

Biological Control Options for Little Bighorn Battlefield National Monument



St. Johnswort, NPS photo 2004

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Introduction

The following report summarizes current and potential biological control options for the Little Bighorn Battlefield National Monument (LIBI) at Crow Agency, MT. The purpose is to create a list of biological control options to treat invasive plants that are currently being managed at the park. The report includes the invasive plant species with corresponding biological control options, potential suppliers with insect availability dates, and a sample price list. The report was compiled as a result of input from various Natural Resource personnel including professors, researchers, suppliers, teachers and government agencies. Table 1, Biological Control Options, is largely summarized from the draft technical document compiled for the Northern Rocky Mountain Invasive Plant Management Plan, which includes 10 National Park Service (NPS) units including LIBI.

Discussion

Of the 19 invasive plant species (Appendix 1) currently being managed at LIBI, 11 have the potential to be treated using biological controls (biocontrols). Table 1 lists the biological control options and shows the target species, possible agents and their function.

Table 1. Biological Control Options

| Target Species | Insects Pathogens - Fungus | Function |
|--|---|---|
| Russian knapweed <i>(Acroptilon repens)</i> | Stem gall nematode <i>(Subanguinea picridis)</i> | Galls form on stems, leaves and root crowns. |
| Cheatgrass <i>(Bromus tectorum)</i> | Head smut <i>(Ustilago spp.)</i> | N/A |
| Spotted knapweed <i>(Centaurea biebersteini,</i> formerly <i>C. maculosa)</i> | Root-boring moth <i>(Agapeta zoegana)</i> | Emerges in July – Sept. (moths) Larvae feed on roots and can kill small rosettes – best combined with other root borers or seed feeders |
| | Seed head weevil <i>(Bangasternus fausti)</i> | Adults feed on foliage in the spring and flowers in the summer. Larvae feed on seed heads, reducing seed production by up to 100%. Prefers undisturbed sites with dry summers. |
| | Seedhead fly <i>(Chaetorellia acrolophi)</i> | Larvae feed in the flower buds, reducing seed production (note: more research is needed on this species) |
| | Root-boring weevil <i>(Cyphocleonus achates)</i> | Adults feed on interior leaves of rosettes. Larvae destroy the interior of the tap root. Intense feeding causes plant to become stunted and may die one season after the initial attack. Recommended in conjunction with other root-boring and seed-feeding insects. South facing slopes or exposed soils with high temperatures are recommended for establishment. |
| | Lesser knapweed and blunt knapweed flower weevil <i>(Larinus minutus/obtusus)</i> | Adults feed on foliage and flowers. Larvae consume developing seeds and reduce seed production after a very long period of time. May not notice a decrease in plant density until the seed bank falls below a critical threshold. |
| | Spotted knapweed seed head moth <i>(Metzneria paucipunctella)</i> | Adult moths lay eggs on bracts at the base of flowers. Larvae consume florets and, later, seeds. Mature larvae mine the receptacle tissue, which can destroy 90% of |

