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Animal and Plant Health Inspection Service

Field release of the gall mite, *Aceria drabae* (Acari: Eriophyidae), for classical biological control of hoary cress (*Lepidium draba* L., *Lepidium chalapense* L., and *Lepidium appelianum* Al-Shehbaz) (Brassicaceae), in the contiguous United States.

Environmental Assessment, January 2018

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Table of Contents

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), Pests, Pathogens, and Biocontrol Permits (PPBP) is proposing to issue permits for release of a gall mite, *Aceria drabae* (Acari: Eriophyidae). The agent would be used by the permit applicant for the biological control of hoary cress, *Lepidium draba* L., *L. chalapense* L., and *L. appelianum* Al-Shehbaz) (Brassicales: Brassicaceae), in the contiguous 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. drabae* to control infestations of hoary cress within the contiguous United States. This EA considers the potential effects of the proposed action and its alternatives, including no action. Notice of this EA was made available in the Federal Register on December 5, 2017 for a 30-day public comment period. Two comments were received on the EA by the close of the comment period. However, these comments did not raise any specific or substantive issues.

APHIS has the authority to regulate biological control organisms under the Plant Protection Act of 2000 (Title IV of Pub. L. 106–224). Applicants who wish to study and release biological control organisms into the United States must receive PPQ Form 526 permits for such activities. The PPBP received a permit application requesting environmental release of a gall mite, *A, drabae,* from Europe, and the PPBP is proposing to issue permits for this action. Before permits are issued, the PPBP must analyze the potential impacts of the release of this agent into the contiguous United States.

The applicant's purpose for releasing *A. drabae* is to reduce the severity of infestations of invasive hoary cress in the contiguous United States. The hoary cress complex of invasive weeds (*Lepidium draba, L. chalapense* (= *L. draba* spp. *chalapensis*), and *L. appelianum*) is native to the Balkans, the Caspian Sea region of southwestern Asia, and the Middle East, and is found throughout Europe. Hoary cress was introduced to the United States from Europe in the late 19th century either with ship ballast or contaminated

[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.

alfalfa, grass, or grain. Since then, hoary cress has spread to all regions of the United States except the southeast. Hoary cress is a perennial weed that reproduces from seeds and a spreading root system. The root system consists of vertical and lateral roots from which rosettes and shoots arise. Vertical roots may penetrate as deep as five feet, thus making control through cultivation difficult. Plants may produce up to 850 flowers with a total seed output of 1,200 to 4,800 seeds. Nearly 84 percent of the seeds germinate the first year. A single plant grown without competition can produce as many as 455 shoots in one year.

Existing options for management of hoary cress are expensive, temporary, ineffective, and can have nontarget impacts. Hoary cress is difficult to control using chemical or cultural control practices. For these reasons, the applicant has a need to release *A. drabae,* a host-specific, biological control organism for the control of hoary cress, into the environment.

II. Alternatives

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

A third alternative was considered, but will not be analyzed further. Under this third alternative, PPBP would have issued permits for the field release of *A. drabae*; 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, PPBP would not issue permits for the field release of *A. drabae* for the control of hoary cress. The release of this biological control agent would not take place. The following methods are presently being used to control hoary cress; these methods will continue under the "No Action" alternative and will likely continue even if permits are issued for release of *A. drabae*, depending on the efficacy of the organism to control hoary cress.

1. Chemical Control

Chemical control of hoary cress is possible with selective herbicides applied at the rosette stage or during the period of fall regrowth before frost (Sheley and Stivers, 1996). Herbicides such as sulfonylureas and immadazalones are the most effective; phenoxy herbicides are not as effective in controlling hoary cress.

2. Mechanical Control

Hoary cress is difficult to control with mechanical or cultural control techniques (see Mulligan and Findlay, 1974; Sheley and Stivers, 1996, Holm et al., 1997). However, cultivation, hand pulling, and mowing are used to control hoary cress. Deep cultivation, repeated throughout the year and repeated over a two to four year period can suppress hoary cress infestations. Hand pulling may be used in small areas of infestation.

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

Under this alternative, PPBP would issue permits for the field release of the gall mite, *A. drabae*, for the control of hoary cress. These permits would contain no special provisions or requirements concerning release procedures or mitigating measures.

Biological Control Agent Information

1. Taxonomy

Common name: Hoary cress gall mite (unofficial)
Scientific name: *Aceria drabae* (Nal.)
Synonyms: (Amrine and Stasny, 1994; doubtful synonymy see Lipa, 1978):

Phytoptus drabae Nalepa 1890 [species]
Phytoptus capsellae Nalepa 1890
Eriophyes cardaminesbellidifoliae Liro 1940
Phytoptus longior Nalepa 1891

Class: Arachnida
Subclass: Acari
Order: Acariformes
Family: Eriophyidae
Tribe: Aceriini
Genus: *Aceria*
Specific name: *drabae* - (Nalepa, 1890)

2. Description of *A. drabae*

Aceria drabae was originally described by Nalepa (1890) as *Phytoptus drabae*; type host *Lepidium draba*. Eriophyid mites are very small but can be discerned by the use of a good quality magnifying glass or microscope. *Aceria drabae* is typical of mites of the tribe Aceriini. Mites are usually translucent to opaque white; often turning yellow/orange with age. The

opisthosoma (abdomen) is tubular or cylindrical consisting of more or less equally spaced annuli (rings) with cone-shaped microtubules. The numbers of legs of eriophyid mites are reduced to two pairs and are located towards the head of the mite. Feather claws located at the tips of the legs are typically diagnostic in character. Locomotion may be aided by an anal clasper. This clasper also helps to elevate the mite to be wind dispersed.

Aceria drabae has four life stages: egg, first instar nymph (or larva), second instar nymph, and adult. Eggs are clear to slightly yellow (with age), spherical, and approximately 0.04 millimeters (mm) in diameter. First instar nymphs generally have reduced (or not completely developed) features and are smaller in length. Second instar nymphs are similar to adults but lack a genital opening. Adults are approximately 0.2-0.3 mm in length. Deutogynes (overwintering forms) of this species are not known.

3. Geographical Range of *A. drabae*

a. Native Range

Aceria drabae appears to be widespread across Europe and Eurasia, although its distribution may be disjunct. Lipa et al. (1998) observed the mite in Spain but also reported the mite in Austria, Bulgaria, Czechoslovakia, Finland, Hungary, Poland, and Sweden (Lipa, 1976; 1978; Lipa et al., 1998). Liro (1940) also reported the mite from Finland. More recent surveys or reports have located *Aceria drabae* in Romania (Talmaciu et al., 2010), Greece, Turkey, and Russia (Littlefield et al., 2012). *Aceria drabae* has been reported in coastal regions of the Netherlands, in the British Isles (Redfern and Shirley, 2012), Germany, and the Republic of Georgia (Buhr, 2012).

b. Expected Attainable Range of *A. drabae* in North America

The mite is expected to establish across the range of hoary cress in North America based upon climate matching of collection sites in Europe with potential release sites in North America (Climex 1.1, Sutherst et al., 1999)

3. Life History of *A. drabae*

The life cycle of *A. drabae* is typical of eriophyid mites (Littlefield et al., 2012). Eggs are laid within galls (an abnormal growth of plant tissue caused by insects and mites) or on plant tissue or modified plant tissue. The eggs hatch into first instar nymphs. A second molt occurs prior to becoming a sexually mature adult. Generation time from egg to adult is approximately 10 to 14 days depending upon temperature (Littlefield et al., 2012).

