USDA Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Field Release of the Knotweed Psyllid *Aphalara itadori* (Hemiptera: Psyllidae) from Murakami, Japan for Classical Biological Control of Japanese, Giant, and Bohemian Knotweeds, *Fallopia japonica*, *F. sachalinensis*, and *F*. x *bohemica* (Polygonaceae), in the Contiguous United States.

Final Supplemental Environmental Assessment

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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 the knotweed psyllid, *Aphalara itadori* (Hemiptera: Psyllidae) from a new source location, Murakami, Japan. The release of *Aphalara itadori* from Murakami, Japan would be used for the classical biological control of Japanese, giant, and Bohemian knotweeds (*Fallopia japonica*, *F. sachalinensis*, and *F.* x *bohemica* (Polygonaceae)) in the contiguous United States.

Classical biological control of weeds is a weed control method where natural enemies from a foreign country are used to reduce exotic weed infestations that have become established in the United States. Several different kinds of organisms have been used as biological control agents of weeds: insects, mites, nematodes, and plant pathogens, although plant-feeding insects are the most commonly used. Efforts to develop a weed biological control agent consist of the following steps (TAG, 2021):

1. Foreign exploration in the weed's area of origin.
2. Host specificity studies.
3. Approval of the exotic agent by PPBP.
4. Release and establishment in areas of the United States invaded by the target weed.
5. Post-release monitoring.

This supplemental environmental assessment (SEA) 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. itadori* from Murakami, Japan to control infestations of Japanese, giant, and Bohemian knotweeds within the contiguous United States. This SEA considers the potential effects of the proposed action and its alternatives, including no action. APHIS made a final environmental assessment (EA) (USDA-APHIS, 2020) and finding of no significant impact (fonsi) for release of *A. itadori* from Kyushu and Hokkaido, Japan available to the public in the Federal Register on November 30, 2020 (2020-26290.pdf (govinfo.gov)). That EA and fonsi is incorporated by reference in this SEA. Notice of this SEA was made available in *Federal Register* on February 10, 2023 for a 30-day public comment period. APHIS received nine comments on the EA by the close of that comment period. All comments were in support of the proposed action. One commenter suggested that introductions of *A. itadori* should be carried out gradually with monitoring to ensure that there will not be unexpected effects before wider release, which is the plan for the proposed release, as described in appendix 2.

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 the knotweed psyllid, *A. itadori,* from Murakami, Japan, 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 from a new source in Japan into the contiguous United States.

The applicant's purpose for releasing *A. itadori* from Murakami, Japan is to reduce the severity of infestations of invasive knotweeds in the contiguous United States. Invasive knotweeds in North America are a complex of three closely related species in the family Polygonaceae that were introduced from Japan during the late 19th century (Barney, 2006). They include *Fallopia sachalinensis* (F. Schmidt) Ronse Decraene (giant knotweed), *F. japonica* (Houtt.) Ronse Decr. (Japanese knotweed), and the hybrid between the two *F.* x *bohemica* (Chrtek & Chrtková) J. P. Bailey (Bohemian or hybrid knotweed). These large herbaceous perennials have spread throughout much of North America with the greatest infestations in the Pacific Northwest (Oregon, Washington, and British Columbia), the northeast of the United States, and eastern Canada. While capable of growing in diverse habitats, the knotweeds have become especially problematic along the banks and floodplains of rivers and streams, where they crowd out native plants and potentially affect stream nutrients and food webs (Beerling and Dawah, 1993; Maerz et al., 2005; Gerber et al., 2008; Urgenson et al., 2009; McIver and Grevstad, 2010). Several states have active control programs against knotweeds. However, the large scale of the knotweed invasion in North America, the inaccessibility of some of the infestations, and the difficulty with which the plants are killed, all suggest that complete eradication of this plant is unlikely.

Existing options for management of invasive knotweeds are expensive, temporary, ineffective, and can have nontarget impacts. Biological control has the potential to provide widespread and sustained reduction in knotweed abundance at a very low cost. Although two lines of *A. itadori* (Kyushu and Hokkaido lines) have been permitted by APHIS for release into the contiguous United States, the new population (or line) from Murakami, Japan could offer improved effectiveness against invasive knotweeds because (1) it comes from a location that has a better climate and photoperiod match to the primary target knotweed regions of the United States, (2) it is recently collected and thus field-adapted (not lab-adapted as are the current permitted lines), and (3) it performs particularly well on hybrid knotweed (*F.* x *bohemica*) which is the most abundant type of knotweed in the United States. For these reasons, the applicant has a need to release *A. itadori* from Murakami, Japan, or potentially other lines of *A. itadori*, a host-specific, biological control organism for the control of invasive knotweeds, into the environment of the contiguous United States.

II. Alternatives

This section will explain the two alternatives available to the PPBP—no action (continued environmental release of only the Kyushu and Hokkaido lines of *A. itadori*) and issuance of permits for environmental release of *A. itadori* from Murakami, Japan as well as other lines of *A. itadori* from other locations in Japan if APHIS determines that the host specificity and potential environmental impacts are similar to previously approved lines of *A. itadori* (preferred alternative). Although the PPBP's alternatives are limited to a decision on whether to issue permits for release of *A. itadori* from Murakami, Japan or other areas, other methods available for control of invasive knotweeds are also described. These control methods are not decisions to be made by the PPBP, and their use is likely to continue whether or not permits are issued for environmental release of *A. itadori* from Murakami, Japan, depending on the efficacy of *A. itadori* to control invasive knotweeds. These are methods presently being used to control invasive knotweeds by public and private concerns.

A third alternative was considered but will not be analyzed further. Under this third alternative, the PPBP would have issued permits for the field release of *A. itadori* from Murakami, Japan, or other equivalent lines/sources of *A. itadori*; however, the permits would contain special provisions or requirements concerning release procedures or mitigating measures. However, no issues have been raised that would indicate special provisions or requirements are necessary.

A. No Action

Under the no action alternative, the PPBP would not issue permits for the field release of *A. itadori* from Murakami, Japan or any other lines/sources of *A. itadori* for the control of invasive knotweeds. The release of other lines of this biological control agent would not take place. The following methods are presently being used to control invasive knotweeds; these methods will continue under the "No Action" alternative and will likely continue even if permits are issued for release of *A. itadori* from Murakami, Japan, depending on the efficacy of the organism to control invasive knotweeds.

1. Chemical Control

In the United States, several states have active control programs against knotweeds where herbicide foliar application and stem injection are commonly used. Favored herbicide formulations contain the active ingredient glyphosate (Rodeo®, Roundup®, Aquamaster®) or imazapyr (Habitat®). Due to the extensive root systems of knotweed that can extend up to 3 meters (m) deep, knotweeds must be treated year after year to completely eliminate plants. In British Columbia, broad spectrum herbicide use is operationally restricted to 15 m above the the high water mark in riparian zones. Specific applications for knotweed are only possible using glyphosate hand wipes or injection within 1 m of the high water mark.

2. Mechanical Control

Small isolated plants or knotweed patches can be effectively removed by covering them for several years with sturdy tarps or by hand digging, but only if the root system is not yet well established. As an alternative to herbicides, some success in weakening knotweed stands with salt water has been reported.

3. Biological Control

APHIS permitted the release of Kyushu and Hokkaido populations of *A. itadori* in 2020. The two populations of *A. itadori* (lines)--one from northern Japan (Hokkaido) performs better on *F. sachalinensis* and the other from southern Japan (Kyushu) performs better on *F. japonica*.

Host specificity of *A. itadori* and the potential environmental impacts of release of the Kyushu and Hokkaido lines of *A. itadori* were described in the EA prepared prior to permit issuance for their environmental release. This EA (USDA-APHIS, 2020) is incorporated by reference in this SEA. In host specificity testing conducted on the Kyushu and Hokkaido populations of *A. itadori*, both types usually died out when forced to reside long-term on non-target host plants. Often this happened within one generation, but in some cases after one or two generations. There was some persistence of *A. itadori* on buckwheat (*Fagopyrum esculentum*), *Muehlenbeckia axillaris*, and *Fallopia cilinodis*, but risk to these plants is low. The researchers found that both lines (Kyushu and Hokkaido) of *A. itadori* significantly reduced the growth of both *F. sachalinensis* and *F. x bohemica* resulting in more than a 50 percent reduction in biomass after 50 days exposure to *A. itadori* as compared to controls (Grevstad et al., 2013).

