USDA-APHIS-PPQ Biocontrol Target Pest Canvassing and Evaluation 2005–2006 Final Report (November 2006)

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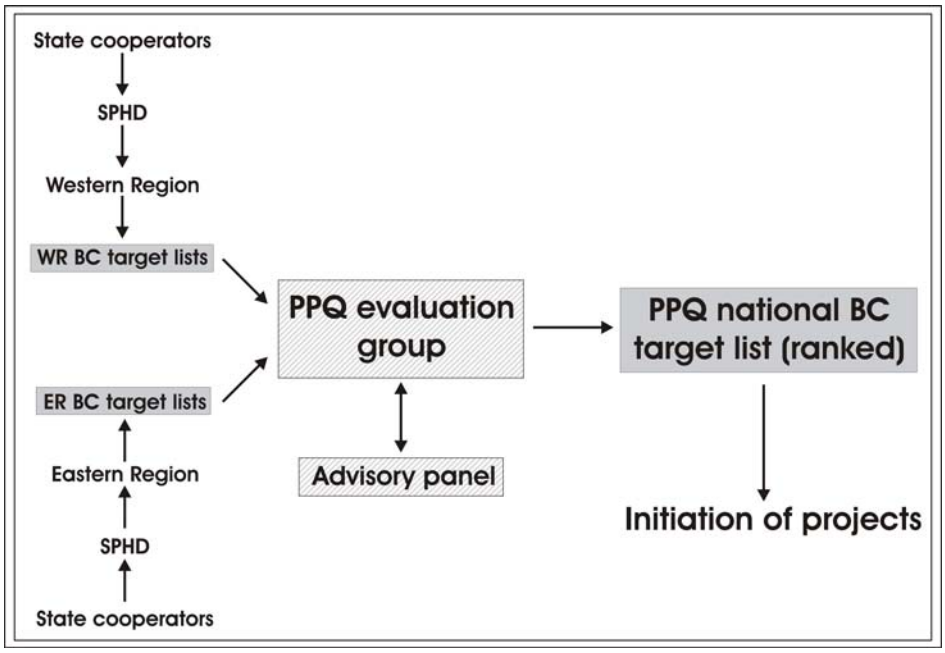
The 2005–2006 biocontrol evaluation process consisted of two main components: (a) the target canvassing process; and (b) the biocontrol feasibility analysis. Each is addressed below; Figure 1 summarizes the overall evaluation process.

Figure 1. Summary of 2005–2006 biocontrol evaluation process.



A. Target canvassing. In 2005, State Plant Health Directors (SPHDs) 'canvassed' various entities (e.g. Federal, tribal, and state agencies, universities, weed management districts) in each state, soliciting input on important exotic insects and weeds that might be considered as possible targets for cooperative biological control programs. Each pest was scored using a standard survey sheet (Appendix 1). Scores were based on the origin of the pest, the availability of other management tools, the level of financial and personnel support, and the distribution, spread and impacts of the pest in that state.

Each SPHD, in consultation with state cooperators, then produced a state list of the 'top three' potential insect and weed targets for biocontrol programs. Eastern and Western Region program

managers compiled all state lists, and produced ranked regional lists of potential target pests. Regional rankings were based on the ranking scores from each state and the number of states reporting each pest on its ranked list. 'Top ten' lists of potential insect and weed targets for biological control were then forwarded for subsequent feasibility analysis from each Region.

B. Insects

Eastern Region priority insect targets
Imported fire ant, *Solenopsis invicta*
Japanese beetle, *Popillia japonica*
Hemlock wooly adelgid, *Adelges tsugae*
Small hive beetle, *Aethina tumida*
Soybean aphid, *Aphis glycines*
Oriental beetle, *Exomala orientalis*
Varroa mite, *Varroa jacobsoni*
Emerald ash borer, *Agrilus planipennis*
Winter moth, *Operophtera brumata*
Brown marmorated stink bug, *Halyomorpha halys*

Western Region priority insect targets
Alfalfa weevil, *Hypera postica*
Emerald ash borer, *Agrilus planipennis*
Soybean aphid, *Aphis glycines*
Mountain pine beetle, *Dendroctonus pondeosa*
European corn borer, *Ostrinia nubilalis*
Grasshoppers

Assessing biological control feasibility. The goal of the canvassing effort was to identify and prioritize new biological control targets. The process chosen worked well for weeds (see below) but was less useful for insect pests. First, there was little consensus across states and Regions on what the top priority targets were. In the Eastern Region, only four insects had more than two states identifying them as pests of primary concern (imported fire ant and Japanese beetle each were listed by four states). In the Western Region, only two insects were listed by more than two states (alfalfa weevil by five states and emerald ash borer by four states) and only four additional insects were listed by at least two states. Emerald ash borer and soybean aphid were the only insects ranked by both Regions. Second, those insects that were identified through the canvassing effort tended to be either old targets that have proven difficult to manage through classical biological control (e.g. alfalfa weevil, Japanese beetle, soybean aphid) or existing targets with significant biological control programs already underway (e.g. IFA, EAB, HWA). As such, the Regional insect priority lists were not evaluated further for their 'suitability' or 'feasibility' as potential new biocontrol targets.

The fact that the canvassing process was less well suited for insect biocontrol targets than weed targets probably should have been anticipated. The detection of a new exotic insect pest typically triggers an immediate assessment of its potential impact, followed closely by a decision to try and eradicate it, develop management options, or do nothing if the risk appears low. Therefore, potential insect biocontrol targets are continually being assessed and needs prioritized. In contrast, the detection of a new exotic plant in the field generally does not trigger an emergency response, and management options are developed more on a wait-and-see, as needed basis. The PPQ Biological Control Leadership Team (Program Managers from HQ, ER, WR and CPHST) is currently reviewing whether a canvassing effort that occurs every five years is appropriate for insects; how to identify insects that initially may have been considered low risks, and thus biological control efforts were never implemented, but later developed into significant pests; and how to identify and prioritize off-shore insect pest threats for biological control.

C. Weeds

Eastern Region priority weed targets	Western Region priority weed targets
Tropical soda apple, *Solanum viarum*	Perennial pepperweed, *Lepidium latifolium*
Cogongrass, *Imperata cylindrica*	Musk thistle, *Carduus nutans*
Common reed, *Phragmites australis*	Common reed, *Phragmites australis*
Giant hogweed, *Heracleum mantegazzianum*	Hawkweeds, *Hieracium* spp.
Canada thistle, *Cirsium arvense*	Canada thistle, *Cirsium arvense*
Multiflora rose, *Rosa multiflora*	Dyer's woad, *Isatis tinctoria*
Japanese knotweed, *Polygonum cuspidatum*	Japanese knotweed, *Polygonum cuspidatum*
Tropical spiderwort, *Commelina benghalensis*	Houndstongue, *Cynoglossum officinale*
Giant salvinia, *Salvinia molesta**	Yellow toadflax, *Linaria vulgaris*
Catclaw mimosa, *Mimosa pigra*	Scotch thistle, *Onopordum acanthium*

*Not included in subsequent analysis since it was already an ongoing PPQ biocontrol program

Assessing biological control feasibility. Weeds identified on the Eastern and Western Regional 'top ten' lists were further evaluated for their 'suitability' or 'feasibility' as potential biocontrol targets. Because of overlap, 16 weeds were evaluated. This was accomplished utilizing a standardized scoring system that assessed each weed on the basis of (1) potential value of biological control for weed management; (2) potential conflicts of biological control agents with nontarget plants and animals; (3) relative status of biological control efforts; and (4) potential for successful biological control implementation (Appendix 2). Scoring was done by a nine-member PPQ 'evaluation group', comprised of representatives from both Regions, CPHST, and PPQ Headquarters who have experience in biocontrol and weed management programs. Feasibility evaluations were also solicited from an external 'advisory panel', comprised of US weed bicontrol experts from across the US. For this group, 20 scientists were invited to participate, and seven eventually contributed to the feasibility analysis.