Mites overwinter on root buds or possibly in protected places at the base of the plant. The existence of deutogynes (alternate morphological form(s) of the mite; usually seasonal, e.g. overwintering form) is not known. As the plants develop in the spring mites feed on the developing tissue. This

feeding occasionally induces bud galls; however, *A. drabae* may oviposit (lay eggs) and develop on what appears to be slightly modified tissues such as thickened/curled leaves or stems. It appears that gall material is more favorable for population development of *A. drabae* compared with vegetative tissues. As the plant develops flower buds *A. drabae* typically moves into these buds and induces gall formation (Figure 1). Mites develop several generations within the gall tissue. As the plant senesce during the summer, mites migrate back down to the roots. Mites are primarily dispersed by wind although being carried on the body of other insects may also occur. (From: Littlefield et al., 2012)

Figure 1. *Aceria drabae* flower gall (From: Littlefield et al., 2012).

III. Affected Environment

A. Taxonomy of Hoary Cress

In a recent comprehensive study that examined all major classifications of the plant family Brassicaceae, 308 genera and about 3,600 species (92 percent) of the family were assigned to 44 tribes with the *Lepidium* genus assigned to the tribe Lepidieae (Warwick et al., 2010; Franzke et al., 2011).

Until recently, hoary cress species were regarded as an independent genus, *Cardaria*, consisting of five similar looking species: *C. chalapensis, C. draba, C. fenestrata, C. propinquum,* and *C. pubescens,* which could only be distinguished by the size and shape of the seed pods (silicles) (Muenscher, 1955; Mulligan and Frankton, 1962). In 2002, Al-Shebaz et al. proposed a new classification based predominantly on molecular systematic information that combined three genera, *Cardaria, Stroganowia,* and *Coronopus,* with *Lepidium*. Consequently, *Cardaria draba* and *C. chalapense* were united into subspecies of *Lepidium draba,* and *C. pubescens* became *L. appelianum*. Recently, the subspecies of

Lepidium draba were again elevated to the full species, *L. draba* and *L. chalapense* (Francis and Warwick, 2008). The common name 'hoary cress' refers to *Lepidium draba*, *L. appelianum*, and *L. chalapense*, although *Lepidium draba* and *L. chalapense* were treated as a single species in host specificity tests (Littlefield et al., 2012). Because of the taxonomic similarity of *L. chalapense* to *L. draba*, it is not discussed further in this document.

The appropriate taxonomic placement of the three hoary cress species targeted for biological control is as follows:

Class: Magnoliopsida
Subclass: Dilleniidae
Order: Brassicales (formerly placed in Capparales)
Family: Brassicaceae (= Cruciferae)
Subfamily: Asclepiadoideae
Tribe: Lepidieae
Genus: *Lepidium* L.
Species: *Lepidium draba* L.; *L. chalapense* L.; and *L. appelianum* Al-Shehbaz

***Lepidium draba* L.**
Synonyms: *Cardaria draba* (L.) Desv.; *Lepidium draba* L. ssp. *draba* Thell., *Cardaria chalepensis* (L.) Handel-Mazzetti, *Lepidium chalepense* L., *Lepidium draba* L. ssp. *chalepense* Thell., *Lepidium draba* L. ssp. *chalepense* Thell. var. *repens* (Schrenk) Thell. *Cardaria draba* (L.) Desv. var. *repens* (Schrenk) Rollins, *Cardaria draba* (L.) Desv. ssp. *chalepense* (L.) O. E. Schulz var. *repens* (Schrenk) O. E. Schulz, Physolepidion repens Schrenk, *Lepidium repens* (Schrenk) Boiss., *Cardaria repens* (Schrenk) Jarm., *Hymenophysa macrocarpa* Franchet, *Cardaria macrocarpa* (Franchet) Rollins.
Common names: heart-podded hoary cress, lens-podded hoary cress, whitetop, whiteweed, peppergrass, pepperwort.

***Lepidium chalapense* L.**
Synonyms: *Cardaria chalapensis* (L.) Hand.-Mazz., *C. draba* ssp. *chalapensis* (L.) O.E. Schulz, *C. draba* var. *repens* (Schrenk) Rollins, *Lepidium draba* ssp. *chalapensis* (L.) Thellung
Common names: Lens-podded hoary cress
Note: Both *Lepidium chalapense* and *Lepidium draba* ssp. *chalapensis* are used in the current literature depending upon the author.

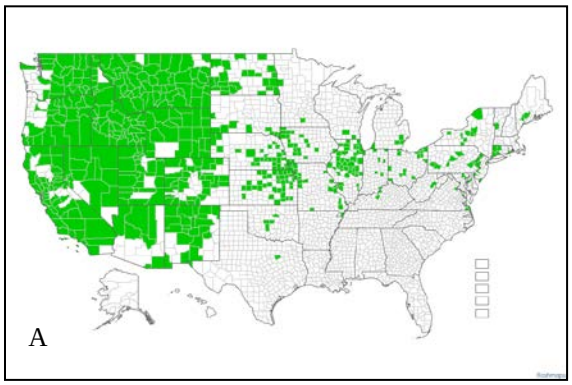
***Lepidium appelianum* Al-Shebaz**
Synonyms: *Cardaria pubescens* (C. A. Meyer) Jarmolenko, *Hymenophysa pubescens* C. A. Meyer, *Cardaria pubescens* (C. A. Meyer) Rollins var. *elongate* Rollins
Common names: globe-podded hoary cress.

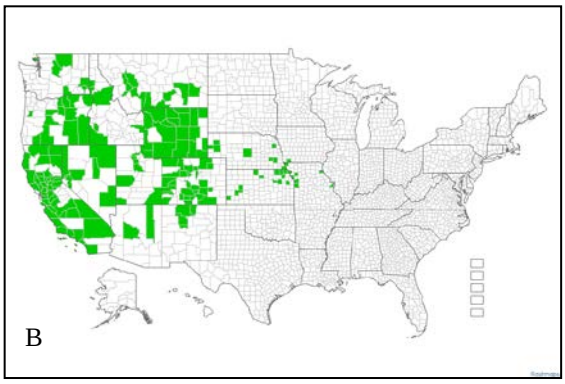
B. Areas Affected by Hoary Cress

1. Native and Introduced Range of Hoary cress

The term 'hoary cress' refers to all hoary cress species (*L. draba, L. appelianum*, and *L. chalapense*) because they are morphologically and ecologically very similar and because more than 95 percent of hoary cress infestations in North America are *L. draba.*

Hoary cress was introduced to the United States from Europe in the late 19th century either with ship ballast or contaminated alfalfa, grass, or grain. Since then, it spread to all regions of the United States except the southeast, and to all Canadian provinces except Prince Edward Island, New Brunswick, and Newfoundland (Mulligan and Findlay, 1974). Hoary cress is native to the Balkans, the Caspian Sea region of southwestern Asia, and the Middle East (Mulligan and Findlay, 1974). The plant has been widely distributed throughout Europe, North America, South America, South Africa, Australia, and New Zealand (Mulligan and Findlay, 1974; Holm et al., 1997). Hoary cress has dramatically increased its distribution in the Intermountain West (Washington, Oregon, Idaho, Montana, and Wyoming) in the past 20 years, from 72 western counties in 1981, to 162 counties in 2001 (Forcella and Harvey, 1980; Rice, 2011). Except areas west of the Cascade mountain range, hoary cress has invaded almost all counties in the five northwestern states (Figure 2). Hoary cress is a declared a noxious weed in 18 U.S. States and Canadian Provinces (Alaska, Arizona, California, Colorado, Hawaii, Idaho, Iowa, Kansas, Michigan, Montana, Nevada, New Mexico, Oklahoma, Alberta, British Columbia, Manitoba, and Saskatchewan) (USDA-NRCS, 2011).