Although it is too soon to know if these introduced *A. itadori* lines will be successful, early results suggest high mortality of the nymph stage leading to little or no recovery of the insects in late summer and in the following spring. In the United Kingdom and in Canada where the Kyushu line of *A. itadori* has been repeatedly introduced for many years, permanent establishment has still not been confirmed. So far in the United States, overwintered *A. itadori* have been detected at very low numbers (from one to five individuals) at only four of 27 release sites.

B. Issue Permits for Environmental Release of *A. itadori* from Murakami, Japan and Other Equivalent Lines (Preferred Alternative)

Under this alternative, the PPBP would issue permits for the field release of the knotweed psyllid, *A. itadori*, from Murakami, Japan for the control of invasive knotweeds. Under this alternative, APHIS would also issue permits of *A. itadori* from other locations if APHIS determines that the host specificity and potential environmental impacts are similar to previously approved lines/sources of *A. itadori*. In that case, the permit applicant would submit to PPBP results of host specificity testing for proposed lines/sources of *A. itadori* for environmental release. The PPBP would evaluate the test results, and if host specificity and environmental impacts are similar to previously released lines of *A. itadori*, the PPBP would also approve permits for those lines/sources of *A. itadori.* These permits would contain no special provisions or requirements concerning release procedures or mitigating measures.

Biological Control Agent Information

1. Taxonomy

Common name: knotweed psyllid
Phylum: Arthropoda
Class: Insecta
Order: Hemiptera
Family: Psyllidae
Genus: *Aphalara*
Species: *itadori*
Authority: Shinji

2. Description of *A. itadori* from Murakami, Japan

Aphalara itadori was first described as *Psylla itadori* by Shinji (1938) but was moved to the genus *Aphalara* by Miyatake (1964). A more recent description is provided by Burckhardt and Lauterer (1997). The *Aphalara* genus includes around 40 species, many of which are difficult to distinguish from each other and are often identified from their distinct host ranges (Burckhardt and Lauterer, 1997). Damage to knotweeds caused by *A. itadori* can be seen in figure 1.

The identity of the psyllid collected from Murakami, Japan was confirmed as *A. itadori* (Kurose and Shaw, 2020). Sampled insects from this collection were found to have 99.13 percent–99.28 percent DNA sequence similarity to the original Kyushu collection. The Kyushu collection was previously found to be similar to the Hokkaido collection within about 1 percent. All are well inside the range of variation within a species. Specimens of the Murakami line of *A. itadori* were deposited in the Natural History Museum in London (NHM ref: IAS 2019-7604).

Figure 1. Damage to *F. sachalinensis* caused by *A. itadori* nymphs (Grevstad et al., 2012).

3. Geographical Range of *A. itadori*

a. Native Range

The native range of *A. itadori* includes Japan, Korea, and the Kurile and Sakhalin Islands (Burckhardt and Lauterer, 1997). The occupied latitude ranges from 31º N latitude at the southern end of Japan to approximately 50º N on Sakhalin Island. In surveys in Japan, it was found from sea level to 2,150 m above sea level (Shaw et al., 2009). The Kyushu (or "southern") line was collected in southern Japan from *F. japonica* (Shaw et al., 2009). A second ("northern") line was collected from *F. sachalinensis* on the Island of Hokkaido in northern Japan in 2007. The third line of *A. itadori* that is considered in this SEA was collected from near Murakami on the Island of Honshu in central Japan. *Aphalara itadori* adults were collected in June of 2019 from hybrid (*Fallopia x bohemica*) knotweed plants in the vicinity of Murakami, Japan (approximately 38.32° N, 139.52° E), which falls in between the collection locations of the currently approved populations. The location of the northern approved line is 300 miles to the north of Murakami (on the Island of Hokkaido) and the location of the southern approved line is 610 miles to the southwest of Murakami (on the Island of Kyushu). The distribution of *A. itadori* and its host plants is continuous throughout the Islands of Japan. Giant knotweed (*F. sachalinensis*) is more abundant in the north and Japanese knotweed (*F. japonica*) in the south. At intermediate latitudes including the area around Murakami, a spectrum of hybrid knotweeds occur that are similar in appearance to the targeted *F. x bohemica* in North America. If other lines of *A. itadori* are identified, they would be collected from the native range.

b. Non-native Range

The Murakami line of *A. itadori* was recently permitted for release into the Netherlands (2020), the United Kingdom (2021), and Canada (2021).

c. Expected Attainable Range of *A. itadori* in North America

Assuming that *A. itadori* comes to occupy a similar climatic range in North America as the full range that it occupies in Asia, the new range would span from the State of Georgia to Newfoundland in the east and from central California to Alaska in the west. This fully covers the regions where knotweeds are invasive. However, localized climate adaptations of the two currently approved lines have limited their establishment in North America. Although climate match analysis using Climex® software indicated that the Kyushu and Hokkaido line source locations were a good match to North American locations, especially for the eastern United States, this new line from Murakami, Japan could offer improved effectiveness because it comes from a location that has a better climate and photoperiod match to the primary knotweed target regions in the United States.

3. Life History of *A. itadori*

The life history of the Murakami line of *A. itadori* is identical to that of the two approved lines, as described in the 2020 *A. itadori* EA (USDA-APHIS, 2020). Nymphs and adults feed by inserting sucking mouthparts into the phloem cells of the leaves and stems and removing sap. Adult female psyllids lay up to 600–700 eggs on the plant surface during their lifetime (Shaw et al., 2009). Eggs hatch after about 12 days and the nymphs pass through five instars. A full generation requires 33 days at 23 °C. While feeding, nymphs excrete crystallized honeydew (forming lerp) that is conspicuous as white strings or flakes on the plant surfaces. Adult *A. itadori* are winged and can fly. However, whether there is a distinct flight season and how far they can fly are not known. The psyllids overwinter as adults. While they have been found overwintering on the bark of conifers (Baba and Miyatake, 1982; Miyatake, 2001), they have also been observed remaining on the leaves of senesced knotweed plants through the winter when kept in outdoor cages. For most regions of the United States where knotweeds are a problem, *A. itadori* is expected to complete two generations per year.

III. Affected Environment

Full details on the target weed biology, taxonomy, description, distribution, and impacts are available in the 2020 EA for *Aphalara itadori* (USDA-APHIS, 2020). The most relevant information is provided here.

A. Taxonomy and Description of Japanese, Giant, and Bohemian Knotweeds

Invasive knotweeds are a complex of three closely related and interbreeding species in the family Polygonaceae: Japanese knotweed *Fallopia japonica* (Houtt.) Dcne., giant knotweed *Fallopia sachalinensis* (F. Schmidt ex Maxim.) Dcne., and bohemian (or hybrid) knotweed *Fallopia* x *bohemica* (Chrtek & Chrtková) JP Bailey. Knotweeds are herbaceous perennials that form dense thickets of tall stalks 1 to 4 meters high with large leaves. Japanese knotweed tends to have smaller leaves that are square at the base and which lack leaf hairs. Giant knotweed has larger leaves with lobed bases and fine hairs on the underside. Hybrid knotweed has leaves that are intermediate in shape and with small spikes instead of hairs.

B. Areas Affected by Invasive Knotweeds

1. Native Range of Japanese, Giant, and Bohemian Knotweeds

Fallopia japonica is native to East Asia including Japan, China, Korea, and Taiwan. *Fallopia sachalinensis* is native to northern Japan and Sakhalin Island. Hybrid forms can be found in Japan at mid-latitudes.

2. Introduced Range of Japanese, Giant, and Bohemian Knotweeds

Japanese, giant, and Bohemian knotweeds have spread throughout much of North America with the greatest infestations in the Pacific Northwest (Oregon, Washington and British Columbia), the northeast of the United States, and eastern Canada. *Fallopia japonica* and *F. x bohemica* occur in at least 41 of the United States, including Alaska, and in eight Canadian provinces. *Fallopia sachalinensis* occurs in fewer states and provinces than Japanese or hybrid knotweed but is locally just as invasive. All three species have become most abundant and problematic in the northeastern States and in the Pacific Northwest. In surveys of knotweed in the western United States, it was found that pure *F. sachalinensis* plants represented approximately 15 percent of the field plants surveyed, 15 percent were *F. japonica*, and 70 percent were hybrids

(McIver and Grevstad, 2010; Gaskin et al., 2014). The northeastern United States appears to have a greater proportion of *F. japonica* (Gammon and Kesseli, 2010). In British Columbia, Japanese knotweed is the most common of the three species based on records in the Invasive Alien Plant Program (IAPP) database (IAPP, 2012) with the number of records for *F. sachalinensis* and *F. x bohemica* at approximately 10 percent of the *F. japonica* numbers. While there may be some cases of misidentification of *F. japonica* sites that are actually hybrids, the relative abundance of knotweed records by species in IAAP has remained consistent between 2008 (Bourchier and VanHezewijk, 2010) and 2012.