For each of the 16 weeds, feasibility was assessed by summing all scores (PPQ evaluation group) or calculating an average score (external advisory panel) for each weed. These composite scores were then used to rank all 16 potential weed targets. A ranking score was then calculated using the equation (2*P) + (X), where P is the rank assigned by the PPQ evaluation group and X is the rank assigned by the external advisory panel; rank values range from 1 (highest) to 16 (lowest). The final score was generated by subtracing the actual ranking score for each weed target from the maximum possible ranking score (48).

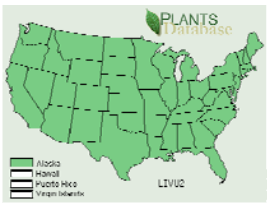
Potential biocontrol target	Score	Rank
Yellow toadflax, *Linaria vulgaris*	44	1
Tropical soda apple, *Solanum viarum*	43	2
Houndstongue, *Cynoglossum officinale*	39	3
Dyer's woad, *Isatis tinctoria*	36	4
Canada thistle, *Cirsium arvense*	31	5
Musk thistle, *Carduus nutans*	31	5
Hawkweed(s), *Hieracium* spp.	24	7
Scotch thistle, *Onopordum acanthium*	22	8
Common reed, *Phragmites australis*	20	9
Japanese knotweed, *Polygonum cuspidatum*	18	10
Perennial pepperweed, *Lepidium latifolium*	16	11
Multiflora rose, *Rosa multiflora*	12	12
Catclaw mimosa, *Mimosa pigra*	9	13
Cogongrass, *Imperata cylindrica*	9	13
Giant hogweed, *Heracleum mantegazzianum*	9	13
Tropical spiderwort, *Commelina benghalensis*	1	16

Narratives for each prospective weed target follow.

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Yellow toadflax (also known as common toadflax, butter-and-eggs, wild snapdragon)
Scientific name: *Linaria vulgaris*
Plant family: Scrophulariaceae

Background: Yellow toadflax is a perennial forb that is native to central and southern Eurasia. It was deliberately introduced into North America as an ornamental, for medicinal purposes, and as a dye plant, beginning in the 17th century. Yellow toadflax escaped from cultivation and has become a widespread weed in a variety of disturbed, somewhat mesic habitats, including pastures, rangeland, forest openings, roadsides, and annual and perennial crops. It is found in every US state except Hawaii, and in every Canadian province. Yellow toadflax is more abundant in the eastern US, but is also a significant pest in the western US; it is listed as a noxious weed in nine western states. Once established, yellow toadflax spreads vegetatively to form dense infestations. It has a deep root system that makes it an effective competitor for water and nutrients, eventually displacing desirable plants. The weed is considered mildly poisonous to most grazing mammals, but it is distasteful and rarely grazed.



Status of classical biological control: Eight deliberately- or accidentally-introduced insects are utilized to varying degrees for biological control of yellow toadflax and the closely-related Dalmatian toadflax (*L. dalmatica*), also invasive in North America. Most of these agents do not effectively control either toadflax species in most of the US. The only effective Dalmatian toadflax biocontrol agent is the stem-mining weevil *Mecinus janthinus* (Coleoptera: Curculionidae). This insect may also utilize yellow toadflax, but it has not been effective as a biocontrol control agent of this weed in the US. It is believed that differences in plant phenology and growth form account for the varying utilization of the two plants.

CABI Bioscience (Delémont, Switzerland) is continuing pre-release research on several prospective toadflax biocontrol agents. The most promising is another stem-mining weevil, *Mecinus heydeni*, which appears to be adapted to yellow toadflax. *Mecinus* weevils kill toadflax shoots; if *M. heydeni* is as effective as *M. janthinus* is on Dalmatian toadflax, it could be a valuable biocontrol agent for yellow toadflax. Another potential yellow toadflax agent is the stem-galling weevil *Rhinusa hispida*. CABI is continuing host specificity testing with these two agents in 2006 and 2007. Even if weevils meet pre-introduction (regulatory) restrictions, neither is likely to be permitted for US release until 2008 at the earliest. This research is being funded by the North American 'toadflax consortium', with contributions from various federal, state, provincial, and local agencies, including PPQ.

Feasibility score: 44 **Feasibility ranking**: **1** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	5	3	5	18
B	4	5	3	5	17
C	4	4	5	5	18
D	5	3	4	5	17
E	4	4	5	4	17
F	4	4	3	4	15
G	5	4	3	4	16
H	4	2	3	4	13
External					
A	5	2	2	4	13
B	3	3	4	3	13
C	4	4	4	4	16
E	3	2	3	4	12
F	5	3	5	3	16

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Tropical soda apple
Scientific name: *Solanum viarum*
Plant family: Solanaceae

Background: Tropical soda apple is a perennial forb or shrub native to South America that was probably accidentally introduced into Florida in the 1960s and 1970s. The plant can spread locally by vegetative reproduction; longer-distance dispersal is accomplished by seeds contained within fleshy fruits. Fruits are consumed and seeds spread by cattle and other mammals; human-induced dispersal also occurs through contaminated vehicles, farm machinery, and hay and other commodities. Since its initial introduction into Florida, tropical soda quickly became an invasive weed and spread rapidly throughout that state and into other southeastern states; more than 500,000 hectares are infested in Florida alone. It is primarily a pest of pastures, but also invades forests and other natural areas, roadsides and right-of-ways, and various agricultural crops. Though livestock can consume fruits, livestock generally avoid tropical soda apple since the plant is spiny and its foliage is unpalatable. This results in significantly reduced carrying capacity in infested pastures. Tropical soda apple also serves as a reservoir for a variety of crop diseases and pest insects. In natural areas, the weed displaces native plants and may serve as a barrier to wildlife movement. Tropical soda apple is a Federal Noxious Weed, and is listed as a noxious weed by at least 13 states.

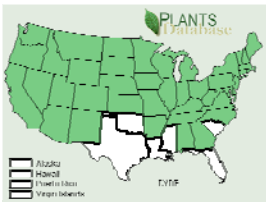
Status of classical biological control: Chemical and cultural control options for tropical soda apple are limited due to the extensive infestations of the weed and its large and persistent seedbank. Beginning in the mid-1990s, USDA-ARS and the University of Florida initiated development of a classical biological control program by conducting natural enemy surveys in South America. A number of promising insect herbivores of tropical soda apple were identified and host specificity experiments conducted. The first biocontrol agent approved for release in the US was the leaf beetle *Gratiana boliviana*, which was first introduced in Florida in 2003. In 2005, PPQ Eastern Region and CPHST began a collaborative project with the University of Florida to rear and distribute G. boliviana throughout infested southeastern states. The beetle has been released in Florida, Alabama, and Georgia.

After biocontrol feasibility analysis, tropical soda apple received a feasibility score of 43 and was the second-highest ranked weed target. However, PPQ initiated a program to implement biological control in 2005 (see above), while the canvassing project was underway. **Thus, we now consider tropical soda apple as the target of an ongoing PPQ biocontrol program and not a potential new weed target, and this weed was removed for further discussion in the current canvassing process.**

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Houndstongue (also known as dog bur, gypsyflower)
Scientific name: *Cynoglossum officinale*
Plant family: Boraginaceae

Background: Houndstongue is a biennial or short-lived perennial forb native to eastern Europe and western Asia that reproduces by seeds. In the 1800s, it was accidentally introduced into North America as a contaminant of crop seeds, and is now a widespread exotic weed in the US and Canada. Houndstongue has been reported from more than 40 states, but is primarily a pest in the western US; it is listed as a noxious weed in six western states. It invades disturbed, dry rangeland, pastures, roadsides, and abandoned crop fields. Houndstongue reproduces by seed, and the barbed fruits are spread by humans and domesticated and wild animals. The fruits themselves may cause skin and eye injuries to livestock and degrade the quality of wool. Houndstongue is also toxic to most domestic grazing mammals. The weed is an effective competitor for scarce water on dry sites and may displace native grasses and forbs.



Status of biological control: Two classical biocontrol agents have been released in Canada: the root-boring weevil *Mogulones cruciger* and the root-feeding flea beetle *Longitarsus quadriguttatus*. However, both were not permitted for US release due to concerns about potential utilization of native US plants. *M. cruciger* is well-established in western Canada and has significantly reduced houndstongue abundance at some sites; future migration into northwestern border states is conceivable.

CABI Bioscience (Delémont, Switzerland) is continuing pre-release research on several prospective biocontrol agents for houndstongue. The most promising potential biocontrol agent for US release is a seed-feeding weevil, *Mogulones borraginis*, which appears to be highly host specific. It is hoped that host-specificity testing with *M. borraginis* can be completed in 2007 so that permits for US release can be sought in 2007 or 2008. This research is being funded by the North American 'houndstongue consortium', with contributions from various federal, state, provincial, and local agencies, including PPQ. Biocontrol efforts against houndstongue are complicated by the presence of three native *Cynoglossum* species, and by a relatively large number of native plants in other, related genera in the family Boraginaceae.

Feasibility score: 39 **Feasibility ranking**: **3** (of 16)

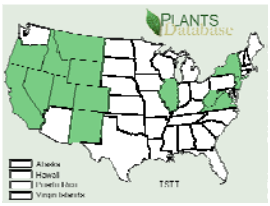
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	2	3	3	**13**
B	3	3	5	4	**15**
C	5	2	3	4	**14**
D	4	3	4	4	**15**
E	4	4	1	2	**11**
F	3	3	5	4	**15**
G	3	3	3	3	**12**
H	4	2	4	4	**14**
External					
A	4	2	3	4	**13**
B	5	4	3.5	4	**16.5**
C	5	1	4	4	**14**
D	5	3	3	5	**16**
E	2	2	3	4	**11**
F	3	1	3	3	**10**

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Dyer's woad
Scientific name: *Isatis tinctoria*
Plant family: Brassicaceae

Background: Dyer's woad is an annual, biennial, or short-lived perennial forb native to central Asia that reproduces by seeds. It was deliberately introduced into North America by European immigrants as a dye and medicinal plant; additional introductions occurred accidentally, via contaminated crop seed. Dyer's woad has become an exotic weed in the US; it has been reported from at least 14 states, but it is primarily a pest in the western US. It is listed as a noxious weed in 11 western states. Dyer's woad infests disturbed and undisturbed rangelands, forests, pastures, roadsides, and a variety of agricultural habitats. The plant produces allelopathic chemicals that enhance its ability to displace other plants. Though it is not believed to be toxic, dyer's woad is distasteful and not eaten by domestic livestock.



Status of biological control: In 2004, CABI Bioscience began a survey for potential dyer's woad biocontrol agents in Europe and Asia. Several interesting insects have been identified, but the survey effort is still in its early stages. This pre-release research project has been funded primarily by county weed districts in Idaho and Utah. At present, there are no classical biocontrol agents available for dyer's woad; it will likely be at least 3-5 years before the CABI effort yields candidate agents for possible release in the US. Possible complications for implementing classical biological control lie in the diverse native flora in the family Brassicaceae, including a number of listed plants.

An endemic fungal pathogen, the rust fungus *Puccinia thlaspeos*, attacks dyer's woad at scattered sites throughout the western US. 'Natural' infestations may reduce growth and seed production and even kill some plants, but generally do not appear to seriously impact dyer's woad populations. Research is currently underway to determine if 'artificial' augmentation of this fungus may enhance its efficacy as a biocontrol agent.

Feasibility score: 36 **Feasibility ranking**: **4** (of 16)

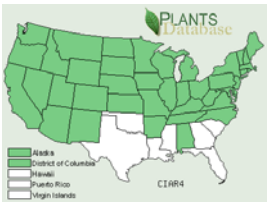
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	4	4	4	5	**17**
B	3	2	3	1	**9**
C	4	4	5	5	**18**
D	4	2	2	3	**11**
E	4	5	5	3	**17**
F	3	2	3	2	**10**
G	4	3	3	3	**13**
H	4	2	2	5	**13**
External					
A	4	4	2	4	**14**
B	4	3	2	3	**12**
C	3	5	2	4	**14**
E	4	3	3	3	**13**
F	5	5	1	3	**14**

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Canada thistle (also known as creeping thistle, California thistle)
Scientific name: *Cirsium arvense*
Plant family: Asteraceae

Background: Canada thistle is a spiny, perennial forb that is apparently native to central Asia; it reproduces vegetatively and by seeds. Canada thistle has been associated with human dispersal since prehistoric times, and became a widespread weed throughout Europe, Asia, and northern Africa. It was probably introduced into North America with European colonization, beginning in the 1600s, as a contaminant of hay, straw, and crop seeds. Canada thistle has become one of the most widespread and damaging exotic weeds in the US, and now occurs in at least 43 states; it is listed as a noxious weed in 31 states. It infests a wide range of annual and perennial crops and almost every type of natural and managed habitat, including grasslands, riparian areas, forest margins, and pastures. Disturbed, somewhat mesic sites are more readily invaded than very dry locations. Canada thistle forms dense monocultures that effectively exploit water, light, and nutrients; this reduces crop yields and displaces native plant species. The weed also has allelopathic properties, and may serve as a reservoir for crop diseases. Because of its spiny leaves and stems, Canada thistle is generally not eaten by domestic livestock or native grazers.



