Biological Control

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Classical biological weed control involves the introduction and management of selected host-specific natural enemies to reduce and suppress problematic non-native weeds. The majority of the Pacific Northwest's weeds are exotic, originating from other continents. These newly introduced plants, freed from the natural enemies found in their native range, gain a competitive advantage over native plants which allows the introduced plants to become weedy. Once weed populations become well distributed, herbicides, cultural, and mechanical methods of weed control are not always economical or physically possible to meet weed management objectives. Classical weed biological control (biocontrol) is a weed management tool that is inexpensive, self-sustaining, and host-specific and may help reduce the negative impact of weeds, particularly where other control methods are not feasible.

Biocontrol differs from other weed control methods because it does not result in immediate weed population reductions. Successful biological control reduces the competitive ability of target weeds, allowing other plants to successfully compete with and suppress target weed populations through time. Unlike other weed control options, biocontrol rarely causes substantial weed population reductions in the initial year of release; however, successful biocontrol can result in significant, sustained weed reductions over a period of years. In the Pacific Northwest, biocontrol has been successful in controlling Mediterranean sage, St. Johnswort (Klamath weed), tansy ragwort, Dalmatian and yellow toadflax, purple loosestrife, diffuse knapweed, and leafy spurge.

Biocontrol is a slow process, and its efficacy is highly variable. Since it can take several years for biological control agent (BCA) populations to build to levels capable of weed suppression, many BCAs have not been present or studied long enough in the Pacific Northwest to determine their ability to control their host weed. Only after monitoring target weed and BCA populations over time will the impact of newly introduced BCAs become evident.

BCAs impact their target weeds directly and indirectly. They directly impact weeds by destroying plant tissues and interfering with plant functions. BCAs cause indirect impact by increasing stress on the weed, which may reduce its ability to compete with desirable plants.

Biocontrol can be integrated with other management practices to reduce target weed populations. For example, once weeds are weakened by BCAs, seeding or planting competitive species can reduce the availability of light, water, and nutrients to already stressed weed populations. In addition, satellite weed populations can be controlled by herbicides or physical means to reduce weed spread while BCAs attack the primary infestation.

Similar to other weed control methods, biocontrol is not a silver bullet; it will not eradicate all of the target weed since a BCA's survival depends on the presence of its host plant. Therefore, when using BCAs, expect weed populations to persist, but at much lower levels. After target weed populations decrease, populations of BCAs will decrease correspondingly. This is a natural cycle. A resurgence of weed populations may occur due to favorable weather, seed reserves in the soil, host weed plants missed by the BCA, and lagging populations of BCAs. In areas where the BCAs do not provide sufficient control, other weed control methods may need to be integrated to achieve desired results, or a search for additional BCAs may be pursued.

The BCAs released in the Pacific Northwest have been tested to ensure they are host-specific (i.e., they will only feed on the host weed species) and they are regulated by the Animal and Plant Health Inspection Service (APHIS) to ensure that they will not become pests. Host-specificity testing is an expensive and time-consuming task that must be done before a BCA is allowed to be introduced into the United States. Some candidate BCAs, which could be effective in reducing target weed populations, may not be approved for introduction because they are not host-specific enough. A candidate BCA that is not sufficiently host-specific will be rejected for release in the United States to ensure that the BCA, in the absence of its host weed, will not move to crops, native flora, or endangered plant species.

Biocontrol of certain weeds may not work in your area, even if it does elsewhere. BCAs require specific conditions to survive and thrive. Climate variations (e.g., cold winters), plant biotype differences, and nearby insecticidal treatments (e.g., mosquito abatement or agricultural pest insect control) may account for some past biocontrol failures. To maximize success, trained personnel should supervise and monitor biocontrol efforts. To monitor BCAs, the Standardized Impact Monitoring Protocol (SIMP) is recommended. More information on SIMP can be found by accessing iBiocontrol.org.

Once release sites for BCAs have been selected, protecting those areas from disturbance so BCAs can get established is essential. Initial BCA releases often consist of a small number of individual BCAs. Establishing collectable populations of the BCA for redistribution to other weed infestations can take three to five years and is generally the first goal of a new biocontrol program. Care should be taken to ensure that BCAs being collected for redistribution are not diseased or parasitized, as this will reduce their efficacy in the new area. The current status and types

of BCAs used in the Pacific Northwest are found in the tables in this section. It may be necessary to release BCAs over successive years to ensure that the BCAs become established and reach the population levels needed to result in target weed suppression, however it is important to monitor for BCA establishment and densities to avoid unnecessary releases. In addition, BCAs will likely need to be reestablished in areas where disturbances, like wildfire or flooding, may have killed previously established populations. Biocontrol has many advantages but also some disadvantages. Advantages include: reducing herbicide residues in the environment, specificity on target weeds, use in areas with limited accessibility, long-term and self-perpetuating control, low cost per acre, host-finding capabilities, synchronizing BCAs to hosts weeds' life cycles, and the unlikelihood that host weeds will develop resistance to BCAs. Disadvantages of biocontrol include: the limited availability of BCAs from their native lands, the dependence of control on plant density, the slow rate at which control occurs and uncertainty of the level of control, biotype or climate matching, and host-specificity when host populations are low.

Biocontrol programs require consistent funding, expertise, and interdisciplinary cooperation. Biocontrol of weeds is not a perfect solution for all weed management programs. It can, however, be effective as an additional tool in combination with other weed management methods. Interdisciplinary vegetation management teams are working strategically to find the best single or combination of weed control tools to minimize adverse environmental and socioeconomic impacts.

If you are considering importing BCAs from another state, be aware that federal interstate transport permits may be required. For more information, contact your state weed biocontrol specialist or nearest USDA APHIS PPQ office, or visit USDA APHIS PPQ Biocontrol Permits. Permits for approved BCAs are free but take time to review and issue so it is best to apply well before your anticipated ship date.

Anyone who implements classical biological weed control is encouraged to follow the International Code of Best Practices for Classical Biological Control of Weeds, adopted by the delegates at the 1999 International Symposium on Biological Control of Weeds. Briefly, the key guidelines for biocontrol implementation includes:

- *Releasing only safe and approved BCAs.*
- *Using the most effective BCAs.*
- *Documenting releases. State agencies can provide release forms and appreciate receiving release information for their records.*
- *Releasing only the intended target BCA by thoroughly removing all other insects and plants from collecting material.*
- *Stopping releases of ineffective BCA, or when control is achieved.*
- *Monitoring for impacts on the host weed, non-target species, and the environment.*

As highlighted in the code of best practices, do not use non-APHIS approved natural enemies as BCAs because unapproved natural enemies have the potential to cause negative nontarget impacts. Examples include accidentally introduced species such as Larinus carlinae (formerly L. planus, Canada thistle weevil), Mogulones crucifer (houndstongue root weevil), Chaetorellia succinea (yellow starthistle seedhead fly), Coniatus splendidulus (splendid tamarisk weevil), and Cassida rubiginosa (thistle tortoise beetle). In addition, BCAs against weedy thistle species (Rhinocyllus conicus and Trichosirocalus horridus) are no longer approved for interstate shipment because of concerns over potential impacts to native thistles. As of 2009, USDA APHIS suspended all permits for the interstate movement of the saltcedar beetle, Diorhabda spp.

The following tables contain lists of target weeds, and the current status of selected BCAs by state. Detailed information about these weeds and their associated biocontrol agents can be found in NAISMA's Weed Biocontrol Fact Sheets. For additional information about accessing, using, and monitoring BCAs, contact your state department of agriculture or land-grant university.

Current Status of Biological Weed Control Agents in Idaho, Oregon, and Washington