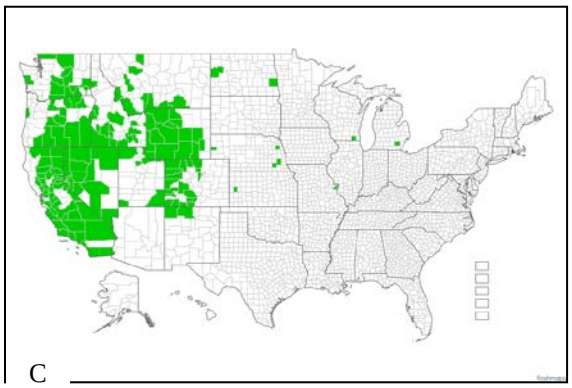


Figure 2. Distribution of *Lepidium draba* (A), *L. chalapense* (B), and *L. appelianum* (C) in the United States (from EDDMapS, 2012)

2. Habitats Where Hoary Cress is Found in North America

Hoary cress thrives in a variety of habitat and soil types. Infestations across the Intermountain West are particularly prevalent in disturbed and degraded habitats associated with cropland, pastures, rangelands, and riparian habitats. Hoary cress is well adapted to open sites with moderate moisture conditions (300–500 mm (12–18 inches) precipitation per year) and elevations ranging from 800–1,600 meters (m) (2,500–5,000 feet).

Hoary cress inhibits and diminishes recreational opportunities, directly impedes crop production, minimizes grazing potential of affected rangelands, degrades wildlife habitat and native plant communities, and restricts waterfowl use of wetlands and stream banks. As a result, farmers, ranchers, recreationists, sportsmen, hunters, and the general public are all affected.

C. Plants Related to Hoary Cress and Their Distribution

The Brassicaceae are one of the largest plant families, with about 340 genera and 3,700 species worldwide. In North America alone, approximately 600 species are represented in more than 37 strictly native genera. The greatest species diversity is found in the semiarid and arid regions of western North America. Brassicaceae are also economically important; species are widely cultivated as important vegetables, industrial and edible oils, condiments, and as ornamentals. In North America, there are at least 123 Brassicaceae species within 23 genera that are economically important. The most important cultivated genera are *Brassica*, *Sinapsis*, *Raphanus,* and *Armoracia*. Most cultivated and ornamental species are non-native and distributed throughout the United States and Canada.

Under the old classification, the genus *Cardaria* was represented in North America by only exotic species. However, following the new classification proposed by Al-Shebaz et al. (2002), *Cardaria,* along with the genera *Stroganowia* and *Coronopus,* have been reunified with the genus *Lepidium*. There are 34 native *Lepidium* species in the United States (including Hawaii) and Canada (Boufford et al., 2010; USDA-NRCS, 2011). Kartesz and Meacham (1999) listed about 80 species, subspecies, and varieties for North America. Within the genus *Lepidium,* species exhibit a wide ecological range, occurring at all latitudes and are adapted to arid, mesic, and tropical environments. In addition, locally occurring, endemic species are common across the United States and Canada. Plant species that were used in testing the specificity of *A. drabae* to hoary cress are listed in appendix 1.

IV. Environmental Consequences

A. No Action

1. Impact of Hoary Cress

a. Plants and Animals

Hoary cress usually occupies disturbed rangeland, sub-irrigated pastures, roadsides, vacant areas, and ditchbanks but also relatively undisturbed ridge draws (Sheley and Stivers, 1996; Holm et al., 1997). Hoary cress can also be a problematic in crops such as alfalfa, small grains, peas, onions, and sugar beets (Sheley and Stivers, 1996; Holm et al., 1997). Weed infestations negatively impact wildlife habitat and biodiversity (Renz, 2001). The plants are considered mildly poisonous to livestock because of high levels of glucosinolates (Whitson, 1987; Lorenz and Dewey, 1988). Hoary cress can serve as an alternate spring feeding plant

for important insect crop pests, e.g. the cabbage seed pod weevil (*Ceutorhynchus obstrictus = C. assimilis*), diamond back moth (*Plutella xylostella*), and the cabbage flea beetle (*Phyllotreta cruciferae*). A detailed analysis of the economic impact of hoary cress in the United States or Canada is lacking.

b. Beneficial Uses

Hoary cress serves as a nectar source for honey bees. Seeds of hoary cress can be used as a substitute for pepper. Few other beneficial uses are known, although the plant has been studied as a source of possible anti-cancer chemicals (Dornberger and Lich, 1982).

2. Impact from Use of Other Control Methods

The continued use of chemical and mechanical 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. drabae* to reduce hoary cress populations in the contiguous United States.

a. Chemical Control

Chemical control of hoary cress is possible with selective herbicides applied at the rosette stage or during the period of fall regrowth before frost (Sheley and Stivers, 1996). Herbicides such as sulfonylureas and immadazalones are the most effective; phenoxy herbicides are not as effective in controlling hoary cress. Herbicides can have impacts on non-target plant species.

b. Mechanical Control

Hoary cress is difficult to control with mechanical or cultural control techniques (see Mulligan and Findlay, 1974; Sheley and Stivers, 1996, Holm et al., 1997). Cultivation can be a major cause of weed dispersal when root fragments are severed and transported. Hand pulling is impractical for large areas and is generally ineffective when roots are not completely pulled. Mowing is ineffective and causes further lateral spread of plants when top growth is removed.

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

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

Host specificity of *A. drabae* to hoary cress has been demonstrated through scientific literature, field observations, and host specificity testing. If the mite or insect species only attacks one or a few closely related plant species, it 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

The host for the type specimen of *Aceria drabae* is *Lepidium* (*Cardaria*) *draba*. The mite has been also reported in the literature on: *Alyssum alyssoides, Alyssum calicium, Arabis arenosa, Berteroa incana, Camelina sativa, Capsella bursa-pastoris, Cardamine bellidifolia, Cardamine pratensis, Cardamine hirsuta, Cardamine sp., Cardaminopsis arenosa, Draba incana, Cochlearia (Hutchinsia) officinalis ssp.* alpina, and *Descurainia sophia* (= *Sisymbrium sophia*) (Davis et al., 1982; Buhr, 2012; Redfern and Shirley, 2012; BRC, 2016). Reports in the literature of *A. drabae* on other host species have been thought by some authors (Lipa, 1978) to be a result of misidentifications or the misinterpretation of synonyms. The collection locations of *A. drabae* on hosts other than *L. draba* (Buhr, 2012; Redfern and Shirley, 2012) appear to be in the supposed northern range of the mite. It is not known if these mites are a biotype of *A. drabae* or a sibling species.