3. Life History of Japanese, Giant, and Bohemian Knotweeds

As herbaceous perennials, knotweeds sprout anew each spring, growing rapidly to a height of 3–4 m by mid-summer. Flowering occurs in September and seeds ripen in October. Knotweeds in North America are variably reported as either dioecious (having the male and female reproductive organs in separate individuals) or gynodioecious (having female flowers on one plant and hermaphrodite (both male and female) flowers on another plant of the same species) (Stone, 2010). However, there is evidence for subdioecy (or “leaky dioecy”) in which there are plants with female flowers (producing copious seeds if there is a pollinator available), male flowers (producing no seed), and hermaphroditic flowers (producing few seeds). Although the seeds have high germination rates in the laboratory, seedling establishment in the field occurs infrequently (Forman and Kesseli, 2003; Engler et al., 2011). Field reproduction appears to occur mainly through clonal fragmentation of stems and rhizomes. Rhizomes are horizontal underground stems that continuously grow and put out lateral shoots and roots at intervals. Stem fragments as small as 40 millimeters have been observed to regenerate (De Waal, 2001). *Fallopia* species spread readily along stream banks where currents and flooding events cause erosion and breaking of rhizomes and stems which are carried downstream. Once a new plant establishes, it spreads clonally by way of rhizomes that grow and spread underground.

C. Plants Related to Invasive Knotweeds and Their Distribution

The closest relatives of the target plants in North America are two native and three introduced *Fallopia* species and three species in the genus *Muehlenbeckia* (Sanchez et al., 2009). *Fallopia cilinodis* (fringed bindweed) and *F. scandens* (climbing buckwheat) are native, perennial, herbaceous vines (Freeman and Reveal, 2005). *Fallopia cilinodis* occurs in dry woods, thickets, and clearings throughout much of the northeastern and midwestern United States and eastern Canada. The range of *F. scandens* is similar but extends further south to the Gulf States. It occurs in low habitats including moist woods and thickets. *Fallopia baldschuanica* (Russian vine or silver lace vine) is a cultivated woody ornamental vine from Eurasia. It is widely distributed in garden plantings in the United States, occasionally escaping cultivation. *Fallopia dumetorum* (copse bindweed) and *F. convolvulus* (black bindweed) are introduced weedy annual plants without ornamental value. The former occurs primarily in the eastern half of the United States and Canada. The latter occurs throughout temperate North America and can be an aggressive crop weed. Three species of *Muehlenbeckia* (wirevines) occur in North America as introduced ornamentals used uncommonly as ground covers (USDA hardiness zones 8–10) or as filler plants for hanging baskets. *Muehlenbeckia axillaris* (creeping wirevine), the only one of this genus that is currently commercially available, is reported outside of cultivation only in

Hawaii (USDA Plants Database). *Muehlenbeckia complexa* and *M. hastatula* are each reported from two counties in California (US Plants Database) where they are locally invasive and targeted for control (Pollak, 2008; Baldwin et al., 2012). Neither was found to be commercially available, suggesting limited use of these two plants in the nursery trade.

D. Climate in Knotweed-Affected Areas

In the United States, knotweeds have spread throughout much of North America with the greatest infestations in the Pacific Northwest (Oregon and Washington) and the northeast of the United States.

Kunkel et al. (2013a) provide a general description of the Northwest climate which is summarized in the following paragraphs.

The mountains that are positioned in a north-south direction cause increased precipitation (rain, snow, sleet, hail) on the west side of the mountain ranges but block the movement of moisture into the eastern interior. This results in a very large difference in precipitation between western and eastern portions of the region. Annual average precipitation ranges from less than 10 inches along the Columbia River in eastern interior Washington to areas receiving 100 or more inches such as in the mountains of northern Idaho, and in Washington's Olympic Peninsula. Many locations west of the Cascade Mountains receive measurable rain on more than half the days of the year, whereas east of the Cascades, measurable precipitation occurs at least 70 to 80 days per year.

The cool temperatures of the ocean surface moderate the warm season temperatures west of the Cascade Range. East of the range, temperatures can be much warmer because ocean-influenced air that would cool temperatures is blocked by the mountain range. Western areas of the region also experience moderate winter temperatures due to the effect of the ocean and blockage by the mountains to the east of cold, Arctic air masses that come from Canada. Similar to the warm season, interior areas experience colder temperatures because the Cascades block the moderating ocean air masses. However, the Rocky Mountains to the east shield interior areas from much of the Arctic air that affects the northern plains. The cold season has frequent extra-tropical cyclones leading to many days with precipitation and cloudy conditions. The coastal areas are the wettest places in the contiguous United States, and the Cascade Range has some of the largest snowfall totals. Summers are dry. Temperatures in the Northwest are generally moderate with mean annual values from near 30°F in higher mountain areas to around 50°F in the lowland areas of the west.

Kunkel et al. (2013b) provide a general description of the Northeast climate which is summarized in the following paragraphs.

The Northeast region is characterized by a highly diverse climate with large spatial variations. Several geographic factors contribute to this. The moderating effects of the Atlantic Ocean affect coastal areas, and the inland regions are also influenced by large water bodies such as the Great Lakes and Lake Champlain. During much of the year, the prevailing westerly flow brings air masses from the interior North American continent across the entire region, bringing bitter cold to the region during winter. The polar jet stream is often located near or over the region during the winter, with frequent storm systems bringing cloudy skies, windy conditions, and precipitation. In the southern portions of the region, the Appalachian Mountains act to partially shield coastal regions from these interior air masses, while also shielding the western part of the region from the warm, humid air masses characteristic of the western Atlantic Ocean, although there is no barrier to humid air masses from the Gulf of Mexico. The local representations of the Appalachians (e.g., the Green Mountains of Vermont and the White Mountains of New Hampshire) also influence the climates of northern New England in ways that lead to significant differences in relation to the climates of southern New England. All of the mountain ranges act as barriers leading to the local enhancement of precipitation during storms through forced rising of air flow.

Northeast summers are warm and humid in the southern part of the region due to a semi-permanent high-pressure system over the subtropical Atlantic Ocean that draws warm, humid air into the area. In the north, summers are considerably more moderate due to their latitude and the frequent infux of cooler air masses from Canada. The Northeast is subject to a strong seasonal cycle and is often affected by extreme events such as ice storms, floods, droughts, heat waves, hurricanes and nor'easters. Its landscape is diverse, ranging from agricultural land to mountains to coastal beaches and estuaries. Other parts of the region are densely populated and highly urbanized. The average annual temperatures in the Northeast are comparable to the Northwest region. The average annual temperature in the coastal regions, especially the more southern areas, is in the 50°F to 60°F range. The coldest average temperatures (between 35°F and 40°F) are observed along the northern border of Maine. Average temperatures in the Northeast generally decrease to the north and with elevation and distance from the coast. Annual average precipitation ranges from less than 35 inches in parts of New York to over 50 inches along the New England coast. However, effects caused by mountains produce localized amounts in excess of 60 inches at inland locations, particularly in West Virginia and New York. The amount of precipitation tends to decrease further inland.

IV. Environmental Consequences

A. No Action

1. Impact of Knotweeds

a. Negative Impacts

The impacts of knotweeds were described in detail in the 2020 EA for *Aphalara itadori* (USDA-APHIS, 2020). Knotweeds have ecological impacts on plant and invertebrate communities, soil properties, and nutrient cycling. While capable of growing in diverse habitats, knotweeds have become especially problematic along the banks and floodplains of rivers and streams, where they crowd out native plants and potentially affect stream nutrients and food webs (Beerling and Dawah, 1993; Maerz et al., 2005; Gerber et al., 2008; Urgenson et al., 2009; McIver and Grevstad, 2010). Lacking fine roots near the surface, knotweeds are less able to hold the surface soil and can cause increased erosion (Child et al., 1992), although they have been planted for the purpose of preventing erosion. Knotweeds can cause costly damage to road and parking lot surfaces, with forceful roots and rhizomes capable of cracking concrete and asphalt (Shaw and Seiger, 2002). Dense knotweed thickets can be a recreational nuisance, limiting stream access for uses such as fishing and boating. The large scale of the knotweed invasion, the inaccessibility of some of the infestations, and the difficulty with which the plants are killed, all point to biological control as a contributing solution.

