THE MONTANA ACTION PLAN FOR THE BIOLOGICAL CONTROL OF INVASIVE PLANTS

Montana Biological Control Working Group

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In Cooperation With:

Montana State University

Various Federal, State, & Tribal Agencies

County Weed Districts

Montana Department of Agriculture

Private Land Managers

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Who We Are

The Montana Biological Control Working Group (MBCWG) was convened in 2008 as a functional unit under the Montana Weed Control Association's Integrated Weed Management Chair. The MBCWG is an open membership group comprised of interested stakeholders including private individuals and participants from state, federal, county, and other organizations. The MBCWG is charged with developing a structure to assist in and improve the current methods for the redistribution and monitoring of biological control agents in the state of Montana. Our plans are to identify any deficiencies in the current implementation of weed biological control in Montana and suggest measures to improve biological control as a weed management tool.

Our Mission

To advance the use of biological control as an integrated management tool to reduce invasive weeds and their impacts in Montana

Our Participants and Stakeholders

Montana consists of approximately 94 million acres of which about 28% are federal land, 6% state, 3% tribal, and 63% private. Rangeland, pastureland, cropland, forests, national parks, nature preserves, and other wild lands comprise about 92 million acres or 98% of the total land area of the state. These lands are vital for agricultural production and for protecting the integrity of Montana's ecological systems. Weed control is an important component for maintaining the health of these vital lands.

Montana's weed program is comprised of **six** cooperative working groups: 1) **County Weed Districts**, which implement and enforce the Montana County Weed Control Act and coordinate weed management activities within the counties; 2) **Private Land Managers**, who work cooperatively with county weed districts and other agencies to manage weeds on private lands; 3) **State Land Management Agencies**, which develop long-term management plans and allocate funds within the counties where they manage lands; 4) **Federal Agencies**, who maintain federal lands including demonstration areas, conduct research and technology transfer programs, protect and promote U.S. agricultural health, regulate imports, interstate shipments of plant and soil and potential plant pests, and work with weed districts and private landowners through cooperative management efforts; 5) **Tribal Lands and Bureau of Indian Affairs (BIA)** conduct noxious weed management activities or efforts on seven reservations and other Indian trust lands; and 6) **Universities**, which provide research, demonstration, and public education programs on noxious weeds. In addition, special Task Forces have been created in Montana to assist weed control efforts (e.g. mapping, education, eradication and biological control) on several new weed invaders

The History of Biological Control in Montana

Biological weed control in Montana dates back to 1948 with the release of *Chrysolina* beetles on St. Johnswort by then State Entomologist, George Roemhilt. In the 1950s, 60s, and early 70s, additional agent releases were made on St. Johnswort, leafy spurge, musk thistle, Canada thistle, puncturevine, and spotted knapweed by the Montana Department of Agriculture and the USDA ARS Rangeland Insect Laboratory. In 1976, with the successful establishment of *Urophora* flies on spotted knapweed and growing awareness of the knapweed problem in western Montana, Montana State University (MSU) hired a fulltime research scientist at the Western Research Experiment Station in Corvallis.

In the 1980s, an assistant professor was added on the main campus of MSU to work primarily on biocontrol of toadflaxes and leafy spurge. To augment the Montana biological control activities and the redistribution of agents by USDA ARS and MSU, the USDA APHIS Center for Plant Health and Science and Technology (CPHST) opened a laboratory in Bozeman. Funding was obtained by MSU to construct the Insect Quarantine Laboratory, which became operational in 1988. At this time, MSU hired a Quarantine Officer/Research Scientist and USDA ARS transferred two entomologists from its quarantine in Albany, California. In 1989, USDA ARS expanded its biological control program by hiring a Research Leader for the newly formed Rangeland Weeds Lab. Additional personnel were assigned to this new lab in Bozeman and another scientist was transferred to the USDA ARS laboratory in Sidney to work on leafy spurge.

The 1990s saw a major expansion of Montana biological control activities as agents became available for spotted, diffuse, and Russian knapweeds; leafy spurge; Dalmatian and yellow toadflax; musk thistle; and other weeds. The USDA Forest Service transferred a research scientist from Hawaii to its Rocky Mountain Research Station in Bozeman. The USDI Bureau of Land Management (BLM) and the Bureau of Indian Affairs (BIA) also began active biological control programs. Various school groups in Columbus, later Whitehall and other areas, became active in rearing and redistributing agents. At the end of the decade the MSU Insect Quarantine Laboratory was expanded to include a plant pathology containment laboratory and additional greenhouses. In the late 1990s, the biological control program at Bozeman began to wane. The USDA ARS moved the Rangeland Weeds Lab to Sidney; USDA APHIS transferred from Bozeman to regional facilities in Fort Collins, Colorado; and one of the MSU scientists left Bozeman to join the USDA Cooperative States Research Service (CSRS) in Washington, D.C.

In the 2000s, the importation of new biological control agents decreased as the regulatory process became more discriminating and lengthier. Agents for spotted knapweed and leafy spurge were established and foreign screening for new agents for these weeds ceased. However, screening of agents for several new target weeds, such as hoarycress, Russian knapweed, and hawkweeds, was initiated. Several regional consortia formed to help fund overseas screening. Biocontrol projects against tansy ragwort, leafy spurge, and spotted knapweed started to show success. On the personnel front, the MSU scientist in Corvallis retired but another MSU professor in Bozeman reinitiated work on toadflax. The USDA ARS Sidney lab expanded its biological control personnel and a second Montanan containment facility was constructed at Sidney. The USDA Forest Service in Bozeman also replaced its retiring scientist with two new research entomologists.

Recently new agents have become available (e.g. for Russian knapweed and hawkweeds) and others are currently in the screening process (see Appendix 2). Release sites and biocontrol agents continue to be monitored, agent redistribution projects are ongoing, and surveys continue for new and extant weeds. In 2013, a new statewide biocontrol coordinator was funded.

Working Across Boundaries

Invasive weeds do not respect political, or administrative boundaries. To be successful we need to develop and implement a regional strategy to manage these species. Through a regional effort and a “neighbor helping neighbor” philosophy we are able to maximize the limited fiscal support, facilities, and expertise that is critical to successful weed management programs.

Code of Best Practices for Biological Control of Weeds

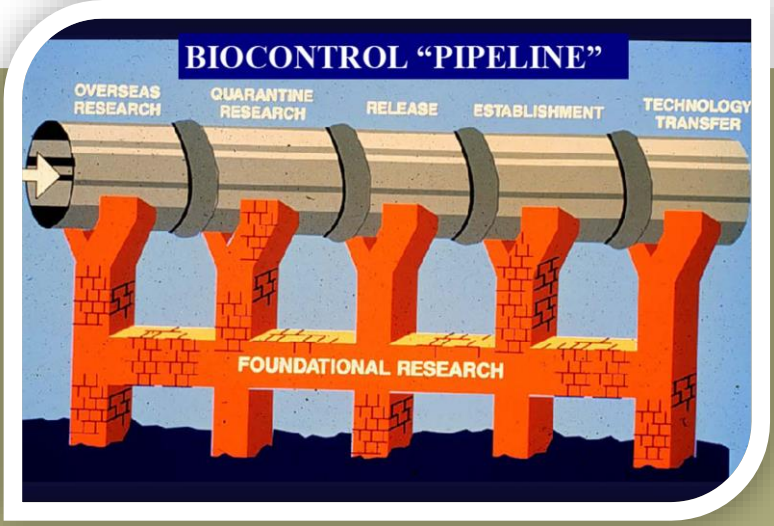
- Ensure target weed’s potential impact justifies release of non-endemic agents.
- Obtain multi-agency approval for target weed.
- Select agents with potential to control target weed.
- Release safe and approved agents.
- Ensure only the intended agent is released.
- Use appropriate protocols for release and documentation.
- Monitor impact on target weed.
- Stop releases of ineffective agents, or when control is achieved.
- Monitor impacts on potential non-target species.
- Encourage assessment of changes in plant and animal communities.
- Monitor interaction among agents.
- Communicate results to public.

The Code of Best Practices was adopted July 9th, 1999, by the delegates to the X International Symposium on Biological Control of Weeds, Bozeman, Montana to provide professional standards for practitioners of classical biological control of weeds.

One Step At A Time

Overseas Testing and Quarantine

Biological control of weed programs consist of three broad phases: **pre-release** – **release** – **post release**. Each phase is equally important in the successful implementation of biological control. Although many land managers and most of the general public only see the end results of biological control, they are largely unaware of the considerable effort required to make agents available for release. **Pre-release** studies may consist of determining the suitability of target weed for biocontrol, determining if naturally occurring enemies are already present, survey and selection of potential agents, conducting host specificity testing & efficacy studies, and identifying potential ecosystem impacts or concerns. This work is largely conducted by overseas cooperators such as CABI Switzerland, USDA-ARS European Biological Control Laboratory, BBCA Rome, Italy, among others. Due to the long-term nature of these projects and expense, consortia groups have been formed to defray the cost of these overseas projects. Suitable agents then enters the **release** phase of biocontrol where the agents need to be permitted for release by regulatory authorities (such as USDA APHIS), and once permitted for release they must pass through quarantine, and be augmented for release. An agent is petitioned to TAG (Technical Advisory Group for the Biological Control of Weeds, an advisory group to APHIS) to determine the suitability of the agent for release or to identify concerns with releasing it into the environment. If recommended by TAG and environmental assessment (EA) is drafted to for review by APHIS, U.S. Fish & Wildlife Service (for potential impacts to threatened & endangered species), tribal agencies and the general public. If permitted for release, agents are eventually "passed-through" a quarantine or containment laboratory to remove contaminating organisms such as parasites or diseases. Since many of these biocontrol agents have low populations in their native range, augmentation and mass rearing may be required to obtain adequate numbers of individuals for field release.



Our Focus:

Using biological control in Montana to:

- **Limit** the spread of existing invasive weed species
- **Abate** the negative ecological and economic impacts of invasive weed species
- **Improve and Support** invasive weed management

Our Objectives

This action plan outlines a **planning strategy** that emphasizes continued **cooperation to build on existing and facilitate future weed biological control efforts** in Montana. Our plan summarizes the **history of Montana weed biological control** and intersperses pivotal biological control **examples**. The plan discusses **four focal areas** which are the cornerstones of biological control programs: 1) **Coordination**; 2) **Research and Development**; 3) **Implementation**; and 4) **Outreach and Technology Transfer**. Within these focal areas, we outline **suggested actions** to further and improve the use of biological weed control as a management tool in Montana. We discuss **Montana's current biological control resources** (programs and personnel) and its future resource and funding needs. Finally, **species released, approved for release, or currently being screened as potential biological control agents** for possible use in Montana are listed.

Montana is a pioneering leader in biological control of weeds with federal, state, county, university, and private land owners and managers working cooperatively on programs

COORDINATION OF BIOLOGICAL CONTROL PROGRAMS IN MONTANA

Purpose: Coordination improves collaboration between all program participants and stakeholders and avoids duplication of efforts.

Because biological control of weeds generally occurs at the landscape level, often transcending political and physical boundaries, leadership, communication, and coordination are essential components of a successful weed management strategy. Increased communication and coordination among agencies and other entities (at the local, regional, and national/ international levels) will aid us to effectively manage and incorporate biological control into existing noxious weed management programs in Montana.

Objectives:

1) Identifying Stakeholders & Participants

Suggested Actions:

- Maintain and update lists of researchers, cooperators, and stakeholders.
- Develop an inventory of available biocontrol agents and record their status, location, and effectiveness of control in Montana.
- Maintain a list of point people who work with each weed or biocontrol agent.
- Maintain a list of the entities interested in obtaining each biocontrol agent.

2) Improving & Continuing Communications

Suggested Actions:

- Foster continuity by maintaining an executive committee that identifies and updates evolving priorities. This committee should consist of representatives from the research community and stakeholders/organizations actively implementing and/or funding weed biological control.

- Conduct an annual or semi-annual meeting of the Montana Biological Control Working Group to share knowledge, provide updates, and review priorities.
- Support and assist the statewide coordinator with the collection, redistribution, and monitoring of agents and with providing communication and organizational leadership.
- Assist area weed coordinators with improving communications about weed biological control at the county and local levels.
- Organize meetings with biological weed control interests from other states, Canada, and Europe to share knowledge and focus priorities.
- Support the formation of consortia as a way to develop funding partnerships and to identify overseas cooperators.
- Conduct periodic meetings of all consortia to coordinate overall funding strategies and to facilitate communication among researchers and stakeholders.

3) Identifying Biological Control Priorities and Funding

Suggested Actions:

- Identify biological control priorities for differing geographic areas, agencies, and landowners.
- Target existing regional/national priority lists as a method to obtain additional funding to support foreign exploration; research, and implementation programs.
- Maintain a list of current consortia and summarize membership, identifying all United States and Montana representatives, frequency of meetings, long-term plans/projects, and sources/levels of funding and support. Maintain representation on these consortia.
- Develop novel funding strategies for new and existing overseas projects. Support the research community's current efforts to fund foreign surveys and biocontrol agent screenings
- Support the research community's efforts to determine the effectiveness of biocontrol agents in Montana and how biological weed control can be integrated with other weed management tools.

4) Coordinating Activities Within Montana

Suggested Actions:

- Support educational programs on biological weed control.
- Organize the distribution of biocontrol agents to weed districts and public land agencies.
- Establish/maintain a statewide mapping program on the location of biocontrol agent releases.
- Assist land managers in implementing monitoring programs to determine the impacts of biological weed control alone or in combination with other weed management tools.
- Optimize the use of the existing containment and other research facilities in Montana.
- To initiate a liaison Montana Invasive Species Council to foster communications.

Working Together

Leafy Spurge and Team Leafy Spurge

LEAFY SPURGE

North American leafy spurge is considered a “complex” of leafy spurge subspecies from multiple introductions. First introduced in 1827, leafy spurge is now found in 35 states in the U.S. and six provinces in Canada. Biological control of leafy spurge in the United States began in 1966 with the release of the leafy spurge hawkmoth in Gallatin County, Montana. To date, a total of thirteen insect species native to Europe and Asia have been permitted for release in the United States; with only eight agents being established. Of these the root feeding Aphthona beetles have been highly successful at reducing spurge infestations in many areas.

TEAM LEAFY SPURGE

The Ecological Area-wide Management (TEAM) Leafy Spurge was a $4.5 million, five-year USDA-ARS research and demonstration program focusing on the Little Missouri drainage in Wyoming, Montana and the Dakotas. Its goal was to research, develop and demonstrate ecologically based Integrated Pest Management strategies that landowners and land managers could use to achieve effective, affordable and sustainable leafy spurge control.

Funded by the USDA-ARS and managed cooperatively with the USDA-APHIS, TEAM Leafy Spurge stressed partnerships, teamwork and a cooperative approach to solving the leafy spurge problem. TEAM members included state and federal agencies, state Cooperative Extension Services, land grand universities, weed managers, county and other local entities, and private landowners and ranchers.

TEAM Leafy Spurge was built on three important concepts:

Integrated Pest Management (IPM) – IPM combines management tools to provide more effective control than any tool could produce alone. Biological control along with other tools – multi-species grazing, herbicides, etc. - offers the flexibility ranchers, landowners and land managers need to devise different strategies for different situations.

Teamwork - TEAM Leafy Spurge stressed that EVERYONE, from the private rancher/landowner to local, state and federal agencies to politicians and other decision makers must WORK TOGETHER to solve the leafy spurge problem.

Regional Approach - Leafy spurge is a regional problem and management is needed over diverse landscapes.

BIOLOGICAL CONTROL RESEARCH AND DEVELOPMENT IN MONTANA

Purpose: **Research and Development prioritizes target weeds; identifies potential biological control agents; assesses candidate agents' ecological relationships to target weeds and wider ecosystems; develops agent rearing and release strategies; evaluates agents' control efficacy/impact; develops and submits documents summarizing research results required to gain regulatory approval for the release of all new agents; and determines how to optimally integrate biological control with other control methods**.

Research plays a central role in the development and implementation of biological control programs in Montana. Biological control research and development includes such areas as identifying target weeds; overseas identification and screening of new agents; quarantine processing, screening, rearing, and releasing of agents; subsequent field establishment and monitoring of agents and release sites; and development of integrated management strategies. Research and development contributes to the overall knowledge of invasive weeds and the role natural enemies play in regulating invasive species. Research goals and projects are diverse and reflect the needs of the country/state and the interests and experience/expertise of individual researchers. Research goals are often fluid and change as additional data and knowledge are accumulated. Research and development are highly funding dependent. While broad-scope, "basic research" contributes greatly to our understanding of complex ecological systems, we will emphasize the applied research that will aid us to effectively develop new and manage existing biological weed control management programs in Montana.

Objectives:

1) Prioritizing Projects and Target Weeds

Suggested Actions:

- Determine the status of existing biological control programs and agents. Identify which of the thirty-two weed species and three regulated plant species listed on the Montanan Noxious Weed List can be effectively controlled by current biological control programs and which need new or additional agents for control.
- Review previous surveys (i.e. by USDA ARS and APHIS) that prioritized invasive weed species and identify species with on-going research that can be targeted in Montana and new species that may be prime candidates for future programs in Montana.