b. Literature for Species Closely Related to *A. drabae*

Mites of the genus *Aceria* feed on many species of plants in several hundred genera and numerous families; however, these mites tend to be host specific. The majority attack only one host and many others are limited to species within a single plant genus. Only a few eriophyoids can feed on host plants from more than one family (Lindquest and Oldfield, 1996; Oldfield, 1996; Skoracka et al., 2010). Skoracka et al. (2010) indicated that approximately 80 percent of eriophyoids have been reported on only one host species, 95 percent on one host genus, and 99 percent on one host family. Due to their high degree of host plant specificity eriophyid mites have also been considered for biological control of weeds (Rosenthal, 1996; Craemer et al., 1997; Littlefield, 2000; Briese and Cullen, 2001; Smith et al., 2010; Skoracka et al., 2010).

c. Field Observations

Lipa (1978) reported surveying a natural stand of hoary cress infested with *A. drabae* in Poland and determining if the mite was present on neighboring mustards. He inspected *Armoracia lapathifolia*, *Berteroa incana*, *Capsella bursa-pastoris*, *Sinapis arvensis*, and *Sisymbrium loeselii* but did not observe the mite. Field tests (also in Poland) to determine the development of the mite on non-target plants were conducted with: *Berteroa incana, Bunias erucago, Diplotaxis tenuifolia, Erysimum cheiranthoides, Lepidium latifolium, Raphanus raphanistrum, R. sativus* var. *oleiformis, R. sativus* var. *radicula, Sisymbrium austriacum,* and *Sisymbrium loeselii*. Mites were not found on any test species. Based

on his findings Lipa (1978) concluded that the mite was probably monophagous and reports in the literature on other host species were a result of misidentifications, or the misinterpretation of synonyms.

Lipa (1974) also surveyed insects associated with cruciferous plants in Poland and surrounding countries from 1969 to 1974. Altogether, 141 Brassicaceae species and 14 cultivars were included in this survey. *Aceria drabae* was only reported on *Lepidium* (*Cardaria*) *draba*.

d. Host Specificity Testing

Host specificity tests are tests to determine how many plant species *A. drabae* attacks, and whether nontarget species may be at risk. See appendix 2 for information regarding host specificity testing methods. In host specificity testing, host utilization by *A. drabae* was confined to *Lepidium draba* and the closely related *Lepidium appelianum*. *Lepidium appelianum* appears to be a less suitable host for the mite but may support some limited development. Native North American *Lepidium* and other native and economic Brassicaceae did not support development of the mite.

(1) Site of Quarantine Studies

Laboratory tests were conducted at the quarantine facilities located at Montana State University, Bozeman, Montana.

(2) Test Plant List

The list of plant species used for host specificity testing of *A. drabae* 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 Brassicaceae are an important economic plant family worldwide, used for food, the production of industrial oil, condiments, and as ornamentals. Representative species for all economically important uses were selected. The family is also represented by approximately 95 indigenous or naturalized genera in North America (Boufford et al., 2010, USDA-NRCS, 2011). Plant species from many of these genera were selected for host-specificity tests (Littlefield et al., 2012). For some of the rare or threatened or endangered native species that were difficult to obtain, more widely distributed native or introduced species were selected to replace these taxa. Plant species from different taxa that contain secondary compounds similar to those found in Brassicaceae were included in host specificity testing because specialist plant feeding organisms are known to

use host plant chemicals in the plant selection and acceptance process.

Plants for testing the host range of *A. drabae* were selected from the following seven categories:

CATEGORY 1: Genetic types of *Lepidium draba*, *L. appelianum*, and *L. chalapense* (varieties, races, forms, genotypes, apomicts, etc.).

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

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

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

CATEGORY 5: North American species in other families in the Brassicales 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.

Host specificity testing of *A. drabae* at Montana State University (MSU) included as many native North American representatives of the various taxa as possible (Appendix 1). *A. drabae* was tested on 89 plant species of which 55 are species native to North America.

(3) Discussion of Host Specificity Testing

See appendix 1 for host specificity testing results.

1. Impact of *A. drabae* on hoary cress

Aceria drabae overwinters on root buds (Talmaciu, 2009; Littlefield et al., 2012) and perhaps in more protected areas of the root crown. Mites are able to develop to a limited extent on modified vegetative tissue and as the

plant bolts in the spring, mites move into the vegetative and flower buds to induce galls, erineum (an abnormal growth of hairs from the leaf surface), and other tissue deformities. Bud galls may be inconspicuous since they are located in the lower part of the crown, but may be common locally. Such damage results in the stunting of the plant. Gall induction within the flowes reduces or completely eliminates seed production (Lipa, 1974; 1976; 1978; 1983; Lipa et al., 1977; Talmaciu, 2009). Presence of disease phytoplasmas associated with plant deformities was not detected in infested plants in Spain (Lipa et al., 1998).

Percent infestation of hoary cress by *A. drabae* appears to be variable under field conditions in its native range. Large infestations of the mite have been reported in Poland (Lipa, 1974; 1976; 1978; 1983; Lipa et al., 1977) and in Russia where up to 95 percent of plants were infested. Talmaciu (2009) and Talmaciu et al. (2010) reported *A. drabae* to be an import natural enemy of hoary cress in Romania along with the gall weevil *Ceutorhynchus cardariae* and the flea beetle *Psylliodes wrasei*. At experimental field plots, Talmaciu (2009) observed that between 15–47 pecent of plants were infested with *A. drabae*. Plots varied from undisturbed (pasture) to disturbed (harrowed), and disturbed and cultivated. In Spain, where *A. drabae* was recently recorded (Lipa et al., 1998), infestations were also variable where the mite was present; up to 60 percent infestation in cultivated/ disturbed sites, 30 percent in uncultivated fields, and 1–3 percent in urban parks and natural areas.

In host specificity testing (Littlefield et al., 2012), after two weeks of testing mites were observed on only four plant species: *Brassica napus* var. *napobrassica* (rutabaga), *Lepidium latifolium*, *Lepidium appelianum*, and the control *Lepidium draba*. Only two live mites were observed on rutabaga var. York (*Brassica napus* var. *napobrassica*) (on 1 of 32 plants). Considering the longevity of eriophyid mites it was expected that *A. drabae* would be able to survive for short periods on other mustard species (such as rutabaga) without reproducing. More survival on the more closely related *Lepidium* species was expected, but with exception of the closely related *Lepidium appelianum* (~8 mites on 5 of 50 plants) and the more distantly related *Lepidium latifolium* (3 mites on 1 of 32 plants), no live mites were observed after two weeks on any *Lepidium* species tested.

After 30 days *Aceria drabae* was only observed on *L. draba* and to a lesser extent on *L. appelianum*. Approximately 83.5 percent (± 4.5 SE) of the *L. draba* controls were infested with mites compared with 10.4 percent (± 4.5 SE) of *L. appelianum* plants. An average of 203.3 (± 39.4 SE) mites were observed per infested *L. draba* plant, compared with 6.8 (±4.1 SE) per infested *L. appelianum* plant (populations were significantly different using Mann-Whitney U Test; U=95.5 P= 0.008, SPSS 11.5). On several *L. draba* plants, mites were too numerous to be counted and populations had to be estimated; for example over 3,500 mites were

estimated for one plant in the 2008 testing. Galls and leaf deformities were only induced on its intended host *Lepidium draba* (range of 1 -35 gall clusters per galled plant). Mites and eggs were also found on non-galled (or slightly modified) tissues indicating that *A. drabae* may live for an extended period on vegetative tissues. However large mite populations were associated with the presence of gall tissue. No gall formation was observed on *Lepidium appelianum*, although plants were more vegetative at the time of testing.