Fallopia japonica is classified as a noxious weed (or similar designation) in 26 states, and giant knotweed is classified as noxious in 15 states. The hybrid Bohemian knotweed is specifically regulated in eight states. However, because Bohemian knotweed has frequently been mistakenly identified in North America as Japanese knotweed (Zika and Jacobson, 2003), it should be considered as included under Japanese knotweed on plant regulation lists. Knotweeds are listed among the world's worst invasive species by the World Conservation Union, having also invaded Europe, New Zealand, and Australia (Lowe et al., 2000).

b. Beneficial Uses

Knotweeds are believed to be beneficial to honey production, providing bees with an abundance of nectar late in the summer (Andros, 2007). The new shoots of knotweed are edible by humans if harvested when young, having a flavor similar to rhubarb. Some people enjoy the aesthetic properties of knotweeds in ornamental plantings and some nurseries still stock ornamental varieties of knotweed that are deemed non-invasive such as varieties 'variegata', 'compacta', 'crimson beauty', 'tricolor', 'freckles', and 'spectabile.' Indeed these varieties do not appear to be naturalized (though they are very uncommon). Giant knotweed has been found to have fungicidal properties and is the active ingredient in a commercial organic fungicide (Regalia®) made by Marrone BioInnovations. Knotweeds also contain a high concentration of resveratrol, a compound that has been studied for its potential anti-aging and anti-cancer properties. Resveratrol applied at high concentrations has been shown to inhibit proliferation of some human cancer cells in culture and to increase longevity in yeast, fish, and mice. However, it has not yet been shown to be effective in treating or preventing cancer or extending the lifespan of humans. Nonetheless, Japanese and giant knotweeds are used as sources of resveratrol for herbal supplements sold commercially. These supplements are manufactured in China using plant material grown there.

2. Impact from Use of Other Control Methods

The continued use of chemical, 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 preferred alternative, depending on the efficacy of various lines/sources of *A. itadori* to reduce knotweed populations in the contiguous United States.

a. Chemical Control

Due to the extensive root systems of knotweed which can extend up to 3 m deep, knotweeds must be treated with herbicide year after year to completely eliminate plants. Even after knotweed patches have appeared dead for several years, shoots may still re-sprout. Thus, management of knotweed through conventional means is generally considered a long-term venture, if not a permanent one.

When broadcast spraying, death of adjacent or underlying non-target plants is often unavoidable. The surfactants used in some herbicide formulations are known to have detrimental effects on fish, amphibians, and aquatic invertebrates in experimental trials (Giesy et al., 2000; Relyea, 2005).

b. Mechanical Control

Small, isolated plants or knotweed patches can be effectively removed by covering them for several years with sturdy tarps or by hand digging, but only if the root system is not yet well established. As an alternative to herbicides, some success in weakening knotweed stands with salt water has been reported, though it is unlikely to be effective or environmentally sound on a large scale.

c. Biological Control

Expected impacts of the Kyushu and Hokkaido lines were described in detail in the 2020 *A. itadori* EA (USDA-APHIS, 2020). In laboratory testing, both lines (Kyushu and Hokkaido) of *A. itadori* significantly reduced the growth of both *F. sachalinensis* and *F. x bohemica* resulting in more than a 50 percent reduction in biomass after 50 days exposure as compared to controls (Grevstad et al., 2013). Interestingly, reductions in biomass occurred even if the *A. iatadori* line did not reproduce well on the plant. Reduced growth of the plant and damage to the meristems appeared to occur as a result of feeding by early instar nymphs before most of the psyllid mortality occurred. A leaf twisting response was observed from the plants that was most pronounced for the Hokkaido line on *F. sachalinensis*. At least some of the nymphs resided inside the twisted leaves, which may provide some protection from predators in the field. Patterns of reproductive success for the two lines on the two hosts were opposite to each other. On *F. sachalinensis*, approximately five times more F_1 adults of the Hokkaido line developed than the Kyushu line. On *F. x bohemica*, five times more of the Kyushu line developed.

Although it is too soon to know if Kyushu and Hokkaido populations of *A. itadori* will be successful, early results suggest high mortality of the nymph stage leading to little or no recovery of the insects in late summer and in the following spring. In the United Kingdom and in Canada where the Kyushu line of *A. itadori* has been repeatedly introduced for many years, permanent establishment has still not been confirmed. So far in the United States, overwintered *A. itadori* adults have been detected at very low numbers (from one to five individuals) at only four of 27 release sites.

B. Issue Permits for Environmental Release of *A. itadori* from Murakami, Japan and Other Equivalent Lines

1. Impact of *A. itadori* from Murakami, Japan on Nontarget Plants

Host specificity of *A. itadori* to Japanese, giant, and Bohemian knotweeds was demonstrated through scientific literature and host specificity testing for the Hokkaido and Kyushu lines of *A. itadori*. The host specificity testing that was conducted for these lines is described in detail in the 2020 *A. itadori* EA (USDA-APHIS, 2020). If the candidate biological control agent 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. In host specificity testing discussed below, the Murakami line was tested on key non-target plant species and was found to have a restricted host specificity profile that is similar to the two approved lines (Hokkaido and Kyushu).

a. **Scientific Literature**

Aphalara itadori is reported as being host specific to *F. japonica* and *F. sachalinensis* (Burckhardt and Lauterer, 1997). As a group worldwide, the genus *Aphalara* is restricted to plants only within the plant family Polygonaceae.

b. Host Specificity Testing

Host specificity tests are tests to determine how many plant species *A. itadori* attacks, and whether nontarget species may be at risk. Host specificity testing was conducted for the Hokkaido and Kyushu lines of *A. itadori*, and also for the Murakami line as described below.

(1) Test Plant List

Test plant lists are developed by researchers for determining the host specificity of biocontrol agents of weeds in North America. Test plant lists are usually developed on the basis of phylogenetic relationships between the target weed and other plant species (Wapshere, 1974). It is generally assumed that plant species more closely related to the target weed species are at greater risk of attack than more distantly related species.

The host specificity test strategy as described by Wapshere (1974) is "a centrifugal phylogenetic testing method which involves exposing to the organism a sequence of plants from those most closely related to the weed species, progressing to successively more and more distantly related plants until the host range has been adequately circumscribed." Researchers do not pursue release of biological control agents that do not demonstrate high host specificity to the target weed.

The Murakami line of *A. itadori* was tested on six non-target plants species that were determined to be possibly at risk based on prior test results (on 71 plant species) of the two Kyushu and Hokkaido lines of *A. itadori* as described in the 2020 *A. itadori* EA (USDA-APHIS, 2020) and the relatedness of those plants to knotweeds. The tested nontarget plant species for the Murakami line of *A. itadori* included *Fallopia convolvulus, Fallopia baldschuanica, Fallopia cilinodis*, *Muehlenbeckia axillaris, Muehlenbeckia complexa,* and *Fagopyrum esculentum.*

Fallopia scandens (native) and *F. dumetorum* (introduced) were not tested because there was no development on these plants by the Kyushu and Hokkaido lines of *A. itadori*.

The reproductive potential of the Murakami line of *A. itadori* on all three target weed species (*F. japonica*, *F. sachalinensis*, and *F.* x *bohemica*) was also assessed using the same methods.

(2) Discussion of Host Specificity Testing

See appendix 1 for a description of host specificity test design.

2. *Performance of the Murakami line on knotweeds*

The Murakami line of *A. itadori* was found to reproduce well on all three knotweed species, but it performed especially well on hybrid knotweed (*F.* x *bohemica*) (table 1 and table 2). The number developing to adulthood was roughly 1.5 times greater on *F.* x *bohemica* than on *F. japonica* and 1.9 times greater than on *F. sachalinensis* (table 2) for plants sampled from European sources. On three *F.* x *bohemica* genotypes sampled from North America, the number of developing adults ranged from 1.8 to 3.5 times that of the number of adults developing on European *F. x bohemica* in the same greenhouse setting (though in a different trial) (table 1). The highest rate of egg laying (oviposition) and development was on the Siuslaw genotype with an average of 661 adults developing per plant.

The impact from the Murakami line of *A. itadori* appeared to be much greater than that from the currently approved Kyushu line. The Murakami line causes a leaf curling and twisting response that is not seen (or is very minor) when the Kyushu psyllid feeds on knotweeds (figure 2). The plant response is similar to that seen in giant knotweed (*F. sachalinensis*) in response to feeding by the Hokkaido line. The tight leaf curls may provide a better microclimate for increased survival of the nymphs to adulthood (figure 2). The shelter may also provide some protection from predators in the field.

Table 1. Number of eggs oviposited and adults developing from those eggs following exposure of five pairs of Murakami line Aphalara itadori to hybrid knotweed genotypes collected from Oregon and New York United States (from Kurose et al., 2021).

