United States Department of Agriculture

Weed Risk Assessment for *Senecio vernalis* Waldst. & Kit. (Asteraceae) – Eastern groundsel

United States
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Agriculture

Animal and Plant
Health Inspection
Service

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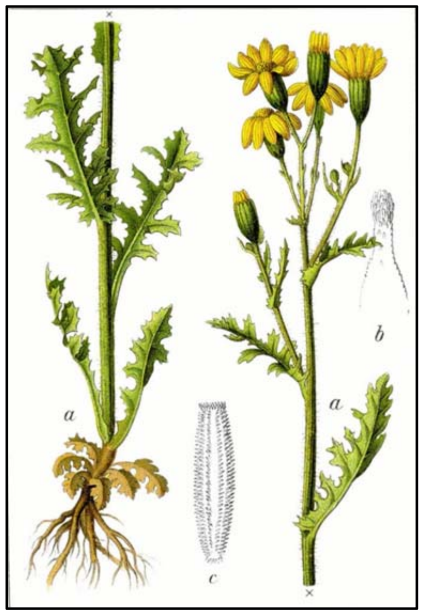

1795 illustration of *S. vernalis* by Johann Georg Sturm from the book *Deutschlands Flora in Abbildungen* (source: https://en.wikipedia.org/).

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Introduction

Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use the PPQ weed risk assessment (WRA) process (PPQ, 2015) to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

The PPQ WRA process includes three analytical components that together describe the risk profile of a plant species (risk potential, uncertainty, and geographic potential; PPQ, 2015). At the core of the process is the predictive risk model that evaluates the baseline invasive/weed potential of a plant species using information related to its ability to establish, spread, and cause harm in natural, anthropogenic, and production systems (Koop et al., 2012). Because the predictive model is geographically and climatically neutral, it can be used to evaluate the risk of any plant species for the entire United States or for any area within it. We then use a stochastic simulation to evaluate how much the uncertainty associated with the risk analysis affects the outcomes from the predictive model. The simulation essentially evaluates what other risk scores might result if any answers in the predictive model might change. Finally, we use Geographic Information System (GIS) overlays to evaluate those areas of the United States that may be suitable for the establishment of the species. For a detailed description of the PPQ WRA process, please refer to the *PPQ Weed Risk Assessment Guidelines* (PPQ, 2015), which is available upon request.

We emphasize that our WRA process is designed to estimate the baseline—or unmitigated—risk associated with a plant species. We use evidence from anywhere in the world and in any type of system (production, anthropogenic, or natural) for the assessment, which makes our process a very broad evaluation. This is appropriate for the types of actions considered by our agency (e.g., Federal regulation). Furthermore, risk assessment and risk management are distinctly different phases of pest risk analysis (e.g., IPPC, 2015). Although we may use evidence about existing or proposed control programs in the assessment, the ease or difficulty of control has no bearing on the risk potential for a species. That information could be considered during the risk management (decision making) process, which is not addressed in this document.

Senecio vernalis **Waldst. & Kit. – Eastern groundsel**

Species Information

Family: Asteraceae

Synonyms: *Senecio leucanthemifolius* subsp. *vernalis* (Waldst. & Kit.) Greuter (NGRP, 2015).

Common names: Eastern groundsel (NGRP, 2015); spring groundsel (Hanf, 1983).

Botanical description: *Senecio vernalis* is an erect, somewhat hairy annual that grows to about 50 cm (Hanf, 1983; Stace, 2010). The lower leaves are petiolate and the upper ones sessile. The ray (i.e., ligulate) flowers are yellow and about 8-10 mm long (Stace, 2010). For a more detailed description refer to Stace (2010).

Initiation: PPQ received a market access request for corn kernels and wheat seed for human and animal consumption from the government of Ukraine (Government of Ukraine, 2013a, 2013b). Commodity import risk analyses associated *S. vernalis* with both of those commodities from the Ukraine. In this WRA, we evaluated the weed risk potential of this species to the United States to help policy makers determine whether it should be regulated as a Federal Noxious Weed.

Foreign distribution: *Senecio vernalis* is native to southern and eastern Europe (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Macedonia, Moldova, Montenegro, Romania, Serbia, and Ukraine) and western and central Asia (Afghanistan, Armenia, Azerbaijan, Cyprus, Georgia, Iran, Iraq, Israel, Jordan, Lebanon, a portion of the Russian Federation, Syria, Turkey, and Turkmenistan) (Kadereit, 1983; NGRP, 2015). It is naturalized in other areas of Europe, including Austria, Belgium, the Czech Republic, Denmark, Estonia, France, Germany, Latvia, Lithuania, the Netherlands, Norway, Poland, Slovakia, Sweden, and the United Kingdom (NGRP, 2015). In the United Kingdom, it is reported as spreading (Stace, 2010). It is a casual alien in Iceland (Wasowicz et al., 2013), Italy (Celesti-Grapow et al., 2009), and Switzerland (NGRP, 2015), and is naturalized in Japan (MotE, 2008).