Mites did not develop on any other test plant species; including some of those listed as host plants in the literature. This lends support to Lipa (1978) field test results and the supposition that *A. drabae* has a restricted host range. Host utilization by *A. drabae* was confined to *Lepidium draba* and the closely related *Lepidium appelianum*. *Lepidium appelianum* appears to be a less suitable host for the mite but may support some limited development. In the United States and Canada, *A. drabae* is expected to reduce hoary cress populations by reducing seed production and potential biomass of hoary cress, thereby reducing spread of the weed into new areas.

2. Uncertainties Regarding the Environmental Release of *A. drabae*

Once a biological control agent such as *A. drabae* is released into the environment and becomes established, there is a slight possibility that it could move from the target plants (hoary cress) 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. drabae*, the resulting effects could be environmental impacts that may not be easily reversed. Biological control agents such as *A. drabae* 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. However, significant non-target impacts on plant populations from previous releases of weed biological control agents are unusual (Suckling and Sforza, 2014).

In addition, this agent may not be successful in reducing hoary cress populations in the contiguous 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 hoary cress by *A. drabae* will not be known until after release occurs and post-release monitoring has been conducted. However, it is expected that *A. drabae* will reduce hoary cress populations by reducing seed production and potential biomass of hoary cress, thereby reducing spread of the weed into new areas.

3. Human Health

Aceria drabae is a plant-feeding mite and poses no risk to humans.

4. Animal Health

Aceria drabae is a plant-feeding mite and poses no risk to animal species. Reduction of hoary cress may be beneficial to cattle because they will not eat it unless there is nothing else to eat, and it contains glucosinolate, an alkaloid toxic to cattle.

5. Beneficial Uses

Aceria drabae would reduce (but not eliminate) the presence of hoary cress as a nectar source for honey bees, or as a source for other beneficial uses. For bees, there would be other sources of nectar for them to use.

6. 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).

Other private and public concerns work to control hoary cress in invaded areas using available chemical and mechanical or cultural control methods. Release of *A. drabae* is not expected to have any negative cumulative impacts in the contiguous United States because of its host specificity to hoary cress. Effective biological control of hoary cress will have beneficial effects for Federal, State, local, and private weed management programs, and may result in a long-term, non-damaging method to assist in the control of hoary cress.

7. 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.

APHIS determined that release of *A. drabae* into the environment may affect, but is not likely to adversely affect listed, proposed, and candidate plants within the family Brassicaceae in the contiguous United States, and will not adversely affect designated or proposed critical habitat of those species (see appendix 4 for list of plants). A biological assessment was prepared and submitted to the U.S. Fish and Wildlife Service (FWS) and is part of the administrative record for this EA (prepared by T.A. Willard, April 19, 2016). APHIS requested concurrence from the U.S. Fish and Wildlife Service on these determinations, and received a concurrence letter/conference report dated August 4, 2016.

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. drabae* 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. drabae*.

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, drabae* on May 1, 2013. TAG members that reviewed the release petition (Littlefield et al., 2012) included USDA representatives from National Institute of Food and Agriculture, Agricultural Research Service, Animal and Plant Health Inspection Service, and U.S. Forest Service; U.S. Department of Interior's Bureau of Indian Affairs, Bureau of Reclamation, and Bureau of Land Management; U.S. Army Corps of Engineers; and representatives from California Department of Food and Agriculture (National Plant Board) and Agriculture and Agri-Food Canada.

This EA was prepared by personnel at APHIS, University of Montana, USDA-Agricultural Research Service, and Birdsall Consulting. The

addresses of participating APHIS units, cooperators, and consultants follow.

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Appendix 1. Results of no-choice larval development testing for *Aceria drabae* on the target weeds and test plants (Littlefield et al., 2012).

Species	Common Name	Test Cat[1]	Native/Intro/ Eur[2]	# Tested	Mites 14 Days[4]	Mites 30+ Days[4]	Galls Present[4]
Alyssum alyssoides	Pale Madwort	3, 7	Intro.	29	0	0	0
Arabidopsis thaliana	Mouseear Cress	3	Intro.	17	0	0	0
Arabis aculeolata	Walso Rockcress	3, 4b	Nat.	18	0	0	0
Arabis alpina (= *A. caucasia*)	Alpine Rockcress	3, 4b	Intro	21	0	0	0
Arabis blepharophylla	Rose Rockcress	3, 4b	Nat	18	0	0	0
Armoracia rusticana	Horseradish	3, 6	Intro.	18	0	0	0
Boechera (Arabis) breweri	Brewer's Rockcress	3, 4b	Nat	24	0	0	0
Boechera (Arabis) dispar	Pinyon Rockcress	3, 4b	Nat	16	0	0	0
Boechera (Arabis) holboellii	Holboell's Rockcress	3, 4b	Nat.	11	0	0	0
Boechera (Arabis) koehleri	Koehler's Rockcress	3, 4b	Nat	16	0	0	0
Barbarea verna	Early Yellowrocket	3, 7	Intro	16	0	0	0
Berteroa incana	Hoary False Madwort	3, 7	Intro.	17	0	0	0
Brassica juncea var. 1	Brown Mustard	3, 6	Intro.	16	0	0	0
B. juncea var. 2	Oriental Mustard	3, 6	Intro.	16	0	0	0
Brassica napus var. *napus*	Rape	3, 6	Intro.	16	0	0	0
var. *napobrassica*	Rutabaga (York)	3, 6	Intro.	32	+	0	0
Brassica nigra	Black Mustard	3, 6	Intro.	16	0	0	0
Brassica oleracea: Acephala *Group*	Kale	3, 6	Intro.	16	0	0	0
Italica group	Broccoli	3, 6	Intro.	16	0	0	0
Brassica rapa: Chinensis group	Pac Choi	3, 6	Intro.	16	0	0	0
Nipposinica group	Mibuna	3, 6	Intro.	16	0	0	0
Perviridis group	Komatsuna	3, 6	Intro.	16	0	0	0
Ruvo group	Broccoli Raab	3, 6	Intro.	16	0	0	0
Camelina microcarpa	Littlepod False Flax	3	Intro.	16	0	0	0
Camelina sativa	Gold-Of-Pleasure	3, 7	Intro.	18	0	0	0
Capsella bursa-pastoris	Shepherd's Purse	3, 7	Intro.	21	0	0	0
Cardamine cordifolia var. *lyallii*	Large Mountain Bittercress	3, 4b	Nat	1	0	0	0
Cardamine pachystigma	Serpentine Bittercress	3, 4b	Nat	16	0	0	0

Appendix 1. Results of no-choice larval development testing for *Aceria drabae* on the target weeds and test plants (Littlefield et al., 2012).