Source	N	Eggs	F1 Adults	Late F1 Nymphs	F1 adults + late F1 nymphs	% Survival (adults)	% Survival (adults and nymphs)
Susquehanna River, New York	6	736.0 ± 85.4	346.5 ± 37.5	156.8 ± 28.1	503.3 ± 37.6	50.5 ± 9.2	71.2 ± 6.9
Luckiamute River, Oregon	6	609.3 ± 194.2	451.0 ± 157.7	58.8 ± 12.9	509.8 ± 168.4	68.4 ± 4.9	80.3 ± 5.6

Siuslaw River, Oregon	6	1022.0 ± 301.4	661.5 ± 145.0	80.3 ± 25.3	741.8 ± 167.4	71.6 ± 5.1	79.8 ± 6.0

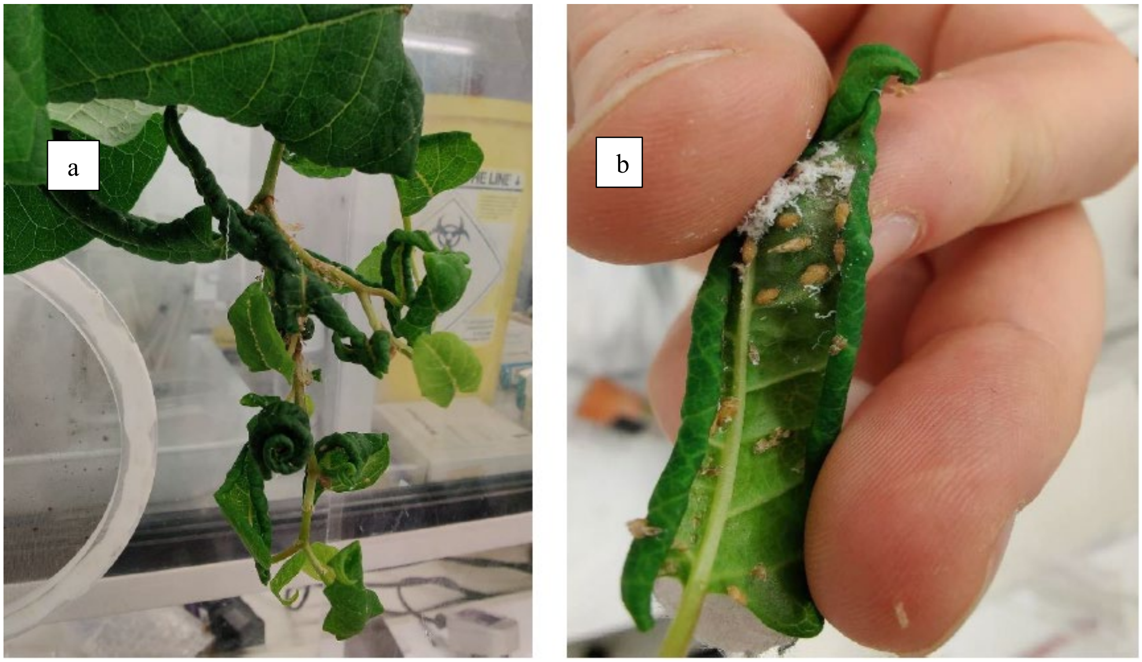

Figure 2. (a) Leaf curling response in hybrid knotweed fed on by Murakami line of *Aphalara itadori*. (b) Curled leaves provide shelter for the developing psyllid nymphs. Photos by D. Kurose, CABI.

Host specificity of the Murakami line

No-choice tests. The Murakami line of *A. itadori* was found to have a similar level of host specificity as the Kyushu and Hokkaido lines (see table 1 and table 2). In no-choice tests carried out by Kurose and Shaw (2020) zero development to the adult stage occurred on the following non-target plants: *Fallopia baldschuanica*, *Fallopia cilinodis*, *Fallopia convolvulus*, and *Fagopyrum esculentum*. There was limited development to the adult stage on the introduced (and sometimes weedy) ornamentals *Muehlenbeckia axillaris* and *M. complexa* similar to what was previously found for the Kyushu and Hokkaido lines. The number of adults developing was a small fraction (1.3 percent for *M. complexa* and 7.8 percent for *M. axillaris*) of the number developing on the primary target weed *F.* x *bohemica*.

Although the Murakami line of *A. itadori* did not develop to adulthood on *F. cilinodis*, some leaf curling was observed in the no-choice tests as a result of partial development of nymphs. The small amount of leaf curling was similar to that observed in the original tests of the Hokkaido psyllid on this plant species. In that original testing a very few nymphs of the Hokkaido line did reach adulthood but follow up studies found no impact on *F. cilinodis* biomass. Psyllid populations are not expected to be sustained on this plant due to the inability to develop to adulthood and because of non-preference by ovipositing females. However, in rare locations where *F. cilinodis* occurs adjacent to a knotweed stand, it is possible that some minor and temporary damage could occur if *A. itadori* attains high densities on knotweeds and "spills over" onto non-preferred plants. Damage will not be sustained because *A. itadori* cannot complete its lifecycle on *F. cilinodis.*

Multiple choice tests. When the Murakami line of *A. itadori* was given a choice between the knotweed host and non-target plants, the non-target plants received one to two order of magnitude fewer eggs (table 3), indicating a strong preference for the target weeds and non-preference for the nontarget species. Similar to the no-choice tests above, development to the adult stage did not occur on *F. cilinodis*, *F. baldschuanica*, or *Fagopyrum esculentum*. It also did not occur from the small number of eggs laid on *M. axillaris* (even though development did occur in the no-choice test). However, a mean of two adults developed per plant on *M. complexa* in these multiple-choice tests (similar to the no-choice test).

In tests offering a choice among the three target weed species, the Murakami line oviposited on all three knotweed species with only a slight preference for *F.* x *bohemica*. These eggs developed well on both *F. sachalinensis* and *F.* x *bohemica*, but development on *F. japonica* was lower (table 3).

Tables 2a-c. No-choice oviposition test results showing the mean numbers of eggs deposited by the Murakami (table 2a), Kyushu (Table 2b), and Hokkaido lines (Table 2c) of *Aphalara itadori* and F1 adults that developed on each test plant species – Data for Murakami line from Kurose et al. (2020) and Kurose and Shaw (2021). Data for Kyushu and Hokkaido psyllids from original host specificity testing as reported in the 2020 *A. itadori* EA (USDA-APHIS, 2020) and in Grevstad et al. (2013).

Murakami *A. itadori*[1]

Target or Non target	Species	N	Eggs	F1 Adults
Target species	*Fallopia japonica* (Oregon, USA)			
Target species	*Fallopia japonica* (U.K.)	18	289.1±31.6	121.1±21.9
Target species	*Fallopia sachalinensis* (Oregon, USA)			
Target species	*Fallopia sachalinensis* (U.K.)	6	160.5±28.4	98.0±27.8
Target species	*Fallopia* x *bohemica* (Oregon and New York, USA)	18	789.1[3]	486.3
Target species	*Fallopia* x *bohemica* (U.K.)	6	229.5±21.0	187.0±30.9
Non-target species	*Fallopia cilinodis* (Canada and New York, USA)	6	20.5±10.8	0.0
Non-target species	*Fallopia baldshuanica* (U.K.)	6	37.2±9.5	0.0
Non-target species	*Fallopia convolvulus* (U.K.)	6	18.8±9.9	0.0
Non-target species	*Muehlenbeckia axillaris* (USA, Germany)	6	33.5±9.2	14.7±3.9
Non-target species	*Muehlenbeckia complexa* (Netherlands)	6	35.7±13.5	2.5±0.9

Table 2b. Kyushu *A. itadori*

Target or Non-Target	Source	N	Eggs	F1 Adults
Target species	*Fallopia japonica* (Oregon, USA)	12	161.9±22.8[2]	73.3±18.8
Target species	*Fallopia japonica* (U.K.)	75	207.1±16.0	NA
Target species	*Fallopia sachalinensis* (Oregon, USA)	6	113.0±20.7[2]	74.0±31.7
Target species	*Fallopia sachalinensis* (U.K.)	18	30.4±7.0	NA
Target species	*Fallopia* x *bohemica* (Oregon and New York, USA)	7	167.6±33.9[2]	86.5±15.1
Target species	*Fallopia* x *bohemica* (U.K.)	12	169.4±41.4	NA
Non-target species	*Fallopia cilinodis* (Canada and New York, USA)	6	19.7±9.0	7.5±7.1
Non-target species	*Fallopia baldshuanica* (U.K.)	15	6.7±2.0[5]	0.0
Non-target species	*Fallopia convolvulus* (U.K.)	6	7.1±3.1[5]	0.0
Non-target species	*Muehlenbeckia axillaris* (USA, Germany)	6	34.8±18.6	3.7±1.7