U.S. distribution and status: Although *S. vernalis* was collected in 1929 in Michigan (Reznicek et al., 2011), it is not currently listed in the U.S. flora (Kartesz, 2015; NGRP, 2015; NRCS, 2015). Furthermore, we found no evidence that it is cultivated in the United States (e.g., Bailey and Bailey, 1930; Bailey and Bailey, 1976; Dave's Garden, 2015; Page and Olds, 2001; Univ. of Minn., 2015) or anywhere in the world. This species is not regulated by any U.S. state (NPB, 2015), nor is it regulated by a foreign government (APHIS, 2015).

WRA area[1]: Entire United States, including territories.

[1] “WRA area” is the area in relation to which the weed risk assessment is conducted [definition modified from that for “PRA area”] (IPPC, 2012).

<u>1. *Senecio vernalis* analysis</u>

Establishment/Spread Potential

Senecio vernalis is a terrestrial, annual, herbaceous species that is strongly self-incompatible (Comes and Kadereit, 1996; Hantsch et al., 2013; Kadereit, 1983). It produces thousands of seeds per plant (Erfmeier et al., 2013; Hanf, 1983) and some populations exhibit seed dormancy (Comes and Kadereit, 1996). Seeds are dispersed by wind (Brandes, 2003; Schmiedel et al., 2014) and in agricultural trade (Clement and Foster, 1994; Dunn, 1905; Kadereit, 1983; Stace, 2010). One or more populations in Israel have developed resistance to five classes of herbicides (Heap, 2015). *Senecio vernalis* has moved beyond its native range in Eurasia to naturalize in other European countries (NGRP, 2015). In fact, during the 1800s and 1900s, it spread rapidly into portions of Europe, and it continues to spread into central, northern, and western Europe (Hanf, 1983; Kadereit, 1983; Meusel and Jäger, 2015; also Ascherson, 1862 cited in Mühlenbach, 1979). Overall, we had average uncertainty with this risk element.

Risk score = 11 Uncertainty index = 0.16

Impact Potential

Senecio vernalis is a disturbance-adapted species that colonizes a variety of anthropogenic and agricultural habitats, such as waste places, roadsides, railways, vacant lots, gardens, row crops, grain fields, and fodder (Brandes, 2003; Dunn, 1905; Hanf, 1983; Hantsch et al., 2013; Kadereit, 1984; Kostov and Pacanoski, 2007; Reed, 1977; Schmiedel et al., 2014; Stevanovič et al., 2007). It is generally recognized as an agricultural weed and is considered to be economically significant and troublesome (Hanf, 1983; Kostov and Pacanoski, 2007). Like other *Senecio* species, it possesses pyrrolizidine alkaloids (Eröksüz et al., 2003), which are toxic to livestock and people (Burrows and Tyrl, 2013). Some evidence indicates that *S. vernalis* reduces yield in winter wheat (Sarpe et al., 2009), and reduces the value of pasture and hay (Petersen, 1999). A few authors report that it is susceptible to soil solarization (e.g., Cohen and Rubin, 2007; Rubin and Abraham, 1983), and particular weed management control strategies (Sarpe et al., 2009). Overall, we had high uncertainty with this risk element due to the lack of detailed species-specific studies.

Risk score = 2.3 Uncertainty index = 0.20

Geographic Potential

Based on three climatic variables, we estimate that about 86 percent of the United States is suitable for the establishment of *S. vernalis* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *S. vernalis* represents the joint distribution of Plant Hardiness Zones 4-12, areas with 0-100 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summers, humid continental cool summers, subarctic, and tundra.

The area of the United States shown to be climatically suitable (Fig. 1) is likely overestimated since our analysis considered only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Senecio vernalis* has been reported to occur in sandy fields, pine plantations, arable fields, rocky slopes, railways, roadsides, fallow land, forest edges, coastal areas, vacant lots, and gardens (Brandes, 2003; Dunn, 1905; Hanf, 1983; Hantsch et al., 2013; Kadereit, 1984; Reed, 1977; Schmiedel et al., 2014).

Entry Potential *Senecio vernalis* is not known to be present in the United States (Kartesz, 2015; NGRP, 2015; NRCS, 2015). The most likely pathway for entry is as a contaminant of seed and possibly grain for processing (Clement and Foster, 1994; Dunn, 1905; Kadereit, 1983; Stace, 2010) and wool (Clement and Foster, 1994). Because this species is not cultivated or positively valued, intentional introduction is unlikely. Our uncertainty was very high for this risk element.