Species	Common Name	Test Cat[1]	Native/Intro/ Eur[2]	# Tested	Mites 14 Days[4]	Mites 30+ Days[4]	Galls Present[4]
Caulanthus anceps (= *Guillenia lemmonii*)	Lemmon's Mustard	3, 4b	Nat.	11	0	0	0
Caulanthus crassicaulis var. *crassicaulis*	Thickstem Wild Cabbage	3, 4b	Nat.	21	0	0	0
Caulanthus inflatus	Desert Candle	3, 4b	Nat.	18	0	0	0
Cleome serrulata	Rocky Mountain Beeplant	5	Nat.	13	0	0	0
Conringia orientalis	Rabbit's-ear	3	Intro.	26	0	0	0
Descurainia sophia	Mountain Tansymustard	3, 7	Intro.	20	0	0	0
Draba aurea	Golden Draba	3	Nat	5	0	0	0
Draba densifolia	Dense-Leaf Whitlow-Grass	3	Nat.	5	0	0	0
Draba grayana	Gray's Draba	3	Nat	16	0	0	0
Draba oligosperma	Few-Seed Whitlow-Grass	3	Nat	21	0	0	0
Erodium cicutarium	Red Stem Stork's Bill	6	Intro.	17	0	0	0
Erysimum capitatum var. *capitatum*	Sanddune Wallflower	3, 4b	Nat.	16	0	0	0
Erysimum capitatum var. *purshii*	Pursh's Wallflower	3, 4b	Nat.	16	0	0	0
Erysimum inconspicuum	Shy Wallflower	3, 4b	Nat.	3	0	0	0
Hesperidanthus linearifolius (= *Schoenocrambe linifolia*)	Salmon River Plainsmustard	3, 4b	Nat.	16	0	0	0
Hesperis matronalis	Dames Rocket	3	Intro.	18	0	0	0
Iberis umbellata	Globe Candytuft	3	Intro.	16	0	0	0
Isatis tinctoria	Dyer's Woad	3	Intro.	16	0	0	0
Lepidium alyssoides var. *montanum* (= *L. montanum* var. *angustifolium*)	Mesa Pepperwort	2	Nat.	16	0	0	0
Lepidium appeliamum	Globe-podded hoary cress; hairy whitetop	1	Intro.	50	+	+	0
Lepidium campestre	Cream-anther Field pepperwort	2	Intro.	16	0	0	0
Lepidium crenatum	Alkalai Pepperweed	2	Nat.	16	0	0	0
Lepidium davisii	Davis' Pepperweed	2, 4a	Nat.	17	0	0	0

Appendix 1. Results of no-choice larval development testing for *Aceria drabae* on the target weeds and test plants (Littlefield et al., 2012).

Species	Common Name	Test Cat[1]	Native/Intro/ Eur[2]	# Tested	Mites 14 Days[4]	Mites 30+ Days[4]	Galls Present[4]
Lepidium densiflorum var. *densiflorum*	Common Pepperweed	2	Nat.	28	0	0	0
Lepidium draba	Heart-podded hoary cress; whitetop	1	Intro.	97	+	+	+
Lepidium flavum	Yellow Pepperweed	2	Nat.	7	0	0	0
Lepidium heterophyllum	Purpleanther Field Pepperweed	2	Intro.	16	0	0	0
Lepidium huberi	Huber's Pepperweed	2	Nat.	18	0	0	0
Lepidium lasiocarpum var. *lasiocarpum*	Shaggyfruit Pepperweed	2	Nat.	17	0	0	0
Lepidium latifolium	Broadleaved Pepperweed	2	Intro.	32	+	0	0
Lepidium montanum var. *montanum*	Mountain Pepperweed	2	Nat.	16	0	0	0
Lepidium nanum	Dwarf Pepperweed	2	Nat.	18	0	0	0
Lepidium oblongum	Veiny Pepperweed	2	Nat.	16	0	0	0
Lepidium papilliferum	Idaho Pepperweed	2, 4a	Nat.	18	0	0	0
Lepidium perfoliatum	Clasping Pepperweed	2	Intro.	21	0	0	0
Lepidium ruderale	Roadside Pepperweed	2	Intro.	16	0	0	0
Lepidium sativum cultivar 1	Garden pepperwort - broadcress	2	Intro.	16	0	0	0
L. sativum cultivar 2	Garden pepperwort - curlycress	2	Intro.	16	0	0	0
Lepidium sordidum	Sordid Pepperweed	2	Nat.	17	0	0	0
Lepidium virginicum var. *medium*	Poorman's Pepperweed	2	Nat.	16	0	0	0
Lobularia maritima	Sweet Alyssum	3	Intro.	16	0	0	0
Nasturtium (Rorippa) gambelii	*Gambel's* Yellowcress	3, 4b	Nat.	16	0	0	0
Nasturtium officinale	Watercress	3, 4b	Nat.	16	0	0	0
Noccaea fendleri ssp. *idahoensis*	Idaho Pennycress	3, 4b	Nat.	16	0	0	0
Noccaea fendleri ssp. *siskiyouensis*	Siskiyou Pennycress	3, 4b	Nat.	16	0	0	0
Pelargonium zonale	Zonal Geranium	6	Intro.	16	0	0	0
Physaria (Lesquerella) arizonica	Arizona Bladderpod	3, 4b	Nat	16	0	0	0
Physaria (Lesquerella) fendleri	Fendler's Bladderpod	3, 4b	Nat.	16	0	0	0

Appendix 1. Results of no-choice larval development testing for *Aceria drabae* on the target weeds and test plants (Littlefield et al., 2012).

Species	Common Name	Test Cat[1]	Native/Intro/ Eur[2]	# Tested	Mites 14 Days[4]	Mites 30+ Days[4]	Galls Present[4]
Physaria floribunda	Point-tip Twinpod	3, 4b	Nat	16	0	0	0
Physaria (Lesquerella) hemiphysaria	Intermountain Bladderpod	3, 4b	Nat.	16	0	0	0
Physaria lepidota var. *membranacea* (= *P. chambersii* var. *membranacea*)	Chamber's Twinpod	3, 4b	Nat.	22	0	0	0
Physaria (Lesquerella) ludoviciana	Keeled Bladderpod	3, 4b	Nat.	16	0	0	0
Physaria (Lesquerella) montana	Mountain Bladderpod	3, 4b	Nat	17	0	0	0
Physaria (Lesquerella) occidentalis	Western bladderpod	3, 4b	Nat	2	0	0	0
Raphanus sativus	Cultivated Radish	3, 6	Intro.	16	0	0	0
Rorippa sinuata	Spreading Yellowcress	3	Nat.	15	0	0	0
Sinapis alba	White Mustard	3	Intro.	16	0	0	0
Sinapis arvensis	Wild Mustard	3, 6	Intro.	31	0	0	0
Sisymbrium altissimum	Tall tumblemustard	3	Intro.	21	0	0	0
Smelowskia calycina	Alpine Smelowskia	3	Nat.	8	0	0	0
Smelowskia ovalis	Alpine False Candytuft	3	Nat.	14	0	0	0
Stanleya albescens	White Prince's-Plume	3	Nat.	16	0	0	0
Stanleya pinnata var. *pinnata*	Desert Princesplume	3	Nat.	29	0	0	0
Stanleya viridiflora	Green Princesplume	3	Nat.	17	0	0	0
Streptanthus farnsworthianus	Evalyn's Jewelflower	3, 4b	Nat.	18	0	0	0
Thelypodium laciniatum	Cutleaf Thelypody	3, 4b	Nat.	19	0	0	0
Thlaspi arvense	Field Pennycress	3, 6	Intro.	21	0	0	0
Tropaeolum majus	Nasturtium	5	Intro.	16	0	0	0
Turritis (Arabis) glabra	Tower-Mustard	3	Nat.	20	0	0	0

1 CATEGORY 1: Genetic types of *Lepidium draba*, *L. appeliamum*, and *L. chalapense* (varieties, races, genotypes, etc.); CATEGORY 2: North American species in the same genus as *Lepidium*, including economically and environmentally important plants; CATEGORY 3: North American species in other genera in the Brassicaceae family, divided by tribe, including economically and environmentally important plants; CATEGORY 4: Threatened and endangered species in the Brassicaceae family, divided by genus and tribe; CATEGORY 5: North American species in other families in the Brassicales order that have some phylogenetic, morphological, or biochemical relationship to the target weed, including economically and environmentally important plants; CATEGORY 6: North

Appendix 1. Results of no-choice larval development testing for *Aceria drabae* on the target weeds and test plants (Littlefield et al., 2012).

