/summer to do it all again.

### *Mode of attack:*

The larvae induce galls within the seed head. The adult flies do not damage the plant.

## Spotted & Diffuse Knapweed



Left: Extreme close-up of the very small knapweed seed-head fly. Right: Note the galls on either side and the broken-open gall showing the minute larva in the middle.

### *How to use:*

These strong-flying small flies are established everywhere in Montana so we do not need to spread them around. They rapidly find new knapweed infestations on their own but do not control knapweed by themselves. Best when combined with knapweed root boring insects.

### *How to collect:*

Collection is not needed, as they have dispersed everywhere.

### *How to monitor:*

From late summer to the following spring, dissect the dried seed heads and look for galls with the small white maggot-like larvae within. The pupae, present in spring, look like small dark brown grains of rice within the gall. You can sweep net or visually inspect for the small adult flies from late spring to late summer.

# Spotted & Diffuse Knapweed

## *In Montana:*

They are established everywhere knapweed occurs and are an important part of the recommended complex of insects.

## *Other Approved Insects:*



## 7. **Spotted knapweed seed head moth.**

Somewhat effective.

### *Scientific name:*

*Metzneria paucipunctella*

*Metzneria* is a small, light gray moth with pepper-like spots and dark wing tips. Its larvae damage seed heads.

## *In Montana:*

This moth is somewhat well-established. Populations are limited in some years due to mortality caused by cold winter temperatures.



Top: Adult moth. Bottom: Upper portion of a larva within a knapweed seed head.

# Spotted & Diffuse Knapweed



## 8. **Broad nosed seed head weevil.**

Unknown effectiveness.

*Scientific name:*  
*Bangasternus fausti*

This is a small, grayish-black weevil. The larvae damage seed heads.

### *In Montana:*

It is established at low population levels, and is more common in ID and WA.



Left: Adult weevil. Right: Pupa within a seed head.

# Spotted & Diffuse Knapweed



## 9. **Brown winged root moth.**

Unknown effectiveness.

*Scientific name:*  
*Pelochrista medullana*

*P. medullana* is a small, tan to grey moth with mottled wings. It has root boring larvae.

### *In Montana:*

Limited establishment.



Left: Adult moth. Right: Larva.

# Spotted & Diffuse Knapweed



## 10. **Bronze knapweed root borer.**

Somewhat effective.

*Scientific name:*

*Sphenoptera jugoslavica*

This is a small, metallic dark reddish-brown beetle. The larvae are root borers.

### *In Montana:*

Bronze knapweed root borers are established in some locations. It does better on diffuse, but will also attack spotted knapweed.



Left: Adult beetle. Right: Larva and larval feeding damage within root.

# Spotted & Diffuse Knapweed



## 11. **Green clearwing fly.**

Unknown effectiveness.

*Scientific name:*

*Terellia virens*

*T. virens* is a small greenish seed head fly. The larvae damage seed heads.

### *In Montana:*

This fly is established in some locations.



Extreme close-up of adult fly.  
[No photo available of larva.]

# Spotted & Diffuse Knapweed



## 12. *Knapweed peacock fly*. Unknown effectiveness.

*Scientific name:*  
*Chaetorellia acrolophi*

This is a small fly with light brown-banded wings.  
The larvae damage seed heads.

### *In Montana:*

Limited establishment; effectiveness and  
distribution unknown.



Left: Adult fly. Right: Larva next to damaged seed head.

## Leafy Spurge



Deep-rooted early flowering perennial. Flowers/bracts yellow, produces milky-white sap; the seed pods burst and throw sticky seeds up to 15 feet.

### *Recommended Insects:*

#### *Flea beetles.*

1. **Brown legged leafy spurge flea beetle.**  
Very effective (most!)
2. **Black dot leafy spurge flea beetle.**  
Very effective.
3. **Black leafy spurge flea beetle.**  
Very effective.
4. **Copper leafy spurge flea beetle.**  
Moderately effective.
5. **Brown dot leafy spurge flea beetle.**  
Moderately effective.

#### *Root boring beetle.*

6. **Red headed leafy spurge stem and root crown borer beetle.**  
Moderately effective.

### *Other Approved Insect:*

7. **Leafy spurge hawk moth.**  
Limited effectiveness.

## Leafy Spurge

*Recommended Complex of Insects:* 

It is best to have a mixture of as many of the flea beetles as possible; however, try and have at least two of the three "very effective" species. Also, include the red headed leafy spurge stem borer as they disperse farther and help open up thick spurge stands to flea beetle attack.



## 1-5. *Flea beetles.*



### *Scientific names:*



1. *Aphthona lacertosa*



2. *A. nigriscutis*



3. *A. czwalinae*



4. *A. flava*



5. *A. cyparissiae*

### *Life Cycle:*

The small adult beetles emerge in early summer. They are gregarious and tend to stay together in one area. They scatter their eggs on the ground near leafy spurge plants. The minute larvae

# Leafy Spurge

hatch, they burrow down into the soil and begin feeding on spurge roots. They feed all fall through late spring. Flea beetles pupate in the soil and emerge in early summer to do it all again.

## *Mode of attack:*

The larvae do the most damage by feeding on the roots. Adults in high numbers can defoliate the plant.

## *How to use:*

Release 500+ adult beetles onto a warm, dry stand of leafy spurge that will not flood. They prefer areas where some sunlight reaches the ground so their eggs will quickly hatch to prevent predation. Avoid releasing them near ant piles. These gregarious beetles stay together and tend to cause what is known as the “bomb-shell effect.” That is, they kill a small area around the initial



Left: Adult beetle. Note the grasshopper-like rear leg that allows these very small beetles to hop. Right: The minute larva in the soil feeding on spurge roots.

## Leafy Spurge

release site the first year making a "crater" of dead or dying spurge plants. This crater increases each year thereafter. Standing water will drown the larvae so these beetles do not work well along ditch banks or where flood or heavy irrigation is used. In a heavy spurge infestation, release every  $\frac{1}{4}$  section. It is best to combine multiple species of these flea beetles and use in combination with the red headed spurge root boring beetle *Oberia*.



A brown and a black flea beetle.  
Try and have good mixtures of  
the 6 recommended species.

