

Approved and effective biological control agent site preferences, collection, and mode of impact:

Acroptilon repens (Russian Knapweed)

Aulucidea acroptilonica, a gall wasp, overwinters in the larval stage emerging in the spring, mate, and oviposit in the meristematic tissue where the larvae create a gall and undergo their entire life cycle, pupating in early spring.

Jaapiella ivannikovi, a gall midge, overwinters in the pupal stage inside galls which are caused by larval feeding. The feeding in turn causes stunted growth of the shoot and a fusion of rosette leaves. Four to five partially overlapping generations are possible with each about one month long.

Subanguina picridis, a gall-inducing nematode, has successfully established in states other than Idaho. It is effective at reducing plant biomass and flowering, but this agent is not consistent from year to year and does not emigrate effectively once established.

Centaurea diffusa (Diffuse Knapweed), C. maculosa (Spotted Knapweed), and C. pratensis (Meadow Knapweed)

Agapeta zoegana, the sulfur knapweed moth, attacks the cortex of the root in the larval stage. It is established in Idaho. The adults emerge from mid-June to early September and can be collected using blacklights with a modified insect vacuum or reared from infested roots.

Bangasternus fausti, the broad-nosed seed head weevil, is capable of consuming 100% of the seeds in a flower head in its destructive larval stage. The weevil is established in Idaho and prefers hot, dry areas. It does not do well at high elevations or areas with prolonged rain. Adults can be collected using a sweep net in late spring to early summer when plants begin to bloom.

Cyphocleonus achates, the knapweed root weevil, reduces knapweed biomass and density in its destructive larval stage. It is established in Idaho and prefers hot, dry, well-drained sites with low, scattered vegetation in temperate areas. Adults can be collected in the field or reared from infested roots.

Larinus minutus, the lesser knapweed flower weevil, has caused dramatic reductions of diffuse knapweed at sites in Montana, Oregon, and Washington, but effects in Idaho have not been monitored although it is established here. *L. minutus* prefers hot, dry areas, is destructive in the larval and adult stages, and should be collected when diffuse knapweed is at 50% bloom. Adults are active in the field from May through mid-September and can be collected with an aspirator in the spring, as they congregate around the root crown, or using a sweep net during early to mid-bloom.

Larinus obtusus, the blunt knapweed flower weevil, prefers dry, open sites. It is established in Idaho, Montana, Oregon, Washington, and Wyoming. Larvae are the destructive growth stage, but *L. obtusus* is generally collected in the adult stage with a sweep net during knapweed bloom.

Sphenoptera jugoslavica, the bronze knapweed root borer, prefers diffuse knapweed, but also attacks spotted and squarrose knapweed. The root borer is

established in Idaho, but is available in Oregon and Washington for collection. Adults can be collected with a sweep net in mid-July in the early evening.

Urophora affinis, the banded gall fly, attacks developing flower heads in the larval stage. It is widely distributed throughout the Northwest and well established in Idaho. *U. affinis* does not disperse as rapidly as *U. quadrifasciata*, but it is a more persistent colonizer and is commonly the species where both flies are present.

Urophora quadrifasciata, the UV knapweed seed head fly, is well established throughout the Northwest. See comments above for *U. affinis* as these agents are very common.

Centaurea solstitialis (Yellow Starthistle)

Bangasternus orientalis, the yellow starthistle bud weevil, is destructive in the larval stage and may cause minor damage as an adult. *B. orientalis* is established in Idaho and surrounding states and adults can be redistributed by sweeping or handpicking from host plants in the spring or early summer.

Eustenopus villosus, the yellow starthistle hairy weevil, is widespread throughout the west and is commonly found wherever yellow starthistle is found. It is destructive in the adult and larval stage. The larvae can reduce seed production by as much as 90-100%. This agent attacks both buds and flower heads.

Larinus curtus, the yellow starthistle flower weevil, attacks seed heads and is destructive in the larval stage. Larval feeding can reduce seed production up to 100%. This agent is well established and adults can be collected in June and July. Adults are easily collected by handpicking them from flowering plants when they are at 10% bloom.

Chondrilla juncea (Rush Skeletonweed)

Bradyrrhoa gilveolella, the skeletonweed root moth, is destructive in the larval stage and attacks the roots. This agent was initially released in Idaho in 2002, but establishment has not yet been confirmed. Adults can be collected with a sweep net during the evening. Likely areas for establishment are sandy, granitic soils.