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| | | seeds. This species does not do well in the cold (below -22°F) with little snow cover. |
| | Bronze knapweed root borer (<i>Sphenoptera jugoslavica</i>) | First instar larvae feed in the leaf axils, second-instars tunnel into the root. |
| | Seedhead fly (<i>Terellia virens</i>) | Larvae feed on seeds, reducing seeds by up to 90%. Co-exists with <i>C. acrolophi</i> and <i>Urophora</i> spp, but is poor competitor with <i>Larinus</i> spp. Does best on south facing slopes and dry locations. |
| | Seedhead fly (<i>Urophora affinis</i> , <i>U. quadrifasciata</i>) | Larvae cause gall formation on seedhead, aborting flowers. <i>U. affinis</i> lay eggs in immature flower heads, producing hard galls and <i>U. quadrifasciata</i> lay eggs in mature flower heads, causing thin, soft galls. Both types of galls act as a nutrient sink, reducing seed production by up to 95%. Prefers open areas with full sun. |
| | Fungus (<i>Alternaria alternata</i>) | Can destroy majority of foliage. Younger leaves and buds are unaffected. |
| | Fungus (<i>Sclerotinia sclerotiorum</i>) | Kills juvenile spotted knapweed, and all life stages are susceptible to the fungus, decreasing biomass. |
| | Stem blight fungus (<i>Fusarium avenaceum</i>) | Stunts growth and causes yellowing and stem decay. Can cause up to 100% decrease in seed. |
| Canada thistle (<i>Cirsium arvense</i>) | Canada thistle stem weevil (<i>Ceutorhynchus litura</i>) | Larvae feed on roots in spring and early summer. Secondary damage can occur as holes made by exiting larvae exposing plants to other pathogens. When possible, combine it with other pathogens like <i>S. sclerotiorum</i> to increase this effect. Prefers moist disturbed areas where Canada thistle is dense and not stressed by drought, grazing or other control methods. |
| | Musk thistle crown weevil (<i>Trichosirocalus horridus</i>) | Larvae attack growing tips; adults feed on rosette leaves. The rosette boring weevil works best in open infestations and can reduce seed production. |
| | Canada thistle stem gall fly (<i>Urophora cardui</i>) | Larvae deposited in stems cause galls and stunting, which reduces seed production and vigor. Works best in scattered populations that are not subject to grazing, mowing, or chemical treatments. Evidence shows this fly is not particularly effective at controlling Canada thistle. |
| | Artichoke plume moth (<i>Platyptillia carduidactyla</i>) | A native that attacks bull, Canada, and marsh thistles. Impacts host plant enough to prevent flowering. |
| | Painted lady butterfly (<i>Vanessa cardui</i>) | A native that can defoliate bull, Canada, and Scotch thistles, although plants often regrow after defoliation. |
| | Fungus (<i>Sclerotinia sclerotiorum</i>) | May be most effective when combined with <i>C. litura</i> . Effects enhanced during drought years. |
| | Rust Fungus (<i>Puccinia punctiformis</i>) | Not yet approved. May have synergistic effects with other biocontrol agents, but not expected to be effective if used alone. |
| | Bull thistle (<i>Cirsium vulgare</i>) | Musk thistle crown weevil (<i>Trichosirocalus horridus</i>) |
| Bull thistle seed head gall fly (<i>Urophora stylata</i>) | | Larvae feed on seed heads. |
| Field bindweed (<i>Convolvulus arvensis</i>) | Bindweed gall mite (<i>Aceria malherbae</i>) | Nymphs and adults form galls on leaves, petioles and stem tips. Appears to be most effective insect available. |
| | Bindweed moth (<i>Tyta luctosa</i>) | Larvae feed on flowers and leaves at night. Only impacts foliage, not roots. |
| | Tortoise beetles (<i>Chelymorpha cassidea</i> , <i>Metriorhynchus bicolor</i> , and <i>Jonthonata</i>) | Native beetles that feed on leaves of plants. |

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| | <i>nigripes</i>) | |
| | Stem-mining agromyzid fly ¹ (<i>Melanagromyza albocilia</i>) | N/A |
| | Root feeding flea beetle ¹ (<i>Longitarsus pellucidus</i>) | N/A |
| | Fungus (<i>Alternaria, Fusarium, Phoma proboscis, and Phomus convolvulus</i>) | <i>P. convolvulus</i> sporulates only in conditions of high humidity. <i>P. proboscis</i> is resistant to herbicides, but also requires high humidity. |
| St. Johnswort (<i>Hypericum perforatum</i>) | St. Johnswort root borer (<i>Agrilus hypericic</i>) | Larvae feed on roots and may completely consume the tissues. Any stems produced from an infested root crown are stunted and flower production is reduced. Most plants infested by this beetle are killed. Best in dry mountainous areas. |
| | Moth (<i>Aplocerus plagiata</i>) | Larvae feed on foliage and flowers. Prefers dry open areas with sandy, rocky soils, soils with limestone parent material. Does not do well in areas with high rainfall. |
| | Beetle (<i>Chrysolina hyperici, C. quadrigemina</i>) | Beetles feed on foliage as plants begin to flower. Best in mountainous, open, sunny, warm areas. |
| | Gall midge (<i>Zeuxidiplosis giardi</i>) | Prefers damp locations. Has not done well in dry, continuously windy, or heavily grazed areas. |
| Dalmatian toadflax (<i>Linaria dalmatica</i>) | Toadflax flower-feeding beetle (<i>Brachypterolus pulicarius</i>) | Adults feed on shoot tips, axillary buds at the base of the leaves, and on reproductive parts, stunting the plant and reducing seed production. Adapted strain specific to Dalmatian toadflax. |
| | Toadflax moth (<i>Calophasia lunula</i>) | Larvae defoliate leaves and stems. Effective on seedlings and young plants. |
| | Toadflax root-boring moth (<i>Eteobalea intermediella</i>) | Feeds on roots. |
| | Toadflax root-galling weevil (<i>Gymnetron linariae</i>) | Larvae form galls in root and rhizomes and adults attack shoots. |
| | Toadflax stem weevil (<i>Mecinus janthinus</i>) | Feeds on stems. Larvae bore into stems and adults feed on shoots. |
| Prickly Russian thistle (<i>Salsola tragus</i>) | Moth (<i>Coleophora klimeschiella</i>) | N/A |
| | Fungus (<i>Colletotrichum gloeosporiodes</i>) | N/A |
| | Gall midge (<i>Desertovellum stackelbergi</i>) | N/A |
| Saltcedar (<i>Tamarix ramosissima</i>) | Leaf beetle (<i>Diorhabda elongata</i>) | N/A |
| Common mullein (<i>Verbascum thapsus</i>) | Mullein seed-eating weevil (<i>Gymnetron tetrum</i>) | Larvae are laid in seed capsules, feed on seeds and chew holes in seed capsules to escape. |

¹ under investigation by APHIS at this time

Target Species: Current invasive plants for consideration for biocontrol treatment.

Insects, pathogens, and fungus: The biocontrols in this column reflect current options for 10 National Park Service (NPS) units included in the Northern Rocky Mountain Invasive Plant Management Plan, including LIBI. Not all biocontrols may be appropriate or available for the area of LIBI.

Function: This describes the efficacy of each biocontrol and, in some cases, the part of the plant

the agent attacks.

Only 5 of the 11 invasive plant species with biocontrol options have available biocontrols from suppliers mentioned in this report. Table 2, Insect Availability by Supplier, lists each plant species with current biological control options and their availability by supplier in Montana.

Table 2. Insect Availability by Supplier

| Species | MT War on Weeds Whitehall HS | Bio Control on Weeds, Inc. Bozeman, MT | Integrated Weed Control Bozeman, MT | Weed Busters Bio Control Missoula, MT |
|--|---------------------------------|---|--|--|
| SPOTTED KNAPWEED | | | | |
| Root-boring weevil <i>Cyphocleonus achates</i> | Aug | July - Sept | Aug - Sept | Late July - mid Sept |
| Lesser and blunt knapweed flower weevil <i>Larinus minutus/obtusus</i> | Aug | ----- | June - July | June - July |
| Bronze knapweed root borer <i>Sphenoptera jugoslavica</i> | ----- | ----- | June - Aug | ----- |
| Spotted knapweed seed head moth <i>Metzneria paucipunctella</i> | ----- | ----- | June - July | ----- |
| ST. JOHNSWORT | | | | |
| Beetle <i>Chrysolina quadrigemina</i> | ----- | June - July | June - Sept | Mid June - mid July |
| Moth (larvae) <i>Aplocerus plagiata</i> | ----- | June - July | May - July | ----- |
| CANADA THISTLE | | | | |
| Canada thistle stem gall fly <i>Urophora cardui</i> | ----- | June - mid July | May - June | ----- |
| Canada thistle stem weevil <i>Ceutorhynchus litura</i> | ----- | April, May - Aug, Sept | April - Aug | Sept |
| TOADFLAX | | | | |
| Toadflax flower-feeding beetle <i>Brachypterolus pulicarius</i> | ----- | ----- | June | ----- |
| Toadflax moth <i>Calophasia lunula</i> | ----- | ----- | June | ----- |
| Toadflax root-galling weevil <i>Gymnetron</i> spp. | ----- | July | June - July | ----- |
| Toadflax stem weevil <i>Mecinus janthinus</i> | ----- | May | May | Mid May - June |
| COMMON MULLIEN | | | | |
| Mullein seed-eating weevil <i>Gymnetron tetrum</i> | ----- | ----- | May - July | ----- |

Supplier: The suppliers represent a few companies/organizations in Montana where the listed biocontrols are available.

Dr. Jeff Littlefield of MSU visited LIBI during August 2010 to determine if there were any naturally-occurring biocontrol agents already present. He showed us indicators of mites, in field bindweed (*Convolvulus arvensis*). The indicators are distorted and curled leaves as the photo shows. It has been suggested that there were not enough mites in the population at LIBI for any significant control. Hilary Parkinson of MSU recommended using bindweed gall mite (*Aceria malherbae*). She indicated this was worth trying in addition to what native biocontrols may already be present.



Mite damage to field bindweed, NPS photo 2010

Dr. Littlefield noted there are several native biocontrols listed in Table 1, which could indicate why they are not available commercially. He said that native species controls are not consistent enough to be adequate alone.

In addition to pointing out physical appearance of bindweed infected with native mites, Dr. Littlefield provided instruction on how to look for weevil larvae in Canada thistle (*Cirsium arvense*), by splitting the stem length ways. Mining beetle larvae (*Mordellista* spp.) were observed in the stems as the photo shows. Generally, current biocontrols for Canada thistle are thought to be minimally effective.



Mining beetle larva, NPS photo 2010

For St. Johnswort (*Hypericum perforatum*), Dr. Littlefield used a sample net to gather any insects that may have been present, however plants were too dry for sampling. Dr. Littlefield recommended sampling in spring when plants are green. St. Johnswort infestations, though large in size at LIBI, tend to be scattered and less dense. This could restrict some biocontrol's utility, due to some beetles' inability to fly and disperse, according to Dr. Littlefield. It is common for densities of colonies to cycle with biocontrol populations. As colonies increase, biocontrol populations increase, because there is more plant material to sustain high insect numbers.

The leaf beetle (*Diorhabda elongata*) biocontrol for Saltcedar (*Tamarix ramosissima*) is currently unavailable. Updates from the Animal and Plant Health Inspection Service (APHIS) agency will be available.

It is currently believed that the best biocontrol for spotted knapweed (*Centaurea biebersteinii*) are weevils. Hilary Parkinson notes that the root-boring weevil (*Cyphocleonus achates*) seems to be the most effective at this time. This corresponds with recommendations by Todd Breitenfelt of Montana War on Weeds (MTWOW). Mr. Breitenfelt noted that using several different seed head feeders and root-boring weevils together would be a good management practice. He indicated we may already have some of the insects on hand, such as seedhead fly (*Urophia* spp). For spotted knapweed and dalmatian toadflax, the best time to check for larva in the stem is in the spring when plants are green and easier to split along the stem.

While there are some biological control options for spotted and diffuse knapweed, commercially-available insects for Russian knapweed (*Acroptilon repens*) may be unavailable. Some of the

biocontrols are still being investigated. For example, screening and testing of the flower gall mite (*Aceria acroptiloni*) and root gall moths (*Cochylimorpha nomadana*) is ongoing. Todd Breitenfelt agreed that acquiring biocontrols for Russian knapweed may be unavailable.

Currently, Jane Mangold of MSU is doing research on head smut as a biocontrol for cheatgrass (*Bromus tectorum*). No commercial pathogens, including fungus, are available at this time. There is a concern that current pathogens will move to non-targeted plants.

At present, observations appear to suggest that size of infestations at LIBI may not warrant implementation of biocontrols for plants listed in Table 1. According to David Burch of Montana Department of Agriculture, infestation colonies less than 30 to 40 acres may not be worth resources and time to apply biocontrols. This may be due to the fact that some insects are not winged, making travel between colonies difficult and effectiveness subsequently poor.

Summary

Current invasive plant infestation sizes at Little Bighorn Battlefield National Monument do not warrant the expenditure of resources and man hours to implement biological controls at this time.

The recommended time to check for beetles and larva in dalmatian toadflax and Canada thistle is the spring when plants are green. Evidence of biocontrols, like mites on field bindweed and mining beetle larva in Canada thistle, has been observed at Little Bighorn. However, the native population is not large enough to cause any significant impact.

There are 5 invasive plant species (spotted knapweed, St. Johnswort, Canada thistle, dalmatian toadflax, and common mullein) that have biocontrols available from suppliers included in this report. Currently, no pathogens are available. Contacting potential suppliers well in advance of the scheduled treatment would help with planning and implementation of the biocontrol treatment. Results from biocontrol treatments may not be readily apparent. In most cases, it may be a couple of years or longer before the effects of healthy establishments of biocontrol insects are visible.


For more information, the Oregon State University Press publication, *Bio Control of Invasive Plants in the United States* (Erick Coombs/Janet Clark, <http://oregonstate.edu/dept/press/a-b/BioControl.html>) was recommended by Dr. Littlefield. The book describes biocontrols for terrestrial and aquatic, invasive plants and includes photos. Topics include: ecology, safety testing, monitoring biological control agents, and descriptions of species.

Appendix 1. Non-native species currently managed at Little Bighorn

| Species | Common Name | State Noxious Weed List |
|--------------------------------|-----------------------|-------------------------|
| <i>Acroptilon repens</i> | Russian knapweed | MT, WY |
| <i>Bromus inermis</i> | Smooth brome | |
| <i>Bromus tectorum</i> | Cheatgrass | |
| <i>Cardaria draba</i> | Whitetop, hoary cress | MT, WY |
| <i>Centaurea biebersteinii</i> | Spotted knapweed | MT, WY |
| <i>Cirsium arvense</i> | Canada thistle | MT, WY |
| <i>Cirsium vulgare</i> | Bull thistle | |
| <i>Convolvulus arvensis</i> | Field bindweed | MT, WY |
| <i>Cynoglossum officinale</i> | Houndstongue | MT, WY |
| <i>Elaeagnus angustifolia</i> | Russian olive | |
| <i>Halogeton glomeratus</i> | Halogeton | |
| <i>Hypericum perforatum</i> | St. Johnswort | MT, WY |
| <i>Kochia scoparia</i> | Common kochia | |
| <i>Linaria dalmatica</i> | Dalmatian toadflax | MT, WY |
| <i>Poa bulbosa</i> | Bulbous bluegrass | |
| <i>Rumex crispus</i> | Curly dock | |
| <i>Salsola tragus</i> | Russian thistle | |
| <i>Tamarix ramosissima</i> | Saltcedar | MT, WY |
| <i>Verbascum thapsus</i> | Common mullein | |

Appendix 2. Sample Product Price List

Biological Control of Weeds, Inc.



Biological Control of Weeds

1-800-334-9363

Products

Prices

Ordering Info

Insect Photography

Articles & Links

Questions & Answers

About BCW

Site Index

2010 Product Price List

LEAFY SPURGE INSECTS

| product | quantity | price |
|---|----------|----------|
| Black Dot Spurge Flea Beetle, <i>Aphthona nigriscutis</i> | 500+ | \$50.00 |
| Brown-Legged Spurge Flea Beetle, <i>Aphthona lacertosa</i> | 500+ | \$50.00 |
| Flea Beetle Combination Carton: Two species, your best value! | 1200+ | \$100.00 |
| Red-Headed Spurge Stem Borer, <i>Oberea erythrocephala</i> | 110 | \$225.00 |
| Spurge Shoot-Tip Gall Midge, <i>Spurgia esulae</i> | 55 galls | \$50.00 |

KNAPWEED INSECTS

| product | quantity | price |
|--|----------|----------|
| Blunt Knapweed Flowerhead Weevil, <i>Larimus obtusus</i> <i>Special! Buy 3 cartons, get 4th carton FREE!</i> | 105 | \$75.00 |
| Knapweed Root Weevil, <i>Cyphocleonus achates</i> <i>Special! Buy 3 cartons, get 4th carton FREE!</i> | 105 | \$100.00 |
| Lesser Knapweed Flowerhead Weevil, <i>Larimus minutus</i> <i>Special! Buy 3 cartons, get 4th carton FREE!</i> | 105 | \$75.00 |

ST. JOHNSWORT INSECTS

| product | quantity | price |
|---|----------|---------|
| Klamath Weed Beetle, <i>Chrysolina quadrigemina</i> | 105 | \$75.00 |
| St. Johnswort Inchworm, <i>Aplocera plagiata</i> | 105 | \$75.00 |

YELLOW STARThISTLE INSECTS

| product | quantity | price |
|--|----------|---------|
| Yellow Starthistle Hairy Weevil, <i>Eustenopus villosus</i> <i>Special! Buy 3 cartons, get 4th carton FREE!</i> | 105 | \$40.00 |

CANADA THISTLE INSECTS

| product | quantity | price |
|--|----------|----------|
| Canada Thistle Stem Gall Fly, <i>Urophora cardui</i> | 105 | \$100.00 |
| Canada Thistle Stem Mining Weevil, <i>Ceutorhynchus litura</i> | 105 | \$150.00 |

TANSY RAGWORT INSECTS

| product | quantity | price |
|---|----------|----------|
| Ragwort Flea Beetle, <i>Longitarsus jacobaeae</i> | 105 | \$150.00 |

YELLOW AND DALMATIAN TOADFLAX INSECTS

<http://www.bio-control.com/pricing.php>[8/24/2010 7:03:53 PM]

| product | quantity | price |
|--|----------|----------|
| Toadflax Stem-Boring Weevil, <i>Mecinus janthinus</i> <i>Special! Buy 3 cartons, get 4th carton FREE!</i> | 105 | \$100.00 |
| Toadflax Seed Capsule Weevil, <i>Gymnetron antirrhini</i> | 105 | \$75.00 |

PURPLE LOOSESTRIFE INSECTS

| product | quantity | price |
|--|----------|---------|
| Loosestrife Defoliating Beetle, <i>Galerucella pusilla</i> | 105 | \$75.00 |

EDUCATIONAL SLIDE SERIES

| product | quantity | price |
|---|-----------|----------|
| Exotic weeds and their bio-control agents | 85 Slides | \$250.00 |

BOOK: *Biological Control of Invasive Plants in the United States*

| product | quantity | price |
|---|----------|---------|
| Published in Autumn '04 - 448 pages - the new bible of bio-control! | 1 Book | \$40.00 |



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