**How to collect:**  

Sweep net through well-infested stands of leafy spurge. If the new release site is within a few minutes' drive, just fold the sweep net over until you reach the site. Open the net at the release site and shake them out. To collect large numbers for longer transport, sweep net and place the nettings into an accelerator (separator, see: Insect Handling Tools). As the small flea beetles fall through the small screen in the accelerator

## Leafy Spurge

and into the container at the bottom, scoop a preset volume of beetles (usually 3-5 thousand) into appropriate insect containers with spurge foliage. Cool immediately in a cooler with ice.

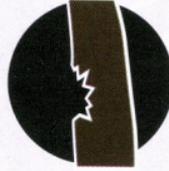
Often, a few years after the initial release, high numbers can be collected before the site crashes (*i.e.* most of the weeds die and so do many of the flea beetles). It is important to closely monitor the release site so as not to waste this useful burst of insects, sometimes numbering into the several millions.

### *How to monitor:*

Sweep net through leafy spurge stands, checking the net often for the small black or brown adult flea beetles. Also, look for the bomb-shell effect craters at the release sites.

### *In Montana:*

In many parts of the state, these insects are very effective.



**6. Red headed leafy spurge  
stem and root crown borer beetle.**

Moderately effective.

*Scientific name:*

*Oberea erythrocephala*

*Life Cycle:*

Adult beetles emerge in midspring. They lay their eggs on the lower part of large spurge stems, usually one per stem. The larvae hatch and mine their way down the stem into the root. They overwinter in the root crown or stem and pupate within the root crown in early spring. They emerge in midspring and do it all again.

*Mode of attack:*

The most damage is done by larval root feeding. The adult females often girdle the stem as they lay each egg which may kill that stem or greatly decrease its seed production.

# Leafy Spurge



Left: Adult beetle. Note the white sticky sap produced by leafy spurge.  
Right: Larva within a spurge root.

## *How to use:*

Release 70+ beetles in warm open to partially shady and moist sites of leafy spurge infestation. These beetles are strong fliers and will rapidly disperse from the initial release site. Because these beetles spread out so rapidly, the damage within the spurge infestation is subtle and hard to observe. They tend to damage scattered larger spurge stems rather than all the plants in an area. Best when used in combination with the flea beetles. They tend to open up dense stands of spurge to allow the flea beetles to be more effective.

*How to collect:* 

Sweep net through infested spurge stands midspring through midsummer and hand pick out of the net. They will often be mixed in with flea beetle collections and can be hand picked from the top of the accelerator after most of

## Leafy Spurge

the flea beetles have dropped through into the bottom container.

### *How to monitor:*

Sweep net for adult beetles through spurge stands from midspring to midsummer. You can also observe spurge stems for egg laying damage all summer. In early spring, dig up and dissect spurge roots and observe larvae.

### *In Montana:*

These insects are becoming well-established in many areas of the state. Their effects are spread out and subtle.

# Leafy Spurge

*Other Approved Insect:*



## 7. **Leafy spurge hawk moth.**

Limited effectiveness.

*Scientific name:*

*Hyles euphorbiae*

This moth has very large colorful defoliating larvae. Large hawk moth adults can sometimes be mistaken for a hummingbird.

### *In Montana:*

Established at numerous locations, populations vary greatly from year to year. The larva defoliates the plant too late in the season to stop seed production or decrease root food reserves.

# Leafy Spurge



Above: Large adult moths.

Below: Large and colorful larva feeding on spurge foliage.



# St. Johnswort

Long-lived perennial with radiating roots; 1-4 feet tall with yellow flowers.



## *Recommended Insects:*

- 1-2. **Klamath weed beetles.**  
Moderately effective.

## *Other Approved Insects:*

3. **St. Johnswort moth.**  
Unknown effectiveness.
4. **St. Johnswort root boring beetle.**  
Unknown effectiveness.

## *Complex of Recommended Insects:*



Both Klamath weed beetles. However, they go through cycles of population highs and lows.

# St. Johnswort



## 1-2. **Klamath weed beetles.**

Moderately effective.

### *Scientific names:*

*Chrysolina hyperici* & *Chrysolina quadrigemina*

### *Life Cycle:*

These shiny metallic green, black, bronze, or blue beetles have a complex and variable life cycle in Montana. Usually, adults emerge from spring to early summer. They feed on St. Johnswort foliage for several weeks. They then rest in the soil during



Left: *Chrysolina hyperici*. Right: *Chrysolina quadrigemina*.

# St. Johnswort

the hot summer. Fall rains, when present, stimulate them to mate and lay eggs on the leaves. They also lay eggs in the spring. *Chrysolina* overwinter as eggs, larvae, and sometimes adults. The larvae hatch and feed on leaf buds and immature leaves.

## *Mode of attack:*

Larvae and adults feed on the foliage.

## *How to use:*

Release 100+ adult beetles in sunny, open areas.

## *How to collect:*



Sweep net or hand pick adults from plants during midspring to summer.

## *How to monitor:*

Observe adults or larvae on plants or sweep net during midspring to summer.

## *In Montana:*

Well-established and widespread. Although very effective in California, these insects are not able to produce two generations per year in Montana, thus they are only moderately effective. Populations are cyclic within the state.

# St. Johnswort

## Other Approved Insects:



### 3. **St. Johnswort moth.**

Unknown, established at low population levels.

*Scientific name:*

*Aplocera plagiata*



Left: Adult moth. Right: Larva; moves like an "inch-worm" caterpillar.

### *Mode of attack:*

Damage to the plant is caused by larval feeding on the leaves and flowers. *Aplocera* produces 2 generations each summer and the 2<sup>nd</sup> generation overwinters as larvae in the soil litter.

### *How to use:*

Release 100+ larvae onto St. Johnswort plants in warm, dry, low-elevation areas early enough in the summer

# St. Johnswort

for *Aplocera* to complete both generations.

**How to collect:** 

Larvae can be collected by hand picking and light sweep netting from spring to late summer. The 2<sup>nd</sup> generation usually has higher numbers than the first.

**In Montana:**

Works best in warm, low-elevation areas of the state, but results are variable.



## 4. **St. Johnswort root boring beetle.**

Unknown effectiveness.