Weed	Biocontrol Agent	Oregon				Washington				Idaho			
		Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]
Bindweed, field (*Convolvulus arvensis*)	*Aceria malherbae*	L	M	F	L	L	M	F	M	L	L	F	L
	Tyta luctuosa	L	L	P	U	U	U	U	U	L	L	U	L
Broom, French (*Genista monspessulana*)	*Bruchidius villosus*	W	H	G	M	—	—	—	—	—	—	—	—
Broom, Scotch (*Cytisus scoparius*)	*Bruchidius villosus*	W	H	G	M	W	H	G	M	L	U	U	U
	Exapion fuscirostre	W	H	G	M	W	M	G	L	L	U	U	U
	Leucoptera spartifoliella	W	M	P	L	L	M	P	L	—	—	—	—
Crupina, common (*Crupina vulgaris*)	*Ramularia crupinae**	U	U	U	U	—	—	—	—	U	U	U	U
Gorse (*Ulex europaeus*)	*Exapion ulicis*	W	H	G	M	M	H	F	L	—	—	—	—
	*Sericothrips staphylinus**	L	U	U	L	L	U	U	L	—	—	—	—
	Tetranychus lintearius	W	L	P	L	W	L	P	L	—	—	—	—
Hawkweeds (mouse-ear [*Pilosella officinarum*]; orange [*P. aurantiaca*]; whiplash [*P. flagellaris*])	*Aulacidea subterminalis**	—	—	—	—	U	U	U	U	—	—	—	—
	*Cheilosia urbana**	—	—	—	—	—	—	—	—	—	—	—	—
Hemlock, poison (*Conium maculatum*)	*Agonopterix alstroemeriana*	W	L	P	M	W	L	P	L	L	L	P	L
Knapweed, diffuse (*Centaurea diffusa*)	*Agapeta zoegana*	W	U	U	L	L	U	U	L	U	U	U	U
	Bangasternus fausti	W	H	G	M	W	H	G	M	L	L	F	L
	Chaetorellia acrolophi	U	U	U	U	U	U	U	U	U	U	U	U
	Cyphocleonus achates	W	L	F	M	W	M	G	L	L	M	G	M
	Larinus minutus	W	H	E	M	W	H	E	M	W	H	E	M
	Larinus obtusus	U	U	U	U	U	U	U	U	U	U	U	U
	Metzneria paucipunctella	U	U	U	U	U	U	U	U	U	U	U	U
	Pterolonche inspersa	L	L	L	U	F	—	—	—	F	—	—	—
	Sphenoptera jugoslavica	W	H	G	L	W	H	G	M	W	H	G	M
	Terellia virens	U	U	U	U	U	U	U	U	U	U	U	U

Weed	Biocontrol Agent	Oregon				Washington				Idaho			
		Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]
	Urophora affinis	W	H	G	M	W	H	G	M	W	H	G	M
	Urophora quadrifasciata	W	H	G	M	W	H	G	M	W	H	G	M
Knapweed, meadow (*Centaurea* x *moncktonii*; = *C. debeauxii* subsp. *grandiflora*; *C. jacea* nothosubsp. *pratensis*)	*Larinus minutus*	L	M	F	L	L	M	F	L	—	—	—	—
	Larinus obtusus	W	H	G	M	W	H	G	M	—	—	—	—
	Urophora quadrifasciata	W	L	F	L	L	M	F	L	—	—	—	—
Knapweed, Russian (*Rhaponticum repens*; = *Acroptilon repens*)	*Aulacidea acroptilonica*	W	H	F	M	W	H	G	M	W	M	F	M
	Jaapiella ivannikovi	W	L	P	M	W	M	F	M	L	M	F	L
	Mesoanguina picridis (formerly *Subanguina picridis*)	L	U	U	U	F	—	—	—	U	U	U	U
Knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*; = *C. virgata*; = *C. squarrosa)*	*Bangasternus fausti*	—	—	—	—	—	—	—	—	U	U	U	U
	Cyphocleonus achates	—	—	—	—	—	—	—	—	U	U	U	U
	Larinus minutus	—	—	—	—	—	—	—	—	U	U	U	U
	Sphenoptera jugoslavica	—	—	—	—	—	—	—	—	U	U	U	U
	Urophora affinis	—	—	—	—	—	—	—	—	U	U	U	U
	Urophora quadrifasciata	—	—	—	—	—	—	—	—	U	U	U	U
Knapweed, spotted (*Centaurea stoebe*; = *C. stoebe* ssp. *micranthos*)	*Agapeta zoegana*	L	H	G	U	L	M	U	L	W	M	U	L
	Bangasternus fausti	W	L	G	M	L	L	U	L	L	U	U	L
	Chaetorellia acrolophi	L	L	F	L	L	L	U	L	L	L	U	L
	Cyphocleonus achates	W	M	F	M	L	M	F	L	L	M	G	M
	Larinus minutus	W	H	E	M	W	H	E	M	W	H	E	M
	Larinus obtusus	W	H	E	M	W	H	E	M	L	M	F	L
	Metzneria paucipunctella	W	L	F	L	W	L	F	L	W	H	G	M
	Sphenoptera jugoslavica	W	H	G	L	W	H	G	M	L	L	P	L
	Terellia virens	L	M	G	L	L	U	U	U	L	U	U	U
	Urophora affinis	W	M	G	M	W	H	G	M	W	H	G	M
	Urophora quadrifasciata	W	H	G	M	W	H	G	M	W	H	G	M
Knotweed, giant (*Reynoutria sachalinensis*; = *Polygonum sachalinense*; = *Fallopia sachalinensis*)	*Aphalara itadori** – Hokkaido strain	U	U	U	L	U	U	U	L	—	—	—	—
Knotweed, Japanese	*Aphalara itadori** – Kyushu	L	U	U	L	U	U	U	L	U	U	U	L