Table 2c. Hokkaido *A. itadori*[2]

Target or Non-Target	Source	N	Eggs	F1 Adults
Target species	*Fallopia japonica* (Oregon, USA)	**7**	124.7±19.9	1.0±0.6
Target species	*Fallopia sachalinensis* (Oregon, USA)	108, 87[4]	160.3±9.3	76.8±5.8
Target species	*Fallopia* x *bohemica* (Oregon and New York, USA)	18	247.2±34.6	11.6±5.3
Non-target species	*Fallopia cilinodis* (Canada and New York, USA)	8	39.3±14.1	7.0±4.6
Non-target species	*Fallopia baldshuanica* (U.K.)	6	61.0±17.8	0.1±0.1
Non-target species	*Fallopia convolvulus* (U.K.)	6	60.1±27.0	0.0
Non-target species	*Muehlenbeckia axillaris* (USA, Germany)	6	12.0±1.8	5.2±1.5

[1]Tests of Murakami and Kyushu psyllid conducted at CABI U.K., except where otherwise noted.
[2] Tests conducted at Oregon State University
[3] Mean for 3 U.S. genotypes from Table 1.
[4] N=108 for oviposition, N=87 for development to F1 adults
[5] *F. baldshuanica* and *F. convolvulus* were tested by CABI in a multi-choice test with target weed absent

Table 3. Oviposition choice tests using the Murakami line of *Aphalara itadori*. Mean number of eggs deposited per plant when offered a choice between target weed and non-target plants, and the number of adults developing from those plants (from Kurose et al., 2020).

Plant Species	N	Eggs	Adults
Fallopia japonica	18	301.61± 56.08	41.17± 14.11
Fallopia sachalinensis	6	363.33± 87.90	205.50± 74.80
Fallopia x bohemica	6	401.50± 81.70	198.67± 11.53
Fallopia baldschuanica	6	29.17± 11.52	0
Fallopia cilinodis	6	48.50± 41.28	0
Fagopyrum esculentum	6	4.83± 3.69	0
Muehlenbeckia axillaris	3	13.33± 13.33	0
Muehlenbeckia complexa	6	8.50± 7.19	2.00± 1.29

Impacts on target weeds

By ingesting the sap, *A. itadori* reduces the ability of knotweed plants to grow and store energy in roots, making them less competitive against other plant species. *Aphalara itadori* causes twisting and knotting of the leaves, which is particularly pronounced from the population recently collected from Murakami. The leaf twisting can lead to reduced leaf area and a reduced photosynthetic rate, which will in turn lead to further reduction in growth and competitive ability of the plant. Moreover, the tight leaf curls appear to provide protection from predators and from drying out for the developing nymphs allowing them to achieve a higher reproductive rate. In the laboratory, *A. itadori* can easily overcome and kill a potted knotweed plant within one to two generations. The potential for impact on knotweed plants in the field is high, provided the insects are able to build to high densities.

Impacts on non-target plants

Results of host specificity testing indicate that the Murakami line of *A. itadori* is highly host specific to the target knotweeds and poses little, if any, threat to non-target plants in the field. Compared with the two previously approved lines of *A. itadori* (Hokkaido and Kyushu), the Murakami line has a similar restricted host range.

As was the case for the Hokkaido and Kyushu lines, a small risk is present for the ornamental and sometimes weedy genus *Muehlenbeckia* spp. (wirevines), including *Muehlenbeckia axillaris* and *M. complexa*. Development to adulthood occurred on *M. axillaris* at a rate that was approximately 7.8 percent of that on the corresponding knotweed controls. There was no visible damage on this plant in replicates where development occurred. In the field, mortality factors not present in the lab and the tendency of psyllids to disperse away from these non-suitable hosts will make persistence on these plants very unlikely. *Muehlenbeckia* spp. were included in the original test list based on their relatedness to knotweed. However, these non-native plants have no ecological or cultural significance, and they have only minor economic importance as a nursery plant.

Although the Murakami line of *A. itadori* did not develop to adulthood on *Fallopia cilinodis*, some wrinkling and curling of leaves was observed in the no-choice tests that appeared to result from feeding by early-stage nymphs before those nymphs died (Kurose et al., 2020). Though it occurred only on a few leaves, the effect was similar to the leaf curling response seen in the target weed species. There is the possibility that this type of damage could occur in a spillover situation in the field. Any damage would be temporary because the insect is unable to complete development and sustain a population on *F. cilinodis*. Moreover, the insect exhibits non-preference for this plant when offered a choice. In previously conducted no-choice tests designed to measure any impacts from the Hokkaido and Kyushu lines from partial development of nymphs, no effect on plant biomass or plant height was detected. *Fallopia cilinodis* is relatively common and widespread throughout the eastern United States, but is listed as rare (level S3) in the state of New Jersey. It is unknown how often, or whether, this species co-occurs in the same habitat with knotweed. While knotweed is most prevalent in riparian zones and flood plains, the habitat of *F. cilinodis* is described as dry woods, thickets, and clearings (Freeman and Reveal, 2005).

2. Uncertainties Regarding the Environmental Release of the Murakami line of *A. itadori*

Once a biological control agent such as the Murakami line of *A. itadori* is released into the environment and becomes established, there is a slight possibility that it could move from the target plants (invasive knotweeds) 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. itadori*, the resulting effects could be environmental impacts that may not be easily reversed. Biological control agents such as *A. itadori* 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). All classical biological control agents carry at least some risk. The Murakami line of *A. itadori* poses no additional risk over the two *A, itadori* lines that are already approved and introduced into the United States. If it occurs at all, damage to nontarget plant species would likely be minor, temporary, and limited to locations immediately adjacent to knotweed stands because the insect cannot maintain populations on non-targets, with a possible exception in the case of *Muehlenbeckia* spp. (wirevines). *Muehlenbeckia* species are cultivated ornamental plants introduced from New Zealand and Australia with minor economic value. They are known to be weedy where they have naturalized in California. The environmental and economic benefits to be gained by controlling knotweed greatly outweigh any incidental damage that may occur to this plant.

In addition, this agent may not be successful in reducing invasive knotweed 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 invasive knotweeds by the Murakami line or any other line of *A. itadori* will not be known until after release occurs and post-release monitoring has been conducted (see appendix 2 for release protocol and post-release monitoring plan). However, it is expected that the Murakami line of *A. itadori* will reduce the biomass of invasive knotweeds.

4. Impacts on Invasive Knotweeds

Similar to the original permitted populations of *A. itadori* as described in the 2020 *A. itadori* EA (USDA-APHIS, 2020), the Murakami line exhibits very low risk for environmental impact. The gradual reduction of invasive knotweeds may be beneficial as it may allow a gradual return to pre-existing soil chemistry. In addition, erosion may be reduced as native stream bank vegetation returns. *Aphalara itadori* is a plant-feeding insect and poses no risk to wildlife species. Reduction of invasive knotweeds may be beneficial because invasive knotweeds have no known beneficial value to wildlife. Reduction of invasive knotweeds would be beneficial for roads and parking lots as well as to homeowners. Reduction of dense stands of invasive knotweeds that block stream access would be beneficial for boating and fishing and other recreational activities.

5. Impact on Beneficial Uses

The Murakami line of *A. itadori* would reduce (but not eliminate) the presence of invasive knotweeds in the environment; thus, it would still be available for beneficial uses, including honey production and as a source of resveratrol. It may cause damage to ornamental or commercial plantings of invasive knotweeds.

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 invasive knotweeds in invaded areas using available chemical, mechanical, and biological control methods. Release of the Murakami line of *A. itadori* is not expected to have any negative cumulative impacts in the contiguous United States because of its host specificity to invasive knotweeds. Effective biological control of invasive knotweeds 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 Japanese, giant, and Bohemian knotweeds. The release of the Murakami line that may be better adapted to the target are of the United States may increase the effectiveness of the knotweed biological control program and may further reduce the need for chemical and mechanical methods of control.

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.