**Scientific name:**

*Agrilus hyperici*

**Mode of attack:**

Adults emerge mid to late summer. They lay eggs on the stem and the larvae mine down to the root. Larvae overwinter within the root, and

# St. Johnswort

pupation occurs within the root. Larval feeding does the most damage to the plant.

## *How to use:*

Release 100+ adult beetles onto St. Johnswort plants in open to shaded areas. Larvae in overly-damp sites may die from fungal attacks.

## *How to collect:*



Adults can be collected from mid to late summer by sweep netting or hand picking on hot afternoons.

## *How to monitor:*

Because these beetles disperse widely by flying they are often not recovered for several years after release. Then the population will suddenly increase and cause much damage to the plant.

## *In Montana:*

Established at low population levels, impact unknown.



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Left: Adult beetle. Right: Larva and root damage.

## Dalmatian & Yellow Toadflax

Dalmatian and yellow toadflax are perennials with yellow snapdragon-like flowers.

Dalmatian toadflax can be 1-3 feet tall with thick waxy leaves. Yellow toadflax can be 1-2 feet tall with thinner, less waxy leaves. Both plants have extensive lateral root systems and can spread via seeds and roots.



### *Recommended Insect:*

1. **Toadflax stem weevil.**  
Effective.

### *Other Approved Insects:*

2. **Toadflax seed capsule weevil.**  
Somewhat effective.
3. **Toadflax flower feeding beetle.**  
Somewhat effective.

# Dalmatian & Yellow Toadflax



## 1. **Toadflax stem weevil.**

Effective.

*Scientific name:*

*Mecinus janthinus*

### *Life Cycle:*

Adult weevils emerge from toadflax stems in early spring and lay eggs on new growing stems all spring. The eggs soon hatch and the minute larvae mine the inside of the stem. They pupate within the stem in about a month and become adults within the pupal chamber in the stem. These adults stay within the stem all fall and winter. In spring they emerge to do it all again.

### *Mode of attack:*

Larval stem mining causes the upper stem to be deformed and often decreases seed production. When present in high numbers, adult leaf feeding can also damage the plant.

# Dalmatian & Yellow Toadflax

## *How to use:*

Release 100+ adult weevils in spring on warm, dry open or forested areas with large-stemmed toadflax. If in hilly country, it is best to release them on the lower part of a hill as these strong fliers tend to spread up hill over time. They survive winter better in areas where snow covers and insulates the stems.

## *How to collect:*



In spring, shake insects from the stems into a bucket. Quickly aspirate or dump the insects from the bucket into a suitable insect container. You can also sweep net through infested toadflax stands in spring. A third method is to collect infested toadflax stems in the fall and store these in the refrigerator. This will decrease winter cold



Left: Close-up on an adult. Right: Feeding damage and adult weevils within cut-open stems. Adults overwinter within the stems.

## Dalmatian & Yellow Toadflax

mortality as the refrigerator does not have the large temperature swings that tend to kill the adults within the stem. Tie bundles of these stems to fence posts or trees in early spring after danger of extreme cold snaps has passed. The adults should emerge from these stems correctly timed with the local environment.

### *How to monitor:*

In spring, visually check or sweep net plants for adults. In summer dissect the stems and look for larval feeding damage, larvae, or pupa. From fall to spring, stem dissection will disclose adults within the stem.

### *In Montana:*

These insects are starting to work in western Montana where the winters are mild and in areas where snow provides winter insulation for the adult weevils within the stems. East of the divide success is variable and slow.

# Dalmatian & Yellow Toadflax

*Other Approved Insects:*



## 2. **Toadflax seed capsule weevil.**

Somewhat effective.

*Scientific name:*

*Gymnetron antirrhini*

### *Life cycle:*

Adults emerge in spring and lay eggs within toadflax flowers.

### *Mode of attack:*

Larval feeding destroys most of the seeds within that flower and pupation occurs within the seed capsule. Adults emerge in late summer and cause some damage by feeding on actively growing toadflax stems. They soon go into hibernation and overwinter in soil debris or within the seed capsule. They are strong fliers and have dispersed to most of the yellow toadflax throughout the state by themselves. This insect has a yellow and

## Dalmatian & Yellow Toadflax

a Dalmatian toadflax strain. The yellow toadflax strain is most likely everywhere large infestations of the weed occur so it does not need to be redistributed.

### *How to use:*

Release 100+ insects of the correct strain on any toadflax site.

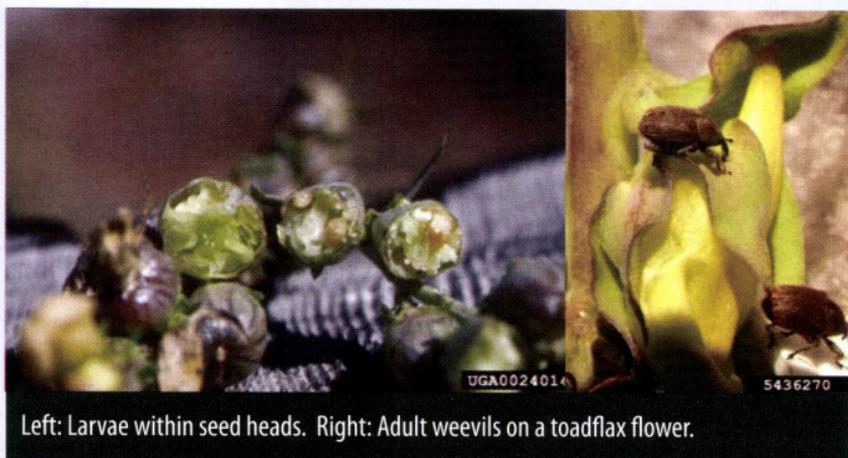
### *How to collect:*



Collect in the spring with a sweep net or aspirator. Look within the flowers of the plant.

### *In Montana:*

The yellow toadflax strain is common throughout the state. The Dalmatian toadflax strain is increasing at several sites in Montana.



Left: Larvae within seed heads. Right: Adult weevils on a toadflax flower.

# Dalmatian & Yellow Toadflax



## 3. **Toadflax flower feeding beetle.**

Somewhat effective.

*Scientific name:*

*Brachypterolus pulicarius*

### *Life cycle:*

Adults emerge in spring and lay their eggs in toadflax flowers. Pupation occurs within the soil near the toadflax plants.