Status of biological control: A classical biological control program targeting Canada thistle in the US was initiated in the 1960s. To date, four Eurasian insects have been introduced as biocontrol agents, though only two have become established in the US (the root-crown weevil *Ceutorhynchus litura* and the stem gall fly *Urophora cardui*). Four accidentally-introduced European thistle-feeding insects and a rust fungus have also been employed as biocontrol agents. Finally, two classical biocontrol agents released against musk thistle have also been utilized against Canada thistle. Though quantitative data are generally lacking, it appears than none of these biocontrol agents effectively controls Canada thistle except on a very local basis. Several of these insects have also been observed attacking native *Cirsium* thistles (e.g. the accidentally-introduced seedhead weevil *Larinus planus* and leaf beetle *Cassida rubiginosa*). Thus, there are currently no reliably-effective biocontrol agents available for Canada thistle management in the US.

CABI Bioscience (Delémont, Switzerland) is continuing research efforts with prospective new biocontrol agents from central Asia and China. However, it appears that most or all of these insects will not be sufficiently host-specific to allow US release. CABI and Canadian researchers are also examining several Eurasian pathogens as possible classical biocontrol efforts. Any efforts to introduce new classical biocontrol agents into the US will be severely restricted by host specificity issues; there are more than 90 native *Cirsium* thistles in the US, and at least nine of these are Federal or state-listed threatened or endangered plants. US and Canadian researchers are studying endemic Canada thistle natural enemies, especially plant pathogens, to determine if any have biocontrol potential. This is probably the most fruitful route for developing new biocontrol tools for Canada thistle management.

Feasibility score: 31 **Feasibility ranking**: **5** (of 16)

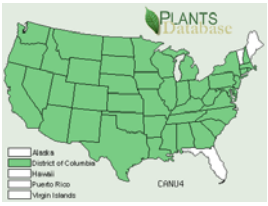
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	2	3	3	13
B	5	1	3	3	12
C	4	1	3	2	10
D	5	1	4	4	14
E	3	2	3	2	10
F	5	3	3	3	14
G	5	2	2	3	12
H	4	4	3	5	16
External					
A	5	1	4	2	12
B	3	4.5	5	2	14.5
C	5	1	1	2	9
D	5	5	1	3	14
E	5	2	2	3	12
F	3	5	1	1	10

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: **Musk thistle** (also known as nodding thistle)
Scientific name: *Carduus nutans* (also known as *Carduus thoermeri*)
Plant family: Asteraceae

Background: Musk thistle is an annual or biennial forb native to Eurasia that reproduces by seeds. It was accidentally introduced into the US beginning in the early 1800s, probably as a contaminant of crop seeds. By the 1950s, musk thistle had become a widespread exotic weed; it is now found in at least 45 states, and is listed as a noxious weed in at least 24 states. Musk thistle may invade undisturbed grassland and rangeland habitats, but more commonly infests overgrazed grasslands and pastures and disturbed areas, such as agricultural fields and roadsides. Musk thistle appears to be adapted to somewhat mesic conditions and does poorly on very wet or very dry sites. The weed outcompetes and displaces native species and other desirable plants. Domestic livestock do not eat the spiny weed and often avoid heavily-infested areas altogether, greatly reducing the carrying capacity of infested sites. Native mammals, birds, and other animals also rarely use the weed. Dense musk thistle infestations may restrict human access in recreational areas.



Status of biological control: Classical biological control efforts targeting musk thistle in the US began in the 1960s, and four European insects have been introduced as biocontrol agents. Only two appear to have become established: the seedhead weevil *Rhinocyllus conicus* and the rosette weevil *Trichosirocalus horridus*. Both agents have been widely distributed in the US, and both have significantly reduced musk thistle densities at some sites. However, neither weevil effectively and predictably controls musk thistle throughout its range; in general, quantitative data describing agent impacts are lacking. *T. horridus* and *R. conicus* have relatively broad host ranges and have been observed attacking native thistles in the genus *Cirsium*. In particular, *R. conicus* has become a symbol of nontarget impacts by weed biocontrol agents, due to its documented utilization of native *Cirsium* species, and is no longer permitted by USDA for intrastate distribution. A rust fungus, *Puccinia carduorum*, was introduced into the US as a biocontrol agent in 1970s, and probably experienced several accidental introductions. This pathogen has become established at scattered locations across the US but does not appear to successfully control musk thistle.

There are two relatively effective biocontrol agents established in the US, but continued distribution of these agents is problematic, especially for the seedhead weevil. Introduction of new musk thistle agents will be a difficult task, primarily due to host specificity issues. Although there are no native *Carduus* species in the US, there are nearly 100 native thistles in the related genus *Cirsium*; this group includes a number of threatened or endangered plants. The negative publicity connected with the musk thistle agent *Rhinocyllus conicus* will certainly increase public skepticism with even the most host-specific potential new biocontrol agent.

Feasibility score: 31 **Feasibility ranking**: **5** (of 16)

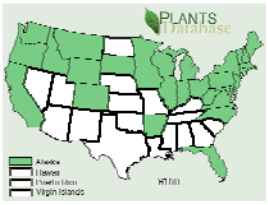
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	3	3	3	14
B	3	1	1	3	8
C	4	2	3	2	11
D	4	2	5	4	15
E	3	5	5	4	17
F	3	3	1	3	10
G	4	3	2	3	12
H	4	2	4	5	15
External					
A	4	1	4	3	12
B	3	5	4.5	4	16.5
C	2	1	1	4	8
E	3	3	3	3	12
F	1	1	5	1	8

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Hawkweeds, primarily **orange hawkweed** (also known as devil's paintbrush)
Scientific name: *Hieracium* spp.; *Hieracium aurantiacum*
Plant family: Asteraceae

Background: Orange hawkweed is a perennial forb native to Europe; local spread occurs vegetatively, by stolons and rhizomes, and long-distance dispersal occurs by seeds. Orange hawkweed was introduced into the US as an ornamental plant, beginning in the early 1800s. It quickly escaped from cultivation and became an exotic weed, especially in the northern tier of states; it is now found in more than 30 states and is listed as a noxious weed in five states. Orange hawkweed infests disturbed mesic grasslands, meadows, forest openings, pastures, and roadsides and right-of-ways. Through vegetative spread, orange hawkweed is able to form large, dense mats that displace almost all other plants. The weed is a very effective competitor for light, water, and nutrients and appears to have allelopathic properties.



Orange hawkweed is the primary invasive hawkweed, but there are other introduced species that are also exotic weeds; their life histories and impacts are similar to those of *H. aurantiacum*. These include meadow hawkweed (*H. caespitosum*) and mouse-ear hawkweed (*H. pilosella*). The situation is further complicated by the fact that introduced hawkweeds can hybridize with each other and, apparently, with native species.