There are 21 plants that are federally-listed or proposed for listing in the contiguous United States in the family Polygonaceae, the same family as the target weed. These are: cushenbury buckwheat (*Eriogonum ovalifolium* var. *vineum*), Ione buckwheat (*Eriogonum apricum* (incl. var. *prostratum*)), scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*), steamboat buckwheat (*Eriogonum ovalifolium* var. *williamsiae*), Umtanum desert buckwheat (*Eriogonum codium*), cushenbury oxytheca (*Oxytheca parishii* var. *goodmaniana*), sandlace (*Polygonella myriophylla*), Ben Lomond spineflower (*Chorizanthe pungens* var. *hartwegiana*), Howell's spineflower (*Chorizanthe howellii*), Monterey spineflower (*Chorizanthe pungens* var. *pungens*), Orcutt's spineflower (*Chorizanthe orcuttiana*), robust spineflower (*Chorizanthe robusta* var. *robusta*), San Fernando Valley spineflower, (*Chorizanthe parryi* var. *fernandina*), Scotts Valley spineflower (*Chorizanthe robusta* var. *hartwegii*), slender-horned spineflower (*Dodecahema leptoceras*), Sonoma spineflower (*Chorizanthe valida*), clay-loving wild buckwheat (*Eriogonum pelinophilum*), gypsum wild-buckwheat (*Eriogonum gypsophilum*), southern mountain wild-buckwheat (*Eriogonum kennedyi* var. *austromontanum*), Scotts Valley polygonum (*Polygonum hickmanii*) and wireweed (*Polygonella basiramia*). Because of their relatedness to the target weed, these plants could potentially be attacked by *A. itadori.* However, based on host specificity of *A. itadori* reported in testing and in the scientific literature, APHIS has determined that environmental release of *A. itadori* may affect, but is not likely to adversely affect these plant species or their critical habitats.

Japanese knotweeds occur in the habitat of the Jesup's milkvetch (*Astragalus robbinsii* var. *jesupi*), and Virginia spiraea (*Spiraea virginiana*) and compete with them. Therefore, APHIS has determined that release of *A. itadori* may affect beneficially the Jesup's milkvetch, and Virginia spiraea.

A biological assessment was prepared and submitted to the U.S. Fish and Wildlife Service (FWS) and is part of the administrative record for the 2020 *A. itadori* EA (USDA-APHIS, 2020) and this SEA (prepared by T.A. Willard, October 5, 2016). APHIS requested concurrence from the FWS on these determinations and received a concurrence letter dated April 27, 2018.

APHIS reviewed the proposed action to determine if reinitiation of consultation with FWS was necessary. However, no changes in species listings have occurred that would change the consultation outcome. Therefore, APHIS has determined that reinitiation of the consultation for the Murakami line of *A. itadori* is not necessary.

8. Climate Change

Climate change has already affected the northwestern United States where knotweeds are most problematic, and the region has warmed nearly 2°F since 1900. May et al. (2018) indicates that warming is expected to continue in the Northwest and summarized the effects of climate change in the region. Some of these include:

-increase in winter precipitation, as well as year-to-year variability in precipitation;
-years of low precipitation, prolonged drought conditions, and water scarcity;
-increases in extreme weather events;
-reduction in snowpack;
-increased wildfire risk;
-increased risk for insect infestation
-warmer ocean waters leading to altered chemistry, sea level rise, and shifts in marine ecosystems; and
-increased storm surge, large waves, and coastal erosion.

Dupigny-Giroux et al. (2018) summarize the changes expected in the northeastern United States: Precipitation throughout the northeastern United States has been increasing in rainfall intensity, and further increases in rainfall intensity are expected. Seasonal differences in Northeast temperature have decreased in recent years as winters have warmed three times faster than summers and by the middle of the century winters will become even milder with fewer cold extremes (Thibeault and Seth, 2014). This will likely result in a shorter and less pronounced cold season with fewer frost days and a longer transition out of winter. Changes in the Northeast's seasons will continue to affect terrestrial and aquatic ecosystems, forest productivity, agricultural land use, and other resource-based industries.

1) Impact of Climate Change on Proposed Action

Because the Murakami line of *A. itadori* originates from a more northern collection location, compared to the Kyushu line, the Murakami psyllid is likely to be better adapted to the current climate and photoperiod where knotweeds are most abundant in the northwestern and northeastern United States. However, as the climate warms, and particularly as northeastern winters become less severe, it is likely that the colder adapted Murakami line may become less adapted and other lines of *A. itadori* may become more adapted to overwinter in the northwestern and northeastern United States.

2) Impact of Proposed Action on Climate Change

Sources of greenhouse gas emissions as a result of permitting the environmental release of the Murakami line of *A. itadori* would include (1) vehicle use by the permittee and cooperators during biocontrol agent delivery and monitoring in the field, and greenhouse gas releases associated with heating and cooling the greenhouse used during the rearing of *A. itadori*. It is not possible to predict the number of site visits or distance traveled to those sites. Initially, these visits would be expected to be more frequent as *A. itadori* is distributed and monitoring activities are conducted by the permittee and cooperators. Over time, as the agent establishes and spreads on its own, site visits would be expected to decrease. The Oregon State University greenhouse facility where *A, itadori* will be reared would contribute only a small portion of the greenhouse gases produced by the facilities. In addition, if *A. itadori* is successful in reducing invasive knotweed populations, the greenhouse gas emissions from vehicles used to apply herbicides or use mechanical methods to control invasive knotweeds would be reduced or eliminated.

V. Other Issues

A. Equity and Underserved Communities

In Executive Order (EO) 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, each agency must assess whether, and to what extent, its programs and policies perpetuate systemic barriers to opportunities and benefits for people of color and other underserved groups. In EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, Federal agencies must identify and address disproportionately high and adverse human health or environmental impacts of proposed activities.

Consistent with these EOs, APHIS considered the potential for disproportionately high and adverse human health or environmental effects on any minority populations and low-income populations. APHIS did not identify any disproportionately high or adverse environmental or human health effects from the field release of the Murakami line of *A. itadori.* The preferred action will not have disproportionately high or adverse effects to any minority or low-income populations.

Federal agencies also comply with EO 13045, Protection of Children from Environmental Health Risks and Safety Risks. This EO requires each Federal agency, consistent with its mission, to identify and assess environmental health and safety risks that may disproportionately affect children and to ensure its policies, programs, activities, and standards address the potential for disproportionate risks to children. Consistent with EO 13045, APHIS considered the potential for disproportionately high and adverse environmental health and safety risks to children. No aspects of the proposed field release of the Murakami line of *A. itadori* could be identified that would have disproportionate effects on children.

B. Tribal Consultation and Coordination

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 contacted tribes in the affected area and is 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.

APHIS reviewed the proposed action to determine if reinitiation of tribal outreach was necessary. However, no changes in the proposed action have occurred that would result in new impacts to tribes. Therefore, APHIS has determined that reinitiation of tribal notification or consultation for the Murakami line of *A. itadori* is not necessary.

VI. Agencies, Organizations, and Individuals Consulted

The Technical Advisory Group for the Biological Control Agents of Weeds (TAG) recommended the release of the Hokkaido and Kyushu lines of *A. itadori* on October 28, 2013. TAG members that reviewed the release petition (12-08) (Grevstad et al., 2012) included USDA representatives from the National Institute of Food and Agriculture, Animal and Plant Health Inspection Service, and U.S. Forest Service; U.S. Department of Interior's Bureau of Land Management; U.S. Army Corps of Engineers; and representatives from California Department of Agriculture and Agriculture and Agri-Food Canada.

This SEA was prepared by personnel at APHIS, Oregon State University, Agriculture and AgriFood Canada-Lethbridge Research Centre, CABI, University of Washington, and the U.S. Forest Service. The addresses of participating APHIS units, cooperators, and consultants follow.

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

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

Oregon State University
Department of Botany and Plant Pathology
Corvallis, OR 97331

Agriculture and AgriFood Canada-Lethbridge Research Centre,
Lethbridge, AB
T1J 4B1, Canada

Centre for Agriculture and Biosciences International
Bakeham Lane
Egham, Surrey
TW20 9TY, United Kingdom

University of Washington,
Olympic Natural Resources Center
Forks, WA 98331

U.S. Department of Agriculture
Forest Service
Forest Health Technology Enterprise Team
Morgantown, WV

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Appendix 1. Host-specificity testing methods (Grevstad et al., 2021)

Reproductive potential of Murakami psyllids on North American knotweed genotypes

Tests of the reproductive potential of the Murakami line on three North American genotypes of *F.* x *bohemica* were carried by Kurose et al. (2021) at CABI in the United Kingdom. Rhizomes of *F.* x *bohemica* were collected from 3 river systems: The Luckiamute River (Oregon), the Siuslaw River (Oregon), and the Susquehanna River (New York). Previous genetic work (Gaskin et al., 2014) determined that the Luckiamute River and the Siuslaw River are each dominated by a single genotype (spreading clonally) that is different between the two rivers. The Luckiamute genotype also dominates several other river systems in the Pacific Northwest.

The plants were grown from rhizomes in one-gallon pots until ready to test. Ten pairs of psyllids were caged onto each of six individual potted plants of each of the three genotypes for ten days. After the ten days, adults were removed and eggs were counted. The plants were maintained for 48 days and the number of new emerged adults were counted.