Cystiphora schmidtii, the rush skeletonweed gall midge, attacks the leaves and stems in their larval form. This agent is well established in Idaho, but its efficacy is limited due to predation. *C. schmidtii* is most abundant in areas where the average temperature exceeds 17°C and precipitation is less than 400 mm. Redistribution is best accomplished by harvesting galled stems from early July to late September.

Eriophyes chondrillae, the rush skeletonweed gall mite, is destructive in the nymphal and adult stages attacking axillary and terminal buds. This agent is well established in Idaho and galls can be gathered from July to mid-October. *A. chondrillae* is an excellent disperser.

Puccinia chondrillina, the rush skeletonweed rust fungus, is established in Idaho and surrounding states and survives best in mesic habitats. Urediospores can be transplanted during the summer.

Cirsium arvense (Canada Thistle)

Hadroplantus* (= *Ceutorhynchus*) *litura, the Canada thistle stem weevil, effectively exposes Canada thistle plants to opportunistic pathogens, but the agents

themselves are not particularly effective. This agent is established in Idaho and is readily available in many states in the early spring. Adults can be collected in early spring when rosettes are 5 cm tall and Canada thistle is dense and not stressed by grazing, dry conditions, flooding, mowing, or herbicides.

Urophora cardui, the Canada thistle stem gall fly, deposits eggs in the stems of Canada thistle plants and the larvae tunnel into the stems causing galls to form. Stems above the galls often do not produce flowers. This agent is established in Idaho and in neighboring states. The fly does best in moist, disturbed areas that are semi-shaded. Galls can be collected in the fall, winter, or early spring.

Convolvulus arvensis (Field Bindweed)

Aceria malherbae, the bindweed gall mite, stunts the plant and reduces flowering. Nymphs and adults are the destructive stages. This agent has not been reported as established in Idaho, but it has established in Colorado, Washington, and Wyoming. Galls can be handpicked and stored for several weeks if kept cool. Spring or early summer releases may be preferable as they likely give the mite extra time to increase populations. This agent can be redistributed by mowing infested patches.

Tyta luctuosa, the bindweed moth, is destructive in the larval stage. This agent is not yet established in Idaho. It has been released in Montana and Washington but not recovered. Studies suggest that the moth is not restricted to any particular habitat in its native region.

Cytisus scoparius (Scotch Broom)

Bruchidius villosus, the Scotch broom bruchid, prefers meadows and hillsides with southern exposures. The larval stage is the destructive stage as larvae feed in seeds in pods. This agent has successfully established in Oregon and Washington where it has reduced seed production by up to 25%. Adults should be collected after they have mated, in early summer. Heavy duty sweep nets can be used to collect these insects.

Exapion fuscirostre, the Scotch broom seed weevil, is established in California, Oregon, and Washington where it has effectively reduced seed production by up to 60%. This agent prefers meadows and hillsides with southern exposures and disperses rapidly. Adults should be collected after they have mated, usually in the spring during mid to late flower.

Euphorbia esula (Leafy Spurge)

Aphthona czwalinae, the black leafy spurge flea beetle, does well in continental climates with warm and dry summers and sites with relatively high humidity and mesic, loamy soils where the host plant is growing with other vegetation. This agent is established in Idaho and surrounding states and has shown to effectively reduce cover, density, and biomass 3 – 5 years post-release. This agent can be collected from mid-June through July.

Aphthona flava, the copper leafy spurge flea beetle, is well established in Idaho and surrounding areas and does well in areas that are sunny and without clay or acidic soils. This agent is effective once established, reducing plant densities dramatically. *A. flava* can be collected from June through mid-August. As with other

Aphthona species, larvae feed on the root hairs of leafy spurge while adults feed on leaves and flowers.

Aphthona lacertosa, the brown-legged leafy spurge flea beetle, is destructive in the larval and adult stages. This species is established in Idaho and surrounding states. Adults are collected from early summer through July. Redistribution efforts should concentrate on open, sunny, mesic sites.

Aphthona nigriscutis, the black dot leafy spurge flea beetle, is established in Idaho and surrounding states. It is destructive in the larval and adult forms and best suited to dry sites with maximum solar exposure where ant and/or grasshopper populations are minimal. This species can be collected from June through August.

Oberea erythrocephala, the red-headed leafy spurge stem borer, damages leafy spurge plants in the adult and larval life stages. Adults girdle the stem of the plant when ovipositing and the larvae mine down the stem and feed in the crown and root system. Larval galleries may allow pathogenic fungi to enter the roots as well. Plants with stem diameters in excess of 3.0 mm are necessary in addition to with riparian areas with trees. This agent is established in Idaho and surrounding states. Adults can be hand-picked in the morning before they become too active.