### *Mode of attack:*

Adult feeding on stems and flowers causes the plant to branch more and also lowers seed production. The larvae feed within the flowers and decrease seed production. The beetle overwinters as a pupa. They are strong fliers and have dispersed to most of the yellow toadflax throughout the state. This insect has a yellow and a Dalmatian toadflax strain. The yellow toadflax strain is most likely everywhere large infestations of the weed occur and so does not need to be redistributed.

# Dalmatian & Yellow Toadflax

## *How to use:*

Release 100+ insects of the correct strain on any toadflax site.

## *How to monitor:*

In spring/early summer, look for these small beetles on the upper parts of the plant and within the flowers. Sweep net through stands of the weeds.

## *How to collect:*

Collect in the spring with a sweep net or aspirator. Look within the flowers of the plant.

## *In Montana:*

The yellow toadflax strain is common throughout the state. The Dalmatian toadflax strain is increasing at several sites in Montana.



Left: Extreme close-up of this small adult beetle.

Right: A larva (lower left) and a damaged toadflax flower.

# How to do Biological Weed Control ?

Now that you have thought about using biological control in your Integrated Weed Management Plan, weighed the pros and cons of biological control and studied the “label” of the insects you are interested in, it is time to learn the “how to” of biological weed control. The following how to sections will help you establish the recommended complex of insects as rapidly as possible using the label to decide where and how to best release them.

These sections are followed by a table: Manual, Mechanical, and Biological Methods for Many Montana Noxious Weeds, a glossary of useful terms, and other useful contact information.

## Insect Ecology

Plant-feeding insects divide up the plant community much as we divide up our economy. Many of us specialize in our jobs such as plumbers, architects, or ranchers. Over time many insects have become so specialized that they can only eat one species of plant (they are host-specific) and often just one part of that plant. Feeding specialties include: leaf feeders, leaf gallers, seed head feeders, stem miners, stem gallers, and root borers. Often, the larvae feed on different plant parts than the adults.

# How to Include Biological Control in Integrated Weed Management (IWM)

Biological control insects are often used in areas unsuitable for herbicide use. These insects need a release site that fits their ecological needs (know the label) and enough of the weed species to support their population over time.

One hypothetical example: Picture the whole weed patch. Some people find it helpful to think of the weed patch as if it were a grass fire and the smaller satellite patches as if they were spot fires out in front of the main fire. Within the main patch, find the site that best fits the ecological needs of the insect (know the label) and release the insects there. Fence a 30 yard area around the release site. Apply herbicides to the satellite patches, edge of the whole weed patch, and along all fences and roads to keep the weeds from spreading. Hand pull along water ways. Graze the rest with sheep or goats. Over time, work inwards with herbicide and grazing and let the insects work their way out.

## How to Pick a Good Release Site for the Insects

*The release site should:*

1. Have a large infestation of the weed.
2. Be contiguous to other infestations so that the insects can spread.
3. Fit the ecological needs of the biological control agent to increase chances of establishment.

4. Fit the goals of the land owner.
5. Be easy to get to, to monitor, and collect from in the future.
6. Be relatively undisturbed (not heavily grazed, plowed, etc.) for at least 5 (preferably 10) years with a land owner agreement in writing.
7. Be well marked, photographed, and mapped (Township/Range and/or GPS waypoint).

## How to Acquire Biological Control Insects

Each county in Montana has a Weed District with a County Weed Coordinator. Contact the Weed District and request insects for your weeds. They may also show you where and how to collect insects from established sites in the area. Be sure you have land owner permission before collecting insects! There are also several private business firms that sell biological weed control insects. Inform your County Weed Coordinator of all insect releases you make. Be aware that you cannot ship/transport biological weed control insects across state lines without an approved federal permit from USDA APHIS PPQ.

# How to Collect Biological Control Insects

Each insect species has a different method for collections so know the label! Many insects are best collected during the hottest part of the day.

Three common insect collection methods are:



1. **Sweep netting:**

Using a special sturdy "butterfly net" with a robust canvas bag and "sweeping" it through the weeds where the insects are. The mixture of insects in the net is then separated either by hand picking out of the net or by various "separators."



2. **Hand picking:**

Getting down into the weeds, locating the insect, and picking it up by hand.



3. **Pan collecting or tapping:**

Shaking or tapping the weed into a sweep net, bucket or pan (such as a clean kitty litter pan). The insects in the pan can then be aspirated or dumped into a suitable container.

As you collect, biological control insects should be immediately put into an appropriate container and into a cooler with an ice pack (but not a freezer!) for protection and transport.

Hand picking.



## How to Release Biological Control Insects

Insects should be released as soon as possible after collection. If possible also record the number of insects released, the general soil type, and the weather conditions at the time of the release. If the insects have been cooled, they need to be allowed to warm up for at least 10 minutes so that they can escape their predators. They should not be released near an ant pile, just before or during a rain storm, on cold days, or just before sunset.

To release most insect species, carefully open the container and sprinkle them onto the weeds in a small area. Be sure not to step or drive through that area as you leave.

Take a photo of the site that shows enough background terrain so anyone can find the site using the photo. Take a GPS waypoint (longitude and latitude) of the site as well as make a map to the site that starts from a known landmark such as a city or major highway. Record this at the site on the day you make the release. Provide a copy of your site information to your County Weed Coordinator. (Montana Weed Control Association [www.mtweed.org](http://www.mtweed.org)).

## How to Monitor Biological Control Release Sites

*Four reasons* to monitor release sites would be to determine:

1. If the insects become established.
2. The effect on the weed population.
3. If the insects have spread from the release site.
4. If the insect population is large enough to collect for redistribution.

Try to take a photo of the site from the same location at about the same date each year.

Each insect species has a different method for monitoring so know the label!

1. **Seed head feeders:**  
Sweep net for adults, observe the seed head for damage, dissect the seed head and look for feeding damage or larvae/pupae.
2. **Foliage feeders:**  
Sweep net for adults, look for larvae (caterpillars) and feeding damage to plant.
3. **Galling insects:**  
Sweep net for adults; observe the appropriate weed part for the galls (swellings).
4. **Stem miners:**  
Sweep net for adults, dissect the stem and look for feeding damage or larvae/adults.