Host specificity tests

No-choice tests. The Murakami line of *A. itadori* was tested by Kurose and Shaw (2020) using methods similar to those used for the Kyushu and Hokkaido lines (Grevstad et al., 2013). Oviposition, adult survival, and nymph development were assessed on each plant species by caging psyllids onto individual potted plants. *F. japonica* was used as the positive control in all trials. Plants of the six non-target species and three target weed species were grown in pots in glasshouse until of an appropriate size to test. Ten adults (5 pairs) were enclosed with a fine mesh sleeve onto each of 6 plants of the nontarget plant species and 6 control plants. At the end of seven days, the adults were removed and *A. itadori* eggs on the plant surface were counted. The plants were then covered by ventilated “bread bags” and maintained until any nymphs had sufficient time to develop into adults (48 days), at which time the number of adults were counted.

Multiple-choice test. Oviposition preference of the Murakami psyllid was tested using a caged multiple-choice test in which either three or four plant species, including *F. japonica* (considered the control), were caged with 30 adults for seven days (Kurose and Shaw, 2020). Adults were removed and eggs were counted on each plant at the end of seven days. The plants were then individually caged and maintained for 48 days, sufficient to complete development. At that point, the number of new adults was counted. The test combinations were as follows:

1. *F. japonica* vs. *F. sachalinensis* vs. *F. x bohemia* (6 replicate cages each having one of each species)

2. *F. japonica* vs. *F. baldschuanica* vs. *M. axillaris* vs. *M. complexa* (6 replicate cages, each having one of each species)
3. *F. japonica* vs. *F. cilinodis* vs. *Fag. esculentum* (3 replicate cages, each having two of each species)

Pathogen screening

Some psyllid species are known to carry plant diseases such as *Candidatus Liberibacter* spp. (e.g., causing citrus greening) and *Candidatus Phytoplasma* spp. of group 10 (e.g., apple proliferation disease). However, psyllids in the genus *Aphalara* have never been reported to transmit such diseases. In surveys for pathogens on knotweed carried out in Japan, no insect-vectored diseases were detected (Kurose et al., 2006). As part of the screening of the Murakami population, Kurose and Shaw (2020) used PCR assays to confirm the absence of *Ca. Liberibacter* spp. and phytoplasmas using insects recently collected from the field in Murakami. Both pathogens were absent from the psyllid and plant samples, but were present in positive controls.

Appendix 2. Release Protocol and Post-Release Monitoring Plan for *Aphalara itadori* (Grevstad et al., 2021).

Release Protocol

When permits are obtained, the Murakami line of *A. itadori* will be imported from the Insect Microbial Containment Facility at the Lethbridge Research Centre, in Lethbridge, Alberta, Canada, where rearing cultures are currently maintained free of parasites and disease. The insects will be thoroughly screened just prior to shipping to ensure they are pest-free and that no cryptic species are present. The insects will be screened again and observed for least at least one generation in a greenhouse at Oregon State University before they are released into the field. Voucher specimens of the Murakami line of *A. itadori* have been deposited in the Canadian National Collection in Ottawa. Additional vouchers will be deposited in the Oregon State University Arthropod Collection and the Smithsonian National Museum upon importation.

The permittee will follow release protocols used for the other two lines of *A. itadori* which consist of a combination of sleeved releases and free releases. By putting 30 adults into each of 3 to 6 sleeves per site for one week, we will have a cohort of eggs in a known location that we can follow through development to determine reproductive success compared with the other psyllid lines. In addition, we will make free releases of up to 5,000 psyllids per site.

During the first summer, releases will be made at sites close to Oregon State University, so that observations and experiments can be carried out to determine if the Murakami line has improved performance over the previous released lines. Research sites will include the Luckiamute and Siuslaw Rivers, because the Murakami psyllids have already demonstrated good performance on genotypes of *F.* x *bohemica* collected from these rivers.

Post-Release Monitoring

Initial monitoring will focus on survival of the developing nymphs, adult abundance throughout the season, and adult overwintering survival to the following spring. Monitoring will take place weekly during the first month and then monthly during the growing season after that. Upon each site visit, we will carry out a series of ten 3-minute searches at ten randomly selected point locations throughout the site in order to quantitatively estimate abundance. If no adults are found during this quantitative survey, the permitee will thoroughly search the entire site to determine presence or absence of the psyllids. It is possible that psyllids will not be detected even if present. Periodic monitoring will continue for a few years.

No non-target impacts are expected based on host specificity testing. However, it is important to document that these surveys were carried out, even if no non-target use is found. Non-target monitoring will start following release and will involve searching other plants in the family Polygonaceae that are present within a few hundred yards of the original release site for any signs of use by *A. itadori*. Once the psyllids demonstrate the capacity to establish and begin to expand their populations, we will then begin monitoring for impacts to knotweed plants. The permittee will follow methods described in Grevstad et al. (2018), which involves setting up permanent plots along transects and taking plant measurement at the end of each growing season. Measurements will include plant density, height, basal diameter, and flowering status.

Decision and Finding of No Significant Impact
for
Field Release of the Knotweed Psyllid *Aphalara itadori* (Hemiptera: Psyllidae) from Murakami, Japan for Classical Biological Control of Japanese, Giant, and Bohemian Knotweeds, *Fallopia japonica*, *F. sachalinensis*, and *F.* x *bohemica* (Polygonaceae), in the Contiguous United States.

March 2023

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) is proposing to issue permits for release of the knotweed psyllid, *Aphalara itadori* (Hemiptera: Psyllidae) from a new source location, Murakami, Japan and other source locations. The release of *A. itadori* from Murakami, Japan would be used for the classical biological control of Japanese, giant, and Bohemian knotweeds (*Fallopia japonica*, *F. sachalinensis*, and *F.* x *bohemica* (Polygonaceae)) in the contiguous United States. Before permits are issued for release of *A. itadori* from Murakami, Japan or other source locations, 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 prepared a final environmental assessment (EA) and finding of no significant impact (fonsi) for release of *A. itadori* from Kyushu and Hokkaido, Japan into the contiguous United States and made it available to the public in the Federal Register on November 30, 2020 (2020-26290.pdf (govinfo.gov)). APHIS has prepared a supplemental environmental assessment (SEA) that analyzes the potential environmental consequences of the release of *A. itadori* from a new source location, Murakami, Japan. The 2020 EA and this SEA are available from:

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Permitting and Compliance Coordination
4700 River Road, Unit 133
Riverdale, MD 20737
USDA APHIS | Biocontrol of Non-Federal Weeds Environmental Assessments

The SEA analyzed the following two alternatives in response to a request for a permit authorizing environmental release of *A. itadori* from Murakami, Japan: (1) no action, and (2) issue permits for the environmental release of *A. itadori* for biological control of knotweeds from Murakami, Japan and other source locations. 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 SEA, would likely result in the continued use at the current level of chemical, mechanical, and biological controls for the management of knotweeds. These control methods described are not alternatives for decisions to be made by APHIS, but are presently being used to control knotweeds in the United States and may continue regardless of permit issuance for field release of *A. itadori* from Murakami, Japan. Notice of this SEA was made available in *Federal Register* on February 10, 2023 for a 30-day public comment period. APHIS received nine comments on the EA by the close of that comment period. All comments were in support of the proposed action. One commenter suggested that introductions of *A. itadori* should be carried out gradually with monitoring to ensure that there will not be unexpected effects before wider release, which is the plan for the proposed release, as described in appendix 2.

I have decided to authorize APHIS to issue permits for the environmental release of *A. itadori* from additional sources into the contiguous United States. The reasons for my decision are:

- *Aphalara itadori* from Murakami, Japan is sufficiently host specific and poses little, if any, threat to the biological resources, including non-target plant species, of the contiguous United States and, is sufficiently similar to the original permitted populations of *A. itadori* as described in the 2020 *A. itadori* EA.

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

- *Aphalara itadori* poses no threat to human or wildlife health.

- *Aphalara itadori* is expected to result in benefits to soil, wildlife, property, and recreational opportunities.

- No negative cumulative impacts are expected from release of *A. itadori* from Murakami, Japan.

- There are no disproportionate adverse effects to underserved communities, minorities, low-income populations, or children in accordance with Executive Order (EO) 13985, "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government", EO 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations" and EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks."

- While there is not total assurance that the release of *A. itadori* from Murakami, Japan or additional source locations 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.

/s/ ______________________________ March 29, 2023
David S. Neitch, Acting Director Date
Permitting and Compliance Coordination
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine