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Field Release of the Gall Wasp, *Aulacidea subterminalis* (Hymenoptera: Cynipidae), for Biological Control of Invasive Hawkweeds (*Hieracium* spp.) in the Continental United States

Environmental Assessment, February 2011

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I. Purpose and Need for the Proposed Action

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), Pest Permitting Branch (PPB) is proposing to issue permits for release of the hawkweed gall wasp, *Aulacidea subterminalis* (Hymenoptera: Cynpidae). The agent would be used by the applicant for the biological control of the hawkweeds *Hieracium pilosella, H. aurantiacum, H. floribundum,* and *H. flagellare* in the continental United States. Before permits are issued for release of *A. subterminalis*, the APHIS–PPQ, PPB must analyze the potential impacts of the release of this agent into the continental United States.

This environmental assessment[1] (EA) has been prepared, consistent with USDA, APHIS' National Environmental Policy Act of 1969 (NEPA) implementing procedures (Title 7 of the Code of Federal Regulations (CFR), part 372). It examines the potential effects on the quality of the human environment that may be associated with the release of *A. subterminalis* to control infestations of hawkweeds within the continental United States. This EA considers the potential effects of the proposed action and its alternatives, including no action.

The applicant's purpose for releasing *A. subterminalis* is to reduce the severity of infestations of invasive hawkweeds in the United States. There are many species of non-native, invasive hawkweeds in North America. These species originated in Europe, which is the native range to a massive complex of species, subspecies, and varieties of *Hieracium*. Invasive hawkweeds were probably introduced into the eastern United States and Canada during the 1800s. Several hawkweed species are considered noxious in many western States. Introduced hawkweeds are highly competitive and relatively free of insects and pathogens in North America. These species outcompete native and desirable vegetation, forming near monocultures and limiting economic use of infested land.

Existing management options for management of invasive hawkweeds are expensive, temporary, and have nontarget impacts. For these reasons, the applicant has a need to release *A. subterminalis*, a host- specific, biological control organism for the control of invasive hawkweeds, into the environment.

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[1] Regulations implementing the National Environmental Policy Act of 1969 (42 United States Code 4321 et seq.) provide that an environmental assessment "shall include brief discussions of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted." 40 CFR § 1508.9.

II. Alternatives

This section will explain the two alternatives available to the PPB—no action and issuance of permits for environmental release of *A. subterminalis*. Although the PPB's alternatives are limited to a decision on whether to issue permits for release of *A. subterminalis*, other methods available for control of hawkweeds are also described. These control methods are not decisions to be made by the PPB, and their use is likely to continue whether or not permits are issued for environmental release of *A. subterminalis*, depending on the efficacy of *A. subterminalis* to control hawkweeds. These are methods presently being used to control hawkweeds by public and private concerns.

A third alternative was considered, but will not be analyzed further. Under this third alternative, the PPB would have issued permits for the field release of *A. subterminalis*; however, the permits would contain special provisions or requirements concerning release procedures or mitigating measures. No issues have been raised that would indicate special provisions or requirements are necessary.

A. No Action

Under the no action alternative, the PPB would not issue permits for the field release of *A. subterminalis* for the control of invasive hawkweeds. The release of this biological control agent would not take place. The following methods are presently being used to control hawkweeds; these methods will continue under the "No Action" alternative and will likely continue even if permits are issued for release of *A. subterminalis*, depending on the efficacy of the organism to control invasive hawkweeds.

1. Chemical Control

Hawkweeds may be controlled by using herbicides. Herbicides, such as 2,4-D, clopyralid, aminopyralid, and picloram have resulted in the greatest degree of control when applied at the normally recommended rate for perennial pasture weeds (Noel et al., 1979; 1992a; Wilson et al., 1997; 2005; 2006). Studies conducted at the University of Idaho showed that over 50 percent control was achieved for 6 years following treatment with a 1 pint per acre rate of clopyralid (Lass and Callihan, 1992). Similar results were achieved using picloram at the rate of 0.25 to 0.5 pounds of active ingredient per acre. Other herbicides either failed to control meadow hawkweed or suppression was for less than 3 years (Lass and Callihan, 1992; Miller et al., 1998). More recently, aminopyralid (Milestone™) has been recommended as an effective herbicide (http://www.msuextension.org/ruralliving/Dream/PDF/hawk.pdf *last accessed* March 23, 2010).

2. Mechanical Control

Mechanical control of invasive hawkweeds has had limited success.

Digging the plants or otherwise disturbing the stolons, rhizomes, or roots only serves to spread the weed because plants can grow from buds on small root, stolon, and rhizome fragments. A stolon is a shoot that bends to the ground or that grows horizontally above the ground and produces roots and shoots at the nodes. A rhizome is similar to a stolon and is a horizontal, usually underground, stem that often sends out roots and shoots from its nodes. Disturbance by machinery spreads the weeds across the field. Local disturbances caused by grazing livestock, ungulates, and rodents also enhance the rate of spread of hawkweed. In lawns, mowing does not kill invasive hawkweeds because the low-lying stolons and rhizomes are missed by the mower blades. Although mowing prevents seed production by removing flowering stems, repeated mowing encourages faster vegetative spread (Callihan et al., 1997).

3. Cultural Control

When perennial grasses, legumes, and other beneficial forbs are present in the plant community, fertilizers can help control hawkweed by increasing the competitive ability of the more desirable species. This may be particularly important on rangelands and pastures because these lands are generally not priority areas for supplemental fertilization, and soil nitrogen levels may be inadequate for optimal grass health. Marked reductions of hawkweed density and vigor have been obtained by fertilizer treatments in the United States (Reader and Watt, 1981), Canada (Hay and Ouellette, 1959), and New Zealand (Scott et al., 1990) when competing vegetation is present. However, Reader and Watt (1981) found that repeated fertilizer treatments had no effect on dense patches of hawkweed that contained few grasses or other forbs. Depending on soil productivity and grass condition, a single nitrogen application may be sufficient for grasses to competitively suppress hawkweed growth for 3 to 5 years (Reader, 1990).

4. Biological Control

Five species of *Hieracium*-specific insects have been tested and released for the biological control of hawkweeds in New Zealand. They are:

(1.) *Aulacidea subterminalis* (Insecta: Hymenoptera: Cynipidae)—hawkweed gall wasp;
(2.) *Cheilosia psilophthalma* (Insecta: Diptera: Syrphidae)—hawkweed crown-feeding hover fly;
(3.) *Cheilosia urbana* (Insecta: Diptera: Syrphidae)—hawkweed root-feeding hover fly;
(4.) *Macrolabis pilosellae* (Insecta: Diptera: Cecidomyiidae)—hawkweed stem gall midge; and

(5.) *Oxyptilus pilosellae* (Insecta: Lepidoptera: Pterophoridae)—hawkweed plume moth.

None of these insects have been released in North America. An additional *Aulacidea* wasp, besides *A. subterminalis*, is being considered as a biological control candidate for release in North America. *Aulacidea* *pilosellae*, a wasp that forms galls on stems, leaves, and stolons of hawkweeds, is currently undergoing testing and appears to be host-specific (Littlefield et al. 2008).

B. Issue Permits for Environmental Release of *A. subterminalis*

Under this alternative, the PPB would issue permits for the field release of the gall wasp, *A. subterminalis*, for the control of invasive hawkweeds. These permits would contain no special provisions or requirements concerning release procedures or mitigating measures.

Biological Control Agent Information

1. Taxonomy

Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Superfamily: Cynipoidea
Family: Cynipidae
Subfamily: Cynipinae
Tribe: Aylacini
Genus: *Aulacidea*
Species: *A. subterminalis* Niblett

2. Geographical Range of *A. subterminalis*

a. Native Range

Aulacidea subterminalis is fairly common and widespread on *H. pilosella* in Northern Europe (Syrett et al., 1998). Fauna Europaea (2007) records *A. subterminalis* as present in Britain, France, and Germany. In its native habitat, *A. subterminalis* occurs on *H. pilosella* inhabiting arid, nutrient poor grasslands, poorly fertilized upland pastures, inland dunes, and man-made heaths (Ellenberg, 1988).

b. Other Areas of Introduction

A. subterminalis is one of five insect biological control agents introduced to New Zealand for suppression of *H. pilosella* (Syrett et al., 2001). In New Zealand, *A. subterminalis* was approved for import and release in 1998, and was first released in 1999. It has since been released at 99 sites throughout the North and South Island, with establishment confirmed at approximately 37 percent of these sites (Aspinall, 2006; Smith et al., 2007). The failure of many releases was due to drought conditions following the release or site disturbance due to cropping or herbicide treatment (Smith et al., 2007).

c. Expected Attainable Range of *A. subterminalis* in North

America

A. subterminalis is fairly common and widespread on *H. pilosella* in Northern Europe and it is also establishing well in more moist areas of New Zealand, but is not well adapted to survive in dry or droughty environments where plants may senesce early (Littlefield et al., 2008). Climate matching using CLIMEX Version 1.1 (CSIRO Australia) suggests that the wasp's potential range in North America should match much of the distributions of the targeted *Hieracium* species (Littlefield et al., 2008).

3. Life History of *A. subterminalis*

A. subterminalis is parthenogenetic (a form of asexual reproduction in which females produce eggs that develop without fertilization by males). Eggs are laid into the stolen tips. Eggs are milky-white in color, 0.24 millimeters (mm) long and 0.09 mm wide and have a stalk approximately 1.18 mm long. Larvae develop inside the developing stolon-tip gall. Galls are abnormal outgrowths of plant tissues and can be caused by various parasites, including insects. Galls are about 4.5 mm in diameter (Klöppel et al., 2003), but gall size is dependent upon the number of larval chambers present. Galls become evident approximately five weeks after the plant is exposed to the female wasp. Galls continue to enlarge for an additional 5 weeks (Littlefield et al., 2008). Mature larvae are somewhat fusiform (tapered at each end, spindle-shaped), with a distinctive, unpigmented head. The wasp overwinters in the larval stage. Pupation occurs in April, and adult wasps emerge from the galls from the beginning of May to the end of June in Switzerland. *A. subterminalis* has one generation per year. Adults are generally short lived; up to a week under ambient laboratory conditions.

III. Affected Environment

A. Target Weeds

(1.) Scientific name: *Hieracium pilosella* L.
Family: Asteraceae
Synonyms: none
Common name: Mouse ear hawkweed

(2.) Scientific name: *Hieracium aurantiacum* L.
Family: Asteraceae
Synonyms: *H. brunneocroceum* Pugsley.
Common name: Orange hawkweed, Grim the Collier

(3.) Scientific name: *Hieracium floribundum* Wimm. & Grab.
Family: Asteraceae
Synonyms: none
Common name: King devil hawkweed

(4.) Scientific name: *Hieracium* x *flagellare* Willd. (*caespitosum* x *pilosella*)
Family: Asteraceae
Synonyms: *Hieracium* x *duplex*, *H.* x *macrostoloum*
Varieties: cernuiforme, flagellare, glatzense
Common name: Whiplash hawkweed

Introduced hawkweeds are perennial plants that contain a milky sap and are generally stoloniferous (plants that bear or form stolons). *Hieracium piloselloides* and *H. glomeratum* are the only non-stoloniferous introduced species. Each young plant consists of a rosette of 5 to 12 hairy leaves arising from a short, thick rhizome with a shallow, fibrous root system. The flowers are yellow or orange (*H. aurantiacum* is the only orange-flowered species). New plants begin as seedlings or as leaves sprouting from stolons, rhizomes (Thomas and Dale, 1974), and/or roots (Peterson, 1979). Juvenile plants consist of low-lying rosettes that develop into flowering plants as erect, slender stems arise from the rosette center.

All of the invasive hawkweeds reproduce asexually by apomixis (asexual seed production) and by vegetative spread by stolons, rhizomes, and root buds. Orange hawkweed sends out from three to eight long, slender stolons along the soil surface. Meadow hawkweed also produces long, slender stolons, but some of its vegetative structures grow as shallow, underground rhizomes. Stolons and rhizomes, initiated from buds at the base of rosette leaves, begin to grow when the plant initiates flowering. Once established, vigorous stolon growth quickly expands the colony, forming dense patches that can have as many as 3,200 plants per square yard. The slender, leafy stolons elongate through the summer and form daughter rosettes at their tips (Thomas and Dale, 1974). Hawkweeds regrow each year from short, below-ground rhizomes. In *H. piloselloides*, axillary buds develop into secondary flowering shoots rather than stolons.

Invasive hawkweeds also occasionally produce seeds sexually by periodic pollination and outcrossing. At lower elevations, flowering occurs around mid-June and seeds ripen by early August. Mature seeds can germinate as soon as they are released from the plant (Stergios, 1976). Studies have shown that seeds are viable in the soil for up to 7 years (Panebianco and Willemsen, 1976). Invasive hawkweeds have relatively short life cycles, completing a generation within 4 months.

Although most new hawkweed infestations are probably started by seeds, expansion of established populations is mostly vegetative. Thomas and

Dale (1974) found that only 1 percent of new plants in a *H. floribundum* population were derived from seedlings. Studies in eastern Canada showed that seeds are not carried far by the wind; although minute barbs along ribs on the seeds enable them to stick to hair, fur, feathers, clothing, and vehicles, and can be carried long distances.

B. Areas Affected by Hawkweeds

1. Native and Introduced Range of Hawkweeds

In their native ranges, hawkweeds occur in the northern, central, and eastern portions of Europe as ruderal species (plants that grows in rubbish, poor land, or waste) of pastures, roadside cutbanks, abandoned fields, and meadows (Skalinska, 1976). In most cases they are found in small, isolated pockets. Their highest densities are found on recently disturbed areas and they do not persist as dominant members of the early successional community (Skalinska, 1976). From Europe, hawkweeds spread to North America, New Zealand, Australia, Chile, and Argentina.