Status of biological control: There are no biological control agents currently available for management of exotic hawkweeds in the US. CABI Bioscience (Delémont, Switzerland) has an ongoing research program developing prospective classical biocontrol agents for invasive hawkweeds, which is funded by New Zealand, Canada, and several federal and state agencies in the US. Five European insects have been approved for release in New Zealand, which has no native *Hieracium* species. However, none of these agents was sufficiently host specific to be considered for US introduction. Research on several additional European insects that might be specific enough to allow US release is ongoing.

Efforts to develop classical biocontrol agents for use in the US will be complicated by the presence of more than 30 native *Hieracium* species throughout the US. These include at least nine state-listed threatened or endangered plants.

Feasibility score: 24 **Feasibility ranking**: **7** (of 16)

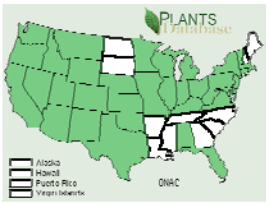
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	3	2	3	3	11
B	3	2	3	3	11
C	4	4	3	4	15
D	4	1	3	4	12
E	4	4	1	2	11
F	3	2	2	3	10
G	4	3	3	3	13
H	3	2	1	4	10
External					
A	4	2	3	3	12
B	5	4	3	3	15
E	2	1	3	3	9
F	3	1	3	1	8

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: **Scotch thistle** (also known as cotton thistle or woolly thistle)
Scientific name: *Onopordum acanthium*
Plant family: Asteraceae

Background: Scotch thistle is an annual, biennial, or short-lived perennial forb that is native to Europe and western Asia. It was introduced into North America as an ornamental and medicinal plant in the 1800s, and then escaped from cultivation to become an exotic weed. Scotch thistle has been found in more than 30 states but is primarily a pest in the western US; it is listed as a noxious weed in 14, primarily western, states. It invades dry and moist rangelands, pastures, fallow agricultural fields, and roadsides and other disturbed areas, and also occurs along rivers, irrigation ditches, and other waterways. With its deep taproot, Scotch thistle is an effective competitor for water and nutrients, and may form dense monocultures. These displace native plants, and the spiny plants severely restrict grazing and water access by livestock and wildlife species. Scotch thistle reproduces only by seeds.



Status of biological control: No Scotch thistle biocontrol agents have been released in the US. Occasionally, the weed is attacked by agents released against musk thistle and other exotic thistles (e.g. the musk thistle seedhead weevil *Rhinocyllus conicus*), but these insects have little or no impact. Scotch thistle is an important exotic weed in Australia, where a number of Eurasian insects have been have been released or are undergoing prerelease research as classical biocontrol agents. However, it appears that the Australian agents are not sufficiently host-specific for US release. USDA-ARS (Montpellier, France) is conducting European and Asian surveys for, and host-specificity testing with, prospective biocontrol agents for use in the US. However, it will be at least three to five years before any agents can be formally evaluated for possible US release. The presence of a large and diverse native thistle flora, primarily in the genus *Cirsium*, will be an obstacle for implementing classical biological control against Scotch thistle and other exotic thistles.

Feasibility score: 22 **Feasibility ranking**: **8** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	2	3	3	13
B	2	2	1	3	8
C	3	2	3	3	11
D	4	2	2	4	12
E	3	4	4	3	14
F	2	2	1	3	8
G	3	2	3	3	11
H	4	3	2	4	13
External					
A	5	2	2	3	12
B	5	4	3	4	16
C	3	2	2	4	11
E	5	3	1	3	12
F	1	1	1	1	4

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Common reed
Scientific name: *Phragmites australis*
Plant family: Poaceae

Background: Common reed is a large perennial grass that spreads locally by vegetative reproduction while producing seeds for long-distance dispersal. It is one of the most widely-distributed plants in the world, and is believed to occur on all continents expect Antarctica. Common reed is a native plant in North America, where it is found throughout the continental US and in Hawaii. It occurs in a variety of coastal and inland habitats characterized by standing water, and grows in areas with saline, brackish, or fresh water. However, the relative abundance of common reed has increased rapidly during the last 50 to 100 years, particularly along the Atlantic coast and in freshwater habitats in the Midwest. In many areas the plant is now considered to be a weed; it is listed as a noxious weed in at least five states. This expansion is believed to be caused by human disturbance of coastal and other wetland habitats and by the introduction of one or more invasive, exotic genotypes from Europe. Though native and exotic reed biotypes may occur in the same area, exotic genotype(s) are believed to be replacing native strains in many areas and it is primarily these non-native genotypes that are weedy. As a weed, common reed displaces other wetland plants and forms monocultures that reduce the diversity of birds and other animal species.

Status of biological control: At present, there are no recognized biological control agents for invasive common reed in the US. North American surveys have identified native and 'accidentally' introduced Eurasian insects that feed on common reed. Research is underway to assess whether these natural enemies can be utilized in some way as biocontrol agents. However, it is too early to tell if any of these efforts will be successful.

CABI Bioscience (Delémont, Switzerland) is conducting surveys and pre-release research to identify possible European insects that might be considered as classical biocontrol agents in the US. Although this work is in its very early stages, it is clear that introducing agents that, in theory, attack 'part' of an otherwise widespread and beneficial native plant will present a considerable environmental and regulatory dilemma. It may be many years before classical biocontrol agents are considered for US release, if they are considered at all.

Feasibility score: 20 **Feasibility ranking**: **9** (of 16)

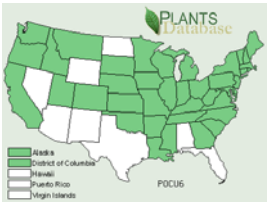
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	2	3	3	13
B	4	2	3	3	12
C	3	3	3	4	13
D	4	1	2	2	9
E	4	3	3	3	13
F	5	3	3	4	15
G	3	3	3	2	11
H	3	3	2	4	12
External					
A	3	1	1	1	6
B	4	3	3	2	12
E	3	1	1	2	7
F	3	1	3	3	10

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Japanese knotweed (also known as Japanese bamboo, Mexican bamboo)
Scientific name: *Polygonum cuspidatum* (also known as *Fallopia japonica*)
Plant family: Polygonaceae

Background: Japanese knotweed is a perennial forb or semi-woody plant native to eastern Asia that reproduces locally via rhizomes and spreads over longer distances by rhizome fragments and seeds. It was introduced to the US as an ornamental, beginning in the nineteenth century, and later planted for erosion control. Since escaping from cultivation, Japanese knotweed has become an exotic weed in the US. It has been observed in at least 40 states, but is primarily a weedy pest in the eastern and midwestern US and the Pacific Northwest; it is listed as a noxious weed in at least seven states. Japanese knotweed is primarily a pest of riparian areas and islands, and the margins of other wetland habitats. It may also infest moist forest margins, roadsides, and urban areas. Japanese knotweed quickly forms dense clonal patches through its early spring growth and rapid rhizomatous spread, and is able to shade out established native riparian and wetland plants and prevent germination of their seeds. Knotweed monocultures provide poor wildlife habitats. The root system may also physically damage roads, trails, dams, and irrigation and flood control structures.