Risk score = 0.09 Uncertainty index = 0.32

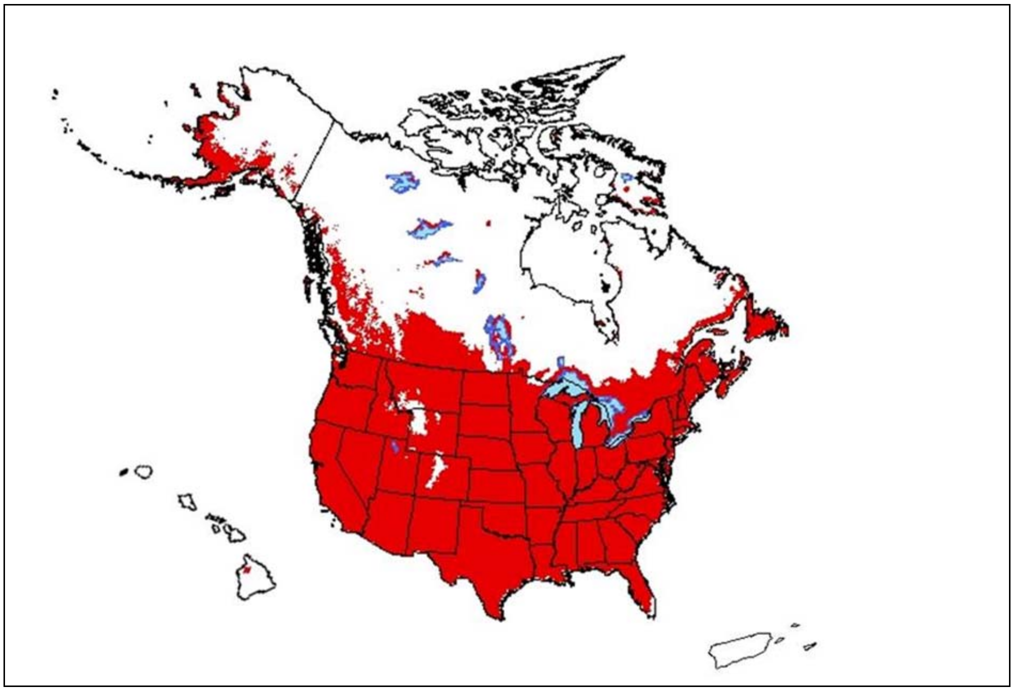

Figure 1. Predicted distribution of *S. vernalis* in the United States. Map insets for Hawaii and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 46.0%
P(Minor Invader) = 50.5%
P(Non-Invader) = 3.4%

Risk Result = High Risk
Secondary Screening = Not Applicable

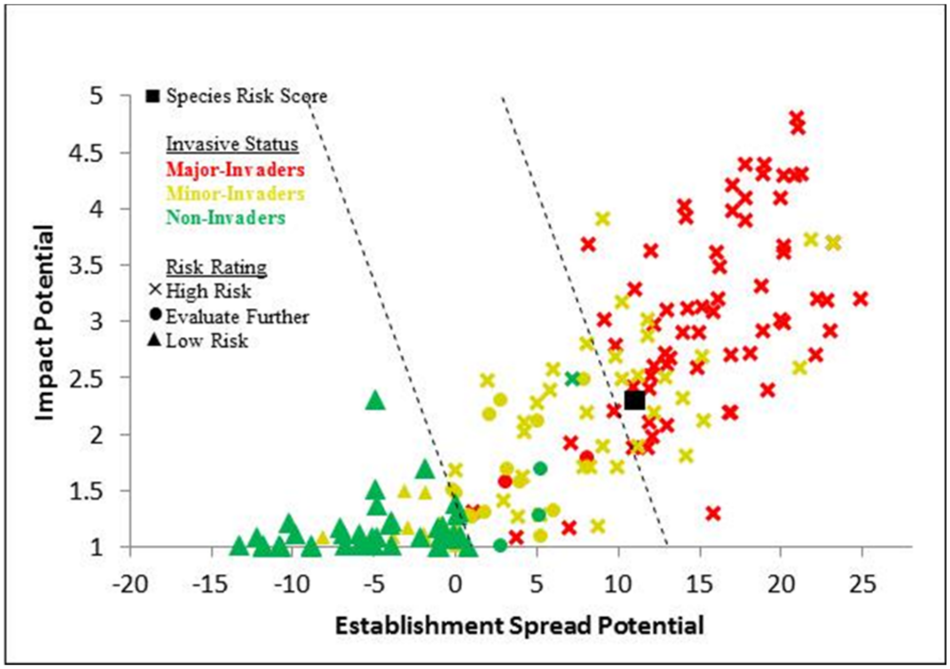

Figure 2. *Senecio vernalis* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