2. Known and Potential Distribution of Hawkweeds in North America

In North America, invasive hawkweeds are primarily weeds of moist pastures, forest meadows, and mesic (moderately moist) rangeland. Based on current infestations, habitats most susceptible to invasion range from the lowlands of the northern Pacific Coast to elevations of 5,000 feet or more in the Mountain States (Littlefield et al., 2008). Sites most vulnerable to invasion include roadsides, mountain meadows, clearings in forest zones, permanent pastures, hayfields, cleared timber units, and abandoned farmland where the soil is well drained, coarse textured, and moderately low in organic matter. Consequently, elk habitat, recreation areas, and pristine mountain meadows in areas that have a climate similar to that in their native range are particularly susceptible. Although introduced hawkweeds can grow in open woodlands, they do not tolerate shade very well. Across the United States and Canada, introduced hawkweeds are closely associated with habitats that can support oxeye daisy (*Chrysanthemum leucanthemum*), sulfur cinquefoil (*Potentilla recta*), spotted knapweed (*Centaurea maculosa*), gray goldenrod (*Solidago nemoralis*), wild carrot (*Daucus carrota*), dandelion (*Taraxacum officinale*), and Kentucky bluegrass (*Poa pratensis*) (Thomas and Dale, 1974; Maycock and Guzikowa, 1984). None of the introduced hawkweed species are found in the natural grasslands or shrub-steppe of the northern Intermountain West, and are not expected to become problem weeds in any dry habitat usually associated with western rangelands. Neither meadow nor orange hawkweed appears to survive in annually tilled cropland.

There are many species of non-native, invasive hawkweeds in North America. These species originated from Europe, which is the native range to a massive complex of species, subspecies, and varieties of *Hieracium*. Invasive hawkweeds were probably introduced into the eastern United States and Canada during the 19th century. Two important subgenera distinguish the group of invasive species, subgenera *Pilosella* and *Hieracium*. Species in these subgenera vary widely, both morphologically and in their invasion history and species distribution. The majority of species belong to subgenus *Pilosella*, including the species considered as targets for *A. subterminalis*. (See figure 1 for a proposed phylogeny (taxonomic grouping) of North American *Hieracium* species.)

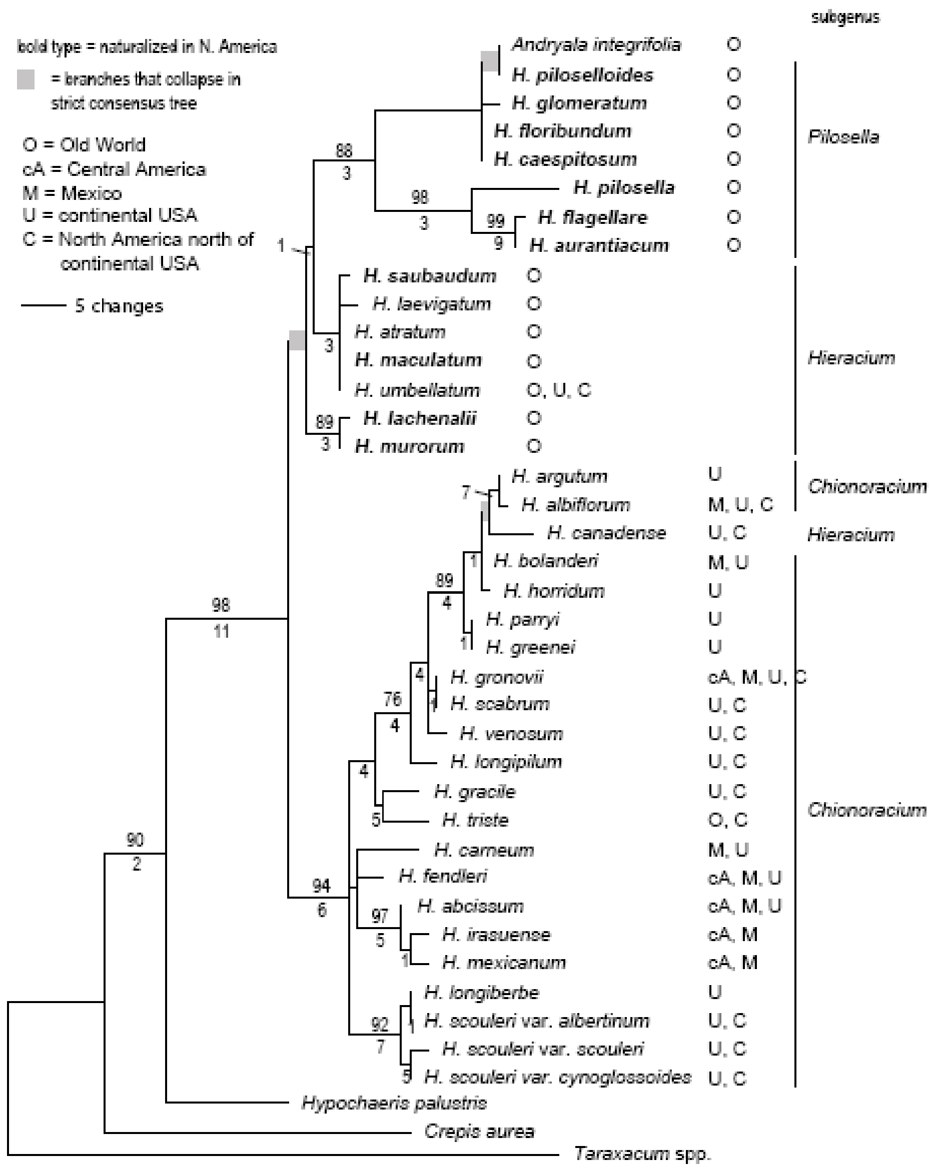

Figure 1. Proposed taxonomic grouping of North American *Hieracium* species by Gaskin and Wilson (2007).

The present distributions of these exotic species in the United States and Canada are provided in table 1.

Table 1. Invasive, Nonnative *Hieracium* species, from subgenus *Pilosella*, in the United States and Canada (from Wilson et al., 2006).

Species	Distribution
H. arvicola Nageli et Peter	**CAN**: NB
H. aurantiacum L.	**CAN**: AB, BC, NB, NL, NS, ON, PE, QC, SK **USA**: AK, AR, CA, CO, CT, FL, ID, IN, IA, MA, MD, ME, MI, MN, MT, NC, NH, NJ, NY, OH, OR, PA, RI, SD, VA, VT, WA, WV, WI, WY
H. bauhini Schult	**CAN**: BC **USA**: CT, ID, MA, MN, NH, NY, VT, WA
H. brachiatum Bertol. ex DC.	**CAN**: QC **USA**: NY
H. caespitosum Dumort	**CAN:** AB, BC, NB, NL, NS, ON, PE, QC **USA**: CT, DE, GA, ID, IL, IN, KY, MA, MD, ME, MI, MN, MT, NC, NH, NJ, NY, OH, OR, PA, RI, SC, TN, VT, VA, WA, WV, WI
H. derubellum Gottschl. et Schuhw. [*H. atramentarium* act.]	**CAN**: QC **USA**: MI, NY, WI
H. flagellare Willd. [incl. *H. macrostolonum*]	**CAN**: BC, NB, NL, NS, ON, PE, QC **USA**: CT, ID, MA, ME, MI, NH, NY, PA, VA, VT
H. floribundum Wimm. & Grab.	**CAN**: BC, NB, NL, NS, ON, PE, QC **USA**: CT, ID, MA, MD, ME, MN, MT, NH, NJ, NY, OH, OR, RI, VA, VT, WA, WV
H. fuscoatrum Nageli & Peter	**USA**: CT, NY, RI
H. glomeratum Froel.	**CAN**: BC, ID, WA
H. lactuella Wallr.	**CAN**: NS
H. pilosella L.	**CAN**: BC, NB, NL, NS, ON, PE, QC, Saint Pierre and Miquelon **USA**: CT, DE, GA, MA, MD, ME, MI, MN, NC, NH, NJ, NY, OH, OR, PA, RI, TN, VA, VT, WA, WV
H. piloselliflorum Nageli et Peter [incl. *H. apatelium*]	**CAN**: NB, NL, NS, ON, PE, QC
H. piloselloides Vill. [incl. *H. preaaltum*]	**CAN:** BC, NB, NL, NS, ON, PE, QC **USA:** CT, DE, GA, IL, IN, IA, MA, ME, MI, MN, MT, NC, NH, NY, OH, PA, RI, SC, VA, VT, WI, WV
H. stoloniflorum Waldst. et Kit.	**CAN**: QC

Hieracium aurantiacum (orange hawkweed) was introduced into Vermont in 1875 as an ornamental and within 25 years spread throughout much of northeastern United States and southeastern Canada (Voss and Böhlke, 1978). Within 25 years it had spread throughout much of New England, west to Michigan (Voss and Böhlke, 1978) and into Canada from New Brunswick to Ontario (Britton and Brown, 1970). It now occurs throughout the eastern seaboard and into the Midwest, extending west to Minnesota and Iowa, and south to Virginia and North Carolina (Johnson and Thomas, 1978). First recorded in Spokane, Washington, in 1945 (Marion Ownbey Herbarium, Wash. State Univ.), *H. aurantiacum* has been collected from gardens in Nevada County, California (Munz and Keck, 1959), on the east slope of the Rocky Mountains in Colorado (Weber, 1990), from coastal Oregon and Washington (Rickett, 1973), and in southwestern British Columbia (Guppy, 1976). In the western United States, populations of orange hawkweed were first reported from coastal Washington and Oregon (Peck, 1941; Abrams and Ferris, 1960). It has also been reported from the lower mainland of British Columbia (Guppy, 1976) where it infests pastures, old fields, and roadsides. *H. aurantiacum* is now also recorded in Idaho, Montana, and Wyoming (USDA–NRCS, 2008). It is more widespread than other hawkweed species primarily because it is planted as an ornamental and often escapes cultivation.

Hieracium pilosella (mouse ear hawkweed) is widespread in the eastern United States and Canada. In the west, it occurs in western Washington, western Oregon, Alaska, and British Columbia.

Hieracium flagellare (whiplash hawkweed) occurs primarily in the northeastern United States and eastern Canada, but also occurs in British Columbia and Wyoming.

Hieracium floribundum (king devil hawkweed) was first reported in northern New York in 1879 (Voss and Böhlke, 1978) and 1900 respectively (Kennedy 1902). Recently, infestations of *H. floribundum* have been reported in western Washington (WSNWCB, 1997), Northern Idaho (L. Wilson, unpubl. data.), and Montana (USDA–NRCS, 2008), and is reportedly expanding in range.

Hieracium piloselloides has been recorded in the western States of Montana and Washington (USDA–NRCS, 2008), and is also reportedly expanding in range. Suspected hybridization between *H. caespitosum*, *H. floribundum*, and *H. piloselloides*, and the potential threat of these species in western habitats is the rationale for including these species as target weeds in the biological control program.

Hieracium caespitosum (meadow hawkweed) was likely introduced into the United States in 1828 (Britton and Brown, 1970), and is now commonly found from Québec and Ontario (Frankton and Mulligan, 1970) southward to Georgia and Tennessee (Rickett, 1973). The first record of *H. caespitosum* in the western United States was in Pend Oreille County, Washington, in 1969 (Marion Ownbey Herbarium, Wash. State Univ.). *H. caespitosum* is now recorded in the western States of Idaho, Montana, Oregon, Washington, and Wyoming, and is widespread throughout most of southern British Columbia and Alberta.

C. Plants Related to Invasive Hawkweeds and Their Distribution

Plants related taxonomically to invasive hawkweeds would be the most likely to be attacked by the proposed biological control organism *A. subterminalis*. Plants related to the target hawkweeds are discussed below.

There are many species of *Hieracium* native to North America (Wilson et al., 1997). Distribution of native *Hieracium* species ranges from the east coast to west coast, from sea level to over 9,000 ft. in elevation, and from northern to southern latitudes. As with the European hawkweeds, the number of native species has long been disputed. In order to understand species relationships in *Hieracium*, a brief outline of the generic divisions is provided.

There are generally considered to be about 36 species of *Hieracium* belonging to the three subgenera in America north of Mexico (Strother, 2006). A review of the regional flora revealed that about 25 species are native to the United States and Canada and fall into two subgenera: *Hieracium* (3 species) and *Chionoracium* (22 species). Subgenus *Hieracium* occurs chiefly throughout the boreal regions of North America and Eurasia, and is represented in North America by *H. umbellatum* L., *H. robinsonii* Zahn, and *H. canadense* Michx. (considered part of *Chionoracium* by Gaskin and Wilson, 2007).

Subgenus *Chionoracium* is restricted to the New World and contains most of our native taxa. Conflicting characters used to distinguish species have generated considerable debate regarding classification. For example, Guppy (1978) suggested that *H. scouleri* Hook., *H. albertinum* Farr., and *H. cynoglossoides* L. are too closely correlated in characters to be distinguished into separate species and, instead, form a complex of species. Guppy (1978) also suggested that *H. umbellatum* L. and its close relative, *H. canadense* Michx., may be two forms of the same species. Deardorff (1977) added *H. longiberbe* Howell and *H. nudicale* Heller to the *H. scouleri* complex. Kartesz and Meacham (1999) provided a comprehensive synthesis of *Hieracium* spp. in America north of Mexico in which they list 108 species, subspecies, and hybrids, clearly giving evidence of the myriad of described taxa in the genus.

Ten additional hawkweed species found in the United States and Canada are introduced from Europe and belong to two subgenera. Four species belong to the subgenus *Hieracium*: *H. argillaceum* Jordan group, *H. groenlandicum* Arv.-Touv., *H. lachenalii* K.C. Gmel., *H. murorum* L., and *H. sabaudum* L. Plants in this subgenus, except for *H. lachenalii*, have not become weedy in North America. The remaining six species belong to the subgenus *Pilosella* and include the species targeted for biological control by *A. subterminalis*.

Species that were used in testing the specificity of *A. subterminalis* to hawkweeds are listed in appendix 1.

IV. Environmental Consequences

A. No Action

1. Impact of Spread of Invasive Hawkweeds

Most invasive hawkweeds are perennial, creeping stoloniferous plants that can crowd out competing vegetation. They are not drought tolerant and cannot withstand prolonged periods of drying. However, they are very cold tolerant and easily persist at higher elevation, making the upland habitats through the Rocky Mountains and other western mountain ranges susceptible to invasion. In northern Idaho and British Columbia, habitats are open ponderosa pine and interior cedar-hemlock. There are no known medicinal or herbal uses for the invasive hawkweeds, nor do they have any known social or recreational uses.