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

2 Origin: N= Native; Intro.= introduced into US

3 Life stage: A= Annual; B= Biennial; P=perennial

4 Presence: 0 = not present; + = present

Appendix 2. Host-specificity testing methods (Littlefield et al., 2012)

Host specificity testing of *A. drabae* at Montana State University (MSU) included as many native North American representatives of the various taxa as possible (Appendix 1). *A. drabae* was tested on 89 plant species of which 55 are species native to North America.

General Considerations about Testing

No-choice tests were utilized for the mite with the assumption that if mites accidently dispersed to non-target host plants then they have limited options for leaving a plant. Because under no-choice tests, *A. drabae* was very host specific, the researchers decided that open field tests that allow for natural dispersal were not needed. During testing, inoculated plants were inspected twice for the presence of *A. drabae*: once at two weeks to determine if the initial mites were still alive, and a second more comprehensive inspection after 30 days to determine if mites completed a subsequent generation(s) and were able to induce galls. Plants were visually inspected to determine the presence of live mites. Although extraction techniques efficiently removed mites, such techniques do not always differentiate live from dead mites (assuming some mortality due to extraction and dead individuals from the initial inoculation).

Quarantine Studies – No Choice Development Tests

Host specificity testing of the mite *A. drabae* has been conducted over a period of ten years. Testing during this period was intermittent not only due to funding and arranging collections but primarily due to shipping problems (high or complete mite mortality during shipment). The problem of mite mortality during shipment was not uncommon. In 2003, two shipments of *Aceria drabae* sent to Bozeman died during transit despite no delays during shipment; similar problems occurred in 2007 and with several shipments in 2008. However, this was an intermittant problem and healthy mites were received from Greece in other years.

Plants infested with *A. drabae* were collected from sites in northern Greece and sent to the Biological Control Containment Facility at Montana State University (MSU). Mites from these plants were used for no-choice host specificity tests. Test plants were grown to the 5-6 leaves stage to bolting stage and 20 to 25 mites were transferred to the center of the plant. When possible, 8 replications per plant species were made per trial and each trial was repeated, for a total of 16 plants. However, some plant species were difficult to grow and were tested when available. *Lepidium draba* (Bozeman, Montana collection) was used as the control for each testing period or cohort of phenologically similar plants tested. If there was no mite development on the control plants then that cohort of test plants was not considered. Plants were maintained within the greenhouse under ambient humidity, natural light (> 12 hours) and temperatures from 20 ^{o} to 25^{o} C. Plants were visually inspected under a stereoscope for the presence of live mites after two weeks. After a minimum of 30 days (30 to 60 days) test plants were harvested and destructively sampled. The presence of

live mites, galls, or other plant damage was noted.

Results and Discussion

A total of 97 taxa (89 species plus 8 additional subspecies/varieties) were tested, although some species had a low number of replications.

After two weeks of testing mites were observed on only four plant species: *Brassica napus* var. *napobrassica* (rutabaga), *Lepidium latifolium*, *Lepidium appelianum*, and the control *Lepidium draba*. Only two live mites were observed on rutabaga var. York (*Brassica napus var.* napobrassica) (on 1 of 32 plants). Considering the longevity of eriophyid mites it was expected that *A. drabae* would be able to survive for short periods on other mustard species (such as rutabaga) without reproducing. More survival on the more closely related *Lepidium* species was expected, but with exception of the closely related *Lepidium appelianum* (~8 mites on 5 of 50 plants) and the more distantly related *Lepidium latifolium* (3 mites on 1 of 32 plants), no live mites were observed after two weeks on any *Lepidium* species tested.

After 30 days *Aceria drabae* was only observed on *L. draba* and to a lesser extent on *L. appelianum*. Approximately 83.5 percent (± 4.5 SE) of the *L. draba* controls were infested with mites compared with 10.4 percent (± 4.5 SE) of *L. appelianum* plants. An average of 203.3 (± 39.4 SE) mites were observed per infested *L. draba* plant, compared with 6.8 (±4.1 SE) per infested *L. appelianum* plant (populations were significantly different using Mann-Whitney U Test; U=95.5 P= 0.008, SPSS 11.5). On several *L. draba* plants, mites were too numerous to be counted and populations had to be estimated; for example over 3,500 mites were estimated for one plant in the 2008 testing. Galls and leaf deformities were only induced on its intended host *Lepidium draba* (range of 1 -35 gall clusters per galled plant). Mites and eggs were also found on non-galled (or slightly modified) tissues indicating that *A. drabae* may live for an extended period on vegetative tissues. However large mite populations were associated with the presence of gall tissue. No gall formation was observed on *Lepidium appelianum*, although plants were more vegetative at the time of testing.

Mites did not develop on any other test plant species; including some of those listed as host plants in the literature (see above sections). This lends support to Lipa (1978) field test results and the supposition that *A. drabae* has a restricted host range.

Appendix 3. Release Strategy for *Aceria drabae* (Littlefield et al., 2012).

Geographical or Host Source

Aceria drabae was originally collected from *Lepidium draba* in northern Greece for the Montana State University (MSU) host-specificity tests. These same collection locations will be the source of the gall mites released in the United States.

Method to Ensure Proper Identification

As no other eriophyid mites are known to be associated with *Lepidium draba* and no problems with mite identification during collection are expected. However, the mites will be reared through several generations prior to field release. Because this requires that mites are transferred individually or in small groups, the mites will be closely inspected prior to release. Voucher specimens of the mites will be kept for comparative purposes at the MSU containment facility.

Protocol to Ensure the Absence of Natural Enemies

Collected plant material will be inspected for natural enemies. *Aceria drabae* will be separated from other contaminating arthropods either by hand transferring individual or small groups of mites or by using extraction techniques (Monfreda et al., 2007) for separation. Pure rearing colonies will be started and maintained. Nymphs and adults will be sampled and inspected for the presence of pathogens.

Impact of Other Management Practices

Sites with minimal disturbance (i.e., free from grazing, spraying, mowing, etc.) will be chosen. Local cooperators will be involved to help insure against unintentional disturbance to the sites after release. In addition, release sites may be protected from grazing and other disturbances using fencing.

Specific Location of Rearing Facility

Handling and rearing of *Aceria drabae* will be initially conducted within the quarantine facility at Montana State University, Bozeman. Colonies will then be transferred to non-quarantined greenhouses and/or to a field insectary on the MSU campus.

Intended Sites for Initial Release

Initial releases are proposed for Gallatin, Broadwater, and Lake Counties, Montana. Subsequent releases may also be made at selected sites located in Wyoming or Idaho.

Number of Mites to be Released, Timing of Releases and Release Methods

Aceria drabae will be released as extracted nymphs and adults or as laboratory-reared galls/infested plants. Actual numbers released per site will be dependent upon the availability of the mites or of galls, however, target release sizes are several hundred to several thousand individuals per site.