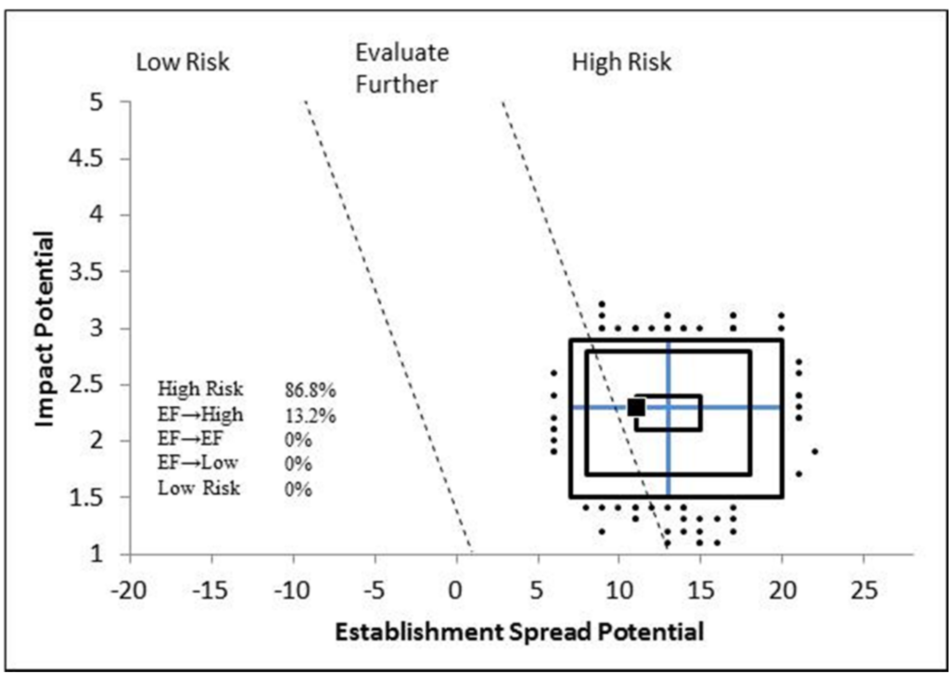

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *S. vernalis*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *S. vernalis* is High Risk (Fig. 2). Our uncertainty analysis supports our main result of high risk since every simulated outcome resulted in a high risk rating, and almost 87 percent directly resulted in high risk ratings (i.e., no secondary screening needed) (Fig. 3).

Senecio vernalis has been spreading in Europe since the 1850s and has been appearing in different habitats recently (Hantsch et al., 2013). High genetic and phenotypic variability has probably contributed to its spread (Comes and Kadereit, 1996; Hantsch et al., 2013). The ecotype that is invading central Europe is different from that in native populations in Israel (Hantsch et al., 2013) suggesting that it may have adapted to climatic conditions in central Europe (Comes and Kadereit, 1996). *Senecio vernalis* (2n=20) is very likely the diploid ancestor of the autotetraploid *S. vulgaris* (2n=40) (Comes, 1994; Kadereit, 1984), which is an invasive and problematic weed in the United States (Burrows and Tyrl, 2013; Holm et al., 1997; Kartesz, 2015; Nelson et al., 2007; NRCS, 2015).

Plants in the genus *Senecio*, including *S. vernalis*, produce pyrrolizidine alkaloids, which cause liver damage in livestock and humans when these compounds are ingested (Cristina Şeremet et al., 2013; Eröksüz et al., 2003; Eröksüz et al., 2008; Kempf et al., 2010; Petzinger, 2011). Human intoxication by *Senecio* species is possible, and often occurs when plant parts are harvested either intentionally or unintentionally for use in herbal teas (Burrows and Tyrl, 2013). We note that *S. vernalis* is a weed of chamomile (Stevanovič et al., 2007) and may be inadvertently harvested with it. For additional information on the toxic nature of these compounds in the genus *Senecio*, please refer to the evidence in question Imp-P5 in Appendix A.

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Appendix A. Weed risk assessment for *Senecio vernalis* Waldst. & Kit (Asteraceae). Below is all of the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file, where this assessment was conducted, is available upon request.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	f - negl	5	*Senecio vernalis* is native to southern and eastern Europe, and western and central Asia (NGRP, 2015). It is a casual alien in Finland (Kurtto and Lahti, 1987), Iceland (Wasowicz et al., 2013), Italy (Celesti-Grapow et al., 2009), and Switzerland (NGRP, 2015). It was introduced to central Europe by people (Comes and Kadereit, 1996) and is currently considered to be naturalized in Austria, Belgium, the Czech Republic, Denmark, Estonia, France, Germany, Latvia, Lithuania, the Netherlands, Norway, Poland, Slovakia, Sweden, and the United Kingdom (NGRP, 2015; Pyšek et al., 2002; Verloove, 2006). It is also naturalized in Japan (Mito and Uesugi, 2004). In the United Kingdom, it is reported as spreading (Stace, 2010). During the 1800s and 1900s, it spread rapidly into Europe, and it continues to spread into central, northern, and western Europe (Hanf, 1983; Kadereit, 1983; Meusel and Jäger, 2015; also Ascherson, 1862 cited in Mühlenbach, 1979). Alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - negl	0	We found no evidence that this species has been domesticated or intentionally selected for reduced weed potential. It was reported to be cultivated in Britain in 1803 (BSBI, 2016), but because we found no evidence that it is currently cultivated as an ornamental, we used negligible uncertainty.
ES-3 (Weedy congeners)	y - negl	1	The genus *Senecio* includes about 1000 species of plants (Mabberley, 2008), and dozens of them have been identified as weedy (Randall, 2012). The following species can probably be considered to be significant weeds based upon the number of weed reports in a global survey of weed species: *Senecio cineraria*, *S. elegans*, *S. glastifolius*, *S. jacobaea*, *S. inaequidens*, *S. madagascariensis*, *S. mikanioides*, *S. pterophorus*, *S. squalidus*, *S. sylvaticus*, *S. viscosus*, and *S. vulgaris* (Holm et al., 1979; Randall, 2012). Some *Senecio* species reduce crop yield (e.g., *S. vulgaris*, CABI, 2016; Frantzen, 2000), others affect pasture productivity and are poisonous to livestock (e.g., *S. madagascariensis*, Burrows and Tyrl, 2013), while others affect native plant communities (e.g., *S. elegans*, Weber, 2003).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	*Senecio vernalis* occurs in sandy fields, pine plantations, arable fields, rocky slopes, railways, roadsides, fallow land, forest edges, coastal areas, vacant lots, and gardens