Invasive hawkweeds do affect threatened, endangered, and sensitive species because of their ability to form dense monocultures. One such example is encroachment by mouse-ear hawkweed of habitat occupied by the threatened golden paintbrush, *Castilleja levisecta*, in Thurston County, Washington (USFWS, 1997). These monocultures compete for soil moisture and nutrients, thereby posing risks to indigenous species. As hawkweed monocultures invade species-rich range and mountain habitats, ecosystem functions and ecological relationships are affected. No known studies specifically address the effects of hawkweed on nutrient cycling and disturbance regimes; however, hawkweed’s ability to dominate a community suggests that these species do affect habitat function. Hawkweeds generally negatively impact plant and animal diversity, and there is serious concern about the loss of native plant biodiversity in infested areas. Ecological losses in plant and animal diversity can be enormous but cannot be economically calculated. Additional expenditures result from control costs. Hawkweeds are tenacious invaders and, once established, quickly develop into a patch that continues to expand until it covers the site with a solid mat of rosettes. Forage species in pastures and abandoned farmland are choked out by the advancing front of hawkweed. Hawkweeds also threaten lawns and gardens. Hawkweeds have been reported to have allelopathic effects (inhibition of growth in one species of plants by chemicals produced by another species) on neighboring vegetation (Dawes and Maravolo, 1973; Makepeace, 1976).

Meadow hawkweed causes severe allergenic reactions. Reactions in people closely working with meadow hawkweed include minor skin rashes, sneezing, congestion, and difficulty in breathing. Similar effects have not been reported in animals. It is not known what portion of the plant causes this allergenic reaction, although latex and other chemicals of closely related Asteraceae plants can cause dermatitis (Dawes et al., 1996).

Invasive hawkweeds have not been placed on the Federal Noxious Weed List but have been listed as noxious in Idaho, Montana, Washington, and British Columbia. Regulations vary by State/Province but generally involve actions such as restricted importation and/or quarantine and prevention, containment, eradication, or other control measures.

2. Impact from Use of Other Control Methods

The continued use of chemical herbicides, and mechanical and biological controls at current levels would be a result if the "no action" alternative is chosen. These environmental consequences may occur even with the implementation of the biological control alternative, depending on the efficacy of *A. subterminalis* to reduce invasive hawkweed populations in the Continental United States.

a. Chemical Control

The use of herbicides, while effective, is limited to relatively accessible sites and control is only temporary. Broadcast applications of herbicides could have adverse impacts on nontarget vegetation if not carefully applied.

b. Mechanical Control

Disturbance of hawkweeds by machinery spreads the weeds across the field. Local disturbances caused by grazing livestock, ungulates, and rodents also enhance the rate of spread of hawkweed. In lawns, mowing does not kill invasive hawkweeds because the low lying stolons and rhizomes are missed by the mower blades. Although mowing prevents seed production by removing flowering stems, repeated mowing encourages faster vegetative spread.

c. Biological Control

No organisms for the biological control of hawkweeds have been released in North America. Gall formation by *A. subterminalis* diverts plant nutrients from the normal growth of other plant tissues. Under certain conditions, galls may stress the plant, reducing competitive ability, seed production, and long distance spread of the weed.

B. Issue Permits for Environmental Release of *A. subterminalis*

1. Impact of *A. subterminalis* on Nontarget Plants

Host specificity of *A. subterminalis* to the invasive hawkweeds *Hieracium pilosella, H. aurantiacum, H. floribundum,* and *H. flagellare* has been demonstrated through scientific literature, field observations, and host specificity testing. If an insect species only attacks one or a few closely related plant species, the insect is considered to be very host-specific. Host specificity is an essential trait for a biological control organism proposed for environmental release.

a. Scientific Literature

In previous literature, *A. subterminalis* has only been reported to induce galls on *H. pilosella* and has not been recorded from any other species (Syrett et al., 1998).

b. Field Observations

In the field, *A. subterminalis* has not been observed or reported on any species other than *H. pilosella* (Syrett et al., 1998).

c. Host Specificity Testing

Host specificity tests are tests to determine how many plant species *A. subterminalis* attacks/eats, and whether nontarget species may be at risk. In host specificity testing (Syrett et al., 1998; 2001; Grosskopf et al., 2001, Littlefield et al., 2008), gall formation by *A. subterminals* only occurred on invasive hawkweed species targeted for biological control. No native hawkweeds or plant species of closely related genera were attacked.

(1) Site of Quarantine and Field Studies

Laboratory tests were conducted at the CABI-Europe Station in Delémont, Switzerland, at the insect containment facility located at the Canterbury Agriculture and Science Centre, Lincoln, New Zealand, and in quarantine facilities at Montana State University (MSU), Bozeman, Montana. Open-field releases began in 1999 in New Zealand.

(2) Test Plant List

The list of plant species used for host specificity testing of *A. subterminalis* is shown in appendix 1. The strategy used for selecting plants for testing is based on the phylogenetic approach, where closely related species are theorized to be at greater risk of attack than are distantly related species (Wapshere, 1974).

The initial host specificity testing of *A. subterminalis* was conducted for the field release of the wasp in New Zealand. Plants utilized for testing were selected from the following categories (Syrett et al., 1998):

- representatives of the plant family Asteraceae (the family to which hawkweeds belong);
- plant species on which the gall wasp has been recorded in the field;
- cultivated plant species and representatives of New Zealand native plant species (various non-Asteraceae families) that have not previously been exposed to the wasp; and
- plant species that are hosts of close relatives of *A. subterminalis*, that is, hosts of other species of *Aulacidea*.

Host specificity testing at the CABI-Europe Station, Delémont, and at the Canterbury Agriculture and Science Centre, Lincoln, New Zealand, consisted of eight species within the genus *Hieracium*, including five from the subgenus *Pilosella* and three from the subgenus *Hieracium*. Thirteen additional species from the tribe Lactuceae were tested, including native New Zealand plant species that would not previously have been encountered by the wasp (*Knightia excelsa*, *Raoulia hookeri*, Kirkianella *novae-zelandiae*, *Celmisia lyalli*, *Helichrysum bellidioides*, *Gaultheria depressa*, and *Discaria toumatou*). A further 11 species within the family Asteraceae were tested, including economically significant cultivated plant species. Species from 21 other families containing important cultivated and native plants were also included, making a total test plant list of 48 species.

Plants for testing the host range of *A. subterminalis* were selected from seven possible categories. Test categories consisted of the following:

CATEGORY 1: Genetic types of *Hieracium* (varieties, races, forms, genotypes, apomicts, etc.).

CATEGORY 2: North American species in the same genus as *Hieracium*, divided by subgenera, including economically and environmentally important plants.

CATEGORY 3: North American species in other genera in the Asteraceae family, divided by subtribe, tribe, and subfamily, including economically and environmentally important plants.

CATEGORY 4: Threatened and endangered species in the Asteraceae family, divided by subgenus, genus, subfamily, and tribe.

CATEGORY 5: North American species in other families in the Asterales order that have some phylogenetic, morphological, or biochemical relationship to the target weed, including economically and environmentally important plants.

CATEGORY 6: North American species in other orders that have some morphological or biochemical relationship to the target weed, including economically and environmentally important plants.

CATEGORY 7: Any plant on which the biological control agent or its close relatives (within the same genus) have been previously recorded to feed and/or reproduce.

(See appendix 2 for a more detailed description of plants selected in each category.)

Host specificity testing of *A. subterminalis* at MSU and CABI-Europe included as many native North American representatives of the various taxa as possible. *Aulacidea subterminalis* was tested on 65 plant species of which 35 are species native to North America (appendix 1).

(3) Discussion of Host Specificity Testing

New Zealand Tests—In overseas testing, Syrett et al. (1998 and 2001) and Grosskopf et al. (2001) reported gall formation on *H. pilosella* and *H. aurantiacum* but not on other tested plant species, while Grosskopf and Senhadji Navarro (2004) reported gall formation on *H. pilosella* but not on *H. aurantiacum* or other tested plant species.

North American Tests—During the North American host specificity test, galls were only induced on four exotic species: *H. pilosella* (its native host), *H. aurantiacum, H. flagellare,* and *H. floribundum* (appendix 4). No native or other test plants were infested.

(See appendices 3 and 4 for host specificity study results.)

2. Impact of *A. subterminalis* on Hawkweeds

To assess the impact of *A. subterminalis* on *H. pilosella* in New Zealand, an experiment was set up to examine the effect of the gall wasp on plant growth under stress-free conditions in a shade house trial with potted plants (Klöppel et al., 2003). Plants with galls showed a reduction in stolon length of 75 percent. They had slightly lower total dry matter and reduced root weight. In a glasshouse experiment, the impact of water stress, nutrient stress, and plant competition on growth of *H. pilosella* and performance of the gall wasp were measured. The number and mean diameter of gall clusters were not significantly different between treatment and control plants. However, galled plants produced more, but shorter, stolons in all stress treatments and stolons that were more branched in nutrient- and water-stressed plants, than ungalled plants. Galling by *A. subterminalis* is likely to reduce vegetative reproduction of *H. pilosella* whether or not plants are stressed, indicating that the wasp may be a successful biocontrol agent (Klöppel et al., 2003).

Researchers expect that *A. subterminalis* will be able to build up substantial populations in North America and, thereby, reduce above-ground biomass and seed output of established invasive hawkweed patches (Littlefield et al., 2008). It is difficult to predict the long-term impact on invasive hawkweed infestations; however, reductions in the above-ground growth rate and seed output may lead to reduced competitive ability of the weed and reduced patch expansion and long-distance dispersal of invasive hawkweed seeds and establishment of new infestations (Littlefield et al., 2008).

3. Uncertainties Regarding the Environmental Release of *A. subterminalis*

Once a biological control agent such as *A. subterminalis* is released into the environment and becomes established, there is a slight possibility that it could move from the target plants (invasive hawkweeds) to attack nontarget plants. Host shifts by introduced weed biological control agents to unrelated plants are rare (Pemberton, 2000). Native species that are closely related to the target species are the most likely to be attacked (Louda et al., 2003). If other plant species were to be attacked by *A. subterminalis*, the resulting effects could be environmental impacts that may not be easily reversed. Biological control agents such as *A. subterminalis* generally spread without intervention by man. In principle, therefore, release of this biological control agent at even one site must be considered equivalent to release over the entire area in which potential hosts occur, and in which the climate is suitable for reproduction and survival.

In addition, this agent may not be successful in reducing hawkweed populations in the continental United States. Worldwide, biological weed control programs have had an overall success rate of 33 percent; success rates have been considerably higher for programs in individual countries (Culliney, 2005). Actual impacts on hawkweeds by *A. subterminalis* will not be known until after release occurs and post-release monitoring has been conducted. It is expected that *A. subterminalis* will reduce invasive hawkweed populations by reducing above-ground biomass and seed output of established invasive hawkweed patches.

4. Human Health

A. subterminalis is a wasp but it does not sting or produce venom. It is a plant-feeding wasp which poses no risk to humans or other animals.

5. Cumulative Impacts

"Cumulative impacts are defined as the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agencies or person undertakes such other actions" (40 CFR 1508.7).

Many Federal and State agencies, as well as private entities, conduct programs to manage hawkweeds, as well as other invasive weeds. Chemical and mechanical methods, as described previously in this document, are used in a wide range of habitats. Some of these control programs in Idaho, Washington, Montana, Oregon, and Alaska are listed below.

Idaho—
Idaho Department of Lands
Kootenai County Weed Board
Palouse Clearwater Cooperative Weed Management Area
Panhandle Lakes Cooperative Weed Management Area
Potlach Corporation
U.S. Department of Interior (USDI), Bureau of Land Management
Rimrock Hawkweed Cooperative
Selkirk Cooperative Weed Management Area
Benewah County Weed Board
Pend Oreille County Weed Board

Washington—
Washington State Weed Board
Stevens County Weed Board
King County Weed Board

Montana—
Gallatin National Forest
Lolo National Forest
Bitterroot National Forest
Flathead National Forest
Kootenai National Forest
Glacier National Park
U.S. Fish and Wildlife Service–Lost Trail Refuge
USDI, Bureau of Land Management
Lincoln County Weed Department
Flathead County Weed Department
Flathead County Extension
Ravalli County Weed Department
Sanders County Extension
Missoula County Weed Department
Mineral County Weed Department
Lake County Weed Department
Glacier County Weed Department

Montana *cont'd.* —
Granite County Weed Department
Powell County Weed Department
Gallatin County Weed District
Judith Basin Weed District
Big Sky Weed Management Area
Montana Department of Agriculture
Montana Noxious Weed Trust Fund
Montana Department of Natural Resources and Conservation
Confederated Salish Kootenai Tribe
Plum Creek Timber Company

Oregon—
Oregon Department of Agriculture
Union County Weed Control
Deschute County Weed Control
Wallowa County Weed Control
Asotin County Weed Control
East Multnomah Soil and Water Conservation District
Wallowa Whitman National Forest

Alaska—
Kodiak National Wildlife Refuge
Homer Soil and Water Conservation District
Kodiak Garden Club
Koniag Native Corporation
University of Alaska Fairbanks Cooperative Extension Service
Upper Susitna Soil and Water Conservation District
Juneau Invasive Plants Action

Release of *A. subterminalis* is not expected to have any negative cumulative impacts in the continental United States because of its host specificity to invasive hawkweeds. Effective biological control of invasive hawkweeds will have beneficial effects for weed management programs, and may result in a long-term, non-damaging method to assist in the control of hawkweeds.

6. Endangered Species Act

Section 7 of the Endangered Species Act (ESA) and ESA's implementing regulations require Federal agencies to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species or result in the destruction or adverse modification of critical habitat.

The adverse effects of hawkweed invasion on threatened and endangered species is not fully known; however, it can be assumed that invasive hawkweeds do affect threatened, endangered, and sensitive species because of their ability to form dense monocultures. One such example is encroachment by mouse-ear hawkweed into habitat occupied by the threatened golden paintbrush, *Castilleja levisecta*, in Thurston County, Washington (USFWS, 1997). These hawkweed monocultures compete for soil moisture and nutrients, thereby posing risks to native plant species. As hawkweed monocultures invade species-rich range and mountain habitats, it is thought that ecosystem functions and ecological relationships are affected (Littlefield et al., 2008).

Host specificity has been demonstrated by *A. subterminalis*. From the literature, field observations, and host specificity testing, it has been determined that *A. subterminalis* is specific to species in the genus *Hieracium*, subgenus *Pilosella* (Littlefield et al., 2008). There are no *Hieracium* species federally listed as threatened or endangered. No federally listed animal species are known to use invasive hawkweeds.

For these reasons, APHIS has determined that environmental release of *A. subterminalis* will have no effect, or a potentially beneficial effect, depending on the efficacy of the organism, on threatened and endangered species.

V. Other Issues

Consistent with Executive Order (EO) 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations,” APHIS considered the potential for disproportionately high and adverse human health or environmental effects on any minority populations and low-income populations. There are no adverse environmental or human health effects from the field release of *A. subterminalis* and will not have disproportionate adverse effects to any minority or low-income populations.

Consistent with EO 13045, “Protection of Children From Environmental Health Risks and Safety Risks,” APHIS considered the potential for disproportionately high and adverse environmental health and safety risks to children. No circumstances that would trigger the need for special environmental reviews are involved in implementing the preferred alternative. Therefore, it is expected that no disproportionate effects on children are anticipated as a consequence of the field release of *A. subterminalis*.

EO 13175, “Consultation and Coordination with Indian Tribal Governments,” was issued to ensure that there would be “meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications….”

APHIS is consulting and collaborating with Indian tribal officials to ensure that they are well-informed and represented in policy and program decisions that may impact their agricultural interests in accordance with EO 13175.

VI. Agencies, Organizations, and Individuals Consulted

The Technical Advisory Group for the Biological Control Agents of Weeds (TAG) recommended the release of *A. subterminalis* on August 10, 2009. TAG members that reviewed the release petition (Littlefield et al., 2008) included representatives from APHIS, Cooperative State Research, Education, and Extension Service, Forest Service, Environmental Protection Agency, U.S. Army Corps of Engineers, the National Plant Board, and representatives from Canada.

This EA was prepared and reviewed by APHIS. The addresses of participating APHIS units, cooperators, and consultants (as applicable) follow.

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Policy and Program Development
Environmental Services
4700 River Road, Unit 149
Riverdale, MD 20737

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Pest Permitting
4700 River Road, Unit 133
Riverdale, MD 20737

Montana State University
Department of Land resources and Environmental Sciences
P.O. Box 173120
Bozeman, MT 59717–3020

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Appendix 1. Plant species tested during *A. subterminalis* host specificity trials (excluding NZ tests). Asteraceae species are listed by family, subfamily, tribe, and subtribe with species listed alphabetically within tribes. Common names, State distributions, growth habits, durations, and U.S. nativities are from the USDA–NRCS Plants Database (2008) and Canadian from Flora of North America North of Mexico (1993) (from Littlefield et al., 2008).

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Asteraceae Cichorioideae Lactuceae Microseridinae	*Agoseris glauca*	pale agoseris	AK, AZ, CA, CO, IA, ID, MI, MN, MT, ND, NE, NM, NV, OR, SD, UT, WA, WY AB, BC, MB, NT, ON, SK, YT	Forb/herb Shrub Subshrub	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Microseridinae	*Agoseris grandiflora*	bigflower agoseris	CA, ID, MT, NV, OR, UT, WA BC	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Catananchinae	*Catananche caerulea*	Cupid’s Dart	Cultivated	Forb/herb	Perennial	Cultivated	3b Ornamental
Asteraceae Cichorioideae Lactuceae unassigned	*Cichorium intybus*	chicory	AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY AB, BC, MB, NB, NF, NS, ON, PE, PQ, SK	Forb/herb	Biennial Perennial	Introduced	3b Economic
Asteraceae Cichorioideae Lactuceae Crepidinae	*Crepis atribarba*	slender hawksbeard	CO, ID, MT, NE, NV, OR, UT, WA, WY AB, BC, SK	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Crepidinae	*Crepis biennis*	hawksbeard	MI, NY, OH, PA, VA, VT NF	Forb/herb	Biennial Perennial	Introduced	3b
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium albiflorum*	white hawkweed	AK, CA, CO, ID, MT, NV, OR, SD, UT, WA, WI, WY AB, BC, NT, PQ, SK	Forb/herb	Perennial	Native	2
Asteraceae	*Hieracium argutum*	southern	CA	Forb/herb	Perennial	Native	2

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Cichorioideae Lactuceae Hieraciinae		hawkweed					
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium aurantiacum*	orange hawkweed	AK, AR, CA, CO, CT, FL, GA, IA, ID, IL, IN, MA, MD, ME, MI, MN, MT, NC, NH, NJ, NY, OH, OR, PA, RI, SD, TN, VA, VA, VT, WA, WI, WV, WY AB, BC, LB, MB, NB, NF, NS, ON, PE, PQ, SK	Forb/herb	Perennial	Introduced	1
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium bolanderi*	Bolander's hawkweed	CA, OR	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium caespitosum*	meadow hawkweed	CT, DC, GA, ID, IL, IN, KY, MA, MD, ME, MI, MN, MT, NC, NH, NJ, NY, OH, OR, PA, RI, SC, TN, VA, VT, WA, WI, WV, WY BC, MB, NB, NF, NS, ON, PE, PQ	Forb/herb	Perennial	Introduced	1
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium canadense*	Canadian hawkweed	MI, ME AB, BC, LB, MB, NB, NF, NS, NT, ON, PE, PQ, SK, YT	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium carneum*	Huachuca hawkweed	AZ, NM, TX	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium fendleri*	yellow hawkweed	AZ, CO, NM, TX, VT, WY	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium flagellare*	large mouseeared	CT, DE, IN, MA, ME, MI, NJ, NH, NY, OH, PA, VA, VT, WY BC, NB, NS, PE, PQ	Forb/herb	Perennial	Introduced	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium floribundum*	king devil	CT, ID, MA, MD, ME, MI, MN, MT, NH, NJ, NY, OH, RI, VA, VT, WA, WV, WY BC	Forb/herb	Perennial	Introduced	1

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium glomeratum*	queen-devil	WA, ID BC	Forb/herb	Perennial	Introduced	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium gracile*	slender hawkweed	AK, CA, CO, ID, MT, NM, OR, UT, WA, WY AB, BC, NT, YT	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae	*Hieracium greenei*	Greene's hawkweed	CA, OR	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium gronovii*	queen devil	AL, AR, CT, DC, DE, FL, GA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MO, MS, NC, NJ, NY, OH, OK, PA, RI, SC, TN, TX, VA, WY ON	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium horridum*	prickly hawkweed	CA, NV, OR	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium longiberbe*	longbeard hawkweed	OR, WA	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium longipilum*	hairy hawkweed	AR, IA, IL, IN, KS, KY, LA, MI, MN, MO, NE, OH, OK, TN, TX, WI ON	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium parryi*	Scouler's woollyweed	CA, ID, MT, NV, OR, WA, WY	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium pilosella*	mouseear hawkweed	CT, GA, MA, ME, MI, MN, NC, NH, NJ, NY, OH, OR, PA, RI, TN, VA, VT, WA BC, NB, NF, NS, ON, PQ	Forb/herb	Perennial	Introduced	1

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium piloselloides*	yellow devil hawkweed	CT, DE, GA, IA, IL, IN, MA, ME, MI, MN, MT, NC, NH, NJ, NY, OH, PA, RI, VA, VT, WA BC, NB, NF, NS, ON, PE, PQ	Forb/herb	Perennial	Introduced	1
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium scabrum*	rough hawkweed	AR, CT, DC, DE, GA, IA, IL, IN, KY, MA, MD, ME, MI, MN, MO, NC, NH, NJ, NY, OH, OK, PA, RI, SC, TN, VA, VT, WI NB, NS, ON, PE, PQ	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium scouleri* var. *albertinum*	western hawkweed	ID, MT, OR, WA, WY BC	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium scouleri* var. *cynoglossoides*	houndstongue hawkweed	CA, ID, OR, WA BC	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium scouleri* var. *scouleri*	Scouler's woollyweed	CA, ID, MT, NV, OR, WA, WY	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium stoloniflorum*		Not Present in United States or Canada				2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium umbellatum*	narrowleaf hawkweed	AK, CO, IA, ID, IL, IN, MI, MN, MO, MT, ND, NE, NH, OR, SD, WA, WI, WV, WY AB, BC, LB, MB, NB, NF, NS, NT, ON, PE, PQ, SK, YT	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae Hieraciinae	*Hieracium venosum*	rattlesnakeweed	AL, CT, DC, DE, FL, GA, IN, KY, MA, MD, ME, MI, MO, MS, NC, NH, NJ, NY, OH, PA, RI, SC, TN, VA, VT, WY ON	Forb/herb	Perennial	Native	2
Asteraceae Cichorioideae Lactuceae	*Hypochaeris radicata*	hairy catsear	AK, AL, AR, CA, CO, CT, DC, DE, FL, GA, HI, ID, IL, IN, KY, LA, MA, MD, ME, MI, MO, MS, MT, NC, NH, NM, NJ, NV, NY, OH, OR, PA,	Forb/herb	Perennial	Introduced	3b

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Hypochaeridinae			RI, SC, TN, TX, UT, VA, VT, WA, WI, WV BC, LB, NF				
Asteraceae Cichorioideae Lactuceae Microseridinae	*Krigia biflora*	twoflower dwarfdandelion	AL, AR, AZ, CO, CT, DE, GA, IA, IL, IN, KS, KY, MA, MD, MI, MN, MO, MS, NC, NJ, NM, NY, OH, OK, PA, TN, VA, WI, WV ON	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Lactucinae	*Lactuca sativa*	garden lettuce	AL, CA, DC, DE, ID, IL, IN, MA, ME, MI, MO, ND, NM, NY, OH, OK, OR, PA, WA, WV, Puerto Rico, Virgin Islands	Forb/herb	Annual Biennial Perennial	Introduced	3b Economic
Asteraceae Cichorioideae Lactuceae Lactucinae	*Lactuca serriola*	prickly lettuce	AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY AB, BC, MB, NB, NS, ON, PE, PQ, SK	Forb/herb	Annual Biennial	Introduced	3b
Asteraceae Cichorioideae Lactuceae Lactucinae	*Lactuca virosa*	bitter lettuce	AL, CA, DC	Forb/herb	Annual Biennial	Introduced	3b
Asteraceae Cichorioideae Lactuceae Stephanomeriinae	*Lygodesmia juncea*	rush skeletonplant	AR, AZ, CO, IA, ID, IN, KS, MN, MO, MT, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA AB, BC, MB, SK	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Microseridinae	*Microseris nutans*	nodding microseris	CA, CO, ID, MT, NV, OR, SD, UT, WA, WY AB, BC	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Lactucinae	*Prenanthes racemosa*	purple rattlesnakeroot	CO, IA, IL, IN, KY, ME, MI, MN, MO, MT, ND, NE, NJ, NY, OH, PA, SD, WI, WY AB, BC, MB, NB, NF, NS, ON, PE, PQ, SK	Forb/herb	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae	*Sonchus asper*	spiny sowthistle	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM,	Forb/herb	Annual	Introduced	3b

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Sonchinae			NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY, Puerto Rico AB, BC, LB, MB, NB, NF, NS, ON, PE, PQ, SK, YT				
Asteraceae Cichorioideae Lactuceae Sonchinae	*Sonchus arvensis*	field sowthistle	AK, CA, CO, CT, DC, DE, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OR, PA, RI, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY AB, BC, MB, NB, NF, NS, NT, ON, PE, PQ, SK, YT	Forb/herb	Perennial	Introduced	3b
Asteraceae Cichorioideae Lactuceae Sonchinae	*Sonchus oleraceus*	common sowthistle	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY, Puerto Rico, Virgin Islands AB, BC, MB, NB, NF, NS, ON, PE, PQ, SK, YT	Forb/herb	Annual	Introduced	3b
Asteraceae Cichorioideae Lactuceae Stephanomeriinae	*Stephanomeria cichoriacea*	chicoryleaf wirelettuce	CA	Forb/herb Subshrub	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Stephanomeriinae	*Stephanomeria minor*	lesser wirelettuce	AZ, CA, CO, ID, MT, ND, NM, NV, OR, TX, UT, WA, WY BC, SK	Forb/herb Subshrub	Perennial	Native	3b
Asteraceae Cichorioideae Lactuceae Crepidinae	*Taraxacum officinale*	common dandelion	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA,HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY, Puerto Rico AB, BC, LB, MB, NB, NF, NS, NT, NU, ON, PE,	Forb/herb	Perennial	Native Introduced	3b

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
			PQ, SK, YT				
Asteraceae Cichorioideae Cardueae Centaureinae	*Acroptilon repens*	hardheads	AR, AZ, CA, CO, IA, ID, IL, IN, KS, KY, MI, MN, MO, MT, ND, NE, NM, NV, OH, OK, OR, SD, TX, UT, WA, WI, WY AB, BC, MB, ON, SK	Forb/herb	Perennial	Introduced	3c
Asteraceae Cichorioideae Cardueae Carduinae	*Cirsium arvense*	Canada thistle	AK, AL, AR, AZ, CA, CO, CT, DC, DE, IA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OR, PA, RI, SD, TN, UT, VA, VT, WA, WI, WV, WY AB, BC, MB, NB, NF, NS, NT, ON, PE, PQ, SK, YT	Forb/herb	Perennial	Introduced	3c
Asteraceae Cichorioideae Cardueae Carduinae	*Cynara scolymus*	globe artichoke	AZ, CA	Forb/herb	Perennial	Introduced	3c
Asteraceae Asteroideae Anthemideae Artemisiinae	*Artemisia dracunculus*	tarragon	AK, AZ, CA, CO, IA, ID, IL, KS, MA, MN, MO, MT, ND, NE, NM, NV, NY, OK, OR, SD, TX, UT, WA, WI, WY AB, BC, MB, SK, YT	Forb/herb	Perennial	Native	3d Economic
Asteraceae Asteroideae Anthemideae Chrysantheminae	*Chrysanthemum cinerariifolium*	pyrethrum	Cultivated	Forb/herb	Perennial	Cultivated	3d
Asteraceae Asteroideae Eupatorieae Eupatoriinae	*Eupatoriadelphus (Eupatorium) maculatum*	spotted trumpetweed	CT,GA, IA, IL, IN, KY, MA, MD, ME, MI, MN, NC, NH, NJ, NY, OH, PA, RI, TN, VA, VT, WI, WY MB, NB, NS, ON, PE, PQ	Forb/herb	Perennial	Native	3d
Asteraceae Asteroideae Helenieae Pectidinae	*Tagetes erecta*	Aztec marigold	AR, CA, CT, FL, KY, LA, MA, MD, MO, NC, NY, OH, OK, PA, SC, UT, VA, Puerto Rico, Virgin Islands	Forb/herb	Annual	Introduced	3d Ornamental
Asteraceae Asteroideae Heliantheae	*Dahlia* sp.	dahlia	Cultivated	Forb/herb Subshrub	Perennial	Cultivated	3d Ornamental