Spurgia esulae, the leafy spurge tip gall midge, is destructive in the larval stage, attacking the growing tips of leafy spurge plants and destroying the shoot's ability to flower and produce seeds. This agent is established in Idaho and surrounding states. To redistribute, galls containing mature larvae can be clipped, bunched, and wrapped in damp towels or damp cotton. They should be taken to the field as quickly as possible and placed upright in a wire frame or other device so that the larvae will not be found by ants and other predatory insects.

***Linaria genistifolia* and *L. vulgaris* (Dalmatian and Yellow Toadflax)**

Mecinus janthinus, the toadflax stem weevil, is destructive as larvae, mining the stems and adults, feeding on leaves and stems. This agent is available in Idaho and surrounding states. *M. janthinus* prefers hot, dry, forested areas or grasslands with large-stemmed toadflax plants, typically Dalmatian toadflax. Adults can be collected from the end of May to mid-July via sweep net while they are actively feeding and ovipositing.

***Lythrum salicaria* (Purple Loosestrife)**

Galerucella californiensis, the black-margined loosestrife beetle, is destructive in the adult and larval stages feeding on leaf and bud plant material. This agent is highly mobile and is well established in Idaho and surrounding states. Continuously flooded sites are not suitable for beetle survival unless drier overwintering sites are available nearby. Sweep nets and/or handpicking adults have been effective with releases made with 250 to 500 adults. Collecting the insects in the early spring (late April or early May) by beating them off of plants is the easiest way to collect them.

Galerucella pusilla, the golden loosestrife beetle, is destructive in the adult and larval stages feeding on leaf and bud plant material. This agent is highly mobile and is well established in Idaho and surrounding states. Continuously flooded sites are not suitable for beetle survival unless drier overwintering sites are available nearby. Sweep nets and/or handpicking adults have been effective with releases made with

250 to 500 adults. Collecting the insects in the early spring (late April or early May) by beating them off of plants is the easiest way to collect them.

Hylobius transversovittatus, the loosestrife root weevil, attacks the root structures of purple loosestrife as larvae and the adults feed on the foliage. This agent is established in Idaho, but collection sites have not been identified. The effects of the larvae depend on root size, attack intensity, and duration. This agent prefers sites without prolonged flooding. Adults are commonly collected at night and are the easiest life stage to collect.

Nanophyes marmoratus, the loosestrife seed weevil, attacks unopened flower buds as larvae and adults attack developing leaves. This agent is established and can be collected in Idaho. Sites without prolonged flooding that are deficient of *Galerucella* spp. are ideal for *N. marmoratus*. Adults can be collected with a heavy-duty sweep net concentrating on the flower spikes. A release of 100 to 200 adults is recommended for establishment.

Salvia aethipis (Mediterranean Sage)

Phrydiuchus tau, the Mediterranean sage root weevil, is established in Idaho and surrounding states. It does best at warm, dry sites and is available for collection along the Salmon River or in Lakeview, Oregon. The larvae are the destructive stage, feeding inside root crowns or shoot buds. Adults can be collected with a sweep net, by handpicking, or with an aspirator from rosettes in late fall during the mating season when flowers are at 25% bloom.

Senecio jacobaea (Tansy Ragwort)

Longitarsus jacobaeae, the tansy ragwort flea beetle, is destructive in the larval stage, when it mines the roots of rosettes, and the adult stage when it feeds on leaves and rosettes. This is a very effective biological control agent and is established in California, Oregon, Montana, and Washington. *L. jacobaeae* prefers sunny pastures that are not prone to flooding. Adults are the best growth stage to transfer and should be gathered in groups of 100-500 using a sweep net in October through November. Initial attempts to establish this insect east of the Cascades were unsuccessful. Consequently, a new strain of this beetle was identified and approved for release in North America in 2002.

Tribulus terrestris (Puncturevine)

Microlarinus lareynii, the puncturevine seed weevil, is destructive in the larval stage, developing inside the fruits where they feed on the seeds. The distribution and abundance of the beetle is limited by cold winter temperatures. It is currently not established in Idaho and may not be able to. In areas where it is established, the agent can be redistributed by collecting adults from the soil litter beneath the plants.

Microlarinus lypriformis, the puncturevine stem weevil, is limited by cold temperatures. The larvae mine the stems and root crowns, damaging the puncturevine vascular tissue. This agent also is not established in Idaho. In areas where it is established, the agent can be redistributed by collecting adults from the soil litter beneath the plants.