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(*Reynoutria japonica*; = *Polygonum cuspidatum*; = *Fallopia japonica*); **Bohemian** (*Reynoutria x bohemica*; = *Polygonum* x *bohemicum*; = *Fallopia* x *bohemica*)	strain												
Knotweed, Japanese (*Reynoutria japonica*; = *Polygonum cuspidatum*; = *Fallopia japonica*); **Bohemian** (*Reynoutria x bohemica*; = *Polygonum* x *bohemicum*; = *Fallopia* x *bohemica*)	*Aphalara itadori** – Murakami strain	U	U	U	L	U	U	U	L	—	—	—	—
Loosestrife, purple (*Lythrum salicaria*)	*Galerucella calmariensis*	W	H	E	M	W	H	E	M	W	H	E	M
	Galerucella pusilla	W	H	E	M	W	H	E	M	W	H	E	M
	Hylobius transversovittatus	W	H	G	L	L	M	F	L	L	L	F	L
	Nanophyes marmoratus	W	M	F	M	L	M	F	M	W	L	F	M
Puncturevine (*Tribulus terrestris*)	*Microlarinus lareynii**	L	L	P	L	L	L	P	U	L	L	P	U
	*Microlarinus lypriformis**	F	—	—	—	U	U	U	U	L	L	P	U
Ragwort, tansy (*Jacobaea vulgaris; = Senecio jacobaea*)	*Botanophila seneciella*	W	S	P	L	W	H	G	M	L	L	F	U
	Longitarsus jacobaeae	W	H	E	M	W	H	E	M	W	H	G	L
	*Tyria jacobaeae**	W	H	E	M	W	H	G	M	—	—	—	N
Sage, Mediterranean (*Salvia aethiopis*)	*Phrydiuchus tau*	W	H	G	L	L	M	L	N	W	H	G	M
St. Johnswort (*Hypericum perforatum*)	*Agrilus hyperici*	L	H	E	L	L	M	U	L	W	H	E	M
	Aplocera plagiata	W	M	P	M	L	M	U	L	W	M	F	M
	Chrysolina hyperici	W	H	G	L	W	H	E	M	W	H	E	M
	Chrysolina quadrigemina	W	H	G	L	W	H	E	M	W	H	E	M
Saltcedar (*Tamarix chinensis, T. parviflora, T. ramosissima*)	*Diorhabda* spp.*	W	M	F	L	—	U	—	U	L	H	G	L
Skeletonweed, rush (*Chondrilla juncea*)	*Aceria chondrillae* (formerly *Eriophyes chondrillae*)	W	H	E	M	W	H	G	M	W	H	E	M
	Bradyrrhoa gilveolella	L	S	U	U	U	U	U	U	L	M	G	L

Weed	Biocontrol Agent	Oregon				Washington				Idaho			
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	Cystiphora schmidti	W	H	G	M	W	H	G	M	W	H	E	M
	*Puccinia chondrillina**	W	M	G	L	W	H	G	M	W	H	G	M
Spurge, leafy (*Euphorbia virgata; = E. esula*)	*Aphthona cyparissiae*	L	H	E	L	L	M	F	L	L	L	G	M
	Aphthona czwalinai	L	H	E	M	L	L	U	U	L	L	G	M
	Aphthona flava	L	H	F	L	L	M	F	L	L	L	G	M
	Aphthona lacertosa	W	H	E	M	L	M	U	L	W	H	E	M
	Aphthona nigriscutis	W	H	E	M	L	M	F	U	W	H	E	M
	Hyles euphorbiae	F	—	—	—	—	—	—	—	W	M	G	M
	Oberea erythrocephala	W	L	G	M	L	U	U	U	W	H	E	M
Starthistle, yellow (*Centaurea solstitialis*)	*Bangasternus orientalis*	W	L	P	L	W	L	P	L	W	L	P	M
	*Ceratapion basicorne**	—	—	—	—	—	—	—	—	U	U	U	L
	Chaetorellia australis	W	H	E	M	W	M	G	M	W	M	G	M
	Eustenopus villosus	W	H	E	M	W	H	E	M	W	H	E	M
	Larinus curtus	W	H	E	M	W	M	F	L	W	H	E	M
	Puccinia jacea var. *solstitialis**	L	S	U	U	U	U	U	U	U	U	U	U
	Urophora sirunaseva	W	L	P	L	W	L	U	L	W	L	U	L
Thistle, bull (*Cirsium vulgare*)	*Cheilosia grossa* (formerly *C. corydon*)	W	U	U	L	W	M	L	U	U	U	U	L
	*Rhinocyllus conicus**	W	M	F	N	W	L	L	N	W	M	F	N
	*Trichosirocalus horridus**	L	U	U	N	U	U	U	N	L	L	U	N
	Urophora stylata	W	H	G	M	L	M	F	L	L	L	U	L
Thistle, Canada (*Cirsium arvense*)	*Hadroplontus litura* (formerly *Ceutorhynchus litura*)	L	H	P	U	L	M	P	L	L	L	F	L
	*Puccinia punctiformis**	L	H	G	U	U	U	U	U	L	L	L	U
	*Rhinocyllus conicus**	W	H	F	N	W	H	P	N	W	F	F	N
	Urophora cardui	W	H	P	M	W	H	P	M	L	M	F	M
Thistle, Italian (*Carduus pycnocephalus*)	*Cheilosia grossa* (formerly *C. corydon*)	W	H	L	L	—	—	—	N	—	—	—	N
	*Rhinocyllus conicus**	W	H	G	N	—	—	—	N	L	H	G	N
	*Trichosirocalus horridus**	W	H	U	N	—	—	—	N	L	L	U	N

Weed	Biocontrol Agent	Oregon				Washington				Idaho			
		Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]
Thistle, milk (*Silybum marianum*)	*Rhinocyllus conicus**	W	H	G	N	—	—	—	N	—	—	—	—
Thistle, musk (*Carduus nutans*)	*Cheilosia grossa* (formerly *C. corydon*)	W	U	U	L	U	U	U	U	U	U	U	U
	*Rhinocyllus conicus**	W	H	G	N	W	H	G	N	W	H	G	N
	*Trichosirocalus horridus**	L	M	G	N	—	—	—	N	L	M	G	N
Thistle, plumeless (*Carduus acanthoides*)	*Cheilosia grossa* (formerly *C. corydon*)	—	U	U	U	U	U	U	U	U	U	U	U
	*Rhinocyllus conicus**	L	H	G	N	W	H	G	N	W	H	G	N
	*Trichosirocalus horridus**	U	U	U	U	L	L	U	N	L	L	U	N
Thistle, slenderflower (*Carduus tenuiflorus*)	*Cheilosia grossa* (formerly *C. corydon*)	W	M	F	M	L	U	U	N	—	—	—	—
	*Rhinocyllus conicus**	W	H	G	N	—	—	—	N	—	—	—	—
	*Trichosirocalus horridus**	W	H	F	N	—	—	—	N	—	—	—	—
Toadflax, Dalmatian (*Linaria dalmatica*)	*Brachypterolus pulicarius*	W	M	P	M	W	M	P	M	W	H	E	M
	Calophasia lunula	L	L	P	U	W	M	P	U	W	L	U	L
	Mecinus janthiniformis (formerly *M. janthinus*)	W	H	E	M	W	H	E	M	W	H	E	M
	Rhinusa spp.	W	U	U	L	W	U	U	L	U	U	U	U
Toadflax, yellow (*Linaria vulgaris*)	*Brachypterolus pulicarius*	L	M	F	L	L	M	F	L	L	M	P	L
	Calophasia lunula	L	U	U	U	L	U	U	U	L	M	F	L
	Rhinusa spp.	W	M	U	L	L	M	U	L	L	M	U	L
	*Rhinusa pilosa**	U	U	U	U	—	—	—	—	U	U	U	L
	Mecinus janthinus	L	H	E	L	L	M	U	U	W	H	E	L
Watermilfoil, Eurasian (*Myriophyllum spicatum*)	*Euhrychiopsis lecontei**	L	L	U	U	W	M	F	U	W	L	F	L
Whitetop or hoary cress (*Lepidium draba*)	*Aceria drabae**	—	—	—	—	—	—	—	—	U	U	U	L

[1] Distribution within host range: W = widespread; L = limited sites; F = failed to establish; U = unknown status; — = not released

[2] Attack rate host: H = heavy (> 70%); M = medium (> 30%); L = light (> 10%); S = slight (< 1%); U = unknown status

[3] Control ability on seeds and/or plant density: E = excellent; G = good; F = fair; P = poor; U = undetermined

[4] Availability for redistribution: M = mass collections; L = limited (Limited availability indicates biocontrol agent populations are slow in building or are recently introduced. Work on these species should be coordinated through biological control specialists at the state department of agriculture or state university); U = unavailable; N = not recommended. These biocontrol agents may attack native species and interstate shipments are no longer permitted.

Weed	Biocontrol Agent	Oregon				Washington				Idaho			
		Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]	Distribution[1]	Attack Rate[2]	Control[3]	Availability[4]

* Indicates biocontrol agents where redistribution limitations may apply. See Table 2 for additional information.

Biological Control Agents and Their Roles

Classical biological control agents introduced into the Pacific Northwest for the management of weeds and the general role of each biocontrol species.
HIGHLIGHTED SPECIES (GREY) ARE NOT APPROVED BY USDA-APHIS FOR INTERSTATE COLLECTION AND RE-DISTRIBUTION.

Biocontrol Agent	Role	Weed Species
Aceria chondrillae (formerly *Eriophyes chondrillae*)	bud gall mite	Skeletonweed, rush (*Chondrilla juncea*)
Aceria drabae [F]	gall mite	Whitetop or hoary cress (*Lepidium draba*)
Aceria malherbae	bud/leaf gall mite	Bindweed, field (*Convolvulus arvensis*)
Agapeta zoegana	root-boring moth	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*; knapweed, diffuse (*Centaurea diffusa*)
Agonopterix alstroemeriana	defoliating moth	Hemlock, poison (*Conium maculatum*)
Agrilus hyperici	root-boring beetle	St. Johnswort (*Hypericum perforatum*)
Aphalara itadori [F] – Hokkaido strain	sap-sucking psyllid	Knotweed, giant (*Reynoutria sachalinensis; = Polygonum sachalinense; = Fallopia sachalinensis*)
Aphalara itadori [F] – Kyushu strain	sap-sucking psyllid	Knotweed, Japanese (*Reynoutria japonica; = Polygonum cuspidatum; = Fallopia japonica*); *Bohemian* (*Reynoutria x bohemica; = Polygonum x bohemicum; = Fallopia* x *bohemica*)
Aphalara itadori [F] – Murakami strain	sap-sucking psyllid	Knotweed, Japanese (*Reynoutria japonica; = Polygonum cuspidatum; = Fallopia japonica*); *Bohemian* (*Reynoutria x bohemica; = Polygonum x bohemicum; = Fallopia* x *bohemica*)
Aphthona cyparissiae	root/defoliating flea beetle	Spurge, leafy (*Euphorbia virgata; = E. esula*)
Aphthona czwalinai	root/defoliating flea beetle	Spurge, leafy (*Euphorbia virgata; = E. esula*)
Aphthona flava	root/defoliating flea beetle	Spurge, leafy (*Euphorbia virgata; = E. esula*)
Aphthona lacertosa	root/defoliating flea beetle	Spurge, leafy (*Euphorbia virgata; = E. esula*)

Biocontrol Agent	Role	Weed Species
Aphthona nigriscutis	root/defoliating flea beetle	Spurge, leafy (*Euphorbia virgata; = E. esula*)
Aplocera plagiata	defoliating moth	St. Johnswort (*Hypericum perforatum*)
Aulacidea acroptilonica	gall wasp	Knapweed, Russian (*Rhaponticum repens; = Acroptilon repens*)
Aulacidea subterminalis [F]	gall wasp	Hawkweeds (mouse-ear [*Pilosella officinarum*]; orange [*P. aurantiaca*]; whiplash [*P. flagellaris*])
Bangasternus fausti	seed head weevil	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Bangasternus orientalis	seed head weevil	Starthistle, yellow (*Centaurea solstitialis*)
Botanophila seneciella	seed head fly	Ragwort, tansy (*Jacobaea vulgaris; = Senecio jacobaea*)
Brachypterolus pulicarius	flower beetle	Toadflax, yellow (*Linaria vulgaris*); toadflax, Dalmatian (*L. dalmatica*)
Bradyrrhoa gilveolella	root-boring moth	Skeletonweed, rush (*Chondrilla juncea*)
Bruchidius villosus	seed beetle	Broom, Scotch (*Cytisus scoparius*); broom, French (*Genista monspessulana*)
Calophasia lunula	defoliating moth	Toadflax, Dalmatian (*L. dalmatica*); toadflax, yellow (*Linaria vulgaris*)
Ceratapion basicorne [F]	root crown weevil	Starthistle, yellow (*Centaurea solstitialis*)
Chaetorellia acrolophi	seed head fly	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*)
Chaetorellia australis	seed head fly	Starthistle, yellow (*Centaurea solstitialis*)
Cheilosia grossa (formerly *C. corydon*)	stem fly	Thistle, slenderflower (*Carduus tenuiflorus*); thistle, Italian (*C. pycnocephalus*); thistle, bull (*Cirsium vulgare*); thistle, musk (*Carduus nutans*)
Cheilosia urbana [F]	root-boring fly	Hawkweeds (*Pilosella aurantiaca, P. caespitosa, P. flagellaris, P. floribunda, P. glomerata, P. officinarum, P. piloselloides*)
Chrysolina hyperici	defoliating beetle	St. Johnswort (*Hypericum perforatum*)
Chrysolina quadrigemina	defoliating beetle	St. Johnswort (*Hypericum perforatum*)
Cyphocleonus achates	root-boring/gall weevil	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Cystiphora schmidti	stem/leaf gall midge	Skeletonweed, rush (*Chondrilla juncea*)
Diorhabda spp. [C]	leaf beetle	Saltcedar (*Tamarix chinensis, T. parviflora, T. ramosissima*)
Euhrychiopsis lecontei [E]	stem weevil	Watermilfoil, Eurasian (*Myriophyllum spicatum*)

Biocontrol Agent	Role	Weed Species
Eustenopus villosus	seed head weevil	Starthistle, yellow (*Centaurea solstitialis*)
Exapion fuscirostre	seed weevil	Broom, Scotch (*Cytisus scoparius*)
Exapion ulicis	seed weevil	Gorse (*Ulex europaeus*)
Galerucella calmariensis	leaf beetle	Loosestrife, purple (*Lythrum salicaria*)
Galerucella pusilla	leaf beetle	Loosestrife, purple (*Lythrum salicaria*)
Hadroplontus litura (formerly *Ceutorhynchus litura*)	crown/stem-mining weevil	Thistle, Canada (*Cirsium arvense*)
Hyles euphorbiae	defoliating moth	Spurge, leafy (*Euphorbia virgata; = E. esula*)
Hylobius transversovittatus	root-boring weevil	Loosestrife, purple (*Lythrum salicaria*)
Jaapiella ivannikovi	shoot tip gall midge	Knapweed, Russian (*Rhaponticum repens*; = *Acroptilon repens*)
Larinus curtus [D]	seed head weevil	Starthistle, yellow (*Centaurea solstitialis*)
Larinus minutus	seed head weevil	Knapweed, spotted (*Centaurea stoebe*; = *C. stoebe* ssp. *micranthos*); knapweed, meadow (*C. debeauxii* subsp. *grandiflora*; *C. jacea* nothosubsp. *pratensis*)); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Larinus obtusus	seed head weevil	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, meadow (*C. debeauxii* subsp. *grandiflora*; *C. jacea* nothosubsp. *pratensis*)
Leucoptera spartifoliella	twig mining moth	Broom, Scotch (*Cytisus scoparius*)
Longitarsus jacobaeae	root/defoliating flea beetle	Ragwort, tansy (*Jacobaea vulgaris*; = *Senecio jacobaea*)
Mecinus janthiniformis (formerly *M. janthinus*)	stem-boring weevil	Toadflax, Dalmatian (*Linaria dalmatica*)
Mecinus janthinus	stem-boring weevil	Toadflax, yellow (*Linaria vulgaris*)
Mesoanguina picridis (formerly *Subanguina picridis*)	stem/leaf gall nematode	Knapweed, Russian (*Rhaponticum repens*; = *Acroptilon repens*)
Metzneria paucipunctella	seed head moth	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, diffuse (*C. diffusa*)
Microlarinus lareynii [G]	seed weevil	Puncturevine (*Tribulus terrestris*)
Microlarinus lypriformis [G]	stem weevil	Puncturevine (*Tribulus terrestris*)
Nanophyes marmoratus	flower bud weevil	Loosestrife, purple (*Lythrum salicaria*)
Oberea erythrocephala	stem-boring beetle	Spurge, leafy (*Euphorbia virgata*; = *E. esula*)
Phrydiuchus tau	crown/root weevil	Sage, Mediterranean (*Salvia aethiopis*)
Pterolonche inspersa	root-boring moth	Knapweed, diffuse (*Centaurea diffusa*)
Puccinia chondrillina [H]	rust fungus	Skeletonweed, rush (*Chondrilla juncea*)

Biocontrol Agent	Role	Weed Species
Puccinia jacea var. *solstitialis* [H]	rust fungus	Starthistle, yellow (*Centaurea solstitialis*)
Puccinia punctiformis [H]	rust fungus	Thistle, Canada (*Cirsium arvense*)
Ramularia crupinae [H]	fungus	Crupina, common (*Crupina vulgaris*)
Rhinocyllus conicus [A]	seed head weevil	Thistle, slenderflower (*Carduus tenuiflorus*); thistle, plumeless (*C. acanthoides*); thistle, musk (*C. nutans*); thistle, milk (*Silybum marianum*); thistle, Italian (*C. pycnocephalus*); thistle, Canada (*Cirsium arvense*)
Rhinusa spp.	seed head weevil	Toadflax, Dalmatian (*L. dalmatica*); toadflax, yellow (*Linaria vulgaris*)
Rhinusa pilosa [F]	shoot-galling weevil	Toadflax, yellow (*Linaria vulgaris*)
Sericothrips staphylinus [F]	leaf thrips	Gorse (*Ulex europaeus*)
Sphenoptera jugoslavica	root-boring/gall beetle	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Terellia virens	seed head fly	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*)
Tetranychus lintearius	spider mite	Gorse (*Ulex europaeus*)
Trichosirocalus horridus [A]	root/crown weevil	Thistle, slenderflower (*Carduus tenuiflorus*); thistle, plumeless (*C. acanthoides*); thistle, musk (*C. nutans*); thistle, Italian (*C. pycnocephalus*); thistle, bull (*Cirsium vulgare*)
Tyria jacobaeae [B]	defoliating moth	Ragwort, tansy (*Jacobaea vulgaris; = Senecio jacobaea*)
Tyta luctuosa	defoliating moth	Bindweed, field (*Convolvulus arvensis*)
Urophora affinis	seed head gall fly	Knapweed, spotted (*Centaurea stoebe; = C. stoebe* ssp. *micranthos*); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Urophora cardui	stem gall fly	Thistle, Canada (*Cirsium arvense*)
Urophora quadrifasciata	seed head gall fly	Knapweed, spotted (*Centaurea stoebe*; = *C. stoebe* ssp. *micranthos*); knapweed, meadow (*C. debeauxii* subsp. *grandiflora*; *C. jacea* nothosubsp. *pratensis*); knapweed, diffuse (*C. diffusa*); knapweed, squarrose (*Centaurea virgata* subsp. *squarrosa*)
Urophora sirunaseva	seed head gall fly	Starthistle, yellow (*Centaurea solstitialis*)
Urophora stylata	seed head gall fly	Thistle, bull (*Cirsium vulgare*)

[A] *Rhinocyllus conicus* and *Trichosirocalus horridus* are not recommended. They attack native thistles and interstate permits are suspended.

[B] *Tyria jacobaeae* is not recommended east of the Cascades, particularly in Idaho. It attacks several native plant species.

[C] Interstate permits are suspended for *Diorhabda* spp.

[D] *Larinus curtus* may be infected with a disease that can reduce insect populations. It should not be redistributed to avoid spreading the disease to healthy *L. curtus* populations.

[E] *Euhrychiopsis lecontei* is a native insect, and thus, not a classical biological control agent. The weevil is co-evolved with native milfoil, *Myriophyllum sibiricum*, but also attacks Eurasian watermilfoil, *M. spicatum*. It is naturally-occurring at many lakes in the Pacific Northwest but is not currently available for

Biocontrol Agent	Role	Weed Species

redistribution.

[F] *Aceria drabae*, *Aphalara itadori*, *Aulacidea subterminalis*, *Ceratapion basicorne*, *Cheilosia urbana*, *Rhinusa pilosa*, and *Sericothrips staphylinus* are new biocontrol agents that are still undergoing testing and establishment. It is unclear when they will be available for widespread distribution or how effective they will be on their host plant.

[G] Puncturevine weevils (*Microlarinus lareynii* and *M. lypriformis*) cannot survive cold winters in the Pacific Northwest and do not sustain large enough populations to provide adequate control.

[H] Special research permits are currently required for all pathogen biocontrol agent distribution. It is illegal to redistribute pathogens, both inter- and intrastate, without a permit.