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
Coreopsidinae							
Asteraceae Asteroideae Heliantheae Helianthinae	*Helianthus annuus*	common sunflower	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY, Puerto Rico AB, BC, MB, NB, NF, NS, NT, ON, PE, PQ, SK	Forb/herb	Annual	Native	3d Ornamental Economic
Asteraceae Asteroideae Vernonieae Vernoniinae	*Stokesia laevis*	Stokes' Aster	AL, FL, GA, LA, MS, NC, SC	Forb/herb	Perennial	Native	3d Ornamental
Asteraceae Gnaphalioideae Gnaphalieae Cassiniinae	*Antennaria dioica*	stoloniferous pussytoes	AK	Forb/herb	Perennial	Native	3d
Asteraceae Gnaphalioideae Gnaphalieae Gnaphaliinae	*Gnaphalium audax*		Not Present in United States or Canada				
Liliaceae	*Allium cepa*	garden onion	AR, CA, CT, IL, IN, KS, KY, LA, MA, ME, MI, MO, MS, MT, NC, NH, NY, OH, OR, PA, SC, TX, VT, WI	Forb/herb	Perennial	Introduced	5 Economic
Asclepiadaceae	*Asclepias syriaca*	common milkweed	AL, AR, CT, DC, DE, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NH, NE, NJ, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV	Forb/herb	Perennial	Native	5
Chenopodiaceae	*Beta vulgaris*	common beet	AL, CA, CT, MA, ME, MI, MO, MT, NC, NH, NY, OR, PA, SC, TX, UT, VA, WV	Forb/herb	Annual Biennial	Introduced	5 Economic
Lamiaceae	*Monarda fistulosa*	wild bergamot	AL, AR, AZ, CO, CT, DC, DE, GA, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI, WV, WY	Forb/herb Subshrub	Perennial	Native	5
Papaveraceae	*Papaver nudicale*	Iceland poppy	Cultivated AK	Forb/herb	Biennial Perennial	Cultivated	5 Ornamental

Family Subfamily Tribe Subtribe	Scientific Name	Common Name	U.S. - State Distribution Canada - Province Distribution	Growth Habit	Duration	U.S. Nativity	Test Category[1]
			YT				
Apiaceae	*Petroselinum crispum*	parsley	AR, CA, CT, FL, GA, HI, IA, ID, KS, LA, MA, MD, MI, MS, MT, NC, NV, NY, OH, PA, RI, TX, SC, UT, WA, Puerto Rico	Forb/herb	Annual Biennial	Introduced	5 Economic
Fabaceae	*Pisum sativum*	garden pea	CA, CT, FL, IL, KS, KY, LA, MA, ME, MI, MO, MS, NC, NH, NY, OK, OR, PA, SC, UT, VA, WA	Forb/herb Vine	Annual	Introduced	5 Economic
Fabaceae	*Vicia faba*	horsebean	CA, CT, DC, MA, MD, ME, MT, NY, OR, PA, VA, VT, WA	Forb/herb Vine	Annual	Introduced	5 Economic

[1]Test Categories: 1. Genetic types of target weed; 2. Species of the same (or closely related) genus; 3. Species in the same family as the target weed (3a. Plants in same subtribe; 3b. Plants in same tribe; 3c. Plants in same subfamily; and 3d. Plants in same family); 4. Threatened and endangered species in the same family; and 5. Species in other families.

Appendix 2. Description of plants chosen for each category for host specificity testing (from Littlefield et al., 2008)

CATEGORY 1:
Genetic types of *Hieracium* (varieties, races, forms, genotypes, apomicts, etc.).

The natural host of *A. subterminalis* is mouse-ear hawkweed, *H. pilosella*. Although specific genotypes of *H. pilosella* were not tested, plants from Europe, New Zealand, and the United States (Washington) were tested. In general, a high proportion of these plant collections supported gall development (54 to 97 percent), although infestation levels probably varied due to testing conditions. Since galls were also induced in other species within the subgenus *Pilosella*, it is thought that *A. subterminalis* is not highly specialized or limited to a particular *H. pilosella* genotype. Host specificity tests conducted for New Zealand indicated that orange hawkweed, *H. aurantiacum*, also supported gall development and the emergence of viable adults. Orange hawkweed is more widespread and abundant in the western United States and Canada and, therefore, a more important target weed. North American testing also indicated that this plant host is suitable, but perhaps less so compared to *H. pilosella*. Infestation levels varied from 13 to 67 percent. Although *H. pilosella* appears to be genetically diverse (Trewick et al., 2004), *H. aurantiacum* has a very limited genetic diversity, especially for North American populations (Loomis, 2007). Therefore, Littlefield et al. (2008) speculate that differences observed in infestations levels were due more to environmental conditions than genotypic differences in *H. aurantiacum*.

CATEGORY 2:
North American species in the same genus as *Hieracium*, divided by subgenera, including economically and environmentally important plants.

2.a. Species in the same subgenus (*Pilosella*):

This subgenus is not represented in the native flora of North America - all members of this subgenus (or genus) are European. For North American testing *H. caespitosum*, *H. glomeratum*, *H. piloselloides*, *H. stoloniflorum*, *H. flagellare*, and *H. floribundum* were included. *Hieracium praealtum* was also tested in New Zealand but was not attacked. Galls were induced only on *H. flagellare* and *H. floribundum*. Gaskin and Wilson (2007) indicated two distinct species grouping within the *Pilosella*. *Hieracium flagellare* is more closely related to both *H. pilosella* and *H. aurantiacum*. *Hieracium floribundum* however, is more closely related to the group containing *H. caespitosum*, *H. glomeratum*, and *H. piloselloides*. Although *H. floribundum* was attacked in tests conducted at MSU, it was not infested in CABI tests. *Hieracium floribundum* is thought to be a cross between *H. caespitosum* and *H. lactucella*, although back crosses with other *Hieraciums* (e.g. *H. aurantiacum*) sometimes occur (Krahulec et al., 2008). H*ieracium stoloniflorum* is another cross (*H. aurantiacum* x *H. pilosella*) (Krahulec et al., 2008), although based upon host utilization of *H. pilosella* and *H. aurantiacum* in the host specificity tests *H. stoloniflorum* was expected to be a potential host, but no gall induction was observed.

2.b. Species in the subgenus *Hieracium*:

From the subgenus *Hieracium*, the North American representative to this subgenus was tested, *H. umbellatum*, and no gall development occurred. Although *H. canadense* has previously been placed in this subgenus, recent work by Gaskin and Wilson (2007) placed this species in the subgenus *Chionoracium*. Other representatives (*H. lepidulum*, *H. murorum*, and *H. sabaudum*) to this subgenus were tested by CABI and in New Zealand, but not attacked by *A. subterminalis*.

The subgenus *Hieracium* is poorly represented in North America. *Hieracium umbellatum* is Holarctic in distribution and is thought to be a native. Other subgenus *Hieracium* species in North America include *H. argillaceum*, *H. murorum*, *H. groenlandicum*, and *H. sabaudum*; all of which are introduced. However, these species are generally not considered noxious weeds.

Based on host specificity testing, it is unlikely that any plant in this subgenus would be utilized as a host by *A. subterminalis* since none are stoloniferous (produce stolons). *A. subterminalis* attacks and causes galls only in stolons and not other plant parts.

2.c. Species in the subgenus *Chionoracium*:

Subgenus *Chionoracium* is represented throughout North America. Sixteen species representative of the geographic range of native species were tested. From the Northwest and Intermountain region, *H. gracile*, *H. longiberbe*, *H. parryi*, and *H. scouleri* var. *albertinum* and *scouleri*, and the white flowered *H. albiflorum* were tested. From southern Oregon and northern California, *H. bolanderi*, *H. horridum*, and *H. greenei* were used. From California, *H. argutum* was tested. From the Southwest, *H. carneum* and *H. fendleri* were tested, and from the East and Midwest, *H. longipilum*, *H. gronovii*, *H scabrum*, and *H. venosum* were tested. *Hieracium canadense* was also tested and its distributions extend over much of the northern United States and southern Canada. None of these species were infested by *A. subterminalis* and none of the hawkweed species associated with the subgenus *Chionoracium* produces stolons in which the gall wasp induces galls. It is highly unlikely that *A. subterminalis* would utilize these plants as hosts.

CATEGORY 3:
North American species in other genera in the Asteraceae family, divided by subtribe, tribe, and subfamily, including economically and environmentally important plants.

The Asteraceae is the largest plant family and is divided into 3 subfamilies, 17 tribes, and numerous subtribes. In developing our list of plants to be tested, we followed the reclassification of the Asteraceae by Bremer (1994).

3.a. Species in the same subtribe (Hieraciinae) as *Hieracium*:

Other genera in the Hieraciinae subtribe include *Andryala*, *Arnoseris*, *Hispidella*, *Hololeion*, and *Tolpis*. No species from these genera were tested since they are not native to North America, nor do they contain any economically important plants in North America (Bremer, 1994). Only two species, *Arnoseris minima* and *Tolpis barbata* are reported to occur in the United States and Canada (Flora of North America North of Mexico, 2008; USDA-NRCS Plants Database 2008).

3.b. Species in different subtribes of the same tribe (Lactuceae) as *Hieracium*:

The Lactuceae is one of the best known tribes of the Asteraceae and is well supported as a distinct monophyletic group. Subtribal and generic classifications are more defined in this tribe than in most other tribes (Bremer, 1994). The Lactuceae are set apart from other Asteraceae by a ligulate capitula, milky latex, and absence of oil ducts (except in *Scolymus*), although none of these characteristics are restricted to the Lactuceae alone (Mañez *et. al*., 1994). Besides the Hieraciinae, there are five Lactuceae subtribes that contain species native to North America (Crepidinae, Lactucinae, Malcothrinae, Microseridinae, and Stephanomeriinae); four subtribes with introduced species (Catananchinae, Hypochaeridinae = Leontodontinae, Scorzonerinae, and Sonchinae); and two introduced genera (*Cichorium* and *Scolymus*) that have not been assigned to a subtribe (Bremer, 1994).

Two genera in the Crepidinae subtribe (*Crepis* and *Taraxacum*) contain species native to North America (Bremer, 1994). *Crepis* is an important genus to test because of the number of native and a few introduced species in the United States (Flora of North America North of Mexico 2008, USDA-NRCS, 2008). The two *Crepis* species we tested were *Crepis atribarba* (native) and *Crepis biennis* (introduced). *Taraxacum* is another important genus to test because of the presence of native species in Western North America (USDA-NCRS, 2008), some of which are threatened, endangered, or sensitive (see Category 4). The cosmopolitan species *Taraxacum officinale* was tested, and in New Zealand, *T. magellanicum* was also tested.

Within the Lactucinae, two genera contain species native to North America: *Lactuca* and *Prenanthes* (Bremer, 1994; USDA-NRCS, 2008). *Lactuca sativa* (lettuce) was included because of its economic importance. In addition, *Lactuca serriola* and *L. virosa* were tested since they are widespread weeds. *Prenanthes sagittata* was tested since it is a native.

The Microseridinae contains the following genera native to North America: *Agoseris*, *Krigia*, *Microseris*, *Nothocalais*, *Phalacroseris*, *Pyrrhopappus*, *Stebbinsoseris*, and *Uropappus* (Bremer, 1994; USDA-NCRS, 2008). Four native species: *Microseris nutans*, *Agoseris glauca*, *A. grandifolia*, and *Krigia biflora* were included in tests. In New Zealand, *Microseris scapigera* was used.

The Stephanomeriinae contains the following genera native to North America: *Chaetadelpha*, *Lygodesmia*, *Prenanthella*, *Rafinesquia*, *Shinnersoseris*, and *Stephanomeria* (Bremer, 1994; USDA-

NCRS, 2008). Three native western species were tested: *Lygodesmia juncea*, *Stephanomeria cichoriacea*, and *S. minor* (= *S. tenuifolia*).

The Malcothrinae contains the following genera native to North America: *Anisocoma*, *Atrichoseris*, *Calycoseris*, *Glyptopleura*, *Malacothrix*, and *Pinaropappus* (Bremer, 1994; Flora of North America North of Mexico, 2008; USDA-NCRS, 2008). Most are native to the Southwestern United States, except *Glyptopleura* (western annuals) and *Malacothrix* (western annuals and perennials). No species from this subtribe were tested because sources for seeds and/or plant material were identified.

Of the four subtribes with introduced species but no natives, *Catanache caerula*, an introduced ornamental from the Catananchinae was included. For the subtribe Sonchinae: *Sonchus arvensis, S. asper*, and *S. oleraceus* were tested; plus *S. kirkii*, which was also tested in New Zealand. No species from the Hypochaeridinae, or Scorzonerinae were included, as these subtribes are not native to North America and contain no economically important introduced species (Bremer, 1994; USDA-NCRS, 2008). Among the introduced genera unassigned to a subtribe, *Cichorium intybus* (chicory) was used in both New Zealand and North American tests because of its economic importance.

In summary, 26 species belonging to other subtribes within Lactuceae were tested during North American and New Zealand host specificity tests. None were utilized by *A. subterminalis* as a host.

3.c. Species in different tribes in the same subfamily (Cichorioideae):

According to Bremer (1994), the subfamily Cichorioideae contains three tribes with natives in North America (Cardueae, Mutisieae, and Vernonieae) plus a tribe with some introduced ornamentals (Arctoteae). The Mutisieae and the Vernonieae are believed to be closely related to the Lactuceae (Mañez et al., 1994; Tomb, 1977). Like the Lactuceae, several species of *Mutisieae* and *Stokesia* have ligulate corollas (Tomb, 1977). *Stokesia laevis*, a native ornamental in the Veronieae was used for testing. From the Cardueae, we used two weedy species that can reproduce asexually by lateral roots, *Acroptilon repens* (Russian knapweed) and *Cirisium arvense* (Canada thistle), as well as *Cynara scolymu*s (globe artichoke). Both *Carthamus tinctorius* (safflower) and globe artichoke were tested from this subfamily for the New Zealand tests. Galls were not induced by *A. subterminalis* on any of these species.