5. **Root borers:**

Sweep net for adults, pull up weeds and dissect the roots looking for feeding damage or larvae.

## **How to Redistribute Biological Control Insects**

Once the insects have become well-established and built up a large population it is a good idea to start moving them about on your land (or sharing them with your neighbors). Insects are small creatures and often have a hard time moving to new weed patches in this great big world. We can help them by moving them ourselves. Simply collect the insect as is appropriate for that species and quickly take them to your newly selected release site that fits within your IWM plan and release!

## **When NOT to use Biological Weed Control**

1. On a small, isolated infestation.
2. On an area that is being treated or is planning to be treated with herbicide or is scheduled to be controlled with mechanical controls; *i.e.* burning, plowing, etc.
3. On a new weed that is under eradication by the state.
4. On a site where you are not sure if it will be disturbed within the next 5 or so years.



## Insect Handling Tools

### *Sweep Net*

Many insects are best collected with a sweep net during the heat of the day. A sweep net is a robust net with a canvas bag used to sweep through weed infestations to collect

biological control insects. To collect, sweep the net rapidly and repeatedly through the weeds where and when the insects are present. Be careful not to pick up ground litter or rocks as these will damage the insects within the net. Also, do not hit sharp objects such as barbed wire fences or tree branches as these will tear the net. As you sweep, collect the insects periodically



Sweep nets in use.



from the net. This can be done by hand, with an aspirator, or the sweepings can be dumped into an insect separator or container. Many County Weed Districts will have sweep nets that you can check out or rent.

### *Separator or Accelerator*

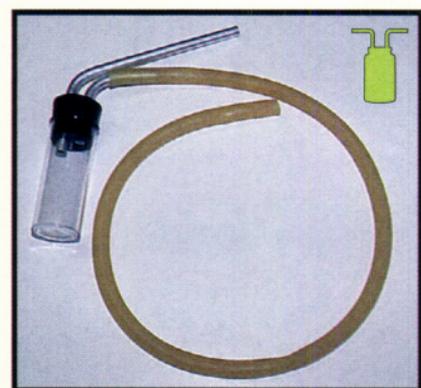
This is a field device used primarily for collecting leafy spurge flea beetles. Dump the flea beetle sweepings into the top of the device and the small flea beetles will hop through a small mesh screen and fall through a funnel into a container. Periodically empty the container

into suitable insect transport containers. This device will keep the larger insects and many of the smaller insects out of your insect collections, leaving mostly flea beetles which can be measured (counted) by volume.

### *Aspirator and Pump*

An aspirator is a small device that uses a vacuum to pull an insect into a container. They are a good way of completely separating the species of interest from all the other

insects. Aspirators work well for smaller, hard bodied insects. The vacuum can be created by lung power (inhaling) or a vacuum pump. To aspirate an insect, simply inhale on the plastic tube while pointing the open metal tube close to the insect. Make certain the metal tube is



turned 180 degrees away from the example in the photo. Be sure and keep the screen on the tube you are inhaling through so as not to inhale insects or other particles. Filters can also be purchased from insect supply companies.



## Volume Count Container

The container is a 9 dram plastic vial (measuring 1" x 2 5/8") with the volume measurements for leafy spurge flea beetles, toadflax stem boring weevils and knapweed seed head weevils. The vials can be secured from an insect supply house. To make the stick-on labels E-mail the Whitehall Project at: [tbreit@whitehallmt.org](mailto:tbreit@whitehallmt.org). They will send you a Microsoft Word document that you can print out onto clear plastic with a sticky backing. Cut this out and stick it to the outside of your vial. Many County Weed Districts will have volume count containers that you can check out or rent.



## Insect Containers

Plastic, glass, or coated containers should be avoided unless suitable ventilation holes are provided. Cylindrical cardboard containers are best because they are strong enough to keep the insects from being crushed but allow for good air flow. Plant material (the weed with no seeds or flowers) and/or crumpled paper towels should be placed within the container before the insects are added. This gives the insects something to hold onto and moisture/food. For short transport almost any container will work. In a pinch, paper lunch sacks stapled shut will do. Keep the containers out of the direct sun so the insects do not overheat. Tape the lid shut with masking tape so the container does not come open during transport.

## *Cooler and Refrigerator*

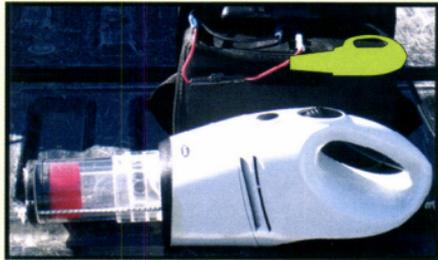
Large numbers of insects within a container create their own heat and must be cooled immediately. Cooling the insects also slows them down so that they do not injure each other within the container.



Insects should be stored and transported in cool but nonfreezing temperatures. For transport, they should be placed in a cooler with an ice pack with packing to separate them from the ice. If the insect container touches the ice, the insects on that side of the container may freeze. For storage, place insects in a refrigerator. Do not allow them to freeze. Generally, beetles/weevils can be stored for up to a week whereas delicate insects like moths should not be stored for more than 1-2 days. Insects should be released as rapidly as possible.

## *Insect Vacuum*

Several insect supply houses sell insect collection vacuums. These are expensive, used in the field, and should only be used when high insect numbers are involved. Leaf blowers/vacuums can also be modified for this purpose.

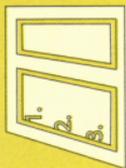


Most of the above mentioned insect handling tools can be purchased at insect supply houses.