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(Brandes, 2003; Dunn, 1905; Hantsch et al., 2013; Kadereit, 1984 Hanf, 1983 #8353; Reed, 1977; Schmiedel et al., 2014). This range of habitats indicates it prefers open and sunny habitats and perhaps partially sunny ones (e.g., pine plantations), and suggests that it may not be well adapted to particularly shady environments. However, we found one report that it is shade loving (Greuter, 1979). Given the preponderance of the evidence for open and sunny habitats, we answered no, but with moderate uncertainty.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - low	0	*Senecio vernalis* is an erect, somewhat hairy annual that grows to about 50 cm (Hanf, 1983; Stace, 2010). It is not a vine. Furthermore, we found no evidence that it forms a basal rosette of tightly appressed leaves.
ES-6 (Forms dense thickets, patches, or populations)	n - mod	0	We found no evidence.
ES-7 (Aquatic)	n - negl	0	*Senecio vernalis* is a terrestrial herb growing in a wide range of non-aquatic habitats (e.g., Hantsch et al., 2013; Reed, 1977; Schmiedel et al., 2014).
ES-8 (Grass)	n - negl	0	It is not a grass; rather it is an herb in the Asteraceae family (NGRP, 2015).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Furthermore, it is not in a plant family that is known to contain nitrogen-fixing species (Martin and Dowd, 1990; Santi et al., 2013), and it is not a woody plant.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	This species reproduces through seed production (Comes, 1994; Hanf, 1983).
ES-11 (Self-compatible or apomictic)	n - low	-1	It has a strong outbreeding system and is strongly self-incompatible (Comes and Kadereit, 1996; Hantsch et al., 2013). An obligate outcrosser (Comes and Abbott, 1999). One plant was found in Israel that was self-compatible and strongly self-pollinating; however, its progeny exhibited signs of inbreeding depression (Comes, 1994). Although technically the species is self-compatible, because this is very rare (only one documented individual) and because selfed progeny exhibit inbreeding depression (Comes, 1994), we answered no with low uncertainty.
ES-12 (Requires specialist pollinators)	n - low	0	We found no evidence that this species requires specialist pollinators. *Senecio vernalis* is primarily and strongly outcrossing (Comes and Abbott, 1999). It is reported to be pollinated by insects (Hantsch et al., 2013) and has flowers with well-developed ray florets (Stace, 2010), which help to attract pollinators (Kadereit, 1984). Honeybees fed from this species in a feeding experiment (Reinhard et al., 2009). The genus *Senecio* is pollinated by generalist pollinators such as bees and butterflies (Schmitt, 1980).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - negl	1	*Senecio vernalis* is an annual (Hantsch et al., 2013; Kadereit, 1983). In central Europe, it behaves mostly as a winter annual (Comes and Kadereit, 1996), while in Israel it is a spring annual (Comes, 1994). Because we found no other information indicating lower or higher generation times, our alternate answers for the Monte Carlo simulation were "c" and "a."
ES-14 (Prolific reproduction)	y - high	1	We did not find enough information to properly estimate seed production rates per square meter quantitatively. However, this species is reported to produce several thousand seeds per plant (Hanf, 1983), which has likely contributed to its invasive ability in Europe (Hantsch et al., 2013). "As a ruderal species of the Asteraceae, *S. vernalis* is characterized by the release of large amounts of achenes per individual … and therefore able of exerting high propagule pressure" (Erfmeier et al., 2013). Based on this qualitative evidence, we believe that this species likely meets our threshold of 5000 seeds per square meter, so we answered yes with high uncertainty. Other evidence: About 100 seeds per capitulum (Hantsch et al., 2013). In one study, the species occurred at about 1.7 plants per square meter (Hantsch et al., 2013). Occurs at densities ranging from 0.1 to 1 plant per square meter in olive groves (Rubin and Abraham, 1983).
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	We found no evidence that it is dispersed unintentionally by people. However, because it is a well-known agricultural weed (see evidence under Imp-P6), it seems likely that it would be dispersed by farming and other agricultural activities. Consequently, we answered unknown.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	A contaminant of grass seed and possibly wool (Clement and Foster, 1994; Stace, 2010). Most often seen in newly seeded roadside verges (Kadereit, 1983). "It has been noticed many times in connection with grain introduction in England" (Dunn, 1905). "Initially, the species seems to have been dispersed naturally by wind into the eastern Baltic region and Poland, but then increasingly profited from being unintentionally admixed to clover and grass seed" (Hantsch et al., 2013).
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed traits for questions ES-17a through ES-17e: Seeds (achenes) are 2-3 mm long, appressed hairy, pedunculate, and the pappus is white, silky, shiny, approximately 5-6 mm long (Hanf, 1983; Reed, 1977). Pappus seen only on immature achenes (Reed, 1977), but a study examining variation in seed traits reported that they removed the pappus from collected seeds (Hantsch et al., 2013).
ES-17a (Wind dispersal)	y - negl		Wind-dispersed (Brandes, 2003; Schmiedel et al., 2014). "[T]he high propagule production of small and light pappus-bearing achenes facilitates long-distance dispersal" (Hantsch et al., 2013). Adapted for long-distance dispersal with pappus-bearing fruit (Comes and