Status of biological control: Currently, there are no biocontrol agents available for management of Japanese knotweed in the US. Preliminary surveys indicate that few endemic insects attack the weed in the US, and these species cause little damage. CABI Bioscience (Delémont, Switzerland) has conducted an initial survey for knotweed natural enemies in Japan, and may soon begin host-specificity testing with several of the most promising insects and pathogens. This work has been largely funded by land management agencies in the UK, where the plant is also a significant pest. An effort to develop a Japanese knotweed 'consortium' has begun in the US, to fund an expanded effort that will develop possible biocontrol agents for release in the US. However, this effort is in its infancy, and it will likely be 5 to 10 years before potential classical biocontrol agents can even be considered for US release. The search for Japanese knotweed biocontrol agents will undoubtedly be complicated by the diverse native flora in the family Polygonaceae. There are more than 40 native US *Polygonum* spp., including about 15 plants that are listed as threatened or endangered, and a number of species that are important wildlife food plants.

Feasibility score: 18 **Feasibility ranking**: **10** (of 16)

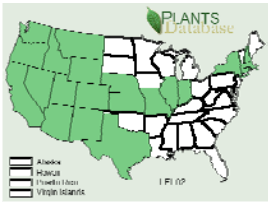
Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	2	2	2	11
B	1	3	1	1	6
C	2	3	2	3	10
D	5	3	1	4	13
E	4	3	1	2	10
F	4	3	1	3	11
G	5	3	2	3	13
H	4	2	1	5	12
External					
A	4	3	2	3	12
B	5	2	2	3	12
F	3	1	3	3	10

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Perennial pepperweed (also known as tall whitetop, ironweed)
Scientific name: *Lepidium latifolium*
Plant family: Brassicaceae

Background: Perennial pepperweed is a perennial forb native to eastern Europe and western Asia that spreads locally via its creeping root system; long-distance dispersal is accomplished by seeds or root fragments. It was accidentally introduced into North America as a contaminant of crop seeds in the early 1900s, and has become an invasive exotic weed in the US. Perennial pepperweed is found in more than 20 states, but is primarily a weedy pest in the western US; it is listed as a noxious weed in 14 primarily western states. Perennial pepperweed infests a variety of habitats, but is primarily associated with moist sites. The weed grows along rivers, lakes, irrigation ditches, wet meadows, estuaries, and other wetland areas. It may also infest mesic rangeland, pastures, hay meadows, agricultural fields, and roadsides. Because of its rapid clonal reproduction, high density, and tall growth form, perennial pepperweed forms dense uniform stands that shade out other plants. It is tolerant of alkaline and saline habitats and can act as a 'salt pump', accumulating salt in its foliage; pepperweed litter increases the soil salt content, which inhibits seed germination and growth of many native plants. Perennial pepperweed is associated with saltcedar in parts of California and Nevada, complicating saltcedar management efforts.



Status of biological control: Presently, there are no biological control agents available for perennial pepperweed management in the US. As a first step in identifying potential classical biocontrol agents for the US, CABI Bioscience (Delémont, Switzerland) has conducted a preliminary survey of perennial pepperweed natural enemies in Russia and China. This effort is currently being expanded to include surveys in other parts of Asia and Europe; the CABI initiative is largely funded by Idaho state agencies. The search for, and development of, possible pepperweed agents is just beginning, and it may require and additional 5 to 10 years before any promising agents are considered for US release. Development of classical biocontrol for perennial pepperweed will undoubtedly be complicated by the diverse native flora in the family Brassicaceae. This includes more than 30 native US species in the genus *Lepidium*, at least four of which are listed by states as threatened or endangered.

Feasibility score: 16 **Feasibility ranking**: **11** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	5	3	3	3	14
B	1	1	1	3	6
C	4	2	3	3	12
D	5	2	2	5	14
E	4	3	1	2	10
F	2	2	1	2	7
G	5	3	2	3	13
H	4	5	1	2	12
External					
A	3	1	1	1	6
B	5	4	2	3.5	14.5
C	4	2	2	4	12
E	5	2	1	4	12
F	3	1	3	3	10

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: **Multiflora rose** (also known as rambler rose)
Scientific name: *Rosa multiflora*
Plant family: Rosaceae

Background: Multiflora rose is a trailing, prickly perennial shrub native to eastern Asia. It reproduces vegetatively, by root sprouts and layering, and also produces fleshy fruits that facilitate seed dispersal by birds and other animals. Multiflora rose was first introduced into the US in the late 1880s as rootstock for ornamental roses. From the 1930s through the 1960s, it was widely planted for erosion control, 'improving' wildlife habitat, and highway landscaping. Multiflora rose quickly escaped from cultivation and has become an invasive exotic weed in the US; it infests an estimated 45 million acres, and is listed as a noxious weed in at least 10 states. It occurs in more than 40 states, but is primarily a weedy pest in eastern and midwestern states. Multiflora rose invades natural grasslands, forests, riparian areas, pastures, abandoned agricultural fields, and fence rows. It forms dense thickets that shade out other plants, restrict human utilization of recreational sites, and limit grazing by domestic livestock and native mammals. Multiflora rose is considered somewhat beneficial, in that many native birds, mammals, and insects consume the fruits and use rose thickets for cover and nesting.

Status of biological control: Several endemic organisms are being evaluated as possible biocontrol agents for multiflora rose. Rose rosette disease (RRD) is caused by a virus or virus-like organism and is vectored by a mite, *Phyllocoptes fructiphilus*, which is probably native to the US. RRD causes stunting and 'witches-brooming' of infected rose plants, which may be severely weakened or killed. RRD now occurs throughout midwestern and eastern states, and appears to be spreading on its own. However, the potential use of RRD as biocontrol agent may be hampered by its ability to infest ornamental and native roses. Two accidentally-introduced insects have been observed attacking multiflora rose in the US. The seed wasp, *Megastigmus aculeatus* var. *nigroflavus*, is a Japanese insect that was introduced along with multiflora rose; it feeds on seeds within developing fruits. The stem girdling beetle, *Agrilus aurichalceus*, is a European native that girdles and often kills rose stems. The host specificity of these insects is not clearly understood.

Classical biological control may not be a viable option for multiflora rose. There are more than 30 native *Rosa* species in the US, and the many species and hybrids of ornamental roses are an extremely valuable horticultural crop throughout the country. Related genera include *Rubus* (cane fruits) and *Fragaria* (strawberries), which contain many native and economically-important crop plants.