Dalmatian Toadflax

# Table: Manual, Mechanical, and Biological Methods for Many Montana Noxious Weeds



Weed Species	Hand-pulling/Digging	Tillage	Mowing	Biological Agents <sup>3</sup>
Blueweed	Plants can be dug successfully; remove at least 3" of root crown	May be reduced by tillage	Reduces seed production if mown at late bud growth stage; no plant control	No biocontrol agents available
Cinquefoil, sulfur	Difficult to hand pull; digging is effective on individual plants	May be reduced by tillage	Reduces seed production if mown at bud stage; no plant control	No biocontrol agents available
Common tansy	Stops seed production, will not control plant	Tillage will spread root fragments	Mow at late bud growth stage to reduce seed production; no plant control	No biocontrol agents available
Dyers woad <sup>1</sup>	Remove upper 3" of crown to control plant by digging	Annual tillage will control in crop	Reduces seed production if mowed at late bud stage; no plant control	No biocontrol agents available <sup>4</sup>
Field bindweed	Stops seed production, will not control plant	Tillage will spread root fragments	Not effective	Mite – available in TX; moth - unavailable
Hawkweeds <sup>2</sup>	Not effective, digging spreads root fragments	Tillage will spread root fragments	Not effective; stimulates vegetative growth	Under screening and evaluation; no agents currently available
Hoary alyssum	Hand pulling effective on small, scattered infestations; remove at least 3" of root crown	May be reduced by tillage	Reduces seed production if mown at bud stage; no control to very limited plant control	No biocontrol agents available

Houndstongue	Plants can be dug successfully; remove at least 3" of root crown	May be reduced by tillage	Reduces seed production if mown at late bud growth stage; no plant control	No biocontrol agents available <sup>4</sup>
Knapweeds - Spotted Diffuse	Hand pulling effective on small, scattered infestations; remove at least 3" of root crown	May be reduced by tillage	Reduces seed production if mown at bud stage; no control to very limited plant control	13 insects introduced for biological management; insects established; reduction of infestations in some locations <sup>4</sup>
Knapweed - Russian	Stops seed production, will not control plant	Tillage will spread root fragments	Reduces seed production if mown at bud stage; no plant control	No biocontrol agents available <sup>4</sup>
Knotweed complex	Large, extensive root system; can dig newly established infestation; must remove all root segments to control plant	Tillage will spread root fragments	Reduces seed production but may expand lateral growth	New invader; control infestations with other methods
Leafy spurge	Stops seed production, will not control plant	Tillage will spread root fragments	Must be mowed every 3 to 4 weeks to stop seed production; no plant control	13 agents available for release; <i>Aphthona</i> sp. most suited to effective IWM <sup>4</sup>
Oxeye daisy	Individual plants can be dug successfully	May be reduced with multiple tillage operations	Reduces seed production if mown at bud stage; may stimulate lateral growth	No biocontrol agents available
Purple loosestrife <sup>1</sup>	Difficult to dig; must remove all root fragments	Tillage will spread root fragments	Reduces seed production if mown at bud stage; may stimulate lateral growth	3 biocontrol agents available <sup>4</sup>

Perennial pepperweed <sup>2</sup>	Stops seed production; will not control plant	Tillage will spread root fragments	Mowing 2 times per season stops seed production (northern CA); no plant control	No biocontrol agents available
Rush skeletonweed <sup>1</sup>	Stops seed production; will not control plant unless done 2-3 times/yr for 6-10 yrs	Tillage will spread root fragments	Limits seed production in dry years; no plant control	Biocontrol agents available but not recommended <sup>4</sup>
St. Johnswort	Only effective on young, isolated plants	Repeated tillage effective	Reduces seed production if mown at bud stage; no plant control	4 insects available; limited success in MT
Tall buttercup <sup>2</sup>	Individual plants can be removed by hand-pulling	Repeated tillage effective	Reduces seed production if mown at bud stage; no plant control	No biocontrol agents available
Tamarisk <sup>2</sup>	Can be dug or pulled with mechanical equipment; difficult to remove	Tillage not effective	Re-sprouts when cut with mower	<i>Diorhabda elongata</i> - for availability contact Gary Adams APHIS 406-449-5210
Tansy ragwort <sup>2</sup>	Individual plants can be removed by hand-digging; remove entire crown	Repeated tillage effective	Reduces seed production if mown at bud stage; no plant control	3 biocontrol agents available; Cinnabar moth most effective
Thistle, Canada	Stops seed production; will not control plant	Tillage will spread root fragments	Must mow 2 X/year to obtain limited plant control; can reduce seed production if mowed at bud stage	2 biocontrol agents available <sup>4</sup>
Toadflax - Dalmatian	Effective on small infestations; must be done for 5-6 consecutive years.	Must be repeated every 7 to 10 days for 2 yrs to be effective	Reduces seed production if mown at bud stage; no plant control	5 biocontrol agents available; <i>Mecinus</i> stem mining weevil most effective <sup>4</sup>

Toadflax – yellow	Must remove all root fragments; must be done for 5-6 consecutive yrs.	Not effective on yellow toadflax; will spread root fragments	Reduces seed production if mown at bud stage; no plant control	5 biocontrol agents available <sup>4</sup>
Whitetop (hoary cress)	Somewhat effective on newly established plants; must pull for 4 consecutive years	Tillage will spread root fragments	Reduces seed production if mown at bud stage; no plant control	No biocontrol agents available
Yellowflag iris <sup>1</sup>	Very difficult to remove, must dig and remove entire root	Tillage not effective	Reduces seed production if mown at bud stage; no plant control	No biocontrol agents available
Yellow starthistle <sup>1</sup>	Hand pulling effective on small, scattered infestations; remove 3" of root crown	Controlled by tillage	Reduces seed production if mown at bud stage	Biocontrol agents available but not recommended <sup>4</sup>

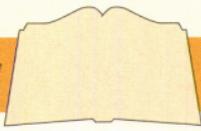
<sup>1</sup> Indicates weeds that are either in Priority 1A (not currently present in the state) or Priority 1B weeds with limited presence in Montana. Highest priority for complete control of infestations. Report new infestations to Montana Department of Agriculture.

<sup>2</sup> Indicates Priority 1B weeds occupying >1000 acres in Montana. Priority for containment and control as resources allow. Report new infestations to Montana Department of Agriculture.

<sup>3</sup> General information on biological control agents can be found in "Biological Control of Invasive Plants in the United States". 2004. Ed. E.M. Coombs, J.K. Clark, G.L. Piper, and A.F. Cofrancesco, Jr. Oregon State Univ. Press. This Montana guide may not list all the agents potentially available for this noxious weed species because these unlisted agents are either not effective or are not established in Montana.

<sup>4</sup> Priority 1A and 1B weeds are slated for complete eradication and biological control is not suitable in Montana.