Question ID	Answer - Uncertainty	Score	Notes (and references)
			Abbott, 1999).
ES-17b (Water dispersal)	n - mod		We found no direct evidence.
ES-17c (Bird dispersal)	n - mod		We found no direct evidence.
ES-17d (Animal external dispersal)	? - max		Possibly attaches to wool (Clement and Foster, 1994).
ES-17e (Animal internal dispersal)	n - mod		We found no direct evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	It "is polymorphic for seed dormancy, which is regulated by a recessive allele of a single gene" (Comes and Kadereit, 1996). Some populations exhibit seed dormancy (Comes, 1994). Because it is not clear from this evidence that seeds can persist for more than a year in the soil, we answered this question as unknown.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - mod	-1	This species is reported to occur in an Iranian habitat after it was burned (Bakhtar et al., 2013), and to colonize habitats after fire in Turkey (Türkmen and Düzenli, 2011). However, we found no specific evidence that this species tolerates or benefits from mutilation or fire, or is likely to tolerate or benefit from such effects beyond most other species.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	y - low	1	One or more populations in Israel have developed resistance to five classes of herbicides (Heap, 2015). Note that *S. vernalis* has been reported to hybridize with *S. vulgaris*, which is also resistant to herbicides (Heap, 2015) to produce *S.* x *helwingii* Beger ex Hegl (*S.* x *pseudovernalis* Zabel, nom. Invalid.).
ES-21 (Number of cold hardiness zones suitable for its survival)	9	0	
ES-22 (Number of climate types suitable for its survival)	9	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence that this species is allelopathic. One study that examined the phytotoxic effects of extracts from various weed species on several crop species found no significant effect by *S. vernalis* (Obaid and Qasem, 2005).
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that this species is parasitic. Furthermore, it is not a member of a plant family known to contain parasitic plant species (Heide-Jorgensen, 2008; Nickrent, 2009; Walker, 2014).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence of any impacts in natural systems. Because this species isn't even reported as a weed of natural areas, we used low uncertainty for all questions in this subelement.
Imp-N2 (Changes habitat structure)	n - low	0	We found no evidence.
Imp-N3 (Changes species diversity)	n - low	0	We found no evidence.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - low	0	We found no evidence.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - low	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	a - mod	0	This species was listed in the Lithuanian Invasive Species Database in 2009 (Gudzinskas, 2009) where an invasive species was defined as “"an introduced … species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity”; however, this database is no longer available online. Because we found no other evidence that it is considered a weed in natural systems or even naturalizes in such systems we answered “a” with moderate uncertainty. Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - low	0	We found no evidence. Because it seems unlikely that an herbaceous aster without thorns would have such impacts, we used low uncertainty.
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	We found no evidence.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - mod	0	We found no evidence.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - high	0	*Senecio vernalis* is a disturbance-adapted species that colonizes a variety of anthropogenic habitats such as waste places, roadsides, railways, vacant lots, and gardens (Brandes, 2003; Dunn, 1905; Hanf, 1983; Hantsch et al., 2013; Kadereit, 1984; Reed, 1977; Schmiedel et al., 2014). However, we didn't find strong evidence that it is considered a weed of these types of systems. It was described generally as an economically important weed (Reed, 1977), and in Serbia was considered a weed in either anthropogenic or production systems (Nestorovic and Konstantinovic, 2011) but it is not clear which system(s) those sources were referencing. We think those sources were likely describing its status in production systems, so we answered "a" with high uncertainty. The alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - high	0.4	*Senecio vernalis* and 7 other dominant weeds of winter wheat in Romania reduced wheat yield by about 14 percent (Sarpe et al., 2009). We answered yes, but with high uncertainty because it is not clear how much of the yield reduction was due to interference by *S. vernalis*.
Imp-P2 (Lowers commodity value)	y - high	0.2	An action plan for the control of *S. vernalis* and *S. jacobaea* in Denmark stated that the calculated limit of *S. vernalis* in pastures was 3,700 plants per hectare, or 0.37 plants per square meter (Petersen, 1999). Thus, above that density *S. vernalis* probably can decrease the value of hay and silage. Because this is indirect evidence, we used high uncertainty.
Imp-P3 (Is it likely to impact trade?)	n - high	0	While some evidence exists that this species moves or can move in trade (see evidence under ES-16), we found no evidence that it is regulated by any foreign countries (e.g., APHIS, 2015) or a U.S. state (USDA-AMS, 2014).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - mod	0.1	Plants in the genus *Senecio*, including *S. vernalis*, produce pyrrolizidine alkaloids, which cause liver damage in livestock and humans (Cristina Şeremet et al., 2013; Eröksüz et al., 2003; Eröksüz et al., 2008; Kempf et al., 2010; Petzinger, 2011). For example, in one case feeding on hay contaminated with *S. vernalis* was believed to have caused staggering in German horses and abnormally large liver cells (Kohler, 1950). Because of its known toxicity to humans, there has been some research on the impact of these compounds on poultry, cattle, and bees, and whether the compounds persisted in the resulting animal products (e.g., Eröksüz et al., 2003; Eröksüz et al., 2008; Kempf et al., 2010; Reinhard et al., 2009; Skaanild et al., 2001). Because pyrrolizidine alkaloids are well known to be toxic (Burrows and Tyrl, 2013) and are present in *S. vernalis* (Hartmann and Zimmer, 1986), we answered yes. However, because it is not clear whether invasion by *S. vernalis* would significantly increase animal and human exposure to these toxic compounds, we used moderate uncertainty. Intoxication due to these types of alkaloids in the genus *Senecio* depends greatly on the palatability of the species, abundance of plants, and availability of other types of forage (Burrows and Tyrl, 2013). Of the various *Senecio* species in North America, *S. flaccidus*, *S. riddellii*, *S. vulgaris*, and *S. jacobaea* pose the most distinct threats to livestock (Burrows and Tyrl, 2013).
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - low	0.6	*Senecio vernalis* is one of 118 weeds of significant economic importance in the Republic of Macedonia, specifically in fodder crops and small grains (Kostov and Pacanoski, 2007). It is a troublesome weed in asparagus and other vegetables (Hanf, 1983) and is a weed of chamomile (Stevanovič et al., 2007). It is a dominant weed in winter wheat in Romania (Sarpe et al., 2009). It is also a weed in olive and citrus groves in Turkey (Koloren and Uygur, 2007; Rubin and Abraham, 1983). It is reported to be a weed in Serbia (Nestorovic and Konstantinovic, 2011). It is reported to be susceptible to soil solarization (Cohen and Rubin, 2007; Rubin and Abraham, 1983). One study in Romania examined how well a certain herbicide and cultivation method controlled *S. vernalis* and seven other dominant weeds of wheat (Sarpe et al., 2009). A Danish official developed an action plan to specifically control *S. vernalis* and *S. jacobaea* in pastures (Petersen, 1999). We found additional, although limited, evidence of control studies in citrus nurseries (Kadioglu et al., 1996) and carrot crops (Ohaly and Zehavi, 1982). Alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained

Question ID	Answer - Uncertainty	Score	Notes (and references)
			from the Global Biodiversity Information Facility (GBIF, 2015).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z3 (Zone 3)	n - high	N/A	We found no evidence that it occurs in this hardiness zone, but there are a few points near this zone in Finland.
Geo-Z4 (Zone 4)	y - negl	N/A	Finland. A few points in Austria and Armenia.
Geo-Z5 (Zone 5)	y - negl	N/A	Numerous points in Finland and Norway. Two points in Germany and Switzerland.
Geo-Z6 (Zone 6)	y - negl	N/A	Germany and Norway. A few points in Finland and Poland.
Geo-Z7 (Zone 7)	y - negl	N/A	Austria, Germany, and Sweden.
Geo-Z8 (Zone 8)	y - negl	N/A	France, Germany, and Sweden.
Geo-Z9 (Zone 9)	y - negl	N/A	Denmark, Sweden, and the United Kingdom.
Geo-Z10 (Zone 10)	y - negl	N/A	Israel. A few points in Greece. Regional occurrence in Cyprus.
Geo-Z11 (Zone 11)	y - negl	N/A	Israel. A few points in Greece. Regional occurrence in Cyprus.
Geo-Z12 (Zone 12)	y - high	N/A	Many points along Israel's coast, where there is a very thin strip of this zone.
Geo-Z13 (Zone 13)	n - low	N/A	One point in Ecuador, but this is likely to be a misidentification or a casual occurrence.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Numerous points in Israel. Two points in Greece. Occurs in steppe environments (Comes, 1994).
Geo-C4 (Desert)	y - mod	N/A	Two points in Israel. One point in Iran. Using moderate uncertainty since there is some evidence it occurs in the 0-10 inch precipitation class.
Geo-C5 (Mediterranean)	y - negl	N/A	Greece. One point each in Lebanon and Spain. Regional occurrence in Turkey (Meusel and Jäger, 2015). Occurs in Mediterranean habitats (Comes, 1994).
Geo-C6 (Humid subtropical)	y - low	N/A	Some points in Greece. Regional occurrence in the Black Sea (Meusel and Jäger, 2015) and in Italy (Celesti-Grapow et al., 2010).
Geo-C7 (Marine west coast)	y - negl	N/A	France, Germany, and the United Kingdom.
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	A few points in Armenia. Regional occurrence in Russia (Meusel and Jäger, 2015).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Austria, Germany, and Sweden.
Geo-C10 (Subarctic)	y - negl	N/A	Several points in Finland, Norway, and Sweden. General distribution in Scandinavia (Meusel and Jäger, 2015).
Geo-C11 (Tundra)	y - high	N/A	One point each in Austria, Bulgaria, Iceland, and Norway. A few points in the German Alps. We used high uncertainty because of potential mapping