3.d. Species in different subfamilies in the same family (Asteraceae):

Besides the Cichorioideae, there are two additional subfamilies (Barnadesioideae and Asteroideae) in the Asteraceae family (Bremer, 1994).

The Barnadesioideae comprise nine genera and are exclusively South American. Because there are no species native to North America (Bremer, 1994), no Barnadesioideae were included in testing.

The Asteroideae include the majority of the Asteraceae and comprise eight tribes with species native to the United States (Anthemideae, Astereae, Eupatorieae, Gnaphalieae, Helenieae, Heliantheae, Plucheeae, and Senecioneae), two additional tribes with ornamental species (Calenduleae and Inuleae), and eight genera unassigned to a tribe (Bremer, 1994). Although acetylenes are relatively rare in the Lactuceae, those which are present belong to a special group which may link the Lactuceae chemotaxonomically with the Astereae and the Anthemideae (Mabry and Bohlmann, 1977). In combined North American and New Zealand tests, 12 species were used representing the eight subtribes of the Asteraceae. Galls were not induced on any of these species.

Category 3 Summary**:** From testing these 42 species in all of Category 3, Littlefield et al. (2008) obtained sufficient evidence to conclude that the feeding range of this gall wasp is restricted to the genus *Hieracium*, subgenus *Pilosella*, and that species in other subfamilies of the Asteraceae family are not at significant risk.

CATEGORY 4: Threatened and endangered species in the Asteraceae family, divided by subgenus, genus, subfamily, and tribe.

4.a. Species in the same subgenus (*Pilosella*):

There are no *Hieracium* species belonging to subgenus *Pilosella* listed as threatened, endangered, or sensitive.

4.b. Species in the same genus as *Hieracium*:

While there are no threatened or endangered species of *Hieracium* in the United States (or Canada), several states identify one or more *Hiearcium* species as being restricted in distribution.

The following is a list of States that list one or more *Hiearcium* species on their Special Plants List (or equivalent).

Pennsylvania http://www.dcnr.state.pa.us/forestry/pndi/fullplants.asp lists *H. kalmii* and *H. trailii*.

Ohio http://www.dnr.state.oh.us/odnr/dnap/heritage/plantlst.html lists *H. canadense* and *H. longipilum*.

Utah http://www.nr.state.ut.us/dwr/dwr.htm lists *H. fendleri.*

In Oregon, the Oregon Natural Heritage Program http://www.heritage.tnc.org/nhp/us/or/vd-l.htm lists *H. bolanderi*, *H. greenei*, and *H. horridum.*

Tennessee http://www.state.tn.us/environment/nh/tnplants.html lists *H. longipilum*, and *H. scabrum*.

Michigan http://www.dnr.state.mi.us/wildlife/heritage/ lists *H. longipilum.*
Native *Hieracium* species were selected from across the geographic range of the genus throughout North America. All of the *Hieracium* species native to North America belong the subgenus Chionoracium, none of which were infested by *A. subterminalis*.

4.c. Species in the same subtribe (Hieraciinae) as *Hieracium*:

There are no threatened, endangered, or sensitive species within the same subtribe as *Hieracium.*

4.d. Species in different subtribes of the same tribe (Lactuceae) as *Hieracium*:

Four of the Lactuceaae subtribes (besides Hieraciinae) have threatened, endangered, or sensitive species in the continental United States (USFWS, 1993; USFWS, 1996). Because obtaining plant material of threatened, endangered, and sensitive species can be difficult and can further decimate populations, listed species were not tested. Instead, a more common member from each genus was selected as a surrogate.

Two Crepidinae species, *Taraxacum californicum* Munz & Johnston, proposed endangered, and *T. officinale* ssp. *ceratophorum* (Ledeb.) Schinz ex. Thellung (syn. *T. carneocoloratum*), sensitive, are listed in the continental United States (http://www.fws.gov/r9endspp/endspp.html). The more common species *Taraxacum officinale* was tested (listed in Category 3.b.). The Lactucinae has two species of *Prenanthes* listed as sensitive [*P. barbata* (Torr. & Gray) Milstead and *P. boottii* (DC.) Gray]. The more common native species, *Prenanthes sagittata*, was substituted (listed in Category 3.b.). The Microseridinae has two species of *Microseris* listed as sensitive (*M. decipens* Chambers and *M. howellii* Gray). The more common native species, *Microseris nutans*, was tested (listed in Category 3.b.). The Stephanomeriinae has one federally endangered *Stephanomeria* (*S. malheurensis* Gottlieb), one sensitive *Stephanomeria* (*S. blairii* Munz. & Johnston) and one sensitive *Lygodesmia* species (*L. doloresensis* S. Tomb). Instead *Stephanomeria minor (= S. tenuifolia*), *S. cichoriacea*, and *Lygodesmia juncea* were tested (listed in Category 3.b.)

4.e. Species in different tribes in the same subfamily (Cichorioideae):

The Cardueae has several *Cirsium* species listed as threatened, endangered, or sensitive in the continental United States (http://www.fws.gov/r9endspp/endspp.html): *Cirsium fontinale* var. *fontinale (*fountain thistle), *Cirsium fontinale* var. *obispoense* (Chorro Creek bog thistle), *Cirsium hydrophilum* var.*hydrophilum* (Suisun thistle), *Cirsium loncholepis* (La Graciosa thistle), and *Cirsium pitcheri* (Pitcher's thistle). All but the last species is federally endangered, while *C. pitcheri* is threatened. Because obtaining achenes and/or plant material of threatened, endangered, and sensitive species can be difficult and can further decimate populations, these rare species were not tested. *Cirsium arvense*, a more common member from this genus which also reproduces asexually by lateral roots was selected.

4.f. Species in different subfamilies in the same family (Asteraceae):

At this level, no representatives from genera with threatened, endangered, or sensitive individuals were tested. With over 20 genera with federally listed threatened or endangered species and over 70 additional genera with sensitive species in the continental United States, the number of species we would need to test is prohibitively large. Testing was conducted on representatives to the various subtribes of Asteraceae (Category 3.d). It was evident from MSU testing and testing conducted for New Zealand that *A. subterminalis* was restricted in its host range and plants outside the genus *Hieracium* subgenus *Pilosella* are not at risk of attack by this agent.

CATEGORY 5:
North American species in other families in the Asterales order that have some phylogenetic, morphological, or biochemical relationship to the target weed, including economically and environmentally important plants.

Neither Cronquist nor Dahlgren list any families other than the Asteraceae in the Asterales order; however, Thorne lists the Calyceraceae as belonging in the Asterales. Cronquist places the Calyceraceae in the Calycerales while Dahlgren places it in the Dipsacales. Since two out of three systems list the Calyceraceae in an order other than Asterales, this family is discussed in Category 6.

CATEGORY 6:
North American species in other orders that have some morphological or biochemical relationship to the target weed, including economically and environmentally important plants.

6.a. Species in other orders that are phylogenetically related to the Asteraceae:

The Asteraceae form such a well-defined group that they are sometimes considered systematically isolated. The most closely related families are generally considered to be the Calyceraceae, Campanulaceae *sensu lato*, and Goodeniaceae (Bremer, 1994). The Calyceraceae contain six genera with about 60 species in southern South America (Bremer, 1994). One species, *Acicarpha tribuloides*, is listed as present in North America (Kartesz and Kartesz, 1980). The Campanulaceae *sensu lato* contain about 85 genera and more than 2,200 species (Bremer, 1994). There are about 23 genera and 290 species in the United States and Canada (Zomlefer, 1994). The Campanulaceae have been shown to be chemotaxonomically linked to the Asteraceae (Mabry and Bohlmann, 1977). The Goodeniaceae contain 12 genera and 400 predominately Australian species (Bremer, 1994). One genus, *Scaevola*, has 2 species listed as present in the central and southern United States (USDA-NRCS, 2008). Due to the apparent specificity of *A. subterminalis*, plants within these orders were not tested (Littlefield et al., 2008).

6.b. Species in other orders that are biochemically similar to the Asteraceae:

Species in the Lactuceae are characterized, in part, by their milky latex. However, more than 12,500 species in 900 genera and 20 families have been identified worldwide that produce latex (Metcalfe, 1967). Over 300 species in the United States have been shown to contain latex (Buchanan, 1978). The following four latex-producing species from different families were selected for testing: *Allium cepa*, *Asclepias syriaca*, *Monarda fistulosa* L., and *Papavar nudicaule* L. All are native or introduced to the western United States. None of these latex-producing species were attacked by *A. subterminalis* (Littlefield et al., 2008).

The Lactuceae also differ phytochemically in that their sesquiterpene lactones are predominately guaianolides, whereas the other Asteraceae subfamilies contain plants with considerable portions of other sesquiterpene lactones (Wapshere, 1983). Unlike most other Asteraceae, the Lactuceae possess either no or a low level of polyacetylene compounds (Sorensen, 1977). The Apiaceae (= Umbellifereae) have been shown to be chemotaxonomically linked to the Asteraceae (Mabry and Bohlmann, 1977). *Petroselinum crispum* (parsley), which is economically important and chemically similar to the Asteraceae, was not infested during the New Zealand tests (Littlefield et al., 2008).

6.c. Selected cultivated species in other orders:

No cultivated species in other plant orders were tested, although several species were tested for the New Zealand project.

CATEGORY 7:
Any plant on which the biological control agent or its close relatives (within the same genus) have been previously recorded to feed and/or reproduce.

Cynipid wasps of the genus *Aulacidea* generally have a narrow host range, confined to the family Asteraceae. A number of species utilized by other *Aulacidea* spp. wasps, including *Acroptilon*, *Hieracium*, *Hypochoeris*, *Lactuca*, *Prenanthes*, *Senecio*, *Solidago*, *Sonchus*, and *Tragopogon,* were tested. Galls were only induced on several species belonging to the *Hieracium* subgenus *Pilosella* (Littlefield et al., 2008).

Conclusions

Based upon test results from Montana State University, as well as testing of *A. subterminalis* for importation into New Zealand, host utilization by *A. subterminalis* is confined to a few closely related hawkweed species all of which are Old World species. Native North American hawkweeds are precluded from attack in that they do not produce stolons, the location where the gall wasp induces galls and completes its development. All native North American hawkweeds are phylogentically distant and distinct from the exotic, and often weedy, hawkweeds of the *Pillosella* group (Littlefield et al., 2008).

Appendix 3. Galling observed in multiple-choice and larval development tests with *A. subterminalis* (combined results for New Zealand host specificity tests 1995 to 1997; taken from Syrett et al., 1998).

Test Plant Species	**Total No. of Plants**	
	Offered	**Attacked**
Asteraceae		
Lactuceae		
Subgenus Pilosella		
Hieracium pilosella L. EUR	76	74
H. pilosella L. NZ	14	10
H. aurantiacum L.	4	2
H. caespitosum Dumort EUR	6	0
H. caespitosum Dumort USA	5	0
H. praealtum Gochnat	3	0
H.x stoloniferum Waldst. et Kit	3	0
Subgenus Hieracium		0
H. lepidulum (Stenstroem) Omang	6	0
H. murorum L.	7	0
H. sabaudum L.	8	0
Representatives of other Subtribes of Lactuceae		
Cichorium intybus L.	7	0
Embergia grandifolia (Kirk) Boules	4	0
Hypochoeris radicata L	8	0
Lactuca sativa L.	4	0
Microseris scapigera (Solex A.Cunn.) Sch.Bip.	5	0
Picris hieracioides L.	7	0
Sonchus kirkii Hamlin	6	0
Sonchus oleraceus L.	6	0
Taraxacum officinale L.	5	0
Taraxacum magellanicum Schutz-Bip.	2	0
Tragopogon porrifolius L.	6	0
Anthemidae		
Artemesia dracunculus L.	1	0
Chrysanthemum cinerariifolium (Treviri) Vis.	7	0
Astereae		
Celmisia sp.	3	0
Olearia avicenniifolia (Raul.) Hook f.	4	0
Cardueae		
Carthamus tinctorius L.	7	0
Cynara scolymus L.	6	0
Heliantheae		
Helianthus annuus L.	6	0

Test Plant Species	Total No. of Plants	
	Offered	Attacked
Senecioneae		
Brachyglottis monroi Hook. f.	2	0
Other Plant Families		
Apiaceae: *Patroselinum crispum* (Miller) A.W. Hill	8	0
Brassicaceae: *Brassica oleracea* L.	7	0
Cannaceae: *Canna edulis* Ker-Gawl.	9	0
Caryophyllaceae: *Dianithus barbatus* L.	7	0
Cyperaceae: *Carex testacea* Sol ex Booth Hook. f.	5	0
Fabaceae: *Trifolium repens* L.	7	0
Iridaceae: *Gladiolus communis* L.	8	0
Lamiaceae: *Mentha* sp.	8	0
Liliaeae: *Allium cepa* L.	8	0
Malvaceae: *Althea rosea* L.	5	0
Myrtaceae: *Leptospermum scoparium* J.R. et G. Forst.	3	0
Oleaceae: *Olea europaea* L.	2	0
Poaceae: *Poa colensoi* Hook. f.	7	0
Poaceae: *Agrostis tenuis* Sibth.	5	0
Poaceae: *Festuca novae-zelandiae* (Hack.), Ckn	7	0
Polyganaceae: *Rumex acetosella* L.	7	0
Rutaceae: *Citrus* sp.	8	0
Scrophulariaceae: *Antirrhinum majus* L.	2	0
Solanaceae: *Lycopersicon esculentum* Miller	8	0
Theaceae: *Camellia japonica* L.	8	0
Urticaceae: *Urtica dioica* L.	7	0

Appendix 4. No-choice oviposition and larval development tests with *A. subterminalis* conducted from 2000 to 2006 at CABI-Europe and Montana State University (Littlefield et al., 2008).