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2) Identify Biological Control Priorities

Suggested Actions:

- Identify biocontrol priorities for differing geographic areas, agencies, and landowners;
- Conduct periodic surveys of county weed districts and public land agencies to determine priority weeds that should be targeted for biological weed control;
- Use existing regional/national priority lists as a way to find and extract additional funding to aid in foreign exploration, research and implementation programs, etc.;

3) Rearing Agents and Developing Insectaries

Suggested Actions:

- Develop specialized rearing protocols and release methods for agents (e.g. eriophyid mites) that have unique biological requirements and/or are difficult to rear. Determine which agents can be artificially reared (e.g. through the use of rearing diets, etc.) and which are obligate (limited) to rearing on their host weeds.
- Mass rear new and existing agents that occur in low numbers in their native ranges to develop adequate populations for field release and redistribution. Initiate greenhouse rearing programs for new agents. Identify and set-up regional field insectaries for agents initially being established.
- Screen new and existing agents to determine the presence and impact of microorganisms associated with biocontrol agents (e.g. *Nosema*, *Wolbachia*, etc.). Evaluate and clean up unwanted microorganisms prior to agent release.
- Develop strategies to optimize rearing of agents in existing rearing facilities including those that are regional.
- Review agents that have been approved by APHIS for release but that have not been established due to lack of adequate numbers for release (i.e. *Eteobalea* on toadflax and *Chamaesphecia* on leafy spurge).
- Review proposed agents to determine any that might be difficult to collect or to rear in adequate numbers.

4) Studying Impacts (Ecological, Non-Target, Etc.)

Suggested Actions:

- Determine the efficacy of biocontrol agents pre- and post-release by determining the factors that affect the performance of the agents such as host plant interactions, climate, mortality, habitat suitability, etc.
- Support/perform long-term monitoring of biocontrol agents, weed populations, and native plant/animal communities. Investigate non-target and ecosystem impacts.
- Devise strategies to continually develop, obtain, compile, analyze, store, and disseminate long-term monitoring data and information.
- Determine the habitat and ecological requirements of biocontrol agents.
- Investigate the population dynamics of the biological control agents and their hosts (e.g. life table analyses).
- Investigate synergy and other interactions among multiple biocontrol agents.

5) Integrating Biological Control with Existing Weed Management Strategies

Suggested Actions:

- Review existing weed systems and/or biocontrol control programs to determine which are amenable to an Integrated Weed Management approach.
- Form partnerships with other researchers/land managers such as weed ecologists, livestock grazing specialists, economists, etc. to develop Integrated Weed Management strategies.
- Provide support and encouragement for additional basic research projects on such topics as natural enemy-plant interactions, ecosystem functions, systematic and phylogenetics of natural enemies and their target hosts, invasive species impacts, etc. that contribute to the general knowledge of biological organisms and their functioning, leading us to better understand and predict the use of biological control as a management tool.

- Form partnerships with overseas agencies, organization, and consultants to survey and screen potential biocontrol agents (e.g. CABI, USDA ARS EBCL, BBCA, and others).

- Conduct periodic meetings with end-users and stakeholders to enable greater interaction with project leaders and researchers. Allow ample time for general discussion and question and answer sessions.

- Conduct periodic surveys of county weed districts and public land agencies to determine priority weeds to target for biological control.

6) Surveying and Screening Agents

Suggested Actions:

- Assist with host specificity testing of new agents by consulting with botanists and land managers to develop host test lists and collect and maintain test plants/seeds.

- Initiate overseas testing of agents or, when appropriate, transfer testing to containment facilities in Montana.

- Develop detailed risk assessments and/or risk benefit analyses for agents that may feed or develop on non-target plants.

- Assist in the development of host plant test lists and new agent release petitions to be submitted to USDA-APHIS and reviewed by the Technical Advisory Group for Biological Control Agents of Weeds (informally known as TAG).

Are We Successful?

The Pros & Cons of Spotted Knapweed Biocontrol

The success of weed biological control is often measured by the amount plant density reduction. Although this seems straightforward, as practitioners of biocontrol we are faced with complex ecological systems and management realities, as well as public perceptions, especially as it pertains to non-target effects. A case in point is the biological control of spotted knapweed. *Centaurea stoebe* (formerly *C. maculosa*) is one of the more common and problematic of weedy knapweed in North America. Seeds of *C. stoebe* are believed to have been introduced to North America from Eurasia as contaminants in alfalfa, and plants were first recorded growing in British Columbia in 1893. It is currently reported in seven Canadian provinces and all but three of the lower 48 states in the U.S.

Due to its invasiveness and impacts on agriculture and natural areas, a biological control program was initiated in 1960s. Overseas surveys and testing of agents was conducted by IIBC (now known as CABI) as well as the USDA ARS European Biological Control Laboratory. Thirteen agents were eventually screened and released into Montana, starting with Urophora affinis in 1973. Agents are comprised of two guilds: flower head and root feeders. Twelve of the 13 spotted knapweed biocontrol agents are now known to be established in Montana and other parts of the U.S. It was theorized that by releasing a number of different agents, an accumulative impact would occur. Seedhead feeders may significantly reduce seed production and may also contribute to plant stress due to gall induction (*Urophora* spp.) or defoliation (*Larinus* spp). The root-feeding agents, especially *Cyphocleonus achates* have been shown to reduce stem length, shoot weight, and flowers per plant, as well as impacting plant density. In many instances reduction in spotted knapweed density have been observed and recorded.

However this approach has been criticized and arguments have been made for releasing agents that show the most efficacy, rather than basing introductions solely on the agent's host specificity. Releasing numerous agents may lead to conflict with those agents that may be consumed by native predators, e.g. spiders, birds or deer mice that may harbor the Hanta virus. Effectiveness of agents may also be hindered through adverse competition among agents, or by compensation by the plant due to agent attack. These non-target effects may *potentially have cascading negative impacts on* other native species, or potentially decrease the effectiveness of biological control agents. Such ecosystem affects are difficult to predict and quantify, and may be transitory depending upon the success of biological control in reducing the target weed. Although current screening of new agents still emphasize their host specificity, greater emphasis has been placed on determining their effectiveness and addressing potential non-target concerns. But the regulatory emphasis, even today, is on risk avoidance rather that the benefits of biological control. By determining the costs verses of benefits of biocontrol programs, we can begin to better define our success.

BIOLOGICAL CONTROL IMPLEMENTATION IN MONTANA

Purpose: **Implementation involves the release, redistribution, and monitoring of approved biocontrol agents and integrates biocontrol with other weed management programs.**

Objectives:

1) Collecting and Redistributing Biocontrol Agents

Suggested Actions:

- Determine which agents can be effectively collected and redistributed in Montana.
- Develop and refine collection methods to collect/redistribute optimal numbers of agents.
- Retain and recruit Area Coordinators (County Weed Offices) to assist in regional collection and redistribution efforts.
- Establish collection days, workshops, etc.
- Determine agents that can be obtained through commercial sources or school programs.
- Standardize marking of biological control release sites in Montana.

2) Monitoring Biocontrol Agents and Sites and Integrating Biocontrol with Other Weed Management Strategies

Suggested Actions:

- Review existing monitoring protocols and databases (e.g. Idaho). Adopt or adapt these to a state of Montana (or regions within Montana) biological control release database(s).
- Adopt or develop standardized forms to record, map, and monitor releases by coordinating amongst biocontrol practitioners and GIS specialists.
- Determine an entity to house, maintain, and update Montana databases and protocols.
- Educate weed practitioners on standardized monitoring techniques and database parameters.
- Request that all new releases be monitored according to protocols as a condition of receiving biocontrol agents for release.

- Determine the extent of establishment of biocontrol agents received through commercial sources, perhaps through a complimentary site inspection by a designated biocontrol practitioner.
- Work with researchers and land managers such as weed ecologists, livestock grazing specialists, economists, etc. to implement Integrated Weed Management strategies.

Of the 32 weed species and three regulated plants listed on the Montana Noxious Weed List, 26 have had classical biocontrol programs implemented against them

Pulling Together

Tansy Ragwort: An Integrated Approach Among Many Landowners

Tansy ragwort (Jacobaea vulgaris formerly Senecio jacobaea) is an invasive weed of meadows and open forests which forms monocultures that displace agricultural and native plants. Introduced to Montana before 1990, tansy ragwort was overlooked until a 1994 wildfire revealed a well-established population. Initially thought to cover only a few hundred acres, surveys showed that the infestation covered several thousand acres within the burned area along with additional infestations in adjacent unburned forest and isolated plants up to 40 miles away. Because of the size of the infestation, eradication was impossible. Many Montana land management agencies and private entities were affected and a long-term management program had to consider the wide range of land ownership. A combination of techniques was implemented to manage tansy ragwort. These included:

1. A conventional chemical control program used helicopters and ground crews to suppress weed populations in the core infestation area and to spray infested roads.
2. Containment involved closing forest areas and limiting human activities (such as firewood cutting) to decrease the potential for spreading tansy ragwort to new areas.
3. Surveys within the management zone identified new and outlying plants that were either pulled or sprayed.
4. A biological control program was implemented. A high elevation population of the cinnabar moth from Oregon was introduced that might withstand the Montana winters. This agent is now well established in Montana. A flea beetle was also introduced but, as it was less compatible with the Montana climate, research began to find, test, and introduce a new strain from Switzerland that was better adapted to our climate. Flea beetles are also now well established.
5. Monitoring the long term effectiveness of the program involves continued surveys of the weed infestation and of biological control agent establishment and effectiveness.

Tansy ragwort populations have decreased dramatically because of these integrated efforts; and forest areas have once again been re-opened. Biological control agents have been highly successful and should continue to provide long-term, cost-effective control against this weed.

BIOLOGICAL CONTROL OUTREACH AND TECHNOLOGY TRANSFER IN MONTANA

Purpose: **Outreach and Technology Transfer provide for a flow of information and resources to the public and land mangers regarding the use and implementation of biological control.**

Objectives:

1) Organizing Field Days and Demo Plots

Suggested Actions:

- Identify prospective locations and dates for field days. Work with local point persons to plan and implement events.
- Help coordinate interactions between researchers and landowners and managers to develop biocontrol demo plots.
- Plan an annual or biannual Montana biocontrol and integrated weed management field tour to bring together biocontrol and other weed researchers and landowners and managers for information exchange.

2) Establishing and Distributing Biocontrol Educational Materials, Web Sites, Media Exposure, Etc.

Suggested Actions:

- Assess existence and use of existing biocontrol educational materials and identify needs for new products.
- Promote and distribute existing educational materials.
- Develop updated posters that list Montana biocontrol agents by weed species, establishment, effectiveness, etc. (similar to the NRCS poster previously developed).
- Summarize and promote information in non-technical terms on current biocontrol research efforts in Montana.
- Utilize existing web sites (e.g. MWCA, SNWAEC, CIPM, and MSU Extension) to convey biocontrol information and availability of biocontrol educational materials.
- Use social media for the dissemination of current biocontrol information and activities in Montana and the surrounding region.

CURRENT MONTANA BIOCONTROL AGENCIES AND RESOURCES AND FUTURE PROGRAM NEEDS

Montana University System: As a land grant institution, Montana State University provides education, research, and extension/outreach programs focused to meet the changing needs of Montana by generating and disseminating superior knowledge and technological solutions to increase the competitiveness of communities capturing value from Montana's agricultural and natural resources, preserve environmental quality, and improve the quality of life for all our citizens. Although 1.25 FTE scientists are directly working on the biological control of weeds, other research and extension scientists (weed and insect ecologists and specialists, risk assessment specialists, botanists, insect and plant systematists, etc.) are available for collaboration. Support facilities include MSU Biological Control Containment Laboratory (3,400 ft^2 of arthropod and plant pathogen containment laboratory/greenhouse space), non-quarantine greenhouse space (Plant Growth Center), field plots (MSU Experiment Farms or Research Centers), and more specialized laboratories (e.g. chemical ecology laboratory, MSU Herbarium, Montana Entomology Collection, Schutter Diagnostic Lab, among others). The University of Montana has several ecologists and botanists on faculty who study invasive species and non-target impacts associated with biological control. University of Montana also houses the U of M Herbarium and the INVADERS Database system.

USDA Forest Service - Rocky Mountain Research Station (RMRS): The mission of the RMRS is to develop and deliver scientific knowledge and technology that will help people sustain our forests, rangelands, and grasslands. RMRS' Bozeman Forestry Sciences Laboratory has two full time research entomologists working on biological control of weeds. Facilities within the 6,300 ft^2 facility include typical office, laboratory, and administrative space, along with specialized research resources such as 1) two research greenhouse bays, a head house and a large fenced garden area; 2) a chemical ecology lab; 3) a separate building housing multiple plant growth chambers and an authorized containment facility for behavioral experiments; 4) support vehicles for field research.

USDA Forest Service - Forest Health: The FHTET biological control program is part of the broader Forest Service's National Strategy and Implementation Plan for Invasive Species Management. The focus of the FHTET-BC is to demonstrate a strong leadership role in the development and implementation of biological control technologies to manage widespread infestations of invasive species and to use biological control as a viable component for integrated invasive pest management efforts. One full time Forest Service entomologist covers USFS Northern Region 1 which includes western Montana and parts of Intermountain Region 4.

USDA ARS Northern Plains Agricultural Research Lab: The mission of the NPARL is to develop and implement ecologically based strategies, technologies, and products for the sustainable management of insects, pests, and weeds in crops and rangeland. Emphasis has been on biological and cultural management strategies that enhance profitability and environmental quality. The lab has 3 full time researchers (entomologist, plant geneticist/molecular biologist (botanist), and plant pathologist) plus several full time support technicians and seasonal personnel. Facilities include: 1) a containment facility with seven rearing rooms, four Percival incubators, and one walk-in cooler; 2) two research greenhouses and one

planting greenhouse; and 3) a molecular biology lab to explore genetics of weeds and biological control agents.

USDA APHIS: APHIS Plant protection and Quarantine (PPQ) is a multifaceted agency whose goals are to safeguard agriculture and natural resources from the entry, establishment, and spread of animal and plant pests and noxious weeds into the United States of America; and supports trade and exports of U.S. agricultural products. The Montana APHIS Plant Protection and Quarantine (PPQ) Biological Control program consists of several officers, specialists, technicians, and seasonal employees; with laboratory/work space in Helena and Billings, MT. The objectives of the PPQ biocontrol program in Montana are to support research and implementation of new biocontrol organisms in the state; provide technical assistance and outreach to stakeholders including Native American tribes; assist in the implementation of biocontrol programs, redistribution and monitoring of biocontrol agents within Montana, including support to the Montana state-wide Biological Control Coordinator; and providing assistance with regulatory compliance related to the movement of biological control agents and their release into the environment. Montana APHIS-PPQ has cooperative projects with Montana State University, various tribal agencies, BIA, BLM, USDA-ARS, Montana Department of Agriculture, county coordinators, among others.

USDI Bureau of Land Management: The Bureau of Land Management is responsible for the stewardship of our public lands. Its mission is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. Management is based upon the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. In Montana the BLM has ongoing partnerships with Montana State University, the University of Idaho, the University of Montana, USDA Animal Plant Health Inspection Service (APHIS), and USDA Agriculture Research Service (ARS), which have allowed BLM to play an important role in the research and development of biological weed control in Montana and across the West. BLM has also utilized partnerships to assist in the implementation, education, and distribution of biological control through high school agriculture/biology programs, universities, watershed groups, and other state and federal agencies. BLM funding for research and implementation for biological weed control has steadily declined due to static and reduced appropriations. At one time, BLM had 1 professional employee (PE) dedicated to biological control support and implementation across MT in addition to a dedicated PE coordinating weed management at the state level and dedicated PEs or Career Seasonal employees in each field office. The Biological Control Position no longer exists and most of the weed responsibilities have been assigned as additional duties to other program specialists at both the State and Field Office Level. Currently, BLM is supporting the Montana Statewide Biological Weed Control Coordination project in an effort to better coordinate biological control efforts of land mangers across the state.

USDI Bureau of Indian Affairs and Tribal Agencies: The Bureau of Indian Affairs (BIA) mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes, and Alaska Natives. The BIA provides technical assistance to Tribes and assists in management of land and natural resources. It is responsible for maintaining and improving the ecological health of the rangeland including the management of noxious weeds. Weed management programs vary greatly among the various Native American reservations and Tribal Trust Lands according to interest, commitment, and local priorities. Many reservation weed management projects are conducted in conjunction with adjoining counties, the BIA, and/or other federal agencies.

County: Montana county weed districts implement and enforce the Montana County Weed Control Act and coordinate management activities within the county. Each county weed control district is responsible for developing a district-wide noxious weed management plan to assist residents in complying with the Montana County Weed Control Act. Management options may include the integration of cultural, chemical, and biological methods. While biological control activities among districts vary widely, regional biological control coordinators (one for each of seven regions) have been identified to help coordinate and assist in the release, redistribution, and monitoring of biocontrol agents and with the establishment of regional insectaries.

Schools: Numerous high schools from around Montana have incorporated the topic of invasive weeds and biological control into existing courses or as summer projects. These courses assists students in developing awareness, knowledge, and skills regarding invasive species that will promote responsible land stewardship in the state of Montana through integrated management of weeds. These student groups often set up insectaries for the rearing and redistribution of insects to the community. The Whitehall Project involves: 1) mass rearing spotted knapweed and Russian knapweed agents on the Whitehall High School grounds, 2) monitoring over 500+ release sites with over 120 landowners, 3) collecting, augmenting, and redistributing bioagents, 4) locating, mapping, and photographing bio-release sites, 5) fostering cooperative weed control relationships, 6) helping other similar projects (at schools or other locations) start up and continue, and 7) educating others about the noxious weed problem and its solutions. The project maintains a weed site “Montana War-On-Weeds” and has published a field guide to the common biocontrol agents of Montana.

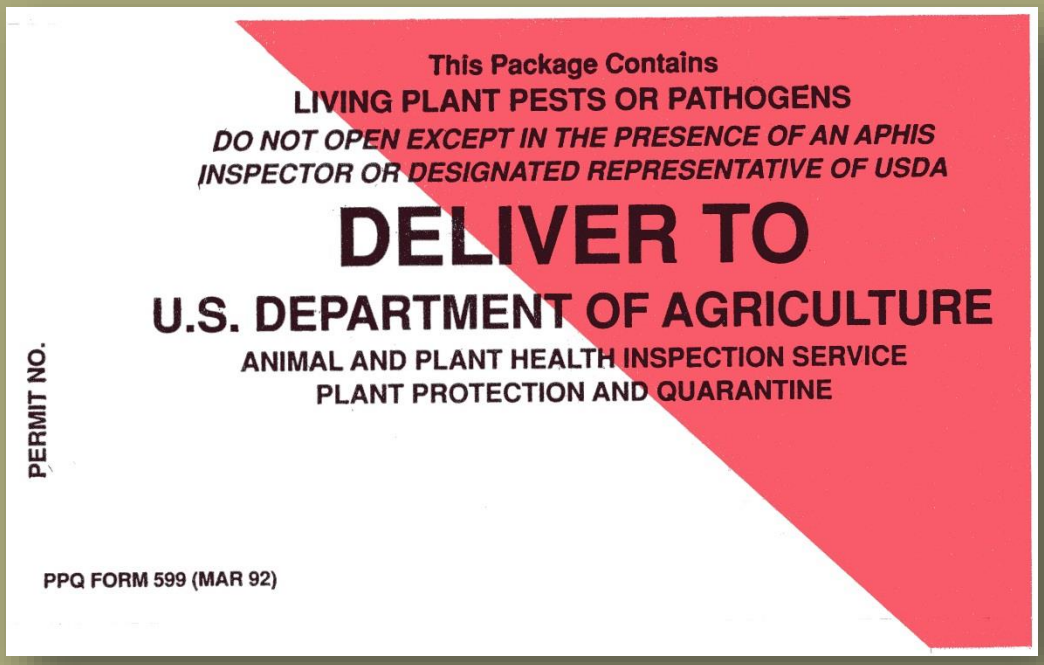
Other: Other state agencies (such as the MDA, MDT, DNRC, and MTFWP) and federal agencies (such as USFS National Forests, USDA NRCS, USDI Bureau of Reclamation, and US Fish & Wildlife Service) are involved with biological control. In addition, several noxious weed task force groups (such as those for Hawkweed and Tansy Ragwort) actively use biological control. Several private companies are present in Montana providing commonly available agents.

Future Program and Funding Needs

During the next ten years we will phase out several of the existing overseas biological control projects while continuing to phase in new projects. Due to the current complexity of screening new agents, it is estimated that it requires at least one million dollars to screen an agent; although this estimate is highly variable. In addition, as the overseas survey and screening process is completed for a project, domestic work will be initiated which will require supplemental funding at least equal to the overseas’ efforts. Although consortia have been formed to help fund these overseas projects, participation has been limited to a small group of states, Canadian provinces and federal agencies. Our challenge is to better engage and enlist other states and entities that benefit from the successful biological control to better fund regional biological control projects. Although these consortia groups have greatly supported the overseas screening of agents they often fail in financing the domestic side of these projects, i.e. the quarantine screening, augmentation, release and monitoring of agents.

Permitting of Agents for Importation & Interstate Shipment

Under the authority of the Plant Protection and Honeybee Acts, a USDA-APHIS Plant Protection and Quarantine (PPQ) 526 permit is required for the importation, interstate movement, and environmental release of plant pests (plant feeding insects, mites, snails, slugs, and plant pathogenic bacteria, viruses, fungi, etc.), biological control organisms of plant pests and weeds, bees, parasitic plants, and Federally listed noxious weeds. PPQ is authorized to inspect shipments and/or facilities at any time to verify compliance with permit conditions. Receipt of a PPQ permit does not relieve the applicant from the obligation to comply with the regulations of other Federal, State, and local agencies (e.g., U.S. Fish and Wildlife Service or the Environmental Protection Agency). Permits for interstate shipment of several weed biocontrol agents (e.g. *Trichosirocalus horridus, Diorhabda carinulata*, several "adventive" agents; see Appendix 1) have been rescinded by APHIS due to non-target concerns.



Biological weed control is the use of an invasive plant's natural enemies to reduce the weed population to a desired level

Measures of Success or Failure

As pointed out by Eric Coombs with the Oregon Department of Agriculture, “not all successes and failures are created equal in either scale or assessment”. The success of a classical biological control program is often difficult to characterize due to numerous known and unknown biotic and abiotic factors that affect agent establishment and impact on the target weed. Success may vary among geographical regions, habitats, or with time. Gauging success also depends upon project management goals or objectives. In Montana, although we have had biological control successes, not all agents have been efficacious. Some agents have failed to establish, failed to increase in population, or failed to impact the plant. Failures can be grouped into three broad categories: operational, abiotic, and biotic. The failure to establish the root moth *Chamaesphecia crassicornis* on leafy spurge is an example of operational issues. In this case only five shipments were received at the MSU quarantine and only two adult moths were reared from the infested roots. Eventually 600 eggs were obtained from overseas and placed on plants for rearing. Failure was largely due to the lack of adequate numbers of individuals available for release and difficulties associated with their rearing. Abiotic factors were involved in the introduction in 1963 of two *Microlarinus* weevils for the control of puncturevine in Montana. These weevils were imported from Italy via California. Despite several releases they were never able to become established. It was later determined that the weevils were not cold hardy and were not able to survive winters in Montana. Not all agents impact their hosts. In the 1970s two *Coleophora* moths (*C. klimeschiella* and *C. parthenica*) were introduced for Russian thistle control. Although they have been established in adjoining states, they have not become effective agents. In the case of *C. klimeschiella*, populations are limited by parasitism by native wasps while *C. parthenica* mines the stem’s pith but has little impact on the plant. By understanding the reason why agents fail can we determine how to better select effective agents.

Into The Future

Biological Control Consortia & New Projects

Classical biological control projects against invasive weeds have been traditionally initiated and funded through the public sector; that is, through governmental agencies or departments. The overseas survey and screening of new agents is an expensive proposition. It has been estimated that it costs one million dollars to screen a typical insect agent; although costs widely differ among target weeds and the agents. Such costs are overly prohibitive for one agency to completely fund and therefore consortia groups have been formed to pool resources and provide direction, management, support, and to prioritize testing of specific agents. Currently Montana participates in eight separate consortia. Several new biological control projects have been implemented by CABI Switzerland and other organizations. These include ox-eye daisy, common tansy, Russian olive, knotweeds, and flowering rush.

APPENDICES:

SUMMARY OF BIOCONTROL AGENTS IN MONTANA

&

ACKNOWLEDGEMENTS

Appendix 1: Agents Released or Approved for Biological Control of Noxious Weeds in Montana – January 01, 2015

Agent*	Order: Family	Type	Established	Comments
FIELD BINDWEED				
Aceria malherbae	Acari: Eriophyidae	gall mite	Y	Well established in eastern Montana, but patchy in distribution, with limited impact
Tyta luctuosa	Lepidoptera: Noctuidae	defoliating moth	?	Not recovered
HAWKWEED				
Aulacidea subterminalis	Hymenoptera: Cynipidae	stolon galling wasp	?	Initial releases made in 2011 for orange hawkweed
KNAPWEED - DIFFUSE & SPOTTED				
Agapeta zoegana	Lepidoptera: Cochylidae	root boring moth	Y	Widespread with impact at some sites
Bangasternus fausti	Coleoptera: Curculionidae	flowerhead weevil	Y	Established at low levels in MT; more common in ID and WA
Chaetorellia acrolophi	Diptera: Tephritidae	flowerhead weevil	Y	Established and widespread.
Cyphocleonus achates	Coleoptera: Curculionidae	root boring moth	Y	Well established and increasing in number and distribution; significant impact on numerous sites
Larinus minutus	Coleoptera: Curculionidae	flowerhead weevil	Y	Well established, widespread; heavy damage to rosettes & stems due to adult feeding, particularly on diffuse knapweed, which is nearly eliminated on many sites
Larinus obtusus	Coleoptera: Curculionidae	flowerhead weevil	Y	Established but difficult to differentiate from *L. minutus*
Metzneria paucipunctella	Lepidoptera: Gelechiidae	flowerhead moth	Y	Well established but populations limited due to cold temperature, winter mortality
Pelochrista medullana	Lepidoptera: Tortricidae	root boring moth	Y	Recovered but unknown establishment
Pterolonche inspersa	Lepidoptera: Pterolonchidae	root boring moth	Y	Limited establishment on spotted knapweed
Sphenoptera jugoslavica	Coleoptera: Buprestidae	root boring beetle	Y	Limited establishment; does well on diffuse but will also infest spotted knapweed

Terellia virens	Diptera: Tephritidae	flowerhead fly	Y	Established in some locations
Urophora affinis	Diptera: Tephritidae	flowerhead fly	Y	Well established and wide spread
Urophora quadrifasciata	Diptera: Tephritidae	flowerhead fly	Y	Well established and wide spread
KNAPWEED – RUSSIAN				
Aulacidea acroptilonica	Hymenoptera: Cynipidae	stem galling wasp	Y	Established with increasing populations.
Jaapiella ivannikovi	Diptera: Cecidomyiidae	tip gall midge	Y	Established with increasing populations.
Mesoanguina picridis (formerly *Subanguina picridis*)	Nematoda - Anguinidae	stem gall nematode	Y	Established but not recently found; damaging in wet years but does poorly
LEAFY SPURGE				
Aphthona abdominalis	Coleoptera: Chrysomelidae	root-feeding flea beetle	N	No reported establishment
A. cyparissiae	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Some establishment
A. czwalinae	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Some establishment; may be mixed with *A. lacertosa*
A. flava	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Some establishment
A. lacertosa	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Good establishment and availability; impacting spurge at numerous sites and across varying habitats; may be mixed with *A. czwalinae*
A. nigriscutis	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Good establishment and availability; impacting spurge at numerous sites
Chamaesphecia crassicornis	Lepidoptera: Sesiidae	root moth	N	No reported establishment; limited releases made
Chamaesphecia empiformis	Lepidoptera: Sesiidae	root moth	N	Not established; limited releases made
Chamaesphecia hungarica	Lepidoptera: Sesiidae	root moth	N	No reported establishment; limited releases made
Dasineura nr. capsulae	Diptera: Cecidomyiidae	seed gall midge	-	Approved but not released due to overwintering mortality in quarantine
Hyles euphorbiae	Lepidoptera: Sphingidae	defoliating moth	Y	Established at numerous locations; populations generally

				variable from year to year with limited impact
Oberea erythrocephala	Coleoptera: Cerambycidae	stem boring beetle	Y	Established at numerous locations; limited effectiveness
Spurgia esulae	Diptera: Cecidomyiidae	tip gall midge	Y	Established; limited effectiveness to date
Spurgia capitigena	Diptera: Cecidomyiidae	tip gall midge	-	DNA analysis indicates this species same as *Spurgia esulae*
PURPLE LYTHRUM (LOOSESTRIFE)				
Galerucella calmariensis	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established
Galerucella pusilla	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established
Hylobius transversovittatus	Coleoptera: Curculionidae	root	?	Released but establishment not confirmed
Nanophyes brevis	Coleoptera: Nitidulidae	flower-infesting weevil	-	Not released in MT(?); limited releases have been made in U.S. due to a parasitic nematode; not available.
Nanophyes marmoratus	Coleoptera: Nitidulidae	flower-infesting weevil	-	Not released in MT?
PUNCTUREVINE				
Microlarinus lareynii	Coleoptera: Curculionidae	seed weevil	N	Not established; not cold hardy
Microlarinus lypriformis	Coleoptera: Curculionidae	stem mining weevil	N	Not established; not cold hardy
RUSSIAN THISTLE				
Coleophora klimeschiella	Lepidoptera: Coleophoridae	defoliating moth	N	Not established
Coleophora parthenica	Lepidoptera: Coleophoridae	stem mining moth	N	Not established
SALTCEDAR				
Diorhabda carinulata (elongata complex)	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established at low levels or colonies have died out; originally released as *Diorhabda elongata*, but recently found to be a complex of several species (released in various U.S. locations; **No** interstate shipping currently allowed
ST. JOHN'S WORT				

Agrillis hyperici	Coleoptera: Buprestidae	root-boring beetle	Y	Established at several sites
Aplocera plagiata	Lepidoptera: Geometridae	defoliating moth	Y	Established and widespread
Chrysolina hyperici	Coleoptera: Chrysomelidae	defoliating beetle	Y	Well established and widespread
Chrysolina quadrigemini	Coleoptera: Chrysomelidae	defoliating beetle	Y	Well established and widespread
Zeuxidipolis giardi	Diptera: Cecidomyiidae	tip-gall fly	N	No reported establishment
TANSY RAGWORT				
Botanophila seneciella	Diptera: Anthomyiidae	flower infesting fly	Y	Released in Lincoln and Flathead Co., MT; widespread but limited impact on seed production
Longtarsus jacobaeae	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Released in Lincoln and Flathead Co., MT; a cold-adapted population from Switzerland was released 2002; established at numerous sites; having impact at most sites
Tyria jacobaeae	Lepidoptera: Arctiidae	defoliating moth	Y	Released in Lincoln and Flathead Co., MT; widespread in the tansy ragwort area; significant control in many areas
THISTLES – BULL				
Urophora stylata	Diptera: Tephritidae	flower-galling fly	?	Unknown establishment
THISTLES - CANADA				
Altica carduorum	Coleoptera: Chrysomelidae	defoliating beetle	N	Not established
Hadroplontus litura (formerly *Ceutorhynchus litura*)	Coleoptera: Curculionidae	stem-boring weevil	Y	Well established; some impact reported
Urophora cardui	Diptera: Tephritidae	stem-galling fly	Y	Established at numerous locations; little significant impact
THISTLES - MUSK				
Cheilosia corydon	Diptera: Syrphidae	stem, rosette-boring fly	N	Released but not established
Psylloides chalcomera	Coleoptera: Chrysomelidae	rosette-boring flea beetle	-	Not released in MT
Rhinocyllus conicus	Coleoptera: Curculionidae	flower weevil	Y	Well established and widespread; effective in

				reducing plant density; will attack native thistles; **NO** interstate movement
Trichosirocalus horridus	Coleoptera: Curculionidae	rosette-boring weevil	Y	Appears to be wide spread in western Montana; may be effective on drier sites with *R. conicus;* **NO** interstate movement
Urophora solstitialis	Diptera: Tephritidae	flower-gall fly	N	Unknown establishment
TOADFLAXES – DALMATIAN and YELLOW				
Calophasia lunula	Lepidoptera: Noctuidae	defoliating moth	Y	Established at various locations; population density varies by site
Eteobelea intermediella	Lepidoptera: Cosmopterigidae	Dalmatian toadflax root-boring moth	N	Released but establishment unknown; difficult to obtain in Europe and to rear
Eteobelea serratella	Lepidoptera: Cosmopterigidae	yellow toadflax root-boring moth	N	Released but establishment unknown; difficult to obtain in Europe and to rear
Rhinusa antirrhini (formerly *Gymnetron antirrhini*)	Coleoptera: Curculionidae	flower-feeding weevil	?	Dalmatian toadflax strain approved for release – unknown recovery; yellow toadflax strain adventive
Rhinusa linariae (formerly *Gymnetron linariae*)	Coleoptera: Curculionidae	root-galling weevil	?	Released; establishment unknown
Mecinus janthiniformis	Coleoptera: Curculionidae	Dalmatian toadflax stem mining weevil	Y	Widespread; impacting populations at some locations; originally released as *Mecinus janthinus*, but recently found to be a separate, cryptic species
Mecinus janthinus	Coleoptera: Curculionidae	yellow toadflax stem mining weevil	Y	Established in limited locations and increasing in number; impacting weed populations at some locations

Note: Does not include adventive agents. See comments regarding agents not approved for interstate shipment.

Appendix 2: Agents Previously Screened or Currently Being Screened for Biocontrol of Noxious Weeds in Montana – January 01, 2015

Agent	Type	Status	Agencies	Notes
Canada thistle				
Aceria anthocoptes (Acari: Eriophyidae)	vagrant mite	adventive	CABI; ARS	European populations were investigated; adventive in the U.S.
Altica carduorum (Coleoptera: Chrysomelidae)	defoliating beetle	released/ rejected	Canada	Two populations tested; one released in 1966 and the other from China rejected due to non-target feeding
Lema cyanella (Coleoptera: Chrysomelidae)	defoliating beetle	rejected		
Misc. pathogens	pathogens	screening	CABI; ARS	
Common tansy				
Cassida stigmatica (Coleoptera: Chrysomelidae)	defoliating beetle	screening	CABI	
Isophritictis striatella (Lepidoptera: Gelichiidae)	stem mining moth	screening	CABI	
Longitarus spp. *noicus* (Coleoptera: Chrysomelidae)	crown/root flea beetle	dropped	CABI	Not host specific
Microplontus millefolii (Coleoptera: Curculionidae)	stem mining weevil	screening	CABI	
Platyptilia ochrodactyla (Lepidoptera: Pterophoridae)	stem mining moth		CABI	
Rhopalomyia tanaceticola (Diptiptera: Cecidomyiidae)	flower gall midge		CABI	
Dyers woad				
Aulacobaris fallax (Coleoptera: Curculionidae)	stem weevil	rejected	CABI	Not host specific
Aulacobaris licens (Coleoptera: Curculionidae)	root weevil	on hold	CABI	Lower priority agent

Ceutorhynchus peyerimhoffi (Coleoptera: Curculionidae)	seed feeding weevil	screening	CABI	
Ceutorhynchus rusticus (Coleoptera: Curculionidae)	root crown weevil	screening	CABI	Additional host specificity testing underway
Lixus spp. (Coleoptera: Curculionidae)		on hold	CABI	Lower priority agent
Psylliodes isatidis (Coleoptera: Chrysomelidae)	shoot mining flea beetle	screening	CABI	Defining genetic boundaries of agent (now a complex)
Psylliodes tricolor (= *P. sophiae*) (Coleoptera: Chrysomelidae)	shoot mining flea beetle	on hold	CABI	
Field bindweed				
Galeruca rufa (Coleoptera: Chrysomelidae)	defoliating beetle	rejected	ARS	Not host specific
Longitarsus pellucidus (Coleoptera: Chrysomelidae)	root flea beetle	screening	CABI	
Melanagromyza albocilia (Diptera: Agromyzidae)	stem mining fly	screening	CABI	
Spermophagus sericeus (Coleoptera: Bruchidae)	seed feeding weevil	on hold		No work currently being conducted
Hawkweeds				
Aulacidea hieracii (Hymenoptera: Cynipidae)	stem gall wasp	rejected	CABI	Several populations tested; none specific to invasive hawkweeds
Aulacidea pilosella (Hymenoptera: Cynipidae)	leaf/stem/stolon gall wasp	screening	CABI; Canada	Two populations currently being tested
Cheilosia psilophthalma (Diptera: Syrphidae)	stem boring fly	on hold	CABI	Host testing on hold
Cheilosia urbana (Diptera: Syrphidae)	stem boring fly	under TAG review	CABI	Petition submitted to TAG 2014

Oxyptilus pilosellae (Lepidoptera: Pterophoridae)	crown boring moth	rejected	CABI	Not host specific
Macrolabis pilosellae (Diptera: Cecidomyiidae)	tip gall midge	rejected	CABI	Not host specific
pathogens		screening	ARS: CABI; Canada; MSU	Various pathogens being investigated, including several *Puccinia* strains
Hoarycress				
Aceria drabae (Acari: Eriophyidae)	leaf/flower gall mite	regulatory action	MSU; CABI; EBCL	TAG review completed
Ceutorhynchus assimilis (Coleoptera: Curculionidae)	root crown gall weevil	screening	CABI; EBCL	Screening continuing
Ceutorhynchus cardariae (Coleoptera: Curculionidae)	stem gall weevil	screening	CABI	TAG review concluded more host specificity testing needed
Ceutorhynchus merkli (Coleoptera: Curculionidae)	stem mining weevil	on hold	CABI	Limited screening but poor performance on target
Ceutorhynchus turbatus (Coleoptera: Curculionidae)	seedpod gall weevil	screening	CABI	Screening continuing
Contarinia cardariae (Diptera: Cecidomyiidae)	seedpod gall midge		CABI	Identified as potential agent
Dasyneura cardariae (Diptera: Cecidomyiidae)	tip gall midge		CABI	Identified as potential agent
Melanobaris sp. pr. *semistriata* (Coleoptera: Curculionidae)	stem boring weevil	rejected	CABI	Rejected due to non-target feeding
Psylloides wrasel (Coleoptera: Chrysomeildae)	stem/crown mining flea beetle	rejected	CABI	Rejected due to non-target feeding
Houndstongue				
Cheilosia pasquorum	root boring fly	rejected	CABI	Not host specific. From Serbia

(Diptera: Syrphidae)				
Longitarsus quardiguttatus (Coleoptera: Chrysomelidae)	root feeding flea beetle	rejected	CABI	Released in Canada but not in U.S. due to non-target concerns. From Austria
Mogulones borraginus (Coleoptera: Curculionidae)	seed feeding weevil	screening	CABI; U. Idaho	Host specificity testing is continuing. From Austria/Hungary
Mogulones cruciger (Coleoptera: Curculionidae)	root/rosette boring weevil	rejected	CABI	Released in Canada but not in U.S. due to non-target concerns
Mogulones trisignatus (Coleoptera: Curculionidae)	stem boring weevil	rejected	CABI	Not currently being considered due to host specificity concerns. From Austria/Hungary
Rabdorrhyncus varius (Coleoptera: Curculionidae)	rosette feeding weevil	rejected	CABI	Not currently being considered due to host specificity concerns
Japanese Knotweed				
Aphalara itadori (Homoptera: Psyllidae)	leaf psyllid	regulatory action	CABI	Petition submitted to TAG 2013
Knapweed – diffuse & spotted				
Aceria centaureae (Acari: Eriophyidae)	foliage gall mite	on hold	MSU; EBCL	Host specificity tests completed; reviewed by TAG; needs additional risk analysis on native knapweeds; not readily available from Greece.
Aceria thessalonicae (Acari: Eriophyidae)	tip mite	dropped	MSU; EBCL	Host specificity tests on hold due to no availability from Greece; since found to be adventive
Leafy spurge				
Aphthona ovata (Coleoptera: Chrysomelidae)	flea beetle	on hold		No work currently being conducted. From Serbia
Aphthona seriata (Coleoptera: Chrysomelidae)	flea beetle	on hold		Some host specificity testing has been completed; no current work being conducted. From China
Aphthona venustula (Coleoptera: Chrysomelidae)	flea beetle	on hold		No work currently being conducted
Aphthona violacea (Coleoptera: Chrysomelidae)	flea beetle	on hold		No work currently being conducted. From Serbia/Hungary

Chamaesphecia astatiformis (Lepidoptera: Sesiidae)	root moth	rejected		Host specificity testing completed; will not infest U.S. leafy spurge. From Yugoslavia
Lobesia euphorbiana (Lepidoptera: Tortricidae)	defoliating moth	rejected		Released in Canada but rejected for release in U.S.
Minoa murinata (Lepidoptera: Geometridae)	defoliating Moth	rejected		Released in Canada but rejected for release in U.S.
Oberea donceeli (Coleoptera: Cerambycidae)	stem mining beetle	on hold		No work currently being conducted. From China
Oberea moravica (Coleoptera: Cerambycidae)	stem mining beetle	on hold		No work currently being conducted. From the Czech Republic
Oncochila simplex (Hemiptera: Pentatomidae)		rejected		Rejected for release in U.S.
Oxicesta geographica (Lepidoptera: Noctuidae)	defoliating Moth	rejected	EBCL; CABI BBCA; MSU	Feeds on nontarget *Euphorbia*
Pegomya curticornis (Diptera: Anthomyiidae)	stem boring fly	rejected		Some feeding on nontarget *Euphorbia;* requires additional testing
Pegomya euphorbiae (Diptera: Anthomyiidae)	stem boring fly	rejected		Some feeding on nontarget *Euphorbia*; requires additional testing
Phyllocoptes nevadensis (Acari: Eriophyidae)	foliage gall mite from France	rejected	MSU; EBCL	Damaging to cypress spurge but not leafy spurge. Probably not adequately host specific for release.
Simyra dentinosa (Lepidoptera: Noctuidae)	defoliating moth	rejected	EBCL; MSU	Feeds on nontarget *Euphorbia*
Tamnurgus euphorbiae (Coleoptera: Scolytidae)	stem boring beetle from Italy	regulatory action	EBCL; ARS	Additional host testing conducted in Italy and MT; approved by TAG; status of EA unknown
Perennial pepperweed				
Ceutorhynchus marginellus (Coleoptera:Curculionidae)	leaf/stem gall weevil	screening	CABI	
Lasiosina deviate	stem mining fly	screening	BBCA	

(Diptera: Chloropidae)				
Melanobaris sp. nr. *semistriata* (Coleoptera: Curculionidae)	root mining weevil	on hold	CABI	Host specificity issue
Metaculus lepidifolii (Acari: Eriophyidae)	gall mite	screening	BBCA; CABI	
Phyllotreta reitteri (Coleoptera: Chrysomelidae)	stem mining flea beetle	on hold	CABI	Host specificity issues
Ox-eye daisy				
Apion stolidum (Coleoptera: Curculionidae)	root weevil	rejected	CABI	Not host specific
Cheilosia vernalis (Diptera: Syrphidae)	shoot mining fly	rejected	CABI	Not host specific
Cyphocleonus trisulcatus (Coleoptera: Curculionidae)	root weevil	screening	CABI	Priority agent; needs host specificity studies
Dichrorampha aeratana (Lepidoptera: Tortricidae)	root mining moth	screening	CABI	Screening and impact studies
Tephritis neesii (Diptera: Tephritidae)	flower feeding fly	screening	CABI	Beginning host specificity testing
Russian knapweed				
Aceria acroptiloni (Acari: Eriophyidae)	flower gall mite	screening	CABI/ EBCL/ MSU	From Uzbekistan and Iran. Defining genetic boundaries of agent (possibly a complex); host testing being conducted on Iranian population by CABI
Aceria sobhiani (Acari: Eriophyidae)	foliage gall mite	rejected	MSU	From Uzbekistan. Not host specific or damaging
Agapanthi leucaspis (Coleoptera: Cerambycidea)	stem mining beetle	rejected	CABI	
Boeremia exigua var. *rhapontica* (Pleosporales: Didymellaceae)	pathogen	under TAG review	ARS	Petition submitted to TAG 2013
Cochylimorpha nomadana	root moth	no work	CABI	From Uzbekistan. Host testing nearly completed but on hold due to host

(Lepidoptera: Cochylidae)				issues and difficulties in working with the moth.
Depressaria squamos (Lepidoptera: Oecophoridae)	stem mining moth	no work	EBCL	Identified as potential agent not present in high numbers
Galeruca sp. (Coleoptera: Chrysomelidae)	defoliating beetle	screening	CABI	Screening continues
Lixus strangulates (Coleoptera: Curculionidae)	stem weevil	rejected	CABI	From Iran. Not host specific (also fed on safflower)
Napomyza sp. nr. *lateralis* (Diptera: Agromyzidae)	stem/root boring fly	rejected	CABI	From Turkey. Not host specific
Pseudorchestes (=*Rhynchaenus*) *distans* (Coleoptera: Curculionidae)	leaf gall weevil	no work		Identified as potential agent
Loewiola acroptilonica (Diptera: Cecidomyiidae)	leaf gall midge	no work		Identified as potential agent
Urophora kasachstanica (Diptera: Tephritidae)	flower gall fly	rejected	EBCL; MSU	Host testing completed; petition approved by TAG but rejected by USFWS due to ovipositional probing of *Cirsium* species in no-choice tests. From Uzbekistan
Urophora xanthippe (Diptera: Tephritidae)	flower gall fly	rejected	EBCL; MSU	Host testing completed; petition approved by TAG but rejected by USFWS (see above). From Uzbekistan
Russian olive				
Aceria angustifoliae (Acari: Eriophyoidea)	gall mite	screening	CABI	Impact studies continue in Turkey and Iran
Aceria sp. (possibly *A. elaeagricola)*	mite	screening	BBCA; CABI	From Uzbekistan
Ananarsia eleagnella (Lepidoptera: Gelechiidae)	shoot moth	screening	CABI	Impact studies continue in Iran
Unidentified weevil	weevil	rejected	CABI	Removed from consideration
Russian thistle				
Aceria salsolae (Acari: Eriophyoidea)	mite	rejected	ARS	Petition submitted to TAG, EA for release rejected due to concerns

				regarding certain native plant species in the family Chenopodiaceae
Colletotrichum salsolae (Glomerellales: Glomerellaceae)	pathogen	under TAG review	ARS; CO	Petition submitted to TAG 2014
Uromyces salsolae	pathogen	screening	ARS	Petition submitted to TAG 2009
Saltcedar				
Acanthococcus orbiculus (Homoptera: Pseudococcidae)	stem gall mealybug	no work?	ARS	Identified as potential agent from China
Adiscodiaspis tamaricicola (Homoptera: Diaspididae)	stem scale insect	no work?	ARS	Identified as potential agent from Turkmenistan and Kazakhstan
Agdistis tamaricis (Lepidoptera: Pterophoridae)	foliage feeding moth	no work?	ARS	Identified as potential agent from Israel
Amblypalpis tamaricella (Lepidoptera: Gelechiidae)	stem gall moth	no work?	ARS	Identified as potential agent from Israel, Kazakhstan and China
Colposcenia aliena (Homoptera: Psyillidae)	stem feeding psyilid	no work?	ARS	Identified as potential agent from China and Turkmenistan
Coniatus tamarisci (Coleoptera: Curculionidae)	defoliating weevil	no work?	ARS	Identified as potential agent from France
Corimalia sp. (Coleoptera: Curculionidae)	seed weevil	no work?	ARS	Identified as potential agent from France and China
Crastina tamaricina (Homoptera: Psyillidae)	stem feeding psyilid	no work?	ARS	Identified as potential agent from Israel, Kazakhstan and Turkmenistan
Cryptocephalus sinaita (Coleoptera: Chrysomelidae)	leaf beetle	no work?	ARS	Identified as potential agent from Israel
Ornativalva sp. (Lepidoptera: Gelechiidae)	foliage feeding moth	no work?	ARS	Identified as potential agent from China
Parapodia sinaica (Lepidoptera: Gelechiidae	stem gall moth	no work?	ARS	Identified as potential agent from France and Israel
Psectrosema noxium	stem gall midge	no work?	ARS	Identified as potential agent from France

(Diptera: Cecidomyiidae)				
Trabutina mannipara (Homoptera: Pseudococcidae)	mealybug	no work?	ARS	Identified as potential agent from Israel
Trabutina crassispinosa (Homoptera: Pseudococcidae)	stem mealybug	no work?	ARS	Identified as potential agent from Turkmenistan
Trabutina mannipara (Homoptera: Pseudococcidae)	branch mealybug	no work?	ARS	Identified as potential agent from Israel and Turkmenistan
Trabutina serpentine (Homoptera: Pseudococcidae)	branch mealybug	no work?	ARS	Identified as potential agent from Israel, Kazakhstan, and China
Sulfur cinquefoil				
Anthonomus rubripes (Coleoptera: Curculionidae)	flower-bud weevil	rejected	CABI	Not host specific.
Diastrophus sp. nr. *mayri* (Hymenoptera: Cynipidae)	gall wasp	screening	CABI	Host testing initiated; known as *Xestophanes potentillae* or sp. in previous reports. From Turkey
Janetiella potentillogemmae (Diptera: Cecidomyiidae)	gall midge	screening	CABI	From Turkey
Tinthia myrmosaeformis (Lepidoptera: Sesiidae)	root feeding moth	rejected	CABI	Host specificity tests are completed but non-target concerns. From Turkey
Tansy ragwort				
Cochylis atricapitana (Leptidoptera: Tortricidae)	stem/crown boring moth	not released		Released in Canada but not U.S.
Longitarsus flavicornis (Coleoptera: Chrysomelidae)	root/crown flea beetle	not released		Adventive to Canada but not U.S.
Platyptilia isodactyla (Lepidoptera: Pterophoridae)	crown/stem boring moth	not released		Released in New Zealand and Australia

Toadflaxes – yellow and Dalmatian				
Mecinus heydeni (Coleoptera: Curculionidae)	yellow toadflax stem mining weevil	screening	CABI	Highly prolific; promising against hybrid toadflax in quarantine tests
Mecinus laeviceps (Coleoptera: Curculionidae)	stem mining weevil	screening	CABI	Oviposits 6-8 weeks earlier than *M. janthiniformis*; adults overwinter in ground shelters, not in host stems like most other *Mecinus* species
Mecinus peterharrisii (Coleoptera: Curculionidae)	Dalmatian toadflax stem mining weevil	screening	CABI	Occurs at high elevations in native European range (=possibly more tolerant of extreme environmental conditions than *M. janthiniformis*)
Rhinusa rara sp. n. (formerly *Rhinusa brondelii*) (Coleoptera: Curculionidae)	Dalmatian toadflax stem galling weevil	screening	CABI	Oviposits on very young shoots, much earlier than *M. janthiniformis*; TAG Petition will be submitted in 2014
Rhinusa pilosa) (Coleoptera: Curculionidae)	yellow toadflax stem galling weevil	regulatory action	CABI	TAG recommended field release in August 2013; released in western Canada summer 2014

Editorial Note: The intent of this table is to provide an overview of agents that are or were of interest to Montana, and not necessarily screened specifically for Montana. It is not a definitive list and is somewhat subjective since some agents have been considered but not actively screened. Agents that are listed "on hold" are in effect in biocontrol Limbo – they have neither been rejected nor are they being screened. Some agents I do not know their current status; so I have left blank fields or inserted a question mark. This list (as well as the previous table) will be periodically update.

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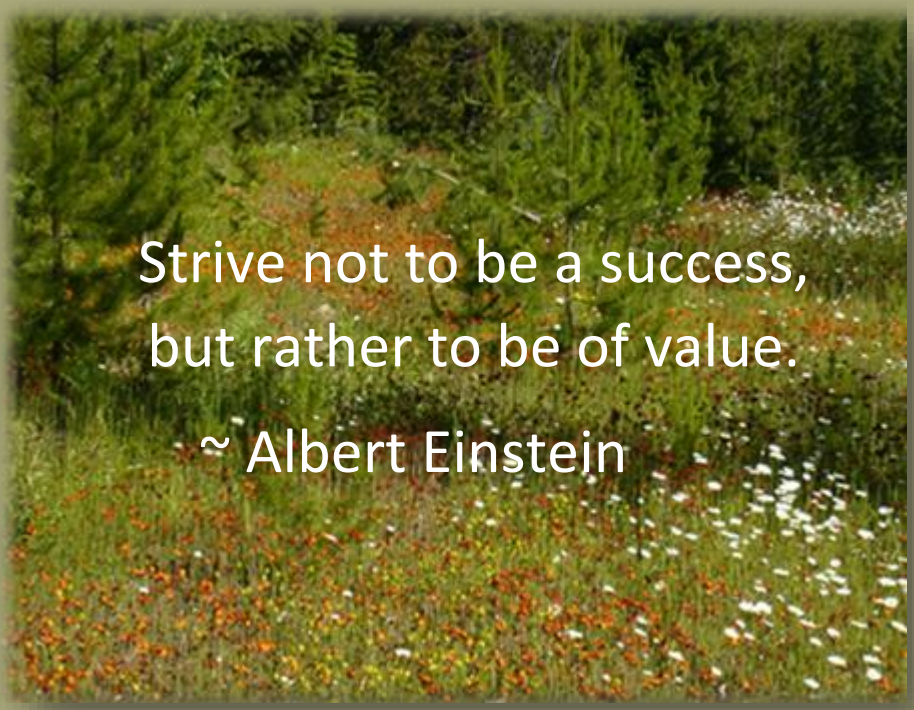
Strive not to be a success,
but rather to be of value.
~ Albert Einstein