Question ID	Answer - Uncertainty	Score	Notes (and references)
			inaccuracies in areas with steep elevation gradients.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	A few points in Armenia and many in Israel. Sampled from one place where rainfall varies between 20 to 30 cm per year (Comes and Abbott, 1999)
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	A few points in Armenia. One point in Iran. Many points in Israel. Sampled from areas in the mesic Mediterranean part of Israel where rainfall varies between 40 and 120 cm per year, except for one place where rainfall varies between 20 to 30 cm per year (Comes and Abbott, 1999).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Belgium, Germany, and Sweden. Sampled from areas in the mesic Mediterranean part of Israel where rainfall varies between 40 and 120 cm per year, except for one place where rainfall varies between 20 to 30 cm per year (Comes and Abbott, 1999)
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Belgium, Germany, and the United Kingdom. Sampled from areas in the mesic Mediterranean part of Israel where rainfall varies between 40 and 120 cm per year, except for one place where rainfall varies between 20 to 30 cm per year (Comes and Abbott, 1999)
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Germany. Sampled from areas in the mesic Mediterranean part of Israel where rainfall varies between 40 and 120 cm per year, except for one place where rainfall varies between 20 to 30 cm per year (Comes and Abbott, 1999)
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Austria and Germany.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Austria and Germany.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Austria and Germany.
Geo-R9 (80-90 inches; 203-229 cm)	y - low	N/A	A few points in Germany and Norway. One point in Austria.
Geo-R10 (90-100 inches; 229-254 cm)	y - high	N/A	A few points in Norway.
Geo-R11 (100+ inches; 254+ cm)	n - high	N/A	One point in Georgia.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - low	0	Although *Senecio vernalis* was collected in 1929 in Michigan (Reznicek et al., 2011), it is not currently known to be present in the U.S. (Kartesz, 2015; NGRP, 2015; NRCS, 2015).
Ent-2 (Plant proposed for entry, or entry is imminent)	n - low	0	Imminent entry is highly unlikely since it has not been proposed for introduction.
Ent-3 (Human value & cultivation/trade status)	a - high	0	We found no evidence that this species is currently cultivated anywhere in the world, is harvested from the wild, or is positively valued by people in general. However, we used high uncertainty because it was cultivated in Britain in 1803 (BSBI, 2016).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - low		We found no evidence that it is present in any of these areas. This species is generally distributed throughout Europe and the Middle East (Kadereit, 1983; Meusel and Jäger, 2015; NGRP, 2015).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence.
Ent-4c (Contaminant of seeds for planting)	y - negl	0.04	A contaminant of grass seed (Clement and Foster, 1994; Stace, 2010). Most often seen in newly seeded roadside verges (Kadereit, 1983). "It has been noticed many times in connection with grain introduction in England" (Dunn, 1905). This species is a well-known agricultural weed of vegetables and grains (e.g., Hanf, 1983; Kostov and Pacanoski, 2007, but also see evidence under Imp-P6).
Ent-4d (Contaminant of ballast water)	n - mod	0	We found no evidence.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - mod	0	We found no evidence.
Ent-4f (Contaminant of landscape products)	? - max		Although we found no specific evidence for this, because it is a known weed of fodder and small grains, it could be imported as a contaminant of straw.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	We found no evidence.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	y - high	0.1	"It has been noticed many times in connection with grain introduction in England" (Dunn, 1905). Although this reference is old, and harvesting and cleaning technologies have changed greatly in the last 100 years, not all countries or farming operations may be using modern technologies. Consequently, we answered yes but with high uncertainty.
Ent-4i (Contaminant of some other pathway)	e - high	0.4	A possible contaminant of wool (Clement and Foster, 1994). Dried plants were found in hay fed to horses when they became sick (Kohler, 1950). We assigned the maximum score possible for this question because whether or not seeds can pass unharmed through animals, not all contaminating seeds seem likely to be consumed during feeding.
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	Because it is not present in a neighboring region (NGRP, 2015), this pathway is very unlikely.