Test Plant[1]	No. Reps	Reps. Infested		Mean No. Gall Clusters/Rep (+ SE)
		No.	%	
ASTERACEAE				
Tribe: Lactuceae				
Subtribe: Hieraciinae **Subgenus: Pilosella**				
Hieracium aurantiacum ID	15	2	13.3	0.13 (0.09)
H. aurantiacum MT	1	0	0	0
H. aurantiacum NZ	6	4	66.7	1.33 (0.49)
H. aurantiacum ID, MT	44	17	38.6	0.89 (0.21)
H. caespitosum ID	33	0	0	0
H. caespitosum ID	3	0	0	0
H. flagellare NH	16	8	50.0	1.62 (0.79)
H. floribundum US	9	0	0	0
H. floribundum	17	9	52.9	1.24 (0.48)
H. glomeratum BC	2	0	0	0
H. glomeratum WA	6	0	0	0
H. glomeratum ID	7	0	0	0
H. pilosella EUR	28	23	82.1	2.68 (0.42)
H. pilosella US	13	11	84.6	1.92 (0.62)
H. pilosella WA	46	25	54.3	1.35 (0.29)
H. piloselloides US	6	0	0	0
H. piloselloides	11	0	0	0
H. stoloniflorum Eur	9	0	0	0
Subtribe: Hieraciinae **Subgenus: Hieracium**				
H. umbellatum	13	0	0	0
Subtribe: Hieraciinae **Subgenus: Chionoracium**				
Hieracium. albiflorum	2	0	0	0
H. albiflorum	18	0	0	0
H. argutum	3	0	0	0
H. argutum	18	0	0	0

Test Plant[1]	No. Reps	Reps. Infested		Mean No. Gall Clusters/Rep (± SE)
		No.	%	
H. bolanderi	15	0	0	0
H. canadense	7	0	0	0
H. canadense	15	0	0	0
H. carneum	1	0	0	0
H. carneum	15	0	0	0
H. fendleri	3	0	0	0
H. fendleri	10	0	0	0
H. gracile	7	0	0	0
H. greenei	14	0	0	0
H. gronovii	3	0	0	0
H. gronovii	17	0	0	0
H. horridum	3	0	0	0
H. longiberbe	8	0	0	0
H. longipilum	15	0	0	0
H. parryi	11	0	0	0
H. scabrum	15	0	0	0
H. scouleri var. *albertinum*	6	0	0	0
H. scouleri var. *albertinum*	11	0	0	0
H. scouleri var. *cynoglossoides*	17	0	0	0
H. venosum	5	0	0	0
Other Subtribes of Lactuceae				
Subtribe: Catananchinae				
Catananche caerula	6	0	0	0
Subtribe: Crepidinae				
Crepis atribarba	10	0	0	0
Crepis biennis	15	0	0	0
Taraxacum officinale	6	0	0	0
Subtribe: Hypochaeridinae				
Hypochoeris radicata	6	0	0	0
Subtribe: Lactucinae				
Lactuca sativa	9	0	0	0

Test Plant[1]	No. Reps	Reps. Infested		Mean No. Gall Clusters/Rep (+ SE)
		No.	%	
Lactuca serriola	3	0	0	0
Lactuca virosa	6	0	0	0
Prenanthes racemosa	4	0	0	0
Subtribe: Microseridinae				
Agroseris glauca	16	0	0	0
Agoseris grandiflora	5	0	0	0
Agroseris grandifolia	3	0	0	0
Krigia biflora	3	0	0	0
Krigia biflora	13	0	0	0
Microseris nutans	11	0	0	0
Subtribe: Sonchinae				
Sonchus arvensis	6	0	0	0
Sonchus asper	8	0	0	0
Sonchus oleraceus	6	0	0	0
Subtribe: Stephanomeriinae				
Lygodesmia juncea	14	0	0	0
Stephanomeria cichoriacea	14	0	0	0
Stephanomeria minor	5	0	0	0
Subtribe: unassigned				
Cichorium intybus	10	0	0	0
Other Tribes of Asteraceae				
Tribe: Anthemideae				
Artemisia dracunculus	6	0	0	0
Chrysanthemum cinerariifolium	9	0	0	0
Tribe: Cardueae				
Acroptilon repens	8	0	0	0
Cirsium arvense	10	0	0	0
Cynara scolymus	9	0	0	0
Tribe: Eupatorieae				
Eupatorium maculatum	9	0	0	0

Test Plant[1]	No. Reps	Reps. Infested		Mean No. Gall Clusters/Rep (± SE)
		No.	%	
Tribe: Gnaphalieae				
Antennaria dioica	9	0	0	0
Gnaphalium audax	9	0	0	0
Tribe: Helenieae				
Tagetes erecta	9	0	0	0
Tribe: Heliantheae				
Dahlia sp.	3	0	0	0
Helianthus annuus	9	0	0	0
Tribe: Vernonieae				
Stokesia laevis	5	0	0	0
OTHER FAMILIES				
Apiaceae: *Petroselinum crispum* (parsley)	3	0	0	0
Asclepiadacea: *Asclepias syriaca* (common milkweed)	7	0	0	0
Chenopodiaceae: *Beta vulgaris* (beet)	9	0	0	0
Fabaceae: *Pisum sativum* (garden pea)	7	0	0	0
Fabaceae: *Vicia faba* (broad bean)	5	0	0	0
Lamiaceae: *Monarda fistulosa* (wild bergamot)	6	0	0	0
Liliaceae: *Allium cepa* (onion)	8	0	0	0
Papavaracea: *Papaver nudicaule* (Islandic poppy)	3	0	0	0

[1] Plant species highlighted in blue indicate those tested at Montana State University.

Appendix 5. Response to comments on draft EA

Four comments were submitted on the draft environmental assessment for release of *A. subterminals* for biological control of hawkweeds. A commenter from the Florida Department of Agriculture and Consumer Services supported the release of the gall wasps as biological control agents. Specific issues were raised by the other three commenters. The issues raised are indicated in bold text and the response follows.

An anonymous commenter indicated general concern with the release of *A. subterminalis,* as well as other concerns with APHIS that are out of the scope of this EA. The commenter indicated that more tests should be done to demonstrate the safety of release of *A. subterminalis.*

Extensive host specificity testing was conducted over a 6-year period that demonstrated the safety of *A. subterminalis* to native plants. Study results were reviewed by The Technical Advisory Group for the Biological Control Agents of Weeds (TAG) and the release of *A. subterminalis* was recommended by the TAG. TAG members that reviewed the release petition included representatives from APHIS, Cooperative State Research, Education, and Extension Service (now National Institute of Food and Agriculture), Forest Service, Environmental Protection Agency, U.S. Army Corps of Engineers, the National Plant Board, and representatives from Canada.

A commenter from the Alaska Association of Conservation Districts supported the release of *Aulacidea subterminalis* but raised two issues. The first was regarding placing a hold on the potential release of *A. subterminalis* in Alaska until field tests prove that it can survive and impact either invasive orange hawkweed (*Pilosella aurantiaca* (=*Hieracium aurantiacum)*) or native *Hieracium umbellatum*.

There are no current plans to release the wasp in Alaska. Any releases made within that state will be largely dependent upon Alaskan cooperators at the federal, state, county or local level. It will likely be a number of years before this gall wasp will be readily available for general release and redistribution. By that time data from the field indicating the potential impact of the wasp on orange hawkweed may be available. No North American native hawkweeds were infested in laboratory host specificity tests, including *Hieracium umbellatum*. Therefore, it is unlikely that *A. subterminalis* would survive on that species in Alaska.

The second issue was in regards to the possible utilization of the native hawkweed *Hieracium triste* by *Aulacidea subterminalis*. According to the Plants Database (USDA, NRCS, 2010) *H. triste* (woolly hawkweed) has two varieties: *H. triste* var. *fulvum* and *H. triste* var. *triste*. *Hieracium triste* var. *fulvum* has been reported only from Alaska, whereas *H. triste* var. *triste* is more widespread occurring in Alaska and in the Canadian provinces of Alberta, British Columbia, Yukon, and Northwest Territories. The Plants Database also lists several varieties of *Hieracium gracile* (slender hawkweed): H. *gracile* var. *alaskanum* found in Alaska*; H. gracile* var.

detonsum located in California, Colorado, Idaho, Oregon, and Washington; *H. gracile* var. *gracile* found in Alaska and most of the western United States; and *H. gracile* var. *yukonense* also found in Alaska. Based upon analyses of certain sequences of chloroplast DNA conducted by Gaskin and Wilson (2007), *H. triste* and *H. gracile* are very genetically similar. This data appears to lend support to the synonymization of *H. gracile* with *H. triste* by some authors (Brouillet et al., 2010; eFloras.org ,2010). Furthermore, both plants seem to share similar life habits and ecological niches (eFloras.org , 2010; Rice and Halpop, 2009). Phylogenetically, this species (or species group) is contained in the subgenus *Chionoracium*, a subgenera of the *Hieracium* to which the majority of native North American hawkweeds belong. *Hieracium gracile* var. *gracile* was tested in host specificity studies but was not infested by *A. subterminalis*. In addition, no North American native hawkweeds were infested in host specificity tests.

Gall induction is a complex biochemical and morphological process; thus, gall-inducing insects tend to be very host and tissue specific, making them attractive for use as biological control agents of weeds. *Aulacidea subterminalis* only induces galls at the tips of stolons which are only produced by invasive hawkweeds of the *Pilosella* genus (formerly considered a subgenus) and not by any of the native hawkweeds. There is no evidence that suggests that *A. subterminalis* will utilize lateral roots or rhizomes should they be produced by native plant species. Because *A. subterminalis* is a stolon feeder and host range is restricted to a small group of related invasive hawkweeds of the genus *Pilosella*; the risk to native hawkweeds, which do not produce stolons, is extremely low.

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A commenter from Habitat Conservation, and Environmental Contaminants, U.S. Fish and Wildlife Service, Region 8 Ecological Services, Sacramento, CA raised two issues of concern. The first comment was in regards to the geographic, ecological, and economic impact of invasive hawkweed species. The commenter believed that the purpose and need for the proposed action does not adequately describe the impact of non-native hawkweeds in a manner that justifies the risk of introduction of a non-native insect.

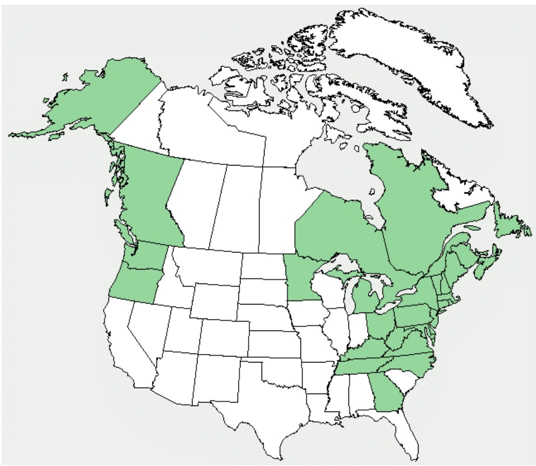
The Pacific Northwest (PNW) is in a phase of exponential expansion and colonization by invasive hawkweed species. The number of counties in the PNW reporting new infestations of both orange (*P. aurantiaca*) and meadow hawkweed (*P. caespitosa*) has significantly increased over the past 10 – 15 years (Rice, 2010). In Montana it is estimated that 57,000 acres were infested by invasive hawkweeds in 2000, but as of 2008 this estimate has been revised to well over 120,000 acres (M. Funk, Montana Hawkweed Coordinator, pers. comm.). It has been estimated that the annual increase of invasive hawkweeds within Flathead County Montana is over 11% per year while Wilson (2002 in Duncan and Clark, 2005) reported a 16% annual increase for the northwestern U.S. Risk maps of Montanan weeds indicate that large portions of western areas of the state could be subject to invasion (www.fs.fed.us/r1/cohesive_strategy/data/weeds/wra.ppt *last accessed* January 25, 2011). It was estimated by Wilson (2002 in Duncan and Clark, 2005) that over 1.2 million acres within the United States are infested with hawkweed. Of that, 650,000 occurs in the northwestern United States (ID, MT, OR, WA). In British Columbia, both orange and meadow hawkweeds are widespread in southern and central portions of the province (E-Flora BC Klinkenberg, 2010) and are of serious concern in northeastern British Columbia (Giroday and Baker, 2006). Information regarding hawkweed infestation within eastern United States is often unavailable, but several invasive hawkweed species are widespread (see distribution maps below).

Although hard data regarding the invasiveness of hawkweed in North America is difficult to obtain, existing data suggests a moderate to high invasive potential by these exotic hawkweed species. Risk analysis of orange and/or meadow hawkweed has been conducted in Alaska and northeastern British Columbia and both indicate a moderate to a high degree of invasiveness (e.g. in Alaska both orange and meadow hawkweeds were rated 79 out of a possible 100 total points http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm *last accessed* January 25, 2011) (Carlson et al., 2008; Giroday and Baker, 2006). A 2005–2006 USDA-APHIS-PPQ Biocontrol Target Pest Canvassing and Evaluation survey of various Federal, tribal and state agencies, universities, and weed management districts ranked both orange and meadow hawkweeds as western region priority weeds for biological control, ranking seven out of 16 noxious weed species cited by land managers (Hansen and Bloem, 2006). Orange and/or meadow hawkweeds have been included on noxious weed lists in Alaska, Colorado, Idaho, Montana, Oregon, and Washington, and the Canadian provinces of Alberta, British Columbia, and Quebec. Regulations vary by state/province but generally involve actions such as restricted importation and/or quarantine and prevention, containment, eradication, or other control measures. In some states such as Oregon and Montana, plants are ranked according to various criteria including detrimental effects, mode of spread or reproduction, distribution or potential distribution, and difficulty in control (Oregon Department of Agriculture, 2010; T. Moon (Montana Department of Agriculture) pers. comm.). Invasive hawkweeds also have an adverse economic impact. Wilson (2002 in Duncan and Clark, 2005) estimated a $58.2 million dollar impact for the treatment of hawkweeds in western United States.