Feasibility score: 12 **Feasibility ranking**: **12** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	4	2	3	2	11
B	2	1	1	1	5
C	3	2	2	2	9
D	5	1	2	3	11
E	4	5	5	4	18
F	4	3	1	4	12
G	3	2	3	2	10
H	4	4	2	3	13
External					
A	3	1	2	1	7
B	3	3	2	2	10
E	1	1	1	1	4
F	1	1	1	3	6

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Catclaw mimosa (also known as giant sensitive plant, black mimosa)
Scientific name: *Mimosa pigra*
Plant family: Fabaceae

Background: Catclaw mimosa is a thorny shrub that is native to tropical regions of Mexico, Central America, and South America. It reproduces by seeds, which are dispersed by water or after the fruits are eaten by animals. Catclaw mimosa has been widely introduced throughout tropical areas of the world as an ornamental and forage plant, and it is considered an invasive exotic weed in Australia and parts of Africa and Asia. In these areas, it infests wet forests, marshes, riparian areas, and other wetland habitats, and may also be a weed in pastures and agricultural fields. It forms dense thickets that shade out other plants and restrict human access and utilization by livestock. In the US, catclaw mimosa has been introduced as an ornamental and has escaped from cultivation in subtropical areas of Florida, Texas, and Puerto Rico. Generally, eradication is attempted in the US, though it appears that populations are permanently established in Florida. Catclaw mimosa is listed as a Federal Noxious Weed in the US.

Status of biological control: No biological control agents are currently available for catclaw mimosa management in the US. Even if available, it is uncertain how biocontrol might be successfully incorporated into eradication strategies employed against this weed in the US.

Classical biological control agents from Mexico and South America, including 10 insects and two pathogens, have been released in Australia, and at least five insect species are currently established. Overall, it is too early to assess whether the Australian biocontrol program has provided successful mimosa control. It is not clear if Australian agents, or other classical biocontrol agents, can be utilized in the US. There are no native plants in the genus *Mimosa* or other closely-related genera in Australia. However, there are about 25 native *Mimosa* species in the US, as well as many native species in Mexico and Central America that could be at risk from US introductions. Thus, the host-specificity issues confronting classical biological control in the US will be much more restrictive than those experienced in Australia.

Feasibility score: 9 **Feasibility ranking**: **13** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	1	3	3	3	10
B	1	1	2	5	9
C	2	3	3	4	12
D	3	1	3	2	9
E	4	3	1	2	10
F	3	3	3	3	12
G	3	3	2	3	11
H	3	2	1	4	10
External					
A	1	1	1	3	6
B	3	3	2.5	3	11.5
F	1	3	1	5	10

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Cogongrass
Scientific name: *Imperata cylindrica*
Plant family: Poaceae

Background: Cogongrass is a perennial grass that is native to southeastern Asia; it reproduces vegetatively, via rhizomes, and by seeds. Cogongrass is a widespread exotic weed in tropical and subtropical areas throughout the world. It was accidentally introduced into the US as a contaminant of packing material, and was later deliberately planted as a potential forage grass and for erosion control. Cogongrass is now established in at least nine states, primarily in the southeastern US, and is most abundant in Florida and Mississippi; the US infestation exceeds 25,000 acres and is expanding rapidly. Cogongrass infests a wide range of mesic and dry habitats, including forests, grasslands, pastures, orchards, roadsides, and utility rights-of-way; natural areas and parks are readily invaded. Its dense above- and below-ground growth pattern eliminates most other vegetation at a site. Young cogongrass may be eaten by livestock, but mature foliage is unpalatable. It is highly flammable and greatly increases the risk of fire at infested sites, especially in winter. Cogongrass is a Federal Noxious Weed, and is listed as a noxious weed by at least 10 states.

Status of biological control: There are presently no biological control agents available for cogongrass management in the US. Despite its world-wide pest status, little effort has been to develop classical biological control in other countries. There has been a general reluctance to utilize biocontrol against exotic grasses, due to phylogenic relationships with cereal crops, horticultural species, and native grasses. In the US, surveys of endemic natural enemies have been conducted in southeastern states, and several pathogenic fungi that attack cogongrass have been identified. Ongoing research projects are examining the effectiveness of these pathogens and their potential for utilization as augmentative or inundative biocontrol agents (e.g. use as 'bioherbicides'). The use of endemic cogongrass natural enemies will probably be more fruitful than classical biocontrol; although there are relatively few native grasses closely-related to cogongrass, there are many native grass species that would have to be included in host specificity testing. In addition, it appears that the genus *Imperata* is closely-related to cultivated sugarcane.

Feasibility score: 9 **Feasibility ranking**: **13** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	3	2	3	2	10
B	4	2	1	2	9
C	2	2	2	2	8
D	3	2	1	3	9
E	3	4	1	2	10
F	4	2	1	3	10
G	5	3	2	2	12
H	4	4	1	4	13
External					
A	3	3	2	2	10
B	3	3	2	2	10
F	5	3	1	3	12

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Giant hogweed
Scientific name: *Heracleum mantegazzianum*
Plant family: Apiaceae

Background: Giant hogweed is a perennial forb native to central and southern Asia that reproduces by seeds. It produces spectacular annual growth in the spring and summer, reaching heights of 10-20 feet and producing compound leaves that up to three feet wide and inflorescences that are two or more feet wide. Giant hogweed was planted in the US as an ornamental, and has subsequently escaped from cultivation and become an exotic weed. It is known to occur in at least nine states, is listed as a Federal Noxious Weed, and is classified as a noxious weed by at least 13 states. Giant hogweed typically invades moist sites, including riparian and lakeside habitats, forest edges, wet meadows, vacant lots, and roadsides. Giant hogweed typically grows in dense patches that shade out and replace native wetland plants; this may lead to increased erosion at some sites. The stems and leaves produce a sap containing various toxins, and contact with this liquid can directly lead to severe dermatitis in humans. The sap also induces a photosensitive skin response, which may increase skin lesions when affected individuals are in the sun. Thus, giant hogweed is considered a public health threat; similar skin lesions have also been reported in birds and mammals.

Status of biological control: Currently, there are no biological control agents available for giant hogweed management in the US. Since most infested states are adopting an eradication strategy for this weed, it is uncertain what role, if any, biocontrol can or will play in dealing with hogweed in the US. Clearly, however, adopting a management rather than eradication focus with giant hogweed will significantly increase the value of classical biological control. Hogweed should be considered as a suitable target for classical biocontrol in the US, since other management options are limited and host specificity issues should not be restrictive. There is only a single native congeneric species, the widespread *Heracleum maximum* (cow-parsnip); this plant is listed as endangered in Kentucky, but giant hogweed does not presently occur in the state.

Giant hogweed is also a widespread exotic weed in Europe. Currently, CABI Bioscience (Delémont, Switzerland) has initiated preliminary surveys to identify promising natural enemies in central Asia that might be considered as potential biocontrol agents in Europe. However, US entities are not partnering in or funding these research and development efforts at this time.