# Glossary



**Accelerator** (separator) - A device used for separating various species of insects (see insect collection section).

**Annual** - A plant that has a one year life cycle, flowers, produces seeds, and dies.

**Aspirator** - A hand-held device that uses negative air pressure to collect small individual insects (see insect collection section).

**Basal rosettes** - A cluster of leaves radiating out from the base of the plant.

**Biennial** - A plant that has a two year life cycle. Usually growing a basal rosette the first year and flowering the next.

**Bomb-shell effect** - The somewhat circular crater-like area of dead or dying plants around a release site. Often produced by leafy spurge flea beetles.



**Boring** - Feeding into or through a plant part making a hole.

**Complex of insects** - A group of biological weed control insect species all feeding on the same noxious weed species. It is a good strategy to release a complex of insects on the weed species.

**Control** - Reducing the population of weeds on a site to the point where they no longer cause undue economic or environmental harm.

- Defoliate** - Remove the leaves of.
- Disperse** - To spread to new areas.
- Dissect** - To cut or tear apart and observe what is inside.
- Density** - The number of weeds or insects in a unit of area.
- Eradicate** - Completely wipe-out the weeds in an area.
- Estivation** (aestivation) - "Summer sleep," is a state of dormancy somewhat similar to hibernation but in response to hot or dry weather.
- Foliage** - Above ground plant parts.
- Frass** - A mixture of insect droppings and partly chewed plant material. Often black or brown in color. Indicates presence of feeding insects.
- Gall** (galling) - Swelling, a biological agent causing a plant part to swell and be deformed.
- Girdle** -To feed or strip a ring around the outside of a stem. This often kills the stem above this point.
- Hibernation** - "Winter sleep," a rest period in response to inclement winter conditions.
- Host specific** - An insect that can feed on only one (or a few closely related) type(s) of weed species.
- Infestation** - Large numbers of a weed or insect in an area.
- Integrated Weed Management** (IWM) - The weed management technique of using multiple weed control methods together for a greater chance of success.
- Know The Label** - For herbicides this is the information printed on the packaging label that an applicator must know before using the herbicide. For biological weed control insects this is each species' individual ecological needs, life cycle, and how to use them.
- Larva** (larvae) - The immature stage of an insect between an egg and a pupa. Often worm-like, and referred to as a caterpillar, grub, or maggot.
- Mine** - Insects feeding through (inside) a plant part.
- Monitor** - Check for establishment of a biological control agent.
- Noxious weed** - A state-designated weed that causes (or has the potential to cause) undue economic or environmental

damage. Montana land owners have a legal responsibility to control them.

**Overwinter** - Surviving through the winter.

**Perennial** - A plant that has the potential to live for three or more years.

**Pupa** - The immature stage of an insect between a larvae and an adult. Inactive, undergoing metamorphosis. Sometimes within a cocoon.

**Pupate** - To become a pupa.

**Root crown** - The upper portion of a root at ground level. Often just below the basal rosette.

**Root hairs** - Small hair-like extensions near the tip of a root. They function to increase the root's surface area for water and mineral absorption.

**Seed head** - The fruit of a plant that holds the seeds, produced by the flower.

**Soil litter** - Dead plant and animal material lying on top of the soil.

**Sweep net** - A robust canvas net used to collect insects. Often swept through vegetation.

**Weevil** - One of many forms of beetles with a long snout.

## Photo Credits



<b>Accelerator/Separator</b> .....	67
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Aspirator</b> .....	67
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Bomb-shell effect</b> .....	75
<b>Broad nosed Seed head Weevil, Adult</b> .....	29
<i>USDA APHIS PPQ Archive, bugwood.org</i>	
<b>Broad nosed Seed head Weevil, Pupa</b> .....	29
<i>USDA ARS European Biological Control Laboratory, France</i>	
<b>Bronze Knapweed Root borer, Adult</b> .....	31
<i>Norman E. Rees, USDA ARS - Retired, bugwood.org</i>	
<b>Bronze Knapweed Root borer, Larva</b> .....	31
<i>University of Idaho Archive, University of Idaho, bugwood.org</i>	

<b>Canada Thistle</b> .....	10
<i>USDA APHIS PPQ Archive, bugwood.org</i>	
<b>Canada Thistle Stem Gall</b> .....	14
<i>Theodore Webster, USDA ARS, bugwood.org</i>	
<b>Canada Thistle Stem gall Fly, Adult</b> .....	14
<i>Norman E. Rees, USDA ARS - Retired, bugwood.org</i>	
<b>Canada Thistle Stem Weevil, Adult</b> .....	11
<i>N. Poritz, bio-control.com</i>	
<b>Canada Thistle Stem Weevil, Larva</b> .....	12
<b>Cinnabar Moth, Larvae</b> .....	5
<i>Jeff Littlefield</i>	
<b>Cinnabar Moth, Adult</b> .....	6
<b>Cooler</b> .....	69
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Cover Photo</b>	
<i>Jim Story, Montana Ag. Experiment Station, Corvallis, MT</i>	
<b>Girls Sweep-netting</b> .....	66
<i>Todd Breitenfeldt, Whitehall Biological Weed Control Proj.</i>	
<b>Green Knapweed Clearwing Fly</b> .....	32
<i>USDA APHIS PPQ Archive, bugwood.org</i>	
<b>Hand Picking</b> .....	62
<i>Gary Adams</i>	
<b>Insect Vacuum</b> .....	69
<i>Mike Battaiola, Whitehall Biological Weed Control Proj</i>	
<b>Klamath Weed Beetle, Adult [hyperici]</b> .....	46
<b>Klamath Weed Beetle, Adult [quadrigemina]</b> .....	46
<i>Cheryl Moorehead, individual, bugwood.org</i>	
<b>Knapweed Brown winged Root Moth, Adult</b> .....	30
<i>USDA APHIS PPQ Archive, bugwood.org</i>	
<b>Knapweed Brown winged Root Moth, Larva</b> .....	30
<i>USDA ARS European Biological Control Laboratory, bugwood.org</i>	
<b>Knapweed Peacock Fly, Adult</b> .....	33
<i>CABI Biosciences Archive, CABI Biosciences, bugwood.org</i>	
<b>Knapweed Peacock Fly, Larva</b> .....	33
<i>Gary L. Piper, Washington State University, bugwood.org</i>	
<b>Knapweed Root boring Moth, Adult</b> .....	21
<i>Todd Breitenfeldt, Whitehall Biological Weed Control Proj.</i>	
<b>Knapweed Root boring Moth, Larva</b> .....	21
<i>N. Poritz, bio-control.com</i>	