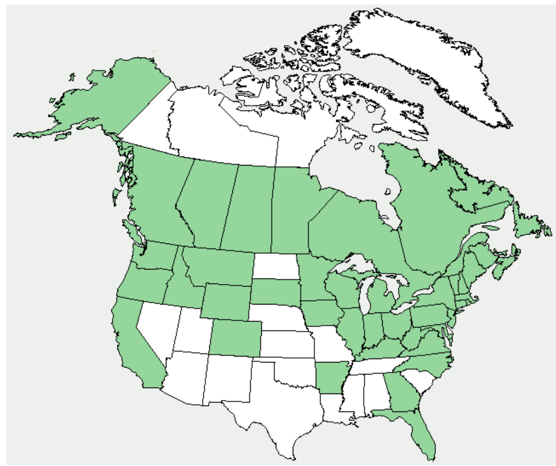
Invasive hawkweeds have been proven detrimental in other areas of the world. From Europe, hawkweeds have spread to North America, New Zealand (Grundy, 1989), Australia (Syrett, pers. comm.), Japan (Suzuki and Narayama, 1977), Chile and Argentina (Norambuena, pers. comm.). In New Zealand, 10 species of hawkweeds infest over 1.25 million acres in the South Island alone (across 42% of the landmass) (McMillan, 1991), while other figures list 15 million acres infested in both islands with an economic impact of $42 million (New Zealand Dollars) (Sheean, 2009).
In North America, invasive hawkweeds are primarily weeds of moist pastures and forest meadows, and mesic rangeland. The potential for spread in the northern Great Plains and the Columbia River region is difficult to predict at this time. However, invasive hawkweed occurrences as weeds in the northeastern states during the last century, and their original distribution in northern and central Europe, suggest that they pose the greatest threat to cooler, sub-humid to humid sites in the northern regions of the United States and Canada. Habitats most susceptible to invasion range from the lowlands of the northern Pacific Coast to elevations of 5,000 feet or more in the Intermountain States. Sites most vulnerable to invasion include roadsides, mountain meadows and clearings in forest zones, permanent pastures, hayfields, cleared timber units, and abandoned farmland where the soil is well drained, coarse textured, and moderately low in organic matter. Consequently, elk habitat, recreation areas, and pristine mountain meadows in areas that have a climate similar to that of hawkweeds in their native range are particularly susceptible. None of the introduced hawkweed species are found in the natural grasslands or shrub-steppe of the northern Intermountain West, and are not expected to become problem weeds in any dry habitat usually associated with western rangelands, except where irrigated. Neither meadow nor orange hawkweed appears to survive in annually tilled cropland.

Most invasive hawkweeds are perennial, creeping stoloniferous plants that can displace native vegetation. Forage species in pastures and abandoned farmland are choked out by the advancing front of hawkweed. Hawkweeds threaten lawns and gardens, as well. Hawkweeds have been reported to have allelopathic effects on neighboring vegetation by exuding toxic chemicals into the soil (Dawes and Maravolo, 1973; Makepeace, 1976). These monocultures compete for soil moisture and nutrients, thereby posing risks to native species. As hawkweed monocultures invade species-rich range and mountain habitats, ecosystem functions and ecological relationships are affected. While no studies specifically address the effects of orange hawkweed on nutrient cycling and disturbance regimes, hawkweed's ability to dominate a community suggests that these species do affect habitat function. Hawkweeds generally negatively impact plant and animal diversity and there is serious concern about the loss of native plant biodiversity in infested areas. Ecological losses in plant and animal diversity can be enormous but cannot be economically calculated. Additional expenditures result from control costs. Hawkweeds are tenacious invaders, and once established, quickly develop into a patch that continues to expand until it covers the site with a solid mat of rosettes.

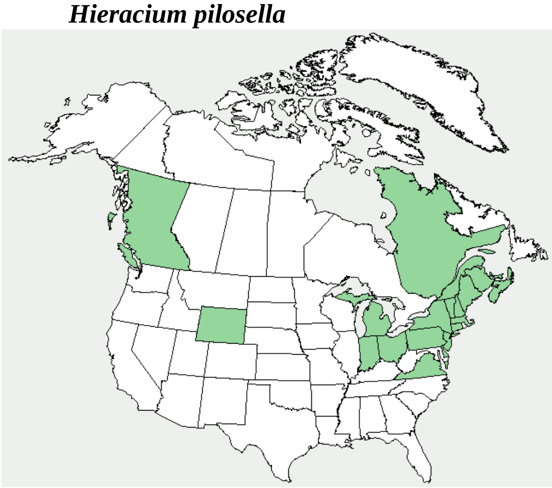
Distribution maps of target *Hieracium* species in North America (USDA Plants Database, 2010).



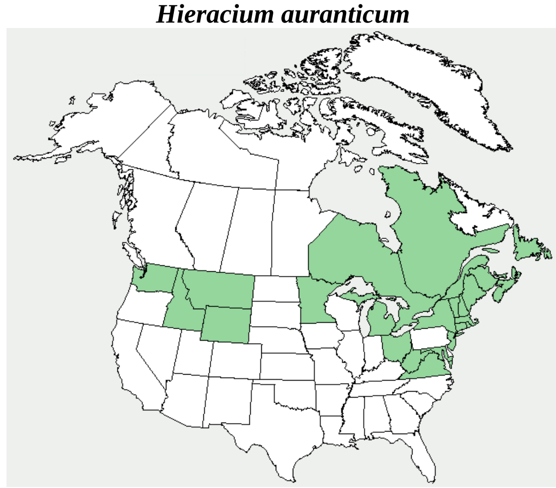
Hieracium pilosella



Hieracium auranticum



Hieracium flagellare



Hieracium floribundum

The invasion by hawkweeds may potentially contribute to the further decline of native bee populations, which are already being severely affected by habitat loss and pesticide use. Nearly 70% of native bees are ground nesting (http://www.xerces.org/wp-content/uploads/2008/11/nests_for_native_bees_fact_sheet_xerces_society.pdf). These bees often nest in open, well drained soils, of which invasive hawkweeds readily invade. Because these invasive species form dense mats of vegetation (over 3,200/square meter) (Wilson et al., 1997), such infestations could limit the ability of these bees to construct or maintain nests. Also a loss of biodiversity may occur with the introduction of invasive hawkweeds (Rose et al., 1995; Treskonova, 1991). This would result in less pollen and nectar sources for native bees and pollinators during the course of the summer. The reliance of herbicidal applications to mitigate hawkweed invasions may also have a detrimental impact on native pollinators by the short term loss of flora diversity of non-target flowering forbs. Although native forbs (if initially present) may return after herbicidal treatment, some current research being conducted at the University of Montana suggests that flowering of these native forbs may be negatively affected for several seasons until they have a chance to recover (Crone et al., 2009).

Meadow hawkweed causes severe allergenic reactions. Reactions in people closely working with meadow hawkweed include minor skin rashes, sneezing, congestion and difficulty in breathing (Wilson, pers. comm.). Similar effects have not been reported in animals. It is not known what portion of the plant causes this allergenic reaction; although latex and other chemicals of closely related Asteraceae plants can cause dermatitis (Dawes et al., 1996).
Based upon the rate of spread and potential ecological impacts of invasive hawkweeds, the introduction of *A. subterminalis*, a host specific biological control agent with potentially negligible secondary impacts (see below), is warranted to help mitigate the impacts of these invasive weeds.

The second issue from the Fish and Wildlife commenter was in regards to possible interactions of *Aulacidea subterminalis* and native hymenopteran species; in particular the potential for the introduction of disease-causing pathogens through *A. subterminalis*.

Few studies have been conducted on interactions between *A. subterminalis* and non-plant organisms in its native range so it is difficult to predict how the introduction of the gall wasp will impact non-plant species, in this case native hymenopterans in North America. However, little impact is expected by the presence of *A. subterminalis* for the following reasons.

First, there will be few opportunities for direct interaction (i.e., displacement) of other *Aulacidea* spp. wasps or other wasps in the insect family Cynipdae once *A. subterminalis* is released in North America. Gall wasps of the genus *Aulacidea* are wide ranging in their distributions, being found in both Holarctic (northern) and Nearctic (biogeographic region that includes the arctic and temperate areas of North

America and Greenland) regions. *Aulacidea* species native to the Nearctic region have been collected in the eastern half (Missouri eastward) of the United States and Canada and none are associated with *Hieracium* (Burks, 1979). Only two cynipid wasps have been collected from *Hieracium* in North America; a stem infesting wasp on *H. scouleri* from Idaho) (L. Wilson (British Columbia Ministry Agriculture and Lands) and J. Littlefield (Montana State University), pers. comm.) that has not been identified, and an apparent introduced species, *Aulacidea hieracii*, that has been recorded in the Province of Ontario infesting *H. umbellatum* (Silva and Shorthouse, 2006). These species do not occur on the same host plant as *A. subterminalis* nor in a niche occupied by *A. subterminalis*. Thus, no interactions between *A. subterminalis* and native or other introduced cynipid wasps are expected.

It is possible that native parasitoids (i.e., mainly hymenopterans) will colonize *A. subterminalis* and, through the gall wasp, have indirect negative effects on their native, gall-forming host(s). Because any introduced *A. subterminalis* will be cleaned of any European parasitoids in quarantine before being released in North America, and that the parasitoid guilds of native and European *Aulacidea* are not similar to North American species little parasitism of the gall wasp is expected, and thus, potential indirect effects are not expected. In New Zealand, where *A. subterminalis* has been introduced and established for nearly 10 years, no parasitism has been observed (Paynter et al., 2010). No predators have been observed attacking *A. subterminalis* in the field in Switzerland, and no disease has appeared in the populations being reared in Switzerland, Montana, Canada, or New Zealand (G. Grosskopf-Lachat (CABI Europe), Littlefield (Montana State University), L. Smith (Landcare, New Zealand), R. De Clerck-Floate (Agriculture and Agri-Foods Canada) pers. comm., Syrett et al., 1998). Due to the short life of adult *A. subterminalis* (up to a week under laboratory conditions) and that the larvae feed within a gall in isolation from the general environment, horizontal transmission of pathogens by the wasp would be limited or relatively non-existent. More cryptic insect pathogens such as microsporidians or viruses are more likely to be transmitted vertically if present in *A. subterminalis*, and these pathogens are relatively specific to single species or closely related species (Solter and Maddox, 1998; Solter et al., 2000). Cynipids are distantly related to families to which native bees belong (Ronquist, 1999; Sharkey, 2007; Whitfield, 1998). Therefore, should there be any pathogens cryptically infesting *A. subterminalis*, they would be less likely to infect native bees (Superfamily: Apidoidae). There is no evidence to date that suggests any disease transmission from hymenopterans used for biological control of weeds or for insect pests to species of bees. Reports of disease transmission in native bee populations indicate that closely related species were responsible for possible transmission (http://www.xerces.org/%20bumblebees/ *last accessed* January 25, 2011). For example *Nosema bombi* has been reported to have been transmitted to native *Bombus* spp. bees by the introduction of *Bombus occidentalis* and *B. impatiens* for pollination (although there appears to be some debate regarding this evidence http://www.scientificbeekeeping.com/index.php?option=com_content&task=view&id=84 *last accessed* January 25, 2011).

As part of the quarantine process prior to the release of a biological control agent, insects are reared through a generation to eliminate any parasitoids or contaminating organisms. Laboratory rearing, along with close inspection of the reared insect colony for the incidence of either foreign parasitoids or disease-causing pathogens, is an advised and reliable first line of defense for reducing the risk of introducing biotic contaminants with classical biocontrol agents (Goettel and Inglis, 2006). *Aulacidea subterminalis* has only been collected in one location for rearing and release purposes (i.e. collected from the Black Forest (Germany), and has been reared for several generations as a pure colony at CABI-Europe Switzerland Station, Delémont). Therefore, this population has a known and reliable history of having little parasitism and no disease problems.

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Decision and Finding of No Significant Impact
for
Field Release of the Gall Wasp, *Aulacidea subterminalis* (Hymenoptera: Cynipidae), an Insect for Biological Control of Invasive Hawkweeds (*Hieracium* spp.) in the Continental United States
February 2011

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Pest Permitting Branch (PPB), is proposing to issue permits for release of an insect, *Aulacidea subterminalis* (Hymenoptera: Cynipidae), in the continental United States. The agent would be used by the applicant for the biological control of invasive hawkweeds (*Hieracium* spp.). Before permits are issued for release of *A. subterminalis*, APHIS must analyze the potential impacts of the release of this organism into the continental United States in accordance with USDA APHIS National Environmental Policy Act implementing regulations (7 Code of Federal Regulations Part 372). APHIS has prepared an environmental assessment (EA) that analyzes the potential environmental consequences of this action. The EA is available from:

U.S. Department of Agriculture
Animal and Plant Health inspection Service
Plant Protection and Quarantine
Registrations, Identification, Permits, and Plant Safeguarding
4700 River Road, Unit 133
Riverdale, MD 20737
http://www.aphis.usda.gov/plant_health/ea/index.shtml

The EA analyzed the following two alternatives in response to a request for permits authorizing environmental release of *A. subterminalis*: (1) no action, and (2) issue permits for the release of *A. subterminalis* for biological control of invasive hawkweeds. A third alternative, to issue permits with special provisions or requirements concerning release procedures or mitigating measures, was considered. However, this alternative was dismissed because no issues were raised that indicated that special provisions or requirements were necessary. The No Action alternative, as described in the EA, would likely result in the continued use at the current level of chemical, mechanical, and cultural control methods for the management of invasive hawkweeds. These control methods described are not alternatives for decisions to be made by APHIS but are presently being used to control invasive hawkweeds in the United States and may continue regardless of permit issuance for field release of *A. subterminalis*. Notice of the EA was made available in the Federal Register on October 21, 2010 for a 30-day public comment period. Four comments were received on the EA. The final EA contains a written response to the comments received on the draft EA in appendix 5.

I have decided to authorize APHIS to issue permits for the environmental release of *A. subterminalis*. The reasons for my decision are:

- This biological control agent is sufficiently host specific and poses little, if any, threat to the biological resources, including non-target plant species, of the continental United States.

- The release will have no effect on federally listed threatened and endangered species or their habitats in the continental United States.

- *A. subterminalis* poses no threat to the health of humans or wild or domestic animals.

- No negative cumulative impacts are expected from release of *A. subterminalis.*

- There are no disproportionate adverse effects to minorities, low-income populations, or children in accordance with Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations" and Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks."

- While there is not total assurance that the release of *A. subterminalis* into the environment will be reversible, there is no evidence that this organism will cause any adverse environmental effects.

I have determined that there would be no significant impact to the human environment from the implementation of the preferred alternative (issuance of permits for the release of *A. subterminalis*) and, therefore, no Environmental Impact Statement needs to be prepared.

M. J. Firko — 2/2/2011

Dr. Michael J. Firko — Date
Director
Registrations, Identification, Permits, and Plant Safeguarding
Plant Health Programs
APHIS, Plant Protection and Quarantine