Feasibility score: 9 **Feasibility ranking**: **13** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	2	4	2	2	10
B	2	1	1	1	5
C	2	4	4	4	14
D	3	3	2	3	11
E	3	3	1	2	9
F	5	4	1	3	13
G	3	4	2	2	11
H	3	2	1	2	8
External					
A	3	4	1	1	9
B	4	3	1	3	11
F	3	5	1	3	12

Feasibility summary – New weed biocontrol targets
USDA-APHIS-PPQ Biological Control Target Canvassing, 2005-2006

Common name: Tropical spiderwort (also known as Bengal dayflower)
Scientific name: *Commelina benghalensis*
Plant family: Commelinaceae

Background: Tropical spiderwort is native to tropical Asia and Africa, but has become an invasive weed in tropical and subtropical areas throughout the world. The first US introductions are believed to have occurred accidentally, in the 1920s; the weed has become a troublesome pest mainly in the last 20 years. At present, tropical spiderwort occurs in Florida, Georgia, Hawaii, Louisiana, and southern California. The weed is a perennial creeping forb in its native range, but may grow as an annual or perennial in the US. Reproduction occurs by seed and vegetatively. Tropical spiderwort primarily invades intensively-managed annual row crops, including peanuts, tobacco, and cotton. It reduces establishment of young crop plants, lowers yields, and serves as a reservoir for cucumber mosaic virus. Tropical spiderwort is a Federal Noxious Weed, and is listed as a prohibited pest or noxious weed in nine US states.

Status of biological control: There are no classical biological agents available for management of tropical spiderwort in the US or in other parts of the world. It also appears that there are no research efforts aimed at identifying and evaluating prospective biocontrol agents currently underway in the US or elsewhere.

Tropical spiderwort is primarily a pest of annual row crops, habitats which are generally considered inhospitable to classical biological control because of severe and repeated disturbances (e.g. cultivation and insecticide applications). However, agricultural weeds are not, *a priori*, inappropriate for the development of biological control; pathogens (mycoherbicides, for example) may be more suited to these environments than insects.

There are at least four native North American species in the genus *Commelina*, including two that are listed as threatened or endangered by several states.

Feasibility score: 1 **Feasibility ranking**: **16** (of 16)

Scoring from feasibility evaluation panels

Reviewer	Value of BC (1-5)	Potential for conflicts (1-5)	Present status of BC in US (1-5)	Potential for success (1-5)	TOTAL (20)
PPQ					
A	2	3	1	1	**7**
B	2	3	1	1	**7**
C	2	4	1	1	**8**
D	3	4	1	2	**10**
E	3	2	1	2	**8**
F	2	2	1	3	**8**
G	2	4	1	2	**9**
H	5	2	1	2	**10**
External					
A	3	4	1	2	**10**
B	3	3	2	2	**10**
F	1	3	1	1	**6**

Appendix 1. Survey sheet used to identify and 'score' potential biocontrol targets in each state

2005 Biological Control Target Survey (USDA-APHIS-PPQ)

State: _____
Agency or organization represented: _____
Individual responding: _____ Date: _____

Pest organism
Common name _____ Scientific name _____

1. Type of pest (choose one)
- ○ Weed
- ○ Insect or mite
- ○ Plant pathogen
- ○ Nematode
- ○ Other (specify: _____)

2. Origin of pest (choose one) [max. score: 5]	**Score**
○ Exotic (not native to US)	5
○ Native	0

3. Distribution (choose one) [max. score: 6]	
○ *Everywhere*: found in every county	6
○ *Widespread*: found in 75-99% of counties	5
○ *Moderate*: found in 25-75% of counties	3
○ *Limited*: found in more than two counties but less than 25% of counties	2
○ *Very limited*: found only in one or two counties	1

4. Spread (choose one) [max. score: 5]	
○ Long-term, widespread pest problem	5
○ Spreading rapidly in state	4
○ Spreading slowly in state	2
○ New or recent introduction (too early to evaluate rate of spread)	1

5. Economic impacts (choose all that apply) [max. score: 11]	
○ Causes poisoning or physical injury to humans or animals	3
○ Reduces yields in agricultural, livestock, and forestry systems	3
○ Reservoir for plant diseases or insects that attack crops (weeds), or a vector of plant or animal diseases that attack humans, livestock, or crops (insects, mites, nematodes)	2
○ Contaminant of seed, feed, hay, food products, or other commodities	1
○ Interferes with recreation, transportation, irrigation, wildlife, etc.	1
○ Presence or infestation clearly reduces land values	1

6. Ecological impacts (choose all that apply) [max. score: 6]	
○ Known negative impacts on one or more species of concern (threatened or endangered species, other listed species)	3
○ Able to displace and reduce abundance of native plants	1
○ Able to displace and reduce abundance of native animals	1
○ Able to alter site conditions (e.g. change fire frequencies and intensities, change soil chemistry, increase soil erosion, reduce abundance and availability of water)	1

7. Availability of other management tools (choose one) [max. score: 5]	
○ *Poor*: other management tools do not generally work well	5
○ *Moderate*: other control techniques work, but may require intensive or repeated application or may be applicable only over limited areas	3
○ *Good*: easily controlled with pesticides, cultural methods, or mechanical techniques	1

8. State interest (choose all that apply) [max. score: 12]	
○ Listed on a state pest list (e.g. noxious weed list)	2
○ State and local agencies already contributing resources (e.g. funding foreign exploration and research, university research) to the development or delivery of biological control for this pest	4
○ State and local agencies willing to begin or continue contributing funds to biocontrol project	2
○ State and local agencies willing to begin or continue contributing other resources to biocontrol project (personnel, equipment, etc.)	2
○ State and local agencies presently conducting surveys while managing this pest	2

Total possible score: 50

Appendix 2. Form used by PPQ evaluation group and advisory panel to score 'appropriateness' or 'feasibility' of biological control for potential target weeds

Factors considered in feasibility analysis

1. **Value** of biological control for management of this pest

Factors to consider:
- severity of pest problem (number of states infested, economic and ecological impacts)
- availability and efficacy of other pest management tools (e.g. chemical or cultural)
- compatibility of biological control with crop or habitat management practices, aside from pest management

Scoring:
score 1−5 [1 = low value for biological control; 3 = median value for biological control; 5 = very high value for biocontrol]

2. Potential **conflicts** of biological control agents with native plants and animals, or with humans

Factors to consider:
- relatedness of biocontrol target to Federal- and/or state-listed species
- number of closely-related native species
- presence in habitats of concern (e.g. natural areas, parks)
- potential to become a pest of humans or animals

Scoring:
score 1−5 [1 = very high likelihood of conflicts; 3 = median likelihood of conflicts; 5 = very low probability of conflicts]

3. **Status** of biological control project in the US

Factors to consider:
- has pre-release research and development been initiated?
- is one or more agent(s) close to field release or actually released in US?
- have agents been released in other countries?
- likely regulatory environment for potential agents

Scoring:
score 1−5 [1 = biological control project not yet initiated, and ≥ 5 years required before implementation; 3 = biological control project at least in research and development phase, and 1-3 years required before implementation; 5 = one or more biological control agents already permitted for US release, project ready for immediate implementation]

4. **Potential** for successful biological control

Factors to consider:
- stability of infested habitats (e.g. annual cropping systems vs. forests)
- successful projects against related or otherwise similar pests
- successful projects using closely-related biocontrol agents
- successful biocontrol projects in other countries

Scoring:
score 1−5 [1 = lowest potential for success, 3 = median potential for success, and 5 = highest potential for success]

Maximum score: 20, minimum score: 4