Releases will be made during May through June, depending upon the phenological development of hoary cress plants, that need to be in the vegetative stage at the time of release. Portions of the release site may be mowed to stimulate new stem growth which will extend the period of time in which the mites can be released.

Chopped gall material or extracted mites will be transferred to the rosette or developing stems of plants. Infested plants may be used and will be transplanted into field sites. Mites will naturally disperse to non-infested plants. Release points will be situated to allow the mites to be wind dispersed across the hoary cress infestation and to adjacent patches.

Monitoring Plans

Initial release sites will be utilize primarily for the augmentation of gall mite populations for redistribution, as well as determining initial population buildup and the spatial distributions of the mite. Monitoring of the initial release site(s) for establishment will be carried out by the permittee from Montana State University with the help of federal and local cooperators. Monitoring will occur periodically from early spring to plant senescence for subsequent years following release. Plants infested with galls will be mapped using a GPS unit. At select sites a spatial distribution study will be initiated to characterize the within-site population distribution of *A. drabae* galls in relation to host density and to follow its population development and within field dispersal. A sampling grid with points located 10-20 m apart (depending upon the site) will be established. At each point plant density will be recorded in early summer in permanent 0.25 square meter quadrats. The number of plants infested per quadrat will also be determined. Twenty five plants within the site will be collected and dissected in the laboratory to count total numbers of mites and to assess possible predation. The within field spatial and temporal distribution of *A. drabae* relative to that of hoary cress density will be analyzed using SADIE analysis. Soil and air temperature will be recorded at release site to determine phenological development of the mite and of hoary cress.

Secondary sites will later be developed by various cooperators within Montana and surrounding states (e.g. Wyoming and Idaho). Standardized monitoring of plant and mite densities will occur at these sites. For monitoring vegetation the researcher will adopt the Idaho's Statewide Pre-release Monitoring Guidelines for White-top (Hoary Cress) Stem-galling Weevil (http://www.agri.state.id.us/Categories/PlantsInsects/NoxiousWeeds/Documents/Bio_Control/2011/WT_Pre-Release.pdf). This consists of a 20 meter long transect with 10 equally spaced 0.125 square meter permanent quadrats. Plant density and cover will be recorded

per quadrat. The final monitoring protocols have yet to be developed for the mite but will be based upon the preliminary data collected from the initial release sites. The number of galled plants per sampling quadrat will be calculated.

Appendix 4. Federally listed plants (or species proposed for listing or candidates for listing) that belong to the same family as hoary cress (Brassicaceae).

Plant Species	**Common Name**	**Habit[1]**
Arabis georgiana	Georgia rockcress	B
Arabis macdonaldiana	McDonald's rock-cress	P
Arabis hoffmannii	Hoffmann's rock-cress	P
Arabis perstellata	Braun's rock-cress	P
Arabis serotina	Shale barren rock-cress	B
Cardamine micranthera	Small-anthered bittercress	B,P
Caulanthus californicus	California jewelflower	A
Erysimum capitatum ssp. *angustatum*	Contra Costa wallflower	B,P
Erysimum menziesii	Menzies' wallflower	B,P
Erysimum teretifolium	Ben Lomond wallflower	B, P
Eutrema penlandii	Penland alpine fen mustard	P
Leavenworthia crassa	Fleshy-fruit gladecress	A
Leavenworthia exigua laciniata	Kentucky glade cress	A
Leavenworthia texana	Texas golden gladecress	A
Lepidium barnebyanum	Barneby ridge-cress	P
Lepidium ostleri	Ostler’s peppergrass	P
Lepidium papilliferum	Slickspot peppergrass	A,B,P
Paysonia (*Lesquerella*) *lyrata*	Lyrate bladderpod	A
Paysonia (*Lesquerella*) *perforata*	Spring Creek bladderpod	A
Physaria (*Lesquerella*) *congesta*	Dudley Bluffs bladderpod	P
Physaria douglasii ssp. tuplashensis	White Bluffs bladderpod	P
Physaria filiformis	Missouri bladderpod	P
Physaria globosa	Short’s bladderpod	B,P
Physaria (*Lesquerella*) *kingii* ssp. *bernardina*	San Bernardino Mountains bladderpod	B,P
Physaria obcordata	Dudley Buffs twinpod	P
Physaria (*Lesquerella*) *pallida*	White bladderpod	A
Physaria (*Lesquerella*) *thamnophila*	Zapata bladderpod	P
Physaria (*Lesquerella*) *tumulosa*	Kodachrome bladderpod	P
Rorippa gambellii	Gambel's watercress	P
Schoenocrambe (*Hesperidanthus*) *argillacea*	Clay reed-mustard	P
Schoenocrambe (*Hesperidanthus*) *barnebeyi*	Barneby reed-mustard	P
Schoenocrambe (*Hesperidanthus*) *suffrutescens*	Shrubby reed-mustard	P
Sibara filifolia	Santa Cruz Island rockcress	A
Streptanthus albidus ssp. *albidus*	Metcalf Canyon jewelflower	A,B
Streptanthus niger	Tiburon jewelflower	A
Thelypodium howellii spectabilis	Howell's spectacular	B,P

	thelypody	
Thelypodium stenopetalum	Slender-petaled mustard	B
Thlaspi californicum	Kneeland Prairie penny-cress	P
Thysanocarpus conchuliferus	Santa Cruz Island fringepod	A
Warea amplexifolia	Wide-leaf warea	A
Warea carteri	Carter's mustard	A

[1]A = Annual, B = Biennial, P = Perennial.

Decision and Finding of No Significant Impact
for
Field release of the gall mite, *Aceria drabae* (Acari: Eriophyidae), for classical biological control of hoary cress (*Lepidium draba* L., *Lepidium chalapense* L., and *Lepidium appelianum* Al-Shehbaz) (Brassicaceae), in the contiguous United States.
January 2018

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) is proposing to issue permits for release of the gall mite, *Aceria drabae* (Acari: Eriophyidae). The agent would be used for the biological control of hoary cress (*Lepidium draba* L., *Lepidium chalapense* L., and *Lepidium appelianum* Al-Shehbaz) (Brassicaceae) in the contiguous United States. Before permits are issued for release of *A. drabae*, APHIS must analyze the potential impacts of its release into the contiguous 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
Pests, Pathogens, and Biocontrol Permits
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 a permit authorizing environmental release of *A. drabae*: (1) no action, and (2) issue permits for the release of *Aceria drabae* for biological control of hoary cress. 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 and mechanical controls for the management of hoary cress. These control methods described are not alternatives for decisions to be made by APHIS, but are presently being used to control hoary cress in the United States and may continue regardless of permit issuance for field release of *A. drabae.* Notice of this EA was made available in the Federal Register on December 5, 2017 for a 30-day public comment period. Two comments were received on the EA by the close of the comment period. However, these comments did not raise any specific or substantive issues.

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

- *Aceria drabae* is sufficiently host specific and poses little, if any, threat to the biological resources, including non-target plant species, of the contiguous United States.

- *Aceria drabae* is not likely to adversely affect federally listed threatened and endangered species or their critical habitats in the contiguous United States.

- *Aceria drabae* poses no threat to the health of humans or animals.

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

- 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. drabae* 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 action alternative and, therefore, no Environmental Impact Statement needs to be prepared.

Steven Crook, Director
Permitting and Compliance Coordination
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine

1/8/2018
Date