<b>Knapweed Root boring Weevil, Adult</b> .....	17
<i>N. Poritz, bio-control.com</i>	
<b>Knapweed Root boring Weevil, Larva</b> .....	17
<b>Knapweed Seed head Fly, Adult</b> .....	27
<b>Knapweed Seed head Fly, Larva &amp; Damage</b> .....	27
<b>Knapweed Seed head Weevil, Adult</b> .....	24
<b>Knapweed Seed head Weevil, Damage</b> .....	24
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Leafy Spurge</b> .....	34
<b>Leafy Spurge Flea Beetle, Adult <i>A. nigricutis</i></b> .....	back cover
<b>Leafy Spurge Flea Beetle, Adult [1 &amp; 2]</b> .....	38
<b>Leafy Spurge Flea Beetle, Adult</b> .....	37
<i>N. Poritz, bio-control.com</i>	
<b>Leafy Spurge Flea Beetle, Larva</b> .....	37
<b>Leafy Spurge Hawk Moth, Adult</b> .....	44
<i>Norman E. Rees, USDA ARS - Retired, bugwood.org</i>	
<b>Leafy Spurge Hawk Moth, Larva</b> .....	44
<i>USDA ARS, Sidney, MT</i>	
<b>Red headed Leafy Spurge Stem borer Beetle, Adult</b> .....	41
<b>Red headed Leafy Spurge Stem borer Beetle, Larva</b> .....	41
<b>Spotted Knapweed</b> .....	15
<i>Todd Breitenfeldt, Whitehall Biological Weed Control Proj.</i>	
<b>Spotted Knapweed Seed head Moth, Adult</b> .....	28
<b>Spotted Knapweed Seed head Moth, Larva</b> .....	28
<b>St. Johnswort</b> .....	45
<b>St. Johnswort Root boring Beetle, Adult</b> .....	50
<i>Eric Coombs, Oregon Department of Agriculture, bugwood.org</i>	
<b>St. Johnswort Root boring Beetle, Larva</b> .....	50
<i>Eric Coombs, Oregon Department of Agriculture, bugwood.org</i>	
<b>St. Johnswort Moth, Adult</b> .....	48
<i>Norman E. Rees, USDA ARS - Retired, bugwood.org</i>	
<b>St. Johnswort Moth, Larva</b> .....	48
<i>Eric Coombs, Oregon Department of Agriculture, bugwood.org</i>	
<b>Sweep Nets</b> .....	66
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Tansy Ragwort</b> .....	4
<b>Tansy Ragwort Flea Beetle, Adult</b> .....	7
<i>N. Poritz, bio-control.com</i>	

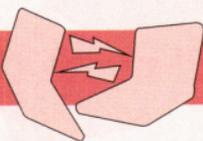
<b>Toadflax Capsule Weevil, Adult</b> .....	56
<i>Eric Coombs, Oregon Department of Agriculture, bugwood.org</i>	
<b>Toadflax Capsule Weevil, Larva</b> .....	56
<i>Eric Coombs, Oregon Department of Agriculture, bugwood.org</i>	
<b>Toadflax Flower eating Beetle, Adult</b> .....	58
<i>Susan Turner, British Columbia Ministry of Forests, bugwood.org</i>	
<b>Toadflax Flower eating Beetle, Larva</b> .....	58
<i>Daniel K. MacKinnon, Colorado State University, bugwood.org</i>	
<b>Toadflax Stem boring Beetle, Adult</b> .....	53
<i>N. Poritz, bio-control.com</i>	
<b>Toadflax Stem boring Beetle, Pupa &amp; Damage</b> .....	53
<i>Bob Richard, USDA APHIS PPQ, bugwood.org</i>	
<b>Volume Container</b> .....	64
<i>Jay Cole, USDA APHIS PPQ</i>	
<b>Yellow Toadflax</b> .....	51



## Montana County Weed Districts

An up-to-date listing of Weed Coordinators by county can be found online at the Montana Weed Control Association website: <http://www.mtweed.org/>

## Other Useful Contacts



### **Montana Department of Agriculture**

<http://www.agr.mt.gov/>

click on [Weeds & Pests](#) and [Noxious Weeds](#)

### **Montana Weed Control Association**

<http://www.mtweed.org/>

406-684-5590

### **Whitehall High School - Montana War on Weeds**

<http://mtwow.org/>

### **Center for Invasive Plant Management**

<http://www.weedcenter.org/>

### **Invaders Database System**

<http://invader.dbs.umt.edu/>

### **USDA APHIS PPQ - Gary Adams**

<http://www.aphis.usda.gov/>

[gary.d.adams@aphis.usda.gov](mailto:gary.d.adams@aphis.usda.gov)

Office 406-449-5210

Fax 406-449-5212

Cell 406-431-6531

1220 Cole Ave.

Helena, MT 59601

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Jeff Littlefield

Kenny Keever

Dave Burch

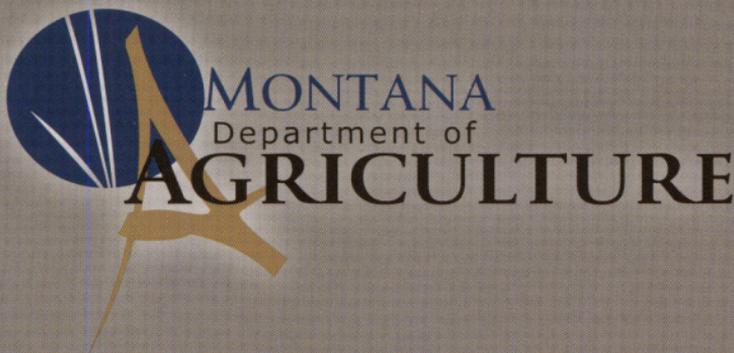
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Above: *Aphthona nigricutis* (leafy spurge flea beetle) adult on Leafy Spurge.

Cover Photo: *Cyphocleonus achates* (knapweed root boring weevils) adults on Spotted Knapweed. photo by Jim Story

leafy spurge